Routine Monitoring of Toxics in New Jersey Fish

Fourth Year (2007) of Routine Monitoring Program Atlantic Coastal Region

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INTRODUCTION

Background

In 1994, research on freshwater fish found mercury concentrations exceeding the risk-based health criteria established by the State of New Jersey. The Department of Health and Senior Services (DHSS) and the New Jersey Department of Environmental Protection (NJDEP) issued statewide, regional, and lake-specific fish consumption advisories for two species, largemouth bass and chain pickerel. Subsequent studies have provided more data on mercury concentrations, as well as data on PCBs, selected organo-chlorine pesticides (OCPs), and other organic contaminants (e.g., PBDEs, dioxins and furans). Additional data were reported in ANSP (1999), Ashley and Horwitz (2000), and Horwitz et al. (2005, 2006, 2008). These data have been used to develop water quality assessments for specific waterways (see NJDEP 2008 for most current list). The State's 303d list of impaired sites (derived from the Clean Water Act) drives the development of Total Maximum Daily Limits (TMDL) and other contaminant control strategies. The results of contaminant monitoring are used to enhance waterbody assessments, to amend existing advisories or, if necessary, develop new advisories, to assist the NJDEP in evaluating trends in contaminant concentrations of these selected species, and to determine necessary, additional research and monitoring studies. The monitoring program described here builds upon NJDEP's Division of Science, Research and Technology (DSRT; now the Office of Science) fish contamination research that identified widespread mercury contamination in the fresh waters of the State, chlordane, polychlorinated biphenyl (PCB) and dioxin contamination in site-specific locations, and PCB contamination predominantly in several estuarine and marine fish species.

In July 2002, the Academy of Natural Sciences of Philadelphia (ANSP) began a Routine Monitoring Program for Toxics in Fish for NJDEP. There has been a clear need for a continuous monitoring program for toxic chemicals in fish to regularly assess the status and trends of fish contamination and related consumption advisories in New Jersey waters, in order to provide current data on a variety of species and sites. Due to the large number of water bodies in the State, the sampling program is based on a rotating assessment of contamination of five regions of the State on a five-year cycle:

1. Passaic River Region;
2. Marine/Estuarine Coastal Region;
3. Raritan River Region;
4. Atlantic Coastal Inland Waterways Region; and
5. Upper and Lower Delaware River Region.

In each period, previously-sampled and new sites are sampled, so that coverage of water bodies increases over time and temporal comparisons of trends can be done. Sampling in the Passaic Region was conducted in 2002-2003, the Marine/Estuarine Region in 2004-06, and the Raritan River Region in 2006-2007. These results were reported in Horwitz et al. (2005, 2006, and 2008). This document reports findings of the fourth year of the cycle, the Atlantic Coastal Inland Waterways Region, which involved freshwater fishes sampled in 2007.

The main objective of this program is to provide current and more comprehensive data to the State of New Jersey on concentrations of toxic contaminants in its freshwater fishes. These data are needed to update consumption advisories for targeted species of recreational and commercial importance in areas under current State advisory and/or in selected areas with little or no current information.

Study Design

Stations were selected to include previously-sampled sites and investigate sites with no contaminant data. Species were selected to include predatory species present in a wide number of sites, allowing comparison among sites. These species are either under consumption advisories on a statewide, regional and waterway-specific basis for mercury (Hg), PCB and/or dioxin contamination or are regularly consumed by recreational anglers within the State. For this region, chain pickerel and largemouth bass have been the primary species monitored. Additional species were selected at specific sites on the basis of their importance in the fishery at that site. Ten species of freshwater fish (see Table 1 for common and scientific names of species) were sampled. Some of the originally designated species from a few locations were not collected, and NJDEP and ANSP project managers reapportioned the missing samples and modified the Task I sampling plan. Individual filets from all fish species sampled were analyzed for various analytes (Table 2).

Samples were taken from 33 sites (Table 3). Sample sites were selected by a stratified random sampling design, slightly modified from that used in the 1992 study. As in the previous study, unique lakes were designated and specified for sampling. Two unique lakes in the region, Manasquan Reservoir and Union Lake, were designated in 1992 and resampled. In addition, Atlantic City Reservoir was designated as a unique lake. This site had originally been picked randomly, but it was re-assigned based on very high mercury content, unusual fish assemblage (mainly largemouth bass, with few forage species), and likelihood of point sources of mercury in its watershed. Other strata were split into two substrata, one for previously sampled sites and the other for sites not previously sampled, and sites were randomly selected from each of these substrata. The allocation of numbers of sites per stratum and substratum were chosen to provide approximately equal overall sampling rates among each stratum.

Only sites in the Atlantic drainage from Sandy Hook south and the Delaware Bay drainage west to Stow Creek were included. The sampling frame was defined as: 1) lakes and impoundments greater than 15 acres with public access, as listed in the latest version of NJ Places to fish; 2) rivers greater than 12 miles long and without any impoundment in the sampling frame; 3) estuarine rivers and associated brackish ponds.

The strata were:

1) Unique lakes; Manasquan Reservoir, Union Lake, and Atlantic City Reservoir;

2) Northeastern Coastal Plain Lakes, including lakes and reservoirs north of Toms River; this stratum was identical to that used in the 1992 study;
3) Pine Barrens Lakes;
4) Pine Barrens River; in 1992, Pine Barrens rivers and lakes were included in the same stratum;
5) Other southern Coastal Plain Lakes; this stratum included lakes south of Toms River and outside the Pine Barrens; this stratum included lakes classed in several strata in 1992 (western Coastal Plain lakes and southern Coastal Plain Lakes;
6) Other non-tidal rivers;
7) Estuarine rivers.

In 1992, strata were defined across the entire State, while only sites in the Atlantic-Delaware Bay region were included in 2007. For example, in 1992, the Pine Barrens stratum included sites in the Atlantic-Delaware Bay region as well as the Delaware River region.

In some cases, sites selected for sampling could not be sampled, because permission for access could not be obtained (these sites no longer have public access), the site did not fit criteria for inclusion (e.g., Birch Ponds, which consists of a number of small ponds, none greater than 15 acres), or the lake had been drained (Rainbow Lake). In these cases, sites were replaced by another randomly-selected site.

Analytes

A total of 223 samples were analyzed. Total mercury was measured on 220 samples (mercury was not measured in 3 white catfish from the Maurice River). Lipid content, PCBs and selected organo-chlorine pesticides (OCPs) were measured on 136 of the samples, selected to include species most likely to show bioaccumulation of these substances and/or important in recreational fisheries. These include predatory fish, benthic fish and fish with high lipid content. Polybrominated diphenyl ethers (PBDEs) were measured on 10 samples. Dioxins and furans were analyzed on 10 of the samples analyzed for PCBs and OCPs. Analytical methods are described in greater detail in the methods section.

SAMPLING PROCEDURES

Field

Specimens were collected by standard fisheries methods and/or by legal angling methods, using an applicable State of New Jersey Freshwater or Marine Scientific Collecting Permit. Extra specimens and species of opportunity collected were retained frozen for possible future analyses.

Fish were collected by a variety of techniques as appropriate to the access of waterbody, location, water levels and species needed. The primary technique used was boat electrofishing (freshwater ponds). Eel pots, angling, backpack electrofishing, and gill netting were also used. Eel pots were used to supplement gill netting (on Stow Creek) and angling was used while scouting some sites. Backpack electrofishing was used on the North Branch Metedeconk River to sample wadeable habitat. Gill netting was used at three sites where lack of boat access (Cedarville Ponds and Lake Nummy) or high salinity (Stow Creek) prevented boat electrofishing. Specimens from a few sites were collected by personnel of New Jersey Division of Fish and Wildlife (NJFGW).

Measurements of pH, conductivity, dissolved oxygen and water temperature were made at the time of sampling, using a YSI multimeter. These parameters were not measured at the sites sampled by NJFGW (Union and Batsto lakes). Measurements at one other site (Wading River) were taken in May 2009, rather than at the time of sampling. For statistical tests, a variable pH group was calculated. pH group is the integral portion of the average measured pH (e.g., a site with average pH of 4.88 is in pH group 4). The pH groups for Union Lake and Batsto Lake were taken as the 1992 values.

All information on specimens collected in the field was kept on data sheets for each station. Field chain-of-custody forms were completed for each collection trip and were used to track transfers of specimens from other collection groups to ANSP fisheries personnel and within ANSP to track laboratory transfers internally and to outside laboratory facilities.

All specimens were placed on ice as soon after capture as practical. Specimens were held in stainless steel containers (pre-cleaned with Micro cleaning solution and rinsed with ambient water at each individual station) until processing. Within 24 h of capture (usually less), specimens selected for dioxin, PCB and pesticide analysis were wrapped in muffled aluminum foil, sealed with freezer tape, labeled and placed in freezers. The specimens selected for mercury analysis only were frozen in Ziploc-type (plastic) or kitchen bags. Specimens for both planar PCB and mercury analysis were wrapped in muffled aluminum foil. All specimens were labeled with both internal and external tags and held frozen until thawed for sample preparation. Samples were maintained with complete sample documentation (chain-of-custody forms, etc.) consistent with the QA/QC Plan.

In order to ensure uncontaminated samples, the sampling gear, coolers, stainless pans and appropriate sample containers (muffled aluminum foil wrap) were cleaned between sampling events. The procedures for cleaning sampling gear and wrapping specimens were consistent with

ANSP standard operating procedures (ANSP SOP P-14_12, Preparation of fish tissues for contaminant analysis).

Laboratory

All samples were stored frozen until processing in the ANSP laboratory. All transfers of samples were properly documented throughout transport and analysis (internal laboratory chain-of-custody). All laboratory equipment was properly calibrated as per each method completed. Careful cleaning of all laboratory equipment and instruments using the appropriate soaps, solvents, acids, and double deionized water (DDW) was done throughout the program.

Tissue preparation of fish followed common preparation methods for consumption. The selected fish specimens were filleted using clean methods for both trace metals and organic contaminants as outlined in EPA (1995; ANSP SOP-14-12r4). The samples were filleted with skin off for American eel and catfish species and with skin on and scales removed for all other species. Filleting was done using stainless steel utensils on glass plates. All fish samples were individual filets, typically the left side filet, with the remains (right side, remaining carcass and head) retained for archival material. The archived sample material (including the extra sample homogenate not analyzed) will be retained by ANSP for a period of one year following project final report submission.

CHEMICAL ANALYSES

Each tissue sample was fileted, homogenized and placed into pre-cleaned jars (e.g., ICHEM) for trace metals and organic analyses. Chemical analyses were performed by ANSP using modified U.S. EPA and NOAA Status and Trends approved methods (ANSP SOPs P-16-84r4, P-16-111, P-16-109r1, and P-16-108). Chemical contaminants and ancillary parameters are listed in Table 2.

As part of quality assurance and quality control (QA/QC), a Standard Reference Material (SRM) was analyzed. The SRM was obtained from the National Institute of Standards and Technology (NIST) or equivalent agency (see Cantillo, 1993; 1995) and consisted of SRM 1946 (Lake Superior Fish Tissue) for both mercury and PCB/OCP analyses. Also, additional duplicate (PCB/OCP and mercury) and triplicate (PCB/OCP) fish tissue samples were analyzed to help assess laboratory variations and provide critical information for the assessment of both geographical and temporal trends.

All glassware and materials coming into contact with the fish were pre-cleaned with the appropriate cleaning agent (e.g., Micro soap, acids, deionized water, solvents, etc.) pertaining to the specific parameter or group of parameters. Cleaning and analytical methods are outlined in the QA/QC documentation for this project (ANSP Ref# 464; January 2007).

Mercury

Extractions and Analyses:
Strong acid digestions were performed using 10 ml nitric acid on approximately 0.5 g homogenized wet fish material in a CEM MDS 2100 microwave digestion system. Mercury quantitation was subsequently accomplished using a Perkin Elmer Fimms 400 Cold Vapor AA. Calibration blanks, intercalibration verification samples, and instrument duplicates were analyzed to ensure instrument performance and accuracy. The QA samples were analyzed at 10% to 15% frequency throughout the study.

Detection Limits and Qualified Data:
The method detection limit (MDL) based on the analysis of 4 replicate samples of a low mercury standard (1.0 µg/L) has a value of 0.03 µg/g wet weight. The instrument detection limit (IDL) is based on the repeated analysis of 19 digestion blanks and has a value of 0.03 µg/L. Total mercury values ranged from 0.02 µg/g to 7.35 µg/g wet weight. The relative percent difference (RPD) for sample duplicates ranged from 0.3 to 22. The highest RPDs were usually for samples with low concentrations.

PCBs, Co-Planar PCBs, Organochlorine Pesticides, Polybrominated Diphenyl Ethers, Dioxins and Furans

Extractions and Analyses:
All methods employed were similar to those used in previous monitoring studies for the State of New Jersey and the Delaware River Basin Commission. Homogenized fish samples were stored frozen until extraction. For extraction, samples were thawed and 2 g of the homogenate was sub-sampled using a Teflon-coated spatula. Approximately 30 g of Na_2SO_4 (previously baked at 450°C for 4 h) was added to the sub-sample to eliminate water. The dried sample was then placed in a glass Soxhlet extractor with ca. 200 ml dichloromethane (DCM) for a minimum of 18 h. For PCBs, co-planars and PBDEs the following surrogates were used, respectively: PCB 14, 65 and 166 (35 ng), PCB 77 (21 ng) and PCB 103 (100 ng). The extracts were then sub-sampled for gravimetric lipid determination. For this, a known volume of extract was transferred to a pre-weighed aluminum pan. The solvent was allowed to evaporate under the fume hood for 6-8 h. The residue remaining (lipid) was weighed and percent lipid calculated. Lipids were removed from sample extracts by gel permeation chromatography (GPC) using DCM as the mobile phase. The collected fraction containing analytes was concentrated by roto-evaporation and a N_2 stream. Solid-liquid chromatography using Florisil was performed as an additional clean-up step. Using this technique, PCBs (as well as heptachlor, nonachlors, and DDEs) were eluted from the chromatographic column containing florisil using petroleum ether (F1 fraction). The remaining organochlorine pesticides were eluted using 50:50 petroleum ether and dichloromethane (F2 fraction).

Congener-specific PCBs and organochlorine pesticides were analyzed using an Agilent 6890 gas chromatograph equipped with a ^{63}Ni electron capture detector and a 5% phenylmethyl silicon capillary column. The identification and quantification of PCB congeners follows the '610 Method' (Swackhamer 1987) in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18 mixture of Aroclors 1232, 1248 and 1262) were determined by calibration with individual PCB congener standards. Congener identities in the sample extracts were based on their chromatographic retention times relative to the internal standards added (PCBs 30 and 204). In cases where two or more congeners could not be chromatographically resolved, the combined concentrations were reported.

In conjunction with the Geochemical and Environmental Research Group (GERG) at Texas A&M University (contact: Dr. Terry Wade), four of the dominant co-planar PCBs (PCB 81, 77, 126 and 169) were also measured**.** All samples were extracted and spiked with surrogate PCB 77 (21ng) by ANSP. Samples were shipped overnight to GERG to be separated on charcoal/silica gel columns and run using high resolution gas chromatography/low resolution mass spectrometry (HRGC/LRMS).

Finally, a subset of extracts from the PCB analyses was used to quantify polybrominated diphenyl ethers (PBDEs), which are components of flame retardants. Thirty-eight conformations of PBDEs (Table 2) were analyzed in extracts using gas chromatograph (Hewlett Packard 5890A, or equivalent). A 0.25 mm x 30 m fused silica capillary column coated with a 5% phenyl methylpolysiloxane column (DB-5MS; 0.25 µm film thickness) was inserted directly into the ion source of the mass spectrometer. One column injection was employed in the gas chromatograph (GC) and the injection port was set to track the oven temperature. The oven temperature program was: 130°C for 1 min followed by a temperature ramp of 12°C/min to 140°C and followed by a temperature ramp of 5°C/min to a final temperature of 300°C which was held for an additional 5 min. The auxiliary temperature and transfer line were maintained at 280°C. For all brominated flame retardant analytes (PBDEs), ions 79 and 81 (bromide ions) were monitored as quantitative and qualitative ions. Analysis of PBDEs was performed by Dr. Terry L. Wade of GERG.

Organochlorine pesticides (OCPs) were identified and quantified based on comparisons (retention times and peak areas) with a known calibration standard prepared from individual compounds.

Quality assurance and control measures were included at a frequency of 10% of the total number of samples. These measures included: evaluation of surrogate recoveries, calculation of blank-based detection limits, use of NIST standard reference materials and involvement in NIST's annual inter-laboratory comparison to assess ANSP's accuracy and precision in quantifying PCBs and OCPs, duplicate analysis, and spike recoveries.

All data and information obtained during the course of this project were kept by the laboratory in either computerized or handwritten form (i.e., notebooks and field sheets) and are available for inspection on request. Field data sheets were used throughout this project. All data were kept on IBM type computers (both hard drives and backed up on fixed media, such as nightly backup from the ANSP server) using Microsoft EXCEL or ACCESS. Reporting of the data was done at specific points during the study.

All data submitted to and generated by ANSP were rigorously documented and underwent external quality assurance by the Robin Davis, the QA Officer, and ANSP staff.

Dioxins and Furans
Selected samples for dioxin/furans were sent to the Texas A&M University, GERG, for full extraction and analysis. The methods outlined below are based on GERG at Texas A&M University SOP -9722 and 9719.

Tissue samples were spiked with labeled compound spiking solution (LCSS) containing specified amounts of isotopically ($^{13}C_{12}$) labeled 2,3,7,8-substituted PCDDs/PCDFs and homogenized in a pre-cleaned centrifuge tube. The tissue was dried with 50 g of sodium sulfate (Na_2SO_4) and extracted by maceration three times in 100-ml aliquots of methylene chloride (CH_2CL_2). After extraction, the samples were spiked with cleanup recovery standard (CRS), $^{37}Cl_4$-2,3,7,8-TCDD, to monitor losses through the extract purification steps. An aliquot for % lipid determination was then removed. The extract was dried with sodium sulfate, concentrated and subjected to bulk purification involving silica gel/sulfuric acid slurry. The extract was then processed through two chromato-graphic procedures to remove co-extracted matrix interferences: a mixed bed silica gel column and an activated charcoal column. All concentration steps were performed using tetradecane as a keeper and the final concentration step reduced the extract to approximately 10 µl tetradecane. An internal standard (IS) of selected $^{13}C_{12}$-labeled PCDD compounds were added to all final extracts before bringing the final volume of the extract to 20 µl of tetradecane.

The GC column used for analysis of PCDDs and PCDFs and for isomer specificity of 2,3,7,8-TCDD was a 60-m J&W DB5 or DB5MS column with a 0.25-mm ID and a 0.25- mm film thickness, or equivalent. The detector used for these analyses was a VG AutoSpec Ultima, or equivalent, utilizing 28 to 40 eV electron impact ionization, capable of repetitively selectively monitoring a minimum of 12 exact m/zs at high resolution ($\geq$10,000) during a period of approximately 1 sec or less. A dedicated data system was employed to control the rapid multiple-ion monitoring process and to acquire the data. Quantitation data (peak areas and/or peak heights) and Selected Ion Monitoring (SIM) traces were acquired during the analyses and stored. The data system is capable of acquiring data at a minimum of 12 ions in a single scan. It is capable of switching to different sets of ions (descriptors) at specified times during an acquisition, and of providing hard copies of individual ion chromatograms for selected gas chromatographic time intervals. It is capable of acquiring mass spectral peak profiles and providing hard copies of peak profiles to demonstrate the required resolving power. The data system permits the measurement of noise on the baseline. The methods outlined above are based on SOP -9722 and 9719 from GERG at Texas A&M University.

Detection Limits and Qualified Data: Organic Contaminants

Detection limits for PCBs and OCPs were defined by the mean plus three times the standard deviation divided by the average extraction mass of measured concentrations in the blanks. Based on these detection limits, measured sample concentrations were qualified as non-detect (ND) or below-detection-limit (BDL), and these qualifiers are contained in the final data package. For data summaries (e.g., mean concentrations among groups of samples) values were uncensored. ND concentrations were treated as zero and the measured concentrations of all other samples were used, even where BDL. While these measured BDL concentrations are not meaningful for interpretation of individual samples, use of the measured concentration reduces potential biases in forming group means. The same approach was used in calculating total concentrations of groups of compounds (e.g, total PCBs, total DDX [DDT, DDE, and DDD], total chlordanes, and total chlorobenzenes). Congeners which are BDL typically contribute relatively little to the sum of compounds within a class, so the difference in treatment of the BDL data has little effect on total concentrations in most cases.

STATISTICAL ANALYSES

Means and maximum concentrations within waterbodies were calculated and reported. Statistical tests of differences in mercury concentrations between 1992 and 2007 were performed using general linear models (GLM) in Statistica. Models were tested using combinations of a discrete spatial variable (waterbody, stratum or pH group), the logarithm of the total length measured in the laboratory (log(LTL), and year (as a discrete variable). Various interactions among variables were also tested. Final models were selected based on significance of factors and r^2. Tests using waterbody only used data from stations sampled in 1992 and 2007. Tests using stratum and pH group used all available data from each year. While most sites were randomly selected within strata (including several that were randomly selected in 1992, some sites sampled in 1992 were targeted for sampling in 2007 as well (e.g., Harrisville and East Creek lakes). Tests were not modified to account for the repeated sampling of several sites.

RESULTS

Overview

Data from individual samples are presented in Appendix I (mercury, PCBs, co-planar PCBs, PBDEs, DDX, chlordanes, and BHCs and lindane), Appendix II (dieldrin, aldrin, endrin, and endosulfans) and Appendix III (furans and dioxins). Averages and maxima of mercury, total PCBs (excluding co-planar congeners), total co-planar PCBs, total DDX, total chlordanes (including heptachlor and heptachlor epoxide), and total BHCs and lindane for each station and species combination are presented in Tables 4 and 5. Data on furans and dioxins are presented in Table 6 and Appendix III. Tables and the appendices use the sum of uncensored concentrations for constituents of each group. These include some concentrations which are below detection limit (BDL). Non-detect concentrations (ND) are treated as zero. All estimated concentrations of total PCBs, DDXs, chlordanes, and PBDEs are above the detection limit and most are above the quantitation limit. Most concentrations of dieldrin and endosulfan II are above the quantitation limit, but there were a number of samples below the quantitation limit. Most concentratations of BHCs, endrin, aldrin, and endosulfan I are below the quantitation limit. Almost all concentrations of co-planar PCBs are below the quantitation limit. Inclusion of the BDL numbers in totals has little effect on the totals, except for low concentrations (Fig. 1-5) of BHCs and PBDEs. The totals, with and without the quantitated BDL concentrations, are nearly identical for total PCB concentrations or total DDX concentrations greater than about 35 ng/g (Figs. 1 and 2), at total chlordane concentrations greater than about 3 ng/g (Fig, 3), and concentrations of BHC plus lindane greater than about 0.5 ng/g. Estimated concentrations of PBDEs with and without BDL substances are nearly identical. The greater contribution of BDL values at low total concentrations presumably results from contribution of noise to quantitated BDL concentrations. Where duplicate or triplicate samples were analyzed, the tables show the average of the multiple values of toxic contaminants for each sample. The lipid percentage is for the first analysis only.

Concentrations of several contaminants are correlated among samples (Table 7). PCBs, chlordanes, endrin and endosulfan II are generally highly inter-correlated. Dieldrin and aldrin are highly correlated. Most other organic contaminants are moderately to weakly correlated. Total mercury is uncorrelated with the organic contaminants. Co-planar PCBs, PBDEs, dioxins, and furans are not included in the correlation analysis because of the low number of samples for these parameters.

The highest average PCB concentrations are seen in channel catfish from the Maurice River and American eel specimens from Deal Lake; these had average concentrations between 454 and 348 ng/g wet weight, respectively. Average PCB concentrations in white perch from Deal Lake and white catfish from Maurice River are also relatively high compared to other sites.

Toxic equivalents (TEQs) of dioxins and furans are calculated from dioxin and furan concentrations (Appendix III). The TEQ is a weighted total of dioxin and furan concentrations, where the weighting factors (TEFs) are based on toxicity relative to the two most toxic dioxin congeners (2,3,7,8-TCDD and 1,2,3,7,8-PeCDD). The TEFs are 1.0 for these congeners, and <1 for other congeners. TEFs (Appendix IV) for OCDD and OCDF were taken from van den Berg, et al. (2006), and all other TEFs were taken from van den Berg, et al. (1998).

Risk Assessment Based on Exceedances of FDA Action Levels

The USFDA nationally promulgates guidelines for the consumption of fish and fishery products by issuing action limits. The primary purpose of these limits is to represent the point at or above which the administration will take legal action to remove products from the market. While fish caught by recreational anglers do not fall under FDA purview, the FDA limits are often used as a benchmark for the concentrations above which ingestion is not recommended. The US EPA and individual states, including New Jersey, have promulgated other action limits. These are often based on risk assessments, may vary with target population and may recommend frequency of consumption rather than setting a single "do not eat" level. These USEPA and State action levels are often lower than those of USFDA. USEPA (2004) defines screening values as "concentrations of target analytes in fish or shellfish tissue that are of potential public health concern and that are used as threshold values against which levels of contamination in similar tissue collected from the ambient environment can be compared." For comparison, screening values (SV) for recreational fishermen (SVrf) are used below (Table 5-4 in USEPA 2004). SV for different groups depend on the balance between different consumption rates and lower body weights of children. For noncarcinogens, relationships between SV for different groups are more complex, since reference doses (e.g., related to developmental or reproductive effects) differ among groups as well.

Mercury

The FDA action limit for total mercury in fish tissue is 1 µg/g on a wet weight basis (or 1 ppm) (FDA 2001). Sixty-one fish (out of the 130 samples) exceeded this value. One fish, a 51-cm largemouth bass from Lower Atlantic City Reservoir had a concentration of 7.35 µg/g. Eighteen fish had concentrations between 0.8 and 1.0. Seventeen fish had concentrations between 0.5 and 0.7. Samples exceeding 0.5 µg/g consisted mostly of large predatory fish (largemouth bass and chain pickerel) and American eel. Other species exceeding 0.5 µg/g less frequently were white perch, yellow perch, yellow bullhead, brown bullhead, and channel catfish. Sixteen specimens of largemouth bass, American eel, chain pickerel, and yellow bullhead had concentrations between 0.4-0.5. Higher mercury concentrations were generally seen in ponds in and near the Pine Barrens.

PCBs

The USFDA "do not eat" limit is 2,000 ng/g for total PCBs. This limit was not exceeded by any sample. Many states and organizations recognize that this limit may be too high and use lower limits. Two samples (one American eel from Deal Lake and one channel catfish from Maurice River) exceeded one-half of the USFDA action limit (1,000 ng/g).

The NJDEP and NJDHSS have developed a set of risk-based consumption advisories for total PCBs (Post, et al. 2001). Consumption advisories are based on cancer risk levels, non-cancer risks, and distinct advisories are issued for different groups at risk.

Chlordane
The USFDA has set an action limit of 300 ng/g wet weight (or 0.3 ppm) for chlordane (cis and trans forms, equivalent to alpha and gamma forms) in fish. Two samples exceeded this limit. These were American eel from Metedeconk River North Branch and Deal Lake. The Metedeconk River specimen also had a high concentration of DDXs, dieldrin, and BHCs and lindane. The Deal Lake specimen also had a high PCB concentration. The American eel from Metedeconk River North Branch was more than six times the USFDA action limit with a chlordane concentration of 1983.7 ng/g. The SVrf for total chlordanes is 114 ng/g wet weight (based on carcinogenic effects). One additional Metedeconk River North Branch American eel exceeded this limit.

DDXs
Because of its bioaccumulative nature and toxicity, the USFDA has set an action limit for DDXs (sum of DDTs, DDEs, and DDDs) at 5.0 ppm (5000 ng/g). None of the 2007 samples exceeded this limit. The SVrf for total DDXs is 117 ng/g, based on carcinogenic effects. Thirty-three samples exceeded this limit.

Dieldrin, Aldrin, Heptachlor and Heptachlor Epoxide
The USFDA's action limit for aldrin and dieldrin in fish is 0.3 ppm (300 ng/g). One sample exceeded this limit for dieldrin. This was an American eel from Metedeconk River North Branch; this specimen also had a high concentrations of several other contaminants. The SVrf for dieldrin is 2.5 ng/g based on carcinogenic effects, which was exceeded by 49 samples.

Comparison with Data from Previous Studies

A number of sites which had been sampled in 1992 and 1996 were re-sampled for this study, thereby allowing comparison of temporal trends in mercury concentrations. In addition to comparisons of single lakes, comparisons among years within strata can be done, providing a greater sample size for comparison. Since mercury concentrations often increase with size of fish, comparisons are by comparing mercury concentration-length relationships among years. Only mercury was analyzed in the 1992 and 1996 studies, so the data from 2007 provide new information on organic contaminants for the sites, but they do not permit temporal comparisons for organic contaminants.

The most comprehensive comparison is for mercury in chain pickerel in Pine Barrens lakes (Fig. 6). In general, mercury concentrations in chain pickerel were similar in 1992 and 1996. Most concentrations in 2007 were similar to those in the earlier years, but some fish showed lower concentrations at size in 2007. These data showed differences among lakes but no clear among-year differences. For lakes sampled in more than one year with moderate sample sizes (Batsto Lake, East Creek Lake, and Harrisville Lake), 2007 concentrations were similar or lower in 2007 than in 1992, although small sample sizes in each lake and differences in size of fish caught in the two years precludes detailed comparisons (Figs. 7-9). Yellow bullhead and brown bullhead were also sampled from Pine Barrens Lakes (Figs. 10-11). However, relatively few fish were analyzed, Hg-length relationships are generally weak, and consistent trends are not apparent for those species. Chain pickerel were sampled from Wading River in 1992 and 2007 and in two other Pine Barrens rivers in 1992 or 1996 (Fig. 12). Concentrations in 2007 were higher than those in earlier samples, even among fish from the same site (Wading River). However the 2007 Wading River chain pickerel were caught from a different reach than in 1992 (farther upstream in 2007), so there may be within-river differences.

For largemouth bass in the Northeastern Coastal Plain lakes (Fig. 13), mercury concentrations in 2007 were generally lower than those in 1992, except for Enno Lake (sampled in 2007), where concentrations were similar or higher than those in 1992. No bass were sampled from the same northeastern sites in both years (access was not possible in 2007 for one site sampled in 1992), so these comparisons involve both among-site and among-year variation.

Largemouth bass and chain pickerel were sampled in a number of southern Coastal Plain lakes in the three survey years (Figs. 14-15). There is no clear difference in mercury concentrations among years for largemouth bass. Mercury concentrations in chain pickerel from southern Coastal Plain lakes were similar or lower than those from 1992. Wilson Lake was sampled in two years (Fig 16); mercury concentrations were highly variable in 1992 and no clear trend is evident.

Largemouth bass were sampled in Union Lake in 1992 and 2007 (Fig. 17); mercury concentrations were similar in both years. Largemouth bass were sampled in Manasquan Reservoir in 1992 and 2007 (Fig. 18). There the mercury concentrations were lower in 2007, even though larger fish were sampled. Mercury concentrations were measured in largemouth bass from upper Atlantic City Reservoir in 1993 and from the lower Atlantic City Reservoir in 2007 (Fig. 19). Access to the upper reservoir could not be obtained in 2007. In 1995, New Jersey DSRT sampled largemouth bass from the reservoirs (9 specimens from the upper and 5 from the lower), chain pickerel from the reservoirs (3 from the upper and 1 from the lower), and one yellow perch from the lower reservoir. Data on size of individual fish from the 1995 samples are not available, preventing precise comparisons of mercury concentrations. Mercury concentrations in largemouth bass from the upper reservoir were lower (mean 3.65 µg/g, range 1.61-4.81 µg/g) than in 1993 (mean 4.47 µg/g, range 3.05-8.94 µg/g). Mercury concentrations in largemouth bass from the lower reservoir in 1995 were similar (mean 1.71 µg/g, range 1.44-1.83 µg/g) to those in 2008 (mean 1.89 µg/g, range 1.64-7.35 µg/g), except for the high mercury concentration (7.35 µg/g) in a large fish (51.3 cm). Applying the ratio of mercury concentrations in the upper reservoir to those in the lower reservoir in largemouth bass from 1995 (2.13) to the 2008 samples, the estimated average mercury concentration of largemouth bass from the upper reservoir would be 4.03, which is somewhat lower than the observed 1993 average. However, the differences in mercury concentrations could reflect differences in the size distributions of specimens in the different samples.

Cedar Lake was also sampled in 1996 and 2007 (Fig. 20), but no consistent differences in mercury concentrations in largemouth bass were evident.

Statistical tests on mercury concentrations in the two most-sampled species across groups of waterbodies did not show differences among strata. Analyses of 1992 and 2007 data did find differences among waterbody pH groups. For chain pickerel, the best model ($r^2 = 0.57$) included pH group as a discrete factor, and a significant pH group * log(LTL) interaction (i.e., separate slopes of the log(LTL) relationship for pH groups). LSMs for this model (Fig. 21) show approximately similar means for pH groups 4, 5 and 6, and a lower mean for pH group 7. Linear contrasts showed pH group 7 to be significantly different from pH group 6 and from pH groups 4, 5 and 6 combined.

For largemouth bass, the best model ($r^2 = 0.64$) included pH group, log(LTL), and pH group * (log(LTL) and year * log(LTL) interactions. The lsmeans (Fig. 22) showed a roughly similar pattern as that for chain pickerel. Linear contrasts found pH group 5 significantly greater than pH group 6, and pH group 7 significantly greater than pH group 8. Statistical tests using waterbody as the treatment factor (i.e., instead of stratum or pH group) found highly significant waterbody differences, as well as highly significant waterbody * year interactions, indicating that the pattern of Hg concentrations among sites differed among years.

Information on contaminant concentrations in the central and southern Atlantic coast drainages can be compared with results from the Raritan Drainage (third year of the routine monitoring program, ANSP 2007) and the Passaic drainage (second year of the routine monitoring program, ANSP 2005). Comparable data are also provided from 1998 studies (Ashley and Horwitz 2000) Regional comparison are complicated by differences in size of fish analyzed and growth rates of fish, as well as by differences in sources or bioavailability of contaminants. Detailed comparisons accounting for these various differences are beyond the scope of this report. The clearest pattern is differences in Hg concentrations. For example, over the 3 surveys, Hg was analyzed at 35 sites, 21 of which were from the S Atlantic drainages (sampled in this study). The 10 highest average concentrations (and 12 of the 13 highest concentrations) were in this study, with the high average concentrations occurring in the Pine Barrens Lakes. Low Hg concentrations in this study were seen in Lefferts Lake and Parvin Pond. Similarly, Hg was analyzed in American eels at 41 sites, including 21 from the S Atlantic drainages. The 14 highest average concentrations of Hg were all in this study. These sites are mainly sites in or near the Pine Barrens. A few S Atlantic drainage sites, such as Parvin Pond, Deal Lake, and Swimming River Reservoir, had relatively low Hg concentrations; these are west or north of the Pine Barrens. Largemouth bass were analyzed at 19 sites from the S Atlantic drainages, and may be compared with data from 61 sites in other regions. The five highest (and seven of the nine highest) average concentrations were found in sites in or near the Pine Barrens sampled in this study. The three lowest sites (Marlu Lake, Swimming River Reservoir, and Deal Lake) were also from S Atlantic drainages

Average concentrations of PCBs show a different pattern. For American eel, 21 of the 24 lowest average concentrations were found in this study. Deal Lake was the only 2007 site sampled with relatively high PCB concentrations. The pattern was not as clear-cut for largemouth bass (for which 8 of 34 sites were from the S Atlantic drainages), although most S Atlantic drainage fish had relatively low to moderate concentrations (all except Swimming River Reservoir with concentrations less than 50 ng/g wet weight). Other species, e.g., brown bullhead, also showed a pattern of lower PCB concentrations in the S Atlantic drainage sites, although bullheads were sampled from few S Atlantic drainage sites.

Average concentrations of DDXs were not as consistent within regions. For American eels, the S Atlantic drainage sites showed the six lowest average concentrations (e.g., in sites in the southern part of the region) and the six highest average concentrations. Sites with high concentrations are in different parts of the region, including the southern part (Cedar Lake), central part (Lenape Lake, Lake Manahawkin, and Lake Absegami), and the northern part (North Branch Metedeconk River, Swimming River Reservoir. For largemouth bass, there was no clear pattern, with a few sites with relatively high average concentrations (e.g., Batsto Lake and Union Lake) and some with low concentrations (e.g., Manasquan Reservoir and lower Atlantic City Reservoir).

DISCUSSION

This study is the first mercury study to extensively re-sample waterbodies in and near the Pine Barrens, following the 1992 study (ANSP 1994). In the previous study, fish from these sites had consistently higher mercury concentrations than fish from other regions in the state, based on length-standardized comparisons within species. A similar pattern was seen in this study, with relatively high concentrations of mercury in a number of specimens of fish, especially chain pickerel. Mercury concentrations in chain pickerel were typically higher than those in other regions, as sampled in the previous studies of northern New Jersey (Horwitz, et al. 2006) and of the Raritan drainage (Horwitz, et al. 2008). The tendency for higher bioaccumulation of mercury of fish in the Pine Barrens may be attributed to aspects of water chemistry and hydrology which favor methylation of mercury.

Stratified random site selection was done for this study, using a modification of the definition of strata used in the 1992 study. Several sites were selected non-randomly, on the basis of results of the 1992 study. The random selection allows inference about contaminant levels within each stratum. However, mercury concentrations did not differ significantly among most strata, so the particular stratification may not be useful in partitioning variability in contamination. Since, mercury contamination varied significantly among groups defined by measured pH, pH would be a better basis for stratification than geographic location, which was used in this and the 1992 study. Most pH measurements were based on a single measurement at the time of sampling and don't account for temporal variation. However, even these single measurements were sufficient for site categorization. In the future, compilation of existing pH data and targeted collection of pH data from water bodies with no data would provide a useful statistical basis for stratification. However, it is easier to develop regulations and consumption advisories on a regional basis, so the geographic stratification may still be valuable for policy and regulation.

A number of specific sites were re-sampled, allowing for comparison of mercury concentrations between 2007 and earlier years (usually 1992). Comparisons were also done across strata, since sites were randomly selected within strata. In general, there were no consistent changes in mercury content between earlier and recent collections, although differences at a few sites were evident. Concentrations of mercury in fish from Manasquan Reservoir were lower in 2007 than in the earlier study. In the earlier study, high mercury concentrations were attributed to the "new reservoir effect", in which fish from newly-made reservoirs tend to have high mercury concentrations. The new reservoir effect may be caused by the abundance of detrital material in the first few years after flooding; this detritus forms a substrate for methylating bacteria. The recent decrease in mercury concentration may be due to the ageing of the reservoir and loss of this bacterial food source. The reasons for differences in mercury concentrations at other sites (e.g., higher concentrations in 2007 at Wilson Lake) are as yet unexplained.

Concentrations of mercury (and other contaminants) typically increase with the age of fish. Length provides a surrogate measure of age, particularly within water bodies. However, in comparisons among water bodies, differences in growth rates may weaken overall length-age relationships, and use of fish length as a covariate may be misleading. For example, the growth rates of many species of fish are likely to be relatively low in Pine Barrens lakes and streams, particularly for species like largemouth bass, which do not thrive in low pH water. As a result, fish of a given size from these waters may be considerably older than similar-sized fish from other areas, so that length would not be an appropriate covariate for analysis of contaminant concentrations. Heads of many of the specimens analyzed in this study have been archived, allowing for future age analyses.

One of the goals of the study is to locate sites with unusually high concentrations of contaminants. These may indicate historical or current point-source contamination. In this study, high concentrations of mercury were seen in fish from the lower Atlantic City Reservoir. In 1992, fish from the Upper Atlantic City Reservoir were sampled and found to have very high mercury concentrations. Higher mercury concentrations were also observed in 2007 at Wilson Lake. In addition, an eel from the North Branch Metedeconk River and an eel from Deal Lake had high concentrations of several organic contaminants. The source of these contaminants is not known.

CONCLUSIONS

This study includes the fourth region of the 5-year rotating routine monitoring program. The study provides relevant data for assessment of potential consumption risks and trends in contaminants. The study included a number of groups of fish that typically bioaccumulate certain organic contaminants. These groups were selected because of high trophic position (e.g., largemouth bass and chain pickerel), lipid content (especially American eel), longevity (e.g., American eel) and/or association with sediment (American eel, white catfish and channel catfish). These data are relevant to risk assessment, since they include sizes and species that are targeted by fishermen, and several conclusions can be drawn from the study.

1) With the exception of mercury, few of the samples exceeded high action levels (e.g., FDA action levels for PCBs, DDX, and chlordane). However, a number of samples exceeded various risk-based thresholds, e.g., as used by NJDEP. In some cases, the same specimens exceeded thresholds for multiple contaminants.

2) Mercury concentrations varied among species and usually increased with size within species. Mercury concentrations were higher in larger, predatory fish such as chain pickerel and largemouth bass. Mercury concentrations were lower in waterbodies with pH greater than 7 than in waterbodies with pH between 4 and 7. For chain pickerel, there was no clear pattern in mercury concentrations among waterbodies with pH between 4 and 7. For largemouth bass, highest concentrations were seen in lakes with pH between 5 and 6.

3) Where comparisons were possible, there was no clear trend in mercury concentrations between 1992 and 2007. Concentrations in Manasquan Reservoir were lower in 2007 than in 1992, which may reflect “ageing” of the reservoir (fish in new reservoirs often have higher mercury concentrations, ultimately due to the amount of decaying organic matter from flooded terrestrial vegetation)

4) In waterbodies where concentrations of PCBs and OCPs were measured in American eels and other species, concentrations of PCBs, DDXs and chlordanes were typically higher in eels. Concentrations of PCBs and OCPs were variable among sites. The highest average concentrations were seen in fish from Deal Lake (PCBs and chlordanes), North Branch Metedeconk River (DDXs and chlordanes), Maurice River (PCBs), and several other lakes (DDXs).

5) This fourth year of the Routine Monitoring Program is designed to address these different scales of variation by sampling a range of size of several species, by sampling new sites in each round to identify previously-unknown hotspots, by re-sampling selected sites to analyze temporal trends, and by rotating among regions to investigate broad, regional patterns in fish contamination. The observed patterns of contaminant concentrations in fish reflect individual fish characteristics such as size (typically higher in larger, older fish), trophic level and lipid content (for organic contaminants), site differences indicative of current or past point sources (e.g., Atlantic City Reservoir) and regional differences which affect contaminant biogeochemistry.

6) Comparisons among sites from the Passaic, Raritan and S Atlantic drainages (this study) show some regional differences, although there are large differences within regions. The highest Hg concentrations were seen in S Atlantic drainage sites, principally Pine Barrens sites. PCBs showed a different pattern, with relatively low to moderate PCB concentrations in fish from most S Atlantic drainage sites. DDXs showed high variability within the S Atlantic drainages, with some of the lowest and highest average concentrations among the three regions. These differences highlight different sources and chemistry of these contaminants. The pattern of Hg reflects conditions promoting high bioavailability through methylation. PCB patterns may reflect industrial patterns of production and use. The weak geographic pattern of DDX concentrations may reflect local sources of production and use.

7) The New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Department of Health and Senior Services (DHSS) use risk-based health criteria for establishing consumption advisories for mercury, PCBs, dioxins, and OCPs. These criteria are typically lower than FDA thresholds for advisories for commercial fish. The data from this study and other portions of the routine monitoring program are used by NJDEP and DHSS to develop fish consumption advisories for New Jersey.

REFERENCES

Academy of Natural Sciences of Philadelphia (ANSP). 1994. Preliminary Assessment of Total Mercury Concentrations in fishes from rivers, lakes and reservoirs of New Jersey. Report 93-15F. Submitted to New Jersey Department of Environmental Protection and Energy, Division of Science and Research. Contract P-35272. 92 pp.

Academy of Natural Sciences of Philadelphia (ANSP). 1999. Phase II Assessment of total mercury concentrations in fishes from rivers, lakes and reservoirs of New Jersey. Report 99-7. Submitted to New Jersey Department of Environmental Protection and Energy, Division of Science and Research. 155 pp.

Academy of Natural Sciences of Philadelphia (ANSP). 2005. Final Report: Routine Monitoring Program for Toxics in Fish. Report No. 04-06. May, 2005. 182 pp.

Academy of Natural Sciences of Philadelphia (ANSP). 2007. Quality Assurance and Quality Control Plan: Routine Monitoring for Toxics in New Jersey Fish: Year 3, Raritan River Region. Contract # SR06-008. Academy Reference No. 464. Submitted to New Jersey Department of Environmental Protection, Division of Science, Research and Technology.

Appel, K.E. 2003. Risk assessment of non-dioxin-like PCBs- report on a WHO-consultation. Freestones Env. Bull. 12(3):268-275.

Ashley, J. and R. Horwitz. 2000. Assessment of PCBs, selected organic pesticides and mercury in fishes from New Jersey: 1998-1999 Monitoring Program, Academy of Natural Sciences Report No. 00-20F. 112 pp.

Cantillo A.Y. 1993. Standard and reference materials for marine science. IOC Manuals and Guides 25. UNESCO, Nairobi, Kenya. 577 pp..

Cantillo, A.Y. 1995. Standard and reference materials for environmental science (Part 1 and Part 2). NOAA Tech. Memo. 94. NOAA/NOS/ORCA, Silver Spring, MD. 752 pp.

Clarkson, T.W. 2002. The three modern faces of mercury. Env. Health Perspectives. 110, Suppl 1. pp. 11-23.

FDA (Food and Drug Administration). 2001. Methyl mercury. Chapter 10 in, Fish and Fisheries Products Hazards and Controls Guidance. Third Edition. http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Seafood/ucm092041.htm

Horwitz, RJ, B. Ruppel, S. Wisniewski, P. Kiry, M. Hermanson and C. Gilmour. 1995. Mercury concentrations in freshwater fishes in New Jersey. *Wat., Air and Soil Poll.* 80:885-888.

Horwitz, R.J., J. Ashley, P. Overbeck and D. Velinsky. 2005. Final Report: Routine Monitoring Program for Toxics in Fish. Contract SR02-064. ANS Report No. 04-06. April 12, 2005. 175 pp.

Horwitz, R. J., P. Overbeck, J. Ashley, D. Velinsky and L. Zadoudeh. 2006. Final Report: Monitoring Program for Chemical Contaminants in Fish from the State of New Jersey. Contract SR04-073. ANS Report No. 06-04F. August 17, 2006. 77pp.

Horwitz, R. J., P. Overbeck, J. Ashley, D. Velinsky and L. Zadoudeh. 2008. Final Report: Monitoring Program for Chemical Contaminants in Fish from the State of New Jersey. Contract SR06-008. December 12, 2008. 69pp.

New Jersey Department of Environmental Protection (NJ DEP). 2008. NJ Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d)). Water Assessment Team. NJDEP. www.state.nj.us/dep/wms/bwqsa/integratedlist2008Report.html.

New Jersey Department of Environmental Protection (NJ DEP). 2008. NJ Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d)). Water Assessment Team. NJDEP.

Post, G., G. Buchanan, P. Cohn, J. Klotz, B. Ruppel and A. Stern. 2001. Options for development of Risk-based fish consumption advisories for PCBs. Report by New Jersey Risk Assessment Subcommittee of the Interagency Toxics in Biota Committee. October 10, 2001. 4 pp.

Ratcliffe, H.E., G.M. Swanson and L.J. Fischer. 1996. Human exposure to mercury: a critical assessment of the evidence of adverse health effects. J. Tox. Env. Health. 49:221-270.

Schoeny, R. 1996. Use of genetic toxicology data in U.S.EPA risk assessment: the mercury study report as an example. Env. Health Perspectives 104, Suppl 3. pp. 663-678.

Swackhamer, D.L. 1987. Quality Assurance Plan for Green Bay Mass Balance Study - PCBs and Dieldrin. U.S. Environmental Protection Agency, Great Lakes National Program Office.

United States Environmental Protection Agency (USEPA). 2004. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 1. Fish sampling and analysis. Third Edition. www.epa.gov/waterscience/fishadvice/volume1/.

Uphoff, J.H., Jr. 2003. Predator-prey analysis of striped bass and Atlantic menhaden in upper Chesapeake Bay. Fisheries Management and Ecology 10:313-322.

van den Berg M, Birnbaum L, Bosveld AT, Brunstrom B, Cook P, Feeley M, Giesy JP, Hanberg A, Hasegawa R, Kennedy SW, Kubiak T, Larsen JC, van Leeuwen FX, Liem AK, Nolt C, Peterson RE, Poellinger L, Safe S, Schrenk D, Tillitt D, Tyskind M, Younes M, Waern F, Zacharewski T. 1998. Toxic equivalency factors (TEF) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106: 775-792.

van den Berg M, Birnbaum L, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicol. Sci. 93: 223-241.

Watanabe, C. and H. Satoh. 1996. Evolution of our understanding of methylmercury as a health threat. Env. Health Perspectives 104, Suppl 2. pp 367-379.

TABLES

Table 1. Scientific and common names of fishes analyzed as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

Scientific Name	**Common Name**
Ameiurus catus	white catfish
Ameiurus natalis	Yellow bullhead
Ameiurus nebulosus	brown bullhead
Anguilla rostrata	American eel
Cyprinus carpio	common carp
Esox niger	chain pickerel
Ictalurus punctatus	channel catfish
Micropterus salmoides	largemouth bass
Morone Americana	white perch
Perca flavescens	yellow perch

Table 2. List of Analytes for the 2007 Routine Monitoring of Toxics in NJ Fish program.

POLYCHLORINATED BIPHENYLS		ORGANOCHLORINE PESTICIDES	POLYBROMINATED BIPHENYL ETHERS	FURANS
1*	136	opDDE	BDE 1 (2-MonoBDE)	OCDF
3*	77+110	ppDDE	BDE 2 (3-MonoBDE)	2,3,7,8-TCDF
4+10	82	op ddt	BDE 3 (4-MonoBDE)	1,2,3,7,8-PeCDF
7	151	pp ddt	BDE 7 (2,4-DiBDE)	2,3,4,7,8-PeCDF
6	135+144	o,p ddd	BDE 8/11 (2,4'-DiBDE/3,3'-DiBDE)	1,2,3,4,7,8-HxCDF
8+5	107	p,p ddd	BDE 10 (2,6-DiBDE)	1,2,3,6,7,8-HxCDF
19	149		BDE 12 (3,4-DiBDE)	2,3,4,6,7,8-HxCDF
12+13	118	alpha BHC	BDE 13 (3,4'-DiBDE)	1,2,3,7,8,9-HxCDF
18	134	beta BHC	BDE 15 (4,4'-DiBDE)	1,2,3,4,6,7,8-HpCDF
17	131	delta BHC	BDE 17 (2,2',4-TriBDE)	1,2,3,4,7,8,9-HpCDF
24+27	146	Lindane	BDE 25 (2,3',4-TriBDE)	
16+32	153+132+105		BDE 28 (2,4,4'-TriBDE)	**DIOXINS**
29	141	Heptachlor	BDE 30 (2,4,6-TriBDE)	OCDD
26	137+176	heptachlor epoxide	BDE 32 (2,4',6-TriBDE)	2,3,7,8-TCDD
25	163+138	Oxychlordane	BDE 33 (2',3,4-TriBDE)	1,2,3,7,8-PeCDD
31+28	158	gamma chlordane	BDE 35 (3,3',4-TriBDE)	1,2,3,4,7,8-HxCDD
53+33+21	129+178	alpha chlordane	BDE 37 (3,4,4'-TriBDE)	1,2,3,6,7,8-HxCDD
22	187+182	cis nonachlor	BDE 47 (2,2',4,4'-TetraBDE)	1,2,3,7,8,9-HxCDD
45	183	trans nonachlor	BDE 49 (2,2',4,5'-TetraBDE)	1,2,3,4,6,7,8-HpCDD
46	128		BDE 66 (2,3',4,4'-TetraBDE)	
52	185	Dieldrin	BDE 71 (2,3',4',6-TetraBDE)	
49	174	Endrin	BDE 75 (2,4,4',6-TetraBDE)	
47	177	Aldrin	BDE 77 (3,3',4,4'-TetraBDE)	
48	202+171	endosulfan I	BDE 85 (2,2',3,4,4'-PentaBDE)	
44	157+200	endosulfan II	BDE 99 (2,2',4,4',5-PentaBDE)	
37+42	172+197		BDE 100 (2,2',4,4',6-PentaBDE)	
41+71	180	**TOTAL MERCURY**	BDE 116 (2,3,4,5,6-PentaBDE)	
64	193		BDE 118 (2,3',4,4',5-PentaBDE)	
40	191	**CO-PLANAR PCBs**	BDE 119 (2,3',4,4',6-PentaBDE)	
100	199	PCB 81	BDE 126 (3,3',4,4',5-PentaBDE)	
63	170+190	PCB 77	BDE 138 (2,2',3,4,4',5'-HexaBDE)	
74	198	PCB 126	BDE 153 (2,2',4,4',5,5'-HexaBDE)	
70+76	201	PCB 169	BDE 154 (2,2',4,4',5,6'-HexaBDE)	
66+95	203+196		BDE 155 (2,2',4,4',6,6'-HexaBDE)	
91	189		BDE 166 (2,3,4,4',5,6-HexaBDE)	
56+60	208+195		BDE 181 (2,2',3,4,4',5,6-HeptaBDE)	
101	207		BDE 183 (2,2',3,4,4',5',6-HeptaBDE)	
99	194		BDE 190 (2,3,3',4,4',5,6-HeptaBDE)	
83	205			
97	206			
87+81	209			
85				

* = not included in PCB totals, averages, and maxima

Table 3. Sites sampled and considered for 2007 Routine Monitoring of Toxics in NJ Fish program. Stratum abbreviations: UL=unique lake; PB=pine barrens; PBL=pine barrens lake; PBR=pine barrens river; WCPL=western coastal plain lake; SCPL=southern coastal plain lake; SECPL=southeastern coastal plain lake; NECPL=northeastern coastal plain lake; NECPR=northeastern coastal plain river; MCP=mixed coastal plain; EstRiv=estuarine river; None=no statum.

Station	County	Lat	Long	Selection	Stratum prior to 2000	Current stratum	Previously sampled	Notes
Atlantic City Reservoir (Lower)	Atlantic	39.438119	-74.523824	Random	UL	UL		
Atlantic City Reservoir (Upper)	Atlantic			Non-Random	PB	UL	1992	no boat access
Atsion Lake	Burlington	39.74115	-74.732121	Random	PB	PBL	1992	
Batsto Lake	Burlington	39.648407	-74.652374	Random	PB	PBL	1992	
Cedar Lake	Cumberland	39.337314	-75.200568	Random	SCPL	WCPL	1996	
Cedarville Ponds	Cumberland	39.327385	-75.184184	Random	SCPL	WCPL		
Deal Lake	Monmouth	40.230953	-74.010473	Random	NECPL	NECPL		
East Creek Lake	Cape May	39.22667	-74.883922	Non-Random	PB	PBL	1992	
Enno Lake (Bennetts Pond)	Ocean	40.130772	-74.283349	Random	NECPL	NECPL		
Harrisville Lake	Burlington	39.665732	-74.523629	Non-Random	PB	PBL	1992	
Horicon Lake	Ocean	40.008385	-74.323249	Random	SCPL	SECPL		
Lake Absegami	Burlington	39.627564	-74.426905	Random	PB	PBL		
Lake Manahawkin	Ocean	39.698079	-74.260812	Random	SCPL	SECPL		
Lake Nummy	Cape May	39.246258	-74.85273	Random	PB	PBL	1992	
Lake Oswego	Burlington	39.734072	-74.485209	Random	PB	PBL		
Lefferts Lake	Monmouth	40.415443	-74.233763	Random	NECPL	NECPL		
Lenape Lake	Atlantic	39.462153	-74.73907	Random	MCP	SCPL	1992	
Manasquan Reservoir	Monmouth	40.177797	-74.19968	Random	UL	UL	1992	
Maple Lake (east of Dorothy)	Atlantic	39.40715	-74.777843	Random	SCPL	SECPL		
Marlu Lake (Thompson Park)	Monmouth	40.336319	-74.155656	Random	NECPL	NECPL		
Maurice River (inc. Heislerville Pond)	Cumberland	39.3837	-75.036544	Random	None	EstRiv	1998	
Menantico Sand Ponds	Cumberland	39.36737	-74.996405	Random	SCPL	SECPL		
Metedeconk River North Branch	Ocean	40.110561	-74.216819	Random	NECPR	NECPR		
Parvin Lake	Salem	39.508358	-75.131457	Random	SCPL	WCPL		
Pohatcong Lake	Ocean	39.60388	-74.343847	Random	SCPL	SECPL		
Shenandoah Lake	Ocean	40.088509	-74.196911	Random	SCPL	SECPL		
Stow Creek Canton	Salem/Cumberland	39.461467	-75.402122	Random	None	EstRiv		

Station	County	Lat	Long	Selection	Stratum prior to 2000	Current stratum	Previously sampled	Notes
Swimming River Reservoir	Monmouth	40.317897	-74.117804	Non-Random	NECPL	NECPL		
Turn Mill Pond	Ocean	40.06283	-74.445042	Random	PB	PBL		
Union Lake	Cumberland	39.409442	-75.059452	Random	UL	UL	1992	
Wading River	Burlington	39.782445	-74.527327	Random	PB	PBR	1992	
Wilson Lake	Gloucester	39.660299	-75.049154	Random	SCPL	WCPL	1992	
Spring Lake	Monmouth	40.148904	-74.028931	Replaced	NECPL	NECPL	1992	Access denied
Lake of the Lilies	Ocean	40.083176	-74.042873	Replaced	SCPL	SECPL		Access denied
Egg Harbor City Lake	Atlantic	39.559936	-74.610405	Replaced	SCPL	MCP		Access denied
Rainbow Lake	Salem	39.491986	-75.114412	Replaced	SCPL	WCP		Lake drained
Birch Grove Park Ponds	Atlantic	39.377671	-74.565623	Replaced	SCPL	SECPL		Single ponds < size threshold

Table 4. Average concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects treated as zeros for calculation of averages.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Ave. Total Hg	Ave. Total PCBs	Ave. Total Planar PCBs	Ave. Total PBDEs	Ave. Total DDXs	Ave. Total BHCs + Lindane	Ave. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Atlantic City Reservoir Lower												
	American eel	3	49.6	270.9	7.46	2.277	170	0.000		68	0.184	13.7
	largemouth bass	4	45.4	1427.4	0.86	3.405	38	0.023		6	0.125	1.3
Atsion Lake												
	American eel	3	38.3	135.8	12.97	0.373	30	0.000		14	0.099	3.2
	chain pickerel	3	39.2	363.7		0.660						
Batsto Lake												
	brown bullhead	3	142.7	418.4	0.59	0.223	12	0.000		6	0.110	0.6
	chain pickerel	4	32.5	199.1		0.584						
	largemouth bass	4	36.3	681.2	0.64	0.818	14	0.000		164	0.111	0.9
Cedar Lake												
	American eel	3	55.6	414.1	16.36	0.187	125	0.000		301	0.310	5.7
	largemouth bass	3	39.5	1060.9		0.707						
	white perch	3	33.3	639.1	2.86	0.353	48	0.000		148	0.398	1.3
Cedarville Ponds												
	chain pickerel	5	35.2	264.2	0.76	0.571	9	0.000		3	0.220	0.2
	yellow perch	3	28.9	296.5	0.88	0.330	6	0.000		1	0.314	0.2
Deal Lake												
	American eel	2	45.5	313.0	11.09	0.055	454	0.000	32.73	131	0.366	246.2
	largemouth bass	3	39.3	938.9	0.54	0.117	48	0.023		17	0.148	17.8
	white perch	3	18.2	88.3	2.79	0.080	184	0.000	16.93	32	0.384	52.8
East Creek Lake												
	American eel	3	49.6	250.1	8.73	1.105	40	0.000		130	0.193	3.8
	chain pickerel	3	39.2	330.2		1.217						
	largemouth bass	3	38.2	964.7		1.273						
Enno Lake												
	American eel	3	36.4	105.4	14.70	0.260	61	0.000		33	0.560	22.9
	largemouth bass	3	30.8	474.4		0.427						
Harrisville Lake												
	American eel	3	40.7	154.2	6.03	0.593	15	0.000		13	0.071	3.1
	chain pickerel	4	29.7	149.5		0.905						
Horicon Lake												
	American eel	3	63.3	499.3	15.95	1.523	145	0.000		143	0.476	14.0
	chain pickerel	3	37.2	300.9		1.260						
Lake Absegami												
	American eel	3	37.3	110.1	15.37	0.483	106	0.000		386	0.548	5.5
	chain pickerel	5	44.1	622.7		1.368						
Lake Manahawkin												
	American eel	3	60.7	590.0	8.16	1.607	95	0.000		426	0.291	31.8
	largemouth bass	3	38.0	793.7		1.257						
Lake Nummy												
	chain pickerel	2	51.1	854.0		1.815						
	yellow bullhead	3	30.8	374.7		0.505						

Table 4 (cont.). Average concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects treated as zeros for calculation of averages.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Ave. Total Hg	Ave. Total PCBs	Ave. Total Planar PCBs	Ave. Total PBDEs	Ave. Total DDXs	Ave. Total BHCs + Lindane	Ave. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Lake Oswego												
	American eel	2	55.1	371.2	16.75	0.580	50	0.000		36	0.532	2.8
	chain pickerel	4	35.8	385.0		1.011						
Lefferts Lake												
	brown bullhead	3	28.6	325.5	0.94	0.090	42	0.000		13	0.408	12.3
	chain pickerel	3	45.1	535.3		0.170						
	yellow perch	3	24.5	184.8	0.65	0.103	32	0.027		8	0.553	7.6
Lenape Lake												
	American eel	3	58.0	443.6	15.97	0.768	150	0.000		311	0.665	28.0
	largemouth bass	3	43.5	1461.7		1.417						
Manasquan Reservoir												
	American eel	3	64.9	573.6	16.09	0.100	136	0.000		101	0.246	19.4
	largemouth bass	3	44.6	1356.7	1.35	0.237	45	0.047		10	0.297	1.5
Maple Lake												
	American eel	3	48.8	225.0	20.21	0.880	91	0.000		62	0.294	7.9
	largemouth bass	4	34.9	528.5		0.903						
Marlu Lake												
	common carp	3	66.3	4583.3	11.10	0.040	117	0.000		198	0.619	39.8
	largemouth bass	3	40.0	1046.5		0.103						
Maurice River												
	channel catfish	3	43.9	788.4	2.63	0.362	348	0.000		58	0.201	9.0
	largemouth bass	3	38.5	940.1		0.590						
	white catfish	3	350.6	716.4	2.87		245	0.000		32	0.704	12.6
	white perch	3	24.7	239.1	2.07	0.330	70	0.040	6.71	18	0.223	3.5
Menantico Sand Ponds												
	American eel	3	67.0	757.0	4.49	0.550	70	0.000		87	0.410	8.2
	largemouth bass	3	38.3	851.6		0.780						
Metedeconk River North Branch												
	American eel	3	39.5	149.2	17.99	0.278	83	0.000		399	6.454	680.4
Parvin Lake												
	American eel	2	64.0	491.9	14.47	0.120	79	0.000	2.04	227	0.097	5.5
	chain pickerel	3	48.3	789.5		0.212						
	largemouth bass	5	42.5	1281.6	0.99	0.219	23	0.000		39	0.325	0.8
Pohatcong Lake												
	American eel	3	51.9	301.1	1.43	0.703	27	0.000		78	0.155	3.0
	largemouth bass	4	42.3	1069.9		0.680						
	yellow perch	3	30.8	361.2	0.92	0.443	6	0.000		14	0.097	0.9
Shenandoah Lake												
	American eel	3	56.7	476.3	8.71	0.360	146	0.000		166	0.216	71.1
	chain pickerel	3	39.3	343.2		0.297						
	largemouth bass	3	41.8	1125.7		0.493						
Stow Creek Canton												
	American eel	3	44.6	194.6	5.88	0.080	68	0.000		23	2.087	2.9

Table 4 (cont.). Average concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects treated as zeros for calculation of averages.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Ave. Total Hg	Ave. Total PCBs	Ave. Total Planar PCBs	Ave. Total PBDEs	Ave. Total DDXs	Ave. Total BHCs + Lindane	Ave. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Swimming River Reservoir												
	American eel	3	59.1	571.5	13.62	0.063	159	0.000		313	4.381	47.1
	largemouth bass	3	44.3	1516.7	1.99	0.110	85	0.000		32	0.680	10.7
Turn Mill Pond												
	American eel	3	54.0	297.8	19.20	0.147	29	0.000		22	0.218	3.1
	largemouth bass	3	29.7	363.0		0.380						
Union Lake												
	brown bullhead	3	29.1	329.5	0.97	0.737	17	0.000		12	0.155	2.1
	chain pickerel	3	45.9	613.6		1.427						
	largemouth bass	4	32.5	495.0	0.63	1.104	16	0.000		117	0.150	1.1
Wading River												
	chain pickerel	3	38.2	287.7	0.51	2.420	13	0.000		3	0.220	0.2
Wilson Lake												
	chain pickerel	3	42.1	543.7		1.653						
	largemouth bass	3	38.4	708.8	0.73	2.143	43	0.000		40	0.310	0.6
	yellow perch	3	28.7	276.2	0.88	1.177	14	0.000		10	0.265	0.4

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Table 5. Maximum concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects are treated as zeros.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Max. Total Hg	Max. Total PCBs	Max. Total Planar PCBs	Max. Total PBDEs	Max. Total DDXs	Max. Total BHCs + Lindane	Max. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Atlantic City Reservoir Lower												
	American eel	3	49.6	270.9	7.46	2.550	259	0.000		105	0.291	22.3
	largemouth bass	4	45.4	1427.4	0.86	7.350	47	0.070		7	0.162	1.4
Atsion Lake												
	American eel	3	38.3	135.8	12.97	0.520	34	0.000		20	0.146	4.1
	chain pickerel	3	39.2	363.7		0.820						
Batsto Lake												
	brown bullhead	3	142.7	418.4	0.59	0.290	18	0.000		8	0.177	1.0
	chain pickerel	4	32.5	199.1		0.850						
	largemouth bass	4	36.3	681.2	0.64	1.250	17	0.000		632	0.155	1.1
Cedar Lake												
	American eel	3	55.6	414.1	16.36	0.220	228	0.000		821	0.441	7.2
	largemouth bass	3	39.5	1060.9		1.630						
	white perch	3	33.3	639.1	2.86	0.510	61	0.000		202	0.411	1.5
Cedarville Ponds												
	chain pickerel	5	35.2	264.2	0.76	0.690	13	0.000		5	0.290	0.2
	yellow perch	3	28.9	296.5	0.88	0.350	6	0.000		2	0.532	0.2
Deal Lake												
	American eel	2	45.5	313.0	11.09	0.060	517	0.000	41.44	152	0.461	307.6
	largemouth bass	3	39.3	938.9	0.54	0.140	77	0.070		21	0.245	22.0
	white perch	3	18.2	88.3	2.79	0.180	252	0.000	28.22	49	0.677	88.0
East Creek Lake												
	American eel	3	49.6	250.1	8.73	1.240	73	0.000		267	0.374	7.0
	chain pickerel	3	39.2	330.2		1.460						
	largemouth bass	3	38.2	964.7		1.400						
Enno Lake												
	American eel	3	36.4	105.4	14.70	0.340	68	0.000		44	0.630	27.4
	largemouth bass	3	30.8	474.4		0.490						
Harrisville Lake												
	American eel	3	40.7	154.2	6.03	0.730	20	0.000		16	0.079	6.0
	chain pickerel	4	29.7	149.5		1.050						
Horicon Lake												
	American eel	3	63.3	499.3	15.95	2.200	150	0.000		196	0.782	20.9
	chain pickerel	3	37.2	300.9		1.780						
Lake Absegami												
	American eel	3	37.3	110.1	15.37	0.800	165	0.000		571	0.615	7.8
	chain pickerel	5	44.1	622.7		1.630						
Lake Manahawkin												
	American eel	3	60.7	590.0	8.16	1.890	169	0.000		807	0.526	59.2
	largemouth bass	3	38.0	793.7		1.760						
Lake Nummy												
	chain pickerel	2	51.1	854.0		2.560						
	yellow bullhead	3	30.8	374.7		0.790						

Table 5 (cont.). Maximum concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects are treated as zeros.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Max. Total Hg	Max. Total PCBs	Max. Total Planar PCBs	Max. Total PBDEs	Max. Total DDXs	Max. Total BHCs + Lindane	Max. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Lake Oswego												
	American eel	2	55.1	371.2	16.75	0.700	59	0.000		42	0.670	3.3
	chain pickerel	4	35.8	385.0		2.050						
Lefferts Lake												
	brown bullhead	3	28.6	325.5	0.94	0.100	83	0.000		28	0.489	26.7
	chain pickerel	3	45.1	535.3		0.210						
	yellow perch	3	24.5	184.8	0.65	0.120	41	0.080		11	0.806	9.0
Lenape Lake												
	American eel	3	58.0	443.6	15.97	1.060	225	0.000		449	1.088	51.9
	largemouth bass	3	43.5	1461.7		1.610						
Manasquan Reservoir												
	American eel	3	64.9	573.6	16.09	0.170	196	0.000		173	0.468	33.8
	largemouth bass	3	44.6	1356.7	1.35	0.400	59	0.140		17	0.309	2.5
Maple Lake												
	American eel	3	48.8	225.0	20.21	1.020	115	0.000		117	0.434	9.5
	largemouth bass	4	34.9	528.5		1.480						
Marlu Lake												
	common carp	3	66.3	4583.3	11.10	0.040	155	0.000		263	1.370	59.8
	largemouth bass	3	40.0	1046.5		0.140						
Maurice River												
	channel catfish	3	43.9	788.4	2.63	0.555	579	0.000		104	0.257	12.8
	largemouth bass	3	38.5	940.1		0.940						
	white catfish	3	350.6	716.4	2.87		460	0.000		65	1.752	18.6
	white perch	3	24.7	239.1	2.07	0.540	84	0.120	11.94	20	0.254	4.9
Menantico Sand Ponds												
	American eel	3	67.0	757.0	4.49	0.700	138	0.000		175	0.834	17.1
	largemouth bass	3	38.3	851.6		0.970						
Metedeconk River North Branch												
	American eel	3	39.5	149.2	17.99	0.385	90	0.000		1083	17.794	1983.7
Parvin Lake												
	American eel	2	64.0	491.9	14.47	0.120	119	0.000	3.16	342	0.098	7.3
	chain pickerel	3	48.3	789.5		0.235						
	largemouth bass	5	42.5	1281.6	0.99	0.270	36	0.000		54	0.400	1.1
Pohatcong Lake												
	American eel	3	51.9	301.1	1.43	0.950	31	0.000		106	0.191	3.7
	largemouth bass	4	42.3	1069.9		0.780						
	yellow perch	3	30.8	361.2	0.92	0.830	7	0.000		17	0.122	1.2
Shenandoah Lake												
	American eel	3	56.7	476.3	8.71	0.420	198	0.000		227	0.305	101.0
	chain pickerel	3	39.3	343.2		0.340						
	largemouth bass	3	41.8	1125.7		0.650						
Stow Creek Canton												
	American eel	3	44.6	194.6	5.88	0.120	78	0.000		27	3.548	3.2

Table 5 (cont.). Maximum concentrations of mercury, PCBs, PBDEs, and selected OCPs in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects are treated as zeros.

Station	Common Name	Number of Samples	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. Total Lipids	Max. Total Hg	Max. Total PCBs	Max. Total Planar PCBs	Max. Total PBDEs	Max. Total DDXs	Max. Total BHCs + Lindane	Max. Total Chlor-danes
			cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Swimming River Reservoir												
	American eel	3	59.1	571.5	13.62	0.080	204	0.000		616	4.974	70.9
	largemouth bass	3	44.3	1516.7	1.99	0.150	125	0.000		33	0.963	16.8
Turn Mill Pond												
	American eel	3	54.0	297.8	19.20	0.160	39	0.000		31	0.245	4.1
	largemouth bass	3	29.7	363.0		0.420						
Union Lake												
	brown bullhead	3	29.1	329.5	0.97	1.730	24	0.000		14	0.194	2.8
	chain pickerel	3	45.9	613.6		1.590						
	largemouth bass	4	32.5	495.0	0.63	1.490	21	0.000		285	0.172	1.5
Wading River												
	chain pickerel	3	38.2	287.7	0.51	2.630	20	0.000		3	0.272	0.2
Wilson Lake												
	chain pickerel	3	42.1	543.7		2.020						
	largemouth bass	3	38.4	708.8	0.73	3.270	66	0.000		60	0.347	0.7
	yellow perch	3	28.7	276.2	0.88	1.410	15	0.000		14	0.306	0.5

Table 6. Average concentrations of total furans and dioxins in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Non-detects (ND) are treated as zeros for calculation of averages.

Station	Common Name	Number of specimens	Ave. Total Length (lab)	Ave. Total Weight (lab)	Ave. % Lipid	Ave. Total Furans	Ave. Total Dioxins
			cm	g		(pg/g) wet	(pg/g) wet
Deal Lake							
	American eel	2	45.5	313.0	29.0	53.87	13.85
	white perch	3	18.2	88.3	6.6	23.61	8.93
Maurice River							
	white perch	3	24.7	239.1	4.0	12.91	10.81
Parvin Lake							
	American eel	2	64.0	491.9	33.9	6.71	10.82

Table 7. Correlation coefficients (r) among concentrations of different organic contaminants among all samples in the 2007 New Jersey Routine Monitoring Program. Boldface shows correlations significant at p<0.05 level, with no correction for experiment-wise error.

	PCBs	Chlordanes	Endrin	Endosulfan II	Endosulfan I	Dieldrin	Aldrin	DDXs
PCBs	1.000	**0.696**	**0.549**	**0.620**	**0.391**	**0.436**	**0.332**	**0.367**
Chlordanes	**0.696**	1.000	**0.797**	**0.922**	**0.522**	**0.527**	**0.323**	**0.367**
endrin	**0.549**	**0.797**	1.000	**0.761**	**0.540**	**0.494**	**0.444**	**0.207**
endosulfan II	**0.620**	**0.922**	**0.761**	1.000	**0.552**	**0.511**	**0.290**	**0.210**
endosulfan I	**0.391**	**0.522**	**0.540**	**0.552**	1.000	**0.220**	0.119	0.032
dieldrin	**0.436**	**0.527**	**0.494**	**0.511**	**0.220**	1.000	**0.737**	**0.297**
aldrin	**0.332**	**0.323**	**0.444**	**0.290**	0.119	**0.737**	1.000	**0.309**
DDXs	**0.367**	**0.367**	**0.207**	**0.210**	0.032	**0.297**	**0.309**	1.000

FIGURES

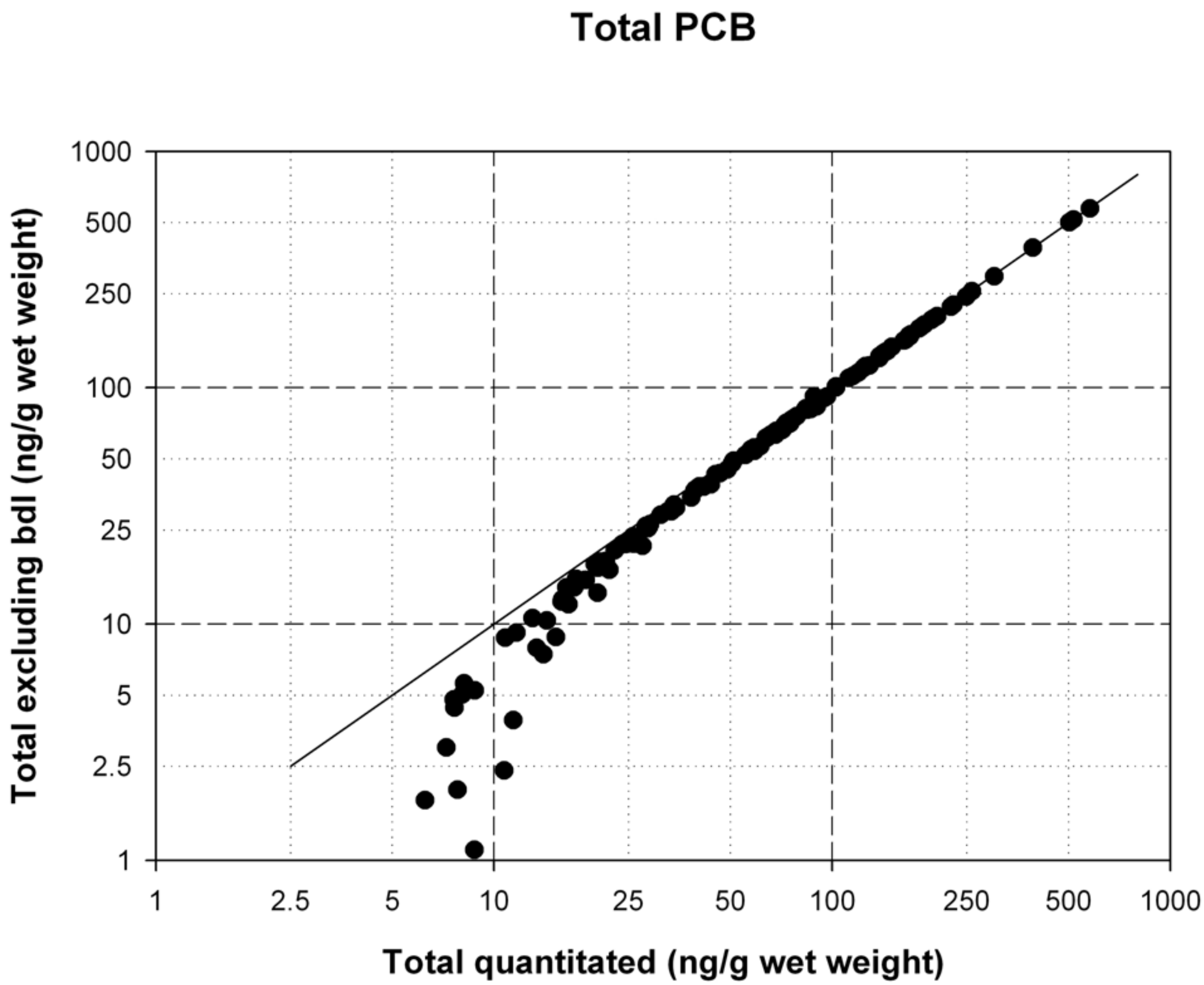

Figure 1. Relationship between average total PCB excluding non-detects and including non-detects as zero as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

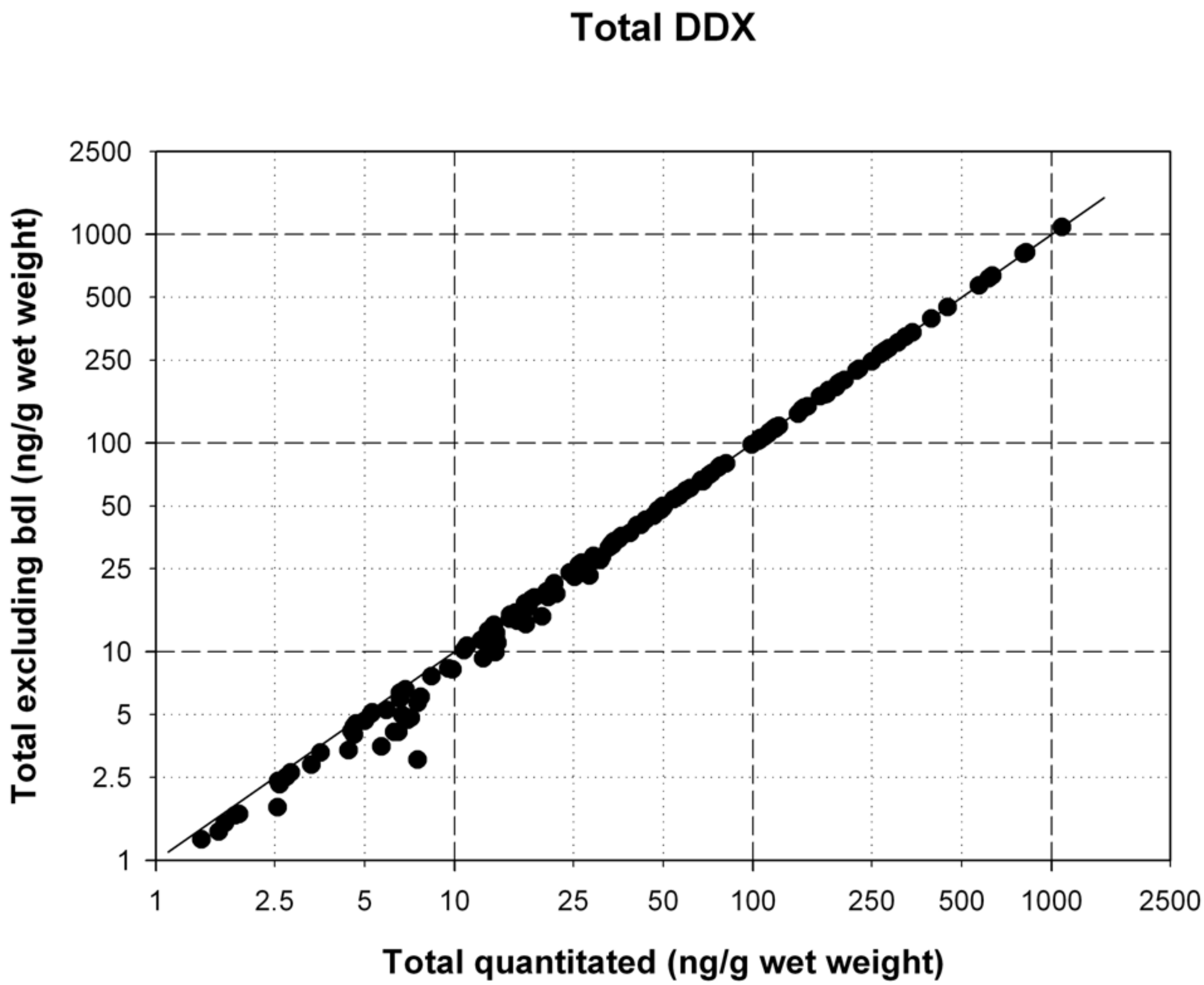

Figure 2. Relationship between average total DDX excluding non-detects and including non-detects as zero as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

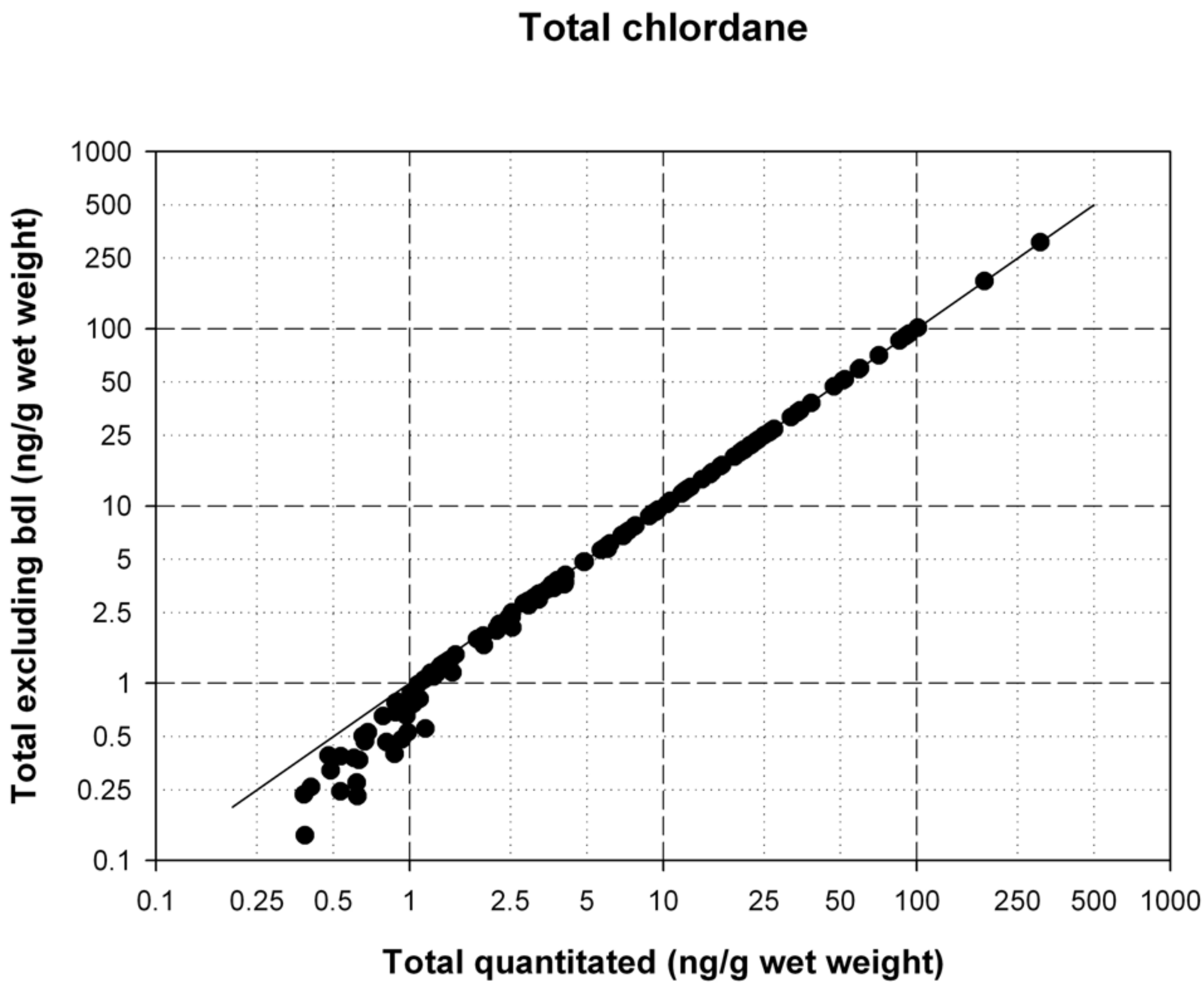

Figure 3. Relationship between average total chlordane excluding non-detects and including non-detects as zero as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

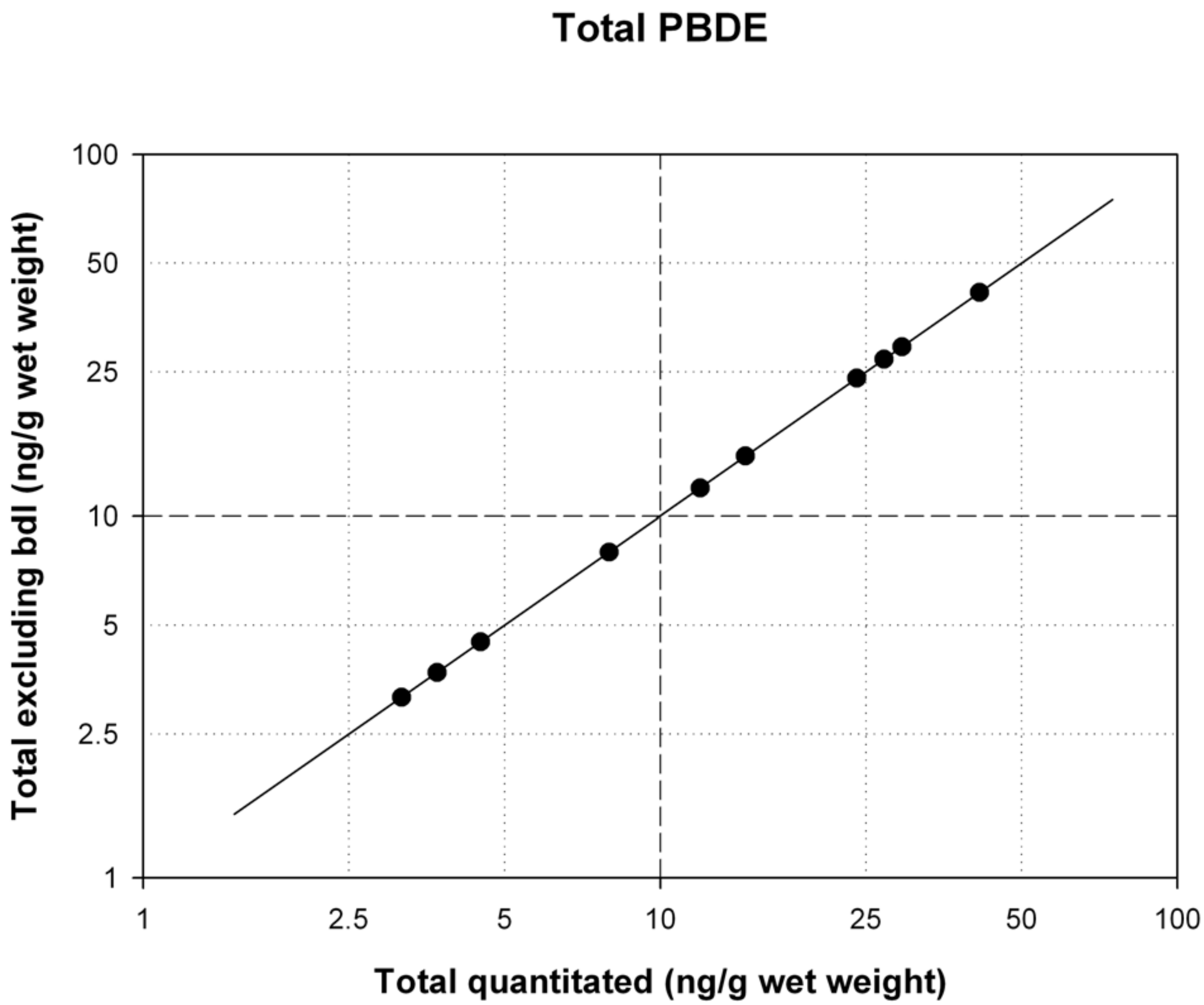

Figure 4. Relationship between average total PDBE excluding non-detects and including non-detects as zero as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

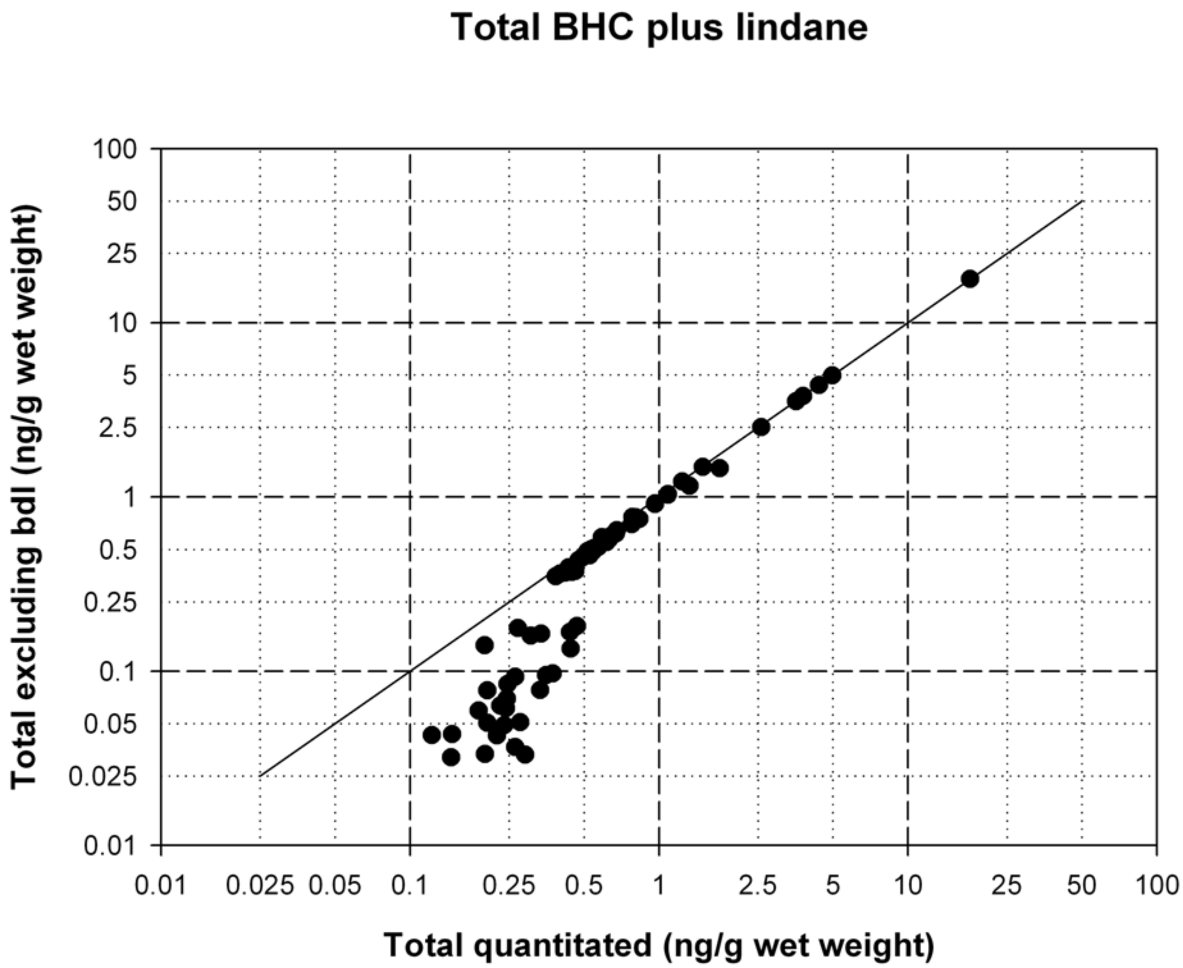

Figure 5. Relationship between average total BHC plus lindane excluding non-detects and including non-detects as zero as part of the 2007 Routine Monitoring of Toxics in NJ Fish program.

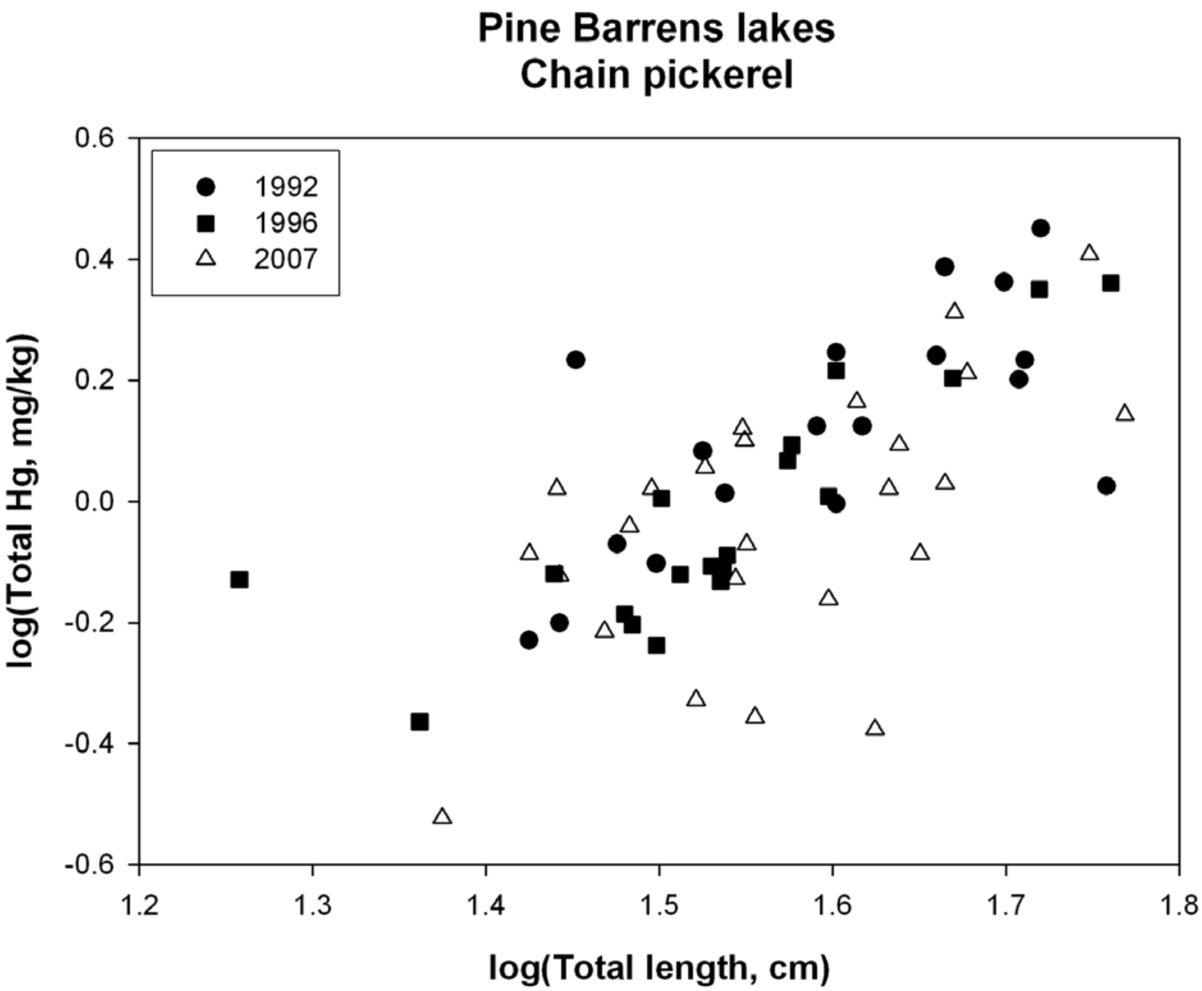

Figure 6. Comparison of total mercury concentrations as a function of total length in chain pickerel from the Pine Barrens lakes from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

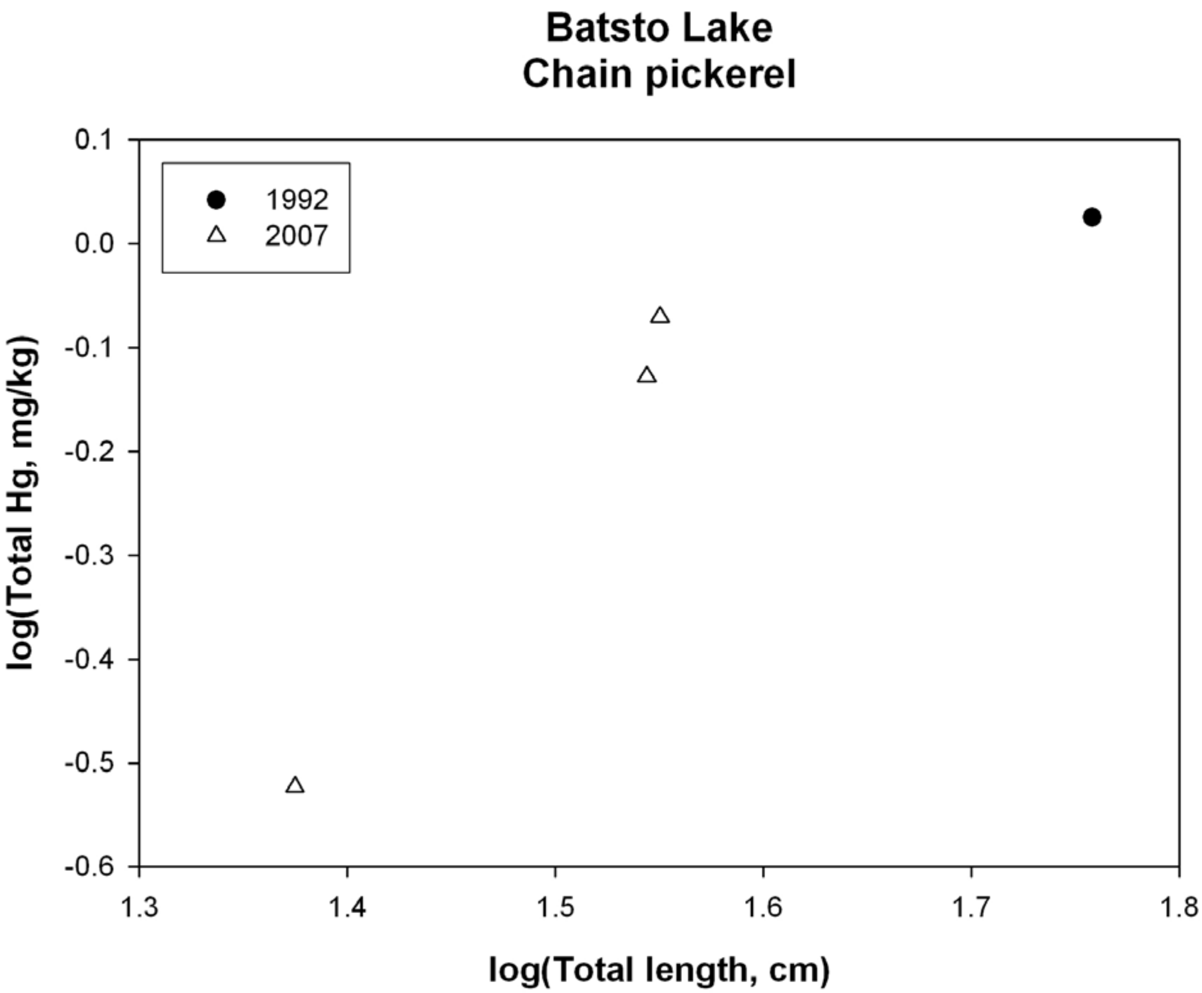

Figure 7. Comparison of total mercury concentrations as a function of total length in chain pickerel from Batsto Lake from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

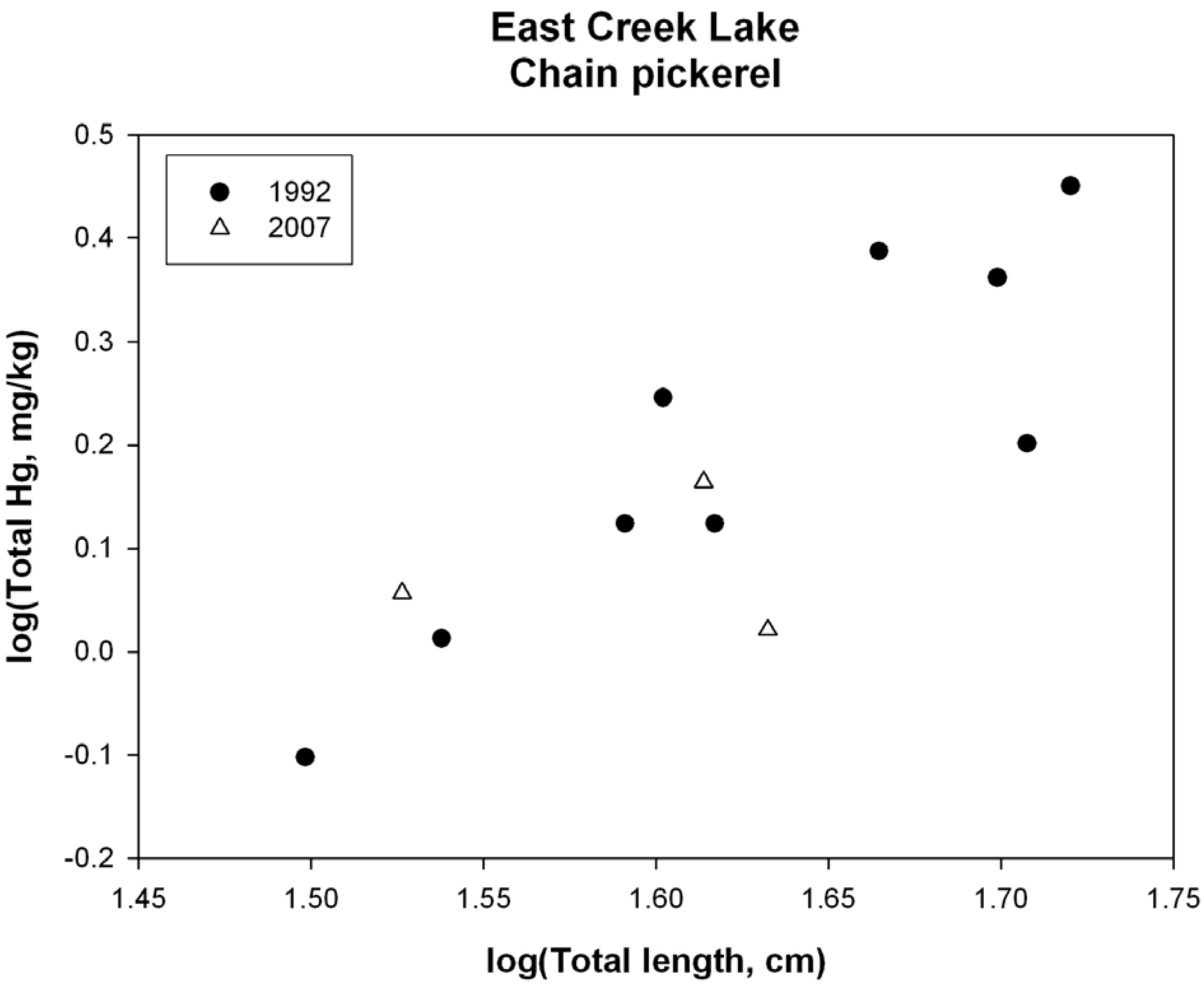

Figure 8. Comparison of total mercury concentrations as a function of total length in chain pickerel from East Creek Lake from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

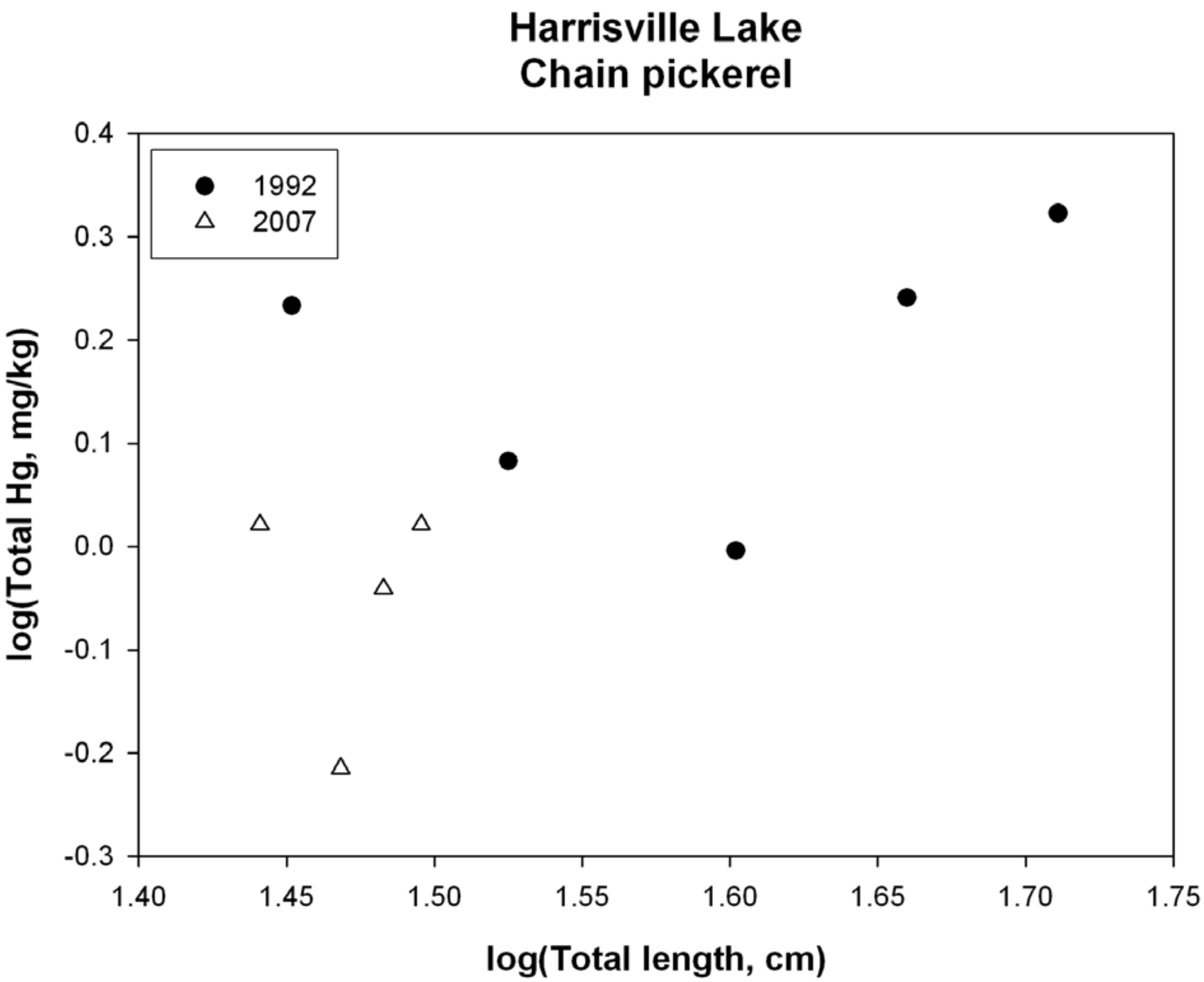

Figure 9. Comparison of total mercury concentrations as a function of total length in chain pickerel from Harrisville Lake from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

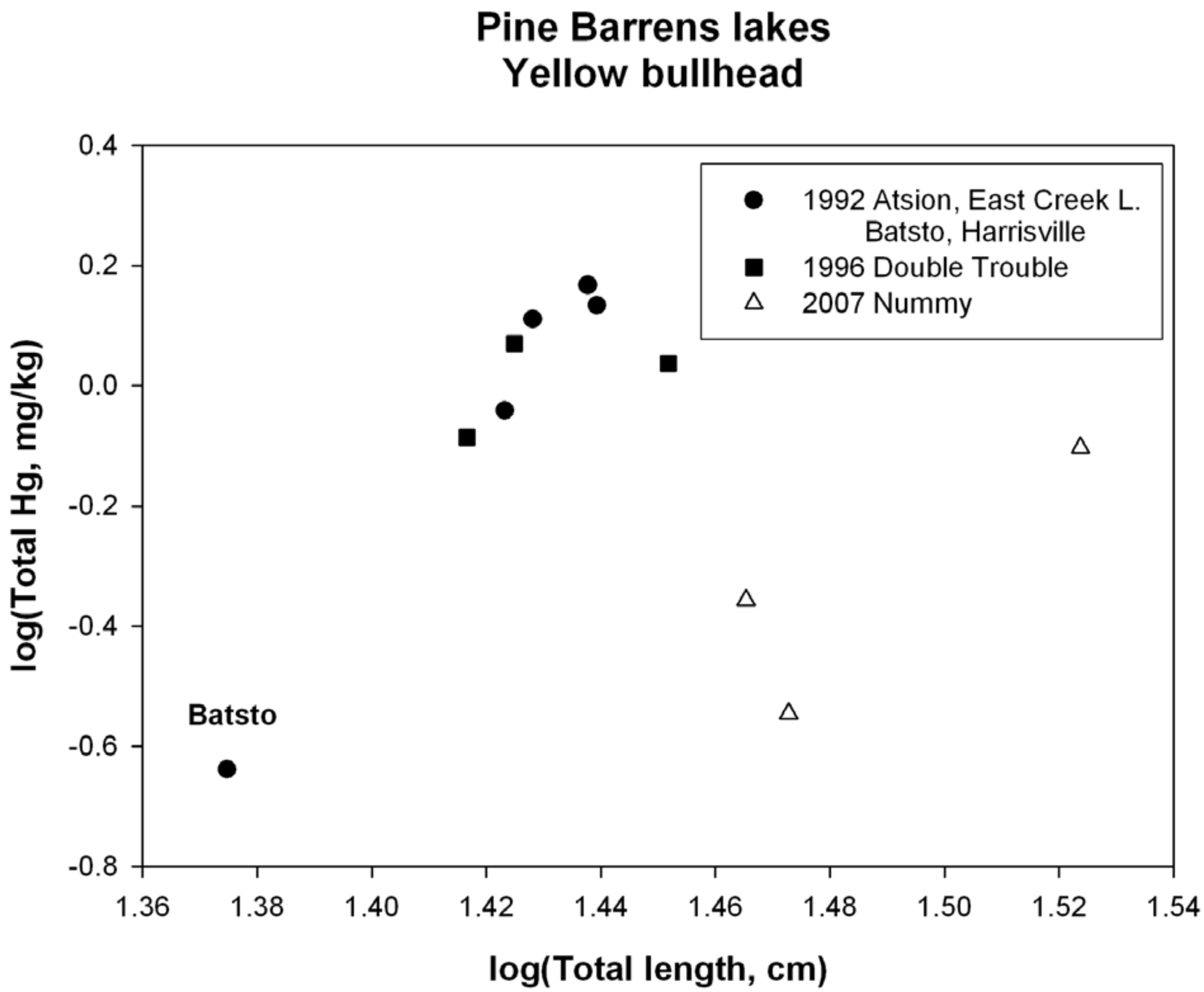

Figure 10. Comparison of total mercury concentrations as a function of total length in yellow bullhead from Pine Barrens lakes from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

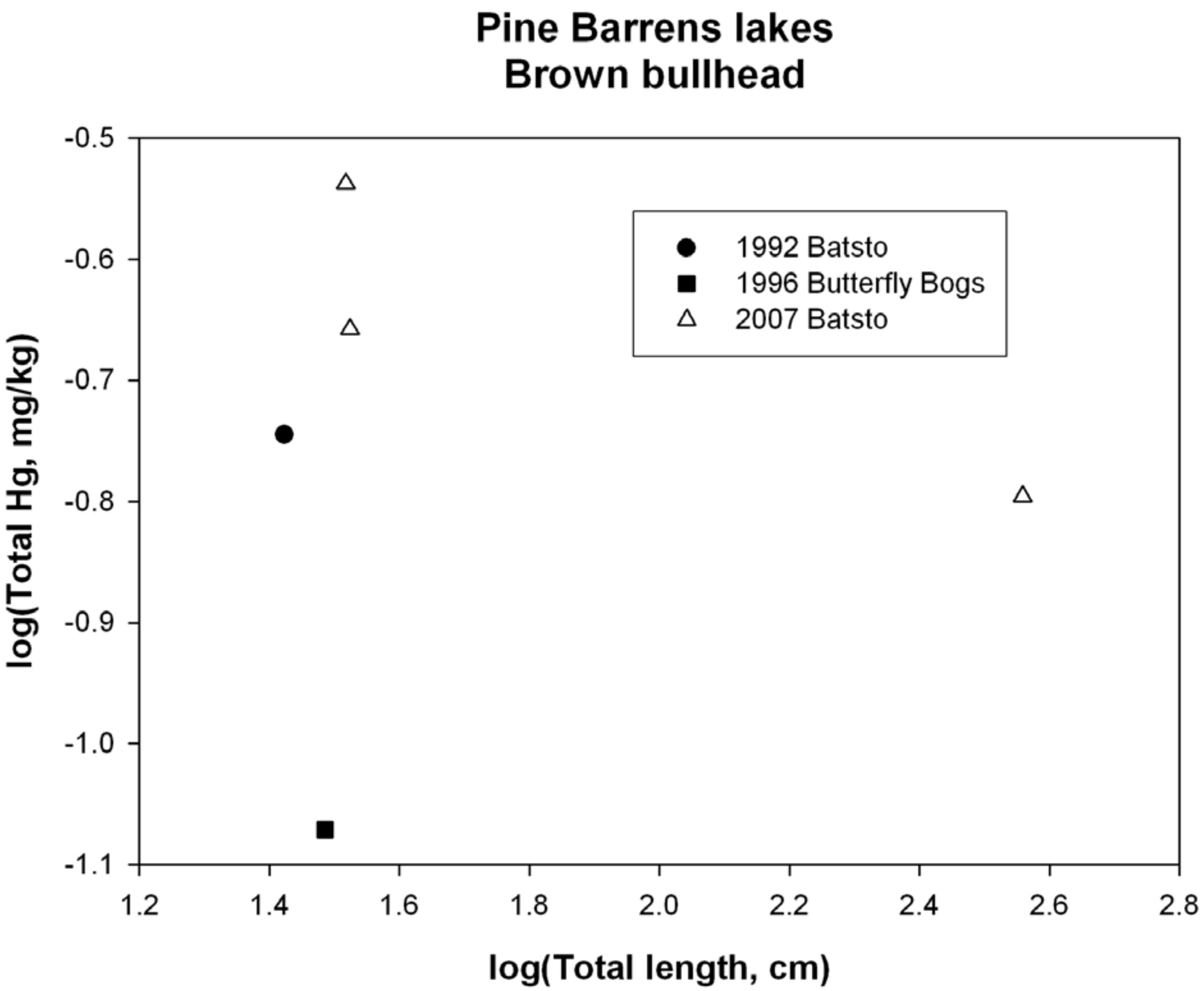

Figure 11. Comparison of total mercury concentrations as a function of total length in brown bullhead from Pine Barrens lakes from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

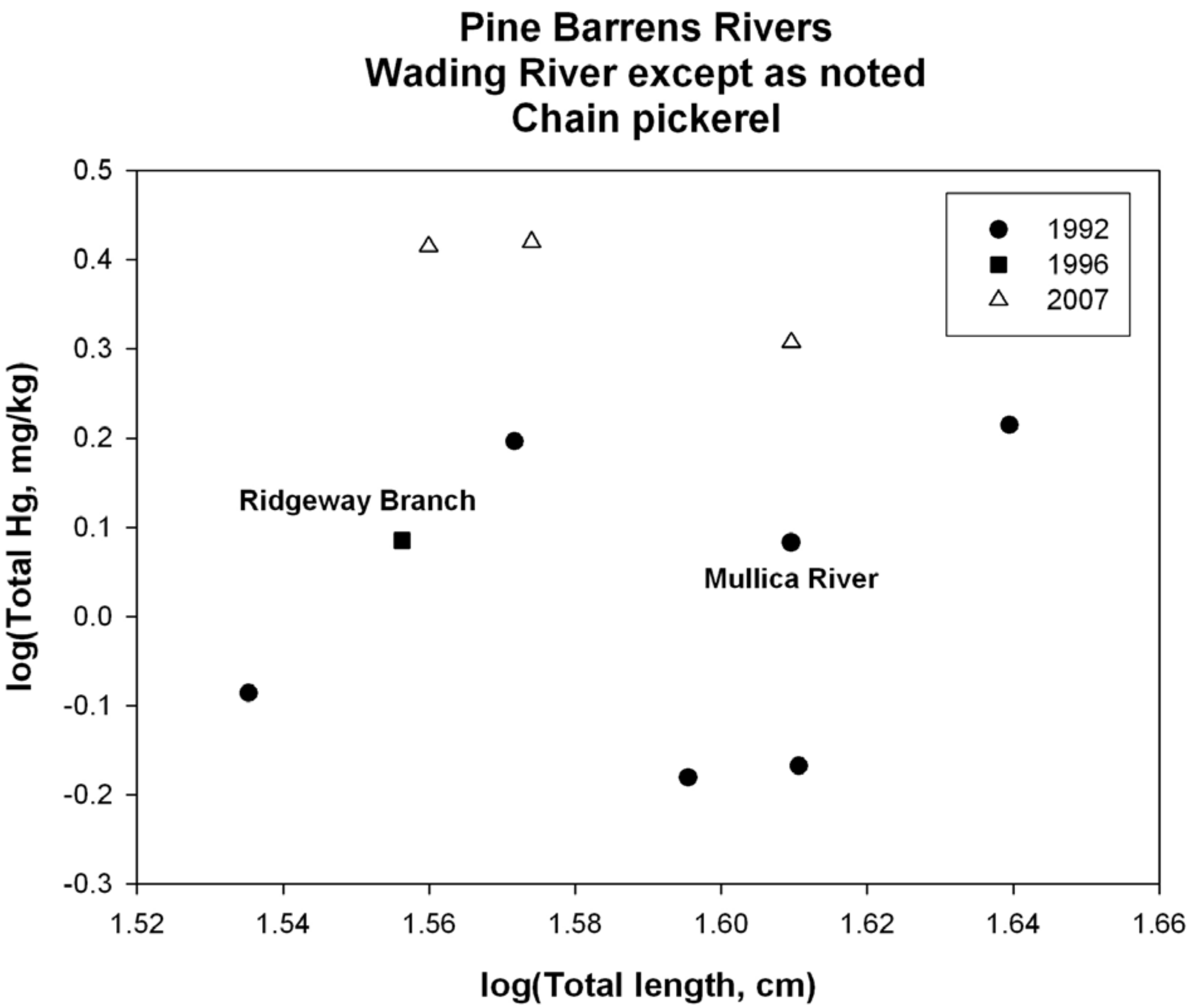

Figure 12. Comparison of total mercury concentrations as a function of total length in chain pickerel from Pine Barrens rivers from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

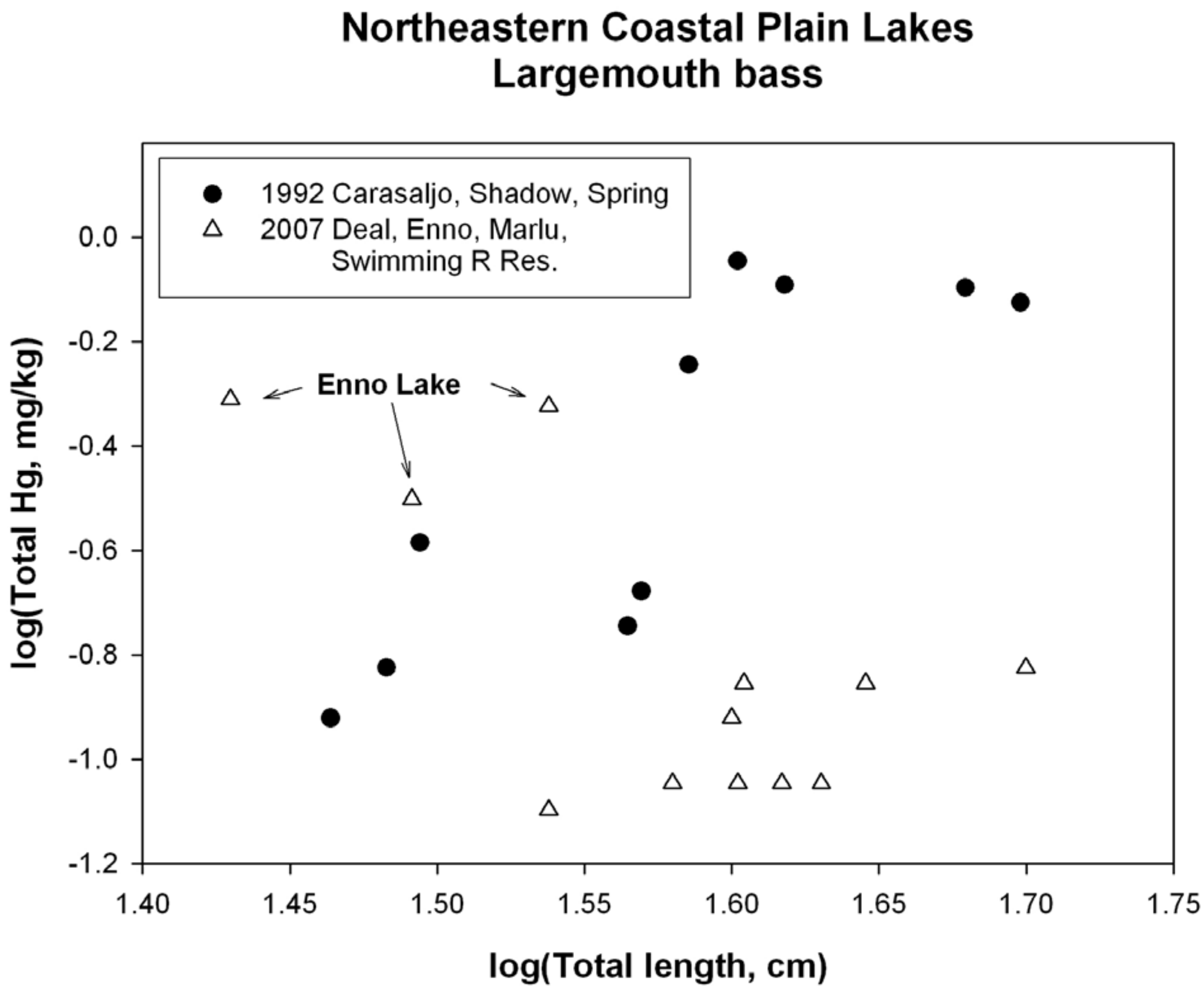

Figure 13. Comparison of total mercury concentrations as a function of total length in largemouth bass from northeast coastal plain lakes from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

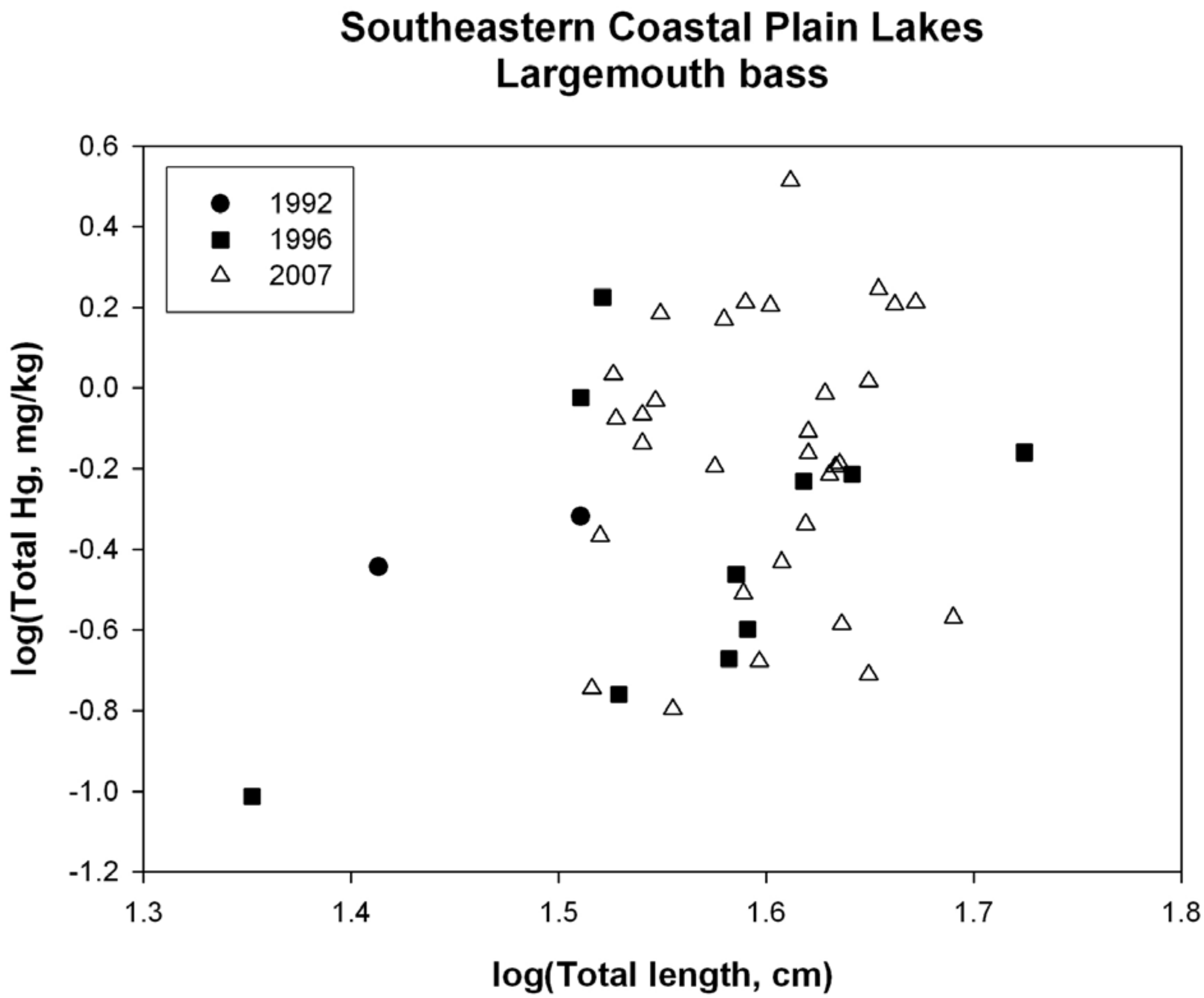

Figure 14. Comparison of total mercury concentrations as a function of total length in largemouth bass from southeast coastal plain lakes from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

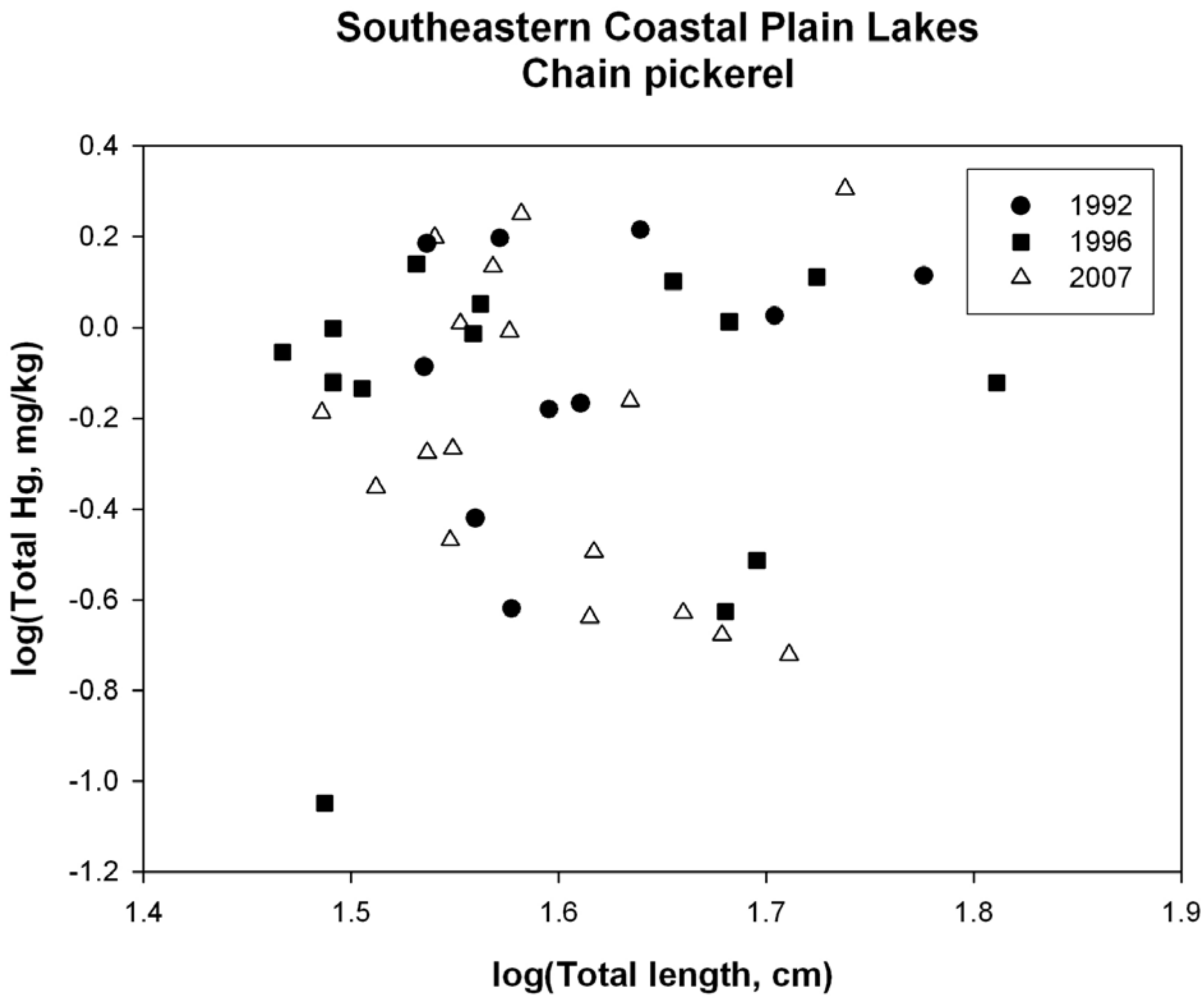

Figure 15. Comparison of total mercury concentrations as a function of total length in chain pickerel from southeast coastal plain lakes from the 1992 and 1996 New Jersey toxics program and the 2007 routine monitoring program.

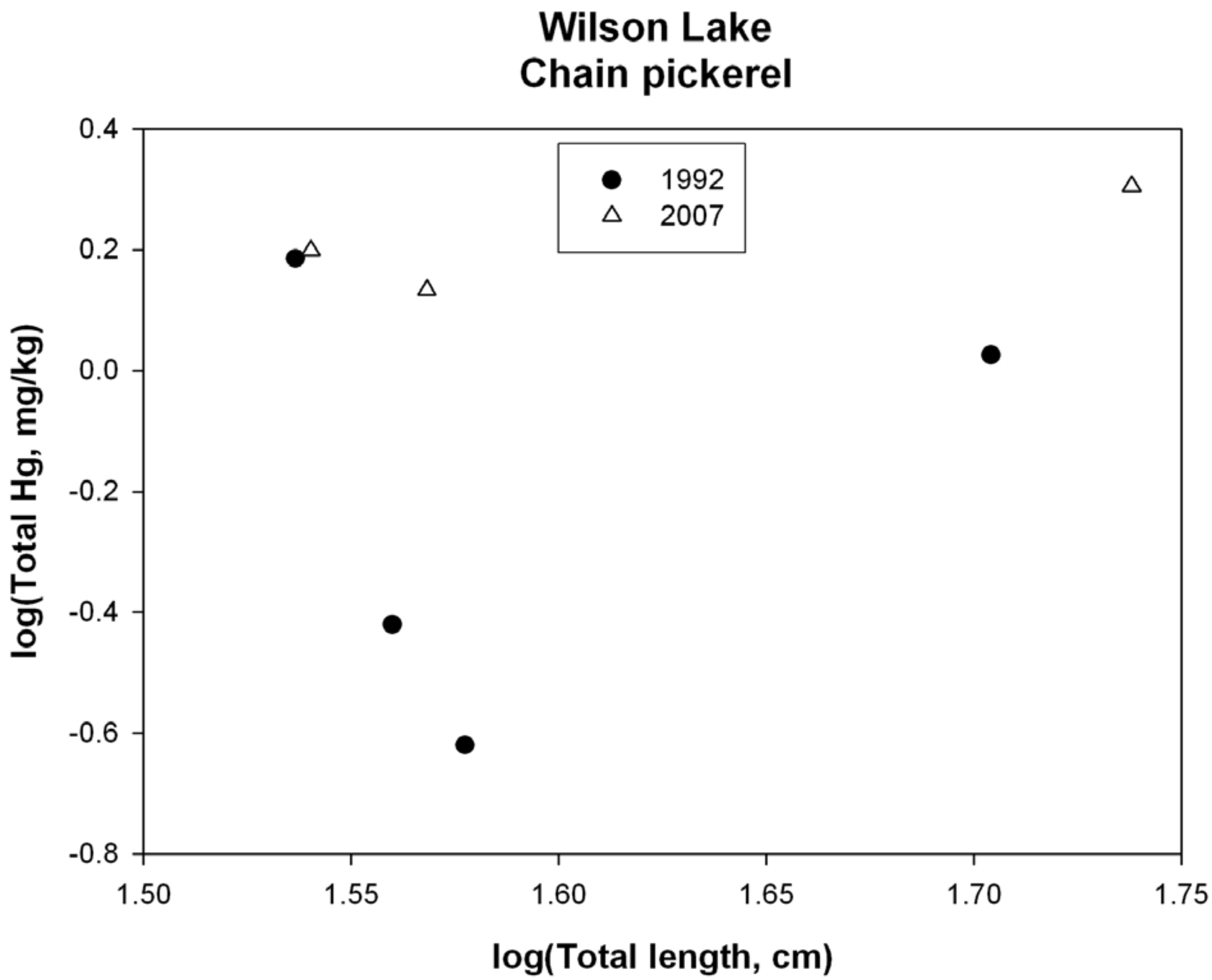

Figure 16. Comparison of total mercury concentrations as a function of total length in chain pickerel from Wilson Lake from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

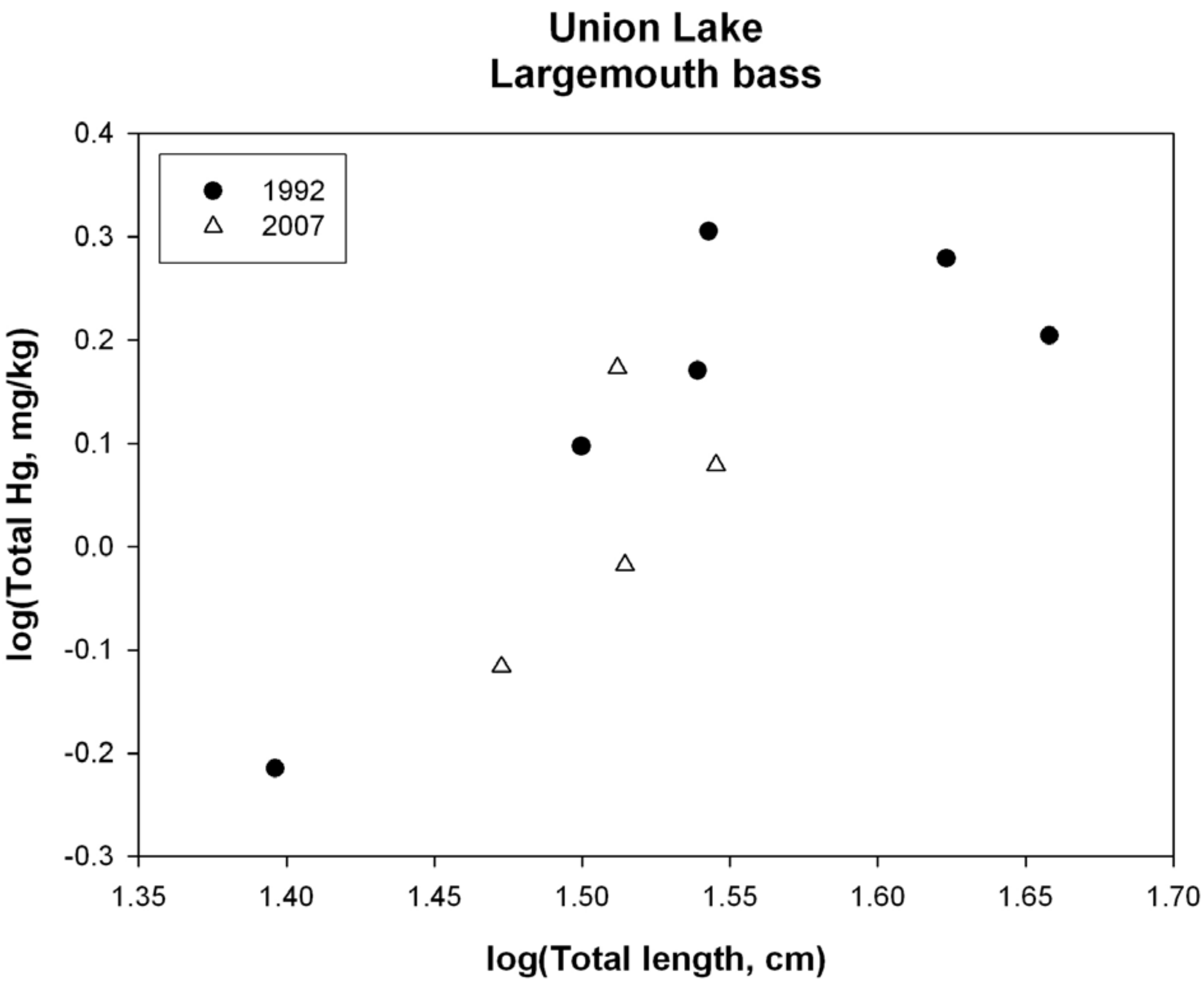

Figure 17. Comparison of total mercury concentrations as a function of total length in largemouth bass from Union Lake from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

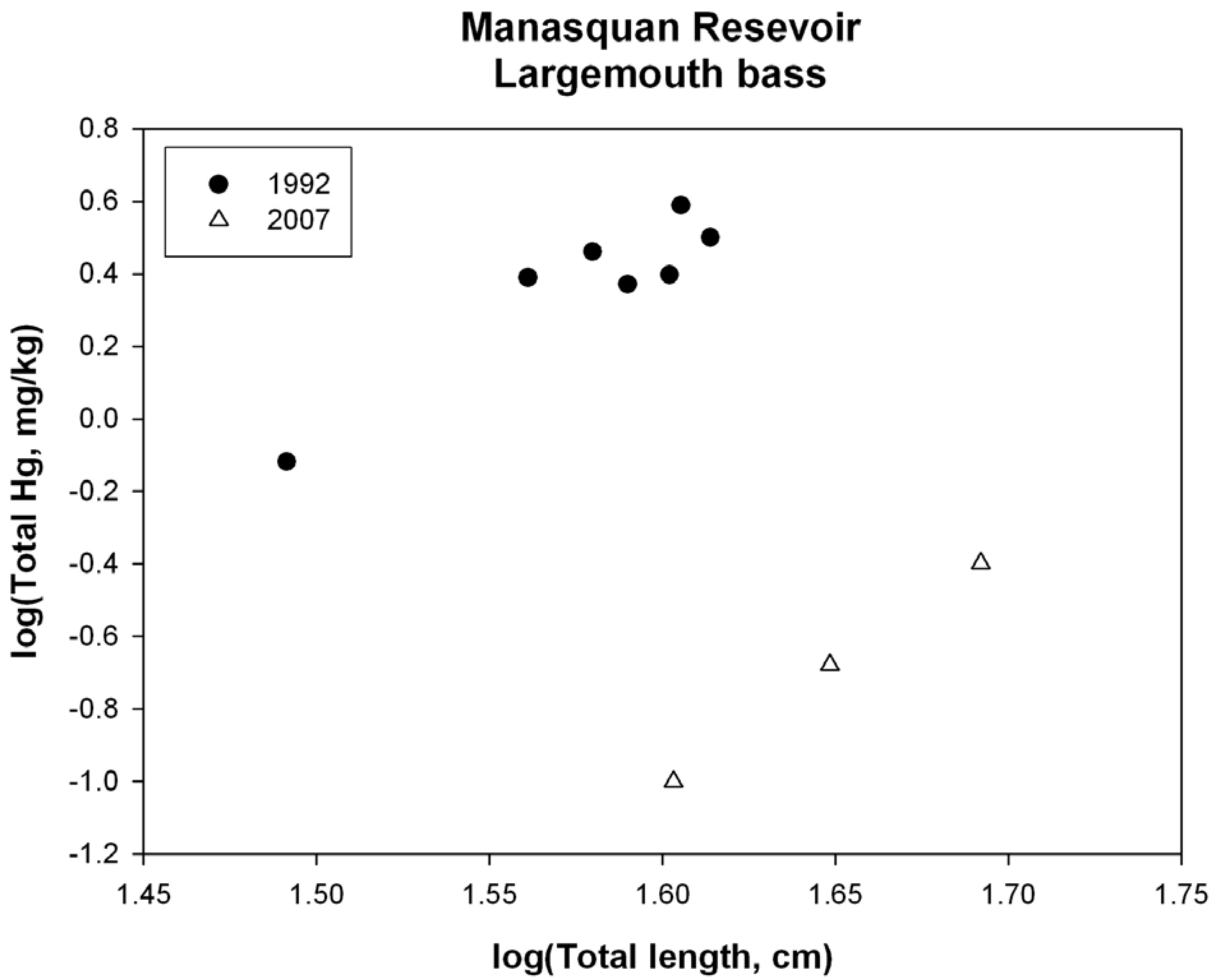

Figure 18. Comparison of total mercury concentrations as a function of total length in largemouth bass from the Manasquan Reservoir from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

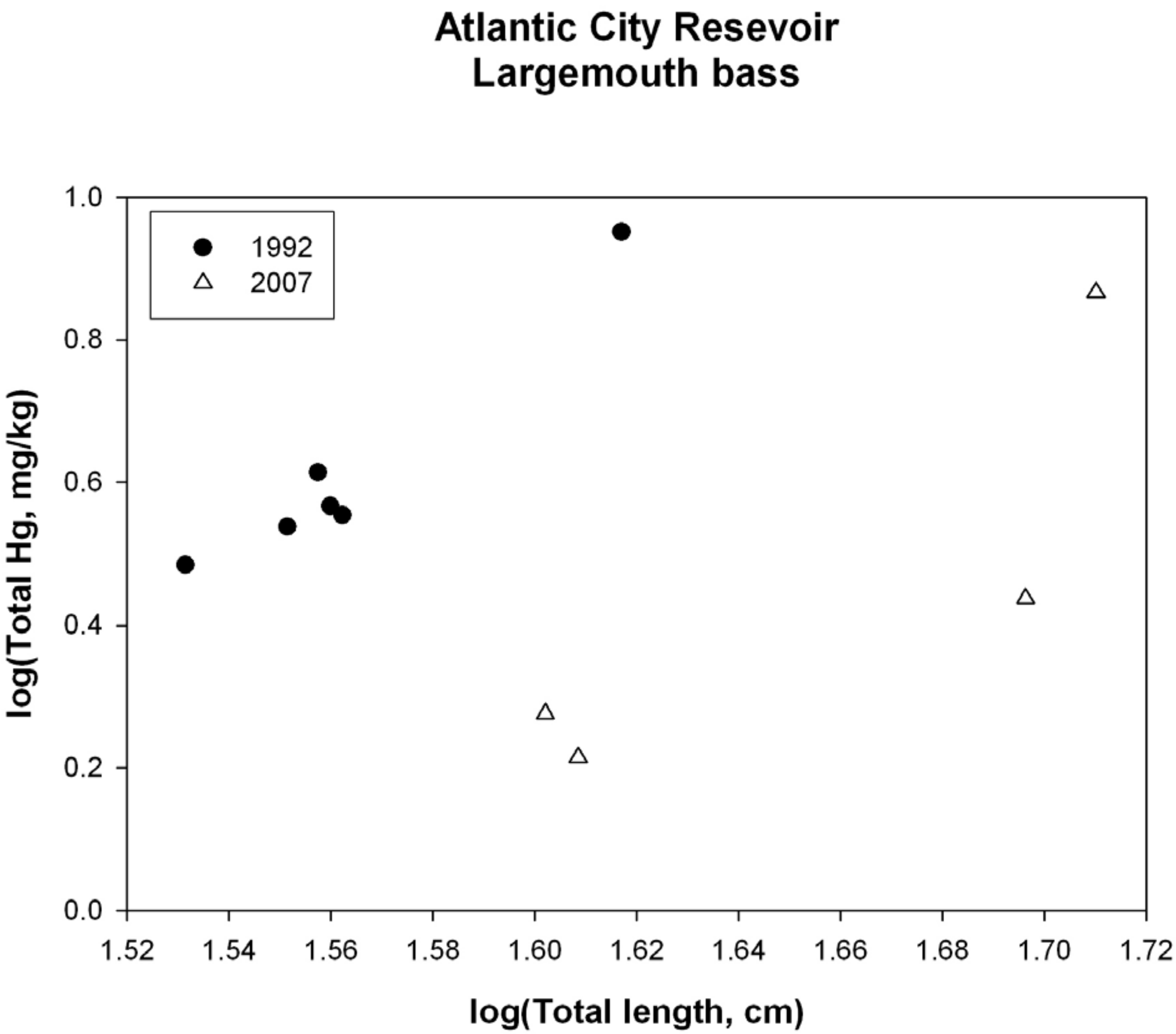

Figure 19. Comparison of total mercury concentrations as a function of total length in largemouth bass from the Atlantic City Reservoir from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

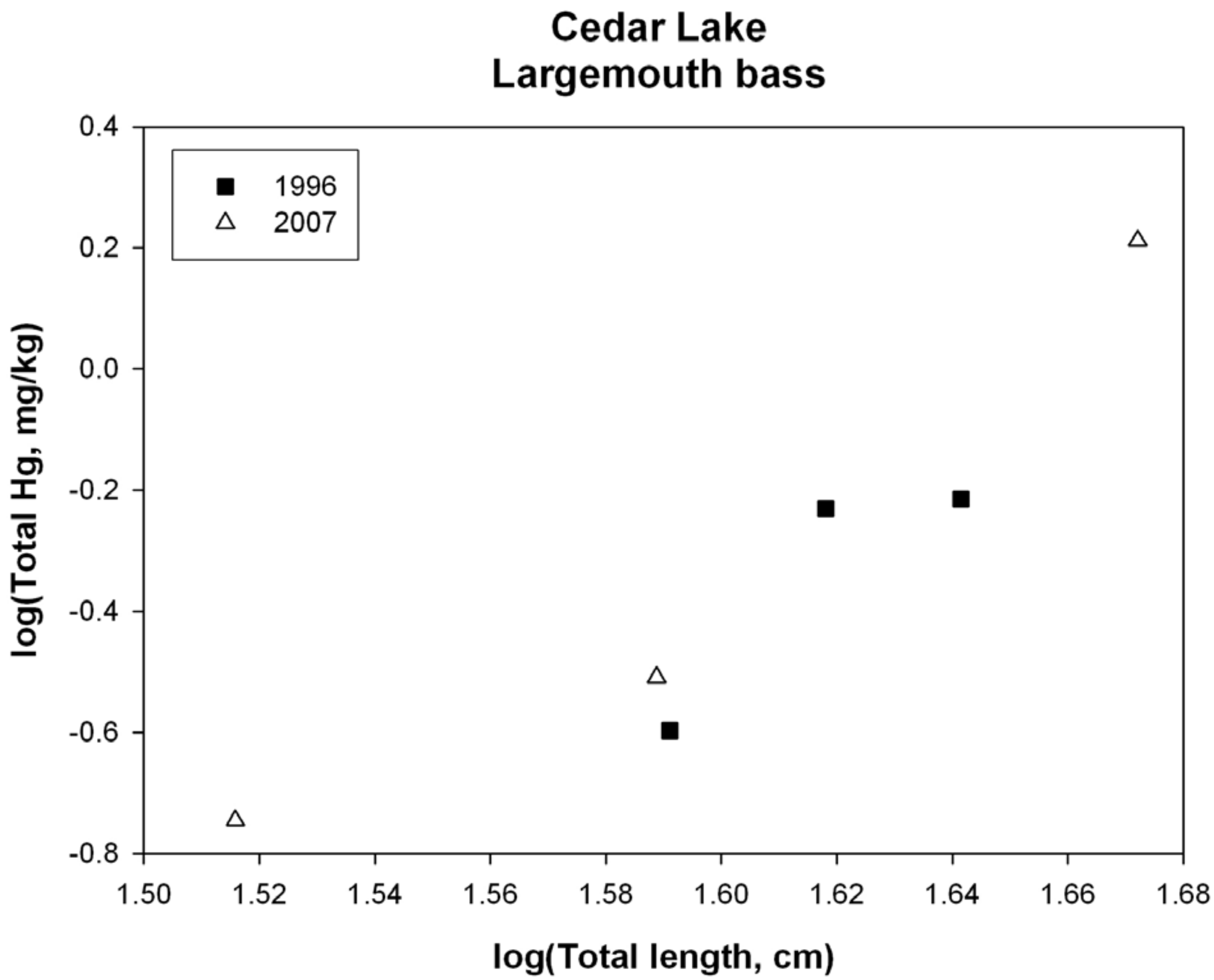

Figure 20. Comparison of total mercury concentrations as a function of total length in largemouth bass from Cedar Lake from the 1996 New Jersey toxics program and the 2007 routine monitoring program.

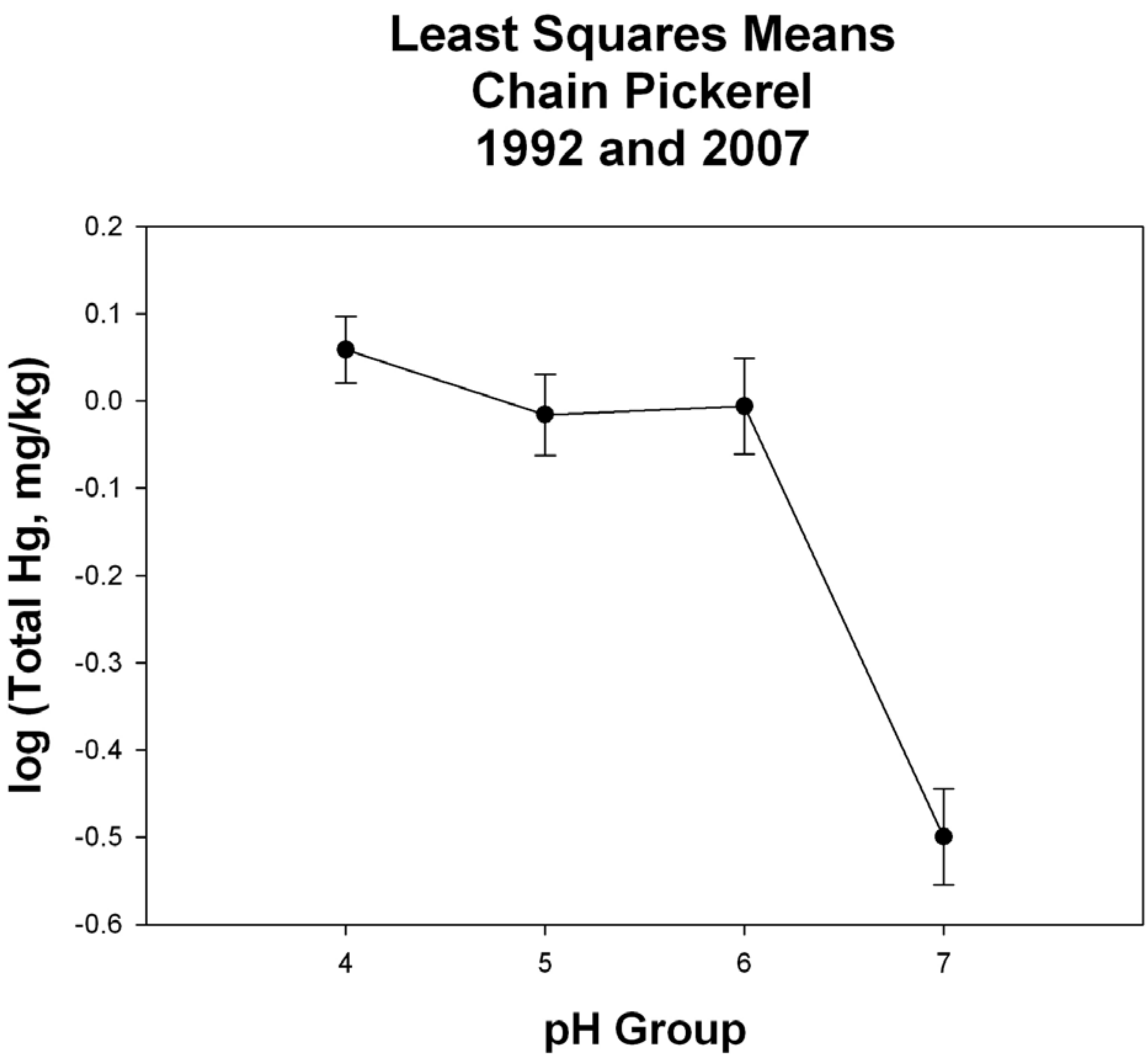

Figure 21. Comparison of total mercury concentrations as a function of pH group in chain pickerel from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

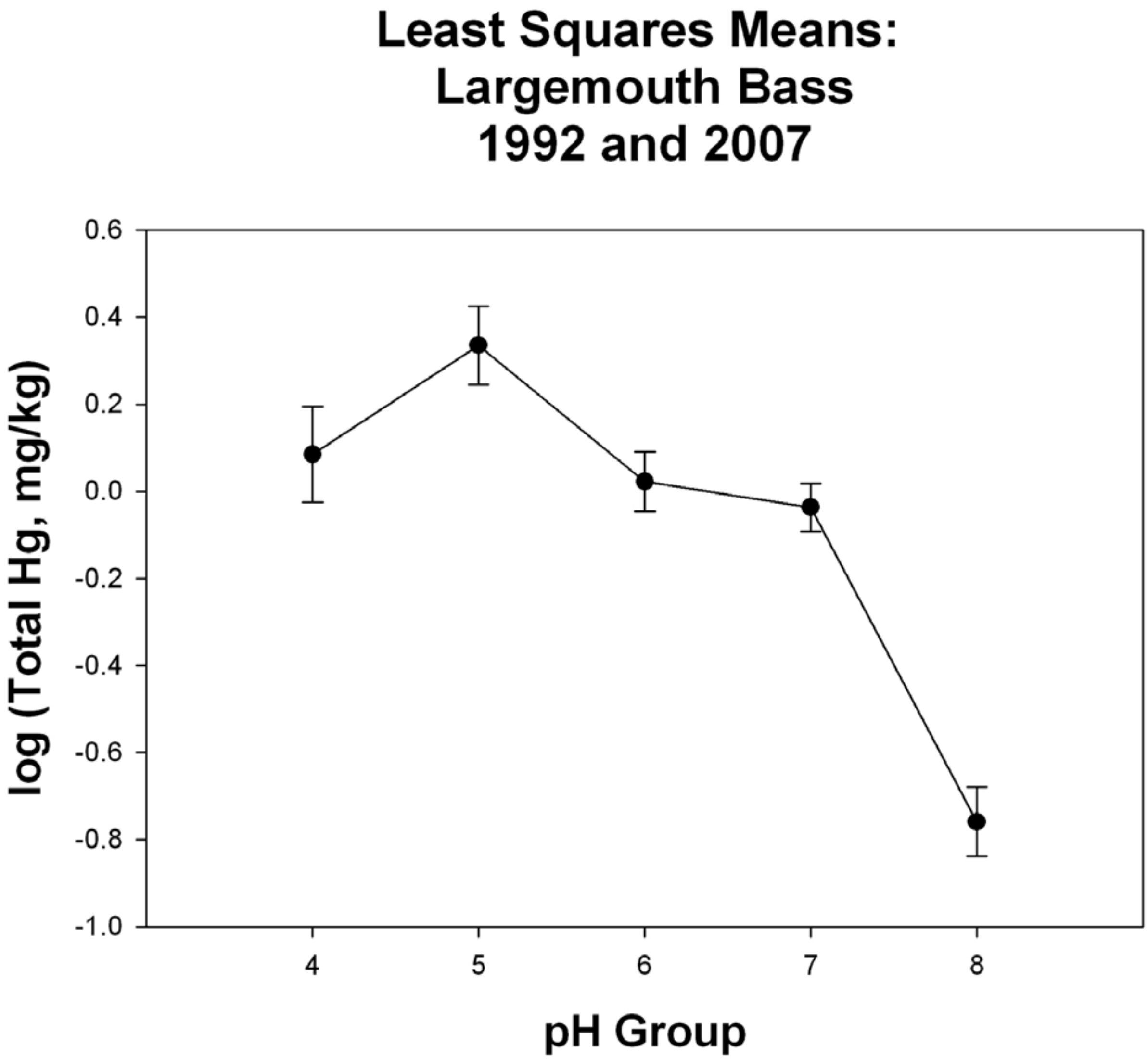

Figure 22. Comparison of total mercury concentrations as a function of pH group in largemouth bass from the 1992 New Jersey toxics program and the 2007 routine monitoring program.

Appendix I.

Data for Individual Samples for Mercury, PCBs, DDX, BHCs and Lindane, PBDEs and Chlordanes

Appendix I. Specimen characteristics and contaminant concentrations for the 2007 Routine Monitoring of Toxics in NJ Fish program. Concentrations were determined using individual filets taken from whole fish. Concentrations below detection limit (BDL) are in italics for PCBs, DDXs, BHCs+Lindane, and Chlordanes. Maximum concentrations per species per station are in bold for values above detection limits. ND=non-detect.

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Atlantic City Reservoir Lower													
	American eel	F-3759	0131	58.1	424.5	14.62	**2.550**	**259**	ND		**105**	*0.291*	**22.3**
	American eel	F-3760	0132	47.0	226.9	6.67	2.190	187	ND		81	*0.148*	15.6
	American eel	F-3761	0133	43.7	161.3	1.08	2.090	64	ND		18	*0.115*	3.2
	largemouth bass	F-3765	0137	40.6	1066.8	0.96	1.640	34	**0.070**		**7**	*0.162*	**1.4**
	largemouth bass	F-3766	0138	40.0	1011.7		1.890						
	largemouth bass	F-3773	0145	51.3	1681.7	0.98	**7.350**	**47**	ND		**7**	*0.108*	1.3
	largemouth bass	F-3774	0146	49.7	1949.2	0.63	2.740	34	ND		*5*	*0.104*	1.3
Atsion Lake													
	American eel	F-3619	10042	51.7	276.8	4.41	**0.520**	33	ND		14	*0.058*	2.9
	American eel	F-3620	10043	32.1	61.7	13.16	0.270	24	ND		10	*0.093*	2.5
	American eel	F-3621	10044	31.2	68.9	21.34	0.330	**34**	ND		**20**	*0.146*	**4.1**
	chain pickerel	F-3616	10039	39.6	329.7		0.690						
	chain pickerel	F-3617	10040	44.7	547.6		**0.820**						
	chain pickerel	F-3618	10041	33.2	213.8		0.470						
Batsto Lake													
	brown bullhead	F-3669	0041	361.8	361.8	0.43	0.160	*6*	ND		6	*0.081*	*0.5*
	brown bullhead	F-3670	0042	33.4	490.2	0.58	0.220	18	ND		*3*	*0.177*	*0.4*
	brown bullhead	F-3671	0043	32.9	403.1	0.76	**0.290**	*12*	ND		**8**	*0.072*	**1.0**
	chain pickerel	F-3678	0050	23.7	71.7		0.300						
	chain pickerel	F-3682	0054	35.0	218.2		0.745						
	chain pickerel	F-3683	0055	35.5	224.9		**0.850**						
	chain pickerel	F-3684	0056	35.9	281.4		0.440						
	largemouth bass	F-3672	0044	35.6	670.4	0.50	1.070	*11*	ND		8	*0.071*	*0.7*
	largemouth bass	F-3673	0045	35.5	638.5	0.49	**1.250**	*11*	ND		7	*0.118*	*0.8*

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	largemouth bass	F-3674	0046	36.7	686.9	0.80	0.850	16	ND		10	*0.099*	1.0
	largemouth bass	F-3675	0047	37.2	729.0	0.76	0.100	17	ND		**632**	*0.155*	**1.1**
Cedar Lake													
	American eel	F-3724	0096	63.9	659.0	18.04	**0.220**	**228**	ND		**821**	*0.181*	**7.2**
	American eel	F-3725	0097	54.2	340.7	18.02	0.180	75	ND		50	**0.441**	5.9
	American eel	F-3726	0098	48.7	242.5	13.03	0.160	71	ND		31	*0.308*	4.1
	largemouth bass	F-3721	0093	32.8	582.2		0.180						
	largemouth bass	F-3722	0094	38.8	1019.3		0.310						
	largemouth bass	F-3723	0095	47.0	1581.2		**1.630**						
	white perch	F-3718	0090	37.4	712.6	0.84	**0.510**	38	ND		118	*0.399*	0.9
	white perch	F-3719	0091	30.7	572.5	4.63	0.330	**61**	ND		**202**	*0.384*	**1.5**
	white perch	F-3720	0092	31.8	632.1	3.10	0.220	44	ND		122	*0.411*	1.4
Cedarville Ponds													
	chain pickerel	F-3710	0082	35.4	251.4	0.93	0.540	*8*	ND		*2*	*0.175*	*0.2*
	chain pickerel	F-3711	0083	34.4	204.8	0.80	0.530	*13*	ND		*5*	*0.195*	*0.2*
	chain pickerel	F-3712	0084	32.5	204.1		0.445						
	chain pickerel	F-3713	0085	43.1	514.7	0.55	**0.690**	*5*	ND		*1*	*0.290*	*0.1*
	chain pickerel	F-3714	0086	30.6	146.2		0.650						
	yellow perch	F-3707	0079	28.0	262.0	0.64	0.310	*6*	ND		*1*	*0.179*	*0.2*
	yellow perch	F-3708	0080	29.8	329.2	0.69	**0.350**	*5*	ND		*1*	**0.532**	*0.2*
	yellow perch	F-3709	0081	28.8	298.3	1.32	0.330	*6*	ND		*2*	*0.230*	*0.2*
Deal Lake													
	American eel	F-3825	0197	60.0	565.1	5.24	0.050	392	ND	24.01	109	*0.271*	184.7
	American eel	F-3828	0200	31.0	60.9	16.94	**0.060**	**517**	ND	**41.44**	**152**	**0.461**	**307.6**
	largemouth bass	F-3668	0040	38.0	841.1	0.32	0.090	23	ND		12	*0.245*	10.7
	largemouth bass	F-3676	0048	39.8	1027.1	0.47	0.120	**77**	ND		18	*0.069*	20.7
	largemouth bass	F-3677	0049	40.2	948.5	0.82	**0.140**	45	**0.070**		**21**	*0.129*	**22.0**
	white perch	F-3823	0195	18.1	89.9	2.65	0.040	170	ND	14.61	28	*0.207*	38.4
	white perch	F-3824	0196	20.2	115.7	2.30	**0.180**	129	ND	7.96	20	**0.677**	31.9

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	white perch	F-3829	0201	16.3	59.2	3.41	*0.020*	**252**	ND	**28.22**	**49**	*0.269*	**88.0**
East Creek Lake													
	American eel	F-3626	10049	51.8	261.1	5.80	1.025	34	ND		99	*0.062*	3.7
	American eel	F-3627	10050	53.9	339.5	18.63	**1.240**	**73**	ND		**267**	*0.374*	**7.0**
	American eel	F-3628	10051	43.2	149.7	1.75	1.050	*13*	ND		25	*0.143*	0.9
	chain pickerel	F-3622	10045	33.6	184.6		1.140						
	chain pickerel	F-3623	10046	41.1	337.9		**1.460**						
	chain pickerel	F-3624	10047	42.9	468.1		1.050						
	largemouth bass	F-3625	10048	30.5	404.7		1.050						
	largemouth bass	F-3630	10053	44.6	1490.3		1.370						
	largemouth bass	F-3633	10056	39.4	999.1		**1.400**						
Enno Lake													
	American eel	F-3735	0107	40.2	162.9	3.30	**0.340**	50	ND		21	0.508	15.0
	American eel	F-3736	0108	35.3	83.9	22.31	0.200	**68**	ND		**44**	**0.630**	**27.4**
	American eel	F-3737	0109	33.6	69.3	18.50	0.240	64	ND		36	0.542	26.2
	largemouth bass	F-3738	0110	26.9	313.4		**0.490**						
	largemouth bass	F-3739	0111	31.0	433.6		0.315						
	largemouth bass	F-3740	0112	34.5	676.2		0.475						
Harrisville Lake													
	American eel	F-3695	0067	27.4	37.1	6.32	0.470	**20**	ND		**16**	*0.079*	**6.0**
	American eel	F-3696	0068	40.5	110.1	3.00	0.580	*8*	ND		7	*0.056*	*0.8*
	American eel	F-3697	0069	54.1	315.5	8.77	**0.730**	18	ND		15	*0.079*	2.4
	chain pickerel	F-3691	0063	31.3	170.6		**1.050**						
	chain pickerel	F-3692	0064	27.6	118.6		**1.050**						
	chain pickerel	F-3693	0065	29.4	146.7		0.610						
	chain pickerel	F-3694	0066	30.4	162.0		0.910						
Horicon Lake													
	American eel	F-3756	0128	60.6	468.7	17.42	0.790	**150**	ND		**196**	**0.782**	**20.9**
	American eel	F-3757	0129	61.9	482.4	13.33	1.580	142	ND		113	*0.276*	11.8

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	American eel	F-3758	0130	67.3	546.9	17.10	**2.200**	143	ND		119	*0.371*	9.3
	chain pickerel	F-3762	0134	38.2	352.6		**1.780**						
	chain pickerel	F-3763	0135	37.7	293.4		0.980						
	chain pickerel	F-3764	0136	35.7	256.6		1.020						
Lake Absegami													
	American eel	F-3732	0104	31.6	57.0	20.06	0.360	96	ND		395	**0.615**	5.7
	American eel	F-3733	0105	47.5	196.6	11.69	**0.800**	**165**	ND		**571**	*0.440*	**7.8**
	American eel	F-3734	0106	32.7	76.7	14.37	0.290	55	ND		193	0.590	2.9
	chain pickerel	F-3727	0099	35.3	216.5		1.320						
	chain pickerel	F-3728	0100	35.4	226.6		1.260						
	chain pickerel	F-3729	0101	43.5	606.1		1.240						
	chain pickerel	F-3730	0102	47.6	641.8		**1.630**						
	chain pickerel	F-3731	0103	58.7	1422.4		1.390						
Lake Manahawkin													
	American eel	F-3786	0158	56.1	325.4	3.96	1.430	76	ND		323	*0.187*	22.0
	American eel	F-3787	0159	79.6	1254.1	17.36	**1.890**	**169**	ND		**807**	**0.526**	**59.2**
	American eel	F-3793	0165	46.3	190.5	3.16	1.500	42	ND		148	*0.160*	14.2
	largemouth bass	F-3788	0160	35.2	557.9		0.930						
	largemouth bass	F-3789	0161	33.6	461.2		1.080						
	largemouth bass	F-3790	0162	45.1	1361.9		**1.760**						
Lake Nummy													
	chain pickerel	F-3640	10063	56.0	1050.5		**2.560**						
	chain pickerel	F-3641	10064	46.2	657.5		1.070						
	yellow bullhead	F-3637	10060	29.2	350.9		0.440						
	yellow bullhead	F-3638	10061	33.4	411.1		**0.790**						
	yellow bullhead	F-3639	10062	29.7	362.0		0.285						
Lake Oswego													
	American eel	F-3770	0142	60.5	485.3	19.54	0.460	**59**	ND		**42**	**0.670**	**3.3**
	American eel	F-3771	0143	49.6	257.0	13.95	**0.700**	40	ND		30	*0.394*	2.3

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	chain pickerel	F-3767	0139	26.6	114.7		0.820						
	chain pickerel	F-3768	0140	27.7	123.4		0.755						
	chain pickerel	F-3769	0141	42.1	486.0		0.420						
	chain pickerel	F-3772	0144	46.8	816.0		**2.050**						
Lefferts Lake													
	brown bullhead	F-3803	0175	28.8	316.9	0.69	**0.100**	22	ND		*5*	0.445	5.2
	brown bullhead	F-3804	0176	29.1	350.3	1.60	**0.100**	**83**	ND		**28**	*0.290*	**26.7**
	brown bullhead	F-3805	0177	27.8	309.4	0.54	0.070	21	ND		*5*	**0.489**	4.9
	chain pickerel	F-3800	0172	46.7	584.1		**0.210**						
	chain pickerel	F-3801	0173	43.9	472.4		0.110						
	chain pickerel	F-3802	0174	44.7	549.4		0.190						
	yellow perch	F-3806	0178	25.3	194.8	0.70	0.090	**41**	**0.080**		**11**	*0.434*	**9.0**
	yellow perch	F-3807	0179	23.8	187.0	0.54	0.100	28	ND		*6*	**0.806**	6.2
	yellow perch	F-3808	0180	24.4	172.5	0.70	**0.120**	26	ND		7	*0.420*	7.7
Lenape Lake													
	American eel	F-3780	0152	58.7	445.3	12.30	**1.060**	138	ND		179	*0.361*	20.2
	American eel	F-3781	0153	62.4	578.3	19.63	0.890	**225**	ND		**449**	0.548	**51.9**
	American eel	F-3782	0154	53.0	307.2	15.99	0.355	88	ND		306	**1.088**	11.9
	largemouth bass	F-3775	0147	45.9	1898.1		**1.610**						
	largemouth bass	F-3776	0148	44.6	1446.1		1.040						
	largemouth bass	F-3777	0149	40.0	1040.9		1.600						
Manasquan Reservoir													
	American eel	F-3797	0169	82.4	1120.8	27.07	**0.170**	**196**	ND		**173**	**0.468**	**33.8**
	American eel	F-3798	0170	58.0	329.4	11.64	0.050	124	ND		67	*0.122*	12.2
	American eel	F-3799	0171	54.2	270.6	9.56	0.080	89	ND		62	*0.148*	12.1
	largemouth bass	F-3817	0189	44.5	1213.4	1.54	0.210	28	ND		8	*0.309*	1.4
	largemouth bass	F-3818	0190	40.1	1031.8	0.93	0.100	49	ND		*4*	*0.283*	*0.7*
	largemouth bass	F-3819	0191	49.2	1824.9	1.59	**0.400**	**59**	**0.140**		**17**	*0.299*	**2.5**
Maple Lake													

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	American eel	F-3783	0155	48.6	227.4	22.12	0.810	87	ND		36	*0.434*	7.3
	American eel	F-3784	0156	53.6	280.8	20.47	**1.020**	**115**	ND		**117**	*0.246*	**9.5**
	American eel	F-3785	0157	44.1	166.9	18.06	0.810	72	ND		34	*0.200*	6.9
	largemouth bass	F-3778	0150	38.0	617.4		**1.480**						
	largemouth bass	F-3779	0151	34.7	494.3		0.860						
	largemouth bass	F-3791	0163	33.7	532.7		0.840						
	largemouth bass	F-3792	0164	33.1	469.5		0.430						
Marlu Lake													
	common carp	F-3634	10057	66.6	4100.0	6.97	**0.040**	84	ND		141	*0.224*	25.0
	common carp	F-3635	10058	64.4	4850.0	8.21	**0.040**	112	ND		190	*0.264*	34.6
	common carp	F-3636	10059	67.9	4800.0	18.13	**0.040**	**155**	ND		**263**	**1.370**	**59.8**
	largemouth bass	F-3629	10052	34.5	623.9		0.080						
	largemouth bass	F-3631	10054	41.4	1063.9		0.090						
	largemouth bass	F-3632	10055	44.2	1451.8		**0.140**						
Maurice River													
	channel catfish	F-3830	0202	42.8	696.3	2.12	0.370	301	ND		36	*0.157*	4.9
	channel catfish	F-3831	0203	42.5	741.6	4.60	0.160	163	ND		34	*0.189*	9.4
	channel catfish	F-3832	0204	46.4	927.2	1.17	**0.555**	**579**	ND		**104**	*0.257*	**12.8**
	largemouth bass	F-3794	0166	32.9	512.6		0.340						
	largemouth bass	F-3795	0167	39.5	979.1		0.490						
	largemouth bass	F-3796	0168	43.2	1328.7		**0.940**						
	white catfish	F-3833	0205	31.2	342.0	2.09		181	ND		15	**1.752**	15.3
	white catfish	F-3834	0206	981.2	981.2	3.45		95	ND		16	*0.168*	3.8
	white catfish	F-3835	0207	39.4	826.1	3.08		**460**	ND		**65**	*0.192*	**18.6**
	white perch	F-3820	0192	24.8	231.4	2.11	0.330	68	**0.120**	3.70	**20**	*0.186*	3.1
	white perch	F-3821	0193	20.6	119.5	2.30	0.120	**84**	ND	**11.94**	**20**	*0.230*	**4.9**
	white perch	F-3822	0194	28.7	366.4	1.78	**0.540**	57	ND	4.49	13	*0.254*	2.5
Menantico Sand Ponds													
	American eel	F-3698	0070	52.7	337.0	0.64	0.670	20	ND		15	*0.162*	1.3

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	American eel	F-3699	0071	71.1	768.7	2.75	0.280	51	ND		71	*0.233*	6.1
	American eel	F-3700	0072	77.1	1165.2	10.07	**0.700**	**138**	ND		**175**	0.834	**17.1**
	largemouth bass	F-3701	0073	34.7	667.7		0.730						
	largemouth bass	F-3702	0074	42.5	1089.3		**0.970**						
	largemouth bass	F-3706	0078	37.6	797.8		0.640						
Metedeconk River North Branch													
	American eel	F-3741	0113	55.5	328.4	13.44	**0.385**	71	ND		47	*0.239*	10.4
	American eel	F-3742	0114	30.5	53.4	18.80	0.250	**90**	ND		68	1.328	47.1
	American eel	F-3743	0115	32.4	65.8	21.74	0.200	88	ND		**1083**	**17.794**	**1983.7**
Parvin Lake													
	American eel	F-3826	0198	63.1	545.8	9.68	**0.120**	39	ND	0.91	112	*0.095*	3.6
	American eel	F-3827	0199	64.9	437.9	19.27	**0.120**	**119**	ND	**3.16**	**342**	*0.098*	**7.3**
	chain pickerel	F-3811	0183	47.7	699.7		0.210						
	chain pickerel	F-3812	0184	51.4	961.1		0.190						
	chain pickerel	F-3813	0185	45.7	707.8		**0.235**						
	largemouth bass	F-3809	0181	35.9	695.5	1.00	0.160	**36**	ND		42	*0.268*	**1.1**
	largemouth bass	F-3810	0182	39.5	923.3	1.02	0.210	25	ND		48	*0.400*	*0.8*
	largemouth bass	F-3814	0186	43.3	1257.3	1.10	0.260	26	ND		**54**	*0.250*	**1.1**
	largemouth bass	F-3815	0187	44.6	1534.0	0.99	0.195	*14*	ND		26	*0.345*	*0.5*
	largemouth bass	F-3816	0188	49.0	1997.9	0.85	**0.270**	16	ND		22	*0.363*	*0.4*
Pohatcong Lake													
	American eel	F-3648	0007	66.2	600.7	2.12	0.720	29	ND		**106**	*0.136*	**3.7**
	American eel	F-3649	0008	45.3	135.9	1.08	**0.950**	**31**	ND		78	*0.191*	3.5
	American eel	F-3650	0009	44.3	166.8	1.10	0.440	20	ND		50	*0.140*	1.8
	largemouth bass	F-3645	0004	42.7	1155.1		0.610						
	largemouth bass	F-3646	0005	41.7	1035.6		**0.780**						
	largemouth bass	F-3647	0006	43.0	1097.4		0.640						
	largemouth bass	F-3667	0039	41.7	991.5		0.690						
	yellow perch	F-3642	0001	26.5	240.7	0.86	0.140	*6*	ND		12	*0.088*	*0.6*

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	yellow perch	F-3643	0002	31.2	397.5	1.20	0.360	*7*	ND		**17**	*0.081*	**1.2**
	yellow perch	F-3644	0003	34.6	445.4	0.69	**0.830**	*5*	ND		14	*0.122*	*0.9*
Shenandoah Lake													
	American eel	F-3679	0051	46.8	226.6	12.62	**0.420**	182	ND		222	*0.199*	**101.0**
	American eel	F-3680	0052	47.9	187.6	1.74	0.240	58	ND		49	*0.145*	19.1
	American eel	F-3681	0053	75.5	1014.7	11.78	**0.420**	**198**	ND		**227**	*0.305*	93.3
	chain pickerel	F-3688	0060	41.4	411.5		0.320						
	chain pickerel	F-3689	0061	35.3	240.1		**0.340**						
	chain pickerel	F-3690	0062	41.2	378.1		0.230						
	largemouth bass	F-3685	0057	41.6	1055.1		0.460						
	largemouth bass	F-3686	0058	40.5	1117.7		0.370						
	largemouth bass	F-3687	0059	43.2	1204.4		**0.650**						
Stow Creek Canton													
	American eel	F-3613	10036	46.6	222.1	7.79	0.050	51	ND		**27**	**3.548**	**3.2**
	American eel	F-3614	10037	49.4	256.6	7.65	0.070	74	ND		26	2.571	**3.2**
	American eel	F-3615	10038	37.9	105.2	2.19	**0.120**	**78**	ND		17	*0.141*	2.2
Swimming River Reservoir													
	American eel	F-3715	0087	42.2	175.7	10.30	0.040	103	ND		177	3.787	19.1
	American eel	F-3716	0088	66.1	716.3	14.03	0.070	**204**	ND		**616**	**4.974**	**70.9**
	American eel	F-3717	0089	68.9	822.4	16.54	**0.080**	171	ND		146	4.383	51.3
	largemouth bass	F-3703	0075	50.1	2392.2	2.49	**0.150**	103	ND		**33**	0.778	12.4
	largemouth bass	F-3704	0076	42.7	1221.8	2.93	0.090	**125**	ND		28	**0.963**	**16.8**
	largemouth bass	F-3705	0077	40.0	936.0	0.55	0.090	26	ND		**33**	*0.300*	3.0
Turn Mill Pond													
	American eel	F-3651	0010	52.4	253.7	10.06	**0.160**	21	ND		14	*0.168*	2.0
	American eel	F-3652	0011	57.9	397.4	24.46	0.140	**39**	ND		**31**	*0.243*	**4.1**
	American eel	F-3653	0012	51.6	242.4	23.08	0.140	28	ND		22	*0.245*	3.2
	largemouth bass	F-3657	0016	30.7	385.5		0.320						
	largemouth bass	F-3658	0017	28.2	341.3		0.400						

Station	Common Name	Analytical Number	Chem ID	Total Length (lab)	Total Weight (lab)	Total Lipids	Total Hg	Total PCBs	Total Planar PCBs	Total PBDEs	Total DDXs	Total BHCs + Lindane	Total Chlor-danes
				cm	g	%	ug/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
	largemouth bass	F-3659	0018	30.3	362.1		**0.420**						
Union Lake													
	brown bullhead	F-3654	0013	27.9	264.1	0.34	0.180	*8*	ND		8	*0.129*	0.9
	brown bullhead	F-3655	0014	31.0	396.7	1.23	**1.730**	**24**	ND		13	*0.194*	**2.8**
	brown bullhead	F-3656	0015	28.4	327.7	1.34	0.300	19	ND		**14**	*0.141*	2.5
	chain pickerel	F-3660	0032	37.5	276.0		1.140						
	chain pickerel	F-3661	0033	51.0	941.1		**1.590**						
	chain pickerel	F-3663	0035	49.3	623.8		1.550						
	largemouth bass	F-3662	0034	29.7	406.1	0.95	0.765	**21**	ND		168	*0.172*	**1.5**
	largemouth bass	F-3664	0036	32.5	517.8	0.50	**1.490**	16	ND		*6*	*0.127*	0.9
	largemouth bass	F-3665	0037	35.1	595.0	0.58	1.200	16	ND		**285**	*0.160*	1.3
	largemouth bass	F-3666	0038	32.7	461.2	0.50	0.960	*10*	ND		9	*0.142*	*0.6*
Wading River													
	chain pickerel	F-3748	0120	40.7	351.8	0.49	2.030	*9*	ND		*3*	*0.184*	*0.2*
	chain pickerel	F-3749	0121	37.5	279.9	0.49	**2.630**	*11*	ND		*3*	*0.272*	*0.2*
	chain pickerel	F-3750	0122	36.3	231.4	0.53	2.600	**20**	ND		*3*	*0.205*	*0.2*
Wilson Lake													
	chain pickerel	F-3745	0117	54.7	1147.0		**2.020**						
	chain pickerel	F-3746	0118	34.7	202.5		1.580						
	chain pickerel	F-3747	0119	37.0	281.7		1.360						
	largemouth bass	F-3753	0125	35.4	579.8	0.80	1.530	27	ND		19	*0.303*	*0.3*
	largemouth bass	F-3754	0126	38.9	798.8	0.47	1.630	36	ND		41	*0.280*	*0.7*
	largemouth bass	F-3755	0127	40.9	747.8	0.92	**3.270**	**66**	ND		**60**	*0.347*	*0.7*
	yellow perch	F-3744	0116	28.0	246.5	0.51	1.250	*11*	ND		7	*0.211*	*0.3*
	yellow perch	F-3751	0123	28.0	267.6	1.25	**1.410**	*14*	ND		11	*0.277*	*0.5*
	yellow perch	F-3752	0124	30.0	314.5	0.87	0.870	15	ND		**14**	*0.306*	*0.4*

Appendix II.

Data for Individual Samples for Dieldrin, Endrin, Aldrin, and Endosulfans

Appendix II. Concentrations of dieldrin, endrin, aldrin, and endosulfans in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Concentrations were determined using individual filets taken from whole fish. Concentrations below detection limit (BDL) are in italics. Maximum concentrations per species per station are in bold for values above detection limits. ND=non-detect.

Appendix II. Concentrations of dieldrin, endrin, aldrin, and endosulfans in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Concentrations were determined using individual filets taken from whole fish. Concentrations below detection limit (BDL) are in italics. Maximum concentrations per species per station are in bold for values above detection limits. ND=non-detect

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Atlantic City Reservoir Lower											
	American eel	F-3759	0131	14.62	58.1	424.5	**3.40**	**0.13**	*0.08*	**0.05**	**2.43**
	American eel	F-3760	0132	6.67	47.0	226.9	1.70	*0.09*	*0.04*	*0.02*	1.90
	American eel	F-3761	0133	1.08	43.7	161.3	0.24	*0.04*	*0.02*	*0.01*	*0.03*
	largemouth bass	F-3765	0137	0.96	40.6	1066.8	*0.09*	*0.05*	*0.02*	*0.01*	*0.03*
	largemouth bass	F-3766	0138		40.0	1011.7					
	largemouth bass	F-3773	0145	0.98	51.3	1681.7	**0.26**	*0.03*	*0.01*	*0.00*	*0.01*
	largemouth bass	F-3774	0146	0.63	49.7	1949.2	*0.05*	*0.03*	*0.02*	*0.01*	*0.02*
Atsion Lake											
	American eel	F-3619	10042	4.41	51.7	276.8	1.08	*0.04*	*0.03*	0.04	*0.02*
	American eel	F-3620	10043	13.16	32.1	61.7	2.63	*0.06*	*0.06*	0.14	0.08
	American eel	F-3621	10044	21.34	31.2	68.9	**4.11**	*0.05*	*0.12*	**0.39**	**0.15**
	chain pickerel	F-3616	10039		39.6	329.7					
	chain pickerel	F-3617	10040		44.7	547.6					
	chain pickerel	F-3618	10041		33.2	213.8					
Batsto Lake											
	brown bullhead	F-3669	0041	0.43	361.8	361.8	0.15	*0.04*	*0.01*	*0.02*	*0.01*
	brown bullhead	F-3670	0042	0.58	33.4	490.2	0.11	*0.13*	*0.01*	**0.03**	*0.03*
	brown bullhead	F-3671	0043	0.76	32.9	403.1	**0.17**	*0.06*	*0.01*	*0.01*	*0.01*
	chain pickerel	F-3678	0050		23.7	71.7					
	chain pickerel	F-3682	0054		35.0	218.2					
	chain pickerel	F-3683	0055		35.5	224.9					
	chain pickerel	F-3684	0056		35.9	281.4					
	largemouth bass	F-3672	0044	0.50	35.6	670.4	0.11	*0.04*	*0.01*	*0.01*	*0.01*
	largemouth bass	F-3673	0045	0.49	35.5	638.5	0.22	*0.09*	*0.01*	*0.01*	*0.01*
	largemouth bass	F-3674	0046	0.80	36.7	686.9	0.21	*0.10*	*0.01*	*0.01*	*0.02*
	largemouth bass	F-3675	0047	0.76	37.2	729.0	**0.29**	**0.24**	*0.03*	**0.08**	**0.07**

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
East Creek Lake											
	American eel	F-3626	10049	5.80	51.8	261.1	0.33	*0.03*	*0.00*	ND	**0.35**
	American eel	F-3627	10050	18.63	53.9	339.5	**1.24**	**0.14**	*0.04*	**0.08**	0.30
	American eel	F-3628	10051	1.75	43.2	149.7	*0.10*	*0.11*	*0.01*	*0.01*	*0.02*
	chain pickerel	F-3622	10045		33.6	184.6					
	chain pickerel	F-3623	10046		41.1	337.9					
	chain pickerel	F-3624	10047		42.9	468.1					
	largemouth bass	F-3625	10048		30.5	404.7					
	largemouth bass	F-3630	10053		44.6	1490.3					
	largemouth bass	F-3633	10056		39.4	999.1					
Enno Lake											
	American eel	F-3735	0107	3.30	40.2	162.9	2.97	*0.09*	*0.52*	0.02	0.85
	American eel	F-3736	0108	22.31	35.3	83.9	**11.80**	0.14	*0.41*	**0.03**	**2.34**
	American eel	F-3737	0109	18.50	33.6	69.3	9.32	**0.17**	*0.25*	*0.02*	1.74
	largemouth bass	F-3738	0110		26.9	313.4					
	largemouth bass	F-3739	0111		31.0	433.6					
	largemouth bass	F-3740	0112		34.5	676.2					
Harrisville Lake											
	American eel	F-3695	0067	6.32	27.4	37.1	**2.33**	*0.04*	*0.07*	0.04	**0.37**
	American eel	F-3696	0068	3.00	40.5	110.1	0.55	*0.04*	*0.02*	0.02	0.04
	American eel	F-3697	0069	8.77	54.1	315.5	1.80	*0.06*	*0.05*	**0.08**	0.06
	chain pickerel	F-3691	0063		31.3	170.6					
	chain pickerel	F-3692	0064		27.6	118.6					
	chain pickerel	F-3693	0065		29.4	146.7					
	chain pickerel	F-3694	0066		30.4	162.0					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Horicon Lake											
	American eel	F-3756	0128	17.42	60.6	468.7	**53.74**	**0.91**	**1.82**	**0.07**	1.81
	American eel	F-3757	0129	13.33	61.9	482.4	7.58	*0.08*	*0.35*	*0.01*	**2.57**
	American eel	F-3758	0130	17.10	67.3	546.9	3.34	0.63	*0.37*	0.04	0.65
	chain pickerel	F-3762	0134		38.2	352.6					
	chain pickerel	F-3763	0135		37.7	293.4					
	chain pickerel	F-3764	0136		35.7	256.6					
Lake Absegami											
	American eel	F-3732	0104	20.06	31.6	57.0	**1.73**	*0.11*	*0.51*	**0.07**	0.48
	American eel	F-3733	0105	11.69	47.5	196.6	1.30	*0.11*	*0.40*	0.05	**0.62**
	American eel	F-3734	0106	14.37	32.7	76.7	1.36	0.25	*0.32*	0.04	0.24
	chain pickerel	F-3727	0099		35.3	216.5					
	chain pickerel	F-3728	0100		35.4	226.6					
	chain pickerel	F-3729	0101		43.5	606.1					
	chain pickerel	F-3730	0102		47.6	641.8					
	chain pickerel	F-3731	0103		58.7	1422.4					
Lake Manahawkin											
	American eel	F-3786	0158	3.96	56.1	325.4	1.68	*0.06*	*0.07*	*0.02*	2.01
	American eel	F-3787	0159	17.36	79.6	1254.1	**8.45**	*0.08*	*0.27*	**0.06**	**5.28**
	American eel	F-3793	0165	3.16	46.3	190.5	1.21	*0.05*	*0.03*	*0.01*	0.82
	largemouth bass	F-3788	0160		35.2	557.9					
	largemouth bass	F-3789	0161		33.6	461.2					
	largemouth bass	F-3790	0162		45.1	1361.9					
Lake Nummy											
	chain pickerel	F-3640	10063		56.0	1050.5					
	chain pickerel	F-3641	10064		46.2	657.5					
	yellow bullhead	F-3637	10060		29.2	350.9					
	yellow bullhead	F-3638	10061		33.4	411.1					
	yellow bullhead	F-3639	10062		29.7	362.0					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Lake Oswego											
	American eel	F-3770	0142	19.54	60.5	485.3	**1.97**	**0.22**	*0.32*	0.05	*0.04*
	American eel	F-3771	0143	13.95	49.6	257.0	1.51	*0.10*	*0.54*	**0.07**	**0.07**
	chain pickerel	F-3767	0139		26.6	114.7					
	chain pickerel	F-3768	0140		27.7	123.4					
	chain pickerel	F-3769	0141		42.1	486.0					
	chain pickerel	F-3772	0144		46.8	816.0					
Lefferts Lake											
	brown bullhead	F-3803	0175	0.69	28.8	316.9	0.35	*0.05*	*0.12*	0.08	0.06
	brown bullhead	F-3804	0176	1.60	29.1	350.3	**1.65**	ND	*0.15*	**0.10**	**1.24**
	brown bullhead	F-3805	0177	0.54	27.8	309.4	0.46	*0.04*	*0.13*	0.06	0.07
	chain pickerel	F-3800	0172		46.7	584.1					
	chain pickerel	F-3801	0173		43.9	472.4					
	chain pickerel	F-3802	0174		44.7	549.4					
	yellow perch	F-3806	0178	0.70	25.3	194.8	0.90	*0.05*	*0.13*	0.05	**0.66**
	yellow perch	F-3807	0179	0.54	23.8	187.0	0.65	*0.06*	*0.14*	**0.06**	0.37
	yellow perch	F-3808	0180	0.70	24.4	172.5	**0.98**	*0.06*	*0.12*	**0.06**	0.34
Lenape Lake											
	American eel	F-3780	0152	12.30	58.7	445.3	4.98	*0.07*	*0.31*	*0.01*	1.74
	American eel	F-3781	0153	19.63	62.4	578.3	**12.00**	*0.11*	*0.44*	**0.06**	**3.15**
	American eel	F-3782	0154	15.99	53.0	307.2	8.45	*0.12*	*0.27*	*0.02*	0.98
	largemouth bass	F-3775	0147		45.9	1898.1					
	largemouth bass	F-3776	0148		44.6	1446.1					
	largemouth bass	F-3777	0149		40.0	1040.9					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Manasquan Reservoir											
	American eel	F-3797	0169	27.07	82.4	1120.8	**7.12**	*0.11*	*0.29*	0.03	**3.30**
	American eel	F-3798	0170	11.64	58.0	329.4	1.89	*0.09*	*0.16*	**0.12**	1.26
	American eel	F-3799	0171	9.56	54.2	270.6	2.75	*0.07*	*0.16*	0.08	1.09
	largemouth bass	F-3817	0189	1.54	44.5	1213.4	**0.14**	*0.07*	*0.12*	**0.02**	**0.14**
	largemouth bass	F-3818	0190	0.93	40.1	1031.8	*0.06*	*0.05*	*0.10*	**0.02**	*0.02*
	largemouth bass	F-3819	0191	1.59	49.2	1824.9	0.11	*0.03*	*0.12*	*0.02*	0.09
Maple Lake											
	American eel	F-3783	0155	22.12	48.6	227.4	4.35	*0.05*	*0.25*	0.10	0.61
	American eel	F-3784	0156	20.47	53.6	280.8	**4.67**	*0.04*	*0.09*	**0.21**	**0.75**
	American eel	F-3785	0157	18.06	44.1	166.9	3.74	*0.03*	*0.06*	0.17	0.46
	largemouth bass	F-3778	0150		38.0	617.4					
	largemouth bass	F-3779	0151		34.7	494.3					
	largemouth bass	F-3791	0163		33.7	532.7					
	largemouth bass	F-3792	0164		33.1	469.5					
Marlu Lake											
	common carp	F-3634	10057	6.97	66.6	4100.0	3.04	0.67	*0.09*	0.09	0.21
	common carp	F-3635	10058	8.21	64.4	4850.0	3.93	0.76	*0.13*	0.10	0.31
	common carp	F-3636	10059	18.13	67.9	4800.0	**6.66**	**0.89**	*0.23*	**0.24**	**0.46**
	largemouth bass	F-3629	10052		34.5	623.9					
	largemouth bass	F-3631	10054		41.4	1063.9					
	largemouth bass	F-3632	10055		44.2	1451.8					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Maurice River											
	channel catfish	F-3830	0202	2.12	42.8	696.3	1.70	*0.06*	*0.11*	0.12	0.12
	channel catfish	F-3831	0203	4.60	42.5	741.6	**4.65**	*0.09*	*0.18*	**0.31**	**0.21**
	channel catfish	F-3832	0204	1.17	46.4	927.2	0.83	*0.10*	*0.10*	0.07	0.09
	largemouth bass	F-3794	0166		32.9	512.6					
	largemouth bass	F-3795	0167		39.5	979.1					
	largemouth bass	F-3796	0168		43.2	1328.7					
	white catfish	F-3833	0205	2.09	31.2	342.0	**6.73**	**0.37**	*0.20*	0.17	**0.54**
	white catfish	F-3834	0206	3.45	981.2	981.2	1.86	*0.06*	*0.04*	0.16	0.10
	white catfish	F-3835	0207	3.08	39.4	826.1	4.40	*0.06*	*0.11*	**0.30**	0.20
	white perch	F-3820	0192	2.11	24.8	231.4	4.34	*0.07*	*0.14*	**0.06**	**0.09**
	white perch	F-3821	0193	2.30	20.6	119.5	**4.81**	*0.05*	*0.15*	**0.06**	**0.09**
	white perch	F-3822	0194	1.78	28.7	366.4	1.88	*0.07*	*0.12*	0.04	*0.03*
Menantico Sand Ponds											
	American eel	F-3698	0070	0.64	52.7	337.0	0.94	*0.05*	*0.03*	*0.01*	*0.02*
	American eel	F-3699	0071	2.75	71.1	768.7	8.29	*0.05*	*0.17*	*0.01*	0.55
	American eel	F-3700	0072	10.07	77.1	1165.2	**23.14**	**0.15**	*0.41*	**0.07**	**1.73**
	largemouth bass	F-3701	0073		34.7	667.7					
	largemouth bass	F-3702	0074		42.5	1089.3					
	largemouth bass	F-3706	0078		37.6	797.8					
Metedeconk River North Branch											
	American eel	F-3741	0113	13.44	55.5	328.4	7.37	*0.07*	*0.18*	0.03	0.52
	American eel	F-3742	0114	18.80	30.5	53.4	35.37	0.26	*0.83*	0.07	3.75
	American eel	F-3743	0115	21.74	32.4	65.8	**1063.16**	**98.67**	**26.79**	**7.29**	**139.51**

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Parvin Lake											
	American eel	F-3826	0198	9.68	63.1	545.8	3.93	ND	*0.15*	0.10	0.39
	American eel	F-3827	0199	19.27	64.9	437.9	**8.91**	**0.29**	*0.28*	**0.16**	**0.87**
	chain pickerel	F-3811	0183		47.7	699.7					
	chain pickerel	F-3812	0184		51.4	961.1					
	chain pickerel	F-3813	0185		45.7	707.8					
	largemouth bass	F-3809	0181	1.00	35.9	695.5	0.27	*0.04*	*0.02*	0.02	*0.01*
	largemouth bass	F-3810	0182	1.02	39.5	923.3	0.25	*0.05*	*0.11*	**0.03**	*0.03*
	largemouth bass	F-3814	0186	1.10	43.3	1257.3	**0.56**	*0.05*	*0.11*	**0.03**	*0.03*
	largemouth bass	F-3815	0187	0.99	44.6	1534.0	0.28	*0.06*	*0.11*	0.02	*0.01*
	largemouth bass	F-3816	0188	0.85	49.0	1997.9	0.17	*0.05*	*0.08*	0.02	*0.02*
Pohatcong Lake											
	American eel	F-3648	0007	2.12	66.2	600.7	**0.45**	*0.05*	*0.02*	*0.02*	**0.14**
	American eel	F-3649	0008	1.08	45.3	135.9	0.31	*0.12*	*0.02*	**0.02**	0.12
	American eel	F-3650	0009	1.10	44.3	166.8	0.16	*0.08*	*0.02*	*0.01*	0.06
	largemouth bass	F-3645	0004		42.7	1155.1					
	largemouth bass	F-3646	0005		41.7	1035.6					
	largemouth bass	F-3647	0006		43.0	1097.4					
	largemouth bass	F-3667	0039		41.7	991.5					
	yellow perch	F-3642	0001	0.86	26.5	240.7	*0.09*	*0.07*	*0.01*	*0.02*	*0.00*
	yellow perch	F-3643	0002	1.20	31.2	397.5	**0.14**	*0.09*	*0.01*	*0.02*	*0.01*
	yellow perch	F-3644	0003	0.69	34.6	445.4	**0.14**	*0.07*	*0.01*	*0.02*	*0.01*
Shenandoah Lake											
	American eel	F-3679	0051	12.62	46.8	226.6	19.81	**0.46**	*0.80*	**0.02**	0.13
	American eel	F-3680	0052	1.74	47.9	187.6	4.85	*0.09*	*0.17*	*0.01*	1.59
	American eel	F-3681	0053	11.78	75.5	1014.7	**35.33**	0.23	*0.38*	ND	**10.72**
	chain pickerel	F-3688	0060		41.4	411.5					
	chain pickerel	F-3689	0061		35.3	240.1					
	chain pickerel	F-3690	0062		41.2	378.1					
	largemouth bass	F-3685	0057		41.6	1055.1					
	largemouth bass	F-3686	0058		40.5	1117.7					
	largemouth bass	F-3687	0059		43.2	1204.4					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Stow Creek Canton											
	American eel	F-3613	10036	7.79	46.6	222.1	**4.46**	ND	*0.09*	**0.14**	*0.03*
	American eel	F-3614	10037	7.65	49.4	256.6	4.42	**0.40**	*0.10*	0.09	**0.16**
	American eel	F-3615	10038	2.19	37.9	105.2	1.63	0.17	*0.06*	0.04	*0.04*
Swimming River Reservoir											
	American eel	F-3715	0087	10.30	42.2	175.7	10.49	0.31	*0.24*	**0.04**	2.25
	American eel	F-3716	0088	14.03	66.1	716.3	21.57	**0.48**	*0.34*	ND	**5.20**
	American eel	F-3717	0089	16.54	68.9	822.4	**24.82**	0.20	*0.31*	ND	4.66
	largemouth bass	F-3703	0075	2.49	50.1	2392.2	3.08	**0.30**	*0.05*	ND	ND
	largemouth bass	F-3704	0076	2.93	42.7	1221.8	**3.17**	0.19	*0.16*	*0.01*	**0.19**
	largemouth bass	F-3705	0077	0.55	40.0	936.0	0.72	*0.11*	*0.04*	*0.01*	ND
Turn Mill Pond											
	American eel	F-3651	0010	10.06	52.4	253.7	0.53	0.14	*0.03*	0.05	0.06
	American eel	F-3652	0011	24.46	57.9	397.4	**1.29**	**0.43**	*0.05*	0.09	**0.08**
	American eel	F-3653	0012	23.08	51.6	242.4	1.25	0.20	*0.04*	**0.11**	0.07
	largemouth bass	F-3657	0016		30.7	385.5					
	largemouth bass	F-3658	0017		28.2	341.3					
	largemouth bass	F-3659	0018		30.3	362.1					

Station	Common Name	Analytical Number	Chem ID	Total Lipids	Total Length (lab)	Total Weight (lab)	dieldrin	endrin	aldrin	endosulfan I	endosulfan II
				%	cm	g	ng/g wet	ng/g wet	ng/g wet	ng/g wet	ng/g wet
Union Lake											
	brown bullhead	F-3654	0013	0.34	27.9	264.1	0.54	*0.12*	*0.02*	0.04	*0.03*
	brown bullhead	F-3655	0014	1.23	31.0	396.7	**1.48**	**0.13**	*0.06*	0.09	**0.08**
	brown bullhead	F-3656	0015	1.34	28.4	327.7	1.36	*0.08*	*0.05*	**0.12**	0.06
	chain pickerel	F-3660	0032		37.5	276.0					
	chain pickerel	F-3661	0033		51.0	941.1					
	chain pickerel	F-3663	0035		49.3	623.8					
	largemouth bass	F-3662	0034	0.95	29.7	406.1	**0.80**	0.15	*0.03*	0.04	**0.05**
	largemouth bass	F-3664	0036	0.50	32.5	517.8	0.33	*0.10*	*0.02*	*0.02*	*0.02*
	largemouth bass	F-3665	0037	0.58	35.1	595.0	0.37	**0.26**	*0.03*	**0.06**	*0.02*
	largemouth bass	F-3666	0038	0.50	32.7	461.2	0.27	*0.07*	*0.02*	*0.01*	*0.01*
Wading River											
	chain pickerel	F-3748	0120	0.49	40.7	351.8	0.23	*0.10*	*0.20*	*0.01*	*0.01*
	chain pickerel	F-3749	0121	0.49	37.5	279.9	**0.25**	**0.14**	*0.32*	*0.01*	*0.01*
	chain pickerel	F-3750	0122	0.53	36.3	231.4	0.23	*0.10*	*0.33*	*0.01*	*0.01*
Wilson Lake											
	chain pickerel	F-3745	0117		54.7	1147.0					
	chain pickerel	F-3746	0118		34.7	202.5					
	chain pickerel	F-3747	0119		37.0	281.7					
	largemouth bass	F-3753	0125	0.80	35.4	579.8	**0.22**	0.24	*0.30*	*0.02*	*0.01*
	largemouth bass	F-3754	0126	0.47	38.9	798.8	*0.08*	**0.25**	*0.27*	*0.01*	*0.01*
	largemouth bass	F-3755	0127	0.92	40.9	747.8	*0.05*	0.19	*0.37*	*0.01*	*0.01*
	yellow perch	F-3744	0116	0.51	28.0	246.5	0.11	*0.06*	*0.21*	0.03	*0.01*
	yellow perch	F-3751	0123	1.25	28.0	267.6	**0.35**	**0.24**	*0.38*	**0.08**	*0.02*
	yellow perch	F-3752	0124	0.87	30.0	314.5	0.16	*0.05*	*0.32*	0.06	*0.01*

Appendix III.

Data for Individual Samples for Total Furan and Total Dioxin

Appendix III. Total furans and dioxins in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Toxic equivalents (TEQD+F) are based on relative toxicities (TEFs) of different dioxin and furan congeners. TEQD+F were calculated from dioxin and furan data only and do not include PCB congeners. Non-detects (ND) were treated as zeros for calculation of TEQD+F. ND=non-detect, Ind.=individual.

Appendix III. Total furans and dioxins in samples from the 2007 Routine Monitoring of Toxics in NJ Fish program. Toxic equivalents (TEQ_{D+F}) are based on relative toxicities (TEFs) of different dioxin and furan congeners. TEQ_{D+F} were calculated from dioxin and furan data only and do not include PCB congeners. Non-detects (ND) were treated as zeros for calculation of TEQ_{D+F}. ND=non-detect, Ind.=indivdual

Station	Common Name	Analytical Number	Chem ID	GERG ID	Tissue Type	Sample Type	Total Length (lab)	Total Weight (lab)	% solid	% Lipid	Total Furans	Total Dixoins	TEQ_{D+F}
							cm	g			(pg/g) wet	(pg/g) wet	
Deal Lake													
	American eel	F-3828	0200	C60019	Filet	Ind.	31.0	60.9	35.25	39.57	71.73	24.22	1.42
	American eel	F-3825	0197	C60016	Filet	Ind.	60.0	565.1	26.06	18.45	36.01	3.49	0.65
	white perch	F-3829	0201	C60020	Filet	Ind.	16.3	59.2	24.10	9.16	28.73	10.34	1.37
	white perch	F-3824	0196	C60015	Filet	Ind.	20.2	115.7	22.42	6.67	16.59	4.48	0.35
	white perch	F-3823	0195	C60014	Filet	Ind.	18.1	89.9	24.35	3.90	25.52	11.98	1.74
Maurice River													
	white perch	F-3822	0194	C60013	Filet	Ind.	28.7	366.4	20.88	3.14	38.73	31.31	4.62
	white perch	F-3821	0193	C60012	Filet	Ind.	20.6	119.5	20.94	5.20	ND	ND	0.00
	white perch	F-3820	0192	C60011	Filet	Ind.	24.8	231.4	21.01	3.79	ND	1.10	0.01
Parvin Lake													
	American eel	F-3827	0199	C60018	Filet	Ind.	64.9	437.9	36.97	33.56	6.88	12.97	0.76
	American eel	F-3826	0198	C60017	Filet	Ind.	63.1	545.8	31.86	34.31	6.54	8.68	0.21

Appendix IV.

Toxic Equivalence Factors for Individual Furan and Dioxin Congeners

Appendix IV. Toxic equivalance factors (TEF) for individual furan and dioxin congeners, used in calculation of total toxic equivalency (TEQ). TEFs are from van den Berg, et al. (1998), except for values marked with an *, which are taken from van den Berg, et al. (2006).

Appendix IV. Toxic equivalance factors (TEF) for individual furan and dioxin congeners, used in calculation of total toxic equivalency (TEQ). TEFs are from van den Berg , et al. (1998), except for values marked with an *, which are taken from van den Berg, et al. (2006).

Congener		TEF (1, 2, 3)
Polychlorinated Dibenzodioxins	2,3,7,8-TCDD	1
	1,2,3,7,8-PeCDD	1
	1,2,3,4,7,8-HxCDD	0.1
	1,2,3,6,7,8-HxCDD	0.1
	1,2,3,7,8,9-HxCDD	0.1
	1,2,3,4,6,7,8-HpCDD	0.01
	OCDD	0.0003*
Polychlorinated Dibenzofurans	2,3,7,8-TCDF	0.1
	1,2,3,7,8-PeCDF	0.03*
	2,3,4,7,8-PeCDF	0.3*
	1,2,3,4,7,8-HxCDF	0.1
	1,2,3,6,7,8-HxCDF	0.1
	1,2,3,7,8,9-HxCDF	0.1
	2,3,4,6,7,8-HxCDF	0.1
	1,2,3,4,6,7,8-HpCDF	0.01
	1,2,3,4,7,8,9-HpCDF	0.01
	OCDF	0.0003*