Contaminant Residues in Young-of-Year Fish from Near-shore Sampling Areas in the New York State's Great Lakes Basin, 2018

Kristen Dieterle
Wayne Richter*

Bureau of Ecosystem Health
Division of Fish and Wildlife
New York State Department of Environmental Conservation
Albany, NY 12833

* Corresponding author

A report in partial fulfillment of the grant
Contaminants in New York Great Lakes Young-of-Year (YOY) Fish
GL-00E02358 from the United State Environmental Protection Agency

January 2023

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

ABSTRACT

During September and October of 2018, composites of young-of-year (YOY) fish were collected by the New York State Department of Environmental Conservation (NYSDEC) from 55 near-shore locations in New York's Great Lakes basin. Samples were collected as part of a continuing contaminant monitoring program that began in the 1980s. A total of 392 composite YOY fish samples were analyzed for polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), and mercury. A subset of these samples was analyzed for per- and polyfluoroalkyl substances (PFAS). We analyzed smaller subsets of the fish from the Niagara River area for polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) and from Lake Ontario for polybrominated diphenyl ethers (PBDEs).

Every sample had a detectable concentration of mercury, although all concentrations were low and well below risk thresholds for humans or piscivorous wildlife. Nonetheless, fish from sites at Gill Creek and tributaries draining the Adirondacks had higher concentrations than elsewhere. The highest sample concentration was 0.126 ppm, and 90% of samples were less than 0.046 ppm.

We detected PCBs in 345 of 392 samples. Most concentrations were relatively low, with a median value of 0.117 ppm. However, some locations had notably high concentrations, particularly from Eighteenmile Creek and several locations on the St. Lawrence River that were over 2 ppm. The elevated concentrations at these sites, as well as at Twomile Creek and Cayuga Creek, suggest continued bioavailability of local sources of PCBs. Concentrations at these locations exceeded criteria to protect piscivorous wildlife and New York State Department of Health guideline values for fish consumption advisories.

DDT and metabolites were the only organochlorine pesticides that were frequently detected, and were found in 63% of the 392 samples. Nearly all concentrations were very low, and below risk thresholds. Mirex, a contaminant of long-term concern in Cayuga Creek and downstream, was detected commonly at multiple locations near the Niagara River including Cayuga Creek and its tributaries, Gill Creek, and the Little River near the mouth of Cayuga Creek, but was detected in only one other sample elsewhere. Concentrations were generally low, although any detections still exceed the 1987 International Joint Commission objective to be below detection. Other OCPs were infrequently detected and only at low concentrations.

We found detectable concentrations of PFAS in all but 1 of 277 samples and found PFOS in all but three of the samples. PFOS was the dominant PFAS in both frequency of detection and concentration, particularly at higher overall concentrations. The highest mean PFOS concentration, 237 ppb, came from Cayuga Creek just downstream from the Niagara Falls International Airport. Locations further downstream also had high concentrations. The St. Lawrence River at Dead Clam Cove also had concentrations exceeding the 50 ppb NYSDOH guideline value for a specific advisory. Concentrations at other locations were generally below the NYSDOH guideline value. Lake Ontario concentrations, downstream from Cayuga Creek and the Niagara River, were higher than in Lake Erie or the streams draining the Adirondacks.

Median mammalian PCDD/F toxic equivalency (TEQ) was between 1.5 ppt and 5.6 ppt in the Cayuga Creek system, and was 10.4 ppt at the Little River upstream of Cayuga Creek, but was 1 ppt or less in the other Niagara River stations upstream of Cayuga Creek. While we found limited exceedance of NYSDOH human consumption guideline values, many mean TEQs, primarily from sites associated with Cayuga Creek, exceeded criteria for the protection of fish consuming wildlife.

PBDE site means ranged from 984 ppt to 9,450 ppt, with a maximum sample concentration of 13,088 ppt. The highest concentrations were from Eighteenmile Creek. Concentrations exceeded Canadian guidelines

for fish tissue and wildlife for a small number of homolog or BDE comparisons, with nine of 12 exceedances coming from Eighteenmile Creek.

YOY fish in or near three of New York State's areas of concern (AOCs) had contaminant concentrations with the potential to pose risks to human or wildlife consumers of the fish. PCBs, PFOS, and PCDD/Fs were all elevated at waters associated with Cayuga Creek and at least some of these contaminants were elevated at other Niagara area waters. Mirex also continued to be detected at many of these Niagara sites. PCBs were highly elevated at several sites in the St. Lawrence River at Massena/Akwesasne AOC; a few sites there also had elevated PFAS concentrations. Both Eighteenmile Creek sites, one below the Burt Dam within the AOC and the other upstream of the dam and the AOC, had highly elevated PCB concentrations above 2 ppm, and the upstream location also had considerably higher PBDE concentrations than elsewhere in Lake Ontario. Comparisons with the same species-site combinations from our previous 2009–2012 study found little directional change in the concentrations of PCBs or the prevalent OCPs. These results point to the need for additional remediation, some of which is already taking place, in these areas in order to reduce undue risks to wildlife and people who might eat fish. In contrast, fish concentrations from the Buffalo River and Rochester Embayment AOCs were generally below risk thresholds.

INTRODUCTION

The New York State Department of Environmental Conservation (NYSDEC) and its northern counterpart, the Ontario Ministry of the Environment, Conservation and Parks (OMECP) have used young-of-year (YOY) fish for monitoring persistent organic contaminants in the Great Lakes basin dating back into the 1970s (Preddice et al. 1998, 2002, 2006, 2011; Skinner and Jackling et al. 1989; Skinner et al. 1994; Paul et al. 2018; Suns et al. 1978, 1983, 1985, 1993). NYSDEC has continued this monitoring on a five to ten-year cycle.

Young-of-year fish are important food items for larger fish as well as many piscivorous birds, reptiles, and mammals. They function as an important pathway, moving contaminants up the food chain to higher trophic levels. These fish are excellent bio-monitors because they are ubiquitous, relatively abundant, are localized near shore in calm waters, and have a limited exposure period of only four to six months when sampled in the fall in New York State. During this short period, they can bioaccumulate contaminants of concern. For these reasons YOY fish are effective in monitoring long-term changes in environmental contaminants, for finding localized contamination, and determining the efficacy of cleanup efforts at specific hazardous waste sites. Sampling YOY fish at multiple locations can provide a detailed mapping of areas with elevated concentrations, suggesting areas that need additional investigation.

Our long-term monitoring has been most consistent for polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs). These legacy contaminants continue to be a problem, and are the impetus for fish consumption advisories (NYSDOH 2022a) in New York's Great Lakes waters. Monitoring these contaminants in YOY fish provides a consistent, long-term record of their environmental status. Although concentrations of mercury, another legacy contaminant, in YOY fish tend not to reach concentrations of concern, spatial differences can point to locations where accumulation might be higher in sport fish.

Polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) are a long-standing problem in the Niagara River and its tributaries associated with Cayuga Creek due to contamination at Love Canal and the 102nd Street Landfill. We provide NYSDEC's first update of PCDD/F concentrations in YOY fish since 1996 (Preddice et al. 1998). We further provide first time YOY information on two classes of contaminants of emerging concern. Per- and polyfluoroalkyl substances (PFAS) have elicited increasing awareness and monitoring due to their persistence and toxicity. Polybrominated diphenyl ethers (PBDEs) have been phased out of production but continue to show up in biota. US EPA specifically requested that we examine their presence in Lake Ontario.

While our most recent effort (Preddice et al. 2011, Paul et al. 2018) required us to split the collections into several years, US EPA GLRI funding enabled us to collect all samples in a single year, 2018, and to analyze the samples for additional contaminants. A YOY project development telephone call occurred in February 2018 with staff from NYSDEC Fish and Wildlife, NYSDEC's Great Lakes Program, US EPA, OMECP, and Environment Canada. Participants concluded that 2018 YOY sampling on both sides of the international border would be valuable and practical, and came to general agreement on the timing of sampling, chemicals to be analyzed, and sample sizes. We consequently coordinated sampling with the Province of Ontario, which collected YOY fish in the same year as our sampling. We report here the concentrations of multiple classes of contaminants in YOY fish from New York's Great Lakes waters, encompassing 55 sites from Lake Erie at Dunkirk to the mouth of the St. Regis River.

METHODS

Sampling: In 2018 we collected fish at 55 sites. We focused on sites previously collected in 1997 (Preddice et al. 2002), 2009 (Preddice et al. 2011), and 2011–2012 (Paul et al. 2018), along with one site last collected in 1996 (Preddice et al. 1998). We also added additional sites at Eighteenmile Creek below the Burt Dam (Station 69) to better characterize this area of concern and the Niagara River at the Tonawanda Coke outflow (Station 70). Sites spanned New York's Great Lakes waters from Dunkirk in Lake Erie to the confluence of the St. Regis River with the St. Lawrence River near the Canadian border (Figure 1).

We analyzed 392 YOY composite fish samples collected in September and October 2018 (Table 1). We targeted seven samples from each location for mercury, PCBs, and OCPs, and targeted five samples from each location for PFAS, analyzing a total of 277 samples. In a few cases, we collected and analyzed additional samples to facilitate same-species comparisons across sites. We targeted four to five PCDD/F samples from each of 11 sites in the Niagara River and Cayuga Creek area (Figure 2) for a total of 50 samples, and three to four PBDE samples from each of 8 sites in Lake Ontario for a total of 23 samples.

Target Species: Because of great abundance, YOY spottail shiner (*Notropis hudsonius*) had been selected as the primary target species for contaminant monitoring studies through about 1992 (Preddice et al. 2011). In 1996, NYSDEC switched to the nearly ubiquitous bluntnose minnow (*Pimephales notatus*) because the abundance of spottail shiner had decreased significantly at most traditional sampling locations. Since then, where spottail shiner and bluntnose minnow were sparse, other fairly common species such as emerald shiner (*Notropis atherinoides*) have been collected. In the 2011-12 YOY sampling, NYSDEC added round gobies (*Neogobius melanostomus*) to the list of target species (Paul et al. 2018). Round gobies are an invasive species that has become quite common within the Great Lakes basin (Lederer et al. 2008, Krakowiak and Pennuto 2008, Johnson et al. 2010, Taraborelli et al. 2010, Kipp et al. 2012, Pennuto et al. 2012). In 2018 we again targeted these species but, in cases where these primary species were not available, we collected other species including rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), brook silverside (*Labidesthes sicculus*), fallfish (*Semotilus corporalis*), striped shiner (*Luxilus chrysocephalus*), common shiner (*Luxilus cornutus*), rainbow smelt (*Osmerus mordax*), and banded killifish (*Fundulus diaphanus*).

Collection, Sample Targets and Handling: We collected young-of-year fish via seining and backpack shocking. We used a variety of seines, ranging from 10–25 feet in length with 3/16-inch mesh. The larger seines included a center bag, but the smaller seines did not. Some locations required the use of a motorized boat for access or to aid in deploying the seine. In areas where seining was not feasible, a Halltech backpack electrofisher unit was used and we collected stunned fish with scap nets. The sampling goal was seven composites, each with 5–50 (depending on size) YOY fish of the same species from each site. We collected more than one species at site if numbers of a single species were not sufficient to achieve seven composites; each composite had fish from a single species During collection, we carefully placed live fish into a food-grade plastic bag with site water until we obtained sufficient numbers to achieve the required composite mass, which depended on the contaminants being analyzed at each station. These fish were carried in a small cooler with ice to ensure freshness and to maintain sample integrity.

Minimum target mass per sample was 5 g for samples analyzed only for PCBs, OCPs and mercury, an additional 3 g for PFAS, and an additional 5 g for either PCDD/Fs or PBDEs. Desired mass when available were approximately double these amounts.

Shortly after collection, we sorted individual fish to species and visually size matched each composite. Where fish were abundant, we selected representative individuals of about the same total length for the composites to be analyzed, but we sometimes needed to make composites that differed in fish size.

Composites were processed using two methods. For samples with fish that weighed less than about 1 gram per individual, we weighed the sample in bulk and measured the length of a visually representative sample of 15 fish to get the average. For samples with fish that weighed more than 1 gram per individual, we weighed and measured every individual fish in the composite. We put each processed composite sample into an individually labeled 4-oz Whirl-Pak bag. All composites from each site were placed in a labeled food grade plastic bag and immediately frozen in either a freezer or a cooler with dry ice. In order to prevent any PFAS contamination, fish were not sorted on or stored in aluminum foil at any point during the study. All field data were recorded onto collection records and maintained with NYSDEC chain of custody forms. Throughout sampling, frozen samples were held in freezers at the Rome Field Station or the NYSDEC Region 6 office until transferred to a secure freezer (-20°C) located at NYSDEC's Hale Creek Field Station (HCFS), Gloversville, NY.

Sample Processing: We homogenized the YOY fish composites at NYSDEC's Hale Creek Field Station. NYSDEC staff partially thawed samples, then chopped and homogenized the fish in each composite. Aliquots of homogenized tissue samples were placed in clean jars and returned to the freezer. All sample aliquots were placed in clear glass jars with PTFE lined lids, except for PFAS aliquots, which were stored in HDPE jars. Samples were collected and processed using protocols to prevent PFAS contamination according to NYSDEC standard operating procedures.

Analytical: Mercury, PCBs, OCPs, PFAS, and percent lipid were analyzed by the Analytical Services Unit (ASU) at NYSDEC's Hale Creek Field Station. PCDD/Fs, PBDEs, and percent lipid were analyzed by Pace Analytical in Minneapolis. Both laboratories analyzed percent lipid gravimetrically. Quality control included at least one method blank, one duplicate, one spiked matrix, and one fish tissue reference material for every 20 samples, except that matrix spikes were not used for the isotope dilution methods used for PFAS, PCDD/Fs, and PBDEs; exceptions are described in the description for specific analytes. Table 2 lists analytical methods and quality criteria. All results are reported in wet weight concentrations.

Mercury, PCB, OCP: To prevent desiccation due to low sample mass, tissue for the mercury and organics analyses were stored in the same jar. Once mercury results were confirmed, the remainder of the sample was used for PCB, OCP, and lipid analysis.

Samples were analyzed for total mercury in fish tissue by thermal decomposition, amalgamation and atomic absorption spectrophotometry using a Milestone Tri-Cell Direct Mercury Analyzer, DMA-80 [HCFS SOP HC-405 (Total Mercury)]. The method is based on EPA method 7473 Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation and Atomic Absorption Spectrophotometry (2007).

NYSDEC's ASU analyzed samples for PCBs and organochlorine pesticides by capillary GC-ECD [HCFS SOP OC1.108 (Organochlorine Residues)]. At least ten percent of the samples were qualitatively confirmed by capillary GC-MS. Prior to analysis, each sample was freeze-dried and soxhlet-extracted with hexane/acetone (1:1), followed by a florisil cleanup step. All samples were analyzed for three PCB Aroclors (Aroclors 1242 and sum of Aroclors 1254/1260) and 19 organochlorine pesticides and metabolites (4,4'-DDE; 4,4'-DDD; 4,4'-DDT; 2,4'-DDE; 2,4'-DDT; heptachlor; heptachlor epoxide; trans-chlordane; cis-chlordane; trans-nonachlor; cis-nonachlor; oxychlordane; aldrin; photomirex; mirex; HCB; alpha-HCH (hexachlorocyclohexane); beta-HCH; and gamma-HCH). The method is based on FDA Pesticide Analytical Manual Vol. 1, 3rd edition, Sections 202, 203 and 304. Calibration of the GC was accomplished with a five-point external standard.

Reference material was DORM-4, SRM 2976, or SRM 1947 for mercury, and Hudson Reference Material (Schantz et al. 2004) or NIST SRM 1947 for PCBs and OCPs. Mercury acceptance limits were 90% to

110% percent for accuracy, and relative percent difference (RPD) of laboratory duplicate analyses ≤ 20% for precision. PCB and OCP quality limits were percent recovery between 50% and 150% for accuracy, and relative standard deviation (RSD) of less than or equal to 50% in matrix spikes, reference material and replicate analyses for precision. The criterion for blanks was non-detection. All criteria were met with the exception of one alpha HCH at 38.1% recovery and one Aroclor 1242 duplicate at 71.5% RPD.

PFAS: NYSDEC's ASU analyzed samples for selected PFAS by LC/MS/MS using isotopic dilution [HCFS SOP HC-511 (PFAS)]. Prior to analysis, each sample was extracted with 0.05 N KOH in methanol followed by ENVI-Carb and SPE cleanup steps. All samples were analyzed quantitatively for 13 PFAS (9 carboxylic acids: PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, and PFDoA; 3 sulfonic acids: PFBS, PFHxS, and PFOS; and 1 sulfonamide: PFOSA). Due to ongoing method development, the first 55 samples were not analyzed for PFBA and PFPeA. The method was developed using guidance from the Department of Defense and Department of Energy consolidated Quality Systems Manual for Environmental Laboratories Version 5.3 and EPA method 533: Determination of Per-and Polyfluoroalkyl Substances in Drinking Water by Isotope Dilution Anion Exchange Solid Phase Extraction and Liquid-Chromatography/Tandem Mass Spectrometry.

Reference material was IRMM 427 and SRM 1947. Accuracy limits were 70% to 130%, and precision limits were RPD less than 30% for duplicates. The blank criterion was less than the minimum detection limit (MDL). All criteria were met except for one PFBS duplicate at 33.2% RPD, a PFBA duplicate at 60.2% RPD, a PFOSA duplicate at 30.7% RPD, a PFBA duplicate at 43.3% RPD, and a PFDoA duplicate at 32.6% RPD.

PCDD/Fs: Pace Analytical analyzed samples for PCDD/Fs using EPA Method 1613B (US EPA 1994). Isotopically labeled analytes were added to the sample, which was then Soxhlet extracted. Following extraction, labeled cleanup and recovery standards were added. Extracts were analyzed using high resolution gas chromatography/mass spectrometry (GC/MS). Results were corrected according to recovery of labeled standards.

The laboratory accidentally spoiled three of the original 50 samples. We had originally over-collected at some sites, so we had available replacements to send. In addition to having these samples analyzed at Pace for PCDD/Fs, we also analyzed them for mercury, PCBs, and OCPs at the NYSDEC laboratory so that we would have these data on all samples.

Pace reported an estimated maximum concentration (EMPC) when an analyte was affected by either general interference or PCDE interference. Samples with toxic equivalence values above 9.0 ppt that also had over 20% contribution from EMPCs were re-analyzed using a more gradual chromatographic program with a slower temperature ramp that better resolved the peaks and reduced interference.

We did not obtain valid reference material results for the PCDD/F analyses. Although we shipped CARP-2 reference material, the laboratory accidentally used NIST 1947. Because all sample mass was consumed in the original analysis, reanalysis with the correct reference material was not possible. The most that can be said is that we had other samples with more available mass that were analyzed at about the same time that were analyzed with CARP-2 results in general agreement with the known results. Several samples in one analytical batch were blank qualified for 2,3,7,8-TCDF and total TCDF. Other quality measures were generally acceptable.

PBDEs: Pace Analytical analyzed samples for PBDEs using EPA Method 1614 (US EPA 2010). Isotopically labeled analytes were added to the sample, which was then Soxhlet extracted. Following extraction, labeled cleanup and recovery standards were added. Extracts were analyzed using high

resolution gas chromatography/mass spectrometry (GC/MS). Results were corrected according to recovery of labeled standards.

The 23 samples were analyzed in two batches, one with 10 samples and one with 13 samples. Due to low sample mass, only the batch with 10 samples had a duplicate. Blank contamination had a substantial effect on several BDEs. Fifteen BDE-99 results were blank qualified. In six of these samples, BDE-99 contributed more than 5% to total PBDE while being less than six times the blank value, suggesting that blank contamination might have made a meaningful contribution to total PBDE. Blank qualified BDE-47 contributed 22% to 56% to total BDE in five samples. Blank qualified BDE-100 contributed an additional 13% to 14% in three of these, again suggesting possible meaningful contribution of blank contamination to the total. BDE-99 also had high recovery in one of the duplicate laboratory control spikes (LCSD), suggesting the possibility of high bias for the eight associated samples. We rejected results for BDE-209 and did not use them in any analysis or reporting because labeled analyte recovery was less than 10% in 13 of samples and only 5 samples had recoveries within method specifications. Additionally, 17 samples had blank-qualified results and only one sample had a BDE-209 non-detect result where labeled analyte recovery was within specifications. Removal of BDE-209 generally made little difference to total PBDE. The exception was a single sample with a concentration of 2000 ppt. This value, five times the next highest BDE-209 result and half the concentration of the rest of the PBDEs in that sample, is likely spurious. Other quality measures were generally acceptable.

Analytical quality review: We reviewed each analytical report in accordance with our SOPs. Briefly, we checked that the reports are complete, that contract laboratory reports meet contractual requirements, that all fish record data are correct, and that results in the EDD and data package match. We used a checklist for each analytical report to ensure that the reviews are complete. In addition, our quality assurance officer oversaw and approved a data useability report for the PCDD/F and PBDE analyses by Pace.

Data management and reporting: We used R version 4.2.0 (R Core Team 2022) for data manipulation and statistical analysis. We present means and standard deviations only when all values involved in a calculation were detections and always provide medians as an estimate of central tendency. We do, however, use means calculated with non-detects set to zero for graphical presentation. Given the broad range of values in the graphs relative to detection limits, this choice has no discernable visual effect. We used the R package ggplot2 (Wickham 2016) for graphics.

We calculated totals for analyte classes such as PCBs or PFAS by summing the individual analytes composing the class with non-detects set to zero. Although this procedure slightly underestimates totals when non-detects are present, the effect is negligible compared to the considerable range of concentrations across all samples and for most PFAS and PBDE samples the considerable concentrations of at least some constituents in nearly all samples. We treated PCDD/F and PBDE results reported as an EMPC as non-detects when calculating toxic equivalencies (TEQs) or totals. Again, this procedure might result in an underestimate. Any underestimate for PBDE totals would be slight because EMPCs were typically a small fraction of total PBDE. The consequences for PCDD/F TEQ might be larger. We nonetheless believe that discounting EMPCs for totals is appropriate for two reasons: When comparing interference from sample to sample, the pattern of EPMC values suggested they were not “real” and because, consistent with general laboratory practice, we prefer to report only what we have confidence is present. We calculated PCDD/F mammalian toxic equivalency from the toxic equivalency factors (TEFs) of Van den Berg et al. (2006). Bird and fish TEFs came from Van den Berg et al. (1998).

Blank contamination occurred in several PCDD/F and PBDE analytes. The laboratory blank qualified any sample results that were less than ten times the value reported in the associated laboratory blank. For all statistical analyses with these blank qualified samples, we subtracted the blank value from the reported

value for blank qualified results, setting the analytical result to non-detect when the value in the blank exceeded the concentration reported for the sample.

We put all data in a project-specific Microsoft Access database. This database has a user-friendly interface to facilitate queries. The Appendix has the data dictionary and entity relations diagram for the database.

RESULTS

Sampling: Although a single species from all sites would be ideal, we necessarily collected a variety of species due to what was available. While we typically analyzed seven composite samples from each of the 55 sites for mercury, PCBs, and organochlorine pesticides, a few sites had more than seven samples. We analyzed these additional samples to obtain another species for comparison to other sites or because the samples were required for other analytes. Station 66 had only five composites because no more fish were available. The collection at the Little River upstream from Cayuga Creek (Station 9) was about 850 m upstream from Cayuga Creek, whereas this site was previously (e.g., Preddice 2011) further upstream near the eastern start of the Little River. Consequently, Station 9 results from the 2018 sampling are not fully comparable to previous results. Other sites were within 500 m of previous collections, as best we could determine.

Emerald shiners and bluntnose minnows were the most commonly collected species, accounting for 29% and 27%, respectively of the 392 samples analyzed for mercury, PCBs, and organochlorine pesticides (Table 3a). These species were collected at 20 and 19 sites, respectively. Spottail shiners, round gobies, and rock bass accounted for between 5% and 13% of samples for these analytes, while an additional eight species accounted for a total of 17% of the samples (Table 3a). The species distribution was similar for the five composite samples per station analyzed for PFAS (Table 3b). For the PCDD/F analyses in the Niagara River corridor, bluntnose minnows (46%) and emerald shiners (22%) were the most commonly analyzed species, with another five species accounting for the remaining 32% of samples (Table 3c). PBDE samples from Lake Ontario were mainly emerald shiner (74%), with round gobies and striped shiners each accounting for 13% (Table 3d).

Mean composite lengths for all species ranged from 24.3 mm to 82.5 mm (Table 4, Figure 4). The larger values are still small enough to assure that most, if not all, fish were young-of-year. Percent lipid values for composites ranged from 1.16% to 9.47% (Table 5). Means for most species were between 3.1% and 4.7%, but yellow perch and rainbow smelt were lower at 1.53% and 2.08%, respectively, while brook silverside was higher at 5.61%. Emerald shiner had an unusually wide range from 2.04% to 9.47%.

Mercury: Mercury, while detected in all 392 samples, was universally low in concentration (Table 6, Figure 5). The highest concentration was 0.126 ppm, with only 1% of the samples greater than 0.11 ppm, and 90% less than 0.046 ppm. Higher mercury concentrations occurred in Gill Creek (Stations 15B and 15A) and the rivers draining the Adirondacks. The contrast between the St. Lawrence River mainstem and the tributaries entering the St. Lawrence in the Massena area is especially notable (Figure 5).

PCBs: Aroclor 1242 was detected in 344 of 392 composites (Table 7a), combined Aroclors 1254 and 1260 was detected in 290 composites (Table 7b), and PCBs overall were detected in 345 composites (Table 7c, Figure 6). While half of the composites had concentrations of 0.117 ppm or less and 90% were below 0.780 ppm, 5% exceeded 2.30 ppm. Non-detects occurred principally upstream of Niagara Falls, at a few St. Lawrence River sites, and in tributaries to the St. Lawrence River (Table 7c). The highest concentrations were at Twomile Creek, Gill Creek, Eighteenmile Creek, and several places in the St. Lawrence River near Massena. The highest sample concentration was 6.01 ppm in a round goby

composite at Dead Clam Cove on the St. Lawrence River (Station 54). Several other samples at Eighteenmile Creek and the St. Lawrence River had concentrations exceeding 2 ppm. Patterns of lipid normalized total PCB were very similar to wet weight PCB (Figure 7), indicating that lipid content did not have a substantial effect on differences among sites.

Organochlorine Pesticides: Among the organochlorine pesticides, only DDT and its metabolites were detected in appreciable frequency, found in 248 of 392 (63%) samples (Table 8). Although widely detected, most DDT concentrations were low, with only 1% exceeding 0.076 ppm. The maximum total DDT was 0.445 ppm in a striped shiner composite from Eighteenmile Creek above the Burt Dam (Station 68). This site also had the highest average concentration at 0.116 ppm. Twomile Creek on the upper Niagara River, most stations in the Cayuga Creek and Gill Creek systems, other sites associated with Eighteenmile Creek, and some Lake Ontario sites had higher concentrations, whereas most sites from the St. Lawrence River and its tributaries were either non-detect or had very low concentrations (Table 8, Figure 8). The metabolite *p,p'*-DDE accounted for most of total DDT, with much smaller contributions and frequencies of detection from *p,p'*-DDD and *p,p'*-DDT. Metabolite *o,p'*-DDE was found in only two samples and *o,p'*-DDT was not detected.

Although mirex and its degradation product photomirex were detected in only 30 samples, all but one detection came from Cayuga Creek and its tributaries, Gill Creek, or the Niagara River near the mouth of Cayuga Creek; the exception was at the mouth of the Salmon River (Station 21). The highest concentrations were the seven Cayuga Creek samples at Porter Road near the Niagara Falls International Airport (Station 14) with concentrations between 0.027 ppm and 0.51 ppm, and a mean of 0.0366 ppm. Hexachlorocyclohexane (HCH) was detected in only 32 samples, all from Cayuga Creek and its tributaries or Gill Creek. The maximum HCB among 15 detections was 0.00486 ppm. Chlordane was detected in 12 samples at six scattered locations at a maximum concentration of 0.0103 ppm. The other organochlorine pesticides, heptachlor and aldrin, were not detected.

PFAS: We detected PFAS in 276 of 277 samples, with PFOS detected in 274 of these (Table 9). Other PFAS detected in appreciable frequency were PFUnA (242 detections), PFDA (223 detections), PFDoA (162 detections), PFNA (81 detections), and PFOSA (52 detections). PFPeA, PFHpA, PFOA, and PFHxS were detected in five or fewer samples, and PFHxA and PFBS were not detected (Table 9). The laboratory reported 126 detections of PFBA, but many of these, if not all, are considered spurious due to background contamination and interference.

Mean PFOS by species and location was under 10 ppb in Lake Erie and at the Buffalo River site and was generally somewhat higher in the upper Niagara River at between 10 and 33 ppb (Table 10, Figure 9). Cayuga Creek and its tributaries had much higher concentrations, up to a mean of 237 ppb in Cayuga Creek just downstream of Niagara Falls International Airport. Concentrations in Lake Ontario and the St. Lawrence River were somewhat elevated compared to the upper Niagara River, while the Adirondack tributaries near Massena had the lowest concentrations (Table 10, Figure 9).

PFOS dominated total PFAS, especially at higher concentrations and in the Cayuga Creek system (Figure 10). PFOS was 73% or more of total PFAS in half the samples, 82% or more in one-fourth of the samples, and 90% or more of the total in 10% of the samples.

Dioxins and Furans: We found non-zero mammalian and bird TEQs in 47 PCDD/F samples and non-zero fish TEQs in all 50 samples. About 10% of individual mammalian TCDD/F TEQs exceeded 6.1 ppt and about 5% exceeded 10.4 ppt. The 10% and 5% exceedances for TEQs calculated from bird TEFs were 9.0 ppt and 18.5 ppt, respectively, and were 6.4 ppt and 10.5 ppt for TEQs calculated from fish TEFs. More generally, bird TEQs tended to be about 1.5 times mammalian and fish TEQs.

Median mammalian TCDD/F TEQ was 1 ppt or less in the Niagara River stations upstream of Cayuga Creek (Table 11a, Figure 11). In contrast, median mammalian TEQ was between 1.5 ppt and 5.6 ppt in the Cayuga Creek system and was 10.4 ppt at the Little River upstream of Cayuga Creek (Station 9). The median in the lower Niagara River at Lewiston (Station 16) was less than 0.01 ppt. Spatial patterns were similar for bird TEQ (Table 11b), fish TEQ (Table 11c), and 2,3,7,8 TCDD (Table 11d).

PBDEs: Among 23 samples, mean total PBDE at the nine Lake Ontario stations ranged from 984 ppt to 9,450 ppt (Table 12, Figure 12). BDE-47 was found in every sample at mean location concentrations between 443 ppt and 6,870 ppt. It was the dominant PBDE in concentration, contributing 28% to 76% to total PBDE, with a contribution over 50% in 18 of 23 samples. BDE-100 was also detected in every sample, contributing between 9% and 19% to the total. Other BDEs contributing at least 5% to total PBDE in at least one sample were BDE-154 (5% or more in 20 samples), BDE-(49/71) (14 samples), BDE-153 (12 samples), and BDE-99 (9 samples). These four BDEs were detected in all samples, except BDE-99 which was detected in 20 samples. Among the other BDEs, only BDE-28/33, BDE-119/120, BDE-155, and BDE-15 were detected in over half the samples. These and other BDEs contributed more than 3% to total PBDE in only three samples.

The three most dominant PBDEs, BDE-47, BDE-100, and BDE-154, contributed between 59% and 89% to total PBDE, and contributed over 71% to 18 of 23 samples. Adding the next three most important congeners or pairs, BDE-(28/33), BDE-(49/71), and BFR-153, brought the percent contribution to between 70% and 99%, with 18 over 81%.

Spatial differences were relatively minor (Figure 12) with the exception that Eighteenmile Creek above the Burt Dam (Station 68) had the two highest sample total PBDE concentrations at 12,110 ppt and 13,008, nearly double the next highest sample at 6,787. Complicating comparison, however, is that the striped shiners collected there were not collected anywhere else and the third striped shiner sample from this location had a much lower total PBDE concentration of 3,154 ppt.

DISCUSSION

We looked at young-of-year concentrations in six classes of contaminants: mercury, PCBs, organochlorine pesticides, PFAS, dioxins and furans, and polybrominated diphenyl ethers. Among these, PCBs and PFAS posed the greatest concern at sites associated with industrial and commercial activity around Niagara Falls and Massena, and to a lesser extent at Eighteenmile Creek. These three areas are within or near three of New York State's five active areas of concern (AOCs) under the Great Lakes Water Quality Agreement, Niagara River, St. Lawrence River at Massena/Akwesasne, and Eighteenmile Creek, respectively.

Thresholds for human and wildlife consumption: We provide context for the results by comparing the contaminant concentrations in young-of-year fish to a variety of thresholds for human and piscivorous wildlife consumption. Unfortunately, no comprehensive, modern compilation of thresholds appears to be available. We use human consumption thresholds for three reasons: They are under more active review, particularly for more commonly found contaminants, and thus reflect more recent scientific findings, small whole fish are eaten by some immigrant communities (Wattigney et al. 2022), and because they enable comparison to results from studies of larger, edible size fish in the same waters (e.g., Li et al. 2014, Skinner et al. 2018, Skinner and Richter 2020, Richter and Skinner 2020). For consumption by piscivorous wildlife we use objectives from the Great Lakes Water Quality Agreement (GLWQA) version from 1987 (IJC 1988), even though the most recent version of the GLWQA (Canada and United States of America 2012) does not include numerical objectives, because the 1987 objectives had some scientific basis that we do not know to have been replaced. We supplement with Canadian federal and Ontario

thresholds when available since these are relevant for our shared waters. We also have used values from Newell et al. (1987) because they are sometimes the only ones available or because they provide a counterpoint to other values.

The empirical cumulative distribution function (ECDF) of mean total PCB concentrations shows a break at about 0.5 ppm (dotted blue line in Figure 13), with 11 of 77 means considerably higher than were found generally. These higher concentrations occurred at Twomile Creek (Station 58), Gill Creek (Station 15B), Eighteenmile Creek (Stations 69 and 68), at several sites in the St. Lawrence River (Stations 54, 28, 55, and 29), and the lower Grasse River (Station 30) (Figure 6). Mean total PCB concentrations exceeding the NYSDOH guideline value of 1 ppm for a don't eat advisory (NYSDOH 2022b) were at the two Eighteenmile Creek sites (Stations 68 and 69) and at three of the St. Lawrence River sites (Dead Clam Cove [Station 54], Upstream from General Motors Co. [Station 55], and General Motors Co. [Station 529]) (Table 7c).

Other locations with elevated PCB concentrations were at a number of other St. Lawrence River sites, where several species means considerably exceeded Newell's (1987) criterion of 0.13 ppm and nearly all exceeded the IJC objective of 0.1 ppm to protect aquatic life and fish-consuming birds (IJC 1988) (middle magenta points in Figure 6). PCB concentrations at many of these mainstem locations (left magenta points in Figure 6) greatly exceeded concentrations at the nearby major tributaries (right magenta points in Figure 6), strongly indicating continued local availably of PCBs. The Eighteenmile Creek results at Stations 68 and 69, at over 2 ppm, greatly exceeded the low concentration at the nearby Lake Ontario Station 17, also indicating a substantial local source (Figure 6). Fish from the Cayuga Creek drainage and the nearby upstream Little River (Station 9) had some elevation relative to most upstream Niagara River locations, suggesting at least some residual local source. Twomile Creek (Station 58) was a high exception among the upper Niagara River sites, again suggesting the possibility of a local source. More generally, 56% of samples and 58% of species-site means exceeded the IJC objective, suggesting some distance before this objective is met overall.

Nearly all PFOS species-site means were under the 50 ppb threshold for a one meal per month advisory set by the Great Lakes Consortium for Fish Consumption Advisories (GLCFCA 2019), also used by NYSDOH (2022b). The exceptions were mainly in the Cayuga Creek system. The highest concentration was at Station 14 (Figure 9), just downstream from Niagara Falls International Airport. These results suggest that use of aqueous film forming foams (AFFFs) has resulted in elevated concentrations of PFAS in nearby biota. Samples from St. Lawrence River locations at Dead Clam Cove (Station 54) and near the General Motors sites (Stations 55 and 29) were also elevated: The mean PFOS in yellow perch of 65.4 ppb at Dead Clam Cove exceeded, and the mean concentration of 41.9 ppb in rock bass at Station 55 and 46.6 at Station 29 approached, the 50 ppb guideline value. These results suggest the possibility that PFAS may be an issue in addition to PCBs at these remediation sites. The elevated mean PFOS concentration of 45 ppm at the mouth of the Salmon River (Station 21) is a puzzle, and suggests that investigation into a local source might be worthwhile. Also noteworthy is that many of the Niagara River, Lake Ontario, and mainstem St. Lawrence River concentrations were higher than many concentrations typically found in inland New York State waters (NYSDEC unpublished data).

PCDD/F TEQs were elevated at the sites associated with Cayuga Creek relative to the nearby sites, suggesting as with PCBs that some residual source remains. Only the species-site mean of 10.2 ppt at the Little River upstream of Cayuga Creek (Station 9) exceeded the NYSDOH guideline value of 10 ppt for a specific advisory (NYSDOH 2022b). Newell et al.'s (1987) criterion for fish consuming wildlife of 2.3 ppt was exceeded by 7 of 16 species-site means for mammal and fish TEQ and for 9 bird TEQ means. Nearly all of these exceedances were from Cayuga Creek, its tributaries, or the Little River. The Canadian Council of Ministers of the Environment produced a mammalian tissue residue guideline of 0.71 ppt and an interim avian tissue residue guideline of 4.75 ppt (CCME 2001). These were exceeded by 11 of the

mammal mean TEQs and 6 of the bird TEQs, respectively. Overall, these findings indicate limited exceedance of human consumption guidelines, but general exceedances of consumption thresholds for piscivorous wildlife in Cayuga Creek and its associated waters.

Other contaminants were generally close to or below concentrations of concern, or found mainly in association with Cayuga Creek. The maximum individual mercury concentration of 0.126 ppm was well below NYSDOH's lowest guideline value of 0.22 ppm for a specific advisory (NYSDOH 2022b), US EPA's water quality criterion of 0.3 ppm (US EPA 2001), and the IJC objective of 0.5 ppm to protect aquatic life and fish-consuming birds (IJC 1988).

The maximum total DDT concentration of 0.445, from a striped shiner from Eighteenmile Creek above the Burt Dam (Station 68), was well below the NYSDOH guideline value of 5 ppm for a specific advisory and below the IJC objective of 1 ppm (IJC 1988). The DDT concentration in this sample was much higher than the next highest sample at 0.0949 ppm, also a striped shiner from the same site. The relatively high concentration from a sample at this location raises the possibility of a local source. The maximum species-site mean of 0.116 ppm was below Newell's (1987) criterion of 0.2 ppm to protect sensitive wildlife consumers, and fewer than 1% of individual samples exceeded this value. It is nonetheless noteworthy that the highest concentrations were in the Niagara River and Eighteenmile Creek AOCs.

The IJC objective for mirex is to be "substantially absent," defined as below detection levels using the best available method (IJC 1988). All but one sample outside of the Cayuga Creek area met this objective, whereas mirex was detected in roughly half the samples from Cayuga Creek and the Little River locations above and below the Cayuga Creek mouth. The maximum concentration of 0.051 ppm was about half the NYSDOH guideline value of 0.1 ppm for a specific advisory. HCH, like mirex, was found only in association with Cayuga Creek. The IJC objective for lindane (γ-HCH) of 0.3 ppm (IJC 1988) was met for all samples to a maximum concentration of 0.024 ppm. One sample for total HCH, however, exceeded 0.3 ppm with a concentration of 0.33 ppm.

The maximum species site mean for PBDEs of 9,450 ppt was below interim Ontario benchmarks for human consumption for any of BDE-47, BDE-99, BDE-153, or BDE-209 (Gandhi 2017), suggesting limited risk from human consumption. Environment and Climate Change Canada developed guidelines for fish tissue and wildlife diet for tri- through deca- homolog groups and for BDE-99 and BDE-100 (E&CC 2013). Concentrations of penta-BDEs exceeded the fish tissue guideline of 1 ppb in 8 of 23 samples to a maximum of 2.4 ppb. No other homolog guideline was exceeded. The guidelines of 1 ppb were each exceeded in two samples in BDE-99 and three different samples in BDE-100, with a maximum concentration of 1.5 ppb for BDE-99 and 1.2 ppb for BDE-100. Nine of the 12 total exceedances came from Eighteenmile Creek above the Burt Dam (Station 68) and east of the Genesee River mouth (Station 18). Overall, exceedances of the available criteria were limited and not large.

While recognizing that the species were different, young-of-year PBDE concentrations were typically somewhat lower than fillets collected in 2010 and 2011 (Skinner and Richter 2020). While the maximum young-of-year composite total PBDE concentration from Lake Ontario waters (excluding the higher upstream Eighteenmile Creek samples) was 6,768 ppt (Table 12), sportfish fillet means reported by Skinner and Richter (2020) exceeded that value for five of six species, and the highest reported concentration was 82,248 ppt. The difference is particularly striking because whole fish concentrations tend to be two to three times fillet concentrations for lipophilic contaminants such as PBDEs. To what extent this difference reflects different species, the relative ages of the species in the two studies, or reduction in biologically available PBDEs between the two studies is unknown.

To summarize, Cayuga Creek, its tributaries Bergholtz Creek and Black Creek, and the Little River locations on either side of the Cayuga Creek mouth had concentrations of concern for PCBs, PFOS, and

PCDD/Fs, and continued to have detectable concentrations of mirex. The Little River location upstream of Cayuga Creek (Station 9) often had among the highest concentrations even though it is a channel of the high volume Niagara River. This station is close to the 102nd Street Landfill and to Love Canal, raising the possibility that these sites are still contributing contaminants to the aquatic system. PCBs continued to be a concern at several locations in the Massena area and in Eighteenmile Creek. PFOS may also be a concern at a few sites in the Massena area. PFAS concentrations from Lake Erie all the way through to the St. Lawrence River were somewhat elevated compared to the Adirondack tributaries and to many inland New York waters (NYSDEC unpublished data). Why this is so is unknown. While this discussion has focused attention on higher concentrations, findings from the great majority of locations from Lake Erie, the Niagara River, Lake Ontario, the St. Lawrence River, and the tributaries draining the Adirondacks are encouraging, with low or undetected contaminant levels.

Historical comparisons: Our 2018 sampling had 22 species-site combinations in common with our previous 2009 (Preddice et al. 2011) and 2011–2012 (Paul et al. 2018) studies that allow for direct historical comparison (Table 13). Total PCB declined in 11 of 22 comparisons. Most changes were small, as only one decrease exceeded 0.07 ppm and only four increases were 0.2 ppm or larger. The major decrease was from 8.9 ppm to 3.5 ppm (-61%) in rock bass at St. Lawrence River at General Motors (Station 29). The four larger increases were at Cayuga Creek at Porter Road (Station 14), St. Lawrence River upstream from General Motors (Station 55), Twomile Creek (Station 58) common shiner, and Gill Creek (Station 15B). Although common shiner at Twomile Creek increased by 96%, emerald shiners at that site decreased by a minor 9%. The percent change at St. Lawrence River upstream General Motors was relatively small at 11%, whereas the other four larger magnitude changes had an absolute value percent change between 61% and 179%. When sampling the western half of our study area, Preddice et al. (2011) found the highest PCB concentrations at Twomile Creek and Gill Creek, as we did for the western area in 2018.

Whereas wet weight PCB concentrations are indicative of environmental impacts, lipid normalized PCB concentrations better reflect changes in the environment by accounting for differences in fish lipid concentrations. Lipid normalized PCB concentrations decreased in 16 of the 22 comparisons. Interestingly, the 96% increase in wet weight PCB in the Two Mile Creek common shiners was due to a change in lipid content, as their lipid normalized PCB decreased by 41%. Conversely, the emerald shiners at Twomile Creek had a near doubling of lipid normalized PCB versus the minor decrease in wet weight concentrations. The 51% decrease at St. Lawrence River at General Motors in lipid normalized PCB was slightly less than the 61% wet weight decrease. The overall historical pattern for PCB concentrations is small changes with roughly even increases and decreases in wet weight concentrations and a tendency to decreases in lipid normalized concentrations.

Preddice et al. (2011) and Paul et al. (2018) detected DDT and metabolites in approximately 76% of samples, somewhat higher than the 63% of samples with detections in 2018. On the other hand, 19 of 55 sites (35%) in 2018 had mean concentrations over 0.010 ppm, an increase from 9 of 44 sites (20%) in the earlier studies with means or medians above that value. Three means from 2018, excluding two from Eighteenmile Creek which were not in the comparison, exceeded 0.030 ppm, versus none from the earlier studies.

The 2018 detections of mirex in 7.7% of samples (30 of 392) is comparable to the combined 6.6% (26 of 394) from Preddice et al. (2011) and Paul et al. (2018). All of the earlier detections came from the sites associated with Cayuga Creek, consistent with the 2018 results. The maximum mean concentration (using zero for non-detects for compatibility with the earlier studies) from 2018 of 0.0366 ppm from Cayuga Creek at Porter Road (Station 14) was close to the 0.0275 ppm maximum from Preddice et al. (2011), which happened to come from the same site. Preddice et al. (2011) reported that individual sample mirex results from all other sites were under 0.010 ppm. Among the 24 mirex detections from sites other than

Porter Road in 2018, only one at 0.015 ppm exceeded this value. Thus, mirex appears to have changed little in the nine years since the Preddice et al. (2011) study.

Overall, concentrations of PCBs and the most prevalent organochlorine pesticides have not changed dramatically since the previous studies, although we have suggestions of improvement in PCBs at some of the Massena area sites. Preddice et al. (2011) found the highest PCB concentrations in the western half of our study area at Twomile Creek and Gill Creek, as we did in 2018. Both studies similarly reported the highest mirex concentrations from Cayuga Creek at Porter Road.

Great Lakes Areas of Concern: While young-of-year fish are not often considered when evaluating beneficial use impairments (BUIs) in Great Lakes areas of concern, they provide supplementary information that can be used in understanding contaminant status (Bhavsar et al. 2018). Moreover, because some communities do eat small whole fish (e.g., Wattigney et al. 2022), their concentrations are relevant to the restrictions on fish and wildlife consumption BUI. Our findings for YOY fish point to continued concerns for this BUI due to high PCB concentrations in YOY fish from the Niagara River, Eighteenmile Creek and St. Lawrence River at Massena/Akwesasne AOCs. PCDD/Fs, which contribute to fish consumption advisories in some of the Niagara River AOC, also had elevated concentrations there. While PFOS does not currently contribute to fish consumption advisories at either the Niagara River or St. Lawrence River AOCs (NYSDOH 2022a), some concentrations exceeded NYSDOH guideline values (NYSDOH 2022b) for a specific advisory. In contrast, YOY fish concentrations in all contaminants analyzed in the Buffalo River and Rochester Embayment AOCs were all below NYSDOH guideline values, a positive finding for these AOCs.

RECOMMENDATIONS

1. Continue to periodically monitor young-of-year fish for their value as local, short-term measures of environmentally available contaminants, to evaluate trends in contaminant concentrations, as supplemental indicators of the need for or effectiveness of remediation, to determine whether and where these prey fish may pose risk to piscivorous wildlife, and for evaluation of fish consumption advisories especially for communities known to eat small, whole fish. We recommend a smaller effort after five years and a more comprehensive effort after ten years from this study. Ideally, these collections would occur in 2023 and 2028 to coincide with Lake Ontario's CSMI field year.

2. Our results point to continued impacts from contaminants in or near portions of the Niagara River, St. Lawrence River at Massena/Akwesasne, and Eighteenmile Creek areas of concern. Cayuga Creek, its tributaries, and the nearby sites in the Little River are of particular concern in and near the Niagara River AOC. It is noteworthy that the Little River site upstream from Cayuga Creek had some of the highest PCB concentrations in the area, suggesting the possibility of continued release from the upstream 102nd Street Landfill or other nearby sites. Many of these sites also had elevated PFAS concentrations. Twomile Creek also had elevated contaminant levels. Both Eighteenmile Creek sites, one below the Burt Dam within the AOC and the other upstream of the dam and AOC, had highly elevated PCB concentrations above 2 ppm. Several sites within the St. Lawrence River at Massena/Akwesasne also had highly elevated PCB concentrations above 2 ppm.

We found continued impacts, stemming from concentrations high enough to pose risks to both wildlife and human consumers, from PCBs in or near all three of these AOCS and from PFAS at the Niagara and St. Lawrence AOCs. Actions to control continued release or removal of source locations appear necessary throughout these areas. Beyond continuing with ongoing remediation activities in these AOCs, these young-of-year results need be considered to make sure that no areas with significant sources of these contaminants within or beyond the AOCs are overlooked. Remedial goals should include removing risk to piscivorous wildlife.

3. PFAS concentrations, including PFOS, were greatly elevated in Cayuga Creek directly downstream from Niagara Falls International Airport. The PFAS source should be investigated and controlled.

4. Great Lakes concentrations of PFAS are generally elevated relative to concentrations in fish from inland New York State waters without known sources. The reasons for the higher Great Lakes concentrations should be determined and measures should be taken to reduce them. The relatively elevated PFAS concentration at the mouth of the Salmon River may warrant local investigation.

5. Continue coordination with the Province of Ontario in obtaining and understanding young-of-year contaminants data. This coordination includes a joint data analysis and future concurrent sampling efforts.

ACKNOWLEDGEMENTS

We wish to thank the United States Environmental Protection Agency for providing Great Lakes Restoration Initiative funding (grant number GL-00E02358) to make this study possible; we especially appreciate the insights and advice from Fred Luckey. Larry Skinner provided advice and insight throughout this project, along with helpful reviews of the data analysis and reporting. Tim Preddice provided invaluable advice in locating historical sites and about sampling procedures. Eric Paul played an essential role in heading sampling crews and by providing knowledge of historical sites. Chris Fidler, Tim Martin, Matthew Porter Stephanie Weston, Molly Schultz, David Rosenbaum, and Chris Driscoll helped with fish collection, often by spending long days in the field followed by late-night fish processing. Yasaman Hassanzadeh and Jesse Becker performed data quality review, and Yasaman Hassanzadeh developed the YOY contaminant database. We also thank members of the Saint Regis Mohawk Tribe for helping us sample a St. Regis River site that was only accessible by boat. We are grateful to the staff of NYSDEC's Analytical Services Unit at the Hale Creek Field Station, particularly David Bryk, Brian Buanno, and Katryn Williams for chemical analysis. We are similarly appreciative to Chuck Sueper, Mary Christie, and Scott Unze at Pace Analytical for their chemical analyses. Mary Ann Mroz and Ashley Ferrusi provided invaluable grant management help.

LITERATURE CITED

Bhavsar, S.P., K.G. Drouillard, R. Tang, L. Matos, and M. Neff. 2018. Assessing fish consumption Beneficial Use Impairment (BUI) at Great Lakes Areas of Concern: Toronto case study. Aquatic Ecosystem Health & Management 3:318–330.

Canada and United States of America. 2012. Great Lakes Water Quality Agreement. https://binational.net/wp-content/uploads/2014/05/1094_Canada-USA-GLWQA-_e.pdf.

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota: Polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

E&CC Canada (Environment and Climate Change Canada). 2013. Federal environmental quality guidelines: Polybrominated diphenyl ethers (PBDEs). http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=05DF7A37-1.

Gandhi, N., S. B. Gewurtz, K. G. Drouillard, T. Kolic, K. MacPherson, E. J. Reiner, and S. P. Bhavsar. 2017. Polybrominated diphenyl ethers (PBDEs) in Great Lakes fish: Levels, patterns, trends and implications for human exposure. Science of The Total Environment 576:907–916.

GLCFCA (Great Lakes Consortium for Fish Consumption Advisories). 2019. Best Practice for Perfluorooctane Sulfonate (PFOS) Guidelines. https://www.health.state.mn.us/communities/environment/fish/docs/consortium/bestpracticepfos.pdf.

IJC (International Joint Commission). 1988. Revised Great Lakes water quality agreement of 1978, signed Nov. 18, 1987. Water Quality Division, IJC. Windsor, Canada.

Johnson, J.H., R.M. Ross, R.D. McCullough, and A. Mathers. 2010. Diet shift of double-crested cormorants in eastern Lake Ontario associated with the expansion of the invasive round goby. J. Great Lakes Res. 36:242-247.

Kipp, R., T. Hébert, M. Lacharité, and A. Ricciardi. 2012. Impacts of predation by the Eurasian round goby (*Neogobius melanostomus*) on molluscs in the upper St. Lawrence River. J. Great Lakes Res. 38:78-89.

Krakowiak, P.J., and C.M. Pennuto. 2008. Fish and macroinvertebrates communities in tributary streams of eastern Lake Erie with and without round gobies (*Neogobius melanostomus,* Pallas 1814). J. Great Lakes Res. 34:675-689.

Lederer, A.M., J. Janssen, T. Reed, and A. Wolf. 2008. Impacts of the introduced round goby (*Neogobius melanostomus*) on dreissenids (*Dreissena polymorpha* and *Dreissena bugensis*) and on macroinvertebrate community between 2003 and 2006 in the littoral zone of Green Bay, Lake Michigan. J. Great Lakes Res. 34:690-697.

Li, X., W. Richter, and L.C. Skinner. 2014. Xenobiotics in fish from Lake Erie, the Niagara River, Cayuga Creek, and Lake Ontario, New York. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, NY. https://www.dec.ny.gov/docs/fish_marine_pdf/xenobiofish2014.pdf.

Newell, A.J., D.W. Johnson and L.K. Allen. 1987. Niagara River biota contamination project: Fish flesh criteria for piscivorous wildlife. Tech. Rep. 87-3, Division of Fish and Wildlife, NewYork State Department of Environmental Conservation. Albany, NY.

NYSDOH (New York State Department of Health). 2022a. Health advice on eating sportfish and game. New York State Department of Health, Albany, NY. https://www.health.ny.gov/publications/2800.pdf. Accessed on 17 January 2023.

NYSDOH (New York State Department of Health). 2022b. Background Information. https://www.health.ny.gov/environmental/outdoors/fish/health_advisories/background.htm. Accessed on 9 January 2023.

Paul, E.A., W. Richter, and L.C. Skinner. 2018. PCBs and organochlorine pesticide residues in young-of-year fish from new and traditional near-shore sampling areas in the eastern portion of New York State's Great Lakes Basin, 2011 and 2012. New York State Department of Environmental Conservation, 2018. Albany, N.Y. https://www.dec.ny.gov/docs/wildlife_pdf/yoy_great_lakes_2011.pdf.

Pennuto, C.M., E.T. Howell, and J.C. Makarewicz. 2012. Relationships among round gobies, Dressenia mussels, and benthic algae in the south nearshore of Lake Ontario. J. Great Lakes Res. 38(Suppl. 4):154-160.

Preddice, T., S. Jackling, and L. Skinner. 1998. Contaminants in young-of-year fish from selected Lake Ontario tributaries, 1996. New York State Department Environmental Conservation. Gloversville, NY.

Preddice, T., S. Jackling, and L. Skinner. 2002. Contaminants in young-of-year fish from near- shore areas of New York's Great Lakes basin, 1997. New York State Department Environmental Conservation. Gloversville, NY.

Preddice, T., L. Skinner and A. Gudlewski. 2006. PCBs and organochlorine pesticide residues in young-of-year fish from traditional near-shore sampling areas, NYS's Great Lakes basin, 2003. New York State Department Environmental Conservation. Gloversville, NY.

Preddice, T., L. Skinner and A. Gudlewski. 2011. PCBs and organochlorine pesticide residues in young-of-year fish from new and traditional near-shore sampling areas in the western portionof NYS's Great Lakes basin, 2009. New York State Department Environmental Conservation. Gloversville, NY.

R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Richter, W. and L.C. Skinner. 2020. Mercury in the fish of New York's Great Lakes: A quarter century of near stability. Ecotoxicology 29: 1721–1738. https://doi.org/10.1007/s10646-019-02130-1.

Schantz, M., D.L. Poster, B.J. Porter, and S.A. Wise. 2004. Preparation and value assignmentof a white perch fish control material for the long-term monitoring of Hudson River fish. Analytical Chemistry Division, National Institute of Standards and Technology, Gaithersburg, Maryland.

Skinner, L.C., A. David, and W. Richter. 2018. Xenobiotics in fish from the St. Lawrence River and connecting tributaries with emphasis on the St. Lawrence River area of concern at Massena/Akwesasne. New York State Department of Environmental Conservation, 2018. Albany, N.Y. https://www.dec.ny.gov/docs/wildlife_pdf/xenobiotics.pdf.

Skinner, L. and S. Jackling. 1989. Chemical contaminants in young-of-year fish from New York's Great Lakes basin, 1984–1987. Tech. Rpt. 89-1 (BEP) Division of Fish and Wildlife, New York State Department Environmental Conservation. Albany, NY.

Skinner, L., S. Jackling and R. Karcher. 1994. Identification of and changes in chemical contaminant levels in young-of-year fish from New York's Great Lakes basin. Tech. Rpt. 94-4 (BEP), Division of Fish and Wildlife, New York State Department Environmental Conservation. Albany, NY.

Skinner, L.C., and W. Richter. 2020. Polybrominated diphenyl ethers (PBDEs) and polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) in fish from New York's Great Lakes and connecting channels. New York State Department of Environmental Conservation. Albany, NY. https://www.dec.ny.gov/docs/wildlife_pdf/xenopbdspcddf.pdf.

Suns, K., G. Crawford, D. Russel and R. Clement. 1985. Temporal trends and spatial distribution of organochlorine and mercury residues in Great Lakes spottail shiners (1975–1983). Ontario Ministry of Environment, Canada.

Suns, K., G. Craig, G. Crawford, G. Rees, H. Tosine and J. Osborne. 1983. Organochlorine contaminant residues in spottail shiner from Niagara River, J. Great Lakes Res. 9(2): 335-340.

Suns, K., G. Hitchin and D. Toner. 1993. Spatial and temporal trends of organochlorine contaminants in spottail shiner from selected sites in the Great Lakes (1975–1990). J. Great Lakes Res. 19(4): 703-714.

Suns, K and G. Rees. 1978. Note: organochlorine contaminant residues in young-of-the-year spottail shiner from Lake Ontario, Erie and St. Claire. J. Great Lakes Res. 4(2):230-233.

Taraborelli, A.C., M.G. Fox, T.B. Johnson, and T. Schaner. 2010. Round goby (*Neogobius melanostomus*) population structure, biomass, prey consumption and mortality from predation in the Bay of Quinte, Lake Ontario. J. Great Lakes Res. 36:625-632.

US EPA (United States Environmental Protection Agency). 1994. Method 1613, Revision B. Tetra- through octa-chlorinated dioxins and furans by isotope dilution HRGS/HRMS. U.S. Environmental Protection Agency, Washington, DC.

US EPA (United States Environmental Protection Agency). 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. U.S. Environmental Protection Agency, Washington, DC.

US EPA (United States Environmental Protection Agency). 2010. Method 1614A. Brominated diphenyl ethers in water, soil, sediments, and tissue by HRGC/HRMS. EPA-821-R-10-005. U.S. Environmental Protection Agency, Washington, DC.

Van den Berg, M., L. Birnbaum, A.T. Bosveld, B. Brunström, P. Cook, M. Feeley, J.P. Giesy, et al. 1998. Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and Wildlife. Environmental Health Perspectives 106: 775–92,

Van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, et al. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93:223–41.

Wattigney, W.A., S.S. Savadatti, M. Liu, M. Pavuk, E. Lewis-Michl, K. Kannan, W. Wang, H. Spliethoff,

L. Marquez-Bravo, and S.-A. Hwang. 2022. Biomonitoring of per- and polyfluoroalkyl substances in minority angler communities in central New York State. Environmental Research 204:112309.

Wickham, H. 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

Table 1. Sampling locations, station numbers, species, and number of young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
Lake Erie, Dunkirk	Beach adjacent to electric generating station near the Lake Erie Fishery Research Station.	1	emerald shiner	7	2		
Lake Erie, Smokes Creek	Woodlawn Beach area about 1/4 mile south of the mouth of Smokes Creek.	2	emerald shiner	7	5		
Buffalo River	North shore opposite upstream edge of Cargill grain silo/bldg.	3	spottail shiner	7	5		
Niagara River, Strawberry Island	Calm protected area mid-island.	4	bluntnose minnow	6	1		
			banded killifish	1	1		
Niagara River, Beaver Island State Park	South (upstream) end of Grand Island, at the mouth of backwater area adjacent to dock at Beaver Island State Park Marina.	5	spottail shiner	7	5		
Niagara River, Tonawanda Coke Outflow	Just outside of the drainage swale for the Tonawanda Coke Corporation	70	bluntnose minnow	7	5		
Twomile Creek	Twomile Creek site, 30-70 yards downstream from Fletcher Street crossing.	58	common shiner	3	3		
			emerald shiner	7	5		
Niagara River, Niawanda Park	In 5-bay boat slip at Niawanda Park, upstream from Erie Canal	67	emerald shiner	2	1		
			rainbow smelt	5	4	4	
Erie Canal, Upstream from junction with Ellicott Creek	At a small single boat slip opposite corner of Service Road and Sweeney Avenue, ~1200 yards from junction with Ellicott Creek.	59	bluntnose minnow	7	5		
Niagara River, Pettit Flume	Upstream of the marina walkway along north and south shores at the mouth of Pettit Flume.	6	bluegill	7	5	4	

Table 1 (continued).

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
Niagara River, Between Pettit Flume and Gratwick-Riverside Park	In a small bay in front of Ziphany Co. at 940 River Road, downstream from small treatment plant (boat site).	60	brook silverside	7	5		
Niagara River, Gratwick- Riverside Park	Upstream side of the Gratwick-Riverside Park boat launch.	7	bluntnose minnow	5	3	2	
			brook silverside	2	2	2	
Niagara River, Bay at upstream edge of 102nd St. Landfill	In small bay located at upstream edge of 102nd St. Landfill (boat site).	61	bluntnose minnow	7	5	3	
			emerald shiner	1		1	
Niagara River, N. Grand Island Bridge	Small embayment located upstream from Woods Creek, Buckhorn Island State Park.	8	emerald shiner	7	5		
Little River, Upstream of Cayuga Creek	South side of river about 200-400 yards upstream from Cayuga Creek, downstream from the boat launch.	9	bluntnose minnow	7	5	4	
Little River, Downstream of Cayuga Creek	North side of river about 250 yards downstream from Cayuga Creek.	10	bluntnose minnow	7	5	5	
Cayuga Creek, Lindberg Ave	West bank about 150 yards upstream from the Lindberg Avenue Bridge.	11	bluntnose minnow	6	2	3	
			emerald shiner	3	1	3	
Cayuga Creek, Cayuga Drive	Within 80 yards upstream of the Cayuga Drive Bridge.	13	bluntnose minnow	7	5	5	
Cayuga Creek, Porter Road	Within 175 yards downstream of the Porter Road Bridge.	14	bluntnose minnow	7	5		
Cayuga Creek, Lockport Road	Lockport Road northeast of Niagara Falls International Airport	66	bluegill	5	5		
Bergholtz Creek, Downstream from old Black Creek	Downstream from mouth of old Black Creek between 90th and 92nd Streets (boat site).	63	emerald shiner	7	5	5	

Table 1 (continued).

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
Bergholtz Creek, Upstream from old Black Creek	Downstream from Williams Road but upstream from mouth of old Black Creek at power line crossing near Mueller Court (boat site).	62	bluegill	2			
			bluntnose minnow	2	2	1	
			common shiner	1	1	1	
			emerald shiner	2	2	2	
Bergholtz Creek	Within 100 yards downstream of the Williams Road Bridge.	12	bluntnose minnow	7	5		
Black Creek	About 30 yards upstream from junction with Bergholtz Creek.	64	bluntnose minnow	6	4		
			common shiner	1	1		
Gill Creek	Within 80 yards upstream of the Buffalo Avenue (Route 384) Bridge.	15B	bluegill	2	2		
			bluntnose minnow	3	3		
			round goby	2			
Gill Creek	Adjacent to parking lot for Police Dept/Traffic Court Bldg. Off Hyde Park Boulevard.	15A	spottail shiner	7	5		
Niagara River - Lewiston	East side of river, downstream and within 1/4 mile of the Lewiston Boat Launch.	16	spottail shiner	7	5	5	
Lake Ontario, Eighteenmile Creek	Within 100 yards west of the west break wall at Krull Park and in pocket formed by the shore and the west break wall at the mouth of the creek.	17	emerald shiner	8	5		4
Eighteenmile Creek	Below Burt Dam at the Fisherman’s Park access site.	69	rock bass	7	5		
Eighteenmile Creek	From Ide Road and downstream for 150 – 175 meters.	68	striped shiner	7	5		3
Lake Ontario, Genesee River	Within 100 yards east of the USCG Station at the river's mouth.	18	emerald shiner	7	5		3

Table 1 (continued).

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
Lake Ontario, Sodus Bay	Within Sodus Bay, shoreline area to the right of the Wayne Co. Water Quality Committee boat launch and at a private boat launch about one-half way out to Sodus Point.	19	yellow perch	7	5		
Lake Ontario, Sodus Point	Beach site just west of the mouth to Sodus Bay.	19A	emerald shiner	7	5		3
Lake Ontario, Oswego River	Within 500 yards west of the residence for the President of SUNY Oswego.	20	round goby	7	5		3
Lake Ontario, Salmon River at the mouth	Sandy beach area on the south side of the river inside the break wall at the river's mouth.	21	emerald shiner	7	5		3
Salmon River, Lower reservoir	At Hogsback Road picnic area.	50	banded killifish	2	2		
			spottail shiner	5	3		
Black River Bay, Area A (North)	North side of bay at river's mouth.	22	emerald shiner	7	5		3
Black River Bay, Area B-1 (Middle)	At the mouth of the river opposite Area A and along northern side of a sandy island with abandon causeway posts (Sackets Harbor).	23	emerald shiner	7	5		1
St. Lawrence River, Cape Vincent	100 yards of shoreline in front of private homes/camps at the west edge of the Burnham Point State Park, not same area sampled in 1992.	25	round goby	7	5		
St. Lawrence River, Oswegatchie River	East and west sides of the peninsula near the light house at the river's mouth.	26	round goby	2	2		
			spottail shiner	5	3		
St. Lawrence River, Barnhart Island (above dam)	Barnhart Island State Park - 150 yards east of the public beach in a small embayment.	27	emerald shiner	7	5		
St. Lawrence River, Upstream of Reynolds Metal Co.	St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	5		

Table 1 (continued).

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
St. Lawrence River, Dead Clam Cove	Dead Clam Cove - small cove located just upstream of site #28. Reynolds Metal has a discharge outfall here. Area has been remediated.	54	round goby	5	5		
			yellow perch	2	2		
St. Lawrence River, Reynolds Metal Co.	100 yards of south shoreline with two discharges from the Reynolds Metal Co.	28	round goby	4	4		
			yellow perch	3	3		
St. Lawrence River, Upstream from General Motors Co.	Just downstream of Seaway International Bridge and just upstream (150 yards) of General Motors Co. for 150 yards.	55	rock bass	3	3		
			round goby	4	2		
St. Lawrence River, General Motors Co.	Embayment area adjacent to a remediated General Motors Co. landfill, and along the western shoreline for 150 yards.	29	rock bass	7	5		
Grasse River, 0.5 mile above mouth	Northwest side about 850 yards upstream from river's mouth, access via VFW Legion Post.	30	spottail shiner	7	5		
Grasse River, Above Massena Dam	North side about 175 yards above the Massena Dam (dam broken), upstream from Rt. 420 and across from the VFW boat launch.	31	spottail shiner	7	5		
Grasse River, Route 37 Bridge	Southwest corner of State Route 37 Bridge, just upstream of bridge. This site is the new “upstream most” site and is just upstream of Massena.	51	fallfish	7	5		
Raquette River, 0.5 mile above mouth	Small embayment on south shore about 1300-1400 yards upstream from river's mouth, access via boat.	32	bluntnose minnow	7	5		
Raquette River, Reynolds Metal Company	North shoreline at the Franklin/St. Lawrence Co. Line, upstream from Rt. 37 bridge, access via field road off seasonal Indian Road.	33	bluntnose minnow	2	2		
			brook silverside	1	1		
			emerald shiner	4	2		

Table 1 (continued).

Station Name	Description	Station	Species	N Hg PCB OCP	N PFAS	N PCDD/F	N PBDE
Raquette River, About 1 mile upstream from Reynolds Metal Company	About 500 yards downstream from the Rt. 37C bridge off North Raquette River Rd. (Raquette River).	34	emerald shiner	7	5		
Raquette River, 1.9 Miles upstream from SR-37C bridge	About 1.9 miles upstream from the Rt. 37C bridge off North Raquette River Road.	52	bluntnose minnow	4	3		
			emerald shiner	3	2		
Raquette River, In Massena	North shoreline above the Rt. 420 bridge, about 50 -75 yards downstream from Trout Brook.	35	bluntnose minnow	6	5		
			rock bass	3	3		
St. Regis River, Near mouth	Near mouth of St. Regis River on southwest corner of small island, near United States – Canada Border.	56	bluntnose minnow	2	2		
			emerald shiner	5	3		

Table 2. Analytical methods, detection limits, and measures of accuracy and precision.

Parameter	***Detection limit[1]***	***Quantification Limit***	***Estimated Accuracy***	***Estimated precision***	***Analytical Method***
Lipid	–	0.01%	± 30%	0.2%	Gravimetric
Moisture	–	0.1%	± 30%	≤ 2.5%	Gravimetric
Aroclor 1242	–	10 ng/g	± 50%	≤ 50%	HCFS SOP OC1.108
Aroclor 1254/1260	–	30 ng/g	± 50%	≤ 50%	HCFS SOP OC1.108
p,p'-DDTs	–	2 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
o,p'-DDTs	–	5 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
Mirex	–	2 ng/g	± 50%	≤ 50%	HCFS SOP OC1.108
Photomirex	–	5 ng/g	± 50%	≤ 50%	HCFS SOP OC1.108
HCB	–	2 ng/g	± 50%	≤ 50%	HCFS SOP OC1.108
Chlordane analytes	–	5 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
Aldrin	–	5 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
Heptachlor + its epoxide	–	5 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
HCHs	–	5 ng/g each	± 50%	≤ 50%	HCFS SOP OC1.108
Mercury (total)	–	4 ng/g	± 10%	≤ 20%	HC-405
PBDEs	0.0005 – 0.020 ng/g	Variable	± 30%	≤ 40%	EPA Method 1614
PCDD/Fs	0.00001 – 0.002 ng/g	Variable	± 30%	≤ 40%	EPA Method 1613B
PFAS	–	1–2 ng/g	± 30%	≤ 30%	HCFS SOP HC-511

[1] NYSDEC's Analytical Services Unit reports only fully quantified results.

Table 3. Collected species for each class of analytes.

Table 3a. PCB, organochlorine pesticide, and mercury species breakdown.

	Number of Composites	Percent of the Total Composites	Number of Sites	Percent of Sites
emerald shiner	112	28.6	20	36.4
bluntnose minnow	105	26.8	19	34.5
spottail shiner	52	13.3	8	14.5
round goby	38	9.7	8	14.5
rock bass	20	5.1	4	7.3
bluegill	16	4.1	4	7.3
yellow perch	12	3.1	3	5.5
brook silverside	10	2.6	3	5.5
fallfish	7	1.8	1	1.8
striped shiner	7	1.8	1	1.8
common shiner	5	1.3	3	5.5
rainbow smelt	5	1.3	1	1.8
banded killifish	3	0.8	2	3.6
Total	392		55[1]	

Table 3b. PFAS species breakdown.

	Number of Composites	Percent of the Total Composites	Number of Sites	Percent of Sites
emerald shiner	73	26.4	19	34.5
bluntnose minnow	72	26.0	19	34.5
spottail shiner	36	13.0	8	14.5
round goby	28	10.1	7	12.7
rock bass	16	5.8	4	7.3
bluegill	12	4.3	3	5.5
yellow perch	10	3.6	3	5.5
brook silverside	8	2.9	3	5.5
common shiner	5	1.8	3	5.5
fallfish	5	1.8	1	1.8
striped shiner	5	1.8	1	1.8
rainbow smelt	4	1.4	1	1.8
banded killifish	3	1.1	2	3.6
Total	277		55[1]	

Table 3c. PCDD/F species breakdown.

	Number of Composites	Percent of the Total Composites	Number of Sites	Percent of Sites
bluntnose minnow	23	46	7	63.6
emerald shiner	11	22	4	36.4
spottail shiner	5	10	1	9.1
bluegill	4	8	1	9.1
rainbow smelt	4	8	1	9.1
brook silverside	2	4	1	9.1
common shiner	1	2	1	9.1
Total	50		11[1]	

Table 3d. PBDE species breakdown.

	Number of Composites	Percent of the Total Composites	Number of Sites	Percent of Sites
emerald shiner	17	73.9	6	75.0
round goby	3	13.0	1	12.5
striped shiner	3	13.0	1	12.5
Total	23		8	

[1] The total is the number of sites, not the sum of the rows for each species, because some sites had more than one species.

Table 4. Summary of length and weight field data, by sampling location, for young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Location	Station	Species	N	Length Mean ± SD[1]	Length Range	Weight Mean ± SD[1]	Weight Range
Lake Erie, Dunkirk	1	emerald shiner	7	51.8 ± 11.05	34.9–68.4	1.14 ± 0.64	0.4–2.2
Lake Erie, Smokes Creek	2	emerald shiner	7	52.5 ± 4.4	46.3–59.2	1.13 ± 0.28	0.7–1.6
Buffalo River	3	spottail shiner	7	58.6 ± 8.7	48.6–70.8	1.84 ± 0.82	1.0–3.0
Niagara River, Strawberry Island	4	bluntnose minnow	6	40.5 ± 6.19	34.1–49.9	0.58 ± 0.3	0.3–1.1
		banded killifish	1	46.5	–	0.98	–
Niagara River, Beaver Island State Park	5	spottail shiner	7	41.8 ± 5.76	34.7–51.9	0.59 ± 0.32	0.2–1.2
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	49.1 ± 3.5	43.9–53	1.05 ± 0.23	0.7–1.3
Twomile Creek	58	common shiner	3	49.9 ± 4.74	44.4–52.9	1.30 ± 0.34	0.9–1.6
		emerald shiner	7	44.8 ± 9.61	29.9–56.1	0.74 ± 0.39	0.2–1.3
Niagara River, Niawanda Park	67	emerald shiner	2	68.4 ± 11.01	60.6–76.2	2.24 ± 0.88	1.6–2.9
		rainbow smelt	5	59.1 ± 4.76	55.1–67.2	1.07 ± 0.25	0.8–1.5
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	49.4 ± 6.42	41.7–61.5	1.05 ± 0.47	0.6–2.0
Niagara River, Pettit Flume	6	bluegill	7	44.5 ± 4.73	36.6–48.9	1.46 ± 0.44	0.8–2.0
Niagara River, Between Pettit Flume and Gratwick- Riverside Park	60	brook silverside	7	69.1 ± 2.84	64.9–72	1.53 ± 0.19	1.3–1.7
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	5	49.4 ± 5.06	43.2–56.5	1.07 ± 0.37	0.6–1.6
		brook silverside	2	73.7 ± 2.37	72.1–75.4	1.77 ± 0.12	1.7–1.9
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	47.7 ± 5.91	37.2–53.6	0.97 ± 0.35	0.4–1.4
		emerald shiner	1	50.2	–	0.92	–
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	64.6 ± 5.78	56.7–70.8	1.91 ± 0.53	1.2–2.6
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	58.7 ± 9.14	45.7–68.3	1.79 ± 0.82	0.7–2.7
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	40.1 ± 4.05	34.3–45.8	0.54 ± 0.17	0.3–0.8
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	43.5 ± 5.21	35.2–51.1	0.64 ± 0.26	0.3–1.1
		emerald shiner	3	54.2 ± 6.75	47.0–60.4	1.09 ± 0.35	0.7–1.4
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	51.5 ± 11.1	38.8–67.3	1.36 ± 0.99	0.5–2.9
Cayuga Creek, Porter Road	14	bluntnose minnow	7	59.6 ± 8.14	47.1–65	2.11 ± 0.77	0.9–2.7
Cayuga Creek, Lockport Road	66	bluegill	5	60.5 ± 4.76	54.7–67.3	4.24 ± 0.93	2.8–5.2
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	48.7 ± 3.86	41.6–53.5	0.89 ± 0.17	0.6–1.1

Table 4 (continued).

Location	Station	Species	N	Length Mean ± SD[1]	Length Range	Weight Mean ± SD[1]	Weight Range
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	46.3 ± 3.39	43.9–48.7	1.60 ± 0.3	1.4–1.8
		bluntnose minnow	2	58.4 ± 12.07	49.8–66.9	2.00 ± 1.27	1.1–2.9
		common shiner	1	65.8	–	2.66	–
		emerald shiner	2	69.8 ± 12.05	61.3–78.3	2.67 ± 1.42	1.7–3.7
Bergholtz Creek	12	bluntnose minnow	7	48.7 ± 5.18	41.9–56.7	1.00 ± 0.38	0.5–1.7
Black Creek	64	bluntnose minnow	6	48.8 ± 8.01	40.7–63.3	1.08 ± 0.64	0.5–2.3
		common shiner	1	57.0	–	1.84	–
Gill Creek	15B	bluegill	2	45.1 ± 2.64	43.3–47	1.47 ± 0.3	1.3–1.7
		bluntnose minnow	3	81.2 ± 1.53	79.5–82.5	5.20 ± 0.44	4.7–5.6
		round goby	2	59.9 ± 7.9	54.3–65.5	2.84 ± 1	2.1–3.5
Gill Creek	15A	spottail shiner	7	58.8 ± 5.34	50.4–64.8	1.76 ± 0.48	1.0–2.4
Niagara River - Lewiston	16	spottail shiner	7	45.8 ± 8.45	34.7–58.2	0.90 ± 0.55	0.3–1.9
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	57.8 ± 9.92	44.7–66.9	1.40 ± 0.62	0.6–2.0
Eighteenmile Creek	69	rock bass	7	57.5 ± 4.2	51.7–64.5	3.14 ± 0.64	2.3–4.3
Eighteenmile Creek	68	striped shiner	7	52.8 ± 6.67	42.5–64.2	1.29 ± 0.5	0.7–2.2
Lake Ontario, Genesee River	18	emerald shiner	7	52.2 ± 4.66	45.5–59.9	0.92 ± 0.24	0.6–1.4
Lake Ontario, Sodus Bay	19	yellow perch	7	65.9 ± 8.23	54.2–79.2	2.74 ± 1.03	1.4–4.6
Lake Ontario, Sodus Point	19A	emerald shiner	7	43.9 ± 5.41	35.9–49.6	0.65 ± 0.2	0.4–0.9
Lake Ontario, Oswego River	20	round goby	7	37.9 ± 6.51	26.1–45.7	0.72 ± 0.32	0.3–1.2
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	44.1 ± 3.45	38.7–48.8	0.64 ± 0.16	0.4–0.9
Salmon River, Lower reservoir	50	banded killifish	2	53.4 ± 5.64	49.4–57.4	1.46 ± 0.42	1.2–1.8
		spottail shiner	5	59.2 ± 5.79	53.2–67.5	1.84 ± 0.63	1.3–2.8
Black River Bay, Area A (North)	22	emerald shiner	7	33.8 ± 4.78	27.5–40.9	0.32 ± 0.12	0.2–0.5
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	36.7 ± 4.74	28.9–43.5	0.35 ± 0.12	0.2–0.5
St. Lawrence River, Cape Vincent	25	round goby	7	46.5 ± 7.09	31.9–52.2	1.28 ± 0.48	0.4–1.8
St. Lawrence River, Oswegatchie River	26	round goby	2	40.4 ± 4.19	37.4–43.3	0.77 ± 0.23	0.6–0.9
		spottail shiner	5	39.9 ± 6.44	30.7–46.5	0.49 ± 0.2	0.2–0.7
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	49.0 ± 9.79	33.5–57.7	1.28 ± 0.72	0.3–2.3
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	60.4 ± 12.36	40.5–72	2.98 ± 1.58	0.8–4.6

Table 4 (continued).

Location	Station	Species	N	Length Mean ± SD[1]	Length Range	Weight Mean ± SD[1]	Weight Range
St. Lawrence River, Dead Clam Cove	54	round goby	5	68.8 ± 4.87	62.3–75.5	4.55 ± 1.03	3.2–5.9
		yellow perch	2	65.9 ± 6.24	61.5–70.3	3.36 ± 1.05	2.6–4.1
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	67.7 ± 5.4	61.2–72.8	4.28 ± 1.06	3.1–5.3
		yellow perch	3	63.0 ± 3.67	59.0–66.2	2.75 ± 0.57	2.1–3.2
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	42.8 ± 2.15	40.6–44.9	1.41 ± 0.21	1.2–1.6
		round goby	4	54.7 ± 13.03	38.9–65.7	2.42 ± 1.55	0.7–4.0
St. Lawrence River, General Motors Co.	29	rock bass	7	42.2 ± 1.76	40.0–44.4	1.32 ± 0.15	1.2–1.5
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	55.7 ± 6.55	48.0–64.4	1.71 ± 0.66	1.0–2.6
Grasse River, Above Massena Dam	31	spottail shiner	7	34.4 ± 5.9	24.3–43.3	0.35 ± 0.2	0.1–0.7
Grasse River, Route 37 Bridge	51	fallfish	7	54.1 ± 3.32	49.3–57	1.54 ± 0.24	1.2–1.8
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	37.8 ± 3.72	30.9–42.6	0.45 ± 0.13	0.2–0.7
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	48.2 ± 8.4	42.3–54.2	1.01 ± 0.54	0.6–1.4
		brook silverside	1	72.0	–	1.66	–
		emerald shiner	4	42.2 ± 17.22	27.7–66.8	0.84 ± 1.02	0.2–2.4
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	48.9 ± 7.39	38.0–55	1.01 ± 0.4	0.4–1.4
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	39.9 ± 4.92	35.1–46.6	0.50 ± 0.22	0.3–0.8
		emerald shiner	3	41.1 ± 14.7	30.5–57.9	0.70 ± 0.8	0.2–1.6
Raquette River, In Massena	35	bluntnose minnow	6	38.0 ± 7.83	29.7–48.6	0.49 ± 0.28	0.2–0.9
		rock bass	3	42.5 ± 2.07	40.2–44.3	1.40 ± 0.2	1.2–1.5
St. Regis River, Near mouth	56	bluntnose minnow	2	42.3 ± 1.34	41.4–43.3	0.66 ± 0.05	0.6–0.7
		emerald shiner	5	40.2 ± 8.32	31.9–51.5	0.59 ± 0.38	0.2–1.2

[1] Mean and standard deviation (SD) are calculated from mean lengths and weights of fish composites, not individual fish.

Table 5. Mean percent lipid, standard deviation, and range by species for samples analyzed by the NYSDEC ASU.

	Mean Percent Lipid	Standard Deviation	Range
banded killifish	4.64	0.425	4.23 – 5.08
bluegill	4.25	0.673	2.97 – 5.75
bluntnose minnow	4.13	1.452	2.12 – 8.00
brook silverside	5.61	0.595	4.61 – 6.37
common shiner	4.43	1.477	2.99 – 6.72
emerald shiner	4.69	1.652	2.04 – 9.47
fallfish	3.34	0.775	2.55 – 4.55
rainbow smelt	1.53	0.199	1.22 – 1.78
rock bass	3.55	0.543	2.62 – 4.76
round goby	3.14	0.971	1.80 – 4.97
spottail shiner	3.84	1.149	1.92 – 6.18
striped shiner	3.58	0.433	2.92 – 4.37
yellow perch	2.08	0.536	1.16 – 2.92

Table 6. Mercury concentrations (ppm wet weight) in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Location	Station	Species	N	Mean ± SD	Min	Max
Lake Erie, Dunkirk	1	emerald shiner	7	0.0076 ± 0.00178	0.006	0.0108
Lake Erie, Smokes Creek	2	emerald shiner	7	0.0060 ± 0.00117	0.0043	0.0076
Buffalo River	3	spottail shiner	7	0.0289 ± 0.00977	0.021	0.0433
Niagara River, Strawberry Island	4	bluntnose minnow	6	0.0059 ± 0.00075	0.0046	0.0066
		banded killifish	1	0.0076	0.0076	0.0076
Niagara River, Beaver Island State Park	5	spottail shiner	7	0.0061 ± 8e-04	0.0053	0.0074
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	0.0107 ± 0.00248	0.0083	0.0157
Twomile Creek	58	common shiner	3	0.0218 ± 0.00147	0.0205	0.0234
		emerald shiner	7	0.0098 ± 0.00133	0.0083	0.0116
Niagara River, Niawanda Park	67	emerald shiner	2	0.0148 ± 0.00559	0.0108	0.0187
		rainbow smelt	5	0.0013 ± 8e-05	0.0012	0.0014
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	0.0065 ± 0.00263	0.0048	0.0123
Niagara River, Pettit Flume	6	bluegill	7	0.0063 ± 0.00063	0.0053	0.0071
Niagara River, Between Pettit Flume and Gratwick- Riverside Park	60	brook silverside	7	0.0088 ± 0.00169	0.0066	0.0116
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	5	0.0079 ± 0.00078	0.007	0.0091
		brook silverside	2	0.0106 ± 0.0012	0.0098	0.0115
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	0.0116 ± 0.00283	0.0083	0.0162
		emerald shiner	1	0.0136	0.0136	0.0136
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	0.0109 ± 0.00169	0.0086	0.0129
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	0.0235 ± 0.00724	0.015	0.0317
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	0.0157 ± 0.00117	0.0146	0.018
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	0.0111 ± 0.00145	0.0093	0.0134
		emerald shiner	3	0.0173 ± 0.00438	0.0124	0.0209
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	0.0150 ± 0.00739	0.009	0.0282
Cayuga Creek, Porter Road	14	bluntnose minnow	7	0.0136 ± 0.00819	0.0021	0.0227
Cayuga Creek, Lockport Road	66	bluegill	5	0.0342 ± 0.01527	0.0217	0.0602

Table 6 (continued).

Location	Station	Species	N	Mean ± SD	Min	Max
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	0.0084 ± 0.00169	0.0066	0.0117
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	0.0111 ± 0.00636	0.0066	0.0156
		bluntnose minnow	2	0.0187 ± 0.01117	0.0108	0.0266
		common shiner	1	0.0210	0.021	0.021
		emerald shiner	2	0.0171 ± 0.00339	0.0147	0.0195
Bergholtz Creek	12	bluntnose minnow	7	0.0106 ± 0.00095	0.0095	0.0122
Black Creek	64	bluntnose minnow	6	0.0132 ± 0.0042	0.009	0.021
		common shiner	1	0.0125	0.0125	0.0125
Gill Creek	15B	bluegill	2	0.1044 ± 0.01442	0.0942	0.1146
		bluntnose minnow	3	0.0916 ± 0.00598	0.0873	0.0984
		round goby	2	0.1141 ± 0.0058	0.11	0.1182
Gill Creek	15A	spottail shiner	7	0.0774 ± 0.01778	0.0542	0.1049
Niagara River - Lewiston	16	spottail shiner	7	0.0114 ± 0.00203	0.0091	0.0143
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	0.0192 ± 0.00355	0.0156	0.0256
Eighteenmile Creek	69	rock bass	7	0.0241 ± 0.00166	0.0214	0.0267
Eighteenmile Creek	68	striped shiner	7	0.0143 ± 0.00152	0.0122	0.0165
Lake Ontario, Genesee River	18	emerald shiner	7	0.0196 ± 0.00159	0.0169	0.0215
Lake Ontario, Sodus Bay	19	yellow perch	7	0.0214 ± 0.00517	0.0132	0.0289
Lake Ontario, Sodus Point	19A	emerald shiner	7	0.0138 ± 0.00197	0.0111	0.0162
Lake Ontario, Oswego River	20	round goby	7	0.0058 ± 0.00093	0.005	0.0072
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	0.0227 ± 0.00339	0.0174	0.0263
Salmon River, Lower reservoir	50	banded killifish	2	0.0291 ± 0.00099	0.0284	0.0298
		spottail shiner	5	0.0404 ± 0.00341	0.0369	0.0459
Black River Bay, Area A (North)	22	emerald shiner	7	0.0373 ± 0.00773	0.0291	0.0462
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	0.0516 ± 0.00287	0.0488	0.0567
St. Lawrence River, Cape Vincent	25	round goby	7	0.0263 ± 0.00159	0.0239	0.0282
St. Lawrence River, Oswegatchie River	26	round goby	2	0.0106 ± 0.00064	0.0102	0.0111
		spottail shiner	5	0.0115 ± 0.00126	0.0099	0.013
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	0.0143 ± 0.00521	0.008	0.0213

Table 6 (continued).

Location	Station	Species	N	Mean ± SD	Min	Max
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	0.0130 ± 0.00347	0.008	0.0186
St. Lawrence River, Dead Clam Cove	54	round goby	5	0.0160 ± 0.00236	0.0139	0.0198
		yellow perch	2	0.0066 ± 0.00028	0.0064	0.0068
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	0.0180 ± 0.00761	0.0129	0.0293
		yellow perch	3	0.0111 ± 0.00142	0.01	0.0127
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	0.0382 ± 0.05053	0.0081	0.0965
		round goby	4	0.0130 ± 0.00464	0.0071	0.0179
St. Lawrence River, General Motors Co.	29	rock bass	7	0.0089 ± 0.00077	0.0077	0.0102
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	0.0267 ± 0.0086	0.0178	0.044
Grasse River, Above Massena Dam	31	spottail shiner	7	0.0328 ± 0.00209	0.0297	0.0356
Grasse River, Route 37 Bridge	51	fallfish	7	0.0446 ± 0.00689	0.0377	0.0565
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	0.0569 ± 0.0206	0.0331	0.0831
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	0.0382 ± 0.00629	0.0337	0.0426
		brook silverside	1	0.0346	0.0346	0.0346
		emerald shiner	4	0.0380 ± 0.0094	0.03	0.0505
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	0.0797 ± 0.02949	0.0438	0.126
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	0.0222 ± 0.00483	0.0191	0.0294
		emerald shiner	3	0.0232 ± 0.00089	0.0222	0.0239
Raquette River, In Massena	35	bluntnose minnow	6	0.0238 ± 0.00153	0.0214	0.0255
		rock bass	3	0.0287 ± 0.00289	0.0254	0.0305
St. Regis River, Near mouth	56	bluntnose minnow	2	0.0383 ± 0.00042	0.038	0.0386
		emerald shiner	5	0.0232 ± 0.00307	0.0197	0.0273

Table 7. Detections and concentrations of PCBs (ppm wet weight) in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Table 7a. Aroclor 1242.

Location	Station	Species	N	Aroclor 1242 Detects	Aroclor 1242 Min	Aroclor 1242 Max	Aroclor 1242 Median	Aroclor 1242 Mean ± SD
Lake Erie, Dunkirk	1	emerald shiner	7	7	0.0156	0.0355	0.0205	0.0238 ± 0.00715
Lake Erie, Smokes Creek	2	emerald shiner	7	0	ND	ND	ND	–
Buffalo River	3	spottail shiner	7	7	0.0137	0.027	0.0154	0.0168 ± 0.00462
Niagara River, Strawberry Island	4	bluntnose minnow	6	0	ND	ND	ND	–
		banded killifish	1	0	ND	ND	ND	–
Niagara River, Beaver Island State Park	5	spottail shiner	7	0	ND	ND	ND	–
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	7	0.0455	0.0558	0.0475	0.0499 ± 0.00452
Twomile Creek	58	common shiner	3	3	0.235	0.462	0.391	0.3627 ± 0.11612
		emerald shiner	7	7	0.117	0.222	0.189	0.1746 ± 0.03789
Niagara River, Niawanda Park	67	emerald shiner	2	2	0.0124	0.0198	0.0161	0.0161 ± 0.00523
		rainbow smelt	5	0	ND	ND	ND	–
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	7	0.0527	0.0894	0.0668	0.0668 ± 0.01204
Niagara River, Pettit Flume	6	bluegill	7	7	0.025	0.0333	0.0296	0.0293 ± 0.00323
Niagara River, Between Pettit Flume and Gratwick-Riverside Park	60	brook silverside	7	7	0.223	0.376	0.298	0.2993 ± 0.0517
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	5	5	0.128	0.156	0.14	0.1428 ± 0.01197
		brook silverside	2	2	0.151	0.16	0.156	0.1555 ± 0.00636
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	7	0.0789	0.119	0.0933	0.0962 ± 0.01527
		emerald shiner	1	1	0.041	0.041	0.041	0.0410
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	6	ND	0.0288	0.0133	–
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	7	0.0921	0.254	0.189	0.1740 ± 0.06618
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	7	0.0448	0.0858	0.054	0.0625 ± 0.01609
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	6	0.0542	0.116	0.075	0.0786 ± 0.02116
		emerald shiner	3	3	0.0508	0.336	0.0681	0.1516 ± 0.1599
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	7	0.0601	0.197	0.0838	0.1134 ± 0.05805

Table 7a (continued).

Location	Station	Species	N	Aroclor 1242 Detects	Aroclor 1242 Min	Aroclor 1242 Max	Aroclor 1242 Median	Aroclor 1242 Mean ± SD
Cayuga Creek, Porter Road	14	bluntnose minnow	7	7	0.0624	0.159	0.105	0.1130 ± 0.03957
Cayuga Creek, Lockport Road	66	bluegill	5	5	0.0127	0.0163	0.0145	0.0146 ± 0.0015
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	7	0.0439	0.113	0.0607	0.0661 ± 0.02236
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	2	0.0858	0.103	0.0944	0.0944 ± 0.01216
		bluntnose minnow	2	2	0.0998	0.193	0.146	0.1464 ± 0.0659
		common shiner	1	1	0.166	0.166	0.166	0.1660
		emerald shiner	2	2	0.0381	0.0824	0.0602	0.0602 ± 0.03132
Bergholtz Creek	12	bluntnose minnow	7	7	0.0643	0.105	0.0814	0.0815 ± 0.01309
Black Creek	64	bluntnose minnow	6	6	0.0246	0.188	0.0642	0.0785 ± 0.05938
		common shiner	1	1	0.0561	0.0561	0.0561	0.0561
Gill Creek	15B	bluegill	2	2	0.239	0.265	0.252	0.2520 ± 0.01838
		bluntnose minnow	3	3	0.269	0.821	0.557	0.5490 ± 0.27609
		round goby	2	2	0.208	0.369	0.288	0.2885 ± 0.11384
Gill Creek	15A	spottail shiner	7	7	0.0207	0.0934	0.0334	0.0422 ± 0.02422
Niagara River - Lewiston	16	spottail shiner	7	7	0.0206	0.205	0.0252	0.0530 ± 0.06742
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	8	0.0427	0.0885	0.0564	0.0597 ± 0.01616
Eighteenmile Creek	69	rock bass	7	7	1.27	1.98	1.81	1.7186 ± 0.25387
Eighteenmile Creek	68	striped shiner	7	7	0.8	2.55	1.27	1.4957 ± 0.59517
Lake Ontario, Genesee River	18	emerald shiner	7	7	0.0206	0.0313	0.0267	0.0258 ± 0.00374
Lake Ontario, Sodus Bay	19	yellow perch	7	7	0.0393	0.061	0.0461	0.0471 ± 0.00729
Lake Ontario, Sodus Point	19A	emerald shiner	7	7	0.0113	0.0176	0.0139	0.0144 ± 0.00254
Lake Ontario, Oswego River	20	round goby	7	7	0.013	0.0239	0.0193	0.0180 ± 0.00445
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	7	0.0115	0.0224	0.0173	0.0172 ± 0.00431
Salmon River, Lower reservoir	50	banded killifish	2	2	0.0102	0.0112	0.0107	0.0107 ± 0.00071
		spottail shiner	5	3	ND	0.0131	0.011	–
Black River Bay, Area A (North)	22	emerald shiner	7	7	0.173	0.224	0.203	0.2014 ± 0.01936
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	7	0.133	0.163	0.146	0.1454 ± 0.01116
St. Lawrence River, Cape Vincent	25	round goby	7	0	ND	ND	ND	–

Table 7a (continued).

Location	Station	Species	N	Aroclor 1242 Detects	Aroclor 1242 Min	Aroclor 1242 Max	Aroclor 1242 Median	Aroclor 1242 Mean ± SD
St. Lawrence River, Oswegatchie River	26	round goby	2	2	0.0757	0.076	0.0758	0.0758 ± 0.00021
		spottail shiner	5	5	0.0975	0.264	0.112	0.1401 ± 0.07015
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	5	ND	0.0195	0.0137	–
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	7	0.064	0.208	0.0977	0.1162 ± 0.0526
St. Lawrence River, Dead Clam Cove	54	round goby	5	5	1.01	3.54	2.42	2.3780 ± 1.05519
		yellow perch	2	2	0.562	0.8	0.681	0.6810 ± 0.16829
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	4	0.325	0.411	0.354	0.3610 ± 0.04101
		yellow perch	3	3	0.0746	0.155	0.133	0.1209 ± 0.04155
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	3	0.363	0.398	0.386	0.3823 ± 0.01779
		round goby	4	4	1.15	2.85	1.7	1.8500 ± 0.73194
St. Lawrence River, General Motors Co.	29	rock bass	7	7	2.08	2.73	2.39	2.4114 ± 0.24052
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	7	0.292	0.489	0.407	0.4057 ± 0.06296
Grasse River, Above Massena Dam	31	spottail shiner	7	7	0.0163	0.0321	0.0266	0.0248 ± 0.00571
Grasse River, Route 37 Bridge	51	fallfish	7	0	ND	ND	ND	–
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	7	0.0229	0.0519	0.0337	0.0351 ± 0.00881
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	2	0.148	0.183	0.165	0.1655 ± 0.02475
		brook silverside	1	1	0.141	0.141	0.141	0.1410
		emerald shiner	4	4	0.0609	0.117	0.0695	0.0792 ± 0.02571
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	7	0.0159	0.0366	0.0295	0.0277 ± 0.00724
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	4	0.0148	0.0176	0.0166	0.0164 ± 0.00134
		emerald shiner	3	3	0.0154	0.0173	0.0166	0.0164 ± 0.00096
Raquette River, In Massena	35	bluntnose minnow	6	6	0.0142	0.0352	0.0165	0.0199 ± 0.00798
		rock bass	3	3	0.0254	0.0278	0.0271	0.0268 ± 0.00123
St. Regis River, Near mouth	56	bluntnose minnow	2	1	ND	0.02	0.005	–
		emerald shiner	5	3	ND	0.0148	0.0122	–

Table 7b. Aroclor 1254/1260.

Location	Station	Species	N	Aroclor 125460 Detects	Aroclor 125460 Min	Aroclor 125460 Max	Aroclor 125460 Median	Aroclor 125460 Mean ± SD
Lake Erie, Dunkirk	1	emerald shiner	7	0	ND	ND	ND	–
Lake Erie, Smokes Creek	2	emerald shiner	7	0	ND	ND	ND	–
Buffalo River	3	spottail shiner	7	5	ND	0.0682	0.0474	–
Niagara River, Strawberry Island	4	bluntnose minnow	6	0	ND	ND	ND	–
		banded killifish	1	0	ND	ND	ND	–
Niagara River, Beaver Island State Park	5	spottail shiner	7	0	ND	ND	ND	–
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	7	0.0351	0.0452	0.0425	0.0415 ± 0.00376
Twomile Creek	58	common shiner	3	3	0.301	0.451	0.397	0.3830 ± 0.07597
		emerald shiner	7	7	0.0778	0.224	0.123	0.1309 ± 0.05467
Niagara River, Niawanda Park	67	emerald shiner	2	2	0.0309	0.107	0.069	0.0689 ± 0.05381
		rainbow smelt	5	0	ND	ND	ND	–
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	7	0.0389	0.0772	0.0424	0.0478 ± 0.01355
Niagara River, Pettit Flume	6	bluegill	7	7	0.0316	0.0427	0.0364	0.0361 ± 0.00403
Niagara River, Between Pettit Flume and Gratwick-Riverside Park	60	brook silverside	7	7	0.0719	0.119	0.098	0.0978 ± 0.01658
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	5	5	0.0687	0.0842	0.0741	0.0745 ± 0.00604
		brook silverside	2	2	0.0659	0.0717	0.0688	0.0688 ± 0.0041
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	7	0.0567	0.069	0.0623	0.0631 ± 0.00398
		emerald shiner	1	0	ND	ND	ND	–
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	7	0.0312	0.0393	0.0348	0.0357 ± 0.00319
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	7	0.0896	0.226	0.198	0.1685 ± 0.05632
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	7	0.0458	0.0751	0.0568	0.0596 ± 0.01064
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	6	0.0767	0.116	0.0907	0.0928 ± 0.01382
		emerald shiner	3	3	0.0634	0.596	0.0651	0.2415 ± 0.30701
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	7	0.0542	0.22	0.0836	0.1269 ± 0.06927
Cayuga Creek, Porter Road	14	bluntnose minnow	7	7	0.115	0.272	0.195	0.1991 ± 0.06733

Table 7b (continued).

Location	Station	Species	N	Aroclor 125460 Detects	Aroclor 125460 Min	Aroclor 125460 Max	Aroclor 125460 Median	Aroclor 125460 Mean ± SD
Cayuga Creek, Lockport Road	66	bluegill	5	1	ND	0.0363	ND	–
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	7	0.0544	0.173	0.062	0.0772 ± 0.04262
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	2	0.0924	0.125	0.109	0.1087 ± 0.02305
		bluntnose minnow	2	2	0.116	0.204	0.16	0.1600 ± 0.06223
		common shiner	1	1	0.159	0.159	0.159	0.1590
		emerald shiner	2	2	0.0818	0.109	0.0954	0.0954 ± 0.01923
Bergholtz Creek	12	bluntnose minnow	7	7	0.159	0.245	0.169	0.1859 ± 0.03198
Black Creek	64	bluntnose minnow	6	6	0.0817	0.21	0.124	0.1299 ± 0.04881
		common shiner	1	1	0.135	0.135	0.135	0.1350
Gill Creek	15B	bluegill	2	2	0.112	0.14	0.126	0.1260 ± 0.0198
		bluntnose minnow	3	3	0.263	0.505	0.389	0.3857 ± 0.12103
		round goby	2	2	0.164	0.188	0.176	0.1760 ± 0.01697
Gill Creek	15A	spottail shiner	7	7	0.0721	0.199	0.162	0.1470 ± 0.05095
Niagara River - Lewiston	16	spottail shiner	7	7	0.0331	0.0489	0.0394	0.0397 ± 0.0057
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	8	0.058	0.0942	0.0772	0.0751 ± 0.01143
Eighteenmile Creek	69	rock bass	7	7	0.412	0.515	0.468	0.4666 ± 0.03743
Eighteenmile Creek	68	striped shiner	7	7	0.575	0.913	0.64	0.6731 ± 0.11223
Lake Ontario, Genesee River	18	emerald shiner	7	7	0.0678	0.107	0.08	0.0819 ± 0.01337
Lake Ontario, Sodus Bay	19	yellow perch	7	7	0.0325	0.0578	0.0381	0.0406 ± 0.00846
Lake Ontario, Sodus Point	19A	emerald shiner	7	5	ND	0.0454	0.0362	–
Lake Ontario, Oswego River	20	round goby	7	0	ND	ND	ND	–
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	7	0.033	0.0935	0.0434	0.0538 ± 0.02198
Salmon River, Lower reservoir	50	banded killifish	2	0	ND	ND	ND	–
		spottail shiner	5	0	ND	ND	ND	–
Black River Bay, Area A (North)	22	emerald shiner	7	7	0.142	0.211	0.192	0.1804 ± 0.02436
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	7	0.137	0.174	0.148	0.1511 ± 0.01483
St. Lawrence River, Cape Vincent	25	round goby	7	0	ND	ND	ND	–
St. Lawrence River, Oswegatchie River	26	round goby	2	2	0.0408	0.0419	0.0414	0.0413 ± 0.00078

Table 7b (continued).

Location	Station	Species	N	Aroclor 125460 Detects	Aroclor 125460 Min	Aroclor 125460 Max	Aroclor 125460 Median	Aroclor 125460 Mean ± SD
		spottail shiner	5	5	0.0418	0.077	0.0476	0.0513 ± 0.01462
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	0	ND	ND	ND	–
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	7	0.104	0.204	0.121	0.1423 ± 0.0425
St. Lawrence River, Dead Clam Cove	54	round goby	5	5	0.996	2.77	1.93	1.8952 ± 0.72731
		yellow perch	2	2	0.514	0.551	0.532	0.5325 ± 0.02616
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	4	0.378	0.46	0.44	0.4295 ± 0.03564
		yellow perch	3	3	0.0921	0.147	0.133	0.1240 ± 0.02853
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	3	0.23	0.236	0.232	0.2327 ± 0.00306
		round goby	4	4	0.789	1.19	1.04	1.0172 ± 0.16924
St. Lawrence River, General Motors Co.	29	rock bass	7	7	0.978	1.23	1.03	1.0794 ± 0.10192
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	7	0.213	0.265	0.246	0.2440 ± 0.01642
Grasse River, Above Massena Dam	31	spottail shiner	7	0	ND	ND	ND	–
Grasse River, Route 37 Bridge	51	fallfish	7	0	ND	ND	ND	–
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	6	ND	0.0365	0.0348	–
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	2	0.16	0.196	0.178	0.1780 ± 0.02546
		brook silverside	1	1	0.139	0.139	0.139	0.1390
		emerald shiner	4	4	0.0606	0.109	0.0796	0.0822 ± 0.02032
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	5	ND	0.093	0.0775	–
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	4	0.0303	0.0409	0.0332	0.0344 ± 0.00481
		emerald shiner	3	2	ND	0.035	0.0303	–
Raquette River, In Massena	35	bluntnose minnow	6	1	ND	0.0363	ND	–
		rock bass	3	1	ND	0.0336	ND	–
St. Regis River, Near mouth	56	bluntnose minnow	2	0	ND	ND	ND	–
		emerald shiner	5	0	ND	ND	ND	–

Table 7c. Total PCB.

Location	Station	Species	N	Total PCB Detects	Total PCB Min	Total PCB Max	Total PCB Median	Total PCB Mean ± SD	Total PCB Lipid Normalized Mean
Lake Erie, Dunkirk	1	emerald shiner	7	7	0.0156	0.0355	0.0205	0.0238 ± 0.00715	0.5847
Lake Erie, Smokes Creek	2	emerald shiner	7	0	ND	ND	ND	–	–
Buffalo River	3	spottail shiner	7	7	0.0137	0.0842	0.0623	0.0545 ± 0.03039	2.0969
Niagara River, Strawberry Island	4	bluntnose minnow	6	0	ND	ND	ND	–	–
		banded killifish	1	0	ND	ND	ND	–	–
Niagara River, Beaver Island State Park	5	spottail shiner	7	0	ND	ND	ND	–	–
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	7	0.0806	0.101	0.0887	0.0914 ± 0.00787	2.1991
Twomile Creek	58	common shiner	3	3	0.536	0.913	0.788	0.7457 ± 0.19203	21.1237
		emerald shiner	7	7	0.1948	0.446	0.312	0.3055 ± 0.09039	8.6014
Niagara River, Niawanda Park	67	emerald shiner	2	2	0.0433	0.1268	0.085	0.0850 ± 0.05904	1.3903
		rainbow smelt	5	0	ND	ND	ND	–	–
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	7	0.0916	0.1666	0.111	0.1146 ± 0.02518	4.2576
Niagara River, Pettit Flume	6	bluegill	7	7	0.0566	0.0752	0.066	0.0654 ± 0.00705	1.5391
Niagara River, Between Pettit Flume and Gratwick- Riverside Park	60	brook silverside	7	7	0.2949	0.495	0.396	0.3971 ± 0.06777	7.1512
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	5	5	0.1967	0.2402	0.214	0.2173 ± 0.01748	5.1183
		brook silverside	2	2	0.2169	0.2317	0.224	0.2243 ± 0.01047	3.6333
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	7	0.1356	0.188	0.157	0.1593 ± 0.01892	3.1372
		emerald shiner	1	1	0.041	0.041	0.041	0.0410	1.1233
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	7	0.0393	0.06	0.0492	0.0501 ± 0.00704	0.705
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	7	0.2016	0.456	0.387	0.3425 ± 0.11867	5.6051
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	7	0.0906	0.1609	0.11	0.1221 ± 0.0263	3.7521
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	6	0.1309	0.232	0.166	0.1714 ± 0.03303	4.6099
		emerald shiner	3	3	0.1159	0.932	0.132	0.3931 ± 0.46674	7.1223
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	7	0.1179	0.404	0.167	0.2403 ± 0.12585	4.4608
Cayuga Creek, Porter Road	14	bluntnose minnow	7	7	0.1803	0.418	0.354	0.3121 ± 0.10008	4.7722

Table 7c (continued).

Location	Station	Species	N	Total PCB Detects	Total PCB Min	Total PCB Max	Total PCB Median	Total PCB Mean ± SD	Total PCB Lipid Normalized Mean
Cayuga Creek, Lockport Road	66	bluegill	5	5	0.0127	0.0526	0.0145	0.0219 ± 0.01721	0.5315
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	7	0.111	0.286	0.115	0.1433 ± 0.06381	2.7411
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	2	0.1954	0.2108	0.203	0.2031 ± 0.01089	4.8722
		bluntnose minnow	2	2	0.2158	0.397	0.306	0.3064 ± 0.12813	4.7896
		common shiner	1	1	0.325	0.325	0.325	0.3250	4.8363
		emerald shiner	2	2	0.1471	0.1642	0.156	0.1557 ± 0.01209	1.9894
Bergholtz Creek	12	bluntnose minnow	7	7	0.2233	0.35	0.254	0.2673 ± 0.04134	7.6063
Black Creek	64	bluntnose minnow	6	6	0.1063	0.346	0.171	0.2084 ± 0.09065	5.137
		common shiner	1	1	0.1911	0.1911	0.191	0.1911	3.8841
Gill Creek	15B	bluegill	2	2	0.351	0.405	0.378	0.3780 ± 0.03818	11.9648
		bluntnose minnow	3	3	0.532	1.326	0.946	0.9347 ± 0.39712	21.3898
		round goby	2	2	0.372	0.557	0.464	0.4645 ± 0.13081	17.2862
Gill Creek	15A	spottail shiner	7	7	0.0928	0.2924	0.194	0.1891 ± 0.07031	4.5624
Niagara River - Lewiston	16	spottail shiner	7	7	0.0566	0.2381	0.0732	0.0927 ± 0.06496	1.7283
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	8	0.1227	0.1543	0.131	0.1348 ± 0.0122	2.121
Eighteenmile Creek	69	rock bass	7	7	1.758	2.429	2.24	2.1851 ± 0.25189	58.5335
Eighteenmile Creek	68	striped shiner	7	7	1.44	3.463	1.88	2.1689 ± 0.68809	59.5309
Lake Ontario, Genesee River	18	emerald shiner	7	7	0.0896	0.1383	0.109	0.1077 ± 0.01658	1.5886
Lake Ontario, Sodus Bay	19	yellow perch	7	7	0.0799	0.1045	0.0833	0.0877 ± 0.0095	5.4165
Lake Ontario, Sodus Point	19A	emerald shiner	7	7	0.0114	0.0623	0.0497	0.0434 ± 0.02177	1.1432
Lake Ontario, Oswego River	20	round goby	7	7	0.013	0.0239	0.0193	0.0180 ± 0.00445	0.7124
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	7	0.0446	0.1126	0.0611	0.0710 ± 0.02348	1.3647
Salmon River, Lower reservoir	50	banded killifish	2	2	0.0102	0.0112	0.0107	0.0107 ± 0.00071	0.2428
		spottail shiner	5	3	ND	0.0131	0.011	–	–
Black River Bay, Area A (North)	22	emerald shiner	7	7	0.332	0.419	0.407	0.3819 ± 0.03931	7.8755
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	7	0.272	0.337	0.288	0.2966 ± 0.02429	6.0999
St. Lawrence River, Cape Vincent	25	round goby	7	0	ND	ND	ND	–	–

Table 7c (continued).

Location	Station	Species	N	Total PCB Detects	Total PCB Min	Total PCB Max	Total PCB Median	Total PCB Mean ± SD	Total PCB Lipid Normalized Mean
St. Lawrence River, Oswegatchie River	26	round goby	2	2	0.1165	0.1179	0.117	0.1172 ± 0.00099	4.8097
		spottail shiner	5	5	0.1393	0.341	0.16	0.1914 ± 0.08473	3.6824
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	5	ND	0.0195	0.0137	–	–
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	7	0.1709	0.412	0.208	0.2585 ± 0.09391	7.9519
St. Lawrence River, Dead Clam Cove	54	round goby	5	5	2.006	6.01	4.35	4.2732 ± 1.76568	100.8532
		yellow perch	2	2	1.076	1.351	1.21	1.2135 ± 0.19445	47.2075
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	4	0.708	0.853	0.8	0.7905 ± 0.06163	17.8543
		yellow perch	3	3	0.1667	0.302	0.266	0.2449 ± 0.07007	9.338
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	3	0.593	0.63	0.622	0.6150 ± 0.01947	17.7949
		round goby	4	4	1.939	4.04	2.74	2.8672 ± 0.87843	79.2047
St. Lawrence River, General Motors Co.	29	rock bass	7	7	3.11	3.93	3.44	3.4909 ± 0.32878	116.2635
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	7	0.505	0.734	0.66	0.6497 ± 0.07338	16.3765
Grasse River, Above Massena Dam	31	spottail shiner	7	7	0.0163	0.0321	0.0266	0.0248 ± 0.00571	0.7557
Grasse River, Route 37 Bridge	51	fallfish	7	0	ND	ND	ND	–	–
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	7	0.0333	0.0875	0.0694	0.0644 ± 0.01719	1.9907
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	2	0.308	0.379	0.344	0.3435 ± 0.0502	11.2384
		brook silverside	1	1	0.28	0.28	0.28	0.2800	5.9829
		emerald shiner	4	4	0.1215	0.226	0.149	0.1614 ± 0.0455	4.9868
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	7	0.0159	0.1296	0.11	0.0865 ± 0.04778	2.0415
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	4	0.0451	0.0585	0.0499	0.0508 ± 0.00602	1.7749
		emerald shiner	3	3	0.0173	0.0504	0.0469	0.0382 ± 0.01818	1.3083
Raquette River, In Massena	35	bluntnose minnow	6	6	0.0142	0.0715	0.0165	0.0260 ± 0.02248	0.7521
		rock bass	3	3	0.0254	0.0607	0.0278	0.0380 ± 0.01972	0.8803
St. Regis River, Near mouth	56	bluntnose minnow	2	1	ND	ND	ND	–	–
		emerald shiner	5	3	ND	ND	ND	–	–

Table 8. Detections and concentrations (ppm wet weight) of *p,p'*-DDD, *p,p'*-DDE, *p,p'*-DDT, and total DDT in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Lake Erie, Dunkirk	1	emerald shiner	7	0	7	0	7	0.0025	0.0054	0.00364	0.0037 ± 0.00093	0.0965
Lake Erie, Smokes Creek	2	emerald shiner	7	0	5	0	5	ND	0.0028	0.00215	–	–
Buffalo River	3	spottail shiner	7	0	3	0	3	ND	0.0037	ND	–	–
Niagara River, Strawberry Island	4	bluntnose minnow	6	0	0	0	0	ND	ND	ND	–	–
		banded killifish	1	0	0	0	0	ND	ND	ND	–	–
Niagara River, Beaver Island State Park	5	spottail shiner	7	0	0	0	0	ND	ND	ND	–	–
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	7	0	0	0	0	ND	ND	ND	–	–
Twomile Creek	58	common shiner	3	3	3	2	3	0.0112	0.022	0.0193	0.0175 ± 0.00561	0.4939
		emerald shiner	7	7	7	0	7	0.0083	0.0497	0.0107	0.0160 ± 0.01495	0.4464
Niagara River,	67	emerald shiner	2	0	2	0	2	0.005	0.0061	0.00553	0.0055 ± 0.00076	0.1101

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Niawanda Park		rainbow smelt	5	0	0	0	0	ND	ND	ND	–	–
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	7	1	7	0	7	0.004	0.0112	0.00463	0.0057 ± 0.00251	0.2099
Niagara River, Pettit Flume	6	bluegill	7	1	7	0	7	0.0021	0.0056	0.00229	0.0028 ± 0.00127	0.0653
Niagara River, Between Pettit Flume and Gratwick-Riverside Park	60	brook silverside	7	0	7	0	7	0.0041	0.007	0.00433	0.0048 ± 0.00106	0.0861
Niagara River, Gratwick-Riverside Park	7	bluntnose minnow	5	0	5	0	5	0.0022	0.0024	0.00235	0.0023 ± 0.00014	0.0545
		brook silverside	2	0	2	0	2	0.0035	0.0048	0.00415	0.0042 ± 0.00093	0.0668
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	7	0	7	0	7	0.0022	0.0026	0.00246	0.0024 ± 0.00013	0.0487
		emerald shiner	1	0	1	0	1	0.0038	0.0038	0.00378	0.0038	0.1036

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Niagara River, N. Grand Island Bridge	8	emerald shiner	7	0	7	0	7	0.0057	0.0085	0.007	0.0071 ± 0.00113	0.0985
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	7	7	7	0	7	0.0085	0.0241	0.016	0.0167 ± 0.00575	0.2921
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	7	2	7	0	7	0.0027	0.0075	0.00321	0.0044 ± 0.00202	0.131
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	6	6	6	0	6	0.0092	0.0126	0.0106	0.0107 ± 0.0011	0.2951
		emerald shiner	3	3	3	1	3	0.0102	0.0323	0.0138	0.0188 ± 0.01184	0.3308
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	7	7	7	0	7	0.0059	0.0195	0.00938	0.0122 ± 0.00519	0.2341
Cayuga Creek, Porter Road	14	bluntnose minnow	7	7	7	0	7	0.0403	0.0643	0.0421	0.0453 ± 0.00855	0.704
Cayuga Creek, Lockport Road	66	bluegill	5	5	5	5	5	0.0467	0.0836	0.0739	0.0694 ± 0.01392	1.4847
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	7	7	7	0	7	0.0081	0.0151	0.0113	0.0113 ± 0.00221	0.2175

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Bergholtz Creek, Upstream from old Black Creek	62	bluegill	2	2	2	0	2	0.0083	0.0096	0.00897	0.0090 ± 0.00091	0.2155
		bluntnose minnow	2	2	2	0	2	0.0079	0.0131	0.0105	0.0105 ± 0.00371	0.1656
		common shiner	1	1	1	0	1	0.0128	0.0128	0.0128	0.0128	0.19
		emerald shiner	2	2	2	0	2	0.0124	0.0157	0.014	0.0140 ± 0.00233	0.1813
Bergholtz Creek	12	bluntnose minnow	7	4	7	0	7	0.006	0.0128	0.00996	0.0093 ± 0.00238	0.2602
Black Creek	64	bluntnose minnow	6	2	6	0	6	0.0044	0.0148	0.00698	0.0087 ± 0.00465	0.2155
		common shiner	1	1	1	0	1	0.0134	0.0134	0.0134	0.0134	0.2726
Gill Creek	15B	bluegill	2	2	2	0	2	0.0079	0.01	0.00898	0.0090 ± 0.00146	0.2853
		bluntnose minnow	3	3	3	3	3	0.0238	0.0283	0.0246	0.0256 ± 0.00242	0.5931
		round goby	2	2	2	0	2	0.0084	0.0105	0.00945	0.0094 ± 0.00141	0.3536
Gill Creek	15A	spottail shiner	7	7	7	0	7	0.0123	0.0266	0.0196	0.0194 ± 0.00489	0.4661
Niagara River - Lewiston	16	spottail shiner	7	0	7	0	7	0.0044	0.0352	0.0172	0.0169 ± 0.01131	0.3051
Lake Ontario, Eighteenmile Creek	17	emerald shiner	8	4	8	0	8	0.0248	0.0464	0.0398	0.0389 ± 0.00684	0.5967
Eighteenmile Creek	69	rock bass	7	7	7	7	7	0.0649	0.0792	0.0673	0.0701 ± 0.00512	1.8726

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Eighteenmile Creek	68	striped shiner	7	7	7	7	7	0.0479	0.4455	0.0605	0.1163 ± 0.14603	3.2264
Lake Ontario, Genesee River	18	emerald shiner	7	7	7	0	7	0.0275	0.055	0.0424	0.0414 ± 0.00935	0.6111
Lake Ontario, Sodus Bay	19	yellow perch	7	7	7	0	7	0.0227	0.0367	0.0247	0.0259 ± 0.00488	1.5758
Lake Ontario, Sodus Point	19A	emerald shiner	7	1	7	0	7	0.0175	0.0325	0.0208	0.0229 ± 0.00535	0.6158
Lake Ontario, Oswego River	20	round goby	7	0	0	0	0	ND	ND	ND	–	–
Lake Ontario, Salmon River at the mouth	21	emerald shiner	7	1	7	0	7	0.0044	0.0252	0.00746	0.0102 ± 0.0073	0.1901
Salmon River, Lower reservoir	50	banded killifish	2	0	0	0	0	ND	ND	ND	–	–
		spottail shiner	5	0	0	0	0	ND	ND	ND	–	–
Black River Bay, Area A (North)	22	emerald shiner	7	0	7	0	7	0.0029	0.0066	0.00489	0.0047 ± 0.00139	0.0977
Black River Bay, Area B-1 (Middle)	23	emerald shiner	7	0	7	0	7	0.0052	0.0083	0.00693	0.0069 ± 0.00121	0.1414

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
St. Lawrence River, Cape Vincent	25	round goby	7	0	0	0	0	ND	ND	ND	–	–
St. Lawrence River, Oswegatchie River	26	round goby	2	0	0	0	0	ND	ND	ND	–	–
		spottail shiner	5	0	2	0	2	ND	0.0025	ND	–	–
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	7	0	1	0	1	ND	0.0022	ND	–	–
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	7	0	0	0	0	ND	ND	ND	–	–
St. Lawrence River, Dead Clam Cove	54	round goby	5	0	0	5	5	0.0041	0.0091	0.00631	0.0065 ± 0.00211	0.1557
		yellow perch	2	0	0	2	2	0.0021	0.0021	0.00212	0.0021 ± 3e-05	0.0823
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	0	0	0	0	ND	ND	ND	–	–
		yellow perch	3	0	0	0	0	ND	ND	ND	–	–
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	0	0	0	0	ND	ND	ND	–	–
		round goby	4	0	1	4	4	0.0041	0.0107	0.00536	0.0064 ± 0.00295	0.1883

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
St. Lawrence River, General Motors Co.	29	rock bass	7	0	6	7	7	0.0045	0.0107	0.00709	0.0081 ± 0.00243	0.274
Grasse River, 0.5 mile above mouth	30	spottail shiner	7	0	0	0	0	ND	ND	ND	–	–
Grasse River, Above Massena Dam	31	spottail shiner	7	0	1	0	1	ND	0.0023	ND	–	–
Grasse River, Route 37 Bridge	51	fallfish	7	0	0	0	0	ND	ND	ND	–	–
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	7	0	1	0	1	ND	0.0027	ND	–	–
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	0	0	0	0	ND	ND	ND	–	–
		brook silverside	1	0	0	0	0	ND	ND	ND	–	–
		emerald shiner	4	0	0	0	0	ND	ND	ND	–	–

Table 8 (continued).

Location	Station	Species	N	*p,p'*-DDD Detects	*p,p'*-DDE Detects	*p,p'*-DDT Detects	Total DDT Detects	Total DDT Min	Total DDT Max	Total DDT Median	Total DDT Mean ± SD	Total DDT Lipid Normalized Mean
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	7	0	0	0	0	ND	ND	ND	–	–
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	4	0	0	0	0	ND	ND	ND	–	–
		emerald shiner	3	0	0	0	0	ND	ND	ND	–	–
Raquette River, In Massena	35	bluntnose minnow	6	0	0	0	0	ND	ND	ND	–	–
		rock bass	3	0	0	0	0	ND	ND	ND	–	–
St. Regis River, Near mouth	56	bluntnose minnow	2	0	0	0	0	ND	ND	ND	–	–
		emerald shiner	5	0	0	0	0	ND	ND	ND	–	–

Table 9. Distribution statistics (ppb) for PFAS in individual samples. P10 through P99 are the values at the 10th through 99th percentiles; P50 is the median.

Analyte	Samples	Detects	Mean	Minimum	Maximum	P10	P50	P90	P95	P99
PFBA[1]	222	126	2.552	ND	21.9	ND	2.14	6.14	9.26	13.2
PFPeA	222	4	0.0514	ND	4.69	ND	ND	ND	ND	1.37
PFHxA	277	0	ND	ND	0	ND	ND	ND	ND	ND
PFHpA	277	1	0.003827	ND	1.06	ND	ND	ND	ND	ND
PFOA	277	5	0.02072	ND	1.2	ND	ND	ND	ND	1.12
PFNA	277	81	0.4088	ND	2.91	ND	ND	1.38	1.76	2.23
PFDA	277	223	2.58	ND	18.09	ND	2.23	4.48	6.15	14.6
PFUnA	277	242	1.971	ND	7.05	ND	1.94	3.26	3.92	5.62
PFDoA	277	162	1.487	ND	14.5	ND	1.14	3.41	5.75	9.99
PFBS	277	0	ND	ND	0	ND	ND	ND	ND	ND
PFHxS	277	5	0.05188	ND	4.09	ND	ND	ND	ND	2.48
PFOS	277	274	27.35	ND	304	3.71	15.6	52	86.3	215
PFOSA	277	52	0.9753	ND	17.5	ND	ND	3.05	5.91	16.7
Total PFAS	277	276	36.93	ND	350.89	5.67	25.5	66.3	102	257

[1] As noted in the text, many and possibly all PFBA detections may be spurious.

Table 10. Detections and concentrations (ppb wet weight) of PFOS and total PFAS in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
Lake Erie, Dunkirk	1	emerald shiner	2	2/2	8.15	10	9.07	9.07 ± 1.31	15.16	19.18	17.2	17.2 ± 2.84
Lake Erie, Smokes Creek	2	emerald shiner	5	5/5	7.99	11.4	8.98	9.58 ± 1.38	10.21	14.06	11	11.4 ± 1.53
Buffalo River	3	spottail shiner	5	5/5	3.8	5.88	5.7	5.21 ± 0.879	3.8	8.34	8.18	7.15 ± 1.93
Niagara River, Strawberry Island	4	bluntnose minnow	1	1/1	20.5	20.5	20.5	20.5	29.37	29.37	29.4	29.4
		banded killifish	1	1/1	18	18	18	18	21.5	21.5	21.5	21.5
Niagara River, Beaver Island State Park	5	spottail shiner	5	5/5	8.44	12.2	12.1	11.2 ± 1.6	14.07	18.98	15.6	16.3 ± 1.89
Niagara River, Tonawanda Coke Outflow	70	bluntnose minnow	5	5/5	11	15.4	12.6	12.9 ± 1.6	20.53	25.57	24.7	23.9 ± 2.13
Twomile Creek	58	common shiner	3	3/3	31.5	35.5	32.1	33.0 ± 2.16	43.56	50.63	49.3	47.8 ± 3.76
		emerald shiner	5	5/5	14.7	20	18.3	18.0 ± 2.18	23.75	28.71	25.9	25.9 ± 1.99
Niagara River, Niawanda Park	67	emerald shiner	1	1/1	16	16	16	16	37.46	37.46	37.5	37.5
		rainbow smelt	4	4/4	5.5	7.33	6.01	6.21 ± 0.803	5.5	7.33	6.01	6.21 ± 0.803
Erie Canal, Upstream from junction with Ellicott Creek	59	bluntnose minnow	5	5/5	8.47	12.9	11.8	11.4 ± 1.73	13.87	21.38	20.6	19.2 ± 3.13

Table 10 (continued).

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
Niagara River, Pettit Flume	6	bluegill	5	5/5	12.8	17.2	15	14.9 ± 1.59	17.04	22.61	20.8	20.3 ± 2.06
Niagara River, Between Pettit Flume and Gratwick- Riverside Park	60	brook silverside	5	5/5	9.68	11.8	10.9	10.7 ± 0.908	18.73	30.2	29.8	27.4 ± 4.9
Niagara River, Gratwick-Riverside Park	7	bluntnose minnow	3	3/3	10.6	16.1	13	13.2 ± 2.76	17.47	26.68	17.7	20.6 ± 5.26
		brook silverside	2	2/2	7.31	7.57	7.44	7.44 ± 0.184	9.77	11.21	10.5	10.5 ± 1.02
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	5	5/5	17.4	20.3	18.4	18.7 ± 1.15	29.7	35.45	32.4	32.2 ± 2.24
Niagara River, N. Grand Island Bridge	8	emerald shiner	5	5/5	9.84	11.09	10.9	10.6 ± 0.557	11.07	12.56	12.3	11.9 ± 0.711
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	5	5/5	18.5	34.2	21.1	23.4 ± 6.24	27.08	50.31	36.1	37.1 ± 8.44
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	5	5/5	26.28	32.45	30.4	29.8 ± 2.26	35.86	41.44	38.2	38.3 ± 2.05
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	2	2/2	123	168	146	146 ± 31.8	145.5	192.35	169	169 ± 33.1
		emerald shiner	1	1/1	53.8	53.8	53.8	53.8	69.35	69.35	69.4	69.4
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	5	5/5	65.2	148	101	100 ± 30.5	89.03	173.62	126	125 ± 31.2
Cayuga Creek, Porter Road	14	bluntnose minnow	5	5/5	195	304	235	237 ± 42	244.65	350.89	278	281 ± 42.4

Table 10 (continued).

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
Cayuga Creek, Lockport Road	66	bluegill	5	5/5	10.3	27.7	16.8	17.2 ± 6.86	14.26	31.19	21.6	23.1 ± 6.86
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	5	5/5	43.5	56.1	50.9	50.2 ± 5.3	52.79	68.74	64.7	61.8 ± 7.52
Bergholtz Creek, Upstream from old Black Creek	62	bluntnose minnow	2	2/2	28.7	38.7	33.7	33.7 ± 7.07	43.45	50.84	47.1	47.1 ± 5.23
		common shiner	1	1/1	31.4	31.4	31.4	31.4	50.44	50.44	50.4	50.4
		emerald shiner	2	2/2	21.1	27	24	24.0 ± 4.17	43.36	46.54	45	45.0 ± 2.25
Bergholtz Creek	12	bluntnose minnow	5	5/5	58.7	88.9	75.5	73.9 ± 12.8	71.65	100.08	88.9	86.7 ± 13.1
Black Creek	64	bluntnose minnow	4	4/4	55.7	133	85.6	90.0 ± 39.5	73.61	150.84	104	108 ± 39.8
		common shiner	1	1/1	181	181	181	181	196.56	196.56	197	197
Gill Creek	15B	bluegill	2	2/2	30.59	31.72	31.2	31.2 ± 0.799	33.13	34.78	34	34.0 ± 1.17
		bluntnose minnow	3	3/3	30.6	32.54	32.1	31.7 ± 1.01	39.68	40.5	40.1	40.1 ± 0.41
Gill Creek	15A	spottail shiner	5	5/5	26.46	38.57	28	29.9 ± 4.98	32.75	45.99	35.1	36.9 ± 5.38
Niagara River - Lewiston	16	spottail shiner	5	5/5	11.65	16.93	13.1	13.8 ± 2.06	15.18	22.16	19.6	18.8 ± 2.68
Lake Ontario, Eighteenmile Creek	17	emerald shiner	5	5/5	14.57	16.72	16.6	15.9 ± 0.983	17.22	20.14	18.1	18.5 ± 1.16
Eighteenmile Creek	69	rock bass	5	5/5	27.6	31.18	28.6	29.0 ± 1.49	52.51	56.28	54.8	54.6 ± 1.38

Table 10 (continued).

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
Eighteenmile Creek	68	striped shiner	5	5/5	9.25	15.35	12.4	12.3 ± 2.17	19.74	26.16	22.6	23.1 ± 2.73
Lake Ontario, Genesee River	18	emerald shiner	5	5/5	32.37	38.35	34.6	34.7 ± 2.35	35.19	42.45	37.5	38.0 ± 2.7
Lake Ontario, Sodus Bay	19	yellow perch	5	5/5	18.92	27.36	22.8	23.3 ± 3.39	38.37	53.04	44.2	45.7 ± 6.07
Lake Ontario, Sodus Point	19A	emerald shiner	5	5/5	9.09	19.02	10.5	12.3 ± 4	9.09	21.79	10.5	12.8 ± 5.18
Lake Ontario, Oswego River	20	round goby	5	5/5	12.1	17.3	15.6	15.4 ± 2.07	15.67	29.71	23.7	23.0 ± 5.32
Lake Ontario, Salmon River at the mouth	21	emerald shiner	5	5/5	36.5	53.1	43.2	45.0 ± 6.99	50.16	74.44	57.7	60.9 ± 10.1
Salmon River, Lower reservoir	50	banded killifish	2	2/2	2.77	3.12	2.94	2.94 ± 0.247	8.57	13.02	10.8	10.8 ± 3.15
		spottail shiner	3	3/3	3.51	4.15	3.84	3.83 ± 0.32	11.51	13.59	11.7	12.3 ± 1.16
Black River Bay, Area A (North)	22	emerald shiner	5	5/5	22.4	30.3	27.1	26.7 ± 2.82	30.69	50.32	38.8	39.3 ± 7.29
Black River Bay, Area B-1 (Middle)	23	emerald shiner	5	5/5	22.9	30	29.6	27.9 ± 3.03	35.36	48.72	36.8	39.8 ± 5.69
St. Lawrence River, Cape Vincent	25	round goby	5	5/5	8.04	12.3	10.3	10.3 ± 1.6	19.16	23.85	21.6	21.6 ± 1.84
St. Lawrence River, Oswegatchie River	26	round goby	2	2/2	10.1	12.2	11.1	11.1 ± 1.48	20.74	23.87	22.3	22.3 ± 2.21
		spottail shiner	3	3/3	31.5	34.7	34.6	33.6 ± 1.82	46.48	54.69	52.3	51.1 ± 4.22

Table 10 (continued).

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	5	5/5	22.7	40.2	30.9	30.7 ± 6.98	29.13	50.35	35.5	38.0 ± 8.5
St. Lawrence River, Upstream of Reynolds Metal Co.	53	round goby	5	5/5	12.6	21.4	13.7	15.3 ± 3.59	17.91	35.34	22.5	24.8 ± 7.05
St. Lawrence River, Dead Clam Cove	54	round goby	5	5/5	10.3	17.5	11.9	13.0 ± 2.94	18.04	31.77	18.8	23.0 ± 6.61
		yellow perch	2	2/2	54.8	76.1	65.4	65.4 ± 15.1	65.16	90.45	77.8	77.8 ± 17.9
St. Lawrence River, Reynolds Metal Co.	28	round goby	4	4/4	13.6	19.8	14.2	15.4 ± 2.93	17.77	29.11	20.7	22.1 ± 5.02
		yellow perch	3	3/3	13.1	32.6	29.4	25.0 ± 10.5	18.93	38.13	34.6	30.6 ± 10.2
St. Lawrence River, Upstream from General Motors Co.	55	rock bass	3	3/3	35.5	48.3	41.9	41.9 ± 6.4	41.06	53.85	48.9	47.9 ± 6.45
		round goby	2	2/2	15.3	15.5	15.4	15.4 ± 0.141	22.18	24.23	23.2	23.2 ± 1.45
St. Lawrence River, General Motors Co.	29	rock bass	5	5/5	41.3	51	46.6	46.6 ± 3.59	50.69	59.86	56	56.4 ± 3.73
Grasse River, 0.5 mile above mouth	30	spottail shiner	5	5/5	20.1	25.7	20.8	22.2 ± 2.52	29.83	40.4	33.8	34.9 ± 5.14
Grasse River, Above Massena Dam	31	spottail shiner	5	5/5	2.17	2.51	2.45	2.38 ± 0.154	3.45	4.07	3.95	3.81 ± 0.276
Grasse River, Route 37 Bridge	51	fallfish	5	5/5	2.04	3.29	2.31	2.46 ± 0.482	3.1	4.45	3.47	3.57 ± 0.519

Table 10 (continued).

Location	Station	Species	N	PFOS/Total PFAS Detections	PFOS Min	PFOS Max	PFOS Median	PFOS Mean ± SD	Total PFAS Min	Total PFAS Max	Total PFAS Median	Total PFAS Mean ± SD
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	5	5/5	3.97	6.06	5.08	5.00 ± 0.984	9.42	18.13	13.3	12.8 ± 3.59
Raquette River, Reynolds Metal Company	33	bluntnose minnow	2	2/2	3.54	4.27	3.9	3.90 ± 0.516	4.83	5.85	5.34	5.34 ± 0.721
		brook silverside	1	1/1	9.96	9.96	9.96	9.96	11.41	11.41	11.4	11.4
		emerald shiner	2	2/2	3.07	3.83	3.45	3.45 ± 0.537	5.15	6.35	5.75	5.75 ± 0.849
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	5	5/5	3.6	6.25	5.32	5.12 ± 0.996	4.88	19.9	13.3	13.7 ± 5.68
Raquette River, 1.9 Miles upstream from SR-37C bridge	52	bluntnose minnow	3	1/3	ND	3.33	–	–	2.69	4.52	3.26	3.49 ± 0.936
		emerald shiner	2	2/2	2.9	3.78	3.34	3.34 ± 0.622	2.9	3.78	3.34	3.34 ± 0.622
Raquette River, In Massena	35	bluntnose minnow	5	4/4	ND	2.74	2.02	–	ND	2.74	2.02	–
		rock bass	3	3/3	2.68	2.94	2.72	2.78 ± 0.14	2.68	2.94	2.72	2.78 ± 0.14
St. Regis River, Near mouth	56	bluntnose minnow	2	2/2	9.82	11.9	10.9	10.9 ± 1.47	19.26	20.87	20.1	20.1 ± 1.14
		emerald shiner	3	3/3	7.22	8.28	8.09	7.86 ± 0.565	11.38	15.78	15.2	14.1 ± 2.38

Table 11. Detections and concentrations (ppt wet weight) of PCDD/F mammal, bird, and fish TEQs, and 2,3,7,8-TCDD in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

Table 11a. Mammal TEQ.

Location	Station	Species	N	TEQ Mammal Detects	Min TEQ Mammal	Max TEQ Mammal	Median TEQ Mammal	TEQ Mammal Mean ± SD
Niagara River, Niawanda Park	67	rainbow smelt	4	2	0	0.35	0.00217	–
Niagara River, Pettit Flume	6	bluegill	4	4	0.5696	3.3159	1.01	1.48 ± 1.27
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	2	2	0.7333	0.8999	0.817	0.817 ± 0.118
		brook silverside	2	1	0	0.1709	0.0854	–
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	3	3	0.105	0.8029	0.4	0.436 ± 0.35
		emerald shiner	1	1	0.1137	0.1137	0.114	0.114
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	4	4	9.2294	10.8141	10.4	10.2 ± 0.706
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	5	5	0.146	13.7282	1.53	3.65 ± 5.69
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	3	3	5.554	5.7223	5.59	5.62 ± 0.0886
		emerald shiner	3	3	0.3494	5.103	3.9	3.12 ± 2.47
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	5	5	2.6366	5.0764	2.77	3.63 ± 1.25
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	5	5	1.958	3.6073	3.21	3.01 ± 0.69
Bergholtz Creek, Upstream from old Black Creek	62	bluntnose minnow	1	1	0.9054	0.9054	0.905	0.905
		common shiner	1	1	4.9908	4.9908	4.99	4.99
		emerald shiner	2	2	0.0595	2.13	1.09	1.09 ± 1.46
Niagara River - Lewiston	16	spottail shiner	5	5	0.0005	0.08	0.00156	0.0171 ± 0.0352

Table 11b. Bird TEQ.

Location	Station	Species	N	TEQ Bird Detects	Min TEQ Bird	Max TEQ Bird	Median TEQ Bird	TEQ Bird Mean ± SD
Niagara River, Niawanda Park	67	rainbow smelt	4	2	0	0.35	0.000244	–
Niagara River, Pettit Flume	6	bluegill	4	4	0.5175	4.3395	1.1	1.76 ± 1.8
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	2	2	2.9569	2.9811	2.97	2.97 ± 0.0171
		brook silverside	2	1	0	1.7003	0.85	–
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	3	3	0.1007	2.6223	0.399	1.04 ± 1.38
		emerald shiner	1	1	0.7015	0.7015	0.702	0.702
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	4	4	16.4218	21.4016	18.5	18.7 ± 2.06
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	5	5	0.1074	19.3624	2.55	5.21 ± 7.99
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	3	3	5.59	6.9013	6.84	6.44 ± 0.74
		emerald shiner	3	3	1.9331	7.1076	5.61	4.88 ± 2.66
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	5	5	2.7288	8.1531	5.8	5.41 ± 2.28
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	5	5	2.7	5.2111	3.36	3.78 ± 1.02
Bergholtz Creek, Upstream from old Black Creek	62	bluntnose minnow	1	1	3.0018	3.0018	3	3
		common shiner	1	1	7.8985	7.8985	7.9	7.9
		emerald shiner	2	2	0.1711	3.101	1.64	1.64 ± 2.07
Niagara River - Lewiston	16	spottail shiner	5	5	0.0002	0.8	0.00052	0.16 ± 0.358

Table 11c. Fish TEQ.

Location	Station	Species	N	TEQ Fish Detects	Min TEQ Fish	Max TEQ Fish	Median TEQ Fish	TEQ Fish Mean ± SD
Niagara River, Niawanda Park	67	rainbow smelt	4	2	0	0.35	0.000244	–
Niagara River, Pettit Flume	6	bluegill	4	4	0.5253	3.4895	1.17	1.59 ± 1.31
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	2	2	0.6061	0.7719	0.689	0.689 ± 0.117
		brook silverside	2	1	0	0.0853	0.0426	–
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	3	3	0.1007	1.3223	0.399	0.607 ± 0.637
		emerald shiner	1	1	0.2445	0.2445	0.245	0.245
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	4	4	9.8018	10.9491	10.4	10.4 ± 0.596
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	5	5	0.1074	13.9194	1.45	3.69 ± 5.78
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	3	3	5.275	6.0408	5.48	5.6 ± 0.397
		emerald shiner	3	3	0.4331	4.9226	3.81	3.05 ± 2.34
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	5	5	2.574	5.0831	2.87	3.61 ± 1.23
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	5	5	1.99	3.6481	3.2	3.02 ± 0.684
Bergholtz Creek, Upstream from old Black Creek	62	bluntnose minnow	1	1	1.5018	1.5018	1.5	1.5
		common shiner	1	1	5.2935	5.2935	5.29	5.29
		emerald shiner	2	2	0.0861	2.401	1.24	1.24 ± 1.64
Niagara River - Lewiston	16	spottail shiner	5	5	0.0002	0.04	0.00052	0.00837 ± 0.0177

Table 11d. 2,3,7,8-TCDD.

Location	Station	Species	N	2,3,7,8-TCDD Detects	Min 2,3,7,8-TCDD	Max 2,3,7,8-TCDD	Median 2,3,7,8-TCDD	2,3,7,8-TCDD Mean ± SD
Niagara River, Niawanda Park	67	rainbow smelt	4	0	0	0	0	–
Niagara River, Pettit Flume	6	bluegill	4	2	0	0.76	0.26	–
Niagara River, Gratwick- Riverside Park	7	bluntnose minnow	2	1	0	0.48	0.24	–
		brook silverside	2	0	0	0	0	–
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	3	1	0	0.37	0	–
		emerald shiner	1	0	0	0	0	–
Little River, Upstream of Cayuga Creek	9	bluntnose minnow	4	4	3.2	4.8	3.6	3.8 ± 0.712
Little River, Downstream of Cayuga Creek	10	bluntnose minnow	5	3	0	2.2	1.2	–
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	3	2	0	5.4	3.7	–
		emerald shiner	3	2	0	4.5	3.3	–
Cayuga Creek, Cayuga Drive	13	bluntnose minnow	5	5	1.9	4.7	2.7	3.06 ± 1.11
Bergholtz Creek, Downstream from old Black Creek	63	emerald shiner	5	5	1.7	3.2	3	2.76 ± 0.627
Bergholtz Creek, Upstream from old Black Creek	62	bluntnose minnow	1	0	0	0	0	–
		common shiner	1	1	2.6	2.6	2.6	2.6
		emerald shiner	2	1	0	1.7	0.85	–
Niagara River - Lewiston	16	spottail shiner	5	0	0	0	0	–

Table 12. Detections and concentrations (ppt wet weight) of PBDEs in young-of-year fish composites from near-shore areas within New York State's Great Lakes basin, 2018.

12a: BDE-47

Location	Station	Species	N	BDE-47 Detects	BDE-47 Min	BDE-47 Max	BDE-47 Median	BDE-47 Mean ± SD
Lake Ontario, Eighteenmile Creek	17	emerald shiner	4	4	1,300	2,300	1,950	1,880 ± 419
Eighteenmile Creek	68	striped shiner	3	3	1,800	10,000	8,800	6,870 ± 4430
Lake Ontario, Genesee River	18	emerald shiner	3	3	2,200	3,400	2,600	2,730 ± 611
Lake Ontario, Sodus Point	19A	emerald shiner	3	3	140	1,100	900	713 ± 506
Lake Ontario, Oswego River	20	round goby	3	3	190	900	240	443 ± 396
Lake Ontario, Salmon River at the mouth	21	emerald shiner	3	3	1,300	1,500	1,300	1,370 ± 115
Black River Bay, Area A (North)	22	emerald shiner	3	3	2,700	3,900	2,800	3,130 ± 666
Black River Bay, Area B-1 (Middle)	23	emerald shiner	1	1	4,300	4,300	4,300	4,300

Table 12b.Total PBDE.

Location	Station	Species	N	Total PBDE Detects	Total PBDE Min	Total PBDE Max	Total PBDE Median	Total PBDE Mean ± SD
Lake Ontario, Eighteenmile Creek	17	emerald shiner	4	4	2,288.47	4,531.47	3,610	3,510 ± 941
Eighteenmile Creek	68	striped shiner	3	3	3,153.53	13,088.37	12,100	9,450 ± 5480
Lake Ontario, Genesee River	18	emerald shiner	3	3	5,027.93	6,152.85	5,870	5,680 ± 585
Lake Ontario, Sodus Point	19A	emerald shiner	3	3	500.46	1,754.32	1,640	1,300 ± 694
Lake Ontario, Oswego River	20	round goby	3	3	594.75	1,612.32	744	984 ± 549
Lake Ontario, Salmon River at the mouth	21	emerald shiner	3	3	2,285.65	2,646.24	2,400	2,440 ± 184
Black River Bay, Area A (North)	22	emerald shiner	3	3	4074.4	6,121.66	4,330	4,840 ± 1,120
Black River Bay, Area B-1 (Middle)	23	emerald shiner	1	1	6,768.05	6,768.05	6,768	6,768

Table 13. Comparison of PCB concentrations (ppm wet weight) between 2018 young-of-year samples and samples from 2009 and 2011-2012. TPCB is mean total wet weight PCB in ppm, LPCB is mean lipid normalized total PCB.

Location	Station	Species	TPCB 2018	TPCB 2009-12	TPCB Difference	TPCB % Difference	LPCB 2018	LPCB 2009-12	LPCB Difference	LPCB % Difference
Twomile Creek	58	common shiner	0.746	0.381	0.365	96	8.601	14.677	-6.076	-41
		emerald shiner	0.306	0.336	-0.03	-9	21.124	10.103	11.021	109
Niagara River, Gratwick-Riverside Park	7	bluntnose minnow	0.217	0.199	0.018	9	5.118	6.412	-1.294	-20
Niagara River, Bay at upstream edge of 102nd St. Landfill	61	bluntnose minnow	0.159	0.143	0.016	11	3.137	5.893	-2.756	-47
Cayuga Creek, Lindberg Ave	11	bluntnose minnow	0.171	0.118	0.053	45	4.61	7.585	-2.975	-39
Cayuga Creek, Porter Road	14	bluntnose minnow	0.312	0.112	0.2	179	4.772	3.435	1.337	39
Gill Creek	15B	bluntnose minnow	0.935	0.395	0.54	137	21.39	18.779	2.611	14
Lake Ontario, Eighteenmile Creek (Krull Park)	17	emerald shiner	0.135	0.119	0.016	13	2.121	3.298	-1.177	-36
Lake Ontario, Genesee River	18	emerald shiner	0.108	0.048	0.06	125	2.121	2.245	-0.124	-6
Lake Ontario, Sodus Point	19A	emerald shiner	0.043	0.051	-0.008	-16	1.143	1.644	-0.501	-30
Lake Ontario, Oswego River	20	round goby	0.018	0.044	-0.026	-59	0.712	1.73	-1.018	-59
St. Lawrence River, Oswegatchie River	26	round goby	0.117	0.119	-0.002	-2	4.81	6.674	-1.864	-28
St. Lawrence River, Barnhart Island (above dam)	27	emerald shiner	0.011	0.043	-0.032	-74	0.437	1.085	-0.648	-60
St. Lawrence River, Upstream from General Motors Co.	55	round goby	2.867	2.58	0.287	11	79.204	74.43	4.774	6

Table 13 (continued).

Location	Station	Species	TPCB 2018	TPCB 2009-12	TPCB Difference	TPCB % Difference	LPCB 2018	LPCB 2009-12	LPCB Difference	LPCB % Difference
St. Lawrence River, General Motors Co.	29	rock bass	3.491	8.935	-5.444	-61	116.264	235.531	-119.267	-51
Raquette River, 0.5 mile above mouth	32	bluntnose minnow	0.064	0.099	-0.035	-35	1.991	3.164	-1.173	-37
Raquette River, Reynolds Metal Company	33	bluntnose minnow	0.345	0.168	0.177	105	11.238	3.992	7.246	182
		brook silverside	0.28	0.216	0.064	30	5.983	4.341	1.642	38
Raquette River, About 1 mile upstream from Reynolds Metal Company	34	emerald shiner	0.087	0.088	-0.001	-1	2.042	2.432	-0.39	-16
Raquette River, In Massena	35	bluntnose minnow	0.026	0.095	-0.069	-73	0.752	2.496	-1.744	-70
		rock bass	0.038	0.089	-0.051	-57	0.88	2.914	-2.034	-70
St. Regis River, Near mouth	56	bluntnose minnow	0.01	0.067	-0.057	-85	0.19	2.314	-2.124	-92

Figure 1. Young-of-year fish sampling locations (see Table 1 for station descriptions).

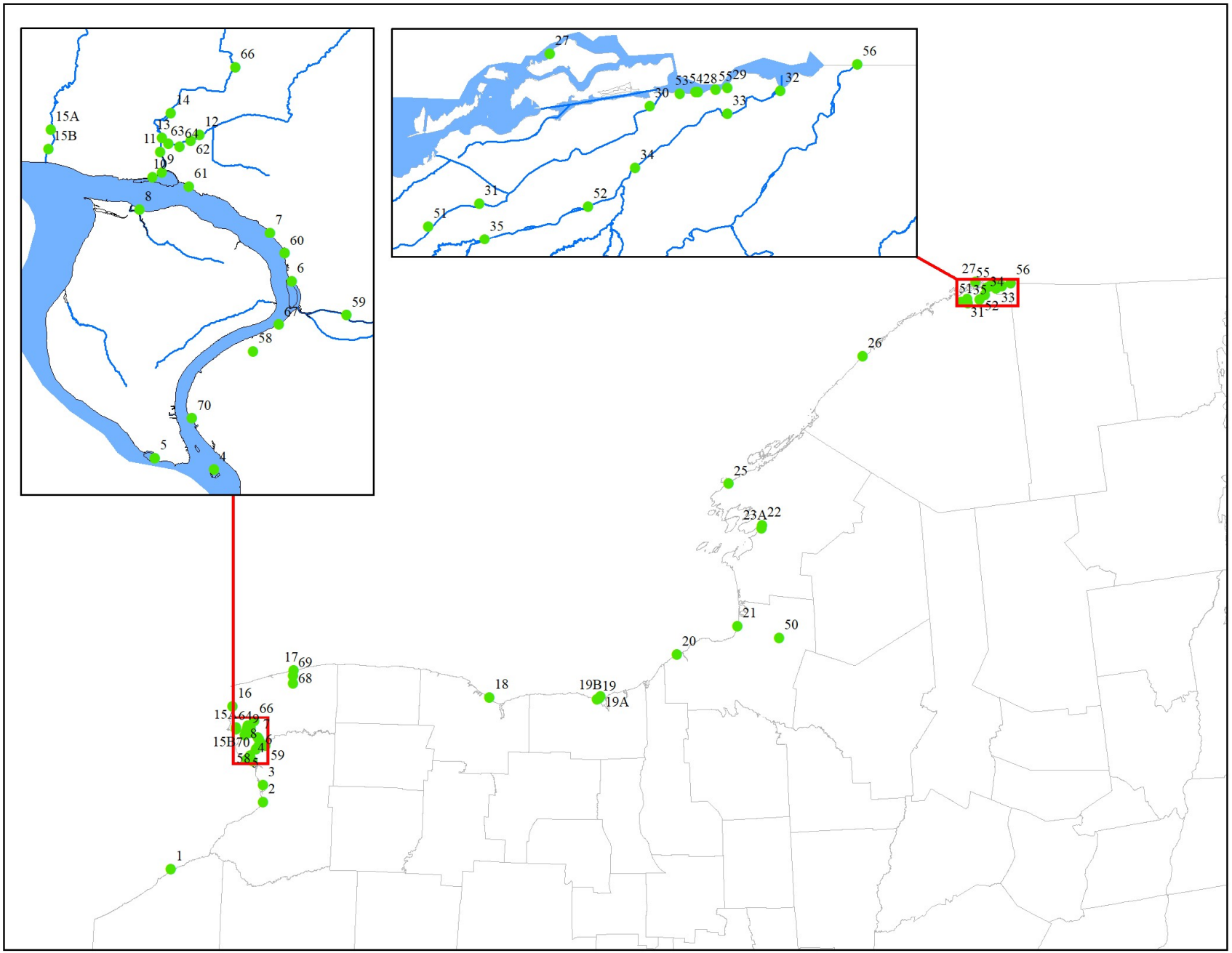


Figure 2. Dioxin and furan sampling locations (magenta symbols).

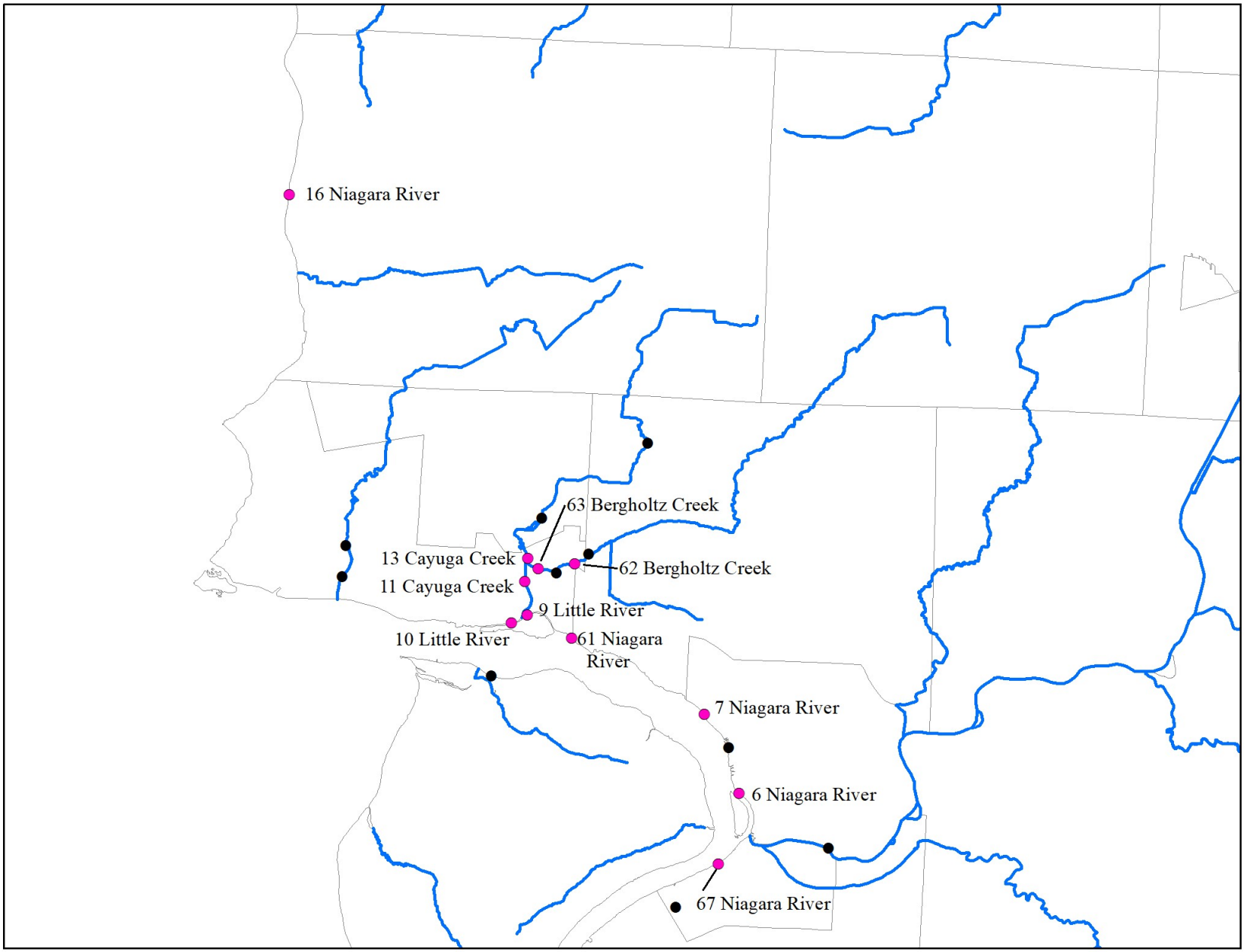


Figure 3. PBDE sampling locations (blue symbols).

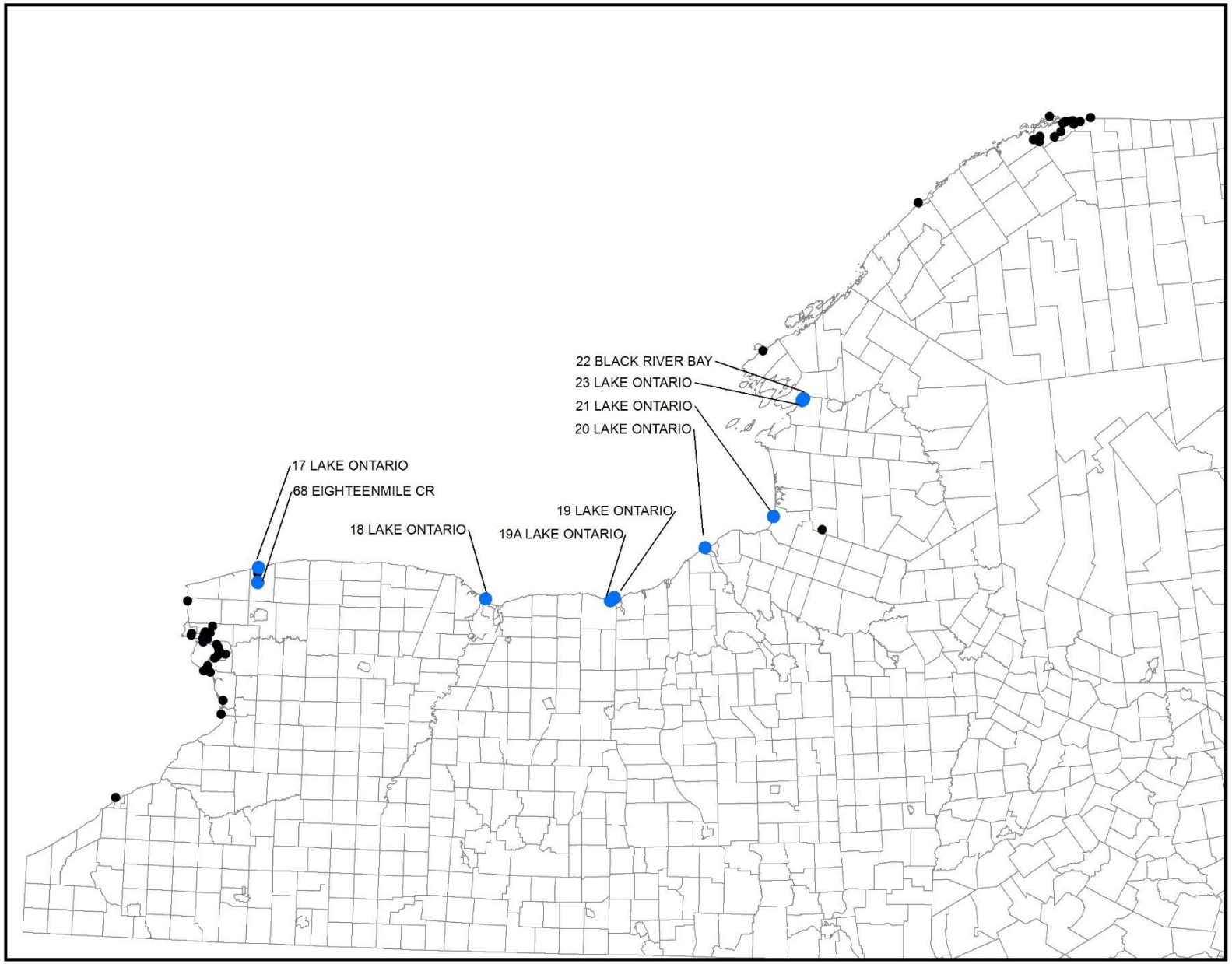


Figure 4. Histograms of mean composite lengths for each species.

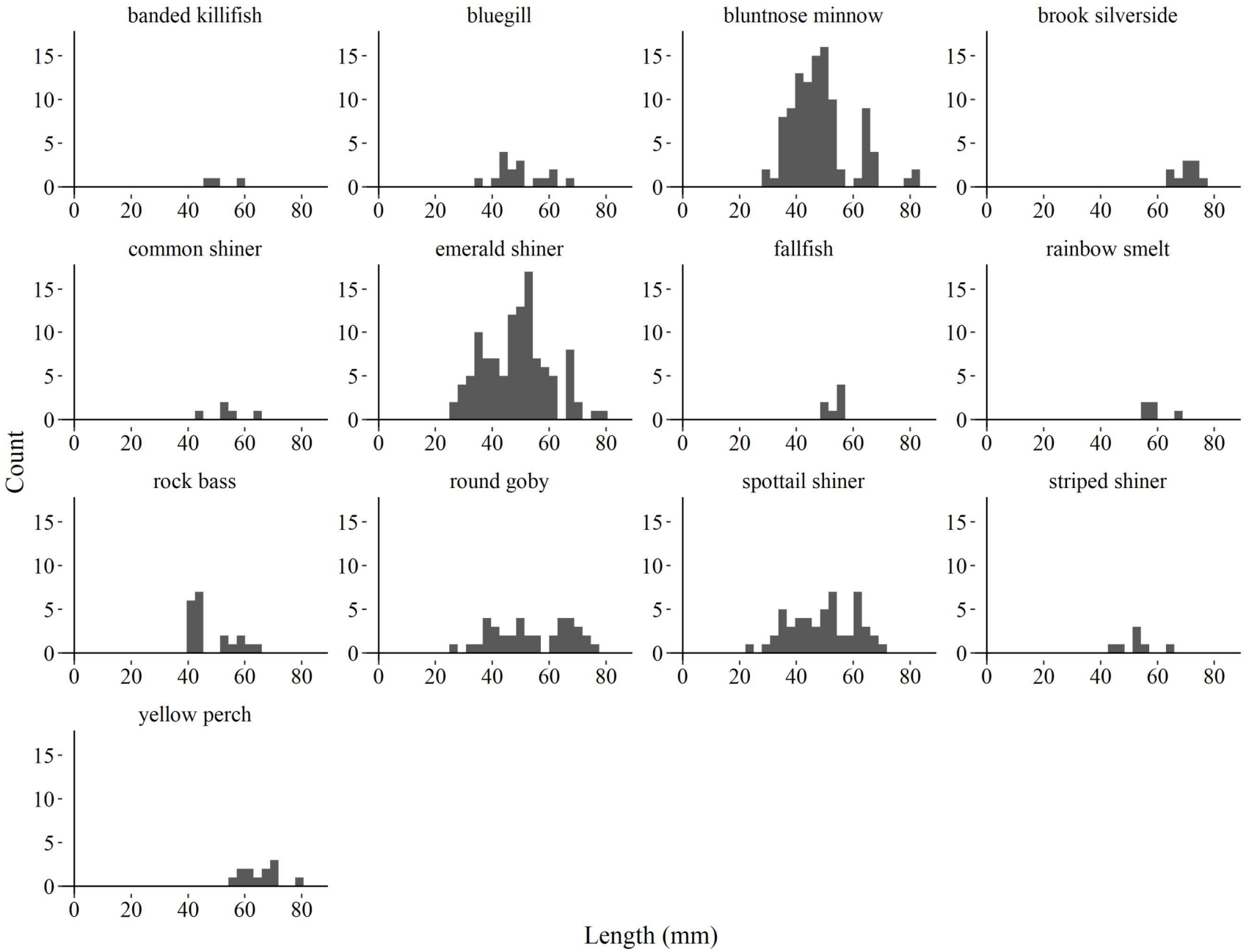


Figure 5. Mercury concentrations at each station. Major water bodies are color coded. Symbols indicate species with other comprising yellow perch, brook silverside, fallfish, striped shiner. common shiner, rainbow smelt, and banded killifish (49 of 392 composites).

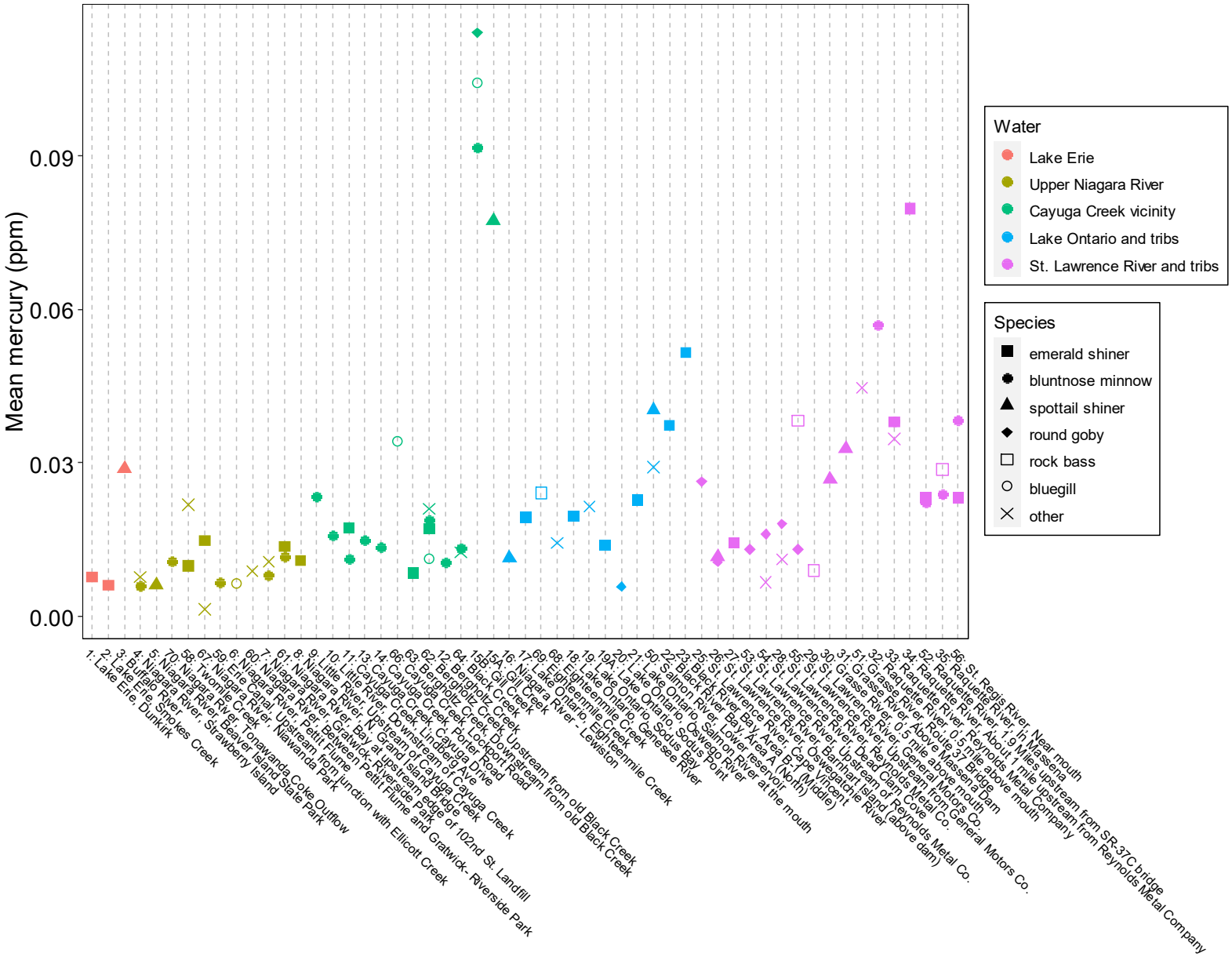


Figure 6. Total mean PCB concentrations at each station by species. Major water bodies are color coded. Symbols indicate species with "other" comprising yellow perch, brook silverside, fallfish, striped shiner. common shiner, rainbow smelt, and banded killifish (49 of 392 composites).

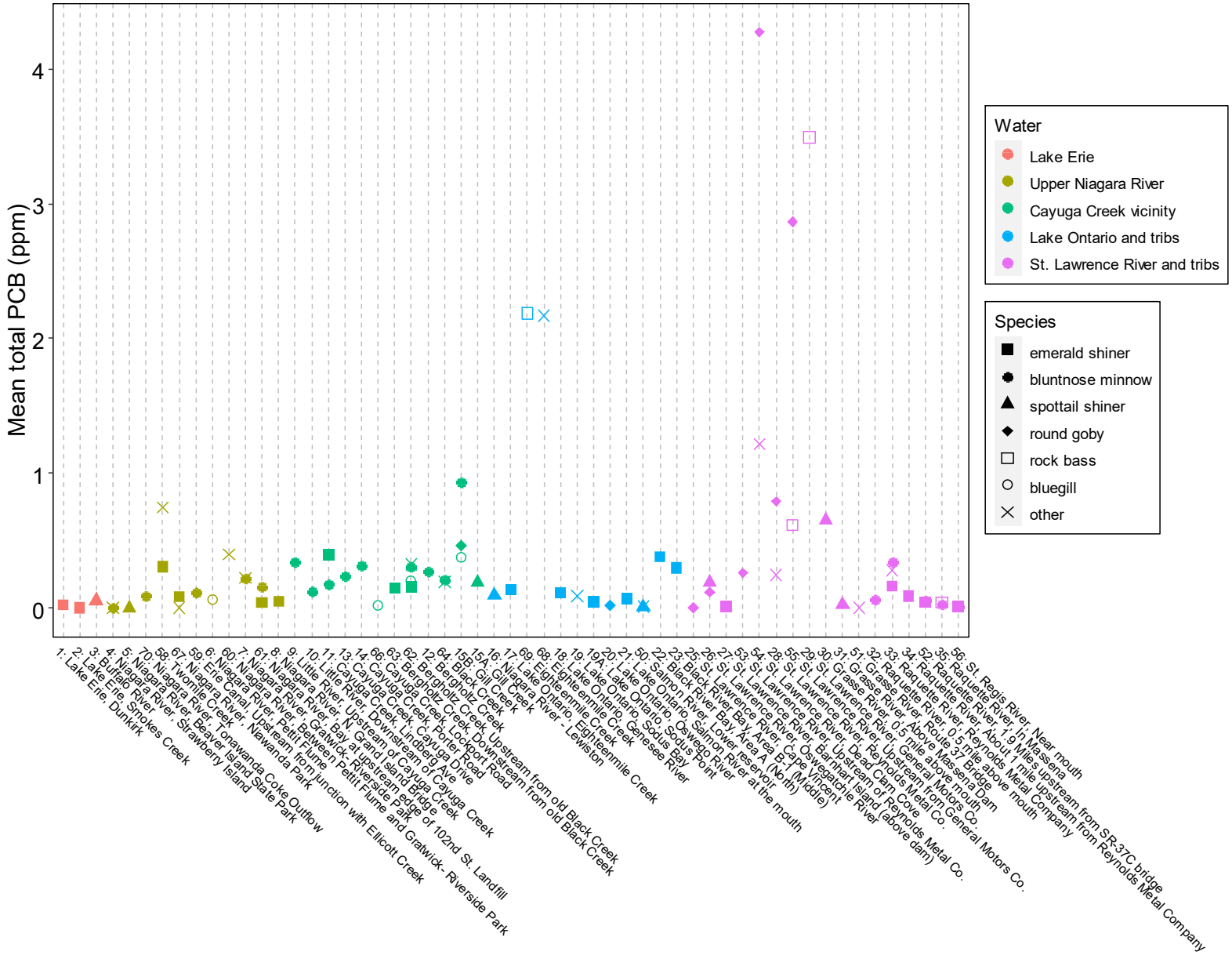


Figure 7. Total mean lipid normalized PCB concentrations at each station by species. Major water bodies are color coded. Symbols indicate species with "other" comprising yellow perch, brook silverside, fallfish, striped shiner. common shiner, rainbow smelt, and banded killifish (49 of 392 composites).

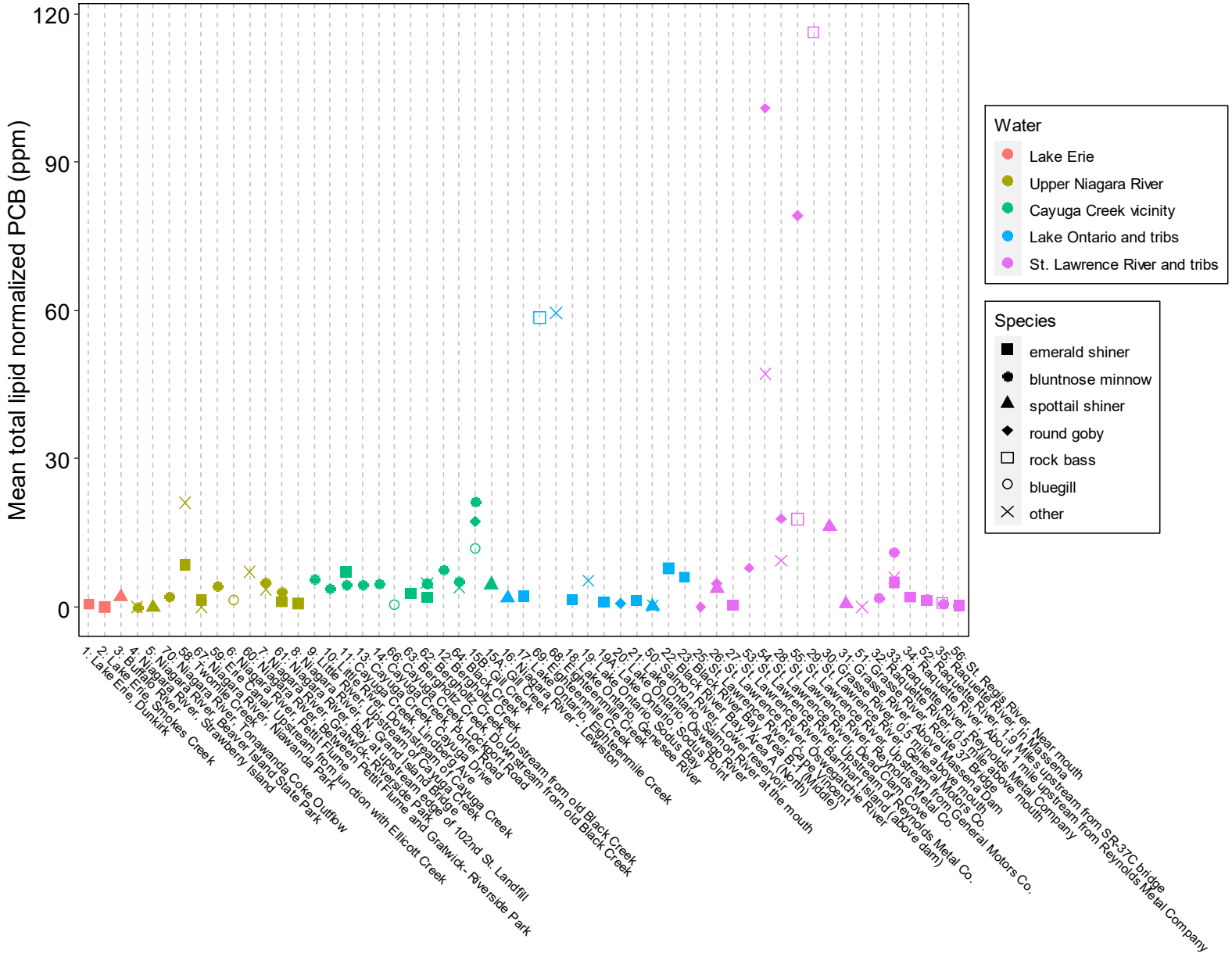


Figure 8. Total mean DDT concentrations at each station by species. Major water bodies are color coded. Symbols indicate species with "other" comprising yellow perch, brook silverside, fallfish, striped shiner. common shiner, rainbow smelt, and banded killifish (49 of 392 composites).

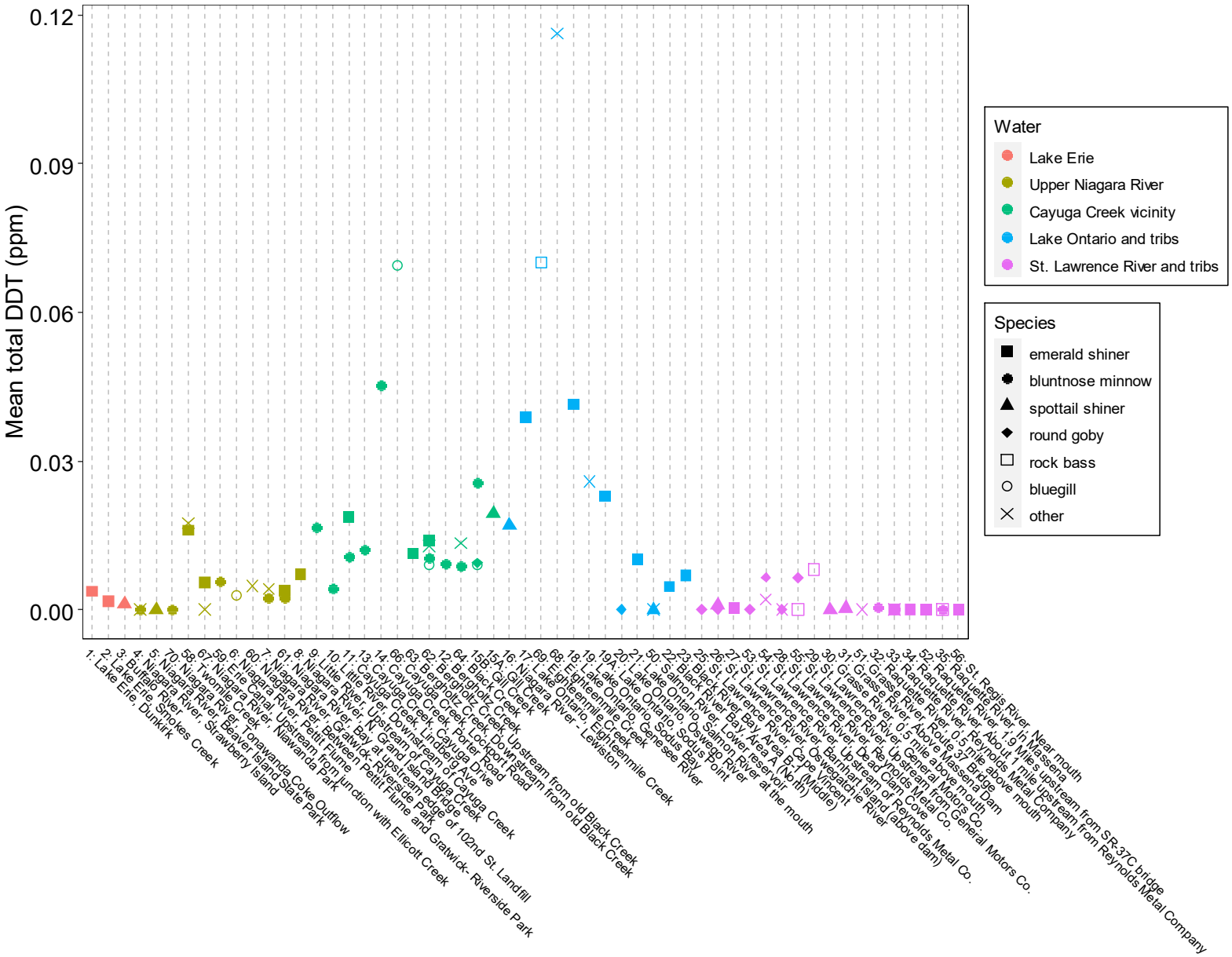


Figure 9. Total mean PFOS concentrations at each station by species. Major water bodies are color coded. Symbols indicate species with "other" comprising yellow perch, brook silverside, common shiner, fallfish, striped shiner. rainbow smelt, and banded killifish (40 of 277 composites).

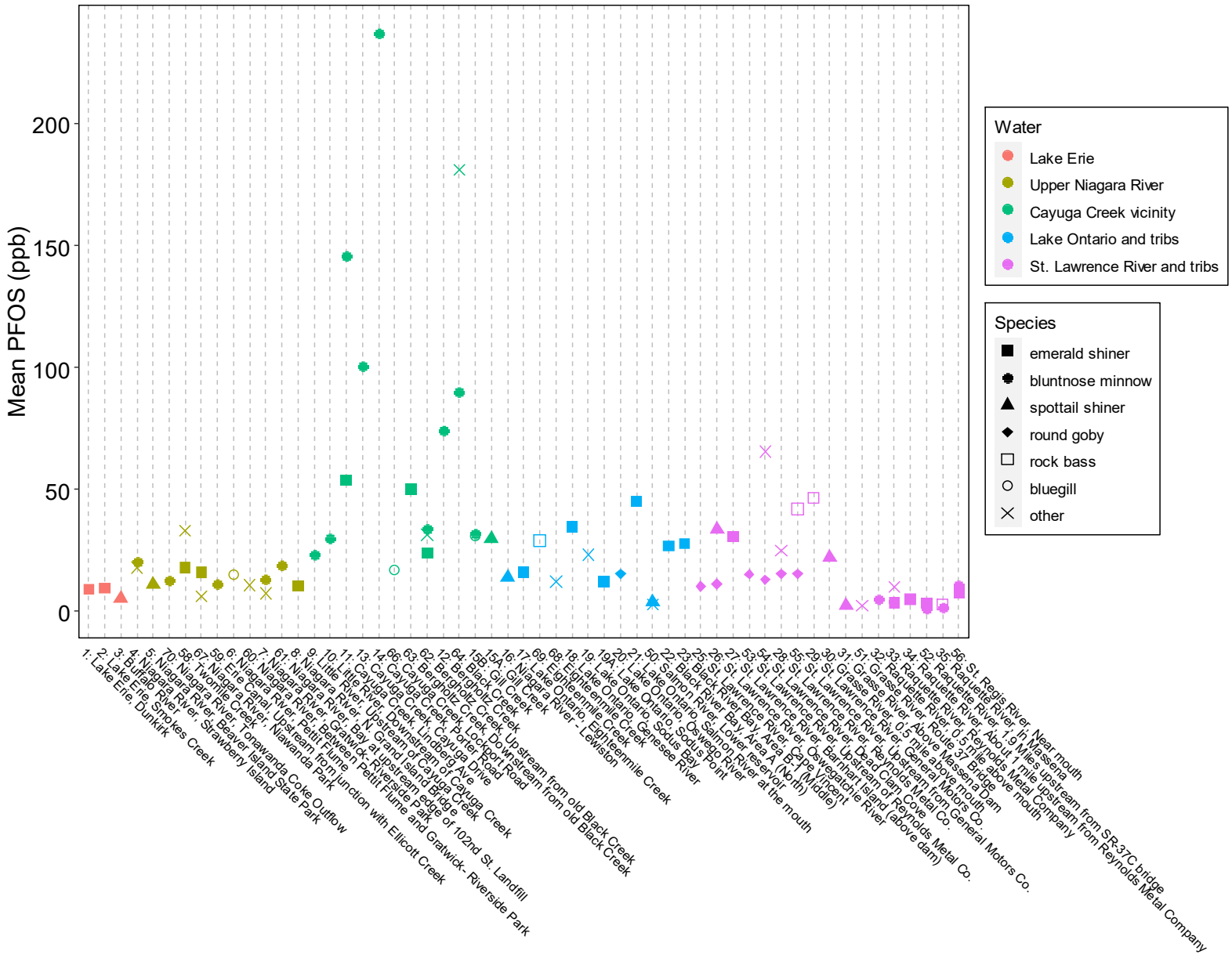


Figure 10. Percent of total PFAS from PFOS versus total PFAS. Major water bodies are color coded. Inset show the empirical cumulative frequency distribution of the percent of total PFAS from PFOS.

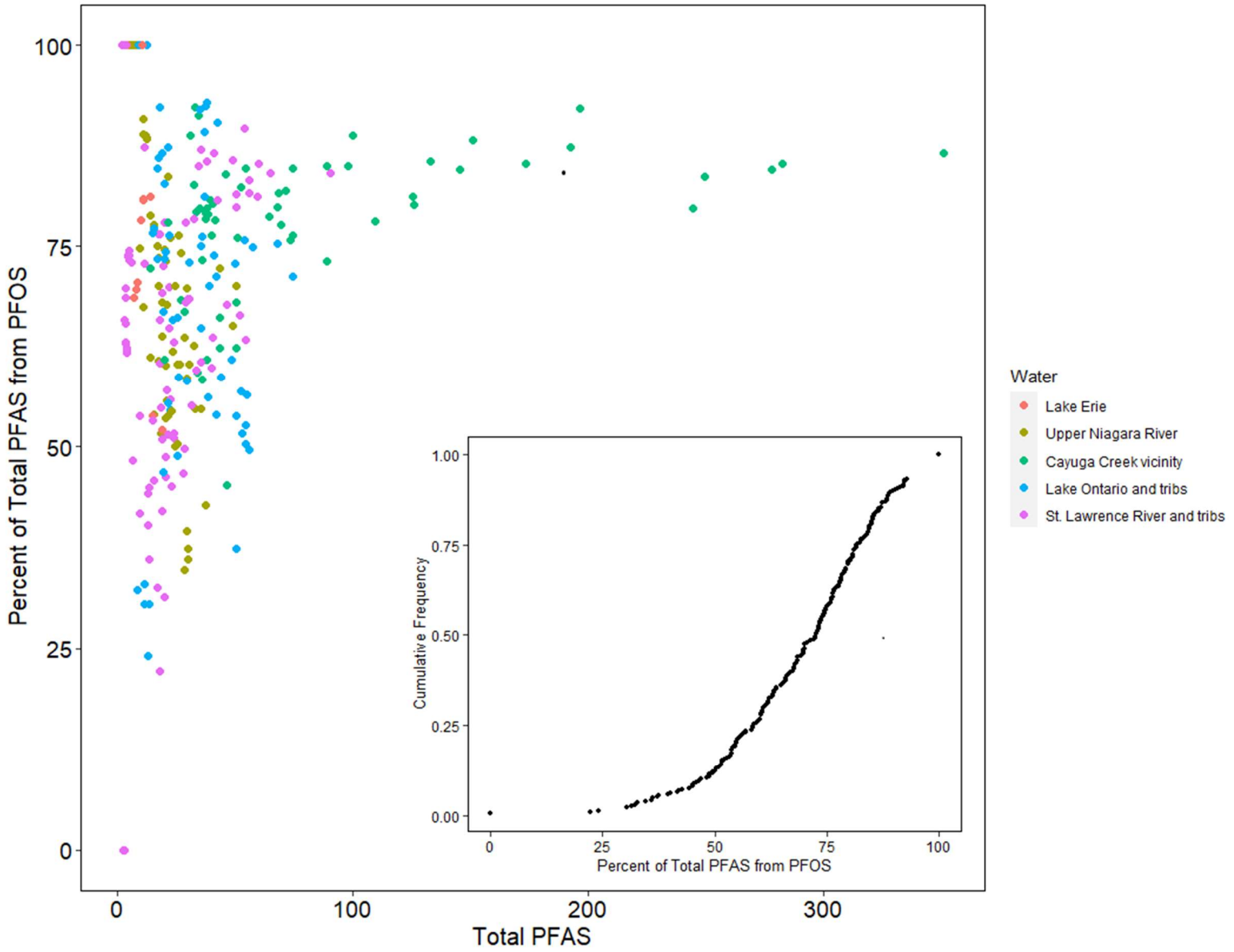


Figure 11. Mean mammal TEQ at Niagara River area stations by species.

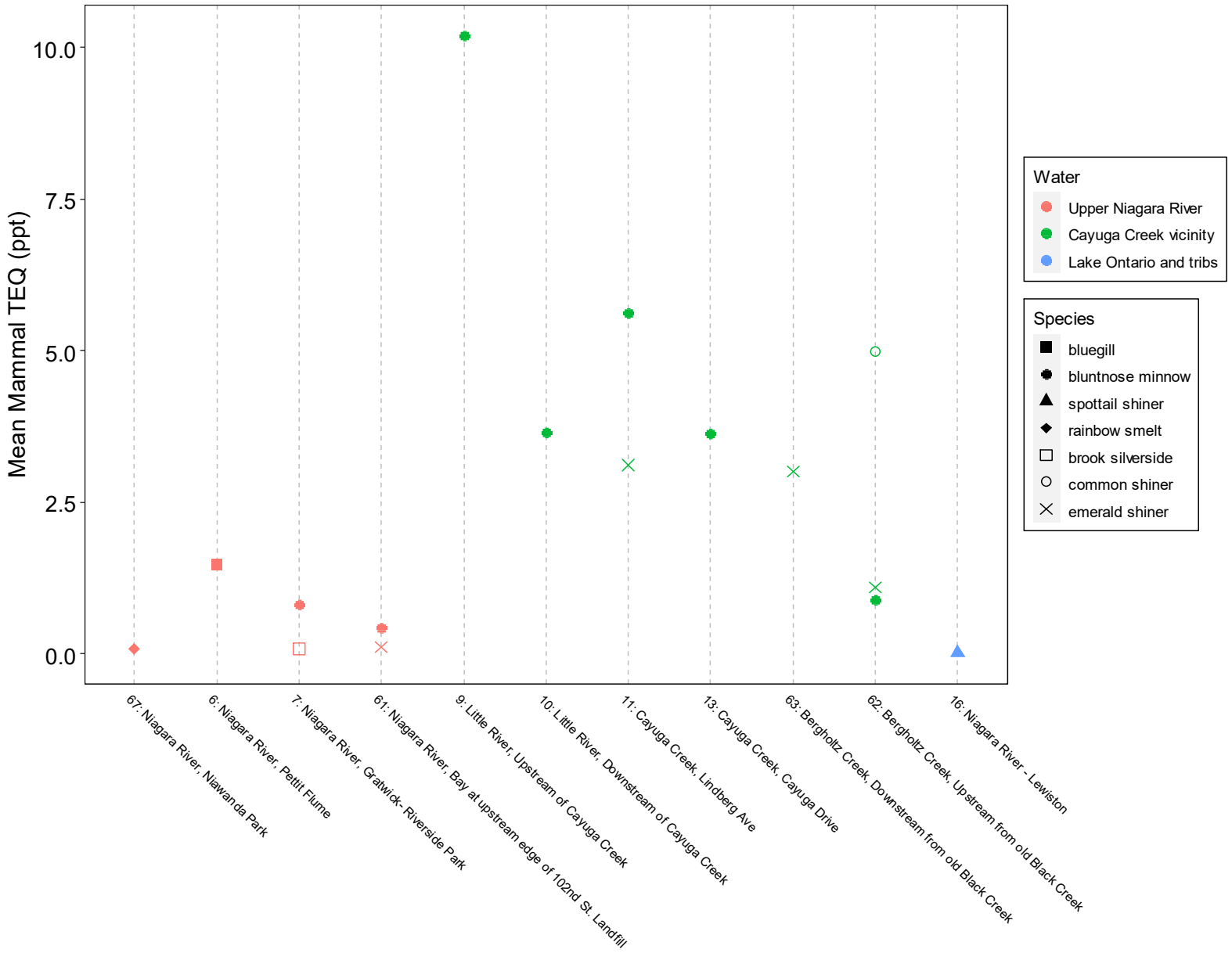


Figure 12. Mean total PBDE at Lake Ontario stations by species.

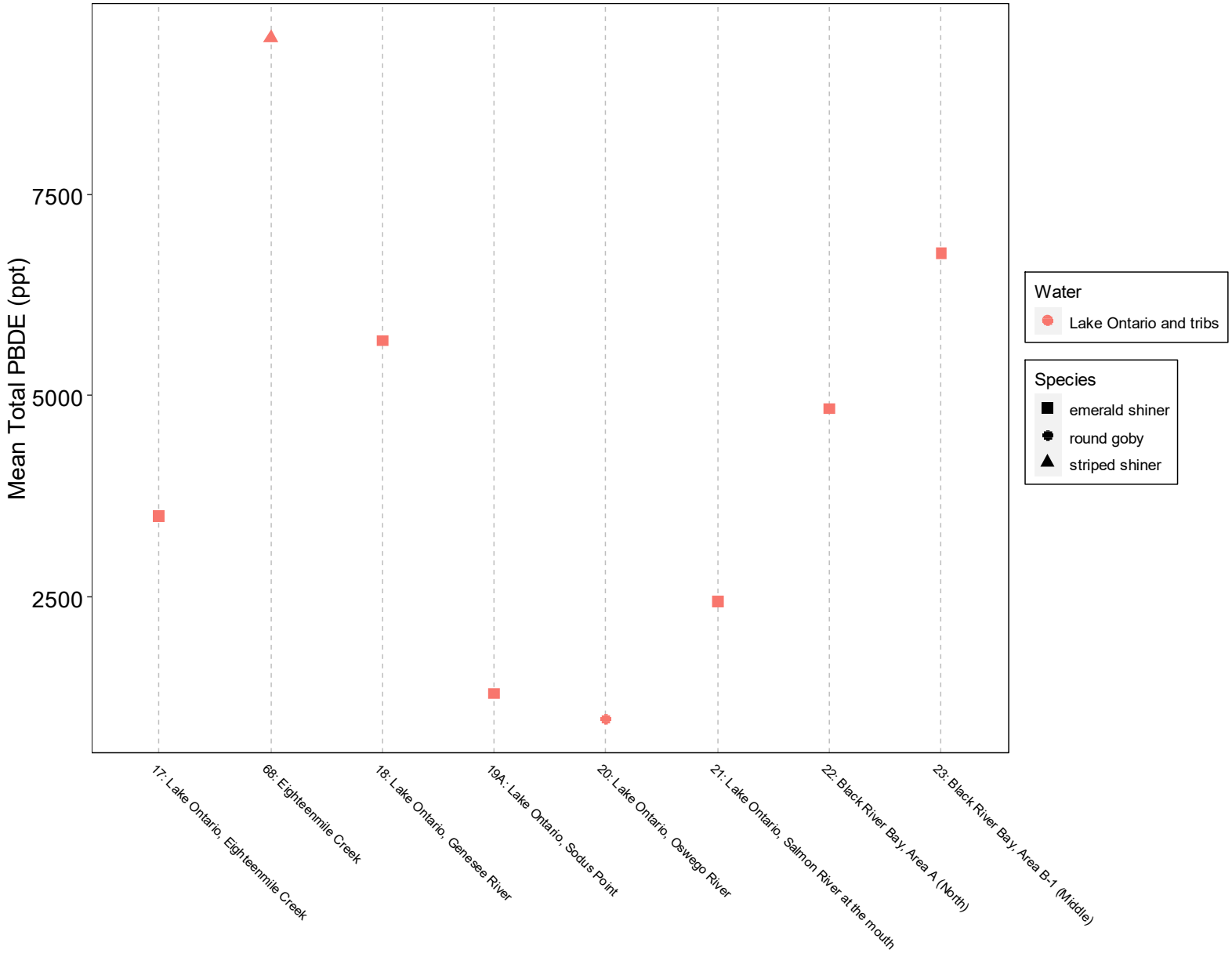
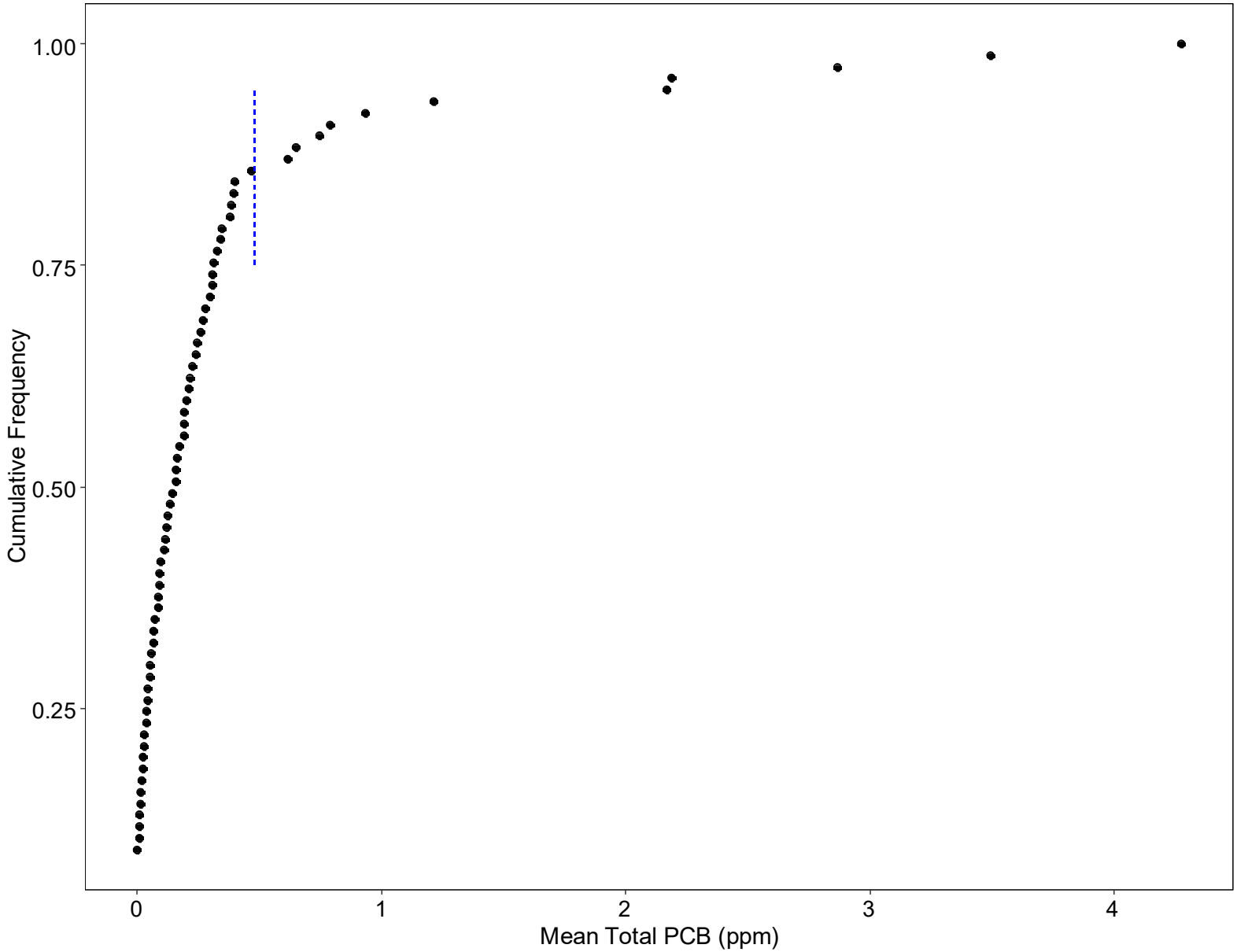


Figure 13. Empirical cumulative distribution function for mean total PCB for each species-site combination. Note that the lowest point for non-detect represents seven species-site means.



Appendix: Database.

GLRI Young-of-Year Database Schema and Dictionary

The database has nine tables. Missing values in numeric fields are coded as -9. Missing values in text fields are blank unless otherwise noted. All tables are hidden.

(1) coords: contains geographic information about sample collection sites.

- BASIN (long integer, primary key): numerical code for the collection site based on basin, sub-basin and sequence number (BBSSLLLL).
- FEATURE (text, length=50): the waterbody where samples were collected.
- LOCATION (text, length=60): geographic description of the collection location.
- NYTMN (double): X coordinate in UTM Zone 18, NAD83. These are the canonical coordinates for a station that represent the general area of collection and that can be used to link stations across years.
- NYTME (double): Y coordinate in UTM Zone 18, NAD83. These are the canonical coordinates for a station that represent the general area of collection and that can be used to link stations across years.
- STATION (text, length=3): The station number of the location where the samples were collected.
- COORDS_REMARKS (text, length=200): comments.
- OID (auto number, integer): a unique integer field to enable ArcGIS operations.
- NYTMN_field (double): X coordinate in UTM Zone 18, NAD83. These are actual field coordinates from the 2018 sampling.
- NYTME_field (double): Y coordinate in UTM Zone 18, NAD83. These are actual field coordinates from the 2018 sampling.

(2) bio: information on the collected samples.

- TAGNO (text, length=20, primary key): the ID that uniquely identifies each sample. For records with field-assigned IDs that may not be unique, follow the DEC convention to make each TAGNO unique, and note the original TAGNO in the Remarks field. Spaces are not allowed.
- SPP (text, length=10): the species code; foreign key to species table.
- BASIN (long integer): numerical code for the collection site based on basin, sub-basin and sequence number (BBSSLLLL).
- STATION (text, length=3): The station number of the location where the samples were collected; foreign key to the coords table.
- SDATE (long integer): the date on which the sample was collected, in YYYYMMDD format. If the date information is unavailable, it should be entered as -9. If the year is known but the month or day is unknown, the unknown month or day should be denoted as 00 in the YYYYMMDD format.
- AGE (integer): age of the organism in years. If the age was not identified, identified as a range or noted as adult versus juvenile, this value should be -9; a possible range of ages or adult versus juvenile is noted in the Remarks field.
- SEX (text, length=1): “M” (male), “F” (Female), or “U” (unidentified).
- NOANLY (integer): number of individuals in the sample. If the sample is composed of a single individual, the value in this field is 1. If the sample is a composite of multiple individuals, the value in this field is the total count of individuals.
- LENMM (double): length of the fish in millimeters; mean length for composites. Length of non-fish species is defined by project specific standards.
- MINLEN (double): length of the shortest fish in a composite (millimeters).

- MAXLEN (double): length of the longest fish in a composite (millimeters).
- SDLEN (double): standard deviation of the individual lengths in a composite (millimeters).
- WGTG (double): wet weight of the organism in grams; mean weight for composites except as noted in the Remarks field (invertebrates are often total weight).
- MINWGT (double): minimum individual weight in a composite (grams).
- MAXWGT (double): maximum individual weight in a composite (grams).
- SDWGT (double): standard deviation of individual weights in a composite (grams).
- PROGRAM (text, length=50): a brief description of the program for which the samples were collected.
- BIO_REMARKS (text, length=200): comments and notes, e.g., if the original TAGNO has been changed to make it unique, it should be recorded here.
- OID (auto number, long integer): a unique integer field to enable ArcGIS operations.

(3) results: information on analytical results.

- TAGNO (text, length=50): the ID that uniquely identifies each sample; foreign key to bio table.
- LABNO (text, length=50): the ID assigned by the analytical lab for each analytical sample.
- PREP (text, length=20): code for the sample preparation type. The PREP codes can be found in the table prep.
- ANALYTE (text, length=50): name or abbreviation of the analyte, e.g., OCTACHL is the abbreviation for octachlorostyrene. Additional information can be found in the analyte table.
- RESULT (double, required): derived from the analytical result by going through the following conversions:

1) Analytical results are converted to the standard unit, as defined in the analyte table, for each analyte.
2) Non-detect analytical results are represented by the detection limit times -1.
3) No blank is allowed in this field. Missing values in this field are denoted as -99.

- DL (double): the detection limit.
- RL (double): the reporting limit.
- REPORTED QUALIFIER (text, length=10): original data qualifiers from the analytical laboratory.
- DEC_QUALIFIER (text, length=10): the qualifiers assigned by DEC after reviewing the data. They reflect DEC's opinions on the usability of the data. This field is not currently used.
- USE_STATUS (text, length=1): code to indicate use of the result. Value are P = primary or general use; S = secondary for results, such as splits or duplicates, that would not ordinarily be used for analysis; I = invalid.
- RESULT_REMARKS (text, length=200): comments and notes.
- FILE_NAME (text, length=200): Name of the file where the result is originally reported
- EMPC (double): Estimated Maximum Possible Concentration results.
- OID (auto number, integer, primary key): a unique integer field. Used as the primary key.

(4) species: information on species (although "species" is used here, the sample may be referenced as a higher taxon)

- SPP (primary key, text, length=10): the species code.
- COMMON_NAME (text, length=60): species common name.
- SCIENTIFIC_NAME (text, length=60): species scientific name.
- TYPE (text, length=20): general classification or description of the species.
    1) AMPH = amphibian
    2) AMPHIPOD
    3) BIRD

4) FISH
5) INVERT = invertebrate
6) MAMMAL
7) MOLLUSK
8) VEG = plant

(5) analyte: information about the analytes. This table facilitates retrieving information for analytes belonging to the same category.

- ANALYTE (text, length=30, primary key): name or abbreviated name of the analyte, e.g., OCTACHL is the abbreviation for octachlorostyrene
- FULL_NAME (text, length=75): the full name of the analyte.
- ALIAS (text, length=100): other names that the analyte may have; a comma separated list.
- CATEGORY (text, length=20): categories of analytes, such as "PBDE" and "Heavy metal".
  Values used in this field are listed. Other values should be added as needed.
  1) OCP = organochlorine pesticide
  2) PCDD/F = polychlorinated dibenzo-*p*-dioxins and furans
  3) PBDE = polybrominated diphenyl ethers
  4) PCB Aroclor = polychlorinated biphenyls as Aroclors
  5) PCB Congener = polychlorinated biphenyls as congeners
  6) Heavy metal
  7) PFAS = per-and polyfluoroalkyl substances
  8) PCN = polychlorinated naphthalenes
  9) PPCP = pharmaceuticals and personal care products
  10) PAH = polycyclic aromatic hydrocarbons
  11) HBCD = hexabromocyclododecanes
  12) CPF = Chloroparaffins
  13) GEN = General Chemistry (for lipids and moisture)
  14) OTHER = other
- UNIT (text, length=10): the units, such as "ppm," of all results for the analyte.

(6) prep: information on the sample preparation type.

- PREP (primary key, text, length=10): code for the sample preparation type.
- DESCRIPTION (text, length=60): description of the sample preparation type.

(7) lab_qualifier: lookup table to retrieve the qualifier codes used by for each analytical laboratory.

- LAB (text, length=20, part of composite primary key): the codes for the analytical laboratory.
- QUALIFIER_CODE (text, length=5, part of composite primary key): the code used by analytical laboratories as qualifiers. The name "Qualifier_Code" is used instead of "Qualifier" because the Qualifier_Code field in this table contains only single qualifier code, while the Qualifier field in the Results table may contain multiple qualifier codes.
- DESCRIPTION (text, length=100): a description of the meaning of the qualifier code.

(8) lab_name: information on the analytical labs

- LAB (text, length=20, primary key): the codes for the analytical laboratory

- LAB_FULL (text, length=100): full name of the analytical lab

Queries: Pre-set queries displaying contaminant results by category. All queries open in read only mode via links on the Welcome form. Additional queries can be created as needed.

(1) wide_cpf
(2) wide_mercury
(3) wide_ocp
(4) wide_pbde
(5) wide_pcb_aroclor
(6) wide_pcn
(7) wide_pcdd/f
(8) wide_pfas
(9) wide_ppcp
(10) long_cpf
(11) long_mercury
(12) long_ocp
(13) long_pbde
(14) long_pcb_aroclor
(15) long_pcb_pcn
(16) long_pcdd/f
(17) long_pfas
(18) lpdmoist
(19) search_query_wide: Blank query set up to be opened by Form2. Contents will change based on user inputs to the form.

Forms:

(1) Welcome: home page opened automatically by AutoExec macro. Contains links to open look-up tables and queries in read-only mode. Links to additional queries and tables can be added as needed.
(2) Form2: data search form opened by Find Data button on Welcome form.
(3) Form3: shows search results with parameters entered in Form2 as a query in read only mode. Opened by the GET DATA button on Form2. The data cannot be manipulated within the form (only simple sorts are allowed) and must be exported as an Excel sheet or saved as an Access query or table for further use.
(4) Form4: interface used to save search results as an Access query. Opens from Form3.
(5) Form5: interface used to save search results as an Access table. Opens from Form3.

Macros:

(1) AutoExec: Macro that runs automatically and opens the Welcome form when the database is opened.

Database schema.