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Of Time, PCBs and the Fish of the Hudson River

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OF TIME, PCBs AND THE FISH OF THE HUDSON RIVER

by

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Abstract:

Fish from the Hudson River have functioned to focus much of the attention on the PCB problem.

In the last 25 years, PCB concentrations have declined dramatically, but the greatest proportion of the decline occurred immediately following the cessation of direct discharges to the river. Other redistribution events, although discernible, were not as pronounced in magnitude or severity. Stability of the PCB concentrations in Hudson River fish has become apparent in recent years, i.e., since about 1996. Declines in fish PCB concentrations seem linked to active measures taken to reduce exposures to sources of contamination such as the elimination of the manufacturing plant discharges (1976-1978). In 1991, another major release did occur from deposits and seeps associated with one of the major capacitor plants, 200 miles upstream from the Atlantic Ocean. An abandoned mill structure known as the Allen Mill, which adjoined the Hudson Falls capacitor manufacturing plant, served as a conduit through which PCB-contaminated materials passed into the river, resulting in increased concentrations in various species of fish at several locations. The increased PCB levels were either statistically significant, particularly near the source, or were, at the least, discernibly higher in relative terms throughout the river.

After the elimination and control of the “Allen Mill event,” fish PCB concentrations declined to levels at or below conditions observed prior to the release. Although it is easiest to observe changes in fish concentrations as a result of mitigative measures closer to a given source condition, results of some of the actions taken are discernible in species at considerable distances away, including migratory, spawning populations of striped bass collected from the Hudson River. In 2003, however, PCB concentrations remain elevated throughout the river. Possession of fish is still not allowed above the Federal Dam at Troy to Bakers Falls in the Village of Hudson Falls.

Continued annual monitoring throughout the system is needed to continue documenting and describing the eventual fate of the PCB contamination.

INTRODUCTION

Describing the long-term consequences of large-magnitude environmental disturbances necessitates the implementation and execution of a sustained commitment to overseeing the culmination of the final vestiges of the original insult. Probably nowhere has that process been so pronounced and prolonged as it has for the polychlorinated biphenyl (PCB) problem in the piscine resources of the Hudson River.

It takes a long time to track “ what’s happenin’ ” in a complicated system affected by a suite of 209 related, but different, synthetic chemicals, especially when they can accumulate in 209 species of fish over approximately 209 miles of river. Since the problem first started to emerge about 29 years ago, there is undoubtedly a considerable period of time to go before the issue may entirely resolve itself. Perhaps, it may be as long as 209 years. In the interim, however, attempts to repair the wounds are moving forward (USEPA 2002). The purpose of this paper is to describe the trends in PCB contamination observed in the fish of the Hudson River over a relatively short period of history for this National Heritage stream; specifically the years 1977 to 2003.

The year 1977 is one endpoint for this tracking, since it followed the formal description of the insult to the fish which was registered in the 1976 Settlement Agreement between the New York State Department of Environmental Conservation (DEC) and the General Electric Company (GE) (Sofaer 1976). This agreement was the culmination of a legal hearing in which it was determined that GE had, in the course of using PCBs as a dielectric fluid in the manufacture of capacitors, discharged varying amounts of PCBs and were responsible for the adverse ecological impacts resulting from that discharge. Estimates of the amounts introduced into the Hudson River from the Ft. Edward and Hudson Falls plant sites from the 1940s to 1977 ranged as high as 1.3 million pounds (USEPA 2002).

Data prior to 1977, largely unpublished, indicated relatively high concentrations in the fish of the Hudson River. Some of these data went as far back as 1969 when the US Fish and Wildlife Service found about 12 parts per million (ppm) of PCBs on a wet weight basis in a sample of goldfish from the Poughkeepsie area. In 1972, another goldfish sample from the same vicinity exhibited 118 ppm. Similarly in 1973, goldfish from this area showed 69 ppm. Then in 1974, Nadeau and Davis (1975, 1976) undertook an investigation which implicated the source conditions at the GE capacitor plants in Ft. Edward and Hudson Falls, nearly 200 miles upriver from New York City, in which rock bass and northern common shiner downstream of the plant sites contained 350 ppm and 78 ppm total PCBs, respectively. Snails contained 27 ppm total PCBs. In 1975 and 1976, the hearing ensued which culminated in a legal opinion indicating the need for the establishment of an Advisory Committee to explore solutions to the PCB problem. The long term plan for the monitoring of Hudson River fish grew out of the committee’s recommendations. The plan, implemented in 1977, forms much of the basis of this report.

The principal objectives of the monitoring plan were:

1. To assess temporal trends in PCB concentrations in selected resident species;
2. To evaluate spatial relationships in Hudson River PCB contamination as reflected by concentrations in the fish; and
3. To ascertain PCB concentrations in the striped bass recreational and commercial fisheries for purposes of providing health advice through the New York State Department of Health and for regulating commercial fisheries when PCB levels exceed the accepted U.S. Food and Drug Administration tolerance level, currently at 2 ppm (USFDA 1984). This last objective, as stated, has been too limited in scope over the years since all species (residential and migrant) have figured into the fish consumption advisories. It was modified in the most recent update to the sampling plan for the Hudson River: To provide data on the PCB concentrations in important commercial and recreational fisheries in the Hudson River (such as that pertaining to striped bass) for purposes of providing health advice through the New York State Department of Health (DOH), for regulating commercial fisheries when PCB levels exceed accepted tolerances, and for modifying or eliminating the catch-and-release fishery regulation on the upper Hudson River (Sloan 2003).

Although previous reports have discussed temporal trends in PCB concentrations for the fish from the Hudson River (Sloan et al. 1983, 1984a, 1988a, 1995, Armstrong and Sloan 1988, Sloan and Armstrong, 1988, Brown et al. 1985, Sloan and Horn 1986, Sloan and Field 1996, Sloan 1993, 1994, 1999a, 1999c, Sloan and Hattala 1991), none have provided as complete a documentation of the results as given herein, particularly for the non-anadromous species.

METHODS AND PROCEDURES

Sampling

The basic framework for sampling has remained the same since the implementation of the “Long Term PCB Analysis Project” in 1977, although there were modifications to the plan as the years passed, funding sources varied and conditions in the river shifted. The locations used for the sampling of biota, particularly the fish, are indicated in Figures 1A and 1B. These figures also highlight the important sections and features of the river as they relate to the discussions on trends in PCB concentrations. Common and scientific names of the fish collected during the course of this project for which results are reported herein are listed in Table 1 according to conventions used by the American Fisheries Society (1991).

Collections were undertaken with provisions for continuity of evidence through the use of chain-of-custody forms, collection record forms and the adoption of standardized procedures for specimen handling and storage. These forms and procedures are presented in more detail in Appendix I.

Upon collection, lengths and weights were recorded and the fish were tagged with unique identifying tags and alphanumeric codes, placed in PCB-free plastic bags and frozen in various DEC freezer facilities. These freezers were located at either the DEC Regional offices, e.g., Warrensburg, Stamford, or New Paltz, or at the DEC Hale Creek Field Station in Gloversville. In some of the more recent years, through a cooperative agreement with GE, a private contractor, Northeast Analytical, Inc. of Schenectady, a private contractor, assumed the responsibility of preparing, storing and shipping of samples to the DEC analytical contract laboratory for the Hudson River project.

Initially, the collection plan was focused on five locations in the Lower Hudson River (i.e., below the Federal Dam at Troy) and one in the Upper River at Stillwater. The original sampling design is provided in Table 2. This basic approach started to diverge as more information came available and the resources committed to the task fluctuated. Over time, the project design shifted to more locations, particularly in the Upper River, and to three basic elements, yearling pumpkinseed, adult resident species and striped bass, which are shown in Tables 3, 4 and 5. These three tables represent the basic sampling design implemented in 2001 (Sloan 2000). The same plan continued with modifications through 2002 and 2003. The greatest changes in the plan were to reduce the sample sizes for striped bass and to shift sample locations for some of the resident species as monitoring needs were perceived to change in preparation for remediation in the Upper Hudson River (Sloan 2003).

Sample preparation

In preparation for shipment of samples to analytical laboratories, samples were removed from the freezer, partially thawed, and standard fillets were removed as per the procedures in Appendix I, or ground and homogenized as whole-body samples. Almost all fish samples were prepared as standard fillets, but yearling pumpkinseed and forage species such as minnows and darters were homogenized as whole fish. The standard fillet was developed early in the project and as part of the Statewide Toxic Substances Monitoring Program as a sample that would serve as a portion suitable for human consumption, but yet would also reflect ecological concerns since the skin would remain on the fillet and the fattier belly flap would also be included in the sample along with the rib bones. Smaller fish in the 6-8 inch (150-200 mm TL) range would usually be prepared as whole-body minus the head and viscera. American eel and catfish species were processed without the skin, since this portion is unusually difficult to grind and homogenize and these species are normally prepared for consumption without the integument.

Laboratory Analyses

Over the years, the laboratories involved in the analyses presented have remained relatively constant with the exception of several name changes, or they were laboratories within the Division of Fish, Wildlife and Marine Resources (DFWMR) in DEC. Initially (1977), WARF (Wisconsin Alumni Research Foundation) Institute in Madison, WI was the prime contract laboratory until it was purchased by Ralston Purina Company in 1978. To reflect the purchase arrangement, the laboratory changed its name to Raltech Scientific Services. In 1982, Hazleton Laboratories, Inc. purchased the laboratory and for the next year, the firm did business as Hazleton Raltech. After 1983, the laboratory used the company name of Hazleton Laboratories, Inc. until it was purchased by Corning in 1987, which resulted in another name change, Corning-Hazleton. There was also a move at that time from the original Kinsman Boulevard address to Science Drive, still in Madison, but the laboratory personnel and equipment (hence procedures) remained largely intact. In late 1991, Hazleton Environmental Services (HES) formed as an employee-owned spin-off company from Corning and became HES, Inc. until March of 1997. The firm's assets were then purchased by En Chem, Inc. while retaining the analytical facility and the personnel. Then in 2002, En Chem reorganized and the Madison analytical functions shifted to the laboratory facility in Green Bay, WI (Marks 2003). During state contract negotiations in 1999, however, the Mississippi State Chemical Laboratory (MSCL) at Mississippi State, MS was awarded the New York State Division of Fish, Wildlife and Marine Resources PCB analytical contract. MSCL has analyzed the Hudson River fish samples since 1999. En Chem, however, did regain contract status in 2002¹, but the bulk of the Hudson River PCB work continued at MSCL until 2003. Whenever the laboratories changed or

¹EnChem was purchased in 2004 by Pace Analytical. The name was officially changed to Pace Analytical Services, Inc. in 2005.

other analysts became involved, quality assurance measures including performance evaluations and interlaboratory comparisons were used to maintain data comparability.

Seven to 16 hours of Soxhlet extraction of usually 20 grams of ground, homogenized tissue and subsequent cleanup and gas chromatographic analysis generally followed the standard procedures as included in Appendix I for the DEC laboratory conducting analyses for organochlorine residues in biological tissues. These procedures include the gravimetric determination of percent lipid as a function of the mass removed during Soxhlet extraction and evaporating to dryness at 40°C.

The general procedure for PCB analyses utilized “Aroclor” quantitations since the regulations and the standards for dealing with PCBs through the years were based on total PCB estimates using the commercial Aroclor mixtures. The analytical approach used by a DEC contract laboratory in recent years is also provided in Appendix I.

Estimates of total PCBs as “Aroclors” has also allowed tracking and comparing various forms of PCBs as lesser chlorinated versus more highly chlorinated types of PCBs. In this paper, the more persistent, bioaccumulable and generally more toxic forms of PCBs are presented as “Aroclor 1254+.” The lesser chlorinated materials are implied as the difference between total PCBs and “Aroclor 1254+.”

Quality Assurance / Quality Control

Since implementation of the project, 15 % of the reported results included quality control measures (QC) in the form of laboratory blanks, randomly selected samples for duplicate analyses, and matrix spiked recoveries. The current criteria for evaluation and approval of data for a given sample delivery group (SDG) is provided in Table 6.

Data Handling

Data received from the laboratories were transferred from hard copy or electronic spreadsheets into the Data Dictionary format (Appendix II) compatible with GIS needs and incorporated into FoxPro Version 6 for purposes of information management. Queries of the resulting Hudson Basin Database (NYSDEC 2004) for specific subsets were made for purposes of statistical analyses, data interpretation and presentation.

Data Analysis

Statgraphics Plus® along with simple regressions and summarizations from Excel® provided the basis for presenting the results and statistical interpretations in this paper. Trend analyses focus principally on fish collected in the spring months of each year in order to maintain consistency and control for potential seasonal differences.

One-way Analyses of Variance (ANOVA) on arithmetic lipid-based PCB concentrations expressed as a standardized wet weight concentration assumes all the fish had 3 % lipid (fat) in the tissue of the standard fillet. This standardization for body fat forms the primary statistical

basis for describing and discussing trends in PCB contamination. However, both wet weight PCB concentrations and straight lipid-based values are presented in the annual summary tables within this report. The rationale and the basis for presenting trend information on a lipid basis has been the subject of a number of papers (Armstrong and Sloan 1988, Foley et al. 1988, Sloan and Armstrong 1988, Sloan et al. 1984a, Sloan et al. 1983, Sloan et al. 1988b, Sloan et al. 2002). While expression of PCB concentrations on a lipid basis does not necessarily result in normalized data sets, the transformation usually improves the skewness and kurtosis coefficients for the data distribution (e.g., Sloan et al. 1995, Sloan 1994). For purposes of consistency and reducing the confusion over whether subsets of data are normally distributed or not, we have adopted the approach to assume normality, recognizing that if the results are significant in comparisons made on non-normally distributed data, the same comparison on normalized data or with a non-parametric test will result in greater significance (lower probability or alpha-level of Type I error). Kruskal-Wallis tests were also conducted concurrent with the ANOVAs to ensure that the conclusions drawn from the parametric approach were also borne out through the non-parametric procedures.

In some cases, particularly for striped bass, expression of trends also included \log_{10} -transformed data. As shown in previous publications, e.g., Sloan et al. 1995, such transformations improve conditions of normality, but they do not entirely eliminate non-normality.

Expressing the data on a standardized 3 % body fat basis does not change the distribution of the data from that obtained in the expression of concentrations in the estimated fat content in the sample, and hence the resulting statistical analysis remains as sensitive as if dealing with the evaluation of the concentrations in the lipid. The standardization also allows the expression of trends on a modified wet weight basis that is more familiar to human consumers, and is important from a toxicological perspective since it provides some measure of the potential level of exposure (dosage) to ecological consumers, including humans. The setting of water quality standards in New York State is also based on the relationship of concentrations in the water being mediated to the fish as a function of the fat content in the fish. Since fat content can vary widely based upon species, sex, age, season and body condition, an average fat content of 3 % was used for the purpose of evaluating bioaccumulation factors in calculating the Ambient Water Quality Value for allowable concentrations in water (NYSDEC 1993). This paper is the first time that the 3 % lipid standardization is used in presenting PCB results. It is our intent that this procedure will lessen the confusion over the expression of PCB concentrations in the lipid while approximating the concentrations observed in a fish having a “standard fat content” of 3 %.

In the calculation of lipid-based PCB concentrations, and lipid standardized values, in which the wet weight concentrations were at or less than the detection limits, the resulting concentrations are biased high. Summary data provided in the foregoing tables, therefore, involving locations with minimal amounts of PCB contamination or having concentrations below the detection limit indicate positive results, but such values in reality are inflated to some extent due to the nature of the calculation. Comparisons between locations and time periods, however, are still considered valid given the general robustness of the available data.

RESULTS AND DISCUSSION

Species Collected

Table 1 lists, by common and scientific name, the 60 fish species collected over the years that are presented and discussed in this report. Other than being listed in the data summary tables, any ancillary invertebrate samples and their related PCB analyses are simply referred to by common name designations where necessary.

Data Prior to 1977

By year available, the results leading up to the implementation in 1977 of the long-term monitoring plan are presented in Table 7. Some of the data prior to 1976 were included in Spagnoli and Skinner (1977). In the earlier years, although efforts were made to begin the standardization process in terms of collections, handling and analysis, the data are relatively sparse and the laboratories were in transitional phases for analytical approaches. Hence, the results are probably more realistically viewed as general approximations. It is clear, however, that PCB contamination in the fish resources of the Hudson River preceded the removal of the Ft. Edward Dam in 1973. Although the dam removal was an important redistribution event for the sediments, and a more complete description of its removal is found in Horn et al. (1979) and Malcolm Pirnie, Inc. (1977), it obviously did not retain and contain PCBs to the extent that the contamination of fish downstream was precluded. PCBs were moving not only over the Ft. Edward Dam but also over the seven other dams in the Upper River and on into the tidal section of the Lower Hudson River.

Implementation of the Plan in 1977

The initial framework for collections called for six locations and nine species with the general purpose to evaluate trends through time, since fish were generally believed to be great integrators of exposure to contamination over wide spatial gradients. We know now that is an oversimplification and fish can and will reflect body burdens on finer spatial and temporal scales (Sloan et al. 1995, 2002, Skinner 1993, Skinner et al. 1996, Parsons 2003, Sloan and Jock 1990). However, the sampling design as presented in Table 3 has generally served through the present (2003) to provide the basic descriptions of trends through space and time. The sampling plan was updated through the years, and starting in 2001, sampling utilized 10 locations and, in general, 10 species (The species have varied through time based upon availability and resource needs.). The basic current plan is presented in Tables 3, 4 and 5. Some shifts in locations and species did occur in 2002 and 2003 which are discussed below.

Summaries of the Results by Year - 2003 to 1977

Since most of this paper discusses the trends observed through time and the trend data are primarily presented as modified lipid-based PCB concentrations, there is a need to provide basic summary data for each collection year. Hence, in the following tables (8-34), summary data include: both wet weight and lipid-based total PCB values; percent lipid; numbers of samples and analyses; length; weight; age (in some cases); location, and year of collection. Most samples were prepared as “standard fillets” as per the procedures outlined in Appendix I. Younger age classes and forage species such as yearling pumpkinseed, minnows and shiners were usually prepared as whole-body samples. One of the purposes of this paper is to present in one summary document as many of the program results as possible and this section starts with the results from 2003 (Table 8) and progresses in reverse order to 1977 (Table 34). The actual numbers of fish represented in the summary tables are greater than those used in the depiction of PCB trends, since at various times through the years, other species, locations, and seasons were collected to address other resource issues and concerns, but one of the purposes of this paper is to present in one summary document as many of the program results as possible. This section starts with the results from 2003 (Table 8) and progresses in reverse order to 1977 (Table 34). Not included are results on analyses of other organs, such as liver and gonad tissues, and other contaminants, since these are topics in other reports or presented elsewhere (e.g., Sloan and Armstrong 1988, Sloan et al. 2002, Sloan 1999a, 1999c, Sloan and Kane 2001). Additionally, this paper does not attempt to present results on congeneric PCB, since such data are limited with some of those results reported elsewhere (e.g., Field et al. 1996, McGroddy et al. 1997).

The wet weight concentrations are those to which a predator or other consumer is exposed at the time of consumption (dose value) and is the more familiar method of expressing concentrations for most people including anglers. These are the values on which exposure criteria are based. For example, Newell et al. (1987), in establishing criteria for the protection of piscivorous wildlife, reviewed the published literature for the concentrations at which deleterious effects were documented for sensitive species of wildlife, of which mink (*Mustela vison*) was determined to be the most sensitive species to PCBs. The studies that they reviewed showed that the wet weight concentration of PCBs in the diet at which mink would be subject to levels of carcinogenic (at a risk of 1 in 100) and non-carcinogenic effects (reproductive, growth, mortality endpoints) was established at 0.11 mg/kg (ppm). Wet weight concentrations are also those on which the New York State Department of Health (NYSDOH) bases the advice related to human consumption of fish. These advisories are updated annually statewide in response to data reported to NYSDOH by DEC. The most recent advisories related to this report are for the years 2004 and 2005 (NYSDOH 2004) which for the most part rely upon data collected in 2003.

The lipid-based values are the concentrations in the fat of the fish and such expressions are used to reduce some of the variability in the results enabling easier interpretation of trend information both spatially and temporally. Since PCBs are lipophilic, the compounds tend to sequester in the fatty, lipid tissues of the exposed organisms (USEPA 1976, 1980). This storage fraction, hence, provides an avenue on which to base PCB trend relationships. Simply adjusting concentrations to the fat content, however, does not explain all of the variability in the data (Hebert and Keenleyside 1995, Stow et al. 1997), but it has been a useful tool (e.g., Sloan et al.

2002, Brown et al. 1985, Armstrong and Sloan 1988). Unfortunately, such expressions on a lipid basis generate confusion for people trying to understand what the values mean to users of the resource. As explained above under Data Analysis on page 5, we are using a modification of the lipid-based concentrations, and modifying the values to the extent that the fish have a standardized 3 % lipid in the tissue being analyzed. In most cases, as stated above, the tissue being discussed is the “standard fillet” (edible portion) which is defined in Appendix I.

Sampling in 2003 (Table 8) involved the second year of fall collections of forage fish species concurrent with the yearling pumpkinseed project. This sampling effort was undertaken to fulfill ecological needs in representing PCB concentrations to which other components (predators) of the aquatic resource are exposed through their feeding and to develop data for ecological modeling. There also was a special collection over several locations associated with the 004 Outfall from the GE Ft. Edward Plant that included both smaller sizes and species of fish and invertebrates that would reflect the more localized influences from the deposits resulting from past PCB discharges. This investigation was related to remedial activities occurring in the vicinity of the outfall. The 2003 sampling also marked the second year in which striped bass collections were reduced in the number of locations and sample sizes as a consequence of fiscal constraints.

There was also, for the first time, a special spring collection effort in 2003 for adult indicator species (Table 8) to stratify sampling over the available habitats in the Thompson Island, Fort Miller, Northumberland and Stillwater Pools in order to develop and determine if river-reach averaging procedures for the trend species was reasonable and possible. Since dredging of the Hudson River as per the USEPA Record of Decision (USEPA 2002) will modify existing habitats, there is interest in estimating whether the potential for increased variability in the PCB concentrations would require expanded sample sizes for analysis. Additional sampling for reach averaging determinations prior to the commencement of remediation will continue in future years. Whether or not reach averaging is conceptually valid is beyond the scope of this report and will be explored analytically in greater detail elsewhere.

Similar to 2003, the 2002 sampling year (Table 9) also involved fall samples of forage fish, reduced numbers of striped bass, and analyses of fish and invertebrates for baseline conditions prior to the start of remediation at the 004 Outfall. Note that at the outfall, the lipid-based PCB concentrations in 2003 are about an order of magnitude greater than they were in 2002. There was a suspected potential but largely un-characterized PCB source condition that became readily apparent during the initial stages of remediation resulting in a pronounced increase in biota concentrations near the site. Re-sampling is scheduled for the summer of 2005.

Also note in 2002 (Table 9, page 3 of 4), samples were collected in the vicinity of the Hudson Falls Plant Site above Bakers Falls and locations around the Ciba-Geigy paint pigment site just upstream of the Village of Hudson Falls. In general, the Ciba-Geigy site appears to not pose a PCB problem, but the area immediately above Bakers Falls near the GE Hudson Falls plant site, following limited remediation in 1997-98 (Farrar, personal communication, 03/07/05), still provided substantial PCB for uptake to the biota, particularly at the point of the original PCB discharge.

Since the Ciba-Geigy site was originally a metals contamination problem, another special collection was undertaken in 2004. Cadmium and mercury analyses on the 138 fish and invertebrate samples should be available in 2005.

For both 2002 and 2003, note that fish from the Niagara Mohawk Queensbury PCB site in the Sherman Island Pool exhibit elevated PCB concentrations compared to those found in fish from adjacent sites in the same Pool. Similarly, this same relationship was apparent for other years including the years of post-site-remediation (1996 to 2003) as it was in the period (1992 to 1995 - Tables 16-19) leading up to the partial site cleanup in 1996. The major difference between these time periods was up to an order of magnitude decline in fish concentrations regardless of location that resulted in the removal of fish consumption advisories due to PCBs for the Sherman Island Pool (NYSDOH 1998). A more comprehensive presentation of the PCB data on the fish collected for the purposes of tracking trends related to this PCB site may be found in Parsons (2005), which reflects the success of cleanup even though it is not entirely completed.

In 2001 (Table 10), in addition to the normal trend tracking locations, some sites were selected to focus localized waste site conditions such as those in the Town of Queensbury and from potential PCB sites in Catskill, Poughkeepsie and Newburgh. The Queensbury location in the Sherman Island Pool is under further evaluation for additional remediation and the fish are reflecting localized inputs from the remaining PCB source associated with the site (Parsons 2003). The other locations associated with the Queensbury site are discussed in subsequent sections, but the fish from this Pool reflect no apparent additional inputs to the Hudson River given their relatively low concentrations compared to levels observed in fish downstream in the Feeder Dam Pool. The influences from the Catskill and Newburgh sites are presented in their respective sections under **Temporal Trends in Species by Location**. The Poughkeepsie site, reported in Sloan et al. (2002), did not pose additional significant input to Hudson River fish.

The 2000 data year (Table 11) was a relatively standard collection year, although Atlantic tomcod were included in the sampling effort to update the database for this particular species. The PCB results on the muscle tissue and the livers were reported more fully in Sloan et al. (2002). That report focused largely on the 1999 data but some of the 2000 results were included, as necessary.

The 1999 data represent a special intensive effort to sample many species over many locations, and were presented in detail in Sloan et al. (2002). However, to provide as complete a compilation of the fish data as possible, the 1999 summary data are included in this report (Table 12). That particular report primarily addressed PCB source conditions as observed in biota, including invertebrates, but it also evaluated trophic structure issues, seasonality, age-related accumulation (or lack thereof) and aspects of partitioning of PCBs in organs such as the liver.

In 1998, a special study to evaluate the potential for fish in the Hudson River to exhibit endocrine disruption was undertaken in cooperation with the U. S. Geological Survey (USGS) (Baldigo et al. 2003). The PCB results from that project are included in Table 13 summarizing the 1998 data. Also note that a special collection at a hazardous waste site in Hastings-on-Hudson indicated that conditions at the site were functioning as a PCB source to biota in that

immediate vicinity. A follow-up collection in 1999 and reported in Sloan et al. (2002), further documented the source aspect of the site. The North Slip and Abandoned Marina locations were the collection sites in closest proximity to the contamination at the waste site. Also note that in 1998, many of the fish collections were aged. Because of the apparent lack of consistency for increasing contamination with age (size) (e.g., Sloan et al. 2002, 1995), with some exceptions, notably younger age classes of pumpkinseed (Sloan et al. 1984a), the age contaminant relationship has not been pursued as part of this report. Further analyses of PCB concentration and age for pumpkinseed, however, are tabulated (Table 41) and discussed in the Newburgh section under **Temporal Trends in Species by Location**.

Another special collection year took place in 1997 with the purpose of evaluating other contaminants in Hudson River fish with the PCB results summarized in Table 14. The other contaminants including organochlorine pesticides such as the DDT group, chlordane complex, endrin, endosulfan, dieldrin, aldrin, mirex, heptachlor, the hexachlorocyclohexanes (Lindane group), toxaphene, and methoxychlor; mercury, cadmium, polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans, were reported in Sloan (1999c) and Sloan and Kane (2001). In that same year, there was an initial opportunity to evaluate the remnant PCB sites in the Upper Hudson River below the GE Hudson Falls Capacitor Manufacturing Plant and adjacent to the GE Fort Edward Capacitor Plant. The PCB-laden sediments in these remnant deposits resulted from contaminated materials from the plant sites settling in the pool formed by the Fort Edward Dam, an earthen-filled log crib structure which was in varying stages of failure prior to its removal in 1973 (Malcolm Pirnie 1977). Following some erosional events in the late 1970s and 1980s, the remaining deposits located above the now-removed Fort Edward Dam were stabilized and capped as an interim remedial measure to impede further introduction of PCBs into the river (O'Brien & Gere 1994). The 1997 results indicated there was the possibility that the remnant deposits may function as a PCB source to the Hudson River, at the least in the vicinity of the remnants. Specifically, note the results for the creek chub around Remnant Sites 3 and 4 and the tendency for PCB concentrations to increase from the north end to the south end (downstream portion) for each of the sites. These findings lead to a more extensive examination in 1999 of the remnant sites and the sediments associated with the 004 outfall from the GE Fort Edward Capacitor Manufacturing facility (Sloan et al. 2002). The remnant area is apparently functioning as a set of source conditions. As noted above (Table 8 - 2003; Table 9 - 2002; Table 12 - 1999), the 004 outfall area is a source of PCBs, but the remnant deposits in 1999 were also responding similarly, although to a lesser degree. Spodaryk et al. (2005) using PISCES (passive in-situ chemical extraction samplers) devices also ascribe source aspects to this area as part of a series of trackdown studies in 1997.

The years 1996 (Table 15) and 1995 (Table 16) were standard trend sampling years, as was 1994 (Table 17). The latter year, 1994, however, did feature the opportunity to analyze some relatively young, aged 2 to 6, Atlantic sturgeon taken as power plant mortalities. There was no apparent tendency for PCB concentrations to increase with age in these sturgeon. A PCB record observation was made in 1996 (Table 15), however, for smallmouth bass as the result of a special collection taken on the face of Bakers Falls (rivermile 196) from a small pool of water which remained after the falls were de-watered in order to continue the investigation of seeps as part of remedial measures in the vicinity of and for the "Allen Mill" problem. There were four

smallmouth bass stranded in this pool as a result of the de-watering in early June and remained there until collection on July 30, 1996. When these fish were analyzed, they contained up to nearly 13,000 ppm in the lipid and 315 ppm on a wet weight basis in the standard fillet. The low values were 4,050 in the lipid and 13 ppm in the fillet. Although these observations were the highest recorded for smallmouth bass, they are not the highest observed in fish. The highest concentrations in fish from the Hudson River are tabulated and discussed in the paragraphs for 1977 and 1978 provided below and in Tables 34 and 33.

Sampling in 1993 (Table 18), although a relatively normal trend year, reflected concentrations at or near the peak of the contaminant release in 1991 associated with the “Allen Mill event.” Consequently, this year, and the period most closely associated with that episode, will be discussed and presented in more detail in subsequent sections of this report.

The years 1992 (Table 19) and 1991 (Table 20) emphasized sampling for more species from more locations in the Upper Hudson River, specifically to determine concentrations for the evaluation of a potential reopening of at least a limited fishery in the reach of the Hudson River that was closed entirely to fishing in 1976 due to the PCB contamination. The 1992 collection also led to the realization that another PCB source existed in the Sherman Island Pool which would lead to the determination and eventual partial cleanup of the Niagara Mohawk Queensbury site. The concentrations in the fish from the Spier Falls Pool, upstream of and above the next dam from Sherman Island, were reflecting a potential small-scale source condition in 1992 compared to the fish from the Blue Ledge area near the Village of North Creek.

For the years of 1989 through 1991, fiscal constraints on the program were occurring. Note that in 1991 (Table 20) no striped bass were collected. During 1990 (Table 21) only some of the resident species were sampled, but striped bass were well-represented.

The 1989 collection year was greatly abbreviated (Table 22), and focused on only the yearling pumpkinseed and a limited sample of American shad to update the data on this species. American shad do not accumulate high levels of PCB since they are in the Hudson River for a short period of time in the spring solely for the purpose of spawning and only feed occasionally during this brief interval (Smith 1985).

For 1988 (Table 23) and 1987 (Table 24), the collections were relatively standard with the exception of 14 brown bullhead in 1987 from the Corinth Pool near river mile 216. That collection was a follow-up to one in 1986 (Table 25) which suggested some PCBs were also present in this area of the Hudson River. These concentrations, however, were much lower than the values observed below Ft. Edward in the more contaminated reaches of the river. The 1986 collection year was otherwise a standard event. The bullhead from these two years (1986 and 1987) were the subjects for two pathology studies (Kim et al. 1989, Bowser et al. 1990, respectively) which indicated higher prevalence of liver lesions and anomalies in the more contaminated sections of the river (Thompson Island and Stillwater Pools) compared to the lesser contaminated reference location (Corinth Pool). Some PCB contamination, however, is evident in the Corinth Pool as exhibited by the brown bullhead results (Tables 24 and 25).

The collections in 1985 and 1984 (Tables 26 and 27, respectively) were notable since the

Thompson Island Pool (Griffin Island) was added to the Project, although a Ft. Edward collection and a limited Griffin Island sampling did occur in 1983 (Table 28) as part of another program within DEC (Sloan 1987).

Pumpkinseed of various age classes were collected in the fall of 1982 (Table 29). These fish, along with similarly aged pumpkinseed from 1981 and 1983, were evaluated for age comparisons by Sloan et al. (1984a). In general, the yearling fish were lower in concentration than the older age classes, but as the fish aged, PCB increases with age were not as apparent. These data plus some from more recent years are discussed further under the Newburgh section on **Temporal Trends in Species by Location**. Sampling in the spring of 1982 for the other species was relatively standard.

Data years 1977-1981, Tables 33-30, respectively, considered as the early years of the Project, reflected some surprise in that the declines in PCB concentrations during that interval were somewhat unexpected given the inordinately high concentrations observed in the 1970s in various media, including fish. Early evaluations, and even a more recent study (Boer et al. 1994), of depuration and environmental responses indicated the stable, persistent nature of PCB contamination, particularly of the more highly chlorinated congeners (USEPA 1976, Eisler 1986) and therefore, the magnitude of the initial declines were not entirely anticipated (Armstrong and Sloan 1980). Consequently, in the early years of the Project, considerable efforts were enjoined to answer other questions and issues that were not trend-related, per se, which necessitated shifting available analyses. For example, were there segments of selected fisheries that may have less contamination and therefore usable? Striped bass, in particular, were examined in great detail in 1978 for different months and locations. Table 33 which shows the concentrations in striped bass by location, indicate overall that the results are relatively uniformly elevated in comparison to the 5 ppm USFDA temporary tolerance level (USFDA 1977) in use at the time to regulate interstate commerce of contaminated fish.

Of particular interest may be some of the high recorded concentrations for the years 1977 and 1978 (Tables 34 and 33). A goldfish from the Stillwater Pool collected in 1978 contained 1,009 ppm on a wet weight basis and nearly 100,000 ppm in the lipid! The total extracted organic material (i.e., oil, lipid or fat) in this animal was nearly 10 percent PCBs. Another goldfish, that had 1,100 ppm (wet weight basis) but with 20 percent fat, had a mere 4,955 ppm in the lipid. The first fish had only about 1 percent fat. In the 1977 samples, also of goldfish from the Stillwater Pool, the highest wet weight PCB value was 1,836 ppm (7,286 ppm in the lipid). The highest concentration in the lipid, however, in that year's collection was 39,968 ppm, but the wet weight level for the same fish was determined to be a nominal 372 ppm. This goldfish had only 0.9 percent fat in the body, an unusually low lipid content for a goldfish. This was the last time concentrations this high were observed for the Hudson River with the exception of the seep basted smallmouth bass mentioned earlier.

Temporal Trends in Species by Location

The ensuing graphs, Figures 2-62, depict trends over time. Negative values for the 95 % confidence intervals from the one-way Analyses of Variance (ANOVAs) conducted to evaluate those trends are not plotted for purposes of making the visual presentation less confusing. The intervals, however, are fully provided in the accompanying tables (35-45). Since the eventual fate of PCBs in this system, as it will be in other PCB-impacted waters, is dependent upon the more persistent and bioaccumulable forms of PCBs, the tracking of that aspect is represented in this treatise as “Aroclor 1254+.” Therefore, as a featured index of this recalcitrant component of the PCB mix, analyses of “Aroclor 1254+” are provided throughout the text, and the accompanying graphs and tables.

Above the Feeder Dam (Reference Area)

The Feeder Dam Pool formed by the Feeder Dam in the City of Glens Falls is used as a reference location for the more severe PCB contamination found further downstream below the Villages of Hudson Falls and Fort Edward. Although PCBs are found in the Feeder Dam Pool fish, their concentrations are generally one to two orders of magnitude less than those observed in the Thompson Island Pool (Sloan et al. 2002). To also provide further perspective on background conditions, results for some of the species comparisons will be made, where appropriate, to those collected in 2000 from the headwaters area near river mile 301. Refer to Table 12 for details on the collection from Sanford Lake.

Summary results from one-way ANOVAs for several fish species from the Feeder Dam Pool are presented in Table 35.

The species with the longest time records are yellow perch and yearling pumpkinseed. Both were first sampled in 1979. **Yellow perch** (Figure 2) have exhibited significant changes in concentrations over the years with an apparent decline after 1993. This decrease may be related to the partial remediation efforts for the Niagara Mohawk Power Corporation (now part of National Grid) Queensbury PCB site located just upstream in the Sherman Island Pool (around river mile 210). Those cleanup efforts and subsequent responses by the fish are discussed in other reports (Sloan et al. 2002, Parsons 2003, 2005).

The **yearling pumpkinseed** (Figure 3) have also experienced declines in total PCB concentrations since the mid-1980s, but this species/age class exhibits considerable fluctuations from one year to the next. Since the late 1980s, the concentrations have continued to fluctuate but at lower concentrations compared to the earlier years. This particular species is presumably responding to a more localized influence of whatever low levels of contamination are present, since these young fish probably do not range as far as the adult yellow perch. A pumpkinseed in 2000 from Sanford Lake (river mile 301), nearly another 100 miles further upstream, contained about 0.01 ppm total PCB at 3 % lipid, an order of magnitude less than the pumpkinseed in the Feeder Dam Pool.

Black bass, composed of combinations of largemouth bass and smallmouth bass but mostly the smallmouth species, are represented by a shorter time interval, 1991 to 2003 (Figure 4). The two species are combined for presentation since the differences in PCB content on a lipid basis between the two species was not significant (*e.g., for 2001, $P > 0.88$*). Although there are statistically significant differences ($P < 0.05$) between years, there are no apparent consistent declines (i.e., conditions are relatively stable at about 26-29 ppm total PCB on a lipid basis, as seen by the overall means presented for black bass from the Feeder Dam Pool in Table 8 or 0.83 ppm at 3 % lipid in Table 35). Two largemouth bass in 2000 from Sanford Lake (river mile 301) at 3 % lipid were calculated to contain about 0.07 ppm and 0.2 ppm.

Brown bullhead from this reference location also exhibit no clear evidence of declines in total PCBs since 1991 (Figure 5). Likewise, neither do the **common carp** (Figure 6) in the interval from 1992 to 2002. **Carp** are not always available every year and hence there are data gaps for this species from some years. Note that for all the species, the predominant component of the PCB mix features the more highly chlorinated fractions as exhibited by estimates of the “Aroclor 1254+” type. It is especially noticeable for carp. In some years for some species such as yellow perch and the yearling pumpkinseed, the lighter chlorinated fraction is easily observed (i.e., the relative distance between the plotted data points and the error bars for total PCB and the “Aroclor 1254+” estimate).

Griffin Island (Thompson Island Pool)

Specific locations for sampling of trend analysis species from the Thompson Island Pool are depicted in Figure 7. Summary results from the one-way ANOVA for fish species from the Thompson Island Pool are presented in Table 36.

Since the original contamination was so severe, a trend location this far upstream, even though closer to the original manufacturing plant sources, was felt to be unnecessary. However, as the fish responded relatively rapidly to cessation of the PCB discharges (Sloan et al. 1983, 1984a; Armstrong and Sloan 1988), more support was provided for including the Thompson Island Pool in the trend analysis project. In 1984, **largemouth bass** were observed in sufficient numbers in the channel on the west side of Griffin Island. Since then, this location has produced relatively consistent annual samples. In the interval from 1984 through 1988, there was a decline in total PCB concentrations (Figure 8), but the “1254+” component remained fairly stable. Also apparent in the graph is the influence of the release of PCBs from the abandoned Allen Mill structure which began in late 1991. The ruins of this Industrial Revolution-era mill on the face of the cliff near the Hudson Falls Plant site, near rivermile 196, housed a gate structure that controlled or impeded water flow through the old mill. Sometime in late 1991, the gate structure failed during a high-water event, releasing large deposits of PCB-laden sediments and debris to the Hudson River just below Bakers Falls in the Village of Hudson Falls. Efforts began in 1992 to deal with the remaining deposits and to control the PCB seeps in the bedrock on the face of Bakers Falls. Concentrations in the bass declined through 1996 as the discharges from the deposits associated with the mill were abated, and are currently slightly lower than they were before the “Allen Mill event.” However, the contaminant conditions for both total PCBs and “Aroclor 1254+” appear relatively stable since 1996.

Brown bullhead were included starting in 1986 with concentrations declining steadily through 1991 (Figure 9). Following the “Allen Mill event” the concentrations increased in the 1992 samples but then declined as the discharges were controlled. Since 1995, however, the concentrations have remained relatively stable. Note that the “1254+” component also tracked the total PCB levels, but in recent years the error bars tend to overlap those of the total mix, implying that what may happen in the future regarding further declines is more dependent upon the more highly persistent PCBs. Note that the brown bullhead peaked more rapidly than the largemouth bass in response to the “Allen Mill event” for both total PCB and the “1254+” component.

Yearling pumpkinseed sampling was initiated in 1987. Although concentrations have fluctuated widely (Figure 10), this combination of species and specific age class did appear to increase in response to the “Allen Mill event” but then declined again through 1995. Unfortunately, the 1991 and 1992 sampling years did not include this species. No significant changes have occurred since 1998 for the yearling pumpkinseed except for an increase in total PCB from 2002 to 2003. The reason for this increase is unknown. In the “Aroclor 1254+” portion, there is a greater degree of stability apparent in the data given the relatively narrower 95 % confidence intervals compared to those for total PCBs. The more highly chlorinated PCBs do not reflect as great an increase in 2003 as did the total PCB concentrations. The data gap evident in the years, immediately preceding and the year following the gate failure in the “Allen Mill,” underscores the need for ensuring continuity and consistency in support of sampling for monitoring large, complex systems impacted by contaminants.

The time line for **yellow perch** began in 1991 which immediately preceded the “Allen Mill event” (Figure 11). Total PCB concentrations declined through 1997, but since then, the levels have remained stable. The “1254+” portion now overlaps the error bars for the total concentrations and has done so since 1997.

Carp had a later start (1992) for determining long-term trends of PCBs (Figure 12). This species is larger than the other fish, more difficult to handle, and to some, less aesthetically attractive. However, it is usually highly oily compared to other species and therefore, typically exhibits high PCB levels on a wet weight basis. On a lipid basis the converse is usually true, but even then, there are sometimes exceptions (Sloan et al. 2002). When observations began in 1992, this fish had probably already experienced the “Allen Mill event” and so the declines in response to controlling that release had begun. The declines continued essentially through 1999, but since then have exhibited stability with the “1254+” PCBs overlapping the PCB totals.

Stillwater Pool

Specific locations for sampling of trend analysis species from the Stillwater Pool are depicted in Figure 13. The initial sampling point for the Stillwater Pool focused on the area above the Stillwater Dam and Champlain Canal Lock 4 near river mile 168, just across the river from the yearling pumpkinseed collection site. Over the years this area was not producing adult fish in consistent and suitable numbers. Hence, in 1993 the sampling location shifted upstream in

the Pool to the Coveville site near river mile 176. This 50-plus acre backwater proved much more productive in terms of the species being sought and as presented in the subsequent discussion, the PCB contamination was similar between the two locations. Summary results from a one-way ANOVA for the Stillwater Pool are presented in Table 37.

The Stillwater Pool was the original upriver location for evaluating trends in PCBs for the Hudson River. Hence, the time line for **brown bullhead** begins in 1977. Concentrations decline significantly through 1982 (Figure 14), but further reductions are particularly slow from that point with no further significant changes in the last 15 years (1986-2003). The data do show a tendency for the brown bullhead to respond to the late 1991 “Allen Mill event,” but the response was not significant. As indicated in the Thompson Island Pool, note that the “Aroclor 1254+” mix has tended to predominate total PCBs through time.

Largemouth bass responded in like fashion to PCBs, in that concentrations declined precipitously through 1982, but then stability reappears in the trend picture (Figure 15). Although this species does not appear to respond in total to the “Allen Mill event,” years 1992-1994, there is a shift during that period to less representation in the total concentrations by the “1254+” component. There is more of the lighter-chlorinated fraction available for exposure, but in the next few years, the higher-chlorinated materials return to prominence. The differences in the overlap of the error bars in 1998 and 1999 suggest there also may have been an addition of fresh PCBs to the system in that interval.

Yellow perch, although not sampled as consistently on an annual basis, also exhibit the dramatic decline in the early years of the project (Figure 16) with a suggestion, although not significant, of the “Allen Mill event.” Since 1997, however, this species shows remarkable stability in total PCBs on a lipid basis with almost all of the contamination composed of the ‘1254+’ material.

The **yearling pumpkinseed** segment of the trend project was initiated in 1979, primarily to take advantage of a younger age class that would have a tendency to respond to contaminant conditions on a localized scale. Hence, if changes in exposure regimes were to occur, this organism would be more likely to exhibit decreases in concentrations more quickly compared to older, more widely ranging adult fish. Also, since they would have a less variable life history, the concentrations in the fish would also exhibit less variability. Figure 17 reflects these conditions quite well. Concentrations declined significantly over time with narrow 95 % confidence limits and numerous significant changes appear between years. Generally, this species tended to show declines through 2001, even in the “Aroclor 1254+” component. Overall, the gap between total PCB concentrations and “1254+” narrowed through time, although there was an apparent divergence between the two measures in 2003.

Carp, although reflecting changes in total PCB concentrations since they were first sampled as part of the trend project in 1992, do not exhibit any consistent declines through 2002 (Figure 18). Carp were not sampled in 2003. This species, similar to the other adult species, also show the comparability in levels between the two main sampling locations (Coveville sampling began in 1993 after collections near the Village of Stillwater ended in 1992.).

Albany/Troy

Hydrologically, the complexity of the river is enhanced in the Albany/Troy area, since the Mohawk River enters the Hudson River near river mile 154 and it contributes about 40 % of the flow and over 60 % of the suspended solids load (Phillips and Hanchar 1996). In addition, the Federal Dam and Lock demarcates the upstream extent of the tidal flow in the Hudson River estuary, although the area is well upstream of any salinity gradient. These features and the urban/industrial conditions in the Capital District factor into the makeup of whatever habitat is available for fish. Figure 19A provides a spatial perspective on the sampling locations that were used for the Albany/Troy area.

The location below the Federal Dam near river mile 153 was one of the original spring collection locations for the PCB project. Summary results from one-way ANOVAs for fish collections below the Federal Dam at Albany/Troy are presented in Table 38. In the early years of the Project some of the adult fish were sampled near the Port of Albany in both the North and the South Turning Basins (Figure 19A). Hence, the trend graphs and the related figures (19B through 25) reflect the range in river miles from 142 to 153, even though in the years since 1980 samples were collected for the most part close to the Federal Dam, where habitat was more available and abundant. The overall trends discussed below were not affected by the two different locations, given the generally high concentrations observed in 1977 and 1978. Yearling pumpkinseed, however, were always targeted from the South Turning Basin on the east side of the river at the Port of Albany.

Black bass: Largemouth bass was a principal target species for collection, but the habitat was not always suitable to produce sufficient numbers of samples, and smallmouth bass were oftentimes substituted. In recent years, smallmouth bass were usually the most plentiful. When both were collected in the same year, the concentrations were comparable between the two species. Therefore, in describing the trends in PCBs at Albany, the two species are combined as **black bass**. A pattern of decline is similar to that observed in the further upstream locations, in that initial declines are steep (Figure 19B). In this case, the decline was apparent through 1988. However, there are some major gaps in the database since these species were not collected in 1978, 1979, nor 1981-1987. The fish were sampled through the early 1990s and the concentrations observed reflected the “Allen Mill event,” 1992-1994, with a decline in 1995 back to 1991 levels. Conditions since 1995 appear relatively stable with “1254+” becoming the predominant feature of total PCB.

Ictaluridae: Initially, brown bullhead was a principal target, but their availability also proved problematic. Eventually, a mix of **catfish (ictalurid) species** was used since the differences in PCB content between the three principal species available was not appreciably different, or consistent. The trend depicted in Figure 20 is a pattern exhibited by a combination of brown bullhead, white catfish and channel catfish. The trend featured appears remarkably similar to that observed in other species from the upriver locations - initial declines, perhaps an increase during the “Allen Mill event” years, but not statistically significant, and a tendency to return to earlier levels followed by general stability. Note that some of the trend pattern is obscured by the inordinately large error bars due to low sample sizes for some years.

White perch are also similar to the patterns seen in the other species (Figure 21), but the “Allen Mill event” is not as prominent, although there are certainly variations in the means between the years 1991-1996 especially for the “1254+” mixture. Overall, there does seem to be a general decrease since the 1980s.

Striped bass, which congregate below the Troy Dam, represent an unusual situation for a species which exhibits an anadromous spawning behavior. This location is the furthest practical extent of the upstream migration, although some striped bass do move into the pools formed by the locks in the lower reaches of the Mohawk River. The bass below the Federal Dam are mostly males which have entered the river from the ocean ahead of the females. The females tend to stay further downriver since they will generally not feed to the same extent as the males and they will tend to leave the river once they spawn. Males, on the other hand, will continue to feed and if prey are available, they will linger in the river. Consequently, at the Federal Dam below the spillways and the tailraces from the powerhouse, food is readily available and these fish accumulate higher levels of PCBs compared to bass collected from downstream locations. As water temperatures increase during the summer and river flows decrease, the bass move back to the ocean or to other locations within the river until temperatures again cool in late summer or fall. Regardless, spring collections of striped bass below the Federal Dam have provided good information on PCB trends for this species and for this tidally controlled location (Figure 22). Concentrations declined, for the most part, through 1990 but increased in 1992, presumably in response to the “Allen Mill event” but then declined again through 1999. Since 1999, however, the concentrations are relatively stable at conditions comparable to those in 1984, and 1987-1990, which also was a stable period in PCB trends. The “1254+” component tracks the same pattern exhibited by total PCB, but note the slight increase of the lighter chlorinated forms during the “Allen Mill event” as seen by the lack of overlap of the error bars between the totals and “1254+” in the years 1992-1995.

The **yearling pumpkinseed** portion of the trend project, implemented in 1979 specifically for the South Turning Basin near the Port of Albany (river mile 142), exhibits PCB declines (Figure 23), similar to the striped bass, but with some major differences. The variability in these fish is obviously much less, based on the relative length of the error bars for the confidence intervals for both the total PCBs and “Aroclor 1254+.” In those years with wider confidence intervals, such as 1988, 1992 or 1999, there were very few yearling pumpkinseed available for analysis. Initially, when this trend evaluation was implemented in 1979, a paucity of fish was not anticipated at the sites selected for collections. However, scarcities did develop and the sample sizes were scaled down at all collection locations from samples of 75 fish analyzed in composites of three to a maximum of 25 individuals at each location. These fish were more specific in their habitat needs compared to larger, older specimens from the other species and therefore, the sites selected for this portion of the Hudson River Project tended to be more restrictive. At the South Turning Basin in the Port of Albany, even the reduced numbers were generally unavailable. The increase in 1980 was perhaps induced by dredging which occurred in the vicinity of the collection location, but note that the levels dropped the next year to concentrations lower than those prior to the maintenance dredging activity two years earlier. The levels continued to decline from 1981 through 1988. Since then, the concentrations fluctuated with a higher average exhibited in 1998, but note that the increase was not due to an upsurge in “1254+.” It is likely these fish were exhibiting exposure to another source condition

in the vicinity of the North Turning Basin. Pumpkinseed habitat is limited in extent in the South Turning Basin at the Port of Albany and the collection crew that year may have taken most of the fish from the nearby North Turning Basin. Hence, given the potential presence of another PCB source in the North Basin, the exposure conditions were perhaps enhanced for this particular age/species combination. Since 1998, the levels declined again and in 2002 and 2003, there may have been a hint of further declines occurring, although the apparent drop is not significant compared to the fish in 2000. The “Aroclor 1254+” fraction appeared relatively stable throughout the 1990s, even when the accompanying error bars were very narrow.

Carp were not part of the targeted sampling effort over the years until they were formally included in 1998. Those collected earlier were primarily taken as targets of opportunity and to update fish consumption advisories by the NYSDOH. However, this species does reflect the general early decline ($P < 0.0015$) but no significant shift in concentrations since 1991 for both total PCBs and “Aroclor 1254+” (Figure 24). Currently, they are not one of the species sought for regular analysis.

A similar situation is also exhibited by **American eel** (Figure 25), in that declines are not evident since 1992 ($P > 0.05$). This species is also not part of the formal sampling plan. Note, however, that American eel PCB concentrations were comprised primarily of “Aroclor 1254+.”

An independent evaluation in the Albany area was undertaken in 2001 as a follow-up to the special spatial study of Sloan et al. (2002) that dealt with an additional potential source condition in the North Turning Basin at the Port of Albany and was intimated in the pumpkinseed discussion above. The results summarized in Table 10 were not readily indicative of another source condition.

Catskill

Summary results from one-way ANOVAs for the fish collected from the Catskill location near river mile 112 (Figure 1B) are presented in Table 39.

At Catskill, there were reliable samples of **American eel** in 1975 and they were used in this trend analysis to indicate the initial early decline (Figure 26). After 1992, however, the PCB concentrations in this species were highly stable and the majority of the total PCBs were comprised of “Aroclor 1254+.”

For **ictalurid species**, the declines in PCB concentrations were also apparent, but they seemed to continue for this group through 1998 (Figure 27). The subsequent years proved to be relatively stable. Although there were some decreases in the “1254+” mix in the interval 1992 to 1998, it appears that further declines are dependent upon this more persistent portion of the PCB spectrum.

Yellow perch exhibited a similar overall pattern as the ictalurids, but there were more years of data available (Figure 28). The decline appears to have continued through 1994 even though it was not significant ($P > 0.05$) in the interval 1981-1994. Since 1994, the concentrations

were relatively constant. As with the other species, further declines were “1254+” dependent.

The time line for the **black bass** is relatively complete with the initial declines through 1980 evident for both total PCBs and the “1254+” component (Figure 29A), and a tendency for further decreases through 1993. Since then further declines are not obvious and the majority of the PCB mix was composed of the heavier, more highly chlorinated forms.

White perch since 1978 tend to be more variable but they did decline through 1998 (Figure 29B). They exhibited a slight increase in 1999 which was not significant ($P > 0.05$) with stable conditions ensuing since that year. This species in 1999 and 2000 showed some signs of influence by the lower chlorinated forms of PCBs, but not to the degree observed in 1978.

The Catskill area at river mile 112 represents a transitional zone for the Lower Hudson River in that the influence of the Mohawk River has had the opportunity to be dampened in the approximately 40 miles from the Federal Dam at Troy. Additional PCB source conditions in that reach are relatively minimal compared to the influence from the upstream source conditions (Sloan et al. 2002). **Striped bass** in the Catskill area were not part of the original sampling plan, but when they were begun to be analyzed in 1980, they still reflected the general initial decline in PCB concentrations and perhaps they indicate to some extent the reduction and control of the “Allen Mill event” as exhibited by the 1990 to 1995 interval (Figure 30). Hence, this migratory species indicates some capacity to reflect localized conditions, both temporally and spatially. Currently, the variability in the data since 1996 generally reflects fairly stable conditions with some year to year variations.

Of additional interest in the 2001 collections was the potential for examining another PCB source in or near the mouth of Catskill Creek. Of the fish collected, which were summarized initially in Table 8, comparisons were made between co-located species in the creek versus the main river. Smallmouth bass, yellow perch and white perch from the creek mouth were significantly lower in PCB concentrations on a lipid basis for both the total and “Aroclor 1254+” components compared to the same species from the river. Likewise, a “species smash”² comparison ($P < 0.01$) also indicated that if there was a source condition in Catskill Creek, it was not a significant contributor to the fish concentrations in the main river. The last section within Table 39 provides a summary of the pertinent statistical results.

²The “species smash” concept is more fully introduced in the section on “**Species Smash**”- Trends Expressed by Combining Species.

Poughkeepsie

Originally, the Poughkeepsie location was selected to focus on two anadromous species, American shad and striped bass (Table 2). Both are important commercial species but striped bass, in particular, is a prized recreational fish. Striped bass results are presented in more detail in a subsequent section as an evaluation of the traditional spring fishery which occurs in the lower estuary from Poughkeepsie to the George Washington Bridge (Sloan et al. 1988, Sloan and Hattala 1991, Sloan 1999c). From the outset of the program, American shad were unusually low in PCB concentrations compared to other species (Sloan and Armstrong 1988), as a result, other species were used for trend purposes or for related resource concerns that were considered more interesting. Consequently, the time line for other trend species is relatively short. A map of the sampling area for Poughkeepsie is provided in Figure 31. Summary results from one-way ANOVAs for fish from the Poughkeepsie location are presented in Table 40.

American eel in the interval 1981 to 1983 were relatively high in PCB content compared to those collected in 1998 and 1999 (Figure 32). Note that most of the contamination is of the more highly chlorinated “1254+” which is unlike that observed in the **common carp** (Figure 33). This latter species does exhibit a decline since 1991 and provides another indication that the determinant for future decreases is perhaps more dependent upon the “1254+” mix.

A mixture of largemouth bass and smallmouth bass, shown as **black bass**, reveal a relatively stable condition for total PCB since 1998 (Figure 34). Unfortunately, neither species was available for collection in 2002 or 2003. However, as indicated in other situations and for other species, the determinant for future trends are dependent upon what happens to the more persistent forms of PCBs.

White perch exhibit significant shifts from year to year, and since 2001 they appear to be experiencing increasing PCB concentrations, both as total PCB and “Aroclor 1254+.” They were actually higher in PCB content in 2003 compared to those in 1998 and 1999 (Figure 35).

In general, **ictalurid** species were not significantly different in PCB content on a lipid basis for a given location in any particular year. Hence, the depiction of trends in PCB concentrations in Figure 36 are denoted simply by “ictalurid species.” Overall, from 1998 to 2001 there were no decreases through time, but note that the spike demonstrated in 2000 is represented by a single white catfish.

When the project segment for **yearling pumpkinseed** started in 1979, a principal location was in the vicinity of Newburgh (RM 60) on the east side of the river at the south end of Denning Point (Figure 39). Through the years, the habitat and/or the pumpkinseed populations changed to the point where it was no longer suitable to continue collections at that location. Other locations in Newburgh Bay also proved unsuitable for pumpkinseed and attention shifted north in 1999 to Poughkeepsie (RM 76), where the habitat conditions and the fish populations were more favorable (Figure 31). The trend pattern expressed by yearling pumpkinseed (Figure 37) indicates a general decline since 1999 for total PCB concentrations, but the “Aroclor 1254+”

component, although shifting significantly between years, is not part of the noted decline between 1999 and 2001. Stability is apparent in the interval from 2001 to 2003 for both total PCB and the “1254+” form.

The data points for **yellow perch** involve only four years (Figure 38), but similar to white perch, the yellow perch increased in PCB concentrations in 2002 and 2003.

Newburgh

The Newburgh-Beacon area for fish collections is generally lacking in habitat and collections usually ranged over the entire area. In recent years, sampling focused on the Pollepel Island location, particularly for brown bullhead and carp (Figure 39), although carp were not usually considered a trend species. The Denning Point area, also depicted in Figure 39, always produced what pumpkinseed were available. Summary results from one-way ANOVAs for fish from the Newburgh area are presented in Table 41.

Similar to the **American eel** at Catskill, eel at Newburgh were also reliably represented in 1975 for trend purposes. Unfortunately, eel from this area were not collected again until 1991 after the initial decline for the Hudson River had already occurred (Figure 40). Concentrations did decline further in 1997 but rebounded in 1999. The 2001 and 2003 samples are comparable to those from 1999 with almost all the PCBs represented as “Aroclor 1254+” since 1991.

Since 1979, PCB concentrations in **ictalurid species** declined through 1999 for both total PCB and the “Aroclor 1254+” component (Figure 41). No other declines are apparent for this species through 2002. The increase in 2003, although striking, was not significant.

Yearling pumpkinseed taken from the Denning Point site in Newburgh Bay (Figure 42) demonstrate the initial pattern of decline for PCBs in the Hudson River, as do the other species in the system. This location also registers a number of pronounced increases and decreases, but the overall trend is downward through 1992. It is not known if the increases through 1994 are influenced by the “Allen Mill event” or not, but since 1996 there has not been further significant declines. In 2001 through 2003, the concentrations are similar to those manifested in 1992 for both total PCB and “Aroclor 1254+.” Since the yearling pumpkinseed collections have become problematic in the Newburgh area due to the lack of habitat in recent years, i.e., since about 1996, attention shifted north to the Poughkeepsie area above Marist College starting in 1999. Since the concentrations are relatively comparable between the two sites, the Newburgh location will no longer be used. Starting in 2004, a Catskill location was added to the yearling pumpkinseed segment of the monitoring project. Results from that site are not yet available.

Sloan et al. (1984a) reported on the relationship between age and PCB content for pumpkinseed collected from 1981 to 1983 from the Hudson River for several locations including Newburgh. Figure 43 summarizes the age/PCB association for these earlier years at Newburgh. In 1997 and 1998, several age classes of pumpkinseed were again analyzed from that location and the results are shown in Figure 44 for comparison purposes. The pattern of accumulation appears similar between the two sets of years but note that the age 2+ fish are significantly

higher in PCB concentrations compared to the age 1+ fish for the later years. Increases between age groups are greater for the lighter chlorinated forms of PCBs in 1997 and 1998 compared to 1981-1983. Overall, concentrations declined between the sets of years. The decrease in the age 4+ group in 1997-1998 was not significant probably due to the small sample size involving the four-year-old fish.

In the years 1991, 1999-2003, changes in PCB concentrations were not highly significant ($P=0.054$) for **white perch** (Figure 45). What is of more interest, perhaps, are some special collections of white perch and carp in 2001 from two separate locations in the Newburgh Bay area. The Consolidated Iron hazardous waste site, situated on the west side of the river in the City of Newburgh, has PCBs associated with the property which is bounded on the east side by the Hudson River (NYSDEC 2002). The site is listed by the USEPA on the National Priorities List. The other collection location was from a small island (Pollepel, also known as Bannerman's Island) on the eastern side of the river just south of Denning Point. The fish from the island in the main river away from the waste site had significantly higher PCB concentrations compared to those sampled near the site. The fish near the waste site also tended to have proportionately less of the "1254+" type (Figure 46). A similar relationship was noted for co-located carp (Figure 47). Although Consolidated Iron is not apparently adversely influencing the PCB situation, it is currently in the investigatory stages potentially leading to remediation which presumably will further ensure and preclude any PCBs associated with the site from entering the system.

Tappan Zee/ Piermont

When the PCB concentrations in the striped bass declined to less than 2 ppm on a wet weight basis in the Lower Estuary in 1997 (Sloan 1999c), there were no plans enacted to evaluate resident species this far downstream. **White perch** and **American eel** were targeted for sampling beginning in 1999. Both of these species indicated that PCBs increased in the interval 1999 to 2001, particularly for the white perch ($P<0.05$), but declined again in 2003 to levels comparable to those in 1999 (Figures 48 and 49). Note that the white perch have proportionately less "Aroclor 1254+" relative to total PCB than do the American eel, although the eel contain less PCB in total than do the white perch. Summary results from one-way ANOVAs for these species plus white catfish and American shad from the Piermont area are presented in Table 42.

White catfish, once sampled in 1984, were not analyzed again until 1999 (Figure 50). There was an attempt to include them in the Project after 1999, but they were not readily available. Hence, given the small numbers sampled, conclusions related to trends in PCB concentrations were not possible. The peak and the related confidence interval in the graph for 2001 is represented by an individual catfish. Ictalurids as a group were not as reliable at a particular location from year to year, perhaps, as were some of the other species in the Hudson River. Hence, several indicator species from each location are used for annual sampling. In the event that particular species are not available in any given year, the others will maintain continuity in the project.

American shad were originally included in the 1977 sampling plan since it is an important commercial species. However, it was determined relatively early in the course of monitoring that it was not as problematic as other species from other locations in the river. It was always below concentrations deemed unsuitable for interstate commerce (i.e., concentrations were less than the USFDA tolerance levels even when the temporary tolerance level of 5 ppm was finalized at 2 ppm in 1984 (USFDA 1984)). This species was, therefore, de-emphasized for long-term monitoring by the mid-1980s. Figure 51 shows the tendency for their decline in PCBs from 1977 through 1992. The apparent but insignificant increase exhibited for 1993 was due at least in part to only two fish being analyzed in 1993 as a cursory check on PCB conditions. Interestingly, this slight increase appears related to more of the lesser chlorinated PCBs since the “1254+” component remained constant. On a 3 % lipid basis, the overall decline from 1977 expressed the usual pattern displayed by the other species from other locations, where rapid initial declines are followed by relative stability (Figure 51). Also note that in 1977, there were only two fish involved in the ANOVA. Even though there were 50 fish sampled, many were analyzed as composite samples and one of the contract laboratories in 1977 did not quantify percent lipid.

Lower Estuary - Striped Bass

PCB results for striped bass from locations in the reach from Poughkeepsie to the George Washington Bridge were usually combined due to the high variability in the data, and the concentrations in striped bass from this 75-mile reach were generally not consistent for expression of a spatial gradient until recent years. This section of the river is usually considered to represent the traditional spring fishery for the striped bass (Sloan 1999c). Figure 52 illustrates the results from a one-way ANOVA on an arithmetic basis for results standardized at 3% lipid, and as was observed for other species and locations, there is the pronounced decline through the early years followed by periods of stability. Summary results from the ANOVA are presented in Table 43A. Table 43B is a representation of a similar ANOVA but on log₁₀ transformed data standardized to 3% lipid. Note that the error bars back transformed to reflect the geometric means associated with each year (Figure 53) accentuate the differences between years for both total PCB and the “1254+” fraction. Although the benefit of the logarithmic lipid standardized transform is apparent visually, it also serves to better approximate a normal distribution. For example, skewness and kurtosis coefficients for the PCB data on the bass used in the ANOVAs in Tables 43A and 43B were improved to the extent that if trends are significant on non-transformed data they become even more significant as a result of the transformations. Also significant ($P < 0.05$), is the influence of the reduction in available PCB due to the control of events associated with the “Allen Mill condition” which becomes evident after 1996 (Figure 53). It is of considerable interest that an anadromous species, like the striped bass, provides a clear manifestation of responses to major source influences.

The greater time lag for reductions in PCB concentrations to occur downstream compared to locations further upriver is perhaps due to the increased distance involved and the longer time needed to translate through to the lower river locations. Reasons why striped bass reflect changes in source conditions may include: there were greater sample sizes involved; bass, like other fish species, accumulate PCBs easily; and they are relatively naive in terms of

exposure since their principal exposures occur during the spawning period each year and the populations are expected to experience a relatively high rate of annual turnover. Striped bass monitoring was also more consistent compared to other species since there was a commitment early in the long-term project to ensure that striped bass would continue to be monitored. Hudson River striped bass also reflect a greater magnitude of exposure to PCBs compared to those from other Atlantic Coast locations (Fabrizio et al. 1991, Sloan et al. 1984b). The reason for the increase exhibited in 1996, in both Figures 52 and 53, is unknown, but the stability observed after 1996 at lower levels is comparable to that observed in other species throughout the system. The upsurge in concentrations in 2002, as explained further below, are largely due to the inadvertent consequences of having to rely on smaller sample sizes and the inclusion of one female in 2002 that had an inordinately high PCB concentration at 52.98 ppm on a wet weight basis.

Results on the reach below the Bear Mountain Bridge (about river mile 47, Figures 54 and 55), are presented as a special case analysis that includes summary results from one-way ANOVAs shown in Tables 44A and 44B. This portion of the Hudson River was under discussion for a possible limited reopening of the Hudson River commercial striped bass fishery (TAC Report 2001) as a consequence of average PCB concentrations reaching 2 ppm or less on a wet weight basis (Sloan 1999c), and were felt to exhibit lower PCB levels than the striped bass further upstream. The Temporary Advisory Committee on the Hudson River Striped Bass convened under Chapter 28 of the Laws of 2000 of New York State, resulted in a deadlock decision over whether to allow a limited re-opening of the commercial striped bass fishery in the Hudson River. Three members of the committee voted in favor; three were opposed and one member abstained (TAC Report 2001). Regardless, the fish from this approximately 45-mile reach also exhibit the same changes as do the fish from the larger data set representing the longer reach, Poughkeepsie to the George Washington Bridge. Both sets of analyses also manifest the greater representation of PCBs by the more highly chlorinated, "Aroclor 1254+" material, particularly in the years following the mid-1980s.

Although striped bass are sensitive to source conditions and respond to changes relatively quickly, larger sample sizes are necessary to show those shifts. In 2002 and 2003, there were fiscal and programmatic requirements that resulted in the reduction of sampling for striped bass. Hence, there are larger confidence intervals and apparent shifts in the means depicted for those years in the figures (52-55) and tables (43A-44B). Even on a transformed scale, the confidence intervals for 2000 and 2003 exhibit concentrations reminiscent of the late 1980s and early 1990s, but as will be indicated below in the section on sex considerations, these years were not only influenced by small sample sizes, but also the unavailability of females, and that an exceptionally high PCB concentration of 52.98 ppm inflated and skewed the average for 2002. Continued monitoring of this important commercial, recreational, and highly desirable species is crucial. Resumption of better stratification and increased numbers throughout the estuary will occur in the future as per the exemplary sampling design in Table 5.

In the mid- to late 1990s, there were requests from several Atlantic Coast states to review their striped bass PCB data in order to allow commercial sales in New York State markets. Hence, there was an opportunity to further compare PCB results from other states to Hudson River conditions (Figure 56). Even though the 1998 Hudson River comparison year reflected

average concentrations on a wet weight basis as being less than 2 ppm for all striped bass below Catskill, the results from the other states were usually substantially lower compared to the Hudson River samples, regardless of location. The other Atlantic states, upon review of the data by New York State (NYSDOH 1996), were eventually allowed to sell striped bass in New York commercial markets since they met the US Food and Drug Administration tolerance level of 2 ppm (USFDA 1984). These states included Massachusetts, Rhode Island, Delaware, Maryland, Virginia and North Carolina (Kim 1997a, 1997b, 1999a, 1999b, Forti 2001). As further illustration for the potential of striped bass to reflect source conditions, compare the concentrations in the Delaware River bass (closer to the Wilmington DE, Philadelphia PA, Trenton NJ area) to those taken from the Delaware Bay. Although these were collected in different years there is still an indication of more PCBs being available further upstream in the larger metropolitan areas. More information on the existence of other PCB sources in the Delaware River has recently appeared (Ashley et al. 2004).

Age - Length - Sex Considerations for Striped Bass

Over most of the years of monitoring striped bass in the Hudson River, a sexual dichotomy for PCB concentrations was apparent and although it was not always significant statistically, the pattern was there. Usually a sex difference is not apparent for other species (Sloan et al. 2002). In 2001 below Poughkeepsie, differences in PCB concentrations as observed in each sex were significant ($P < 0.001$) with means for total PCB of 0.57 ppm for females and 1.02 for males; log₁₀ transformed data at 3 % lipid generated geometric means of 0.38 and 0.61 ppm, respectively. Given the significant difference between sexes for 2001 and that apparent differences were existent since at least 1985, trend analyses are presented in Tables 45A1 and 45A2, and Figures 57A-D for each sex. The figures are presented as bar graphs of the means without the confidence limits in order to provide a better visual perspective on the relative differences between the sexes. However, the 95 % confidence limits are provided in the tables. For striped bass at least, the existence of the “sex difference” may not have as much to do with the physiology but perhaps the behavior of the sexes, since males enter the Hudson River ahead of the females and continue feeding. The females, on the other hand, primarily focus on spawning activity and tend to leave as soon as spawning is complete. Whether they feed or not is largely irrelevant, since they would not be exposed to source conditions for as long a period. For those females that do stay in the river any sex differences disappear by fall (Sloan et al. 2002). The events in 2002 and 2003 differ from the expected pattern due to the lower sample sizes available in both of the later years; the total PCB concentration in one female in 2002 was markedly higher than the rest of the bass at 52.98 ppm on a wet weight basis which dramatically altered the distribution of the data; and during the sampling in 2003, there were no females available. The influence of that single female in 2002 is obvious in Figure 57A. Even when data were transformed and expressed at the standard 3 % lipid, the effect of the one fish is apparent (Figure 57C). By removing the female and re-plotting the data, the plots take on the general pattern observed in the previous years (Figure 57B and 57D). Note, that overall, the transformed concentrations in 2002 tended to be higher than in previous years (Figure 57C and 57D). Unfortunately, females were not available in 2003, but in general the concentrations were lower or comparable to earlier years. This year-to-year variation is probably influenced by having to deal with lower sample sizes and not having the capability in 2003, at least, to obtain temporally

stratified samples during the course of the spawning season. In the future, it is critical to ensure adequate sampling and timing of those samples during the season. It is important to permanently adopt the sampling design similar to that presented in Table 5.

Two other variables that are often given attribution for an association with organochlorine contamination levels, are length and age. The length-PCB relationship for Hudson River striped bass usually tended to have a negative slope and was not significant 11 out of 15 years (Sloan et al. 1995). However, the correlation was sometimes significant, but the variability explained by the association was small, even when various data transformations were used. For example, in 2001 there were 172 striped bass collected from Poughkeepsie to the George Washington Bridge, the correlation between length and PCB concentration was $r = -0.147$ ($P = 0.055$) for both sexes combined using un-transformed data. Log10-transformed, 3% lipid based data increased the correlation to $r = -0.244$ ($P = 0.0013$). This resulted in an increase in R^2 from 2.25% to 5.93%, a significant increase, but still relatively weak. When sex was considered separately, significance of the correlations was lost: un-transformed females, $r = -0.224$ ($P = 0.226$); log10-3% lipid-transform, $r = -0.176$ ($P = 0.343$); un-transformed males, $r = 0.003$ ($P = 0.968$); transformed males, $r = -0.134$ ($P = 0.114$). It is likely that any length-PCB relationship without considering the sex of the sample is spurious.

In coastal New York collections of striped bass, correlations between length and PCB content were usually positive but not always significant, but in the larger sizes the correlations would tend toward a negative relationship (Sloan et al. 1991, 1995). Sex differences were not taken into consideration in those studies, but presumably the larger fish in those evaluations would have been female. Negative correlations between length and PCB concentration were also noted in other studies (Sloan et al. 1988a, 1988b, Gibson and O'Brien 1987).

In terms of an association between age and PCB concentration, the availability of age data requires using a restricted set of data covering the years of relatively stable PCB conditions in the Hudson River from 1989 to 1994 ($n=258$) from Poughkeepsie to the George Washington Bridge. For both sexes combined, the correlation between age and untransformed total PCB concentration was $r = 0.215$ ($P < 0.001$); log10-3% lipid-transformed data produced a correlation of $r = 0.289$ ($P < 0.001$). A highly significant association, but relatively weak since it explains but 8.4 percent of the variability even when transformed. When sexes are considered separately the correlations are even better for the males at $r = 0.33$ un-transformed ($P < 0.001$), and $r = 0.54$ log10-3% lipid-transformed ($P < 0.001$), but the correlations are lost for the females. Age-total PCB correlations for the females were: $r = 0.058$ ($P = 0.596$) and $r = -0.002$ ($P = 0.985$) for un-transformed and transformed data, respectively.

“Species Smash” - Trends Expressed by Combining Species

One of the more useful procedures to evaluate trends, both spatially and temporally, and in evaluating source conditions, involves the judicious application of the “species smash,” a procedure that has been used in several instances (Sloan et al. 1983, 2002, Sloan 1999a, 1999b, Sloan and Field 1996, Sloan and Jock 1990, Foley et al. 1988). Simply expressed it is the averaging of all the observations of PCB concentrations expressed on a lipid basis for all the species from a given location during a particular time. In the depictions for this report, concentrations are expressed on a wet weight basis standardized to a 3 % lipid content, as done for all the preceding analyses. If there are insufficient numbers of individuals and/or species to mix into the average, the process of combining species becomes sensitive to low sample sizes, age class and migration habit. Therefore, the exercise of care in posing comparisons is warranted. For example, using only striped bass or yearling pumpkinseed with limited numbers to contrast with an assemblage of six to nine species represented by robust numbers of samples is a condition best avoided. Hence, in the following discussion on time trends seen in “species smashes” the locations are limited to those at and upstream of Catskill (RM 112) since few resident species, historically, were analyzed in the lower tidal reaches of the Hudson River. Future collections in the more downstream locations will include more of the non-migratory species. There are certainly considerable numbers of samples, however, for the Upper Hudson River and at Albany and Catskill available to use in further describing temporal trends by combining species (i.e., “smashing”). The following analyses will also rely upon log₁₀-transformed PCB concentrations expressed on a 3 % lipid basis. The transformation process better satisfies some of the assumptions underlying the distribution of data used in conducting parametric analyses of variance and provides more sensitive means to visualize and express change (Table 45B).

Above the Feeder Dam (River Mile 204) - Although there were significant changes between years for this reference area, the small sample sizes in 1979 and 1983 probably obscure some of the real changes (Figure 58). However, of the PCBs present, the concentrations did decline in 1997 which followed the 1995-96 partial remediation at the Queensbury PCB site just upstream in the Sherman Island Pool near river mile 209 (Sloan et al. 2002, Parsons 2003, 2005). Observed concentrations in 2002 and 2003 are indicative of some PCBs still present in this vicinity. The overlap of the error bars for “Aroclor 1254+” and total PCB underscores the fact that the preponderance of PCBs in this pool are composed of this more highly chlorinated and bioaccumulative form. The total PCB average for the “species smash” from the Feeder Dam Pool was 0.32 ppm at 3 % lipid versus about 0.05 ppm, also at 3 % lipid for a similar “smash” from Sanford Lake (river mile 301) in 2000.

Griffin Island (River Mile 189) - As indicated previously, this location was not added to the Project until 1984. However, declines were occurring through 1991, but then the “Allen Mill event” took place in 1991. By 1993, the concentrations were comparable to what they had been in 1984, but then abated to the 1991 levels by 1995. Total PCB concentrations declined further through 1997 followed by an increase in 1998. The 1998 increase was also observed in the Stillwater Pool, but no explanation is readily available for the upsurge which then declined again by 2000 to the 1997 level. In the interval from 1996 to 2003, the “1254+” levels were markedly

stable as the gap between total PCB and “1254+” appeared to be narrowing (Figure 59).

Stillwater (River Mile 167/176) - Although the Stillwater Pool was one of the original Project locations, there was a shift in the actual collection location in 1994 to the Coveville site (RM 176) from the area just above the Stillwater Dam (RM 167). Subsequent analyses of samples from both sites reflect comparability between the two locations (Sloan et al. 2002). Regardless, there was a marked decline in total PCB concentrations from 1977 through 1982 (Figure 60). The inset for Figure 60 showing the period from 1985 to 2003 provides a better visual sense of the changes that were occurring during this relatively prolonged “stable” phase. The modified scale in the inset better separates the plotted points so the differences between years are highlighted. There was a continued decline through 1991 followed by the increase due to the “Allen Mill event.” Concentrations decreased through 1997 as the situation was brought under control. The increase in 1998, similar to that noted for the Thompson Island Pool, is also without explanation. Conditions since 1999 appear relatively stable for both total PCB and “Aroclor 1254+.”

Albany/Troy (River Mile 142/153) - The pattern of change at Albany/Troy (Figure 61) is similar to that at Griffin Island and Stillwater, although the magnitude of scale is different. Initial declines in 1978 and 1979 are followed by slower declines through 1985. A slow rise occurs through 1990 with a decline in 1991. The “Allen Mill event” becomes prominent in 1992 to 1994, but by 1995 conditions are comparable to those before the pronounced perturbation. Concentrations generally decrease through 1998 (note that there was no increase for this location in 1998 in contrast to the situation at Griffin Island and Stillwater) and even into 2000. The last three years, however, are stable. “Aroclor 1254+” generally tracks the response of the total PCB pattern with the exception of the “Allen Mill” years and the initial declines in the late 1970s.

Catskill (River Mile 112) - Along with the initial rapid decline through 1980 (Figure 62), this part of the tidal estuary continued to reflect a slow general decrease with some positive and negative shifts through 1998. There was an increase in 1999 followed by a general period of stability to the present (2003). “Aroclor 1254+” has generally tracked the total PCB response since about 1980. The influence of the “Allen Mill event” appears to be involved only with the slower decline in PCB concentrations through 1998.

Spatial Gradients through Time

To describe the changes in fish PCB concentrations with distance downstream from the source conditions in the Upper River, the major temporal trend species were used. Since the temporal trends discussed above included available data for all the years, this section will include only select years, represented by five intervals, to provide the reader a spatial perspective as a function of time. The first group of selected years is the earliest two-year interval, and for most of this presentation most of the focus is on data collected during 1977 and 1978. The earliest years for the yearling pumpkinseed, however, are 1979 and 1980 since this part of the project did not start until 1979. The next set covers the years 1984, 1985 and 1986. Three years

were selected for this interval to represent a relatively stable period in the history of the PCB problem and to ensure relatively robust sample sizes. The next interval selected, to cover the height of the “Allen Mill event,” focused on the 1992 and 1993 results. The last two intervals, 2000-2001 and 2002-2003, provide the spatial perspectives for the present time which were also characterized as relatively stable, but these intervals would represent conditions well post-“Allen Mill event.” Both of these most recent intervals are included since even though conditions are currently stable, they do indicate the dynamic aspect of PCB conditions in the river over a relatively short period of time. In the following graphs (Figures 63-69), there are three sets of figures labeled “A, B and C,” presented within the species sequences. Figures labeled “A” include data from all five intervals and allow the visual presentation of the initial high concentration years. In the “B” figures, the intervals of 2000-01 and 2002-03 are presented for a perspective on the most recent years over the spatial gradient. Then finally, in “C” there is a comparison of the middle intervals (1984-85-86 and 1992-93) with the final 2002-2003 period. In the presentation of these spatial gradients, arithmetic and geometric scales were used, where appropriate, to allow the reader to better visualize the shifts in concentrations for both total PCBs and the “Aroclor1254+” component over the geographic range of the river (Tables 46 - 52 and Figures 63 - 69).

Black bass

As indicated in earlier sections, the lack of major differences in PCB contamination between largemouth and smallmouth bass allow combining their results for purposes of presenting trend information. Table 46 details through one-way ANOVAs and the accompanying 95 % confidence limits from pair-wise comparisons of least significant differences (LSD), the differences in concentrations between sampling locations. The ANOVA conducted on arithmetic data at the standard 3 % lipid are plotted in Figure 63A on a logarithmic scale in order to provide some visual separation between the plotted points. Due to the various time intervals also presented, the confidence intervals are not included in this and subsequent figures in order to minimize visual confusion. The PCB concentrations in the bass from the Feeder Dam Pool provide a reference point for comparing the contamination levels resulting from sources above Hudson Falls to the conditions downstream. In particular, note in the reference area above, or upstream from the major sources near Hudson Falls and the Thompson Island Pool. The concentrations are orders of magnitude less on a logarithmic scale compared to those observed throughout the rest of the river. This characteristic was evident through 2002-2003. The geographic gradient for black bass was evident in 1977-78, but there were only three locations sampled in those years.

For the two most recent time intervals (Figure 63B) changes occurred between 2000-01 and 2002-03 in which the proportional decrease in total PCB was due to the lighter chlorinated component of PCBs declining above the Troy Dam compared to a relatively greater decline in the “1254+” fraction below Albany. Regardless, all locations reflected some decline in total PCBs for these two most recent intervals.

At Griffin Island the influence of the 1991 “Allen Mill event” in increasing the fish PCB levels is in evidence by comparing the higher 1992-93 average of 68.7 ppm compared to the

lower average concentration observed in the mid-1980s of 44.0 ppm (Figure 63C). This incident was not discernible for black bass at Stillwater, the next sampling location downstream where the means for the two time intervals were 23 and 16.5, respectively. Overall, concentrations decrease with distance downstream with the more highly chlorinated portion of the total PCB mix in 2003 being about 50 % throughout the river, but in the reference area about 90 percent of the total PCB is represented by the “1254+” fraction. For additional gradient perspective on the contribution of “Aroclor 1254+” refer to the section at the end of these results and discussions on the ratio of “1254+” to total PCB as a spatial gradient (page 35).

Ictalurid species

Brown bullhead were not available at all locations throughout the river. Therefore, it was necessary to sample some of the other species in the family Ictaluridae. Fortunately, where some of the other species overlap with the bullhead, and as described earlier, differences in PCB concentrations on a lipid basis were not apparent. Consequently the gradient results are presented as a combination of ictalurid species, i.e., brown bullhead, yellow bullhead, white catfish and channel catfish. In addition, there were only three locations sampled in 1977-78 compared to eight in 2000-01. Therefore, the ANOVA, mean comparisons and the averages for total PCB on a 3 % lipid basis and the “Aroclor 1254+” component, presented in Table 47 will exhibit some data gaps particularly for the early years of the project. The plots of the available means are found in Figures 64A, B, and C. Generally, similar gradient patterns were observed for the ictalurids as were seen for the black bass. A decrease with distance below Albany, however, is not apparent and there are some indications that locations in some Lower River locations in some years are higher than others. There is the pronounced decrease from 1977-78 evident in Figure 64A for both total PCB and “1254+” but further declines after 1984-85-86 appear to have been slowed by the “Allen Mill event” (Figure 64C) since average concentrations are similar to or higher in 1992-93 than in 1984-85-86 at Albany and even at Catskill. Why Catskill was higher than the fish at Albany, however, is not clear. Fortunately, the higher concentrations lower in the river are not as apparent in recent years (Figure 64B) and the heavier “1254+” mix is now 60 to more than 70 % of the total PCB in the lower river.

Yellow perch

Yellow perch gradient results are provided in Table 48 and Figures 65A, B and C. Overall, the results on this species represents the frustration of not sampling all the species, all the time from all locations. There is the obvious gradient across the three locations in 1977-78 resulting from the initial major decline in the system, but no perch samples were collected below Catskill and above Stillwater (Figure 65A) through 1984-85-86. Even though there may be a relatively stable period ensuing for the Upper Hudson River as seen in Figure 65B, in the Lower Hudson River below Catskill it appears to be anything but stable with regard to yellow perch. Sharp increases appear in 2002-03 compared to 2000-01 for both Poughkeepsie and Newburgh at 1.86 and 4.6 ppm, respectively, at Poughkeepsie and 1.55 and 6.3 ppm for Newburgh. Similar increases were observed for the “1254+” component of 1.4 to 3.3 ppm and 1.01 to 5.38 ppm. The sample sizes were small at Newburgh but not at Poughkeepsie (Table 48) and therefore any

increases cannot be explained by inadequate sampling. Any response to the “Allen Mill event” that should be apparent in Figure 65C is precluded due to the lack of samples in the Thompson Island Pool (Griffin Island area) prior to the event and similarly for the Albany/Troy location.

White perch

Since white perch were not found in sufficient numbers to sample in the Upper River, especially above Lock 1 in the Champlain Canal, the gradients depicted in Table 49 and Figures 66A, B and C begin at Albany/Troy (river mile 152). Even though the concentrations are significant between locations, notably in the earlier intervals (Figure 66A), the gradient is not as pronounced in the later periods, 2000-01 and 2002-03 ($P = 0.018$ and $P = 0.37$, respectively) (Figure 66B). The gradient for the “Aroclor 1254+” component in 2000-2001 and 2002-03 was not significant ($P > 0.05$), but note the slight upturn in concentrations in the Haverstraw Bay/Tappan Zee area for this part of the PCB mix and the tendency for this increase in some instances for the other years (Figure 66C), such as the pronounced increase in concentrations at Catskill and Poughkeepsie for yellow perch in 2002-03 (Figure 66B). Another feature of the white perch is that since they only occurred in the Lower Hudson River, the magnitude of scale over the gradient allowed more use of arithmetic expression, rather than geometric depictions to indicate shifts in concentrations over distance.

Yearling pumpkinseed

Since this segment of the project was not started until 1979, the first interval considered for this description of gradient changes involves 1979-1980. Sampling conditions for some of the other intervals for this age class resulted in selecting alternative mid-intervals of 1988-1989 and 1993-1994. The results for all intervals across the gradient and for the type of PCBs were highly significant ($P < 0.0001$) and are presented in Table 50. The gradient graphs for the means of total PCBs and the “Aroclor 1254+” component are located in Figures 67A, B, and C.

The patterns of decline, both spatially and temporally, for this relatively localized, young age class is readily apparent. Even though the Griffin Island collection location was not added until after the initial major PCB reductions to the system, the early years of higher concentrations in 1979-80 were followed by lower but stable levels (Figure 67A) through 1988 to 1994 throughout the system (Figure 67C). Then, perhaps in response to improving conditions following the “Allen Mill event,” concentrations again declined in the interval from 1993-94 to 2002-03 (Figure 67B). Strikingly apparent was the decline in the “1254+” concentrations in the interval from 1993-94 to 2002-03 (Figure 67C). Even in the most recent period the spatial gradient is well-developed for this species, but the reason for the increase at Griffin Island in 2002-03 compared to 2000-01 is not known (Figure 67B). Interestingly, that increase was not exhibited by an increase in the “1254+” fraction.

The results from the Catskill location, which was added for collection beginning in 2003, accentuate the potential for other source conditions in the Poughkeepsie and Newburgh areas, as they may be related to this particular species/age class. The upturn in average concentrations for

both total PCB and “1254+” is noticeable in all three figures for Poughkeepsie and Newburgh relative to the lower averages observed at Catskill. In the earlier discussion on temporal trends at Catskill (page 21), an evaluation of a potential source at the mouth of Catskill Creek was negative in the sense that main stem Hudson River fish were actually higher in PCB levels than those at the mouth of the stream. Therefore, it may also be argued that the apparent higher concentrations at Poughkeepsie and Newburgh are only more indicative of main river conditions rather than other sources. This may also emphasize the sensitivity of yearling pumpkinseed to their more localized habitat/exposure regime, and the pumpkinseed at the mouth of the creek are responding to those particular conditions.

Striped bass

Even for an anadromous species such as the striped bass, spatial gradients do exist. This species clearly reflects localized PCB conditions, an aspect which has been reported previously (Sloan et al. 1995, Sloan and Hattala 1991, Sloan et al. 2002, Skinner et al. 1996). Initially, and as detailed in Table 51 and depicted in Figure 68A, the George Washington Bridge area produced striped bass in 1978 that had significantly higher concentrations of both total PCB and “Aroclor 1254+” on a lipid basis than did the other locations, Poughkeepsie and the Tappan Zee, being examined at that time.³ By the early 1990s, however, this condition abated and the influence of the major upriver source was consistently manifesting itself in that the concentrations in the Albany/Troy area (river mile 152) were generally significantly greater than the levels observed in the striped bass from Catskill (river mile 112), (Figure 68C). The Catskill fish were also higher in PCB concentration than those from Poughkeepsie. In summary form, the rank from highest to lowest in 2000-2001 was Albany > Catskill > Poughkeepsie ≈ Tappan Zee ≈ George Washington Bridge (Figure 68B). What confounded this pattern in 2002-2003 was having to deal with smaller sample sizes, lack of males in the samples, reduced locations for collecting striped bass, and an inordinately high PCB concentration in one of the females in 2002.

Through time, the proportion of “Aroclor 1254+” has come to predominate the PCB composition, especially in the lower sections of the river, from Poughkeepsie downstream, and is particularly noticeable in the 2000-2001 interval (Figure 68B).

³The 1977-78 point at Albany, represented by a single observation, is included in the interest of being complete and is not intended to reflect any conclusive evidence of high values in this upper tidal estuary area, although that would have been likely at that time if more samples were available for documentation in this species.

“Species Smash”

As mentioned earlier in introducing the “species smash” concept, the exercise of care in posing comparisons is warranted. For example, using only striped bass or yearling pumpkinseed with limited numbers to contrast with an assemblage of six to nine species represented by robust numbers of samples is a condition best avoided. In the “smash” comparison depicted in Table 52 and Figures 69A, B, and C, therefore, the George Washington Bridge is not included, since striped bass was the only species collected at that location.

The gradient in the early years (Figure 69) for the “species smash,” as it did for some of the other species, also indicated higher concentrations in the Tappan Zee area compared to the levels at Poughkeepsie. The other locations in that early interval provided the expected decreasing scale observed from Stillwater through Poughkeepsie. In the most recent intervals, 2000-01 and 2002-03, there were significant changes between the two periods in the Upper Hudson River but not in the Lower portions (Figure 69B) for total PCB. The “1254+” concentrations, although not different between the two periods, exhibit a relatively flat gradient from Albany on downstream. The flattening of the gradient in 2002-03 at lower concentrations compared to the values in the middle years (1984-85-86 and 1992-93) presumably reflects the lessening of the “Allen Mill event” and perhaps other undocumented exacerbations (Figure 69C).

There was a tendency for higher PCB concentrations to occur in this “species smash” for some of the areas in the Lower Hudson River, especially in 2002 - 2003. Also, since these higher levels were observed for some of the individual species examined over the spatial gradient, including yellow perch (Figure 65), white perch (Figure 66), yearling pumpkinseed (Figure 67), and striped bass (Figure 68), such results underscore the need to continue examining other source conditions. The potential remediation of the Harbor At Hastings site in the Village of Hastings-on-Hudson near river mile 21 (NYSDEC 2003) is a specific case in point. Continued vigilance and mitigation of sites such as this, even though relatively small and localized in influence, will result in the eventual recovery from PCBs of the entire Hudson River. The general lack of homogeneity in PCB concentrations in biota of the Lower Hudson River was also recently observed by McReynolds et al. (2004) which by virtue of the mosaic of results also implied a complex of sources in the lower tidal river, bays and harbors.

“Aroclor 1254+” Proportional Gradients

In order to better visualize the proportional changes of the PCB mix as presented by Aroclors through time and space, Figure 70 (with an accompanying ANOVA provided in Table 53 that also contains 95 % confidence limits) shows how the ratios of “Aroclor 1254+” to total PCBs have shifted over the spatial gradient through selected time intervals. Using the “species smashes” as per the discussion above, and only evaluating the ratios, the ratios in the 1977-78 interval featured the lower chlorinated types of PCBs throughout the system with a gradient from upstream to downstream tending toward relatively higher chlorinated forms in the lower river.

This basic pattern appears in all of the time intervals used in this analysis. In the 1984-85-86 interval, however, there was a major shift from the lighter forms to more highly chlorinated materials, with the most highly chlorinated PCBs appearing in the lower river/Poughkeepsie (river mile 76) downstream to the Tappan Zee area (river miles 24-36) . Note that the reference area above the Feeder Dam (river mile 204) when analyzed always featured highly chlorinated PCBs. When the “Allen Mill event” occurred, i.e., the 1992-93 period, the ratios were suppressed in the upper portions of the Hudson River, particularly in the Thompson Island and Stillwater Pools, but not to the extent observed in the earliest time interval of 1977-78. The lower Hudson River at Poughkeepsie and points downstream did not experience this suppression in the ratio, but in the most recent intervals, post 2000, the proportion of the “1254+” rebounded to some extent in the Upper Hudson River and decreased in the Lower Hudson. Generally, the “Aroclor 1254+” fraction as of 2003 accounts for 40 to 75 % of total PCBs in the river.

IN CLOSING

Documenting future declines in PCB concentrations in the fishery resources of the Hudson River deserves the full support of the interested parties to ensure that an annual, comprehensive, adaptable, fully funded, long-term monitoring plan is adopted and implemented. The data time line for resident species in the lower river is not as long as it is in the upper river, but the data gathered since 1999 provides a baseline allowing long-term monitoring to move forward. Changes in PCB concentrations are anticipated in the system for fish, even in the lower reaches of the river, as remediation proceeds. It is in the interest of all parties that the changes throughout the river are documented.

Comprehensive, consistent sampling and chemical analyses are critical elements for the long-term trend analysis for PCBs. Even though there are gaps in the database, DEC is fortunate to have the record that exists. Through the years, probably the greatest shortcoming in the Project was that it tried to do all things for all concerns and that approach was not always supportable. The framework outlined in the 2002 sampling plan (Sloan 2003) should serve as the basis for the biotic component for long-term monitoring both pre- and post-remediation. The sampling plan that served for previous descriptions prior to 1999 on the fate of PCBs in fish is inadequate to fully describe, track, and document the residues and sources remaining in the system. The 2002 plan is considered minimal, but functional and employable. Source conditions and the accompanying responses can, and have, shifted dramatically. With the issuance of the Record of Decision in 2002 to effect at least a partial remedy of the PCB situation in the Upper Hudson River, and since these remediation scenarios will result in many localized changes in source conditions, a comprehensive biota sampling plan as part of the evaluation process is in order.

Since striped bass have proven responsive in the short term to changes in system PCB conditions, and for this reason alone, inclusion of this species must continue for monitoring PCBs in the Hudson River. Its use is even more imperative given the species position of interest, recreationally and commercially.

The Hudson Basin Database is distributed with the updates as new data become available from the laboratories and the contractors, and it contains some congeneric data and non-PCB analytes which have been reported to some degree (e.g., Field et al. 1996, McGroddy et al. 1997, Sloan 1999c, O'Keefe et al. 1984, Sloan et al. 1984b, Sloan and Kane 2001). These contaminants require further discussion, data analysis and more comprehensive reporting. Similarly, observations on the partitioning of contaminants in other organs and tissues are awaiting further discussions, although some of this information was presented in Sloan et al. (2002) and Sloan and Armstrong (1988).

In the future, Hudson River QA/QC procedures employed during PCB analyses of fish and other biota will utilize recently developed Hudson Reference Material (HRM) in the form of ground, homogenized white perch collected in 2002 from the Catskill area (rivermile 112). With the adoption of the Baseline Monitoring Program (BMP), as part of the PCB Remediation effort, GE took over a portion of the fish monitoring beginning in 2004, but they have adopted the basic DEC plan for the Upper River. The Lower River will continue being sampled by DEC but without full EPA/GE support.

CONCLUSIONS

Temporal declines in PCB concentrations in the fish from the most contaminated sections of the Hudson River have occurred since 1977.

Conditions in recent years have been relatively stable, particularly for the Upper Hudson River locations closest to the original sources of PCB contamination.

Concentrations in the fish from the reference location (Feeder Dam Pool) do not exhibit consistent reductions over time but the concentrations observed are one to two orders of magnitude less than the values in the fish from the most contaminated sample location of the Hudson River.

Fish from the reference location, however, are an order of magnitude higher in PCB concentration than fish from the headwaters of the Hudson River and are obviously responding to other low-level source conditions in this area upstream of the major source influences.

Fish did respond as expected with either decreases or increases in PCB concentrations to known perturbations in the system such as the reductions and eliminations of direct discharges from manufacturing facilities or increases in the fish PCB concentrations resulting from sudden uncontrolled releases from relatively large reservoirs of PCB-oil or from sediment deposits containing PCBs.

The spatial gradient in PCB concentration is observed through the river as decreases in PCB concentrations with distance away from the major source(s), but the gradient tends to flatten over the length of the estuarine, tidal portion in the Lower River.

Other source conditions known to exist in the system, near or relatively close to the main stem, do not necessarily manifest their influence by exhibiting elevated concentrations in the fish from the river, i.e., the principal sources as originally influenced by the plant sites at Hudson Falls and Ft. Edward remain the greatest apparent contributor to PCB concentrations in fish throughout the system.

Since some species in recent years in the Lower Hudson River, particularly below Poughkeepsie, exhibit relatively elevated concentrations at some locations, a more thorough evaluation of other source conditions in the Haverstraw Bay/Tappan Zee area and probably other downstream locations is warranted.

Future trends in fish PCB concentrations are dependent upon the fate of the more persistent, higher chlorinated forms of PCBs that remain in the system.

Annual sampling and analyses are necessary for both the Upper and Lower portions of the Hudson River.

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The life of this project, as can be said for many lives, has had its ups and downs. Over the quarter century for this one, few wars have lasted so long, a multitude of participants have played upon this stage and some are only a memory kept alive by notations on a field form or a laboratory record. Rather than providing a recitation of names, we hope that those who retain an interest in the PCB problem and the Hudson River will obtain a copy of this report, voice with pride their participation and that it could not be done without them. And here is the proof in these Acknowledgments!

Having made the above statement, there is an exception to express. During the final stages of the preparation of this report, we were faced with redrafting all the graphs which involved tedious manipulations of overlaying segments and manually offsetting lines so that comparisons were legible. Needless to say procrastination over dealing with this issue was leading to even more delay in the completion of the document. Serendipity and salvation arrived in the form of an enterprising, talented, dedicated, industrious, intuitive, insightful and intelligent student intern from Russell Sage College. Our gratitude and thanks for outstanding service are extended to Emily Porter-Goff. Those were certainly two well-deserved credits. Emily, thank you!

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LITERATURE CITED

- American Fisheries Society. 1991. *Common and Scientific Names of Fishes from the United States and Canada*. Fifth Edition. Spec. Public. 20. American Fisheries Society, Bethesda, Maryland. 183 p.
- Armstrong, R.W. and R.J. Sloan. 1980. *Trends in Levels of Several Known Chemical Contaminants in Fish from New York State Waters*. Bureau of Environmental Protection, Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 80-2. 77 p.
- Armstrong, R.W. and R.J. Sloan. 1988. PCB patterns in Hudson River fish. I. Resident freshwater species. pp. 304-324. In C.L. Smith (ed.). *Fisheries Research in the Hudson River*. State University of New York Press, Albany, New York. 407 p.
- Ashley, J.T.F., D.J. Velinsky, M. Wilhelm, J.E. Baker, D. Secor and M. Toaspern. 2004. *Bioaccumulation of Polychlorinated Biphenyls in the Delaware River Estuary*. Delaware River Basin Commission (DRBC), Report No. 03-3F. Patrick Center for Environmental Research, Philadelphia Academy of Natural Sciences, Philadelphia, Pennsylvania. January 15, 2004.
- Baldigo, B.P., R.J. Sloan, S.B. Smith and D.P. Keane. 2003. Polychlorinated biphenyls and endocrine biomarkers in fish from the Hudson River, New York, USA. United States Geological Survey website. <http://ny.water.usgs.gov/pubs/posters/pcbendocrine.html>. August 22, 2003. Also presented as: Baldigo, B.P., S.B. Smith, R.J. Sloan and D.P. Keane. 2000. Polychlorinated biphenyls and endocrine biomarkers in fish from the Hudson River, New York, USA. Page 150 in *Third Society of Environmental Toxicology and Chemistry Congress*, May 21-25, 2000, Brighton, UK. Society of Environmental Toxicology and Chemistry, Pensacola, FL.
- Boer, J., F. Valk, M.A.T. Kerkhoff and P. Hagel. 1994. 8-year study on the elimination of PCBs and other organochlorine compounds from eel (*Anguilla anguilla*) under natural conditions. *Environ. Sci. Technol.* 28(13): 2242-2248.
- Bowser, P. R., D. Martineau, R. Sloan, M. Brown and C. Carusone. 1990. Prevalence of liver lesions in brown bullheads from a polluted site and a nonpolluted reference site on the Hudson River, New York. *J. Aquatic Animal Health* 2: 177-181.
- Brown, M.P., M.B. Werner, R.J. Sloan and K.W. Simpson. 1985. Polychlorinated biphenyls in the Hudson River. *Environ. Sci. Technol.* 19: 656-661.
- Eisler, R. 1986. *Polychlorinated biphenyl hazards to fish, wildlife, and invertebrates: a synoptic review*. U.S. Fish Wildl. Serv. Biol. Rep. 85(1.7). 72 p.

- Fabrizio, M.C., R.J. Sloan and J.F. O'Brien. 1991. Striped bass stocks and concentrations of polychlorinated biphenyls. *Trans. Am. Fish. Soc.* 120: 541-551.
- Farrar, K. 2005. Personal communication. GE Hudson Falls Plant site outfall Interim Remedial Measure occurred in 1997 and 1998. Division of Environmental Remediation, New York State Department of Environmental Conservation, Albany, New York. March 7, 2005.
- Field, L.J., R. Sloan, L. Read, C. Severn, and R. Dexter. 1996. *PCBs in Hudson River fish: Comparisons of congener patterns over a geographic gradient*. Poster presentation, 17th Annual SETAC Meeting: Washington, D.C.
- Foley, R.E., S.J. Jackling, R.J. Sloan and M.K. Brown. 1988. Organochlorine and mercury residues in wild mink and otter: Comparisons with fish. *Environ. Contam. Toxicol.* 7: 363-374.
- Forti, A.J. 2001. Personal communication regarding PCB results on Rhode Island striped bass collected in 1996. Bureau of Toxic Substances Assessment, Division of Environmental Health Assessment, New York State Department of Health, Albany, New York. January 16, 2001.
- Gibson, M.R. and J.F. O'Brien. 1987. *PCB levels in migratory striped bass taken from Rhode Island marine waters 1982-1986*. Rhode Island Division of Fish and Wildlife, W. Kingston, Rhode Island. *Ann. Prog. Rep. Proj. AFC-4*, Sept. 1984 - June 1987. 45 p.
- Hebert, C.E. and K.A. Keenleyside. 1995. To normalize or not to normalize? Fat is the question. *Environ. Toxicol. Chem.* 14(5): 801-807.
- Horn, E.G., L.J. Hetling and T.J. Tofflemire. 1979. The problem of PCBs in the Hudson River system. *Ann. N.Y. Acad. Sci.* 320: 591-609.
- Kim, J.C.S., E.S. Chao, M.P. Brown, and R. Sloan. 1989. Pathology of brown bullhead, *Ictalurus nebulosus*, from highly contaminated and relatively clean sections of the Hudson River. *Bull. Environ. Contam. Toxicol.* 43: 144-150.
- Kim, N.K. 1997a. Letter to G. Barnhart, Acting Director, Division of Fish, Wildlife and Marine Resources, transmitting notice of acceptability of PCB results on North Carolina striped bass for sale in New York State markets. Director, Division of Environmental Health Assessment, New York State Department of Health, Albany, New York. January 30, 1997.
- Kim, N.K. 1997b. Letter to G. Barnhart, Acting Director, Division of Fish, Wildlife and Marine Resources, transmitting notice of acceptability of PCB results on Delaware striped bass for sale in New York State markets. Director, Division of Environmental Health Assessment, New York State Department of Health, Albany, New York. October 21, 1997.

- Kim, N.K. 1999a. Letter and data review package to G. Barnhart, Director, Division of Fish, Wildlife and Marine Resources, transmitting notice of acceptability of PCB results on Virginia and Maryland striped bass for sale in New York State markets. Director, Division of Environmental Health Assessment, New York State Department of Health, Albany, New York. February 17, 1999.
- Kim, N.K. 1999b. Letter and data review package to G. Barnhart, Director, Division of Fish, Wildlife and Marine Resources, transmitting notice of acceptability of PCB results on Massachusetts striped bass for sale in New York State markets. Director, Division of Environmental Health Assessment, New York State Department of Health, Albany, New York. March 15, 1999.
- Malcolm Pirnie, Inc. 1977. *Investigation of Conditions Associated with the Removal of the Fort Edward Dam. Review of the 1975 Report*. Malcolm Pirnie, Inc., White Plains, New York. August, 1977. 141 p.
- Marks, M.P. 2003. Personal communication regarding the history of En Chem, Inc. Client Manager, En Chem, Inc., Madison, Wisconsin. July 3, 2003.
- McGroddy, S.E., L.B. Read, L.J. Field, C.G. Severn and R.N. Dexter. 1997. *Hudson River Congener-Specific Analysis Data Summary and Analysis Report*. EVS Environmental Consultants, Inc., Seattle, Washington and National Oceanic and Atmospheric Administration, Damage Assessment Center, Silver Spring, Maryland. EVS Project No.: 2/551-103.
- McReynolds, D., P. Nichols and L.C. Skinner. 2004. *Polychlorinated Biphenyls (PCBs) in Five Fish Species from the New York - New Jersey Harbor Estuary*. Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. February, 2004. 397 p.
- Nadeau, R.J. and R.P. Davis. 1975. *Investigation of Polychlorinated Biphenyls in the Hudson River (Hudson Falls - Ft. Edward Area)*. USEPA Region II report. 39 p.
- Nadeau, R.J. and R.P. Davis. 1976. Polychlorinated biphenyls in the Hudson River (Hudson Falls to Fort Edward, New York State). *Bull. Environ. Contam. Toxicol.* 16(4): 436-444.
- Newell, A.J., D.W. Johnson and L.K. Allen. 1987. *Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife*. Tech. Rep. 87-3. Bureau of Environmental Protection, New York State Department of Environmental Conservation, Albany, New York. 182 p.
- NYSDEC. 1993. *Polychlorinated Biphenyls, PCBs*. New York State - Human Health Fact Sheet - Ambient Water Quality Value Based on Human Consumption of Fish and Shellfish. New York State Department of Environmental Conservation, Albany, New York. March 31, 1993. 7 p.

- NYSDEC. 2002. *Registry of Inactive Hazardous Waste Disposal Sites in New York State, Annual Report, Appendix G, Volume 3*. Consolidated Iron and Metal, Site Code 3360055. p. 3-117. Division of Environmental Remediation, New York State Department of Environmental Conservation, Albany, New York. April 2002.
- NYSDEC. 2003. *Proposed Remedial Action Plan Harbor at Hastings Operable Unit No. 2, Village of Hastings-on-Hudson, Westchester County, New York. Site No. 3-60-022*. Division of Environmental Remediation, New York State Department of Environmental Conservation, Albany, New York. October, 2003. 38 p., 10 figures.
- NYSDEC. 2004. *Hudson Basin Biota Database on Contaminants*. FoxPro Version 6. Bureau of Habitat, Division of Fish, Wildlife, and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. Updated September, 2004.
- NYSDOH. 1996. Letter from Ron Tramontano, Director, Center for Environmental Health to Herbert Doig, Deputy Commissioner for Natural Resources, New York State Department of Environmental Conservation. New York State Department of Health, Albany, New York. May 3, 1996.
- NYSDOH. 1998. *Health Department Issues 1998/99 Fish Consumption Advisories for Recreational Anglers*. Press Release. New York State Department of Health, Albany, New York. April 23, 1998. 2 p.
- NYSDOH. 2004. *2004-2005 Health Advisories: Chemicals in Sportfish and Game*. New York State Department of Health, Albany, New York. 23 p.
- O'Brien & Gere. 1994. *Fort Edward Dam PCB Remnant Containment 1993 Post-Construction Monitoring Program*. O'Brien & Gere Engineers, Inc., Liverpool, New York. May 1994.
- O'Keefe, P., D. Hilker, C. Meyer, K. Aldous, L. Shane, R. Donnelly, R. Smith, R.J. Sloan, L. Skinner, and E. Horn. 1984. Tetrachlorodibenzo-p-dioxins and tetrachlorodibenzofurans in Atlantic Coast striped bass and in selected Hudson River fish, waterfowl and sediments. *Chemosphere*. 13(8): 849-860.
- Parsons. 2003. *Annual Fish Tissue Sampling Program Data Report of 2002 Results and Eight-year Summary (1995-2002)*. Niagara Mohawk Power Corporation Queensbury Site, Town of Queensbury, Warren County, New York. Parsons Engineering Science, Inc., Liverpool, New York.
- Parsons. 2005. *Draft Annual Fish Tissue Sampling Program Data Report of 2004 Results and Ten-year Summary (1995-2004)*. Niagara Mohawk Power Corporation Queensbury Site, Town of Queensbury, Warren County, New York. Parsons Engineering Science, Inc., Liverpool, New York.

- Phillips, P.J. and D.W. Hanchar. 1996. *Water-Quality Assessment of the Hudson River Basin in New York and Adjacent States - An Analysis of Available Nutrient, Pesticide, Volatile Organic Compound and Suspended Sediment Data, 1970-90*. U.S. Geological Survey Water-Resources Investigations Report 96-4065.
- Skinner, L.C. 1993. *Dioxins and Furans in Fish below Love Canal, New York: Concentration Reduction Following Remediation*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. 52 p.
- Skinner, L.C., S.J. Jackling, G. Kimber, J. Waldman, J. Shastay and A.J. Newell. 1996. *Chemicals in Fish, Shellfish and Crustaceans from the New York-New Jersey Harbor Estuary: PCB, Organochlorine Pesticides and Mercury*. Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. 150 p.
- Sloan, R.J., K.W. Simpson, R.A. Schroeder and C.R. Barnes. 1983. Temporal trends toward stability of Hudson River PCB contamination. *Bull. Environ. Contam. Toxicol.* 31: 377-385.
- Sloan, R., M. Brown, R. Brandt and C. Barnes. 1984a. Hudson River PCB relationships between resident fish, water and sediment. *NE Environ. Sci.* 3(3/4): 137-151.
- Sloan, R.J., P. O'Keefe, L. Skinner, C. Meyer and D. Hilker. 1984b. Dioxin, dibenzofuran and PCB distribution as reflected by Atlantic Coast striped bass samples. *Trans. 1984 N.E. Fish Wildl. Conf., 40th N.E. Fish Wildl. Conf., Ocean City, MD.* p.230. Abstr.
- Sloan, R.J. and E.G. Horn. 1986. *Contaminants in Hudson River Striped Bass: 1978-1985*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 86-2(BEP). 21 p.
- Sloan, R.J. 1987. *Toxic Substances in Fish and Wildlife: Analyses since May 1, 1982, Volume 6*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 87-4 (BEP). 182 p.
- Sloan, R.J. and R.W. Armstrong. 1988. PCB patterns in Hudson River fish. II. Migrant and marine species. pp. 325-350. *In* C.L. Smith (ed.). *Fisheries Research in the Hudson River*. State University of New York Press, Albany, New York. 407 p.
- Sloan, R.J., D. Stang and E.A. O'Connell. 1988a. *Ten Years of Monitoring PCB in Hudson River Striped Bass*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 88-2 (BEP). 38 p.

- Sloan, R.J., B. Young, V. Vecchio, K. McKown and E.A. O'Connell. 1988b. *PCB Concentrations in the Striped Bass from the Marine District of New York State*. Division of Fish and Wildlife and Division of Marine Resources, New York State Department of Environmental Conservation. Tech. Rep. 88-1(BEP). 79 p.
- Sloan, R.J. and K. Jock 1990. *Chemical Contaminants in Fish from the St. Lawrence River Drainage on Lands of the Mohawk Nation at Akwesasne and near the General Motors Corporation/Central Foundry Division Massena, New York Plant*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 90-1 (BEP). 96 p.
- Sloan, R.J. and K.A. Hattala. 1991. *Temporal and Spatial Aspects of PCB Contamination in Hudson River Striped Bass*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 91-2 (BEP). 97 p.
- Sloan, R.J. 1993. *Update on 1992 Hudson River Fish PCB Results*. Internal memorandum and short textual report with tables and figures summarizing PCB results in fish from 1977 through 1992. Bureau of Environmental Protection, Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. July 13, 1993. 37 p.
- Sloan, R.J. 1994. *A Brief Report on PCB in Hudson River Striped Bass*. Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 94-3(BEP). 63 p.
- Sloan, R.J., B. Young and K. Hattala. 1995. *PCB Paradigms for Striped Bass in New York State*. Division of Fish and Wildlife, Division of Marine Resources, New York State Department of Environmental Conservation, Albany, New York. Tech. Rep. 95-1 (BEP). 116 p.
- Sloan, R.J. and L.J. Field. 1996. *PCBs in Hudson River Fish: The Historical "Aroclor" Perspective*. Poster presentation, 17th Annual SETAC Meeting: Washington, D.C. November 21, 1996.
- Sloan, R.J. 1999a. *Hudson River Fish and the PCB Perspective*. Presentation to the National Research Council, Committee on Remediation of PCB-contaminated Sediments, Albany, New York. November 8, 1999.
- Sloan, R.J. 1999b. *PCBs in the Biota of the Valatie Kill*. Internal memorandum and brief textual report with tables and figures summarizing results in fish and other biota from 1979 through 1997. Bureau of Environmental Protection, Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, New York.

- Sloan, R.J. 1999c. *Striped bass PCB decline - reopening consideration*. Memo to J. Colquhoun. Briefing on 1997 PCB results. Bureau of Habitat, Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. Feb. 11, 1999.
- Sloan, R.J. 2000. *Long Term Hudson River PCB Analysis Project*. Bureau of Habitat, Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. Revised November 21, 2000.
- Sloan, R.J. and M.W. Kane. 2001. Non-PCB Contaminants in Hudson River Fish. Presentation to Hudson River Environmental Society, Stevens Institute of Technology, Hoboken, New Jersey. November 1, 2001.
- Sloan, R.J., M.W. Kane and L.C. Skinner. 2002. *1999 as a Special Spatial Year for PCBs in Hudson River Fish*. Bureau of Habitat, Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. 111 p.
- Sloan, R.J. 2003. *Long Term Hudson River Biota Evaluation PCB Analysis Project (An update to the Revised November 2000 Long Term Hudson River PCB Analysis Project, with specific reference to the 2002 and 2003 sampling years)*. Bureau of Habitat, Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. January 17, 2003.
- Smith, C.L. 1985. *The Inland Fishes of New York State*. New York State Department of Environmental Conservation, Albany, New York. 522 p.
- Sofaer, A.D. 1976. *Interim Order and Opinion in the Matter of Alleged Violations of the Environmental Conservation Law of the State of New York by General Electric Company, Respondent*. NYSDEC File No. 2833. 77p.
- Spagnoli, J.J. and L.C. Skinner. 1977. PCB's in fish from selected waters of New York State. *Pest. Monit. J.* 11(2): 69-87.
- Spodaryk, J.G., T.L. Preddice, L.C. Skinner, R.J. Sloan, H.C. Rowell. 2005. *Upper Hudson River PCB Trackdown Using PISCES*. Bureau of Habitat, Division of Fish, Wildlife and Marine Resources, New York State Department of Environmental Conservation, Albany, New York. February, 2005.
- Stow, C.A., L.J. Jackson, and J.F. Amrhein. 1997. An examination of the PCB:lipid relationship among individual fish. *Can. J. Fish. Aquat. Sci.* 54: 1031-1038.

- TAC Report. 2001. *Report from the Temporary Advisory Committee on Hudson River Striped Bass to Erin Crotty, Acting Commissioner, New York State Department of Environmental Conservation on The Hudson River Striped Bass Fishery*. New York State Department of Environmental Conservation, Albany, New York. 12 p.
- USEPA. 1976. *Criteria Document - PCBs*. EPA 440/9-76-021. United States Environmental Protection Agency, Washington, D.C. 357 p. plus references and five appendices.
- USEPA. 1980. *Ambient Water Quality Criteria for Polychlorinated Biphenyls*. EPA 440/5-80-068. Office of Water Regulations and Standards Criteria, United States Environmental Protection Agency, Washington, D.C. October, 1980.
- USEPA. 2002. *Hudson River PCBs Site: Record of Decision*. United States Environmental Protection Agency, Washington, D.C. Feb. 1, 2002.
- USFDA. 1977. Polychlorinated biphenyls (PCBs). Fed. Reg. 42(63): 17487-17494.
- USFDA. 1984. Polychlorinated biphenyls (PCBs) in fish and shellfish, reduction of tolerances; final decision. Fed. Reg. 49(100): 21514-21520.

APPENDIX I

Fish Collection, Sample Preparation and Analytical Procedures

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

GENERAL FISH COLLECTION PROCEDURES

- A. Following data are to be taken on each fish collected:
1. Date collected
 2. Species identification (please be explicit enough to enable assigning genus and species)
 3. Total length (nearest mm or smallest sub-unit on measuring instrument) and weight (nearest g or smallest sub-unit of weight on weighing instrument). Take all measures as soon as possible with calibrated, protected instruments (e.g. from wind and upsets) and prior to freezing.
 4. Method of collection (gill net, hook and line, etc.)
 5. Sample location (Waterway and nearest prominent identifiable landmark).
 6. Sex - fish may be cut enough to allow sexing, but do not eviscerate.
 7. Tag number (each specimen to be individually tagged, immediately upon collection, with jaw tag). Must be a unique number, NYSDEC can supply bags and tags, if necessary. For composites of small fish, double bag with tag inside bag. If compositing small fish, try to group similar species together.

Record length and weight as soon as possible after collection and before freezing. Other data are recorded in the field upon collection. An age determination of each fish is optional, but if done, it is recorded in the appropriate "Age" column.

The original of all collection record and continuity of evidence forms shall accompany delivery of fish to the lab. A copy shall be directed to Larry Skinner or Ron Sloan. All necessary forms will be supplied by the Bureau of Habitat.

Please submit photocopies of topographic maps or good quality navigation charts indicating sampling locations. These records are of immense help to us (and hopefully you) in providing documented location records which are not dependent on memory and/or the same collection crew. In addition, they may be helpful for contaminant source trackdown and control efforts of the Department.

- B. Each fish to be wrapped in a plastic bag. The Bureau of Habitat will supply the bags.
- C. Groups of fish, by species, to be placed in one large plastic bag per sampling

location. The Bureau of Habitat will supply the larger bags.

- D. Do not eviscerate.
- E. All fish must be kept at a temperature below 45°F immediately following data processing as soon as possible, freeze at 0° F ± 10 F. Due to occasional freezer failures, daily freezer temperature logs are required.
- F. Prior to any delivery of fish, coordinate delivery with, and send copies of the collection records, continuity of evidence forms, and freezer temperature logs, to:

Larry Skinner, Ron Sloan or Michael Kane
Bureau of Habitat
625 Broadway, 5th floor
Albany, New York 12233-4756
Telephone: (518) 402-8974

Samples will then be directed to the analytical facility and personnel noted on specific project descriptions.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION



I, _____, of _____ have collected the following on
 _____ (Print Name) _____ (Print Address)
 _____, 20____ from _____ in the vicinity of _____
 Town of _____, _____ County.

Item(s): _____

said sample(s) were in my possession and handled according to standard procedures provided to me prior to collection. The sample(s) were placed in the custody of a representative of the New York State Department of Environmental Conservation on _____, 20____.

 Signature Date

I, _____, have received the above mentioned same(s) on the date specified and have assigned identification number(s) _____ to the sample(s). I have recorded pertinent data for the sample(s) on the attached collection records. The sample(s) remained in my custody until subsequently transferred, prepared or shipped at times and dates as attested to below.

Signature	Date	
SECOND RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
THIRD RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
FOURTH RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
RECEIVED IN LABORATORY BY (Print Name)		TIME & DATE
SIGNATURE	UNIT	
LOGGED IN BY (Print Name)	TIME & DATE	ACCESSION NUMBERS
SIGNATURE	UNIT	

NOTICE OF WARRANTY

By signature to the chain of custody (reverse) , the signator warrants that the information provided is truthful and accurate to the best of his/her ability. The signator affirms that he/she is willing to testify to those facts provided and the circumstances surrounding same. Nothing in this warranty or chain of custody negates responsibility nor liability of the signators for the truthfulness and accuracy of the statements provided.

HANDLING INSTRUCTIONS

On day of collection, collector(s) name(s), address(es), date, geographic location of capture (attach a copy of topographic map or navigation chart), species, number kept of each species, and description of capture vicinity (proper noun, if possible) along with name of Town and County must be indicated on reverse.

Retain organisms in manila tagged plastic bags to avoid mixing capture locations. Note appropriate information on each bag tag.

Keep samples as cool as possible. Put on ice if fish cannot be frozen within 12 hours. If fish are held more than 24 hours without freezing, they will not be retained or analyzed.

Initial recipient (either DEC or designated agent) of samples from collector(s) is responsible for obtaining and recording information on the collection record forms which will accompany the chain of custody. This person will seal the container using packing tape and writing his signature, time and date across the tape onto the container with indelible marker. Any time a seal is broken, for whatever purpose, the incident must be recorded on the Chain of Custody (reason, time and date) in the purpose of transfer block container then is resealed using new tape and rewriting signature, with time and date.

**NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
BUREAU OF HABITAT**

FISH PREPARATION PROCEDURES FOR CONTAMINANT ANALYSIS

Background

New York State Department of Environmental Conservation (DEC) conducts studies requiring chemical analysis on fish tissues. Routine monitoring and surveillance studies develop data on contaminants in fish for several reasons:

1. To identify sources of environmental contamination;
2. To identify the geographic extent of environmental contamination;.
3. To identify temporal trends of contaminants in fish and wildlife; and
4. To provide information regarding human consumption advisories.

Chemical analyses of edible-fish flesh have been determined to be the most appropriate analyses for satisfying all of these objectives. The following methodology has been developed in order to standardize the tissues under analysis and to adequately represent the contaminant levels of fish flesh. The methodology is slightly modified from the U.S. Food and Drug Administration procedures. The portion of edible flesh analyzed will be referred to as the standard fillet unless otherwise noted. For some species, the procedure is modified as indicated below.

Procedures for Standard Filleting

1. Remove scales from fish. Do not remove the skin.
2. Make a cut along the ventral midline of the fish from the vent to the base of the jaw.
3. Make diagonal cut from base of cranium following just behind gill to the ventral side just behind pectoral fin.
4. Remove the flesh and ribcage from one-half of the fish by cutting from the cranium along the spine and dorsal rays to the caudal fin. The ribs should remain on the fillet.
5. Score the skin and homogenize the entire fillet.

Modifications to Standard Fillet

Four modifications of the standard fillet procedure are designed to account for variations in fish size or known preferred preparation-methods of the fish for human consumption.

1. Some fish are too small to fillet by the above procedure. Fish less than approximately 6 inches long and rainbow smelt are prepared by cutting the head off from behind the pectoral fin and eviscerating the fish. Ensure that the belly flap is retained on the carcass to be analyzed. When this modification is used, it should be noted when reporting analytical results.
2. Some species are generally eaten by skinning the fish. The skin from these species is also relatively difficult to homogenize in the sample. Hence, for the following list of species, the fish is first skinned prior to filleting:

Brown bullhead	White catfish
Yellow bullhead	Channel catfish
Atlantic sturgeon	Lake sturgeon
Black bullhead	Atlantic tomcod
3. American eel are analyzed by removing the head, skin, and viscera; filleting is not attempted.
4. Forage fish and young-of-year fish are analyzed whole. This category is considered to be less than 150mm (6 inches).

ORGANOCHLORINE RESIDUES
NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Hale Creek Field Station
Toxic Substances Monitoring Laboratory

Reference: See FDA Pesticide Analytical Manual Vol. I,
Sec. 211, 253 2nd Edition

1. Extraction:

- a. Using an analytical balance, (check balance daily, see 3. Calibration) weigh a 250 mL flat bottom boiling flask (24/40) containing 2-3 Teflon boiling chips (hexane-extracted).
- b. Pour ca 200 mL 50/50hexane/acetone into boiling flask and place on cold hot plate.
- c. Place pre-extracted glass wool in soxhlet, covering the bottom and siphon tube inlet. Quantitatively transfer, using hexane, sample into soxhlet. Be sure level of sample is below top of siphon tube (the sample may be compressed with a wad of glass wool). If needed, add glass stoppers to soxhlet until level with top of siphon tube. Connect soxhlet to condenser and boiling flask.
- d. Turn on hot plate at ~2:30pm and extract overnight (ca 16hrs). Check after 30 min to ensure vigorous boiling and vapor condensation. Turn off in the morning and let cool (ca 30-60 minutes).
- e. Remove boiling flask and soxhlet from hot plate. Drain, through siphon tube, remaining hexane into boiling flask and remove soxhlet. Rinse the lower ground glass connection and neck of flask with hexane.
- f. Evaporate hexane/acetone, just to dryness, using the rotary evaporator (rotovap, T=40C). Place flask in desiccator. Wipe the ground glass connection on the rotovap with hexane.

2. Cleanup:

- a. Weigh boiling flask and calculate weight of hexane-extractable material (lipid).
- b. Using a 30 mL beaker, weigh out ca 0.1g (0.07-0.12g) of sample (lipid) on an analytical balance. If total extracted lipid weighs ca 0.1g or less use entire sample (do not transfer to beaker). Alternatively, determine an appropriate dilution (with hexane) and an aliquot from which 0.5-5 mL will yield ca 0.1g of sample lipid (ie: Total weight of extracted lipid is 0.6115g. Add 6.0 mL hexane, stopper and dissolve lipid. Transfer 1.0mL,

which is equal to 0.1019 g of sample, onto column.) Or using a 30 mL beaker, weigh out ca 0.1g (0.07-0.12g) of sample (lipid) on an analytical balance.

- c. Place a 22 mm ID glass chromatography column with a 300 mL reservoir in a clamp. Place small wad of hexane-extracted glass wool in bottom of column.
- d. Fill column with 10 g (~40mL) of activated Florisil (675C for 6 hrs., stored overnight at 130C, record oven temperature in logbook). Tap column to eliminate channeling in the Florisil.
- e. Pour 5 g of anhydrous Na₂SO₄ (heated at 600C for 8 hrs., stored at room temperature) into column.
- f. Add ca 50 ml petroleum ether (pet ether) to the packed column. Drain the pet ether into a waste beaker until pet ether level is at the Na₂SO₄ layer. Turn off stopcock and discard eluate.
- g. Place a labeled glass 250 mL Erlenmeyer flask (24/40), containing 2-3 Teflon boiling chips, underneath the column.
- h. Quantitatively transfer subsample (as determined in 2b above).
- i. Allow sample to drain through column into flask at 4-5 mL per minute. Elute until solution is just at the Na₂SO₄ layer. Close the stopcock.
- j. 6% Elution: Pour 200 mL of 6% ethyl ether/pet ether (v/v) solution onto column. Elute at 4-5 mL per minute. Stop flow when solvent is just at the Na₂SO₄ layer. Remove flask and rinse the neck of the flask with petroleum ether.
- k. 20% Elution: Place a second labeled glass 250 mL Erlenmeyer flask, containing 2-3 Teflon boiling chips under the column. Pour 200 mL of 20% ethyl-ether/ pet ether (v/v) solution onto column. Elute at 4-5mL per minute. Remove flask and rinse the neck of the flask with pet ether.
- l. Sample Concentration -- 6% and 20% Elutions:
 1. Add ~10 drops of keeper solution (1 mL paraffin oil in 100 mL acetone).
 2. Evaporate just to dryness on rotovap.
- m. 6% Fraction: Dilute with isooctane (containing OCN as an internal standard) to an appropriate concentration and stopper. Shake briefly to dissolve sample. The sample is now ready for analysis by GC1.1**.

- n. 20% Fraction: : Dilute with isooctane (containing OCN as an internal standard) to an appropriate concentration and stopper. Shake briefly to dissolve sample. The sample is now ready for analysis by GC1.2**.

3. Calibration

- a. Each day the analytical balance is used, it is calibrated using its internal 100g class S weight.
- b. Analytical standard solutions are prepared from either primary standards or certified standard solutions available from many suppliers. Stock solutions in isooctane may be stored refrigerated up to one year. Working refrigerated standards may be used up to six months. New working standards should agree to within 10% of previous standards (as determined by gas chromatography).
- c. Gas Chromatographs
 1. 6% Hewlett Packard 5890II - Sample results are calculated using an internal standard. At the start of a run, three standards are analyzed and a linear calibration table is calculated. A standard is then run at least once every ten samples and the calibration table recalculated. The range of the calibration table is extended 20% above the high level standard and 20% below the low level standard. The correlation coefficient (r_5) is expected to be ≥ 0.95 . If $r_5 < 0.95$, the sample will be rerun or calculated from the standard which most closely matches it in peak area.
 2. 20% Hewlett Packard 5890II - Sample results are calculated using a single point internal standard. A standard, then up to ten samples, and another standard are injected. If the standard peak areas differ by $>15\%$, the samples are rerun.

4. Quality Control Samples

- a. With every 5 environmental samples a quality control sample is analyzed.
- b. The quality control samples are either a reagent blank, a reagent spike, or a duplicate sample. The type of quality control sample that is run is alternated among the 3 types.
- c. The acceptable criteria for reagent blanks are that no peak will interfere with the quantitation at a level greater than the detection limit.
- d. The acceptable limits for the spikes and duplicates are that the calculated

results will be within ± 3 standard deviations of the expected values (see attached Tables).

- e. If a quality control sample falls outside the acceptable limits, the sample is examined and possibly reanalyzed. If the reanalyzed sample still falls outside the acceptable limits, all analyses are stopped until the problem is rectified. Data from the quality control group are then considered suspect and the samples should be reanalyzed. If the samples cannot be reanalyzed, the data from that quality control group is flagged.

05/30/97

Analysis for PCBs by aroclor in Animal Tissue.

Four-gram animal tissue samples are weighed into a 250 ml beaker then thoroughly mixed with 100 grams of anhydrous sodium sulfate. For samples smaller than four grams, see the method modifications for small samples. The samples are stored in a desiccator overnight. The samples are then soxhlet extracted with 600 ml hexane for seven hours. The extract is concentrated by rotary evaporation; transferred to a tarred test tube through a Pasteur pipette containing sodium sulfate, and further concentrated to dryness for lipid determination.

The weighed lipid sample is dissolved in 4 ml of methylene chloride and the fat removed by injecting 2 ml on a Waters high pressure GPC (Gel Permeation Chromatography)(EPA Method 3640A). The fraction is concentrated by Turbovap and then exchanged into hexane.

The sample is transferred to a 300 ml glass chromatographic column (Kontes # 420280-0242) containing 20 grams of Florisil topped with 1 cm of sodium sulfate and the sample tube rinsed three times with about 2 ml pet ether. The column is eluted with 200 ml 6% diethyl ether /94% petroleum ether. The diethyl ether used in this analysis contains 2% ethanol. The extract is concentrated to an appropriate volume for quantification of residues by capillary column electron capture gas chromatography

GC determinations are run on two Varian 3400 GCs with a Varian Star Data System version 5.4 and a Varian 8200 Autosampler. The primary GCs is equipped with a 60M DB-5 0.25 ID capillary column and the confirmation instrument is equipped with a 60M DB-XLB 0.25 ID capillary column.

The compounds are calculated in the following manner. All the aroclor standards are at 0.5 ng/ul with one ul shot.

Starting with Aroclor 1260, 4 peaks that are unique to this mixture are located. The areas of the standards are summed and the same peaks located in the sample and also summed. Aroclor 1260 is calculated by the following formula to obtain PPM 1260.

$$\frac{(\text{Area sample}) (\text{weight of std shot in ng})}{(\text{Area 1260 std}) (\text{basis shot in mg})}$$

Aroclor 1254 is calculated by locating the major peaks in the mixture that are normally found in samples. The areas of these peaks are summed. Because some of this area comes from Aroclor 1260 and not all from Aroclor 1254, the contribution from the 1260 has to be subtracted from the total area. Aroclor 1254 is calculated by using the formula:

$$\frac{\left[(\text{Area sample}) - \left\{ \frac{(\text{PPM 1260}) (\text{Basis shot in mg}) (\text{area from 1260})}{\text{ng 1260 std}} \right\} (\text{ng 1254 std}) \right]}{(\text{Area 1254 std}) (\text{Basis shot in mg})}$$

Results are in PPM.

Aroclor 1248 is calculated in a similar fashion, subtracting the contribution from 1254 in the 1248. Aroclor 1242 is calculated using the area of five early peaks.

Total PCBs are calculated by adding the sum of Aroclor 1242, 1248, 1254, and 1260.

Basis = (weight of the sample mg/final volume of sample ul)(ul of sample shot)

Method modification for small samples

If the sample is smaller than four grams, then a 0.80-gram sample is weighed and mixed with 65 grams of sodium sulfate. The soxhlet extraction and lipid determination is the same as for large samples. The samples are run through the GPC at 2-ml giving a weight of 0.4g. The samples are run on florisil columns as the larger samples. The final extract volume is 2 ml which makes all samples have a basis of 0.2mg/ul.

APPENDIX II

DATA DICTIONARY

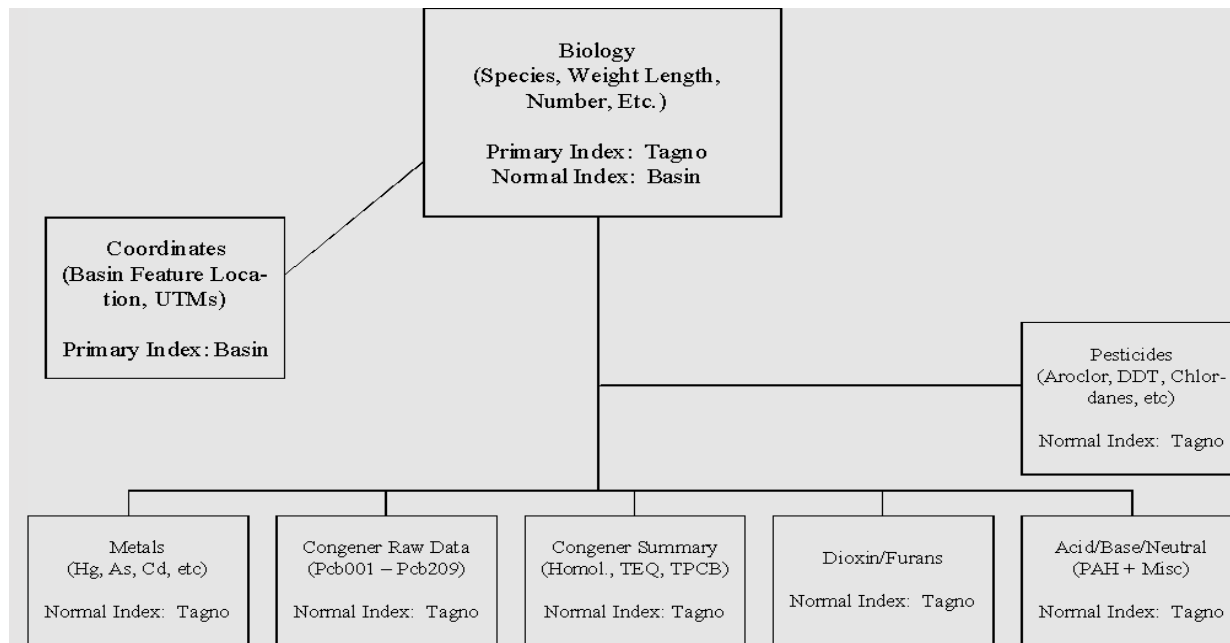
Bureau of Habitat

Data Management Structure and Format

DATA DICTIONARY

The purpose of the Data Dictionary is to specify the standardized format for fish/wildlife contaminant data that are to be appended to the master file.

The above figure represents the structure of the contaminant database. Each box represents an



individual table. Each table has been designed to store important information regarding biota collection and analysis for the Hudson River, Champlain Basin, Long Island watersheds and Marine waters.

The Bio.dbf file is the master table. All other tables link to this file via the TAGNO or BASIN field. The primary index for Bio.dbf is on TAGNO. A primary index accomplishes two simultaneous tasks. The first is to sort the table based upon the field of choice, allowing for fast retrieval during queries. The second is to guard against duplicate entries within that field. Therefore all TAGNO entries must be kept unique. Duplicate entries will result in an error message from FoxPro.

Table descriptions:

Bio.dbf: Contains physical information relating to the sample (length, species, etc.) Along with a field assigned tag number. A BASIN number is assigned in the Bio file also which links back to Coords.dbf.

Coords.dbf: Stores geographic information related to samples in Bio.dbf. Items such as Feature, Location, Basin Number (unique), River Mile, NYTME, NYTMN, and Area are recorded. River mile refers to the number of miles measured from the southern tip of Manhattan, upstream. There are 9 areas in the Marine district, 5 for New York Harbor and 4 for the Long Island Sound and Atlantic.

Hudorg.dbf: Contains organochlorine analyses, which are linked to Bio.dbf through the TAGNO field. In order to account for the multiple preparations which may be done on a single sample, TAGNO is not a unique field.

Hudmet.dbf: Stores metals analyses, such as Mercury, Lead and Cadmium, among others.

Conraw.dbf: Stores congeneric PCB analyses in row order format (due to column limitations).

Consum.dbf: Acts as a summary table for Conraw.dbf. Contains PREP codes, homolog totals and lipid based total PCBs (LPCB).

DioxFur.dbf: Contains Dioxin/DiBenzoFuran analyses

ABN.dbf: ABN is short for Acid/Base/Neutral and contains many water soluble compounds along with

polyaromatic hydrocarbons.

A complete description of each of the tables and their associated fields can be found below.

BIOLOGICAL FILE

(Bio.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
SDATE	19900628 (YYYYMMDD) Date sample(s) collected	8	0	NUMERIC
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
SPECIES (SPP)	LT, YP, SMB, etc. Species analyzed	7		CHARACTER
NO. ORGANISMS IN ANALYSIS (NOONLY)	48 No. In a single analysis Noonly = 1 for individuals	5	0	NUMBER
BASIN	1234567 Numerical code for basin, sub-basin, location (BSSLLL)	7	0	NUMERIC
LENGTH (LENMM)	12345.6 Mean total length of fish in millimeters (mm). Length of non-fish species in defined by other than standards specified in the species code data file	7	1	NUMBER
MINIMUM LENGTH (MINLEN)	12345.6 Total length of shortest fish in sample - units = mm	7	1	NUMBER
MAXIMUM LENGTH (MAXLEN)	12345.6 Total length of longest fish in sample - units = mm	7	1	NUMBER
STANDARD DEVIATION OF LENGTH (SDLEN)	12345.6 Std. Deviation of total length (mm)	7	1	NUMBER
WEIGHT (WGTG)	12345.6 Mean weight of organisms in grams - units = g	7	1	NUMBER
MINIMUM WEIGHT (MINWGT)	12345.6 Weight of lightest organism in sample - units = g	7	1	NUMBER
MAXIMUM WEIGHT (MAXWGT)	12345.6 Weight of heaviest organism in sample - units = g	7	1	NUMBER
STANDARD DEVIATION OF WEIGHT (SDWGT)	123456.7 Std. Deviation of total weight - units = g	8	1	NUMBER
SEX	M or F Sex of organism	2		CHARACTER
AGE	12 Age of organism in years	4	1	NUMBER
REMARKS	If a tag number is changed in order to comply with singularity of the primary index, then place old tag number here.	100		CHARACTER

COORDINATE FILE

(Coords.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
FEATURE	LAKE ONTARIO Lake, river, wetland, site where biota were sampled	15		CHARACTER
LOCATION	Henderson Harbor Geographic description of sample location	55		CHARACTER
BASIN	1234567 Numerical code for basin, sub-basin, location (BSSLLL)	8	0	NUMERIC
NORTH COORDINATE (NYTMN)	123456789 New York Traverse Mercator Coordinate (Northing)	9	0	NUMERIC
EAST COORDINATE (NYTME)	12345678 New York Traverse Mercator Coordinate (Easting)	8	0	NUMERIC
AREA	1 Refers to marine area in which sample(s) was collected	5	0	NUMERIC
RMILE	142 Hudson river mile as measured from the southern tip of Manhattan. Decimal places are only to distinguish between locations with the same Rmile, and in no way correspond to a geo-spatial reference.	8	1	NUMERIC

ORGANOCHLORINE FILE

(Hudorg.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
SAMPLE PREP (PREP)	SF, WH, KID	10		CHARACTER
LAB	Analyzing laboratory	5		CHARACTER
PERCENT MOISTURE (PCTMOIST)	12.34 Percent moisture of sample	5	2	NUMBER
% LIPID (PCTLPD)	12.34 Percent lipid of sample	5	2	NUMBER
AROCLOR 1016 (AR16)	1234.567 concentration as "Aroclor 1016" units = ppm	8	3	NUMERIC
AROCLOR 1254 (AR54)	1234.567 units = ppm	8	3	NUMERIC
AROCLOR 1254 &1260 (AR5460)	1234.567 units = ppm	8	3	NUMERIC
AROCLOR 1260 (AR60)	1234.567 units = ppm	8	3	NUMERIC
AROCLOR 1221 (AR21)	1234.567 units = ppm	8	3	NUMERIC
AROCLOR 1242 (AR42)	1234.567 units = ppm	8	3	NUMERIC
AROCLOR 1248 (AR48)	1234.567 units = ppm	8	3	NUMERIC
a-HEXACHLORO- CYCLOHEXANE (AHCH) aka a-BHC	12.3.4567 ppm	7	4	NUMERIC
b-HEXACHLORO- CYCLOHEXANE (BHCH) aka b-BHC	12.3456 ppm	7	4	NUMERIC
g-HEXACHLORO- CYCLOHEXANE (GHCH) aka Lindane/ g- BHC	12.3456 ppm	7	4	NUMERIC
d-HEXACHLORO- CYCLOHEXANE (DHCH) aka d-BHC	12.3456 ppm	7	4	NUMERIC
P-P' -DDT (DDT)	12.3456 ppm	8	4	NUMERIC
ortho-para DDT (OPDDT)	12.3456 ppm	8	4	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
P-P' -DDE (DDE)	12.3456 ppm	8	4	NUMERIC
ortho-para DDE (OPDDE)	12.3456 ppm	8	4	NUMERIC
P-P' - DDD (DDD)	12.3456 ppm	8	4	NUMERIC
ortho-para DDD (OPDDD)	12.3456 ppm	8	4	NUMERIC
cis-CHLORDANE aka alpha chlordane (CISCHL)	12.3456 ppm	7	4	NUMERIC
trans-CHLORDANE aka gamma chlordane (TRANSchL)	12.3456 ppm	7	4	NUMERIC
OXYCHLORDANE (OXYCHL)	12.3456 ppm	7	4	NUMERIC
METHOXYCHLOR (MEOXYCHL)	12.3456 ppm	7	4	NUMERIC
HEPTACHLOR (HEPTACHL)	12.3456 ppm	7	4	NUMERIC
HEPTACHLOR EPOXIDE (HEPCLEPX)	12.3456 ppm	7	4	NUMERIC
MIREX	12.3456 ppm	7	4	NUMERIC
PHOTOMIREX (PHOMIREX)	12.3456 ppm	7	4	NUMERIC
TOXAPHENE (TOXAPH)	12.3456 ppm	7	4	NUMERIC
TRANSONACHLOR aka alpha nonachlor (TRANSON)	12.3456 ppm	7	4	NUMERIC
CISNONACHLOR aka beta nonachlor (CISNON)	12.3456 ppm	7	4	NUMERIC
OCTACHLORO- STYRENE (OCTACLST)	12.3456 ppm	7	4	NUMERIC
ENDRIN	12.3456 ppm	7	4	NUMERIC
ENDRIN ALDEHYDE (ENDRINAL)	12.3456 ppm	7	4	NUMERIC
ENDOSULFAN I (ENDOSUL1)	12.3456 ppm	7	4	NUMERIC
ENDOSULFAN II (ENDOSUL2)	12.3456 ppm	7	4	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
ENDOSULFAN SULFATE (ENDOSATE)	12.3456 ppm	7	4	NUMERIC
DIELDRIN	12.3456 ppm	7	4	NUMERIC
ALDRIN	12.3456 ppm	7	4	NUMERIC
HEXACHLORO - BENZENE (HCB)	12.3456 ppm	7	4	NUMERIC
a-CHLORDENE (ACHLOR)	12.3456 ppm	7	4	NUMERIC
b-CHLORDENE (BCHLOR)	12.3456 ppm	7	4	NUMERIC
g-CHLORDENE aka Compound E (GCHLOR)	12.3456 ppm	7	4	NUMERIC
TOTAL PCB (TPCB)	1234.567 Total of all "Aroclor" ppm	8	3	NUMERIC
LIPID NORMALIZED PCB (LPCB)	1234.567 Lipid normalized of Total "Aroclor" ppm	8	3	NUMERIC
SIMPLE TOTAL PCB (STPCB)	1234.567 Total PCB shown in data where no "Aroclor" nor congener data was supplied by the provider.	8	3	NUMERIC
TOTAL DDT (TDDT)	123.4567 Total of DDD, DDE, DDT, OPDDD, OPDDE & OPDDT units = ppm	8	4	NUMERIC
TOTAL CHLORDANE (TCHL)	Total of cis & trans chlordanes + oxychlordane + cis & transnonachlors	7	4	NUMERIC
TOTAL HCH (THCH)	Total of AHCH, BHCH, GHCH & DHCH units = ppm	7	4	NUMERIC
TOTAL MIREX (TMIREX)	Total of mirex and photomirex units = ppm	7	4	NUMERIC
TOTAL DIELDRIN (TDLDRN)	total of dieldrin + aldrin units = ppm	7	4	NUMERIC
FILENAME	Name of DEC file from which data were appended	8		CHARACTER

RAW PCB CONGENER FILE

(Conraw.dbf)

The Conraw file is a bit different from other files in the data set. While other files are in column major order, Conraw is in row major order. Column major order is a common tabular format in which one sample (in our case biota) uses only one record in the data set. Row major order uses a variable number of records in the data set equal to the number of analyses performed on that sample. To view the differences, one may compare Consum.dbf (column major order) with Conraw (row major order).

Field Name (mnemonic)	Example/Remarks	Field Width	Decima l	Type
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
CONGENER PCB NUMBER (CHEMCODE)	monoelute = P### coelute = P##### where the two PCB numbers are combined into a single 6 digit number (P004 + P010 = P004010)	10	3	NUMERIC
CONCENTRATION (CONCEN)	12345.678 (ppb)	10	3	NUMERIC

SUMMARY CONGENER FILE

(Consum.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
SAMPLE PREP (PREP)	SF, WH, KID	10		CHARACTER
LAB	Analyzing laboratory	5		CHARACTER
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
COLUMN	DB1 Capillary column used for analyses	6		CHARACTER
MONOPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
DIPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
TRIPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
TETRAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
PENTAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
HEXAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
HEPTAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
OCTAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
NONAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
DECAPCB	1234567.89 10 11 (ppb)	11	4	NUMERIC
TOTAL PCB (TPCB)	123456.78 (ppb) Total PCB as calculated from individual congeners	12	2	NUMERIC
TOTAL LIPID PCB (LPCB)	Lipid normalized of Total "Congener" ppm	20	3	NUMERIC
PCTMOIST	123.45 Percent moisture measured by the lab	5	2	NUMERIC
PCTLPD	123.45 Percent lipid measured by the lab	5	2	NUMERIC
FILENAME	Name of DEC file from which data were appended	8		CHARACTER
REMARKS	If a tag number is changed in order to comply with singularity of the primary index, then place old tag number here.	100		CHARACTER
NO_PEAKS	123 (ppb) Total number of peaks analyzed in a particular analysis	3	0	NUMERIC

METALS FILE

(Hudmet.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
SAMPLE PREP (PREP)	SF, WH, KID	10		CHARACTER
LAB	Analyzing laboratory	5		CHARACTER
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
PCTMOIST	123.45 Percent moisture measured by the lab	5	2	NUMERIC
PCTLPD	123.45 Percent lipid measured by the lab	5	2	NUMERIC
FILENAME	Name of DEC file from which data were appended	8		CHARACTER
REMARKS	If a tag number is changed in order to comply with singularity of the primary index, then place old tag number here.	100		CHARACTER
MERCURY (HG)	1234.56 ppm	6	2	NUMERIC
ORGANIC MERCURY (ORGHG)	1234.56 ppm	6	2	NUMERIC
INORGANIC MERCURY (INORGHG)	1234.56 ppm	6	2	NUMERIC
LEAD (PB)	1234.56 ppm	6	2	NUMERIC
CADMIUM (CD)	1234.56789 ppm	9	5	NUMERIC
COBALT (CO)	1234.56 ppm	6	2	NUMERIC
VANADIUM (VN)	1234.56 ppm	6	2	NUMERIC
ARSENIC (AS)	1234.56 ppm	6	2	NUMERIC
SELENIUM (SE)	1234.56 ppm	6	2	NUMERIC
ZINC (ZN)	1234.56 ppm	6	2	NUMERIC
CHROMIUM (CR)	1234.56 ppm	6	2	NUMERIC
SILVER (AG)	1234.56 ppm	6	2	NUMERIC
COPPER (CU)	1234.56 ppm	6	2	NUMERIC
STRONTIUM (SR)	1234.56 ppm	6	2	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
NICKEL (NI)	1234.56 ppm	6	2	NUMERIC

DIOXIN/FURAN FILE

(Dioxfur.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
SAMPLE PREP (PREP)	SF, WH, KID	10		CHARACTER
LAB	Analyzing laboratory	5		CHARACTER
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
PCTMOIST	123.45 Percent moisture measured by the lab	5	2	NUMERIC
PCTLPD	123.45 Percent lipid measured by the lab	5	2	NUMERIC
FILENAME	Name of DEC file from which data were appended	8		CHARACTER
REMARKS	If a tag number is changed in order to comply with singularity of the primary index, then place old tag number here.	100		CHARACTER
2,3,7,8-TETRA- CHLORODIBENZO- DIOXIN (CDD2378)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,7,8-PENTA- CHLORODIBENZO- DIOXIN (CDD12378)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,6,7,8- HEXACHLORO- DIBENZODIOXIN (CDD123678)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,7,8,9- HEXACHLORO- DIBENZODIOXIN (CDD123789)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,7,8- HEXACHLORO- DIBENZODIOXIN (CDD123478)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,6,7,8- HEPTACHLORO- DIBENZODIOXIN (CDD1234678)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
OCTACHLORO- DIBENZODIOXIN (OCDD)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
2,3,6,7- TETRACHLORO- DIBENZOFURAN (CDF2367)	12345.678 parts per trillion (ppt)	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
2,3,7,8- TETRACHLORO- DIBENZOFURAN (CDF2378)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
3,4,6,7- TETRACHLORO- DIBENZOFURAN (CDF3467)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,7,8- PENTACHLORO- DIBENZOFURAN (CDF12378)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
2,3,4,6,7- PENTACHLORO- DIBENZOFURAN (CDF23467)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
2,3,4,7,8- PENTACHLORO- DIBENZOFURAN (CDF23478)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,7,8- HEXACHLORO- DIBENZOFURAN (CDF123478)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,6,7- HEXACHLORO- DIBENZOFURAN (CDF123467)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,6,7,8- HEXACHLORO- DIBENZOFURAN (CDF123678)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
2,3,4,6,7,8- HEXACHLORO- DIBENZOFURAN (CDF234678)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,7,8,9- HEXACHLORO- DIBENZOFURAN (CDF1,2,3,7,8,9)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,6,7,8- HEPTACHLORO- DIBENZOFURAN (CDF1234678)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
1,2,3,4,7,8,9- HEPTACHLORO- DIBENZOFURAN (CDF1234789)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
OCTACHLORO- DIBENZOFURAN (OCDF)	12345.678 parts per trillion (ppt)	8	3	NUMERIC
TTCD	Total Tetrachloro- dibenzodioxins in ppt	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
TPCD	Total Pentachloro-dibenzodioxins in ppt	8	3	NUMERIC
THCD	HCDD4+HCDD6+ HCDD7 concentration in ppt	8	3	NUMERIC
THPCDD	Total Heptachloro-dibenzodioxins in ppt	8	3	NUMERIC
TTCDF	Total Tetrachloro-dibenzofurans in ppt	8	3	NUMERIC
TPCDF	PCDF1+PCDF4 in ppt	8	3	NUMERIC
THCDF	HCDF14+HCDF16+HCDF19+HCDF46 in ppt	8	3	NUMERIC
THPCDF	HPCDF6+HPCDF9 in ppt	8	3	NUMERIC

ACID/BASE NEUTRAL FILE

(ABN.dbf)

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
SAMPLE PREP (PREP)	SF, WH, KID	10		CHARACTER
LAB	Analyzing laboratory	5		CHARACTER
LAB NUMBER (LABNO)	123M56X2 ID number assigned by laboratory. No hyphens, spaces, etc.	20		CHARACTER
TAG NUMBER (TAGNO)	ABC123D7 sampler. No hyphens, spaces, etc.	20		CHARACTER
PCTMOIST	123.45 Percent moisture measured by the lab	5	2	NUMERIC
PCTLPD	123.45 Percent lipid measured by the lab	5	2	NUMERIC
FILENAME	Name of DEC file from which data were appended	8		CHARACTER
REMARKS	If a tag number is changed in order to comply with singularity of the primary index, then place old tag number here.	100		CHARACTER
BIPHENYL	12345.67 ppb	8	3	NUMERIC
DICOFOL	12345.67 ppb	8	3	NUMERIC
Trifluralin (triflu)	12345.67 ppb	8	3	NUMERIC
Isopropalin (ISOPRO)	12345.67 ppb	8	3	NUMERIC
PERTHANE	12345.67 ppb	8	3	NUMERIC
PHENOI	12345.67 ppb	8	3	NUMERIC
Chlorbenzilate (CLBENATE)	12345.67 ppb	8	3	NUMERIC
BIS(-2-CHLORO- ETHYL) ETHER (BIS2CLET)	12345.67 ppb	8	3	NUMERIC
2-CHLOROPHENOL (CLPH2)	12345.67 ppb	8	3	NUMERIC
1,3-DICHLORO- BENZENE (DCLB13)	12345.67 ppb	8	3	NUMERIC
1,4-DICHLORO-BENZENE (DCLB14)	12345.67 ppb	8	3	NUMERIC
BENZYL ALCOHOL (BENZALC)	12345.67 ppb	8	3	NUMERIC
1,2-DICHLORO-BENZENE (DCLB12)	12345.67 ppb	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
2-METHYLPHENOL (MEPH2)	12345.67 ppb	8	3	NUMERIC
BIS(2-CHLORO- ISOPROPYL) ETHER (B2CLISOE)	12345.67 ppb	8	3	NUMERIC
4-METHYLPHENOL (MEPH4)	12345.67 ppb	8	3	NUMERIC
N-NITROSO-DI-N- PROPYLAMINE (NITNPRAM)	12345.67 ppb	8	3	NUMERIC
HEXACHLORO-ETHANE (HEXCLETE)	12345.67 ppb	8	3	NUMERIC
NITROBENZENE (NITBEN)	12345.67 ppb	8	3	NUMERIC
ISOPHORONE (ISOPHO)	12345.67 ppb	8	3	NUMERIC
2-NITROPHENOL (NITPH2)	12345.67 ppb	8	3	NUMERIC
2,4-DIMETHYL- PHENOL (DIMEPH24)	12345.67 ppb	8	3	NUMERIC
BENZOIC ACID (BENACID)	12345.67 ppb	8	3	NUMERIC
BIS(2-CHLORO- ETHOXY) METHANE (BIS2CLME)	12345.67 ppb	8	3	NUMERIC
2,4-DICHLORO- PHENOL (DICLPH24)	12345.67 ppb	8	3	NUMERIC
1,2,4-TRICHLORO- BENZENE (TRICLB124)	12345.67 ppb	8	3	NUMERIC
1,2,5-TRICHLORO- BENZENE (TRICLB125)	12345.67 ppb	8	3	NUMERIC
1,2,3-TRICHLORO- BENZENE (TRICLB123)	12345.67 ppb	8	3	NUMERIC
NAPHTHALENE (NAPH)	12345.67 ppb	8	3	NUMERIC
4-CHLOROANILINE (CLANIL4)	12345.67 ppb	8	3	NUMERIC
HEXACHLORO- BUTADIENE (HEXCLBUT)	12345.67 ppb	8	3	NUMERIC
4-CHLORO-3- METHYLPHENOL (CL4ME3PH)	12345.67 ppb	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
1-METHYLNAPH- THALENE (MENAPH1)	12345.67 ppb	8	3	NUMERIC
1-METHYLNAPH- THALENE (MENAPH1)	12345.67 ppb	8	3	NUMERIC
2-METHYLNAPH- THALENE (MENAPH2)	12345.67 ppb	8	3	NUMERIC
HEXACHLORO- CYCLOPENTADIENE (HEXCLCYP)	12345.67 ppb	8	3	NUMERIC
2,4,6-TRI- CHLOROPHENOL (TCLPH246)	12345.67 ppb	8	3	NUMERIC
2,4,5-TRI- CHLOROPHENOL (TCLPH245)	12345.67 ppb	8	3	NUMERIC
2-CHLORO- NAPHTHALENE (CLNAPH2)	12345.67 ppb	8	3	NUMERIC
2-NITROANILINE (NITANIL2)	12345.67 ppb	8	3	NUMERIC
DIMETHYL PHTHALATE (DIMEPHTH)	12345.67 ppb	8	3	NUMERIC
ACENAPHTHYLENE (ACNAPHY)	12345.67 ppb	8	3	NUMERIC
2,6 DINITRO- TOLUENE (DINTOL26)	12345.67 ppb	8	3	NUMERIC
3-NITROANILINE (NIANIL3)	12345.67 ppb	8	3	NUMERIC
ACENAPHTHENE (ACNAPH)	12345.67 ppb	8	3	NUMERIC
NITROPHEN	12345.67 ppb	8	3	NUMERIC
2,4-DINI- TROPHENOL (DINIPH24)	12345.67 ppb	8	3	NUMERIC
4-NITROPHENOL (NIPH4)	12345.67 ppb	8	3	NUMERIC
DIBENZOFURAN (DIBFURAN)	12345.67 ppb	8	3	NUMERIC
2,4-DINI- TROTOLUENE (DNITOL24)	12345.67 ppb	8	3	NUMERIC
DIETHYL- PHTHALATE (DIETHPHT)	12345.67 ppb	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
4-CHLOROPHENYL- PHENYLEETHER (CLPH4ETH)	12345.67 ppb	8	3	NUMERIC
FLUORENE (FL)	12345.67 ppb	8	3	NUMERIC
4-NITROANILINE (NITANIL4)	12345.67 ppb	8	3	NUMERIC
4,6-DINITRO-2- METHYLPHENOL (DINMEPH)	12345.67 ppb	8	3	NUMERIC
N-NITROSODI- PHENYLAMINE*(I) (DIPHAM)	12345.67 ppb	8	3	NUMERIC
4-BROMOPHENYL- PHENYLEETHER (BRPH4ETH)	12345.67 ppb	8	3	NUMERIC
PENTACHLORO- PHENOL (PENCLPH)	12345.67 ppb	8	3	NUMERIC
PHENANTHRENE (PHENAN)	12345.67 ppb	8	3	NUMERIC
ANTHRACENE (ANTHRA)	12345.67 ppb	8	3	NUMERIC
DI-N-BUTYL- PHTHALATE (BUTPHTH)	12345.67 ppb	8	3	NUMERIC
FLUORANTHENE (FLANTH)	12345.67 ppb	8	3	NUMERIC
PYRENE	12345.67 ppb	8	3	NUMERIC
BUTYLBENZYL- PHTHALATE (BUBENPHT)	12345.67 ppb	8	3	NUMERIC
3,31-DICHLORO- BENZIDINE (DICBEN33)	12345.67 ppb	8	3	NUMERIC
BENZO(A)- ANTHRACENE (BENANTH)	12345.67 ppb	8	3	NUMERIC
CHRYSENE	12345.67 ppb	8	3	NUMERIC
BIS(2-ETHYL- HEXYL)PHTHALATE (BI2ETHPH)	12345.67 ppb	8	3	NUMERIC
DI-N-OCTYL PHTHALATE (DINOCPTH)	12345.67 ppb	8	3	NUMERIC
DENZO(B)- FLUORANTHENE (BENBFLAN)	12345.67 ppb	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
BENZO(K)- FLUORANTHENE (IBENKFLAN)	12345.67 ppb	8	3	NUMERIC
BENZO(A)PYRENE (BENAPYR)	12345.67 ppb	8	3	NUMERIC
INDENO-(1,2,3- CD)PYRENE (IND123PPY)	12345.67 ppb	8	3	NUMERIC
DIBENZO(A,H)- ANTHRACENE (DIBENANT)	12345.67 ppb	8	3	NUMERIC
IBENZO(G,H,I) PERYLENE (BENGHIPE)	12345.67 ppb	8	3	NUMERIC
2-Picoline (PICOLINE)	12345.67 ppb	8	3	NUMERIC
N-Nitroso- dimethylamine (NITAMINE)	12345.67 ppb	8	3	NUMERIC
Methyl Methane- sulfonate (METHSULF)	12345.67 ppb	8	3	NUMERIC
Ethyl Methane- Sulfonate (ETHYSULF)	12345.67 ppb	8	3	NUMERIC
Pentachloroanisole (PCA)	12345.67 ppb	8	3	NUMERIC
ANILINE	12345.67 ppb	8	3	NUMERIC
1-Nitroso- piperidine (NILPIDN)	12345.67 ppb	8	3	NUMERIC
4,3-Methyl- phenol (ME43PHEN)	12345.67 ppb	8	3	NUMERIC
7,12-Dimethyl- bez(a)anthracene (DIMEANTH)	12345.67 ppb	8	3	NUMERIC
2,6-Dichloro- phenol (DI26PHEN)	12345.67 ppb	8	3	NUMERIC
N-Nitroso- dibutylamine (NIBUTYAM)	12345.67 ppb	8	3	NUMERIC
1,2,3,5-Tetra chlorobenzene (TCB1235)	12345.67 ppb	8	3	NUMERIC
1,2,3,4-Tetra chlorobenzene (TCB1234)	12345.67 ppb	8	3	NUMERIC

Field Name (mnemonic)	Example/Remarks	Field Width	Decimal	Type
1,2,4,5-Tetra- chlorobenzene (TCB1245)	12345.67 ppb	8	3	NUMERIC
Diphenyl Disulfide (DPDS)	12345.67 ppb	8	3	NUMERIC
Diphenyl- hydrazine (DPHYDRAZ)	12345.67 ppb	8	3	NUMERIC
2,3,4,6-Tetra- chlorophenol (TET2346)	12345.67 ppb	8	3	NUMERIC
1-Naphthylamine (NAPLAMINE)	12345.67 ppb	8	3	NUMERIC
Pentachlorobenzene (PENTABEN)	12345.67 ppb	8	3	NUMERIC
Azobenzene (AZOBENZN)	12345.67 ppb	8	3	NUMERIC
Phenacetin (PHACETIN)	12345.67 ppb	8	3	NUMERIC
Pronamide (PRONAMID)	12345.67 ppb	8	3	NUMERIC
4-Aminobiphenyl (AM4BIPHEN)	12345.67 ppb	8	3	NUMERIC
Pentachloro- nitrobenzene (PENNITBENZ)	12345.67 ppb	8	3	NUMERIC
Benzidine (BENZDIN)	12345.67 ppb	8	3	NUMERIC
P-Dimethyl- aminoazobenzene (PDIMAMAZ)	12345.67 ppb	8	3	NUMERIC
Bis(2-Ethyl- hexyl)Phthalate (BIS2ETHPH)	12345.67 ppb	8	3	NUMERIC
3-Methyl- chloranthrene (ME 3 CLANTHR)	12345.67 ppb	8	3	NUMERIC
Chlorpyrifos (CPYRF)	12345.67 ppb	8	3	NUMERIC
Endrin Ketone (Endrket)	12345.67 ppb	8	3	NUMERIC
Dibenz(a,i)- 1 acridine (DIBACRID)	12345.67 ppb	8	3	NUMERIC