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PCB Paradigms for Striped Bass in New York State

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PCB PARADIGMS

FOR STRIPED BASS

IN NEW YORK STATE

by

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ABSTRACT

Documented releases of PCB to the Hudson River continue to result in elevated concentrations of PCB in the fish throughout the lower 200 miles of the river. As a result and to provide a more complete overview of PCB contamination in a portion of an important commercial, recreational fishery for New York State, the 1994 data for PCB in striped bass (Morone saxatilis) are presented in combination for both the Hudson River and the Marine District. The purpose of both sampling efforts was to evaluate PCB concentrations in the standard fillets (edible portion) of the fish. This provides information on the current status of contamination and a view of temporal and spatial trends of the PCB problem as they may relate to source conditions.

In 1994, 275 striped bass were sampled at various times and analyzed for PCB from the Hudson River from rivermile (RM) 153 at Albany/Troy downstream to the Tappan Zee Bridge at RM 27. In the Marine District, sampling was stratified over five areas, three size classes, and three seasons resulting in 862 analyses.

On a wet weight basis, total PCB was highest at RM 153 averaging 6.41 ppm. Concentrations decreased with distance downstream to about 1.9 ppm in the Tappan Zee portion of the Hudson River. PCB levels increased over the spatial gradient in the New York Harbor, area I of the Marine District, to 3.38 ppm for all three seasons and the three size groups represented in the marine sampling. Levels decreased again in the other four marine areas which included the western and eastern Long Island Sound (areas II and IV) and the western and eastern south shores of Long Island (areas III and V) to about 1.15 ppm.

A similar spatial pattern was also apparent for lipid-based log_{10}-transformed data. This transformation provides for a more statistically proper format to describe spatial and temporal differences.

Composition of PCB in 1994 also varied with location, season and size of striped bass in the Marine District. In the Hudson River, the Albany area had considerably more lower-chlorinated PCB than did locations further downstream. The New York Harbor area also had relatively more lesser-chlorinated forms of PCB than did the eastern end of Long Island. Concentrations in New York State fish not only were higher in total but they reflected lesser-chlorinated types of PCB compounds compared to data from Chesapeake Bay striped bass. New York striped bass PCB data, therefore, reflect source conditions for the Hudson River and the Marine District on both the basis of elevated concntrations and the relatively greater proportions of PCB in the fish composed of the lesser-chlorinated types of PCB. Albany/Troy at RM 153 is closer to known sources further upstream. The New York City vicinity has some additional sources although the contamination observed in the striped bass is about one-fourth that at Albany.

Concentrations of PCB in striped bass in the Hudson River as reflected by the spring fishery in the lower portion of the estuary (below RM 76 - Poughkeepsie) have not changed

significantly since about 1986. However, it is appropriate beginning with the 1995 data to start simulating sampling for the marketplace as is done for the Marine District 1995 data.

Declines in PCB concentrations at Albany/Troy and in the fall in the Haverstraw Bay/Tappan Zee are not well-defined. The 1984 levels in both instances were comparable to, if not lower, than those in 1994.

Striped bass from the Marine District in 1994 were similar to those in 1990 for PCB concentrations in the standard fillets. The last sampling for Marine District fish occurred in 1990. Fish in 1984, 1985 and 1987 were higher in PCB content compared to those in 1990 and 1994.

Localized aspects of contaminant conditions are also borne out by striped bass PCB data. Jamaica Bay samples, for example, were much lower in PCB concentrations (0.74 ppm wet weight basis) than were fish from the Upper and Lower Harbors and the East River (3.96 ppm overall).

Sex differences exist in both the Hudson River and Marine District data. Males tend to have higher concentrations than females on both wet weight and lipid bases. These differences are lessened as concentrations diminish and source conditions are less obvious. Differences also diminish with advance of the seasons (i.e. spring vs. fall in the Marine District).

INTRODUCTION

Due to its popularity and tradition as an important commercial and recreational fish, few species evoke as much interest and debate as does the striped bass (Morone saxatilis). The contamination of the Hudson River by polychlorinated biphenyls (PCB) has focused much of the attention on this particular animal even though there are at least 205 other species present in the river.

Monitoring of striped bass PCB concentrations has occurred over a number of years to document the spatial and temporal patterns of PCB contamination for purposes of establishing consumption advisories and to assist in the management and regulation of a contaminated fishery (Sloan 1988a). In the Hudson River although some collections occurred earlier (Spagnoli and Skinner 1977), the timeline for sampling begins in 1978 when collection efforts and analytical methods were established in a relatively systematic framework. Several reports and papers have resulted over the years from this work (e.g. Armstrong and Sloan 1980, Sloan and Armstrong 1988, Sloan 1994, Sloan et al. 1988, Bush et al. 1989).

In the Marine District some of the earliest PCB data were generated by Foehrenbach and Chytalo (1981). With the impending change, however, in the U.S. Food and Drug Administration tolerance level for PCB in fish sold in interstate commerce going from 5 parts per million (ppm) to 2 ppm (USFDA 1977, 1984), efforts to obtain more recent data were undertaken in 1984 (Sloan and Horn 1985). Subsequent sampling in 1985 (Sloan et al. 1986), led to the development of a more robust sampling design which was implemented in 1987 (Sloan et al. 1988). The design was modified to some extent for sampling in 1989 (Sloan 1988b). Due to fiscal constraints, however, the collections did not occur until 1990 (Sloan et al. 1991). The 1994 effort utilized the same approach to evaluate PCB concentrations in the striped bass from the Long Island area.

The principal objectives specific to each of these regions as originally developed (Sloan 1988a, 1988b) were:

Marine District - To fully assess PCB contamination of the striped bass fishery (commercial and recreational) in marine waters of New York with data adequate to discriminate potential differences in contamination between parts of the total fishing season and different zones within the Marine District. In addition the data would assess the potential for modifying the current restrictions on striped bass harvest to allow some use of the resource, if warranted.

Hudson River - To assess temporal and spatial relationships in Hudson River PCB contamination as reflected by concentrations in striped bass and to utilize the information to provide 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.

The purpose of this paper, therefore, is to not only update the efforts separately for both the Marine District and the Hudson River as reflected by sampling and PCB analyses conducted in 1994, but to also document how the two areas are related over time.

An underlying theme to the ongoing investigation involves additional input (source(s)) of PCB to the Hudson River emanating from the two General Electric Company (GE) capacitor manufacturing facilities at Ft. Edward and Hudson Falls, New York. In September of 1991, during routine monitoring by GE as part of the agreement with NYSDEC and USEPA in capping the remnant PCB deposits located along the shore of the Hudson River in the vicinity of Ft. Edward, sudden increases of extremely high PCB levels (in excess of 4000 ng/l) in the water column was noted. High concentrations in the water continued (about 500 ng/l) through 1992. Prior to the 1991 event, concentrations in the 40 mile stretch of the Hudson River from Albany to Ft. Edward were between 30 and 100 ng/l as measured by the U.S. Geological Survey (USGS) and GE (NYSDOH 1995).

Inputs to the river above Rogers Island in the Village of Ft. Edward were also noted during 1990 and 1991 in the preliminary evaluation for the reassessment of the Hudson River as a federal USEPA Superfund site (Tams and Gradient 1991, 1992). This source area was noted in some detail in 1994 (O'Brien & Gere 1994a, 1994b), but the conditions described may have represented an ongoing phenomenon since Tofflemire (1984) had also indicated a decade earlier, from measurements taken in 1980 and 1981, that about 46 percent of the PCB load to the Hudson River was occurring upstream above the remnant deposit areas north of Rogers Island "from unknown sources."

PROCEDURE

In previous years, the data from the Hudson River and the Marine District were reported as separate studies. Since the rationale for the sampling designs and analytical framework are published elsewhere in more detail for both systems (Sloan et al. 1988, 1991, Sloan and Hattala 1991, Sloan 1994), the procedures for the 1994 sampling efforts are only briefly presented here. The basic sampling designs and desired sample sizes are outlined in Tables 1 and 2 for the Hudson River and Marine District, respectively. Sampling for Hudson River striped bass generally occurs from the Albany/Troy area (RM 153) to the George Washington Bridge (RM 12) (Figure 1). In the Marine District, sampling is stratified over five geographic areas as depicted in Figure 2. Of the reports issued since the 1984 study, only once were the marine areas described (Sloan and Horn 1985), but that report included only three such zones. In 1985, however, the sampling was expanded to five areas which formed the geographic basis for subsequent collections. Hence, to update the study record, the five areas are specifically defined as follows:

New York Harbor (Area I) - that portion of the Hudson River south of the George Washington Bridge to an imaginary line between the north side of Rockaway Inlet to the tip of Sandy Hook, New Jersey; all of the East River west of the Throgs Neck Bridge; and the Harlem River south of the Cross Bronx-Expressway (Interstate Rt. 95).

Western Long Island Sound (Area II) - that portion of Long Island in the Sound extending eastward from the Throgs Neck Bridge to a line drawn between the villages of Wading River and Mastic Beach and due north to the state boundary line with Connecticut.

Western Long Island - South Shore (Area III) - that portion of Long Island on the Atlantic Ocean side (south shore) extending from the line drawn between the villages of Wading River and Mastic Beach and due south out to three miles and west to the open channel of East Rockaway Inlet.

Eastern Long Island Sound (Area IV) - that portion of Long Island in the Sound extending from the line drawn between the villages of Wading River and Mastic Beach due north to the state boundary line with Connecticut to an imaginary line formed by the northernmost points of Gardiners Island and Shelter Island.

Eastern Long Island - South Shore (Area V) - that portion of Long Island south from the imaginary line formed by the northernmost points of Gardiners Island and Shelter Island to the south shore on the Atlantic Ocean side west to the line drawn between the villages of Wading River and Mastic Beach and due south out to three miles.

In recent years the Hudson River striped bass collections involved various methods including electroshocking and gill-netting. Most fish, however, are obtained from cooperating commercial fishermen, particularly in the spring as part of the by-catch in the American shad (Alosa sapidissima) commercial fishery in the lower river. In the Marine District in 1994 the sampling effort was contracted to a private consultant, Energy & Environmental Analysts, Inc. (EEA) of Garden City, New York. The support staff requirements were too great in this collection round for the Division of Marine Resources to conduct the sampling. Similar methods of collection were employed in 1994 for the marine waters as were used in previous collections consisting mainly of donations or purchases from recreational anglers or commercial operators.

Fiscal support for marine collections and analyses utilized moneys from the Environmental Quality Bond Act. The Corporate Environmental Program of the General Electric Company provided funding for the Hudson River analyses and some of the collection effort.

Analyses for PCB were conducted at Hazleton Environmental Services, Madison, Wisconsin. In prior years the contract laboratory was Hazleton Laboratories America (HLA). In 1992 the environmental analysis portion of HLA was purchased by the newly formed Hazleton Environmental Services, Inc. (HES) which was the successful bidder on the 1993-1996 analytical contract for the Division of Fish and Wildlife. The methodology utilized by HES remains similar to that used by HLA. There was a shift, however, in the inclusion of other PCB mixtures in the characterization of total PCB. Prior to 1992 the emphasis was on three mixtures of PCB to reflect degrees of chlorination as if they represented the Monsanto commercial PCB products of Aroclor 1221, Aroclor 1016, and Aroclor 1254. The spread of PCB congeners represented by these Aroclor mixtures, in lieu of having congener specific data, ranged from mono-chloro- through hepta-chlorobiphenyl substitutions. Starting with 1992 the chromatograms are quantified on the basis of apparent pattern corresponding to best matches with Aroclors 1016, 1221, 1242, 1248, 1254 or 1260. Since the recent data reported herein still utilize packed column GC-EC methods, the presentation, rather than providing an "Aroclor" estimate, focuses on the spread of PCB homologues or congeners represented as two categories of lesser-chlorinated (fewer chlorines per biphenyl molecule characterized usually as Aroclor

1016, 1242 or 1248) versus higher-chlorinated (more chlorines per biphenyl molecule characterized as combinations of Aroclor 1254 and 1260) PCB. The least chlorinated forms or Aroclor 1221 were not apparent in the striped bass in 1992, 1993 and 1994 and therefore are not part of the PCB totals.

RESULTS AND DISCUSSION

Results in 1994

The Collections

For the most part, collection efforts in 1994 were successful. Of the 290 striped bass targeted (Table 1) for collection from the Hudson River, 275 were sampled and analyzed. The major shortfall occurred for the George Washington Bridge area. In the past few years the cooperation with counterparts in the State of New Jersey on which the effort relied has deteriorated. The Hudson River Unit in the future, starting in 1996, will sample this location and forego attempting to rely on other contacts. This particular location in the past has been important in describing the downstream PCB gradient and has represented the point at which influences from the New York Harbor begin to appear. Fortunately, collections slightly downstream in the New York Harbor areas for the Marine District program were successful in 1994.

Of the 915 striped bass targeted in 1994 for the marine waters PCB project which was stratified over five areas, three size classes and three seasons, 999 were collected (Table 2). From these, 862 were selected for analysis to best fit the sampling design. One extra fish was shipped inadvertently to the laboratory but was not analyzed.

The major problem areas where fish were not as available included the New York Harbor area (I) in the fall for the largest size class (bass > 33 inches total length (TL)). In the western portion of Long Island Sound (area II), the large size category were generally problematic and in the fall efforts, none were obtained. Area III, the south shore of western Long Island, proved productive for the most part except the large fish were not as plentiful as the two smaller size groups (i.e. 18 - 24 inches TL, and 24 - 33 inches TL) across all three seasons. The eastern portion of Long Island Sound (area IV) produced relatively fewer fish in the smallest size category (18 - 24 inches TL) for both the spring and summer months. In the fall, however, the largest size class (> 33 inches TL) were not as available. Area V, the south shore side of the eastern end of Long Island was consistent in producing all sizes sought across all seasons. All areas experienced shortfalls during May due to the tardiness of getting the contract in place for EEA, the consultant, to begin the collections.

Summaries of PCB Results

Summary results from the most recent sampling year of 1994 for the Hudson River and the Marine District are presented in Tables 3 and 4, respectively. In addition to the average total PCB concentrations on a wet weight basis along with the minimum and maximum values, the summary also presents similar information for the lesser-chlorinated and higher-chlorinated types of PCB. The summaries also include information on length and weight.

In 1994, the spring collections from Poughkeepsie south to the Tappan Zee Bridge in the Hudson River produced striped bass which averaged slightly less than 2 ppm at 1.97 ppm on a wet weight basis. The spring collection at Catskill was slightly higher on the average at 3.05 ppm. The summer (August) sample at Albany/Troy had a mean of 6.17 ppm. Another sample from Albany in October averaged 6.86 ppm. Fall collections from the Haverstraw Bay/Tappan Zee area had comparable concentrations to the spring samples from the same vicinity of 1.84 ppm and 1.55 ppm, respectively.

Summaries for the Marine District samples are found in Table 4. This particular table combines the three size classes of striped bass simply to provide an overview of PCB conditions across the three seasons and the five areas involved in the marine study. This presentation also includes summaries of lesser- versus higher-chlorinated PCB. Here, as it was for the Hudson River, the apparent bulk of PCB contamination is composed of the more highly chlorinated compounds. Overall, the average total PCB concentration was highest at 3.38 ppm in the New York Harbor area (I) with average levels being remarkably similar across the other four areas at 1.17 ppm (area II), 1.15 ppm (area III), 1.18 ppm (area IV), and 1.10 ppm (area V).

An additional set of summaries for the marine striped bass specific to the three size classes established for the project are presented in Table 5. Note the tendency for the larger fish to have higher PCB concentrations.

Statistical Comparisons

As in previous years, striped bass samples were evaluated for normality by calculating coefficients of skewness and kurtosis on $\log_{10}$-transformed and untransformed data (e.g. Sloan et al. 1986, 1987, 1988, 1991). In addition, converting the data from a wet weight basis to concentrations in the fat or lipid material has also proven useful, particularly for other species of a non-migratory nature (Armstrong and Sloan 1988; Foley et al. 1988; Sloan et al. 1983, 1984a; Sloan and Armstrong 1988; Brown et al. 1985).

In the most recent reports on PCB in Hudson River striped bass (Sloan and Hattala 1991, and Sloan 1994), another approach to expressing the data in order to reduce the variability and improving the normal distribution entailed combining the lipid-based conversion of the data and the $\log_{10}$-transform. This lipid-based $\log_{10}$-transform is included in the results for the reduction of the skewness and kurtosis coefficients for both the Hudson River and Marine District data in Tables 6 and 7, along with several other variations on the transformation process.

For the spring fishery in the lower Hudson River below RM 80, the lipid-based $\log_{10}$-transform reduced the frequency of significant skewness (g_1) and kurtosis (g_2) coefficients for the 15 years of data from 93.3 percent to 60 percent for g_1 and 93.3 percent to 20 percent for g_2. In all cases, regardless of significance, the transform improved the coefficients.

For the 1994 marine data, the same transformation process from wet weight (arithmetic) values to the lipid-based $\log_{10}$-transform (geometric) for 59 comparisons across the five areas, three size groups and three seasons resulted in reducing the frequency of significant g_1 and g_2 values from 69.5 percent to 20.3 percent for skewness and from 42.4 percent to 6.8 percent for kurtosis. Regardless of significance, the transform improved the skewness values in all but 8.5 percent of the cases. Likewise, kurtosis was reduced in all but 27.1 percent of the instances.

Given the general improvement in normality for both Hudson River and Marine District results, the lipid-based $\log_{10}$-transformation is used throughout this report for evaluating spatial and temporal PCB trends. However, the untransformed data more closely represent the actual dosages to which a consumer is exposed. Therefore, it is necessary to present the data under both regimes and the reader is cautioned in interpreting the resulting transformed (geometric) means since the concentrations are representative of a different scale of measurement. The New York State Department of Health does not use the lipid-based $\log_{10}$-transformed data in developing fish consumption health advisories because they do not reflect contaminant exposure.

Comparisons within Systems - 1994

Hudson River

The collections, from the Hudson River estuary below the Troy Dam and excluding the fall samples from the Haverstraw Bay/Tappan Zee, reflect significant differences between locations similar to what was observed in 1993 (Sloan 1994). For results on both the wet weight and lipid-based transformation expressions see Table 8. Highest concentrations occur in the Albany/Troy area and generally decline with distance downstream, presumably as a consequence of gradually diminished effects of source conditions further upstream. Although the wet weight based total PCB concentrations do not discriminate between other collection locations using unplanned comparisons (Scheffe tests) at a 95 percent probability level ($\alpha = 0.05$), the lipid-based $\log_{10}$-transform does distinguish the locations at Albany (RM 153) versus Catskill (RM 112) which produce higher concentrations compared to the others at Poughkeepsie (RM 76), Cornwall (about RM 40) and the Tappan Zee Bridge (RM 27) (Table 9 and Figures 3 and 4). This downstream gradient was documented previously but to help summarize this aspect further, Table 10 expresses the concentrations on a wet weight basis for the most recent years - 1990, 1992, 1993 and 1994.

In 1994, the sample sizes in the fall fishery focusing on the Haverstraw Bay/Tappan Zee area were greatly increased in order to better describe the PCB levels in this portion of the fishery. Perhaps, the increased sample size, almost double from previous years, explains the similarity in the concentrations between the spring and the fall collected fish (Table 11 and Figure 5). Another possibility is that the available PCB is equilibrating in the river, or the timing of collections (November and December) still precluded more highly contaminated fish from the sampling (i.e. overwintering conditions had not become established by the time of collections). The fish sampled may have represented bimodality with regard to residence time in the river. That is, the fish staying in the river over the summer would have been exposed to PCB over a longer interval compared to coastal fish which may have entered the stream more recently to seek conditions for overwintering. In a comparison of the November collected bass to the December sampling, the concentrations were significantly lower in December ($P < 0.05$) on both wet weight and $\log_{10}$-transformed lipid bases. Mean wet weight levels were 2.36 ppm and 1.39 ppm in November and December, respectively (Table 12 and Figure 6) implying that shifts in the population components may influence the outcome. It is hypothesized that differential movements into the traditional overwintering area in the vicinity of the Haverstraw Bay/Tappan Zee area involve at least two segments of striped bass. The high concentrations noted in November perhaps reflect the movement of the fish from the upstream portion of the river where PCB contamination is more pronounced. The December samples, on the other hand, are diluted to lower PCB levels via recent additions to the overwintering population by fish from the coastal migration which experience PCB exposures of lesser degree. The overall effect is that no apparent discrepancy in concentrations exist between spring and fall conditions.

Sex differences in PCB contamination is another possible explanation for apparent similar levels between spring and fall collected fish from this portion of the river. This subject is explored more fully on pages 17 and 18. Regardless, fall PCB concentrations have always been confusing in that explanations for the results are not readily apparent (Sloan 1994).

Ratios of the lower-chlorinated PCBs to the higher-chlorinated forms also differed with distance downstream. The Albany/Troy area had an average ratio of 0.65 meaning that if the higher chlorinated PCBs were at one part per million, the lower-chlorinated forms would be at 0.65 ppm. Once below Albany the higher-chlorinated, more persistent, forms tend to predominate more with distance downstream, i.e. the ratio decreases (Tables 13 and 14, Figure 7). This relationship is another indication of the influence of upstream source conditions on the patterns of PCB concentrations observed in fish from the Hudson River.

Unlike the absence of significant differences in the spring versus fall PCB concentrations in the Tappan Zee area, the ratio of lower- : higher-chlorinated PCB was significant with the fall fish having relatively more of the lesser chlorinated types of PCB (Table 15, Figure 8a). On the other hand, the difference in the ratio between November and December was not significant (Table 16, Figure 8b). The implication is that the December fish were not in the river as long as the November striped bass but in either situation that the PCB relatively available for accumulation was enhanced with the lower-chlorinated forms.

Marine District

For the total 1994 Marine District striped bass sample analyzed for PCB (862 fish), multifactor analyses of variance for total PCB on wet weight (untransformed) and $\log_{10}$-transformed lipid-based values, showed significant effects across areas, seasons and size classes (Table 17). The New York Harbor (Area I) generated the highest concentrations regardless whether the data were transformed or not. Spring fish were the lowest in PCB levels for untransformed data, whereas the spring samples had the highest concentrations if the data were transformed (Table 18 and Figure 9). The larger the fish, the greater the PCB concentration held true for both transformed and untransformed data (Table 18 and Figure 10), although the differences were more pronounced for the transformed set.

Since transformations allowed for better discrimination between groupings, the process served its function (Table 18). All seasons and size classes were distinguishable. Although not as apparent as the striped bass from Area I, Area II (western Long Island Sound) tended to be higher in PCB concentrations than did Areas III, IV, and V. This apparent distinction is consistent with data from earlier years and is perhaps indicative of other source conditions, although of lesser degree, in this portion of the Marine District.

Many of the two-way interactions were also significant. The three-way interaction could not be evaluated due to confounding in the model (i.e., there were no fish sampled in the largest size class in the fall from Area II). The two-way interactions occur when a portion of the fish for example from a particular area or season has disproportionately more or less PCB than expected. In other words they are departures from the expected pattern of contamination. Rather than explaining all of the significant interactions they are plotted using the transformed data for the Area X Season terms in Figure 11 and for Season X Size in Figure 12.

The composition of PCB in the striped bass also shifted with size of fish, season and area (Table 19). Mean comparisons for the ratios of lower- to higher-chlorinated forms of PCB (Table 20) indicate that the New York Harbor zone (Area I) had relatively more lower-chlorinated PCB than did areas II, IV, and V. Areas III and II tended to be intermediate between Area I and Areas IV and V (Figure 13). Presumably, the higher ratio in the New York Harbor area coupled with the significantly higher PCB concentrations underscores the existence of active source conditions in the vicinity. The lower ratio for the fall collections and the larger size classes may indicate the influence of the coastal migrants damping the influence of source situations in the Hudson River and New York Harbor area in that relatively less time was spent in these locales and they may have rid themselves of some of the less persistent forms of PCB (Boer et al. 1994, Sijm et al. 1992).

Recent information from the State of Maryland on PCB concentrations in striped bass from Chesapeake Bay in 1994 and 1995, indicated not only significantly lower concentrations of total PCB but the composition of the PCB that was present was greatly different from that generally observed in New York waters. In consultation with NYSDEC personnel, staff of the Maryland Department of Natural Resources and their contractor collected striped bass under the same general protocols and had them analyzed at the same laboratory New York State uses for the Hudson River and Marine District PCB programs. The average concentration in the 360 fish analyzed in composite samples of five fish resulted in a mean concentration of 0.45 ppm on a wet weight basis. None of the 72 analyses exceeded 2 ppm. The highest value observed was 1.6 ppm (Hornick, personal communication, August 1995). More surprising, however, the bulk of the contamination was of Aroclor 1260. This particularly persistent, highly bioaccumulative material is also found in New York State striped bass, but it does not predominate in New York samples to the extent that it did in the Maryland fish. These data may well represent a baseline condition for striped bass entering the coastal migrations. This information also falls in line with an earlier study on differences in striped bass, where fish from several Atlantic coastal states were sampled principally for polychlorinated dibenzodioxins and dibenzofurans. PCB was analyzed in the same fish. Chesapeake Bay samples were consistently lower than Hudson River fish for all parameters evaluated, but in addition they were lower than or at least comparable to other coastal locations (Sloan et al. 1984b, O'Keefe et al. 1984). Interestingly, in perusing the earlier data and compared to these recent studies, there has been an apparent coastwide decline in PCB levels since 1983.

Simulation of U.S. Food and Drug Administration Composites

Since there is generally a greater concentration of PCB in larger fish, one method to evaluate severity of contamination is to calculate the simple proportion of striped bass which exceed 2 ppm, the federal tolerance level at which the U.S. Food and Drug Administration (USFDA) would act to restrict interstate commerce. Table 21 details these proportions by size group for the three seasons and five areas evaluated. Several combinations of seasons and areas are also included.

Another method to evaluate exceedances of 2 ppm by size of fish is to conduct a series of simulations which would approximate market place samples, similar to what the USFDA may conduct. A computerized simulation of composite sampling of the 1994 marine striped bass PCB concentrations using a random number generator to select 10 fish per composite sample was used to develop Table 22. This table depicts the proportion of samples in a specified number of simulations (i.e. 25, 50, 100, 200, 400, and 800) that would exceed the USFDA tolerance level of 2 ppm as if the fish were sampled from a commercial interstate market. The results are stratified across the areas, seasons, and size categories established in the original project design (Table 2). Similar exercises were employed in the 1987 and 1990 sampling years in the Marine District (Sloan et al. 1988, 1991). In a 1987 letter the USFDA indicated to the New York State Department of Health that the acceptable quality level would be about 95 percent (i.e. the proportion of exceedances would be 0.05 or less)(Lake, 1987).

Note that the proportions of exceedance within a size group are relatively comparable between composite samples based on equal parts versus weighted samples. A weighted sample (the whole fillet) is one where the proportional mass from a large, highly contaminated fish increases the overall average concentration in a simulated randomly sampled composite. Presumably, this latter procedure more accurately reflects marketplace sampling conditions. When all sizes are combined in a simulation, the proportions exceeding 2 ppm tend to diverge between the two weighting procedures (equal parts vs. whole fillet) because of the general positive correlation between size and PCB content. For example, refer to the subtable in Table 22 for Area III, at 800 simulations the equal vs.whole weighting procedure in the summer 24 to 33 inch size group produced proportions exceeding 2 ppm of 0.39 and 0.56. When fish sizes were not considered, however, the respective proportions were 0.21 and 0.40.

In the size group for fish greater than 33 inches total length, it is interesting that the proportions were actually reversed at 0.72 and 0.55 indicating that smaller fish having unexpectedly high concentrations will produce lower proportions for the whole fillet aspect. This event also occurred during the simulation process for other areas and sizes.

As might be expected, the New York Harbor (Area I) failed the five percent exceedance rate generally across all categories. For the other areas, proportions of simulated samples exceeding 2 ppm were 0.05 or less in almost all areas and seasons for the smallest size group (i.e., ≥ 18 inches to < 24 inches TL).

Generally, the same areas and combinations of areas were simulated in 1994 as was done in 1990 (Sloan et al. 1991). Although Area II had lower proportions of exceedance in the 1994 sampling, the proportion exceeding 2 ppm from this area and area III were generally too high to reasonably include them with Areas IV and V except in the fall samples and in the smaller size classes. Areas IV and V were usually below 0.05 exceedance except in the summer for the two larger size groups.

As noted in the 1990 data report (Sloan et al. 1991), the pattern for the proportions of samples exceeding 2 ppm was usually apparent with 100 simulations. In many cases, it appears that 50 simulations were sufficient.

When the 1995 Hudson River striped bass data come available, and given the consistency of results in the estuary over the last few sampling years, similar simulations on that fishery are warranted, particularly since the procedure has had utility in applying PCB data within the regulatory framework related to the consumption of fish.

Comparisons within Systems - between Years

Hudson River

A summary of the results for the principal component of the

Hudson River monitoring project involving the spring collections from the estuary starting at Poughkeepsie about RM 73 and continuing downstream to the Tappan Zee Bridge (RM 27) or the George Washington Bridge (RM 12) is located in Table 23. As part of the summary the correlations between PCB concentrations and length and lipid content are included through 1994. Note the general lack of significance between length and PCB content but the correlations with fat in the standard fillet is highly significant for both transformed and untransformed data. This is consistent for the most part with results from previous evaluations and differs from what occurs in striped bass samples from the Marine District in that PCB and length does correlate to some extent for marine striped bass.

In the analyses of variance and subsequent mean comparisons and graphs of the results from 1978 thru 1994 for the spring collections in the lower estuary below RM 80, the 1979 results were eliminated due to the inordinately low sample size which tended to obfuscate the trend pattern. Although there were significant changes over the years (Table 24) for both total PCB on a wet weight basis and the $\log_{10}$-transformed lipid-based values, in recent years, since 1986, no declines are statistically apparent on the transformed data and no decrease on the wet weight untransformed data since 1978 (Table 25 and Figures 14 and 15).

Similarly, analyses of the Albany/Troy (RM 153) and the fall collections in the Haverstraw Bay/Tappan Zee reach also provide no clear trend for declining PCB concentrations even though there were significant changes between years. The 1984 data in both situations were comparable to, if not lower than the 1994 concentrations for both wet weight (untransformed) and $\log_{10}$-transformed lipid-based data (Tables 26, 27, 28 and 29, Figures 16, 17, 18, and 19).

Analysis of variance for the shift in PCB composition over the years, 1978 - 1994, indicates little change in the forms of PCB as presented in this report since 1982 (Tables 30 and 31, Figure 20). The bulk of the PCB (80 -90 percent) after 1982 in striped bass is composed of the more highly chlorinated compounds as measured by estimates of Aroclors 1254 and 1260 as compared to that represented by Aroclors 1016, 1242 or 1248 (i.e. lesser-chlorinated material).

Changes between years in the lower- : higher-chlorinated PCB ratios for the fall collections in the Haverstraw Bay/Tappan Zee area and the summer samples from the Albany/Troy location also reflect relative stability in composition over the years examined. Even though there were significant shifts between years at Albany/Troy (Table 32), 1992 had as high or higher ratios than did 1984 (Table 33, Figure 21), indicating source conditions were operating in the Hudson River throughout those years. A greater degree of stability was apparent in the fall samples from the Haverstraw Bay/Tappan Zee area in that the differences between years were not significant (Tables 34 and 35, Figure 22).

Marine District

Unlike the Hudson River data, striped bass in the Marine District usually exhibit a positive correlation between PCB concentrations and total length. Regression analyses from the years 1984, 1985, 1987, 1990 and 1994 are provided in Table 36 which show the correlation coefficients and the regression equation components. Calculations for the expected PCB concentration in a 29 inch fish is provided in the table. In 1984 the expected level for a 29 inch fish from the Marine District was 5.20 ppm, but in 1994 the predicted concentration was 1.68 ppm. Note the tendency for a negative correlation to occur for fish $\geq$ 33 inches total length. For such fish and due to the negative slope, a length at which the fish would exhibit 2 ppm was not calculated.

To provide access to summaries of previously compiled PCB data on striped bass from the Marine District, the results from 1990, 1987, 1985 and 1984 are presented in Tables 37, 38, 39, and 40, respectively. In general, the PCB concentrations were higher in 1987, 1985 and 1984 than they were in 1990 and 1994. To statistically characterize such a trend, analyses of variance were conducted on both wet weight untransformed and $\log_{10}$-transformed lipid-based total PCB data for the years listed plus the 1994 data. Tables 41 and 42, and Figures 23 and 24 confirm the earlier observation that striped bass in 1990 and 1994 were significantly lower in PCB than in the other years sampled. To simplify the analysis and to reduce redundancies from other analytical treatments, the ANOVA was restricted to a two-way factor analysis. Plots of the two-way interaction which was significant is provided in Figure 25. Note the sharp rise in 1994 for the New York Harbor (Area I) striped bass PCB concentrations compared to the level in 1990.

A similar approach was undertaken for the ratio of lower- : higher-chlorinated PCB. The ratio has declined significantly since 1984 and 1985 but significant changes have not occurred since 1987 (Tables 43 and 44, Figure 26). The ratio also decreases with distance away from the New York Harbor area.

Combination of both Systems

As a relatively concise depiction of how concentrations change spatially, a series of one-way ANOVAs on just the $\log_{10}$

lipid-based transformation provide some additional overall perspective by combining the Hudson River and Marine District datasets and looking at the data by area. Tables 45 and 46, and Figure 27 involves an analysis of several years considered together (1985, 1987, 1990 and 1994). The 1984 data were not considered due to relatively small sample sizes for some of the marine areas. What is striking in this analysis and in the subsequent separate analyses by individual year, is the obvious source condition in the upper section of the Hudson River (Albany/Troy - RM 153 and to some extent Catskill - RM 115) and the source influence in the New York Harbor area. Evaluations by year are found in Tables 47 and 48 for 1994, Tables 49 and 50 for 1990, Tables 51 and 52 for 1987, and Tables 53 and 54 for 1985. Figure 28 displays in combined format the spatial array for each year - 1994, 1990, 1987, and 1985. Note the general reduction in concentrations with distance from a source area. The New York Harbor source area also reflects approximately one-fourth the contamination compared to the Albany/Troy location.

That the New York/New Jersey Harbor functions as a source condition is not surprising. Several studies have focused on this area (e.g. Bopp and Simpson 1989, Chillrud 1995). What is striking , however, is the contrast that can be made by striped bass between the New York Harbor zone in comparison to other sectors (i.e. higher concentrations in the harbor compared to adjoining areas such as the Tappan Zee Bridge in the Hudson River at RM 27 and the western end of Long Island on the south shore - Area III).

Further Perspective on 'Source'

It is noteworthy that an animal as mobile and transitory as the striped bass can discriminate between locations through bioaccumulation of materials such as PCB. To further explore this observation, consider that the New York Harbor collections in 1994 were comprised of smaller sets of samples from several locations within Area I which was simply titled New York Harbor. These subsets were East River, Upper New York Harbor, Lower New York Harbor, and Jamaica Bay (Figure 29). The means and 95 percent confidence intervals from a two-factor ANOVA for total PCB on both transformed and untransformed data depicted in Tables 55 and 56, and Figures 30 and 31, reflect some dramatic differences between locations within the broader geographic zone known as Area I. Even though sample sizes were small in some cases, the results were consistent in that Jamaica Bay fish were much lower than all other locations regardless of season. Upper New York Harbor was highest with East River and Lower New York Harbor fish intermediate although since there was a significant interaction term these relationships tended to shift depending upon the season. The two-way interaction comparisons which are plotted in the figures show large shifts in concentration within locations by season especially for the Upper New York Harbor whereas the Jamaica Bay location was consistently low throughout 1994.

This apparent discriminatory feature for striped bass PCB contamination was also apparent in another study undertaken in the same area in the fall of 1993 (Skinner, personal communication, 1995). Table 57 printed here with permission also shows the proclivity of Jamaica Bay to generate lower PCB levels in striped bass compared to other locations in the vicinity of the New York Harbor. Summaries of the fall 1994 striped bass are also listed in Table 57 for comparative purposes. The Skinner study also produced similar average lower PCB concentrations for 12 other species of fish from Jamaica Bay compared to other locations.

<u>Sex Differences</u>

That sex differences in the concentrations of PCB do occur, not only for striped bass but also other species, has been known for some time (Gibson and O'Brien 1987, Sloan 1987). The question from a regulatory standpoint has been what to do about it. Although the differences between male and female striped bass in the Marine District are readily apparent (Tables 58 and 59), explanations for these differences are not. Figure 32 is a compendium of the two-way interactions - area X season, area X sex, and season X sex. Figure 32a shows that the further the fish are from a source condition (e.g. New York Harbor-Area I) the more equal the concentrations are between males and females. Also by fall the two sexes are nearly the same in PCB level (Figure 32c). Some have suggested that the females have less PCB because they tend to lose it through their eggs. This implies a pumping mechanism that selectively removes the contaminant since on a lipid basis the sex differences are still there or does the body equilibrate naturally after the eggs are expelled? Some analyses also indicate that the concentration in the eggs is much less on a wet weight basis than would be expected. Lipid material appears to be limited in the eggs compared to other parts of the adult fish body. However, this proposed mechanism deserves additional study. The tables and figures referred to above are limited to presentations on the concentrations in the lipid or fat in the standard fillet.

Sex differences are explored further through the combining of the 1994 Hudson River and Marine District data and looking at how these differences shift through the river and over the Long Island area (Tables 60 and 61). Figure 33 is a plot of the area X sex interaction. The differences between the sexes are more pronounced at the higher concentrations of PCB. The further away from the source areas in the Hudson River and in the New York Harbor, the differences are not as prevalent.

That the dichotomy exists also explains some of the need for increased sample sizes for adequate monitoring since it certainly contributes to variability in the data. Well designed studies on cohort (age, reproductive condition), body partitioning, selective accumulation and metabolism of specific congeners, could all result from related questions on observations such as this. Seasonal studies are also perhaps warranted in documenting intra-annual variation. On the other hand, although this association and others similar to it are interesting academically, do they matter in the end? Will they have any bearing on determining what to do about PCB issues?

A Final Thought

To paraphrase a popular saying - PCB is PCB: everything else is just details! With all that is said about PCB and the increasing focus on congener-specific data, there appears to be much ado about trivia. What was once relatively simple and straightforward is now bound up in an exponentially exploding array of information going from two or three "Aroclor" mixture estimates to the full potential 209 specific PCB compounds. It is becoming clearer that the original goal to reduce or eliminate to non-problematic proportions the levels of PCB in the environment (e.g. concentrations in fish such as striped bass and others) has become lost in the pursuit of perplexing numerical arrays.

In the search for other paradigms, a suggestion is to pause and ask is the effort justified? Will it clarify or confuse the issues? What is the ultimate goal? Remediation is one thing, but admittedly and unfortunately, it is quite another concern to attempt to answer damage-related questions without focusing on details necessary for that purpose. Certainly the issues related to Natural Resource Damage Assessments, and ecological and health risk assessments do depend on some complex understandings. The details being developed will provide the mechanism to deal with the residuals remaining and to supply insight into the implications for the future after remediation.

In determining these consequences, however, the sources of PCB to the system still require attention. Maintaining the focus toward alleviation and remediation of PCB in the Hudson River and Marine areas is critical. These environments are a great resource which supports a vast array of ecological entities of which the human element is one part. It is our impression that until sources are eliminated, other issues, such as those associated with water vs. sediment exposures of PCB to the fish, are moot.

CONCLUSIONS

1. PCB concentrations in the Hudson River and the Marine District reflect source conditions.

2. Concentrations in striped bass from the Hudson River have not declined significantly since 1986.

3. Ratios of lesser- to higher-chlorinated PCB in the Hudson River reflect source inputs as a function of distance from known source areas in the river.

4. A similar situation exists in the Marine District in that the New York Harbor area provides relatively more lesser-chlorinated PCB compared to other areas close by in the Marine District and in the Hudson River.

5. Based on concentrations observed in the striped bass, source conditions in the New York Harbor area are about one-fourth those in the Albany/Troy area.

6. Concentrations in striped bass from the Marine District have not declined since 1990.

7. It is possible to discriminate between locations using PCB concentrations in striped bass.

8. Male striped bass accumulate higher PCB concentrations than do female striped bass.

9. Sex differences become less apparent (more equal) as concentrations overall diminish and source conditions are not obvious.

10. Sex differences also diminish later in the year (spring vs. fall).

11. Striped bass from the Chesapeake Bay area exhibited overall less total PCB than did striped bass from either the Hudson River or the Marine District regardless of location, season or size.

12. The composition of the Chesapeake Bay PCB was of a more highly-chlorinated mixture compared to the PCB in the fish from New York State.

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Ta 1. Sampling plan for striped bass collections f the Hudson River.

Season	Location	Region	Collection Numbers	Date	Sizes (mm)*	Remarks
Spring (April, May & June only)	Albany/Troy	3	10	June	>457*	
			10	July	>457*	
			10	August	>457*	
	"Catskill" area	3	20	May	>457*	
	Poughkeepsie	3	20	Early run	>457*	----
			20	Late run	>457*	Collect 2 to 4 weeks after first collection
	Stony Point area	3	20	Early run	>457*	----
			20	Late run	>457*	Collect 2 to 4 weeks after first collection
	Tappan Zee Bridge	3	20	Early run	>457*	----
			20	Late run	>457*	Collect 2 to 4 weeks after first collection
	George Washington Bridge	3	20	Early run	>457*	----
			20	Late run	>457*	Collect 2 to 4 weeks after first collection
Fall	Croton Point area	3	20	October	>457*	
			20	November	>457*	
	Tappan Zee area	3	20	October	>457*	
			20	November	>457*	

* 1/3 of total striped bass sample from each location should measure 24 inches total length (610 mm) or more; at least 10% of the total sample should be targeted to be over 33 inches total length (838 mm).

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Table 2. Collection targets and status for 1994 striped bass collections conducted by EEA, Inc.

Month or Season	Length Interval (inches)	I			II			III			IV			V		
		T	A	S	T	A	S	T	A	S	T	A	S	T	A	S
May	18-24	10	10	7	10	2	2	10	0	0	10	0	0	10	1	1
	24-33	10	4	4	10	6	6	10	0	0	10	9	9	10	0	0
	>33	10	0	0	10	1	1	10	0	0	10	3	3	10	0	0
June	18-24	10	16	13	10	15	15	10	23	23	10	11	11	10	24	24
	24-33	10	20	17	10	17	17	10	21	21	10	17	17	10	28	21
	>33	10	19	19	10	7	7	10	11	11	10	14	14	10	20	20
	18-24	20	26	20	20	17	17	20	23	23	20	11	11	20	25	25
SPRING	24-33	20	24	21	20	23	23	20	21	21	20	26	26	20	28	21
	>33	20	19	19	20	8	8	20	11	11	20	17	17	20	20	20
TOTAL SPRING		60	69	60	60	48	48	60	55	55	60	54	54	60	73	66
July	18-24	7	7	4	7	10	10	7	8	8	7	6	6	7	7	7
	24-33	7	7	6	7	13	13	7	5	4	7	10	9	7	15	13
	>33	7	9	9	7	1	1	7	1	1	7	7	6	7	8	5
August	18-24	7	8	4	7	6	6	7	7	5	7	1	1	7	2	2
	24-33	7	7	4	7	3	3	7	18	16	7	12	10	7	12	10
	>33	7	4	4	7	1	1	7	8	8	7	8	8	7	11	11
September	18-24	7	14	13	7	4	4	7	12	8	7	1	1	7	12	12
	24-33	7	20	11	7	1	1	7	4	2	7	8	8	7	7	6
	>33	7	7	7	7	0	0	7	5	5	7	8	7	7	5	5
	18-24	21	29	21	21	20	20	21	27	21	21	8	8	21	21	21
SUMMER	24-33	21	34	21	21	17	17	21	27	22	21	30	27	21	34	29
	>33	21	20	20	21	2	2	21	14	14	21	23	21	21	24	21
TOTAL SUMMER		63	83	62	63	39	39	63	68	57	63	61	56	63	79	71
October	18-24	10	19	12	10	23	15	10	7	7	10	11	8	10	17	13
	24-33	10	14	14	10	12	12	10	22	17	10	5	5	10	20	11
	>33	10	16	16	10	0	0	10	9	9	10	0	0	10	6	6
November	18-24	10	11	8	10	26	18	10	5	5	10	13	12	10	11	7
	24-33	10	8	8	10	11	11	10	25	22	10	24	16	10	21	9
	>33	10	0	0	10	0	0	10	1	1	10	9	9	10	24	24
	18-24	20	30	20	20	49	33	20	12	12	20	24	20	20	28	20
FALL	24-33	20	22	22	20	23	23	20	47	39	20	29	21	20	41	20
	>33	20	16	16	20	0	0	20	10	10	20	9	9	20	30	30
TOTAL FALL		60	68	58	60	72	56	60	69	61	60	62	50	60	99	70
TOTAL COLLECTIONS		183	220	180	183	159	143	183	192	173	183	177	160	183	251	207

ZONE: I - NYC Harbor
II - Western LI-North Shore
III - Western LI-South Shore
IV - Eastern LI-North Shore
V - Eastern LI-South Shore

T - Target 915
A - Actual 999
S - Shipped 863

NOTE: DECEMBER FISH COUNTS IN NOVEMBER COLUMN

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Table 3. PCB concentrations in striped bass from the Hudson River in 1994.

Location	Month Collected	No. of fish	Length (mm) Ave.	Length (mm) Min.-Max.	Weight (g) Ave.	Weight (g) Min.-Max.	Lipid (%) Ave.	Lipid (%) Min.-Max.	Lower-Cl (ppm) Ave.	Lower-Cl (ppm) Min.-Max.	Higher-Cl (ppm) Ave.	Higher-Cl (ppm) Min.-Max.	Total PCB (ppm) Ave.	Total PCB (ppm) Min.-Max.
Albany/Troy	August	19	599	418 - 950	2392	680 - 8890	2.90	0.89 - 6.64	2.31	0.26 - 4.80	3.86	0.37- 6.60	6.17	0.63 -10.50
(RM 153)	October	10	589	492 - 730	2215	1200 - 4120	2.77	1.00 - 5.09	2.80	0.99 - 6.20	4.06	1.70- 7.40	6.86	2.82 -13.60
	All Dates	29	596	418 - 950	2331	680 - 8890	2.86	0.89 - 6.64	2.48	0.26 - 6.20	3.93	0.37- 7.40	6.41	0.63 -13.60
Catskill (RM 112)	May	21	659	470 - 960	3644	1100 - 9540	3.04	0.52 - 7.76	0.45	<0.05 - 2.20	2.60	0.52-11.60	3.05	0.59 -13.80
Poughkeepsie	April	33	666	550 - 908	3293	1560 - 8940	4.97	1.53 - 9.88	0.39	<0.05 - 3.70	2.32	0.39-11.70	2.71	0.41 -15.40
(RM 76)	May	10	669	597 - 880	3090	2040 - 7260	5.62	2.64 - 8.57	0.30	<0.05 - 0.70	1.70	0.72- 4.80	1.99	0.91 - 5.50
	All Dates	43	667	550 - 908	3246	1560 - 8940	5.12	1.53 - 9.88	0.37	<0.05 - 3.70	2.18	0.39-11.70	2.54	0.41 -15.40
Croton Pt.	April	18	653	557 - 710	2887	1640 - 3900	4.32	2.41 - 6.54	0.18	<0.05 - 0.49	1.67	0.46- 3.90	1.85	0.48 - 4.39
(RM 40)	May	25	679	489 - 904	3452	1120 - 8560	4.47	1.41 - 7.58	0.20	<0.05 - 2.20	1.53	0.15- 7.00	1.73	0.20 - 9.20
	All Dates	43	668	489 - 904	3215	1120 - 8560	4.41	1.41 - 7.58	0.19	<0.05 - 2.20	1.59	0.15- 7.00	1.78	0.20 - 9.20
Tappan Zee	April	20	650	548 - 910	2981	1720 - 8760	4.49	1.43 - 7.34	0.24	<0.05 - 1.60	1.67	0.33- 6.30	1.91	0.38 - 7.90
Bridge	May	20	654	536 - 976	2997	1380 -10660	4.06	1.30 - 7.06	0.12	<0.05 - 0.62	1.07	0.31- 3.33	1.19	0.37 - 3.95
(RM 27)	All Dates	40	652	536 - 976	2989	1380 -10660	4.27	1.30 - 7.34	0.18	<0.05 - 1.60	1.37	0.31- 6.30	1.55	0.37 - 7.90
Lower Estuary (RM 12-76)	Spring	126	663	489 - 976	3154	1120 -10660	4.61	1.30 - 9.88	0.25	<0.05 - 3.70	1.72	0.15-11.70	1.97	0.20 -15.40
Haverstraw	November	46	646	495 - 820	3321	1400 - 6700	5.82	1.05 - 9.67	0.44	<0.05 - 1.40	1.92	0.44- 5.00	2.36	0.47 - 6.40
Bay/Tappan	December	53	628	514 - 865	2841	1500 - 5200	5.55	1.35 - 9.66	0.24	<0.05 - 1.70	1.15	0.31- 3.66	1.39	0.36 - 5.36
Zee(RM27-33)	All Dates	99	636	495 - 865	3064	1400 - 6700	5.67	1.05 - 9.67	0.33	<0.05 - 1.70	1.50	0.31- 5.00	1.84	0.36 - 6.40

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Table 4. PCB concentrations in striped bass taken from marine waters of New York State in 1994.

Area	Season Collected	No. of Fish	Length (mm) Ave.	Length (mm) Min.-Max.	Weight (g) Ave.	Weight (g) Min.-Max.	Lipid (%) Ave.	Lipid (%) Min.-Max.	Lower-Cl (ppm)[a] Ave.	Lower-Cl (ppm)[a] Min.-Max.	Higher-Cl (ppm)[b] Ave.	Higher-Cl (ppm)[b] Min.-Max.	Total PCB (ppm) Ave.	Total PCB (ppm) Min.-Max.
New York	Spring	60	708	464 -1022	4095	940 -10370	3.19	0.50 - 9.18	0.43	<0.05 - 2.30	2.[illegible]4	0.52-16.00	2.57	0.54 -18.00
Harbor	Summer	62	712	465 - 993	4172	1070 - 9960	5.05	1.01 -12.90	0.77	<0.05 - 3.10	4.02	0.32-15.30	4.79	0.39 -18.40
(I)	Fall	58	698	457 -1007	3994	950 - 9190	5.15	1.00 -13.90	0.44	<0.05 - 2.50	2.28	0.34- 8.70	2.72	0.36 - 9.00
	All Seasons	180	706	457 -1022	4089	940 -10370	4.46	0.50 -13.90	0.55	<0.05 - 3.10	2.83	0.32-16.00	3.38	0.36 -18.40
Western Long	Spring	48	677	478 - 981	3430	1150 - 9000	3.05	0.62 - 8.14	0.15	<0.05 - 0.85	1.10	0.28- 4.90	1.24	0.32 - 5.75
Island Sound	Summer	39	633	475 - 848	3135	1050 - 6410	6.76	1.03 -12.60	0.18	<0.05 - 0.88	1.18	0.23- 2.62	1.36	0.26 - 3.25
(II)	Fall	56	592	472 - 792	2193	1090 - 4690	3.99	1.07 -11.50	0.11	<0.05 - 0.88	0.85	0.19- 2.17	0.97	0.24 - 2.78
	All Seasons	143	632	472 - 981	2865	1050 - 9000	4.43	0.62 -12.60	0.14	<0.05 - 0.88	1.02	0.19- 4.90	1.17	0.24 - 5.75
Western Long	Spring	55	679	465 - 962	3543	1120 - 9010	3.74	0.86 - 9.60	0.16	<0.05 - 0.66	0.94	0.35- 2.38	1.10	0.40 - 2.77
Island -South	Summer	57	698	461 -1178	4171	1100 -14930	5.03	0.77 - 9.93	0.28	<0.05 - 1.90	1.19	0.25- 5.70	1.47	0.32 - 7.10
Shore	Fall	60	738	469 -1222	4275	1340 -13500	4.54	0.88 -12.20	0.05	<0.05 - 0.50	0.83	0.12- 3.61	0.89	0.17 - 3.64
(III)	All Seasons	172	706	461 -1222	4007	1100 -14930	4.45	0.77 -12.20	0.16	<0.05 - 1.90	0.99	0.12- 5.70	1.15	0.17 - 7.10
Eastern Long	Spring	54	741	525 - 915	4640	1360 - 8860	3.61	0.72 - 9.94	0.13	<0.05 - 0.85	1.07	0.25- 2.80	1.20	0.30 - 3.19
Island Sound	Summer	56	784	500 -1021	5450	1340 -11080	5.38	0.80 -11.30	0.09	<0.05 - 0.53	1.33	0.40- 3.06	1.41	0.42 - 3.59
(IV)	Fall	50	683	484 -1105	3786	1170 -14800	4.54	1.07 -10.10	0.06	<0.05 - 0.50	0.83	0.33- 2.38	0.89	0.36 - 2.70
	All Seasons	160	738	484 -1105	4656	1170 -14800	4.52	0.72 -11.30	0.09	<0.05 - 0.85	1.09	0.25- 3.06	1.18	0.30 - 3.59
Eastern Long	Spring	66	700	500 -1001	4131	1400 - 9970	4.20	0.85 -10.10	0.09	<0.05 - 0.82	0.88	0.18- 3.30	0.97	0.23 - 4.12
Island -South	Summer	71	732	485 -1092	4646	1300 -12900	4.96	0.83 -13.70	0.12	<0.05 - 0.65	1.20	0.22- 4.23	1.32	0.27 - 4.87
Shore	Fall	70	762	477 -1040	5104	1090 -10340	4.52	0.93 -12.47	0.03	<0.05 - 0.24	0.96	0.13- 6.10	1.00	0.18 - 6.15
(V)	All Seasons	207	732	477 -1092	4637	1090 -12900	4.57	0.83 -13.70	0.08	<0.05 - 0.82	1.02	0.13- 6.10	1.10	0.18 - 6.15
Long Island	Spring	223	700	465 -1001	3958	1120 - 9970	3.70	0.62 -10.10	0.13	<0.05 - 0.85	0.99	0.18- 4.90	1.12	0.23 - 5.75
(II - V)	Summer	223	719	461 -1178	4462	1050 -14930	5.40	0.77 -13.70	0.16	<0.05 - 1.90	1.23	0.22- 5.70	1.39	0.26 - 7.10
	Fall	236	699	469 -1222	3923	1090 -14800	4.40	0.88 -12.47	0.06	<0.05 - 0.88	0.88	0.12- 6.10	0.94	0.17 - 6.15
	All Seasons	682	706	461 -1222	4111	1050 -14930	4.50	0.62 -13.70	0.12	<0.05 - 1.90	1.03	0.12- 6.10	1.15	0.17 - 7.10

[a]Lower-Cl characterized as Aroclor mixtures with lesser degrees of chlorination such as Aroclors 1242 and 1248.
[b]Higher-Cl characterized as Aroclor mixtures with greater degrees of chlorination such as Aroclors 1254 and 1260.

Table 5. Polychlorinated biphenyls (PCB) in striped bass representing three size classes; 1994 collections from the Marine District of New York State.

33 INCHES AND GREATER TOTAL LENGTH

Location	No. of Fish	Season	Average PCB (ppm)	Minimum & Maximum
New York Harbor (Area I)	19	Spring	1.97	0.66 - 5.40
	20	Summer	5.17	0.39 -14.90
	16	Fall	3.96	0.85 - 9.00
Western Long Island Sound (Area II)	8	Spring	1.88	0.46 - 5.75
	2	Summer	2.07	1.32 - 2.83
	0	Fall	-	-
Western Atlantic Ocean (Area III)	11	Spring	1.54	0.50 - 2.77
	14	Summer	2.07	0.36 - 7.00
	10	Fall	1.02	0.27 - 3.16
Eastern Long Island Sound (Area IV)	17	Spring	1.45	0.60 - 3.19
	21	Summer	1.65	0.52 - 2.92
	9	Fall	1.28	0.64 - 2.70
Eastern Atlantic Ocean (Area V)	20	Spring	1.44	0.54 - 4.12
	21	Summer	1.72	0.42 - 4.45
	30	Fall	1.00	0.42 - 2.72
Overall	75	Spring	1.64	0.46 - 5.75
	78	Summer	2.66	0.36 -14.90
	65	Fall	1.77	0.27 - 9.00
	218	All seasons	2.04	0.27 -14.90

24 INCHES TO 33 INCHES TOTAL LENGTH

Location	No. of Fish	Season	Average PCB (ppm)	Minimum & Maximum
New York Harbor (Area I)	21	Spring	3.18	0.62 -18.00
	21	Summer	6.92	2.36 -18.40
	22	Fall	3.02	0.66 - 8.72
Western Long Island Sound (Area II)	23	Spring	1.20	0.32 - 3.99
	17	Summer	1.62	0.62 - 3.25
	23	Fall	1.18	0.31 - 2.78
Western Atlantic Ocean (Area III)	21	Spring	1.10	0.47 - 2.08
	22	Summer	1.83	0.38 - 7.10
	38	Fall	0.80	0.17 - 1.90
Eastern Long Island Sound (Area IV)	26	Spring	1.02	0.46 - 2.17
	27	Summer	1.37	0.42 - 3.59
	21	Fall	0.98	0.49 - 2.40
Eastern Atlantic Ocean (Area V)	21	Spring	0.89	0.44 - 1.46
	29	Summer	1.47	0.49 - 4.87
	20	Fall	1.19	0.33 - 6.15
Overall	112	Spring	1.45	0.32 -18.00
	116	Summer	2.52	0.38 -18.40
	124	Fall	1.36	0.17 - 8.72
	352	All seasons	1.77	0.17 -18.40

Table 5. (Con't.).

18 INCHES TO 24 INCHES TOTAL LENGTH				
Location	No. of Fish	Season	Average PCB (ppm)	Minimum & Maximum
New York Harbor (Area I)	20 21 20	Spring Summer Fall	2.48 2.29 1.39	0.54 - 7.27 0.42 - 6.26 0.36 - 4.02
Western Long Island Sound (Area II)	17 20 33	Spring Summer Fall	1.01 1.07 0.82	0.33 - 1.82 0.26 - 2.67 0.24 - 2.00
Western Atlantic Ocean (Area III)	23 21 12	Spring Summer Fall	0.90 0.70 1.07	0.40 - 2.28 0.32 - 1.42 0.30 - 3.64
Eastern Long Island Sound (Area IV)	11 8 20	Spring Summer Fall	1.27 0.93 0.63	0.30 - 2.82 0.45 - 1.40 0.36 - 1.04
Eastern Atlantic Ocean (Area V)	25 21 20	Spring Summer Fall	0.67 0.70 0.82	0.23 - 1.54 0.27 - 1.61 0.18 - 1.65
Overall	96 91 105 292	Spring Summer Fall All seasons	1.23 1.17 0.92 1.10	0.23 - 7.27 0.26 - 6.26 0.18 - 4.02 0.18 - 7.27

Table 6. Influence of several transformations and expressions of data on skewness and kurtosis coefficients for total PCB concentrations in spring collected striped bass (1978-1994) in the lower Hudson River estuary. Underlined values indicate a significant ($P < 0.05$) departure from data indicative of a normal distribution.

	Skewness				Kurtosis			
	Arithmetic		Geometric		Arithmetic		Geometric	
Year	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based
1978	4.6	4.7	1.4	0.87	25.8	28.7	2.21	0.59
1979	0.80	1.6	0.28	0.87	-0.44	1.42	-1.24	.0001
1980	3.6	1.9	0.72	-0.82	15.7	5.28	1.14	0.43
1981	3.0	3.2	0.67	0.16	11.2	14.2	0.15	-0.28
1982	2.8	6.3	1.1	0.61	7.5	53.4	0.89	0.63
1983	3.8	2.2	1.3	0.30	17.6	6.3	2.3	-0.35
1984	4.7	2.9	1.5	0.41	27.5	9.9	3.6	0.09
1985	3.1	2.1	1.2	0.21	1[illegible].0	5.6	1.6	-0.41
1986	3.6	2.9	1.2	0.43	16.7	9.2	1.7	0.17
1987	3.4	2.1	1.3	0.14	12.4	4.8	2.3	-0.17
1988	2.9	3.7	1.1	0.55	9.3	17.3	1.1	0.47
1990	2.9	2.7	1.1	0.52	10.1	9.1	1.0	-0.07
1992	7.2	6.5	2.1	1.0	64.8	57.3	7.3	2.1
1993	5.5	6.4	1.1	1.2	33.8	50.0	3.0	3.1
1994	3.6	2.1	1.2	0.42	17.8	5.5	2.0	-0.17

Note: For additional explanation refer to footnote at the end of Table 7.

Table 7. Influence of several transformations on the 1994 marine district striped bass PCB data distributions as measured by coefficients of skewness (g_1) and kurtosis (g_2) for transformed data as $\log_{10}$ (PCB + 1) to eliminate negative logarithms (geometric) and non-transformed (arithmetic) data for both wet weight and lipid-based expressions of concentrations.

SPRING			Skewness				Kurtosis			
	Size		Arithmetic		Geometric		Arithmetic		Geometric	
Area	Categories (inches)	N	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based
I	18 - 24	20	1.37	0.83	0.36	-0.06	2.03	-0.73	-0.32	-1.23
	24 - 33	21	2.91	2.57	1.04	0.82	10.2	6.77	0.65	-0.32
	> 33	19	1.90	0.81	0.70	-0.78	5.15	0.78	1.28	0.16
II	18 - 24	17	0.28	0.60	-0.01	-0.15	-1.24	-1.04	-1.22	-1.20
	24 - 33	23	1.75	2.22	1.02	1.13	3.30	4.07	0.45	0.62
	> 33	8	1.79	2.34	0.97	1.07	3.31	6.09	0.43	2.33
III	18 - 24	23	1.85	3.52	1.39	1.55	3.03	14.2	1.58	3.25
	24 - 33	21	0.52	1.33	0.21	0.09	-0.87	1.54	-1.11	-0.96
	> 33	11	0.59	0.44	0.07	-0.14	-0.53	-1.66	-0.46	-1.63
IV	18 - 24	11	0.77	1.73	0.14	0.34	0.28	3.14	0.61	-0.98
	24 - 33	26	0.99	2.42	0.51	0.63	1.08	7.32	-0.12	0.65
	> 33	17	1.12	1.06	0.69	0.49	0.34	-0.36	-0.50	-1.32
V	18 - 24	25	1.16	1.45	0.72	0.04	1.21	1.88	0.37	-0.03
	24 - 33	21	0.23	2.45	0.03	1.34	-0.96	5.33	-1.07	1.22
	> 33	20	1.74	2.41	0.88	1.10	3.68	5.39	0.71	0.64

e 7. (Cont.).

SUMMER			Skewness				Kurtosis			
	Size		Arithmetic		Geometric		Arithmetic		Geometric	
Area	Categories (inches)	N	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based
I	18 - 24	21	1.01	1.47	0.07	-0.54	0.64	2.89	-0.80	-1.06
	24 - 33	21	1.43	0.54	0.25	-0.36	2.98	-0.78	-0.35	-0.94
	> 33	20	1.59	1.75	0.11	-0.45	1.95	5.07	0.83	0.56
II	18 - 24	20	0.93	1.91	0.32	0.69	0.65	4.13	-0.55	0.03
	24 - 33	17	0.81	1.97	0.40	0.59	-0.39	4.53	-0.84	-0.77
	> 33	2	0	0	0	0	0	0	0	0
III	18 - 24	21	1.00	0.99	0.77	0.35	-0.10	0.07	-0.56	-1.09
	24 - 33	22	2.40	1.52	1.20	0.39	6.61	1.50	1.80	-0.59
	> 33	14	1.46	-0.04	0.47	-1.37	2.30	-0.75	-0.85	2.04
IV	18 - 24	8	0.34	1.24	0.17	0.83	-1.75	-0.09	-1.56	-0.39
	24 - 33	27	1.78	1.40	0.93	0.54	3.69	1.32	1.55	-0.77
	> 33	21	0.12	1.52	-0.23	0.78	-1.18	1.40	1.18	-0.32
	18 - 24	21	1.29	0.77	0.93	0.41	1.13	-1.02	0.26	-1.42
	24 - 33	29	2.15	2.50	1.06	0.22	5.58	7.76	1.53	0.26
	> 33	21	1.11	1.35	0.55	0.51	0.41	0.63	-0.70	-0.29

Table 7. (Cont.).

FALL			Skewness				Kurtosis			
	Size Categories		Arithmetic		Geometric		Arithmetic		Geometric	
Area	(inches)	N	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based
I	18 - 24	20	1.25	1.29	0.72	0.26	0.75	0.82	-0.62	-0.96
	24 - 33	22	1.53	1.81	0.34	0.26	3.03	3.00	0.18	-0.29
	> 33	16	0.45	2.16	-0.37	0.06	-0.22	6.18	-0.99	0.74
II	18 - 24	33	0.92	3.57	0.44	1.18	0.43	13.6	-0.49	2.36
	24 - 33	23	0.59	0.73	0.17	-0.07	-0.49	0.45	-1.14	0.28
	> 33	0	-	-	-	-	-	-	-	-
III	18 - 24	12	1.82	2.79	1.54	1.33	1.96	8.12	1.10	1.31
	24 - 33	38	0.82	0.78	0.32	-0.36	0.15	0.44	-0.49	-0.48
	> 33	10	1.90	2.17	1.10	0.61	4.24	5.54	1.25	1.80
IV	18 - 24	20	0.79	1.23	0.60	-0.03	-0.22	0.91	-0.48	-0.46
	24 - 33	21	1.61	1.33	1.16	0.31	2.32	1.46	0.81	0.19
	> 33	9	1.56	0.90	1.01	0.58	2.85	-0.91	1.12	-1.61
V	18 - 24	20	0.66	1.85	0.39	0.10	-0.99	4.48	-1.06	-0.37
	24 - 33	20	3.75	3.01	2.49	0.98	15.3	10.8	8.34	2.10
	> 33	30	1.60	0.81	0.88	-0.14	3.42	-0.14	0.86	-0.77

Table 7. (Cont.).

ALL SEASONS			Skewness				Kurtosis			
			Arithmetic		Geometric		Arithmetic		Geometric	
Area	Size Categories (inches)	N	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based	wet weight	lipid based
I	18 - 24	61	<u>1.30</u>	<u>1.73</u>	0.34	-0.00	<u>1.63</u>	<u>2.36</u>	-0.71	-0.93
	24 - 33	64	<u>1.86</u>	<u>3.52</u>	0.26	0.31	<u>4.41</u>	<u>16.1</u>	-0.52	-0.45
	> 33	55	<u>2.04</u>	<u>1.56</u>	0.45	-0.50	<u>4.93</u>	<u>3.54</u>	-0.00	0.31
II	18 - 24	70	<u>0.90</u>	<u>2.82</u>	0.35	<u>0.74</u>	0.60	<u>9.62</u>	-0.60	0.24
	24 - 33	63	<u>1.13</u>	<u>3.37</u>	0.48	<u>0.98</u>	1.06	<u>12.2</u>	-0.56	<u>1.63</u>
	> 33	10	<u>1.69</u>	<u>2.06</u>	0.74	0.09	<u>3.19</u>	<u>5.34</u>	0.13	0.92
III	18 - 24	56	<u>2.75</u>	<u>4.08</u>	<u>1.76</u>	<u>0.98</u>	<u>8.51</u>	<u>19.2</u>	<u>3.49</u>	<u>1.82</u>
	24 - 33	81	<u>3.56</u>	<u>2.12</u>	<u>1.26</u>	0.41	<u>18.1</u>	<u>4.67</u>	<u>3.25</u>	-0.13
	> 33	35	<u>2.03</u>	<u>1.10</u>	0.72	-0.04	<u>5.63</u>	0.46	0.10	-0.89
IV	18 - 24	39	<u>1.90</u>	<u>2.91</u>	<u>1.19</u>	0.56	<u>4.39</u>	<u>10.9</u>	1.31	0.20
	24 - 33	74	<u>1.81</u>	<u>2.24</u>	<u>0.92</u>	<u>0.60</u>	<u>4.55</u>	<u>6.71</u>	<u>1.13</u>	0.04
	> 33	47	0.68	<u>1.69</u>	0.30	<u>0.77</u>	-0.61	<u>2.13</u>	-1.04	-0.47
V	18 - 24	66	<u>1.05</u>	<u>1.67</u>	<u>0.70</u>	0.17	0.17	<u>3.42</u>	-0.29	-0.43
	24 - 33	70	<u>3.35</u>	<u>2.63</u>	<u>1.73</u>	<u>0.77</u>	<u>13.8</u>	<u>7.12</u>	<u>4.47</u>	0.59
	> 33	71	<u>1.74</u>	<u>2.69</u>	<u>0.96</u>	0.54	<u>3.02</u>	<u>8.55</u>	0.48	0.35

Underlining reflects samples that are non-normal with a probability <0.05 ($t_{tab,(\alpha=0.05,\infty\ d.f.)} = 1.96$) that a sample represents a normal distribution. Absolute magnitude of a g_1 or g_2 coefficient is not diagnostic since it is influenced by sample size (Sokal and Rohlf 1969).

The calculated $t_{s_1} = \dfrac{g_1 - \gamma}{s_{g_1}}$ and $t_{s_2} = \dfrac{g_2 - \gamma}{s_{g_2}}$

where g_1 and g_2 are the derived coefficients; $\gamma = 0$; and s_{g1} and s_{g2} are the standard errors associated with the estimate of g_1 and g_2.

$$s_{g_1} = \sqrt{\frac{6n(n-1)}{(n-1)(n+2)(n+3)}} \qquad s_{g_2} = \sqrt{\frac{24n(n-1)^2}{(n-3)(n-2)(n+5)}}$$

Generally, the closer to zero that g_1 and g_2 values are, the more normal the distribution. Negative g_1's are skewed to the left; positive g_1's are skewed to the right. Positive g_2's denote formation of tails in the distribution; a negative g_2 would represent clumping of the data.

ɔle 8. Analyses of variance for untransformed wet weight based and $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River estuary between rivermiles (RM 153 and RM 27) excluding fall samples from the Haverstraw Bay/Tappan Zee area in 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Untransformed wet weight					
Between RMs	488.1	4	122.0	22.2	<0.001
Within RMs	938.6	171	5.5		
Total (corrected)	1426.7	175			
$\log_{10}$-transformed lipid-based					
Between RMs	16.8	4	4.20	48.8	<0.001
Within RMs	14.7	171	0.09		
Total (corrected)	31.5	175			

Table 9. Scheffe tests for comparisons among means of rivermiles (RM) for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass from the Hudson River excluding fall samples from the Haverstraw Bay/Tappan Zee area in 1994 at $\alpha = 0.05$.

Rivermile	N	Mean	95% Confidence Interval	Group Comparisons		
Untransformed (Arithmetic)						
27	40	1.55	0.73 - 2.37	X		
38	43	1.78	1.00 - 2.57	X		
73	43	2.54	1.76 - 3.33	X		
115	21	3.05	1.93 - 4.18	X		
153	29	6.41	5.45 - 7.36		X	
$\log_{10}$-transformed lipid-based (Geometric)						
27	40	29.7	23.5 - 37.6	X		
38	43	33.7	26.9 - 42.3	X		
73	43	40.0	31.9 - 50.2	X		
115	21	73.6	53.2 - 101.9		X	
153	29	227.2	172.4 - 299.6			X

Table 10. Average concentrations of PCB (ppm - wet weight basis) in striped bass collected in the spring of 1990, 1992, 1993 and 1994 from several rivermile (RM) locations in the Hudson River.

Location	1990 - Total PCB (ppm)				1992 - Total PCB (ppm)			
	No. of fish	Ave.	Min.	Max.	No. of fish	Ave.	Min.	Max.
Albany/Troy* RM 153	13	6.90	3.13	11.75	10	17.16	8.66	24.70
Catskill RM 112	20	3.55	0.60	8.79	20	3.29	0.26	14.60
Poughkeepsie RM 76	49	3.74	0.89	20.01	40	1.74	0.32	6.82
Croton Pt. RM 40	35	3.13	0.40	11.33	43	2.06	0.23	26.50
Tappan Zee Bridge RM 27	43	2.07	0.60	14.74	41	1.93	0.56	10.15
George Wash. Bridge RM12	37	1.90	0.30	9.16	20	1.32	0.54	4.12

Location	1993 - Total PCB (ppm)				1994 - Total PCB (ppm)			
	No. of fish	Ave.	Min.	Max.	No. of fish	Ave.	Min.	Max.
Albany/Troy* RM 153	18	12.39	4.82	21.80	29	6.41	0.63	13.60
Catskill RM 112	20	3.74	0.80	8.10	21	3.05	0.59	13.80
Poughkeepsie RM 76	45	3.14	0.66	25.10	43	2.54	0.41	15.40
Croton Pt. RM 40	20	1.59	0.70	2.38	43	1.78	0.20	9.20
Tappan Zee Bridge RM 27	46	2.18	0.42	22.30	40	1.55	0.37	7.90
George Wash. Bridge RM12	13	1.32	0.52	5.18	-	-	-	-

* Striped bass are usually not available in this section of the Hudson River until late spring or early summer.

ble **11.** Results of t-tests for comparing means between spring versus fall samples in the Haverstraw Bay/ Tappan Zee area in 1994 for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

ason	N	Mean	95% Confidence Interval	t-value
transformed (Arithmetic)				
pring	40	1.55	1.10 - 2.00	-1.09
all	99	1.84	1.56 - 2.13	P = 0.28
g_{10}-transformed lipid-based (Geometric)				
pring	40	29.7	23.5 - 37.4	0.68
all	99	27.0	23.3 - 31.3	P = 0.50

ble **12.** Results of t-tests for comparing means between November versus December samples in the Haverstraw Bay/ Tappan Zee area in 1994 for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

nth	N	Mean	95% Confidence Interval	t-value
transformed (Arithmetic)				
vember	46	2.36	2.09 - 2.64	3.60
cember	53	1.39	1.13 - 1.65	P < 0.001
g_{10}-transformed lipid-based (Geometric)				
vember	46	35.2	30.2 - 41.1	3.29
cember	53	21.5	18.6 - 24.8	P = 0.001

Table 13. Analyses of variance for lower- : higher-chlorinated PCB ratios in striped bass collected from several Hudson River locations between rivermiles (RM 153 and RM 27) in 1994 excluding fall samples from the Haverstraw Bay/Tappan Zee area.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Between RMs	6.784	4	1.696	96.9	<0.001
Within RMs	2.993	171	0.018		
Total (corrected)	9.777	175			

Table **14.** Scheffe tests for comparisons among means of lower- : higher-chlorinated PCB ratios in striped bass from several locations in the Hudson River in 1994 excluding fall samples from the Haverstraw Bay/Tappan Zee area at $\alpha = 0.05$.

Rivermile	N	Mean	95% Confidence Interval	Group Comparisons	
38	43	0.10	0.06 - 0.15	X	
27	40	0.11	0.07 - 0.16	X	
115	21	0.14	0.07 - 0.20	X	
73	43	0.14	0.09 - 0.18	X	
153	29	0.65	0.59 - 0.70		X

Table **15.** Results of t-test for comparing means between spring versus fall samples in the Haverstraw Bay/ Tappan Zee area in 1994 for lower- : higher-chlorinated PCB ratios in striped bass at $\alpha = 0.05$.

Season	N	Mean	95% Confidence Interval	t-value
Spring	40	0.11	0.09 - 0.14	-3.71
Fall	99	0.19	0.18 - 0.21	P < 0.001

Table **16.** Results of t-test for comparing means between November versus December samples in the Haverstraw Bay/ Tappan Zee area in 1994 for lower- : higher-chlorinated PCB ratios in striped bass at $\alpha = 0.05$.

Month	N	Mean	95% Confidence Interval	t-value
November	46	0.22	0.19 - 0.24	1.86
December	53	0.17	0.15 - 0.20	P = 0.07

ɔle 7. Analyses of variance for untransformed wet weight based and $\log_{10}$-transformed lipid-based total PCB in striped bass from the Marine District of New York State in 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Untransformed wet weight					
Main Effects					
Area	658.5	4	164.6	81.4	<0.001
Season	82.0	2	41.0	20.3	<0.001
Size Class	115.3	2	57.7	28.5	<0.001
2-factor Interactions					
Area X Season	114.2	8	14.3	7.06	<0.001
Area X Size	96.3	8	12.0	5.95	<0.001
Season X Size	54.0	4	13.5	6.68	<0.001
Residual	1684.8	833	2.02		
Total (corrected)	2881.9	861			
$\log_{10}$-transformed lipid-based					
Main Effects					
Area	24.5	4	6.12	64.8	<0.001
Season	4.30	2	2.15	22.8	<0.001
Size Class	13.6	2	6.78	71.8	<0.001
2-factor Iinteractions					
Area X Season	2.85	8	0.356	3.78	<0.001
Area X Size	1.15	8	0.144	1.53	0.143
Season X Size	1.56	4	0.390	4.13	0.002
Residual	78.6	833	0.094		
Total (corrected)	131.5	861			

Table **18.** Scheffe tests for comparisons among means for main effects (Area, Season, Size Class) from the analyses of variance for untransformed wet weight- and log_{10}-transformed lipid-based total PCB concentrations in striped bass from the Marine District in 1994 at $\alpha = 0.05$.

Level	N	Mean	95% Confidence Interval	Group Comparisons		
Untransformed (Arithmetic)						
AREA						
I	180	3.35	3.14 - 3.56	X		
II	143	1.47	1.12 - 1.82		X	
III	172	1.21	0.98 - 1.43		X	
IV	160	1.15	0.92 - 1.38		X	
V	207	1.07	0.87 - 1.26		X	
SEASON						
Fall	294	1.39	1.20 - 1.58	X		
Spring	283	1.45	1.28 - 1.63	X		
Summer	285	2.11	1.92 - 2.29		X	
SIZE CLASS						
18 - 24	292	1.08	0.91 - 1.25	X		
24 - 33	352	1.84	1.69 - 2.00		X	
≥ 33	218	2.03	1.78 - 2.28		X	
Log_{10}-transformed lipid-based (Geometric)						
AREA						
I	180	64.8	58.4 - 71.9	X		
II	143	32.3	27.1 - 38.5		X	
IV	160	26.2	23.3 - 29.4		X	X
III	172	24.9	22.2 - 27.9		X	X
V	207	22.5	20.4 - 24.8			X
SEASON						
Fall	294	25.4	23.2 - 27.9	X		
Summer	285	31.4	28.7 - 34.4		X	
Spring	283	38.9	35.7 - 42.4			X
SIZE CLASS						
18 - 24	292	19.9	18.3 - 21.7	X		
24 - 33	352	33.7	31.2 - 36.3		X	
≥ 33	218	46.4	41.0 - 52.5			X

Table 19. Analyses of variance for lower- : higher-chlorinated PCB ratios in striped bass from the Marine District of New York State in 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Main Effects					
Area	1.791	4	0.448	32.9	<0.001
Season	0.298	2	0.149	10.9	<0.001
Size Class	0.257	2	0.128	9.4	<0.001
2-factor Interactions					
Area X Season	0.486	8	0.0608	4.46	<0.001
Area X Size	0.409	8	0.0512	3.76	<0.001
Season X Size	0.0366	4	0.0092	0.67	0.611
Residual	11.348	833	0.0136		
Total (corrected)	14.871	861			

Table 20. Scheffe tests for comparisons among means for main effects (Area, Season, Size Class) from the analyses of variance for lower- : higher-chlorinated PCB ratios in striped bass from the Marine District in 1994 at $\alpha = 0.05$.

Level	N	Mean	95% Confidence Interval	Group Comparisons		
AREA						
I	180	0.21	0.19 - 0.22	X		
III	172	0.15	0.13 - 0.17		X	
II	143	0.12	0.10 - 0.15		X	X
V	207	0.09	0.07 - 0.10			X
IV	160	0.08	0.06 - 0.10			X
SEASON						
Fall	294	0.10	0.09 - 0.12	X		
Summer	285	0.14	0.13 - 0.16		X	
Spring	283	0.14	0.13 - 0.16		X	
SIZE CLASS						
24 - 33	352	0.12	0.10 - 0.13	X		
≥ 33	218	0.12	0.10 - 0.14	X		
- 24	292	0.16	0.14 - 0.17		X	

Table 21. Median PCB concentrations in striped bass from the Marine District of New York State collected in 1994 and the proportion (Pr expressed as a fraction) in the samples which exceed 2 ppm.

Area	Size Class (inches)	Spring N	Spring Median	Spring Pr	Summer N	Summer Median	Summer Pr	Fall N	Fall Median	Fall Pr	All Seasons N	All Seasons Median	All Seasons Pr
I	18-24	20	2.14	0.55	21	2.12	0.57	20	1.00	0.25	61	1.68	0.46
	24-33	21	1.54	0.48	21	6.05	1	22	2.55	0.73	64	3.43	0.73
	≥ 33	0	-	-	20	4.01	0.90	16	3.90	0.75	55	3.06	0.69
II	18-24	17	0.85	0	20	1.01	0.10	33	0.78	0.03	70	0.82	0.04
	24-33	23	0.85	0.17	17	1.34	0.24	23	1.00	0.04	63	1.02	0.14
	≥ 33	8	1.27	0.38	2	2.07	0.50	0	-	-	10	1.34	0.40
III	18-24	23	0.75	0.09	21	0.58	0	12	0.46	0.17	56	0.62	0.07
	24-33	21	0.94	0.05	22	1.36	0.23	38	0.74	0	81	0.93	0.07
	≥ 33	11	1.38	0.27	14	1.62	0.43	10	0.77	0.10	35	1.36	0.29
IV	18-24	11	1.14	0.18	8	0.80	0	20	0.57	0	39	0.68	0.05
	24-33	26	0.99	0.04	27	1.26	0.11	21	0.80	0.10	74	1.03	0.08
	≥ 33	17	1.06	0.24	21	1.56	0.38	9	1.22	0.11	47	1.38	0.28
V	18-24	25	0.60	0	21	0.58	0	20	0.64	0	66	0.59	0
	24-33	21	0.84	0	29	1.35	0.10	20	0.91	0.10	70	0.98	0.07
	≥ 33	20	1.29	0.15	21	1.22	0.29	30	0.84	0.07	71	1.10	0.16
IV,V	18-24	36	0.65	0.06	29	0.66	0	40	0.57	0	105	0.62	0.02
	24-33	47	0.96	0.02	56	1.28	0.11	41	0.84	0.10	144	1.01	0.08
	≥ 33	37	1.22	0.19	42	1.55	0.33	39	0.86	0.08	118	1.14	0.20
III, IV,V	18-24	59	0.68	0.07	50	0.61	0	52	0.56	0.04	161	0.62	0.04
	24-33	68	0.94	0.03	78	1.30	0.14	79	0.80	0.05	225	0.97	0.08
	≥ 33	48	1.30	0.21	56	1.55	0.36	49	0.86	0.08	153	1.14	0.22
I,II	18-24	37	1.46	0.30	41	1.26	0.34	53	0.83	0.11	131	1.06	0.24
	24-33	44	1.10	0.32	38	3.28	0.66	45	1.78	0.38	127	1.83	0.44
	≥ 33	27	1.71	0.41	22	3.94	0.86	16	3.90	0.75	65	2.56	0.65
II, III, IV,V	18-24	76	0.74	0.05	70	0.67	0.03	85	0.62	0.03	231	0.68	0.04
	24-33	91	0.94	0.07	95	1.30	0.16	102	0.84	0.05	288	0.98	0.09
	≥ 33	56	1.30	0.23	58	1.55	0.36	49	0.86	0.08	163	1.18	0.23

N = number of fish in the sample.
Median = median PCB level in parts per million (µg/g) wet weight of a standard fillet. Values less than 2 ppm are underlined and represent probabilities of 50% or less that a randomly chosen fish would contain 2 ppm or more PCB.
Pr = the proportion expressed as a fraction rather than percent of fish which exceeds 2 ppm.

Table 22. Proportions (Pr expressed as a fraction rather than a percent) of striped bass samples (10 fish composites) exceeding 2 ppm total PCB on a wet weight basis resulting from simulated random samplings from the 1994 Marine District PCB study with each fish in a composite being given equal weight (i.e. equal parts) or weighted according to the sizes of the individual fish involved (i.e. whole fillet).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
I New York Harbor	18 - 24	25	0.76	0.76	0.64	0.52	0.04	0.24	0.60	0.52
		50	0.78	0.74	0.66	0.58	0.06	0.18	0.58	0.56
		100	0.74	0.73	0.72	0.66	0.05	0.14	0.57	0.55
		200	0.76	0.76	0.73	0.70	0.06	0.14	0.53	0.54
		400	0.74	0.73	0.72	0.68	0.05	0.11	0.55	0.54
		800	0.74	0.74	0.72	0.68	0.06	0.12	0.54	0.54
	24 - 33	25	0.80	0.84	1	1	0.96	1	1	1
		50	0.86	0.86	1	1	0.96	0.98	1	1
		100	0.86	0.86	1	1	0.98	0.99	1	1
		200	0.84	0.85	1	1	0.99	1	1	1
		400	0.80	0.81	1	1	0.98	0.99	1	0.99
		800	0.80	0.82	1	1	0.98	0.98	1	0.99
	≥ 33	25	0.44	0.44	1	1	1	1	1	1
		50	0.48	0.50	1	1	1	1	1	1
		100	0.47	0.55	1	1	1	1	1	1
		200	0.42	0.52	1	1	1	1	0.99	0.98
		400	0.45	0.53	1	1	1	1	1	0.99
		800	0.46	0.53	1	1	1	1	1	0.99
	All Sizes	25	0.72	0.72	1	1	0.64	0.92	0.96	1
		50	0.78	0.70	1	1	0.76	0.94	0.96	1
		100	0.71	0.67	1	1	0.79	0.95	0.90	0.98
		200	0.72	0.70	1	1	0.84	0.96	0.89	0.96
		400	0.70	0.66	1	1	0.84	0.96	0.90	0.96
		800	0.72	0.67	1	1	0.86	0.95	0.89	0.96

Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
II Western Long Island Sound	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0.12	0.04	0.12	0	0	0	0.04
		50	0	0.06	0.02	0.08	0	0	0	0.04
		100	0	0.06	0.06	0.15	0	0	0.01	0.05
		200	0	0.03	0.04	0.12	0	0	0.01	0.05
		400	0	0.03	0.04	0.14	0	0	0	0.04
		800	0	0.03	0.04	0.13	0	0	0	0.04
	≥ 33	25	0.24	0.40	1	1	-	-	0.48	0.52
		50	0.20	0.34	1	1	-	-	0.46	0.50
		100	0.27	0.41	1	1	-	-	0.49	0.51
		200	0.32	0.42	1	1	-	-	0.51	0.54
		400	0.34	0.44	1	1	-	-	0.49	0.52
		800	0.35	0.43	1	1	-	-	0.48	0.52
	All Sizes	25	0.04	0.20	0	0.12	0	0	0	0
		50	0.02	0.14	0	0.10	0	0	0	0.04
		100	0.01	0.12	0.01	0.09	0	0	0.01	0.03
		200	0.02	0.18	0.02	0.09	0	0	0	0.06
		400	0.01	0.16	0.01	0.09	0	0	0	0.05
		800	0.02	0.18	0.01	0.08	0	0	0	0.09

22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
III Western Long Island - South Shore	18 - 24	25	0	0	0	0	0.04	0	0	0
		50	0	0	0	0	0.02	0	0	0
		100	0	0	0	0	0.02	0.01	0	0
		200	0	0	0	0	0.03	0.02	0	0
		400	0	0	0	0	0.02	0.03	0	0
		800	0	0	0	0	0.02	0.03	0	0
	24 - 33	25	0	0	0.4[illegible]	0.48	0	0	0	0.04
		50	0	0	0.38	0.48	0	0	0	0.04
		100	0	0	0.39	0.59	0	0	0.01	0.03
		200	0	0	0.41	0.59	0	0	0.02	0.06
		400	0	0	0.41	0.56	0	0	0.01	0.06
		800	0	0	0.39	0.56	0	0	0.02	0.06
	≥ 33	25	0.04	0.04	0.92	0.84	0	0	0.24	0.16
		50	0.04	0.04	0.82	0.70	0	0	0.24	0.18
		100	0.04	0.03	0.82	0.64	0	0	0.26	0.20
		200	0.03	0.02	0.80	0.61	0	0	0.30	0.21
		400	0.03	0.02	0.74	0.56	0	0	0.28	0.18
		800	0.03	0.02	0.72	0.55	0	0	0.30	0.19
	All Sizes	25	0	0	0.28	0.52	0	0	0.08	0.08
		50	0	0	0.22	0.44	0	0	0.06	0.06
		100	0	0	0.16	0.41	0	0	0.04	0.11
		200	0	0	0.18	0.42	0	0	0.04	0.11
		400	0	0	0.20	0.43	0	0	0.04	0.11
		800	0	0	0.21	0.40	0	0	0.03	0.11

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Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
IV Eastern Long Island Sound	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0	0.04	0.04	0	0	0	0
		50	0	0	0.02	0.02	0	0	0	0
		100	0	0	0.01	0.01	0	0	0	0
		200	0	0	0.01	0.02	0	0	0	0
		400	0	0	0.01	0.02	0	0	0	0
		800	0	0	0	0.02	0	0	0	0
	≥ 33	25	0.04	0.04	0.04	0	0	0	0	0.08
		50	0.04	0.04	0.04	0.02	0	0	0.02	0.06
		100	0.05	0.06	0.06	0.05	0	0	0.02	0.03
		200	0.04	0.06	0.04	0.04	0	0	0.04	0.04
		400	0.04	0.05	0.04	0.04	0	0	0.02	0.02
		800	0.04	0.05	0.04	0.03	0	0	0.02	0.02
	All Sizes	25	0	0	0	0.04	0	0	0	0
		50	0	0	0	0.08	0	0	0	0
		100	0	0	0	0.04	0	0	0	0.01
		200	0	0	0.01	0.04	0	0	0	0.02
		400	0	0.01	0.01	0.04	0	0	0	0.02
		800	0	0	0.01	0.03	0	0	0	0.01

Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
V Eastern Long Island - South Shore	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0	0.08	0.08	0.04	0	0	0
		50	0	0	0.04	0.06	0.02	0	0.02	0.02
		100	0	0	0.03	0.06	0.02	0	0.02	0.02
		200	0	0	0.05	0.08	0.02	0	0.04	0.02
		400	0	0	0.06	0.10	0.03	0.01	0.02	0.02
		800	0	0	0.08	0.10	0.04	0.01	0.01	0.02
	≥ 33	25	0.04	0	0.20	0.16	0	0	0	0
		50	0.04	0.02	0.22	0.18	0	0	0.02	0.04
		100	0.04	0.03	0.27	0.26	0	0	0.01	0.02
		200	0.02	0.02	0.26	0.26	0	0	0.01	0.01
		400	0.02	0.02	0.26	0.24	0	0	0.02	0.02
		800	0.03	0.04	0.27	0.25	0	0	0.02	0.02
	All Sizes	25	0	0	0	0.08	0	0	0	0.04
		50	0	0	0	0.04	0	0	0	0.02
		100	0	0.01	0	0.08	0	0	0	0.03
		200	0	0.01	0.01	0.12	0	0	0	0.02
		400	0	0.01	0.01	0.12	0	0	0	0.03
		800	0	0.01	0.02	0.13	0	0	0	0.02

Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
I, II	18 - 24	25	0.44	0.36	0.24	0.24	0	0.04	0.08	0.12
		50	0.38	0.32	0.26	0.24	0	0.02	0.06	0.06
		100	0.29	0.23	0.30	0.29	0	0.01	0.06	0.04
		200	0.28	0.22	0.27	0.26	0	0	0.09	0.08
		400	0.25	0.20	0.26	0.26	0	0	0.10	0.09
		800	0.26	0.20	0.26	0.26	0	0	0.11	0.10
	24 - 33	25	0.32	0.40	0.96	0.96	0.68	0.76	0.80	0.84
		50	0.22	0.28	0.98	0.98	0.60	0.74	0.80	0.84
		100	0.34	0.39	0.98	0.98	0.59	0.72	0.81	0.84
		200	0.36	0.46	0.99	0.99	0.58	0.72	0.80	0.84
		400	0.37	0.46	0.99	0.99	0.54	0.71	0.79	0.84
		800	0.36	0.46	0.99	0.99	0.55	0.71	0.80	0.86
	≥ 33	25	0.36	0.48	1	1	1	1	1	1
		50	0.32	0.42	1	1	1	1	1	1
		100	0.41	0.50	1	1	1	1	0.99	0.98
		200	0.44	0.52	1	1	1	1	0.96	0.96
		400	0.40	0.48	1	1	1	1	0.96	0.96
		800	0.41	0.49	1	1	1	1	0.96	0.95
	All Sizes	25	0.36	0.44	0.84	0.96	0.2[illegible]	0.72	0.56	0.68
		50	0.40	0.48	0.86	0.9[illegible]	0.30	0.62	0.62	0.76
		100	0.32	0.39	0.89	0.96	0.38	0.68	0.64	0.76
		200	0.37	0.41	0.91	0.97	0.36	0.64	0.64	0.79
		400	0.38	0.43	0.90	0.96	0.37	0.68	0.62	0.79
		800	0.38	0.43	0.91	0.96	0.38	0.68	0.62	0.77

Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring: Pr > 2 ppm Equal parts	Spring: Pr > 2 ppm Whole fillet	Summer: Pr > 2 ppm Equal parts	Summer: Pr > 2 ppm Whole fillet	Fall: Pr > 2 ppm Equal parts	Fall: Pr > 2 ppm Whole fillet	All Seasons: Pr > 2 ppm Equal parts	All Seasons: Pr > 2 ppm Whole fillet
IV, V	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0	0.04	0.04	0	0	0.08	0.08
		50	0	0	0.04	0.02	0.02	0	0.04	0.04
		100	0	0	0.06	0.08	0.01	0	0.03	0.02
		200	0	0	0.08	0.09	0.02	0	0.02	0.01
		400	0	0	0.06	0.07	0.02	0	0.01	0
		800	0	0	0.05	0.06	0.01	0	0	0
	≥ 33	25	0	0	0.12	0.16	0	0	0	0
		50	0	0.02	0.18	0.18	0	0	0	0
		100	0.03	0.04	0.18	0.17	0	0	0	0
		200	0.04	0.04	0.16	0.14	0	0	0.01	0.02
		400	0.03	0.04	0.17	0.16	0	0	0.02	0.02
		800	0.03	0.04	0.15	0.14	0	0	0.02	0.03
	All Sizes	25	0	0.04	0.08	0.16	0	0	0	0
		50	0	0.02	0.04	0.10	0	0	0	0
		100	0	0.01	0.02	0.07	0	0	0	0
		200	0	0	0.03	0.09	0	0	0	0.01
		400	0	0.01	0.02	0.08	0	0	0	0.02
		800	0	0.01	0.02	0.07	0	0	0	0.02

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Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
III, IV, V	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0	0.12	0.24	0	0	0	0
		50	0	0	0.08	0.22	0	0	0	0.02
		100	0	0	0.08	0.19	0	0	0	0.03
		200	0	0	0.08	0.18	0	0	0.02	0.04
		400	0	0	0.10	0.20	0	0	0.01	0.03
		800	0	0	0.12	0.20	0	0	0.01	0.03
	≥ 33	25	0	0	0.32	0.28	0	0	0.12	0.08
		50	0.04	0.04	0.40	0.36	0	0	0.16	0.08
		100	0.03	0.03	0.44	0.32	0	0	0.12	0.08
		200	0.02	0.02	0.39	0.31	0	0	0.08	0.06
		400	0.03	0.04	0.37	0.30	0	0	0.09	0.06
		800	0.02	0.03	0.36	0.28	0	0	0.08	0.06
	All Sizes	25	0	0	0.04	0.12	0	0	0	0
		50	0	0	0.06	0.12	0	0	0	0.02
		100	0	0	0.08	0.16	0	0	0.01	0.07
		200	0	0	0.06	0.16	0	0	0.02	0.06
		400	0	0.01	0.09	0.20	0	0	0.02	0.06
		800	0	0	0.08	0.20	0	0	0.01	0.04

Table 22. (Con't.).

Area	Size (inches)	No. of simulations	Spring		Summer		Fall		All Seasons	
			Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet	Pr > 2 ppm Equal parts	Pr > 2 ppm Whole fillet
II, III, IV, V	18 - 24	25	0	0	0	0	0	0	0	0
		50	0	0	0	0	0	0	0	0
		100	0	0	0	0	0	0	0	0
		200	0	0	0	0	0	0	0	0
		400	0	0	0	0	0	0	0	0
		800	0	0	0	0	0	0	0	0
	24 - 33	25	0	0	0.04	0.20	0	0	0	0
		50	0	0	0.06	0.22	0	0	0.02	0.04
		100	0	0	0.08	0.22	0	0	0.02	0.05
		200	0	0	0.11	0.20	0	0	0.02	0.04
		400	0	0	0.12	0.20	0	0	0.01	0.03
		800	0	0	0.11	0.19	0	0	0.01	0.03
	≥ 33	25	0.16	0.20	0.32	0.20	0	0	0.12	0.12
		50	0.14	0.16	0.38	0.26	0	0	0.14	0.14
		100	0.18	0.19	0.41	0.31	0	0	0.16	0.14
		200	0.11	0.12	0.42	0.33	0	0	0.12	0.10
		400	0.10	0.10	0.38	0.29	0	0	0.13	0.10
		800	0.09	0.10	0.36	0.28	0	0	0.11	0.09
	All Sizes	25	0	0	0.08	0.24	0	0	0	0.08
		50	0	0.02	0.08	0.26	0	0	0.02	0.08
		100	0	0.01	0.06	0.23	0	0	0.02	0.06
		200	0	0.02	0.07	0.24	0	0	0.01	0.06
		400	0	0.02	0.07	0.20	0	0	0.01	0.06
		800	0	0.03	0.07	0.18	0	0	0.01	0.06

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Table 23. PCB concentrations and correlations with length and lipid for Hudson River striped bass taken in the spring from the lower estuary (RM 76-12). The 95% CL refers to 95% confidence limits from analyses of variance conducted across all years (1978 - 1993).

	1978	1979	1980	1981	1982	1983	1984
Number of fish	375	14	193	169	154	137	167
Average length(mm)	587	456	545	523	544	570	577
Total PCB (ppm)							
Mean	18.05	5.17	6.07	4.58	5.52	4.91	4.72
95% CL	16.85 - 19.25	-1.03-11.37	4.40 - 7.74	2.80 - 6.37	3.65-7.39	2.93 - 6.89	2.92 - 6.51
Geometric mean	11.62	4.63	4.28	3.06	3.66	4.08	3.69
95% CL	10.86 - 12.43	3.07 - 6.78	3.84 - 4.75	2.70 - 3.45	3.23 - 4.14	3.58 - 4.63	3.27 - 4.14
Higher Cl-ed PCB[a]							
Mean	7.70	3.96	4.28	3.39	4.09	4.10	3.84
95% CL	7.17 - 8.22	1.25 - 6.68	3.55 - 5.01	2.61 - 4.17	3.27 - 4.90	3.24 - 4.97	3.05 - 4.62
Geometric mean	5.44	3.56	3.12	2.41	2.85	3.44	3.11
95% CL	5.08 - 5.81	2.40 - 5.12	2.80 - 3.46	2.14 - 2.72	2.52 - 3.20	3.04 - 3.88	2.77 - 3.47
Lower Cl-ed PCB[b]							
Mean	9.64	1.20	1.67	1.04	1.19	0.73	0.88
95% CL	8.90 - 10.37	-2.59 - 5.00	0.65 - 2.69	-0.05 - 2.14	0.04 - 2.33	-0.49 - 1.94	-0.22 - 1.98
Geometric mean	5.43	1.10	1.11	0.67	0.75	0.61	0.65
95% CL	5.12 - 5.75	0.63 - 1.72	0.97 - 1.26	0.55 - 0.79	0.62 - 0.89	0.49 - 0.75	0.53 - 0.78
Correlation between length and PCB							
-arithmetic	0.08[ns]	-0.32[ns]	0.11[ns]	0.42[**]	0.37[**]	-0.07[ns]	0.26[**]
-geometric	0.07[ns]	-0.42[ns]	0.07[ns]	0.53[**]	0.39[**]	-0.03[ns]	0.25[**]
Correlation between lipid and PCB							
-arithmetic	0.09[ns]	0.13[ns]	0.21[**]	0.56[**]	0.34[**]	0.05[ns]	0.17[*]
-geometric	0.09[ns]	0.25[ns]	0.15[**]	0.60[**]	0.40[**]	0.02[ns]	0.18[*]
Lipid-based total PCB							
mean	269.8	101.1	165.5	160.7	118.0	73.9	89.3
95% CL	251.1 - 288.6	3.98 - 198.3	139.1 - 191.7	132.7 - 188.5	88.8-147.3	42.9 - 105.0	61.2 - 117.4
geometric mean	160.6	87.1	109.6	107.9	76.5	55.9	66.5
95% CL	147.7 - 174.6	56.3 - 134.4	97.5 - 123.1	95.2 - 122.2	67.0 - 82.2	48.6 - 64.3	58.6 - 75.5

Table 23. (cont.)

	1985	1986	1987	1988
Number of fish	213	204	147	170
Average length(mm)	599	614	640	667
Total PCB (ppm)				
Mean	4.60	3.93	3.61	3.97
95% CL	3.01 - 6.19	2.30 - 5.55	1.69 - 5.52	2.19 - 5.75
Geometric mean	3.59	3.07	2.79	3.04
95% CL	3.23 - 3.99	2.74 - 3.43	2.44 - 3.19	2.69 - 3.43
Higher Cl-ed PCB[a]				
Mean	3.74	3.34	2.97	3.41
95% CL	3.05 - 4.44	2.63 - 4.05	2.13 - 3.80	2.63 - 4.19
Geometric mean	3.03	2.67	2.35	2.69
95% CL	2.74 - 3.35	2.39 - 2.96	2.06 - 2.66	2.39 - 3.01
Lower Cl-ed PCB[b]				
Mean	0.83	0.57	0.64	0.56
95% CL	-0.14 - 1.80	-0.42 - 1.57	-0.53 - 1.81	-0.53 - 1.65
Geometric mean	0.61	0.44	0.52	0.44
95% CL	0.51 - 0.72	0.35 - 0.54	0.41 - 0.65	0.34 - 0.55
Correlation between length and PCB				
-arithmetic	0.02[ns]	0.04[ns]	- 0.01[ns]	0.06[ns]
-geometric	0.03[ns]	0.09[ns]	- 0.03[ns]	0.06[ns]
Correlation between lipid and PCB				
-arithmetic	0.15[*]	-0.05[ns]	0.29[**]	0.10[ns]
-geometric	0.11[ns]	-0.05[ns]	0.26[**]	0.12[ns]
Lipid-based total PCB				
mean	74.6	53.7	65.9	57.1
95% CL	49.7 - 99.5	28.3 - 79.2	35.9 - 95.9	29.2 - 85.0
geometric mean	55.3	36.8	47.7	36.8
95% CL	49.4 - 61.8	32.8 - 41.3	41.6 - 54.6	32.4 - 41.8

[ns] -- not significant ($P > 0.05$)
[*] -- $P < 0.05$
[**] -- $P < 0.01$
[a] Represents more highly chlorinated types of PCB (penta-, hexa- and higher-chlorinated forms).
[b] Represents lesser chlorinated types of PCB, principally tri- and tetrachlorinated biphenyls.

Table 23. (cont.)

	1990	1992	1993	1994
Number of fish	164	143	124	126
Average length(mm)	667	644	687	663
Total PCB (ppm)				
Mean	2.77	1.84	2.34	1.97
95% CL	0.95 - 4.58	-0.10 - 3.78	0.26 - 4.43	-0.10 - 4.04
Geometric mean	2.15	1.48	1.84	1.61
95% CL	1.86 - 2.46	1.24 - 1.74	1.55 - 2.17	1.34 - 1.90
Higher Cl-ed PCB[a]				
Mean	2.31	1.59	1.89	1.72
95% CL	1.52 - 3.10	0.74 - 2.44	0.98 - 2.80	0.81 - 2.63
Geometric mean	1.84	1.31	1.57	1.44
95% CL	1.61 - 2.10	1.11 - 1.53	1.33 - 1.83	1.22 - 1.70
Lower Cl-ed PCB[b]				
Mean	0.45	0.25	0.46	0.25
95% CL	-0.66- 1.56	-0.94 - 1.43	-0.82 - 1.73	-1.02 - 1.51
Geometric mean	0.37	0.19	0.32	0.21
95% CL	0.27 - 0.48	0.10 - 0.29	0.21 - 0.43	0.11 - 0.31
Correlation between length and PCB				
-arithmetic	-0.16^{*}	0.12^{ns}	-0.09^{ns}	0.01^{ns}
-geometric	-0.22^{**}	0.11^{ns}	-0.22^{*}	0.01^{ns}
Correlation between lipid and PCB				
-arithmetic	0.18^{*}	0.28^{**}	0.19^{*}	0.43^{**}
-geometric	0.22^{**}	0.52^{**}	0.21^{*}	0.51^{**}
Lipid-based total PCB				
mean	51.1	41.4	49.4	42.2
95% CL	22.7- 79.5	11.0 - 71.8	16.8 - 82.1	9.8 - 74.6
geometric mean	35.5	32.7	34.5	34.5
95% CL	31.2 - 40.4	28.4 - 37.5	29.8 - 40.1	29.8 - 40.0

^{ns} -- not significant ($P > 0.05$)

* -- $P < 0.05$

** -- $P < 0.01$

[a] Represents more highly chlorinated types of PCB (penta-, hexa- and higher-chlorinated forms).

[b] Represents lesser chlorinated types of PCB, principally tri- and tetrachlorinated biphenyls.

ɔle 24. Analyses of variance for untransformed wet weight based and $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River estuary for spring collections below rivermile (RM) 80 for the years 1978 thru 1994 but excluding the 1979 samples.

ꞩource of ⁄ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Jntransformed wet weight					
ʒetween Years	66055.3	13	5081.2	36.1	<0.001
⁄ithin Years	347332.7	2466	140.8		
Total (corrected)	413388.0	2479			
Log_{10}-transformed lipid-based					
Between Years	147.9	13	11.4	88.6	<0.001
Within Years	316.6	2464	0.13		
Total (corrected)	464.5	2477			

able **25.** Scheffe tests for comparisons among means of years, 1978 thru 1994 excluding 1979, for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in spring collected striped bass from the Hudson River at $\alpha = 0.05$.

ear	N	Mean	95% Confidence Interval	Group Comparisons
ntransformed (Arithmetic)				
.992	143	1.84	-1.48 - 5.16	X
.994	126	1.97	-1.57 - 5.50	X
.993	124	2.34	-1.22 - 5.91	X
.990	164	2.77	-0.33 - 5.87	X
.987	147	3.61	0.33 - 6.88	X
.986	204	3.93	1.15 - 6.71	X
.988	170	3.97	0.92 - 7.01	X
.981	171	4.52	1.49 - 7.56	X
.985	213	4.60	1.88 - 7.32	X
.984	167	4.72	1.65 - 7.79	X
.983	130	4.78	1.30 - 8.26	X
.982	155	5.50	2.31 - 8.68	X
.980	191	6.03	3.16 - 8.91	X
.978	375	18.05	16.00 - 20.10	X
$\log_{10}$-transformed lipid-based (Geometric)				
1992	143	32.5	25.8 - 40.9	X
1993	124	34.3	26.8 - 44.0	XX
1994	126	34.3	26.9 - 43.9	XX
1990	164	35.2	28.3 - 43.6	XX
1988	170	36.4	29.5 - 45.0	XX
1986	204	36.5	30.1 - 44.2	XX
1987	147	47.3	37.7 - 59.4	XXX
1983	130	54.5	42.8 - 69.4	XXX
1985	213	55.0	45.5 - 66.4	XX
1984	167	66.2	53.5 - 82.0	XX
1982	155	76.5	61.3 - 95.4	XX
1980	190	108.8	89.1 - 132.9	X
1981	170	110.8	89.7 - 137.0	X
1978	375	160.2	138.9 - 184.7	X

ble 26. One-way analyses of variance for untransformed wet weight based and $\log_{10}$-transformed lipid-based total PCB in striped bass from the Albany/Troy area (RM 153) for 1984 - 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Untransformed wet weight					
Between years	3709.4	8	463.7	10.7	<0.001
Within years	7426.7	172	43.2		
Total(corrected)	11136.1	180			
Log_{10}-transformed lipid-based					
Between years	4.34	8	0.542	6.02	<0.001
Within years	15.48	172	0.090		
Total (corrected)	19.81	180			

Table 27. Scheffe tests for comparisons among means for years from the analyses of variance for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass from the Albany/Troy area (RM 153) for 1984 - 1994 at $\alpha = 0.05$.

Level	N	Mean	95% Confidence Interval	Group Comparisons			
Untransformed (Arithmetic)							
1994	29	6.41	2.96 - 9.98	X			
1990	13	6.90	1.76 - 12.05	X	X		
1984	17	6.91	2.41 - 11.41	X	X		
1987	30	10.35	6.64 - 13.42	X	X	X	
1988	8	10.32	3.76 - 16.88	X	X	X	X
1993	18	12.39	8.01 - 16.76	X	X	X	X
1986	36	16.40	13.31 - 19.49			X	X
1992	10	17.16	11.29 - 23.02		X	X	X
1985	20	18.80	14.65 - 22.95				X
Log_{10}-transformed lipid-based (Geometric)							
1987	30	97.6	68.3 - 139.3	X			
1988	8	99.8	50.1 - 198.9	X		X	
1990	13	116.0	67.6 - 199.3	X		X	
1984	17	144.7	90.2 - 232.2	X		X	
1986	36	144.8	104.6 - 200.5	X		X	
1985	20	191.8	124.0 - 296.6	X		X	
1994	29	227.2	158.2 - 326.4			X	
1993	18	247.5	156.3 - 392.0			X	
1992	10	309.1	166.8 - 572.7			X	

28. One-way analyses of variance for untransformed wet weight based and log_{10}-transformed lipid-based total PCB in fall collected striped bass from the Haverstraw Bay/Tappan Zee area for 1984 - 1994.

rce of iation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
ransformed wet weight					
ween years	3038.5	8	379.8	11.8	<0.001
hin years	14657.9	456	32.1		
al(corrected)	17696.5	464			
$_{10}$-transformed lipid-based					
ween years	7.55	8	0.943	5.45	<0.001
hin years	78.85	456	0.173		
al (corrected)	86.40	464			

ble **29.** Scheffe tests for comparisons among means for years from the analyses of variance for untransformed wet weight- and log_{10}-transformed lipid-based total PCB concentrations in fall collected striped bass from the Haverstraw Bay/Tappan Zee area for 1984 - 1994 at $\alpha = 0.05$.

vel	N	Mean	95% Confidence Interval	Group Comparisons
transformed (Arithmetic)				
94	99	1.84	0.72 - 2.96	X
84	77	2.14	0.87 - 3.41	X
87	39	2.91	1.12 - 4.69	XX
93	60	3.61	2.17 - 5.05	XX
90	20	3.89	1.40 - 6.38	XXX
88	23	4.28	1.96 - 6.60	XXX
92	33	5.70	3.76 - 7.64	XXX
86	54	6.16	4.65 - 7.68	XX
85	60	9.66	8.23 - 11.10	X
g_{10}-transformed lipid-based (Geometric)				
94	99	27.0	20.6 - 35.4	X
84	77	35.2	25.9 - 47.8	X X
93	60	37.0	26.1 - 53.3	X X
87	39	37.8	24.6 - 58.1	X X
92	33	42.1	26.4 - 67.2	X X
88	23	42.3	24.2 - 74.1	X X
90	20	46.0	25.2 - 83.8	X X
86	54	59.1	41.0 - 85.1	X
85	60	65.1	46.0 - 92.1	X

le 30. Analysis of variance for lower- : higher-chlorinated PCB ratios in spring collected striped bass from Hudson River locations below rivermile (RM) 80 from 1978 thru 1994.

ource of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
etween Years	247.5	13	19.04	307.5	<0.001
ithin Years	152.6	2466	0.062		
otal (corrected)	400.1	2479			

able 31. Scheffe tests for comparisons among means of lower- : higher-chlorinated PCB ratios in spring collected striped bass from several locations in the Hudson River below RM 80 from 1978 thru 1994 at $\alpha = 0.05$.

'e	N	Mean	95% Confidence Interval	Group Comparisons		
1994	126	0.12	0.04 - 0.19	X		
1988	170	0.13	0.07 - 0.20	X		
1992	143	0.14	0.07 - 0.21	X		
1990	164	0.17	0.10 - 0.23	X		
1986	204	0.17	0.11 - 0.22	X		
1983	130	0.17	0.10 - 0.25	X		
1993	124	0.18	0.11 - 0.26	X		
1985	213	0.18	0.13 - 0.24	X		
1984	167	0.20	0.13 - 0.26	X		
1987	147	0.20	0.13 - 0.27	X		
1982	155	0.23	0.16 - 0.30	X		
1981	171	0.25	0.19 - 0.32	X	X	
1980	191	0.36	0.30 - 0.42		X	
1978	375	1.06	1.02 - 1.11			X

le 32. Analysis of variance for lower- : higher-chlorinated PCB ratios in striped bass collected from the Hudson River in the Albany/Troy area near rivermile (RM) 153 from 1984 thru 1994.

ource of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
etween Years	4.22	8	0.527	7.42	<0.001
ithin Years	12.21	172	0.071		
otal (corrected)	16.43	180			

able 33. Scheffe tests for comparisons among means of lower- : higher-chlorinated PCB ratios in striped bass collected from the Hudson River in the Albany/Troy area near RM 153 from 1984 thru 1994 at $\alpha = 0.05$.

ear	N	Mean	95% Confidence Interval	Group Comparisons
1986	36	0.38	0.25 - 0.50	X
1988	8	0.39	0.12 - 0.65	XX
1985	20	0.41	0.25 - 0.58	XXX
1990	13	0.49	0.28 - 0.70	XXXX
1987	30	0.50	0.37 - 0.64	XXXX
1993	18	0.60	0.43 - 0.78	XXXX
1994	29	0.65	0.51 - 0.79	XXX
1984	17	0.81	0.62 - 0.99	X X
1992	10	0.87	0.63 - 1.10	X X

ble 34. Analysis of variance for lower- : higher-chlorinated PCB ratios in fall collected striped bass from the Hudson River in the Haverstraw Bay/Tappan Zee area near rivermiles (RM) 27-35 from 1984 thru 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Between Years	0.48	8	0.060	1.92	0.055
Within Years	14.24	456	0.031		
Total (corrected)	14.72	464			

Table 35. Scheffe tests for comparisons among means of lower- : higher-chlorinated PCB ratios in fall collected striped bass from the Hudson River in the Haverstraw Bay/Tappan Zee area near RM 27-35 from 1984 thru 1994 at $\alpha = 0.05$.

Year	N	Mean	95% Confidence Interval	Group Comparisons
1984	77	0.15	0.10 - 0.21	X
1986	54	0.19	0.12 - 0.26	X
1994	99	0.19	0.14 - 0.24	X
1993	60	0.19	0.13 - 0.26	X
1988	23	0.21	0.10 - 0.31	X
1992	33	0.21	0.12 - 0.29	X
1985	60	0.23	0.17 - 0.29	X
1987	39	0.24	0.16 - 0.32	X
1990	20	0.29	0.18 - 0.40	X

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Table 36. Linear regression relationships between length (X) and total PCB concentrations (Y) in striped bass from the Marine District in 1984, 1985, 1987, 1990 and 1994. Areas and seasons combined.

Year	N	Mean±standard deviation Length (mm)	Total PCB (ppm)	Correlation Coefficient	Y-intercept	Slope	Predicted PCB Conc(ppm) Length(mm) Constant	Y	Predicted Length (mm) PCB(ppm) Constant	X
1984	122	531 ± 77	3.34 ±3.75	0.28**	-4.0315	0.01388	737 (29")	5.20	2	435 (17")
1985	444	680 ±138	2.69 ±2.17	0.26**	-0.0936	0.004097	737 (29")	2.93	2	511 (20")
1987	794	-all sizes 732 ±187	2.17 ±2.33	0.28**	-0.3665	0.00346	737 (29")	2.18	2	684 (27")
	241	≥33 inches 971 ±125	TL 3.30 ±3.34	-0.17*	7.8473	-0.00468	737 (29")	3.40	---	----
1990	885	-all sizes 739 ±165	1.30 ±1.03	0.17**	0.4945	0.00109	737 (29")	1.30	2	1381(54")
	286	≥33 inches 926 ± 84	TL 1.46 ±1.06	-0.10ns	-not	calculated	(corr. not	signif.)		
1994	862	-all sizes 706 ±151	1.61 ±1.83	0.20**	-0.0691	0.00238	737 (29")	1.68	2	869 (34")
	218	≥33 inches 914 ± 68	TL 2.04 ±2.01	-0.22**	8.2146	-0.00675	737 (29")	3.24	---	----

* P < 0.05
** P < 0.01
ns Not significant at P = 0.05

Table Total PCB and other organochlorine concentrations in stripe ss taken from marine waters of New York State in 1990*. Data from Rhode Island collections in 1990 are also include rea VI).

Area	Season Collected	No. of fish	Average Length (mm)	Length Range (mm)	Average Weight (g)	Weight Range (g)	Average PCB (ppm)	PCB Range (ppm)	Average DDE (ppm)	DDE Range (ppm)	Average Nonachlor (ppm)	Nonachlor Range (ppm)	Average Dieldrin (ppm)	Dieldrin Range (ppm)
New York Harbor	Spring	56	709	452-1166	4181	1300-15,500	1.59	0.22- 5.73	0.08	0.02-0.20	0.04	<0.01-0.16	<0.01	<0.01-0.03
	Summer	63	741	491-1057	4793	1250-13,200	2.09	0.19-10.82	0.10	0.02-0.49	0.05	<0.01-0.16	<0.01	<0.01-0.03
(I)	Fall	51	699	534-1005	3964	1480-10,800	1.47	0.24-4.88	0.07	0.01-0.18	0.04	<0.01-0.22	<0.01	<0.01-0.02
	All Seasons	170	718	452-1166	4343	1250-15,500	1.74	0.19-10.82	0.08	0.01-0.49	0.04	<0.01-0.22	<0.01	<0.01-0.03
Western Long	Spring	58	692	464-987	3905	1100-9300	1.39	0.20-5.20	0.07	<0.01-0.28	0.03	<0.01-0.31	<0.01	<0.01-0.02
Island-North	Summer	43	685	466-1008	3742	1150-10,600	1.95	0.40-7.03	0.09	0.02-0.36	0.06	<0.01-0.18	<0.01	<0.01-0.03
Shore	Fall	35	632(34)	458-829	2799	1020-5680	1.49	0.34-3.65	0.07	0.02-0.15	0.04	<0.01-0.10	<0.01	<0.01-0.03
(II)	All Seasons	136	675(135)	458-1008	3569	1020-10,600	1.59	0.20-7.03	0.08	<0.01-0.36	0.04	<0.01-0.31	<0.01	<0.01-0.03
Western Long	Spring	61	691	485-945	3766	1150-7800	1.36	0.38-6.49	0.09	0.02-0.90	0.04	<0.01-0.22	<0.01	<0.01-0.02
Island-South	Summer	63	717	453-1017	4344	950-11,400	1.29	0.49-5.01	0.07	0.02-0.24	0.04	<0.01-0.20	<0.01	<0.01-0.03
Shore	Fall	53	731	450-1185	5093	910-16,590	0.92	0.22-6.03	0.05	<0.01-0.31	0.03	<0.01-0.15	<0.01	<0.01-0.02
(III)	All Seasons	177	712	450-1185	4369	910-16,590	1.20	0.22-6.49	0.07	<0.01-0.90	0.04	<0.01-0.22	<0.01	<0.01-0.03
Eastern Long	Spring	48	805	587-943	5696	2200-95000	1.15	0.22-2.77	0.08	<0.01-0.21	0.03	<0.01-0.08	<0.01	<0.01-0.07
Island - North	Summer	57	771	501-1273	5562	1000-21,400	1.02	0.20-2.89	0.06	0.02-0.17	0.02	<0.01-0.06	<0.01	<0.01-0.02
Shore	Fall	48	727	457-1110	4614	910-18,770	1.00	0.19-3.83	0.05	<0.01-0.15	0.03	<0.01-0.08	<0.01	<0.01-0.02
(IV)	All Seasons	153	768	457-1273	5307	910-21,400	1.06	0.19-3.83	0.06	<0.01-0.21	0.03	<0.01-0.08	<0.01	<0.01-0.07
Eastern Long	Spring	73	767	465-1240	5019	1200-20,100	1.25	0.14-4.18	0.08	<0.01-0.35	0.03	<0.01-0.15	<0.01	<0.01-0.02
Island - South	Summer	64	743	470-1086	5051	1050-24,500	1.06	0.30-5.82	0.07	0.02-0.40	0.02	<0.01-0.10	<0.01	<0.01-0.02
Shore	Fall	63	732	457-983	4658	1140-14,450	0.74	0.20-3.04	0.05	<0.01-0.25	0.02	<0.01-0.06	<0.01	<0.01-0.02
(V)	All Seasons	200	748	457-1240	4915	1050-24,500	1.03	0.14-5.82	0.06	<0.01-0.40	0.03	<0.01-0.15	<0.01	<0.01-0.02
Rhode Island	Summer	13	893	734-1033	6950	3632-10,896	1.31	0.35-2.37	0.10	0.04-0.21	0.03	<0.01-0.09	<0.01	<0.01-0.03
(VI)	Fall	36	996	737-1332	10,076	4540-20,884	1.05	0.06-2.61	0.06	<0.01-0.14	0.02	<0.01-0.05	<0.01	<0.01-0.05
	All Seasons	49	969	734-1332	9246	3632-20,884	1.12	0.06-2.61	0.07	<0.01-0.21	0.02	<0.01-0.09	<0.01	<0.01-0.05

*Numbers in parentheses following a variable average represent the number of samples in which the particular compound was analyzed and detected.

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Table 38. Total PCB and other organochlorine concentrations in striped bass taken from marine waters of New York State in 1987*.

Area	Season Collected	No. of fish	Average Length (mm)	Length Range (mm)	Average Weight (g)	Weight Range (g)	Average PCB (ppm)	PCB Range (ppm)	Average DDE (ppm)	DDE Range (ppm)	Average Nonachlor (ppm)	Nonachlor Range (ppm)	Average Dieldrin (ppm)	Dieldrin Range (ppm)
New York Harbor	Spring	30	711	460-982	4355	1100-10900	3.50	0.63-13.03	0.17	0.02-0.62	0.03	0.01-0.09	0.01(26)	<0.01-0.03
	Summer	31	723	482-1117	4403	1150-14600	2.57	0.40-11.23	0.17	0.01-0.85	0.03	<0.01-0.13	0.01	<0.01-0.03
(I)	Fall	27	689	485-877	3940	1400-7700	2.21	0.77-8.93	0.13	0.04-0.30	0.03	0.01-0.06	0.01	<0.01-0.03
	All Seasons	88	709	460-1117	4245	1100-14600	2.78	0.40-13.03	0.16	0.01-0.85	0.03	<0.01-0.13	0.01(84)	<0.01-0.03
Western Long	Spring	62	719	461-1106	4491	950-14400	3.60	0.52-27.23	0.17	0.02-0.75	0.03(61)	0.01-0.16	0.01(49)	0.01-0.04
Island-North	Summer	56	695	465-1032	3829	1000-10500	2.73	0.62-9.69	0.16	0.03-0.51	0.03	0.01-0.12	0.02	<0.01-0.10
Shore	Fall	45	659	495-879	3293	1200-7100	2.27	0.46-8.53	0.11	0.04-0.51	0.02	0.01-0.09	0.03	<0.01-0.14
(II)	All Seasons	163	695	461-1106	3933	950-14400	2.94	0.46-27.23	0.15	0.02-0.75	0.03(162)	0.01-0.16	0.02(150)	<0.01-0.14
Western Long	Spring	46	650	477-1015	3264	1150-10800	2.05	0.67-8.93	0.12	0.02-0.35	0.02	0.01-0.04	0.01(26)	0.01-0.03
Island-South	Summer	72	769	481-1267	5960	1200-20100	2.25	0.23-9.29	0.15	0.02-0.95	0.03	<0.01-0.18	0.01	<0.01-0.05
Shore	Fall	68	804	476-1290	7189	1300-24500	1.71	0.08-7.44	0.13	0.02-0.85	0.02	<0.01-0.16	0.01	<0.01-0.06
(III)	All Seasons	186	753	476-1290	5743	1150-24500	2.00	0.08-9.29	0.13	0.02-0.95	0.02	<0.01-0.18	0.01(166)	<0.01-0.06
Eastern Long	Spring	57	722	524-1253	4949	1400-21800	1.65	0.20-5.52	0.10	0.02-0.36	0.02(55)	0.01-0.33	0.01(48)	<0.01-0.03
Island - North	Summer	65	766	496-1241	6026	1150-23400	1.69	0.25-7.50	0.12	0.01-0.73	0.02	<0.01-0.10	0.01	<0.01-0.06
Shore	Fall	54	740	450-1181	5364	1050-20000	2.22	0.35-23.43	0.15	0.02-1.10	0.02	<0.01-0.13	0.01	<0.01-0.04
(IV)	All Seasons	176	744	450-1253	5474	1050-23400	1.84	0.20-23.43	0.12	0.01-1.10	0.02(174)	<0.01-0.33	0.01(167)	<0.01-0.06
Eastern Long	Spring	52	697	491-1268	4121	1300-20800	2.14	0.51-15.43	0.13	0.03-0.56	0.02(51)	0.01-0.07	0.01(44)	0.01-0.02
Island - South	Summer	65	757	497-1230	5542	1200-18500	1.55	0.15-6.29	0.12	0.01-0.65	0.02	<0.01-0.08	0.01	<0.01-0.03
Shore	Fall	64	770	471-1329	5839	1200-21600	1.41	0.08-6.93	0.10	0.01-0.37	0.02	<0.01-0.09	0.01	<0.01-0.04
(V)	All Seasons	181	774	471-1329	5239	1200-21600	1.67	0.08-15.43	0.12	0.01-0.65	0.02(180)	<0.01-0.09	0.01(173)	<0.01-0.04
II - V	Spring	217	700	461-1268	4263	950-21800	2.41	0.20-27.23	0.13	0.02-0.75	0.02(213)	0.01-0.33	0.01(167)	<0.01-0.04
	Summer	258	749	465-1267	5409	1000-23400	2.04	0.15-9.69	0.13	0.01-0.95	0.02	<0.01-0.18	0.01	<0.01-0.10
	Fall	231	752	450-1329	5629	1050-24500	1.86	0.08-23.43	0.12	0.01-1.10	0.02	<0.01-0.16	0.01	<0.01-0.14
	All Seasons	706	735	450-1329	5129	950-24500	2.09	0.08-27.23	0.13	0.01-1.10	0.02(702)	<0.01-0.33	0.01(656)	<0.01-0.14

*Numbers in parentheses following a variable average represent the number of samples in which the particular compound was analyzed and detected.

Table 39. R)s from the 1985 Marine District Striped Bass PCB Project.*

Part I

LOCATION	SEASON	NO. OF FISH ANALYZED	NO. OF ANALYSES	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)	AVERAGE WEIGHT (g)	WEIGHT RANGE (g)	AVERAGE LIPID (%)	LIPID RANGE (%)	AVERAGE PCB (ppm)	PCB RANGE (ppm)	AVERAGE DDT (ppm)	DDT RANGE (ppm)
New York City Harbor Area	Spring	30	30	617	460- 985	2898	1020-10433	3.53	0.30- 8.30	2.81	0.63- 6.68	0.33	0.08-1.22
	Summer	30	30	666	565- 949	3385	1816- 9534	5.82	1.19-10.40	3.48	1.49- 7.04	0.31	0.09-0.90
	Fall	30	30	668	465-1098	3976(29)	1021-15890	5.51	0.30-16.00	4.34	0.21-31.10	0.36	0.05-1.45
Western Long Island -North Shore	Spring	30	30	648	464- 961	3070	908- 8853	5.77	1.00-10.70	2.58	0.91- 8.61	0.25	0.05-0.85
	Summer	30	30	657	545- 825	2891	1702- 5675	8.31	2.03-13.67	2.75	1.11- 5.66	0.23	0.04-0.57
	Fall	30	30	628	533- 765	2595	1475- 4880	6.10	1.10-11.50	2.19	0.80- 6.03	0.16	0.07-0.42
Western Long Island -South Shore	Spring	31	31	825	545-1015	6362	2041-11000	6.29	1.20-17.00	3.92	0.02- 9.17	0.40	0.01-1.59
	Summer	28	28	760	631- 932	4956	2721- 9364	5.63	1.03-16.00	3.26	0.26- 8.12	0.29(21)	0.06-0.54
	Fall	30	30	739	525-1188	5907	1929-17463	8.36	2.10-17.80	1.94	0.47- 4.29	0.22	0.08-0.82
Eastern Long Island -North Shore	Spring	30	30	649	467-1173	3604	964-20412	5.83	0.90-16.50	2.01	0.78- 4.95	0.26	0.04-0.61
	Summer	30	30	633	538- 764	2535	1589- 4199	4.66	0.91-15.00	1.76	0.74- 3.42	0.17	0.05-0.74
	Fall	30	30	659	537- 945	2996	1475- 4994	4.03	0.20-11.70	1.97	0.60- 4.13	0.16	0.04-0.56
Eastern Long Island -South Shore	Spring	30	30	671	517-1205	3653	1361-20865	3.89	0.16-13.70	2.70	1.32- 5.48	0.23(11)	0.17-0.35
	Summer	25	25	697	461-1240	4521	1135-25388	5.23	0.42-10.40	2.78	0.85-13.45	0.21(24)	0.05-0.93
	Fall	30	30	689	521-1198	4143	1589-21792	7.41	2.00-20.00	1.91	0.10- 5.44	0.14	0.05-0.35

*Numbers in parentheses following a variable average represent the number of samples in which the particular compound was analyzed and detected. If no parenthtic values are provided, the chemical was analyzed for in all samples. Some compounds are represented as a summation of several other chemicals. Therefore, it is possible that PCB is a total of "Aroclors" 1254, 1016,1221 and 1248; DDT may be a total of DDE, DDD and DDT; Dieldrin must be a total of Aldrin and Dieldrin; Lindane may be a total of α-HCH, β-HCH, and γ-HCH; Heptachlor may be a total of Heptachlor and Heptachlorepoxide; Chlordane might be a total of α-chlordane, γ-chlordane, oxychlordane, transnonachlor and compounds "C" and "E".

Table 40.

LOCATION	SEASON	NO. OF FISH ANALYZED	NO. OF ANALYSES	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)	AVERAGE WEIGHT (g)	WEIGHT RANGE (g)	AVERAGE LIPID (%)	LIPID RANGE (%)	AVERAGE PCB (ppm)	PCB RANGE (ppm)
New York Harbor Area	Spring	5	5	550	458-638	1709	937-2412	3.89	0.57- 7.67	6.50	2.41- 16.05
	Fall	24	24	531	447-802	1761	850-5556	4.87	1.40- 8.40	5.21	1.31- 19.94
Western Long Island Sound	Spring	28	28	545	453-720	1809	880-3576	5.61	0.87-11.80	6.43	0.78-100.5
	Summer	3	3	478	473-489	1200	1134-1304	8.14	7.01- 9.74	2.39	1.60- 3.51
Western Long Island-South Shore	Summer	8	8	489	454-534	1520	964-3375	5.90	2.72- 7.87	1.95	1.33- 2.83
	Fall	3	3	627	565-681	2721	2041-3742	4.80	3.40- 6.60	2.02	1.04- 3.63
Eastern Long Island Sound	Spring	5	5	494	474-539	1333	1247-1419	6.61	2.15-11.80	2.42	1.58- 4.43
	Summer	5	5	494	458-538	1440	1134-1814	6.98	2.75- 9.73	2.05	1.31- 2.70
	Fall	13	13	490	442-591	1298	1020-2053	4.36	2.10- 7.10	1.00	0.40- 2.86
Eastern Long Island-South Shore	Summer	29	29	555	444-756	2169	1020-7188	6.34	3.40-10.20	3.68	1.21- 29.95

Table 41. Two-way analyses of variance by **year** and **area** for untransformed wet weight based and log_{10}-transformed lipid-based total PCB in striped bass from the Marine District of New York State for 1984, 1985, 1987, and 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Untransformed wet weight					
Main Effects					
Year	1034.2	4	258.5	39.7	<0.001
Area	822.3	4	205.6	31.6	<0.001
2-factor Interactions					
Year X Area	599.3	16	37.5	5.75	<0.001
Residual	19754.2	3032	6.52		
Total (corrected)	22510.8	3056			
Log_{10}-transformed lipid-based					
Main Effects					
Year	23.6	4	5.90	50.1	<0.001
Area	24.1	4	6.03	51.2	<0.001
2-factor Iinteractions					
Year X Area	14.0	16	0.878	7.44	<0.001
Residual	357.3	3031	0.118		
Total (corrected)	429.6	3055			

Table 42. Scheffe tests for comparisons among means for main effects (Year, Area) from the analyses of variance for untransformed wet weight- and $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass from the Marine District for the years 1984, 1985, 1987, 1990 and 1994 at $\alpha = 0.05$.

Level	N	Mean	95% Confidence Interval	Group Comparisons		
Untransformed (Arithmetic)						
YEAR						
1990	836	1.32	1.15 - 1.50	X		
1994	862	1.60	1.42 - 1.77	X		
1987	792	2.22	2.04 - 2.41		X	
1985	444	2.68	2.44 - 2.92		X	
1984	123	3.68	3.19 - 4.17			X
AREA						
IV	601	1.49	1.22 - 1.76	X		
III	635	1.85	1.51 - 2.20	X		
V	701	1.97	1.72 - 2.22	X		
II	563	2.83	2.58 - 3.09		X	
I	557	3.35	3.09 - 3.61		X	
$\log_{10}$-transformed lipid-based (Geometric)						
YEAR						
1994	862	30.2	28.7 - 31.9	X		
1990	836	31.7	30.1 - 33.5	X		
1984	123	46.2	39.7 - 53.7		X	
1987	792	46.2	43.6 - 48.9		X	
1985	443	47.9	44.5 - 51.6		X	
AREA						
IV	601	31.9	29.4 - 34.7	X		
V	701	33.0	30.5 - 35.6	X		
III	634	33.3	29.9 - 37.1	X		
II	563	43.0	39.7 - 46.5		X	
I	557	65.1	60.0 - 70.6			X

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.e .Two-factor analysis of variance of **year** and **area** for lower- : higher-chlorinated PCB ratios in striped bass from the Marine District of New York State across the years 1984, 1985, 1987, 1990 and 1994.

ource of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
ain Effects					
Year	7.59	4	1.898	122.5	<0.001
Area	1.38	4	0.345	22.2	<0.001
-factor Interactions					
ear X Area	1.49	16	0.093	6.01	<0.001
esidual	47.00	3032	0.016		
otal (corrected)	59.31	3056			

al 44. Scheffe tests for comparisons among means for main effects (Year, Area) from the analyses of variance for lower- : higher-chlorinated PCB ratios in striped bass from the Marine District across the years 1984, 1985, 1987, 1990 and 1994 at $\alpha = 0.05$.

evel	N	Mean	95% Confidence Interval	Group Comparisons		
EAR						
1994	862	0.13	0.12 - 0.14	X		
1990	836	0.14	0.13 - 0.15	X		
1987	792	0.14	0.13 - 0.15	X		
1984	123	0.21	0.19 - 0.23		X	
1985	444	0.28	0.26 - 0.29			X
AREA						
IV	601	0.14	0.12 - 0.15	X		
V	701	0.17	0.16 - 0.18		X	
III	635	0.18	0.16 - 0.20		X	
II	563	0.19	0.18 - 0.20		X	
I	557	0.22	0.21 - 0.24			X

able 45. Analysis of variance for log_{10}-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District all data combined for the years 1985, 1987, 1990, and 1994.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Log_{10}-transformed lipid-based					
Between Areas	80.8	10	8.1	62.5	<0.001
Within Areas	525.2	4061	0.13		
Total (corrected)	606.0	4071			

Table 46. Scheffe tests for comparisons among means for areas in the Hudson River and the Marine District with combined years 1985, 1987, 1990, and 1994 for log_{10}-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

Area	N	Mean	95% Confidence Interval	Group Comparisons
Log_{10}-transformed lipid-based (Geometric)				
ELI	672	28.7	26.1 - 31.6	X
WLI	623	32.1	29.0 - 35.5	XX
ESN	578	33.3	30.0 - 37.0	XXX
TZ	471	37.0	33.0 - 41.6	XX
WSN	532	40.2	36.0 - 44.8	XX
GW	116	40.3	31.9 - 50.8	XXXXX
PEK	141	44.1	35.7 - 54.5	XXXX
POU	205	53.2	44.7 - 63.4	XX
NYH	528	56.1	50.3 - 62.5	X
CAT	114	83.5	66.0 - 105.6	X
AT	92	151.2	116.4 - 196.3	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ESN = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Shore, Area V.

able 47. Analysis of variance for $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District all data combined for the year **1994**.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
<u>$\log_{10}$-transformed lipid-based</u>					
Between Areas	50.9	9	5.65	48.3	<0.001
Within Areas	131.9	1127	0.12		
Total (corrected)	182.8	1136			

Table **48.** Scheffe tests for comparisons among means for areas in the Hudson River and the Marine District of year **1994** only, for $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

Area	N	Mean	95% Confidence Interval	Group Comparisons
$\log_{10}$-transformed lipid-based (Geometric)				
ELI	207	22.9	20.6 - 25.6	X
WLI	172	23.4	20.8 - 26.3	XX
ESN	160	26.8	23.8 - 30.3	XXX
WSN	143	27.0	23.7 - 30.7	XXX
TZ	139	27.8	24.4 - 31.7	XX
PEK	43	33.7	26.6 - 42.7	XX
POU	43	40.0	31.6 - 50.7	X
NYH	180	64.9	57.8 - 72.8	X
CAT	21	73.6	52.5 - 103.2	X
AT	29	227.2	170.5 - 302.8	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ESN = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Shore, Area V.

able 49. Analysis of variance for $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District all data combined for the year 1990.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Log10-transformed lipid-based					
Between Areas	13.5	10	1.35	12.2	<0.001
Within Areas	115.6	1042	0.11		
Total (corrected)	129.1	1052			

Table 50. Scheffe tests for comparisons among means for areas in the Hudson River and the Marine District of year 1990 only, for $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

Area	N	Mean	95% Confidence Interval	Group Comparisons
Log10-transformed lipid-based (Geometric)				
ELI	200	27.0	22.9 - 31.9	X
GW	37	28.3	19.3 - 41.5	XX
ESN	153	28.4	23.6 - 34.3	XXX
WLI	177	28.9	24.2 - 34.4	XX
PEK	35	32.1	21.7 - 47.5	XX
TZ	63	32.7	24.4 - 43.9	XXXXX
WSN	136	36.3	29.7 - 44.3	XXXX
NYH	170	39.9	33.4 - 47.7	XX
POU	49	54.0	38.7 - 75.2	X
CAT	20	81.9	48.8 - 137.6	X
AT	13	116.0	61.0 - 220.8	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ESN = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Shore, Area V.

le .Analysis of variance for log_{10}-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District all data combined for the year 1987.

ource of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
<u>og$_{10}$-transformed lipid-based</u>					
etween Areas	16.4	10	1.64	13.8	<0.001
ithin Areas	121.6	1020	0.12		
otal (corrected)	138.0	1030			

Table 52. Scheffe tests for comparisons among means for areas in the Hudson River and the Marine District of year 1987 only, for log_{10}-transformed lipid-based total PCB concentrations in striped bass at α = 0.05.

Area	N	Mean	95% Confidence Interval	Group Comparisons
Log_{10}-transformed lipid-based (Geometric)				
ELI	180	31.3	26.1 - 37.4	X
TZ	79	36.3	27.7 - 47.5	XX
ESN	175	40.3	33.6 - 48.3	XX
WLI	186	40.7	34.1 - 48.5	XX
GW	34	41.9	27.7 - 63.2	XXX
CAT	23	54.3	32.9 - 89.7	XXX
PEK	33	56.4	37.1 - 85.7	XXX
POU	40	61.7	42.2 - 90.2	XX
WSN	163	63.2	52.4 - 76.3	X
NYH	88	65.1	50.4 - 84.1	X
AT	30	97.6	62.9 - 151.3	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ES = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Sh e, Area V.

ble 53. Analysis of variance for $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District all data combined for the year **1985**.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
<u>Log_{10}-transformed lipid-based</u>					
Between Areas	15.9	10	1.59	12.5	<0.001
Within Areas	107.2	840	0.13		
Total (corrected)	123.1	850			

Table **54**. Scheffe tests for comparisons among means for areas in the Hudson River and the Marine District of year **1985** only, for $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

Area	N	Mean	95% Confidence Interval	Group Comparisons
Log_{10}-transformed lipid-based (Geometric)				
WSN	90	38.8	29.9 - 50.4	X
ESN	90	44.3	34.1 - 57.6	XX
WLI	88	44.7	34.3 - 58.3	XX
ELI	85	47.8	36.5 - 62.6	XX
TZ	190	48.1	40.2 - 57.6	XX
GW	45	52.3	36.1 - 75.8	XX
POU	73	57.5	43.0 - 77.0	XXX
NYH	90	68.7	52.8 - 89.3	XX
PEK	30	71.8	45.6 - 113.0	XXXX
CAT	50	108.2	76.1 - 153.8	XX
AT	20	191.8	109.9 - 334.5	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ESN = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Shore, Area V.

le 55. Analyses of variance for untransformed wet weight based and log_{10}-transformed lipid-based total PCB in striped bass from four locales within **Area** I (New York Harbor) in 1994.

ɔurce of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
<u>ntransformed wet weight</u>					
ain Effects					
Locale	239.3	3	79.8	11.3	<0.001
Season	59.1	2	29.6	4.2	0.017
·wo-factor Interaction					
ocale X Season	140.2	6	23.4	3.31	0.004
esidual	1184.4	168	7.05		
otal (corrected)	1690.6	179			
<u>og_{10}-transformed lipid-based</u>					
ain Effects					
Locale	24.5	3	3.38	28.2	<0.001
Season	4.30	2	1.48	12.3	<0.001
-factor Iinteractions					
ocale X Season	10.13	6	0.446	3.72	0.002
esidual	20.2	168	0.120		
'otal (corrected)	34.4	179			

Table **56.** Scheffe tests for comparisons among means for main effects (Locale, Season) from the analyses of variance for untransformed wet weight- and log_{10}-transformed lipid-based total PCB concentrations in striped bass from **Area I** in 1994 at $\propto = 0.05$.

Level	N	Mean	95% Confidence Interval	Group Comparisons		
Untransformed (Arithmetic)						
LOCALE						
Jamaica Bay	18	0.74	-0.51 - 1.98	X		
East River	62	3.34	2.63 - 4.04		X	
Lower NY Hbr	63	3.41	2.74 - 4.08		X	
Upper NY Hbr	37	5.95	4.70 - 7.20			X
SEASON						
Fall	58	2.35	1.49 - 3.21	X		
Spring	60	3.77	2.79 - 4.75	X	X	
Summer	62	3.96	3.19 - 4.73		X	
Log_{10}-transformed lipid-based (Geometric)						
LOCALE						
Jamaica Bay	18	14.5	10.0 - 21.1	X		
Lower NY Hbr	63	69.5	56.9 - 84.9		X	
East River	60	71.8	58.0 - 88.7		X	
Upper NY	37	154.3	105.9 - 224.7			X
SEASON						
Fall	58	36.9	28.5 - 47.8	X		
Summer	62	53.1	42.1 - 66.9	X		
Spring	60	98.3	73.3 - 131.9		X	

Table 57. Summaries of PCB concentrations in fall collected striped bass from the New York Harbor in 1993 and 1994 as part of two separate studies - Skinner (1995) and this report.

Location	Skinner - fall 1993 PCB (ppm -wet weight) Mean	N	Min - Max	This study - fall 1994 PCB (ppm - wet weight) Mean	N	Min - Max
Upper NY Hbr	1.65	23	0.45 - 3.53	2.99	7	1.02 - 6.02
East River	2.45	20	0.41 -13.40	3.20	24	0.66 - 9.00
Lower NY Hbr	1.57	11	0.46 - 4.33	2.58	22	0.36 - 8.72
Jamaica Bay	0.78	17	0.23 - 2.00	0.64	5	0.45 - 1.06

le 58. Analysis of variance for $\log_{10}$-transformed lipid-based total PCB in striped bass from the Marine District for **sex** differences by area and season combined for the year **1994**.

ource of ariation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
ain Effects					
Area	19.95	4	4.99	49.9	<0.001
Season	6.06	2	3.03	30.3	<0.001
Sex	7.99	1	7.99	79.9	<0.001
-factor Interactions					
rea X Season	3.22	8	0.403	4.02	<0.001
rea X Sex	1.78	4	0.444	4.44	0.002
eason X sex	3.68	2	1.841	18.4	<0.001
esidual	83.3	832			
otal (corrected)	131.5	861			

able **59**. Scheffe tests for comparisons among means for area, season and **sex** differences in the Marine District in **1994** for $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

rea	N	Mean	95% Confidence Interval	Group Comparisons		
REA						
V	207	23.5	21.2 - 26.2	X		
III	172	24.0	21.5 - 26.9	X		
II	143	27.1	23.9 - 30.6	X		
IV	160	27.9	24.7 - 31.4	X		
I	180	60.9	54.6 - 68.0		X	
EASON						
Fall	294	23.8	21.8 - 26.1	X		
Summer	285	30.1	27.5 - 32.9		X	
Spring	283	39.2	35.9 - 42.8			X
EX						
Female	494	24.1	22.5 - 25.7	X		
Male	368	38.4	35.5 - 41.5		X	

Table 60. Analysis of variance for $\log_{10}$-transformed lipid-based total PCB in striped bass from the Hudson River and the Marine District for **sex** differences by area for the year **1994**.

Source of Variation	Sum of squares	d.f.	Mean square	F-ratio	Observed Significance Level
Main Effects					
Area	26.5	9	2.94	28.0	<0.001
Sex	3.20	1	3.20	30.4	<0.001
2-factor Interaction					
Area X Sex	3.97	9	0.441	4.20	<0.001
Residual	117.3	1116	0.105		
Total (corrected)	129.1	1135			

Table **61.** Scheffe tests for comparisons among means for area and **sex** differences in the Hudson River and the Marine District in **1994** for $\log_{10}$-transformed lipid-based total PCB concentrations in striped bass at $\alpha = 0.05$.

Area	N	Mean	95% Confidence Interval	Group Comparisons
AREA				
ELI	207	24.1	21.7 - 26.8	X
WLI	172	24.6	22.0 - 27.6	X
TZ	138	26.6	23.4 - 30.2	X
WSN	143	27.4	24.2 - 31.0	X
ESN	160	27.9	24.7 - 31.6	X
PEK	43	30.6	23.8 - 39.2	XX
POU	43	43.2	25.4 - 73.4	XXX
NYH	180	60.5	54.1 - 67.6	X
CAT	21	65.2	47.2 - 90.0	XX
AT	29	182.3	106.6 - 311.9	X
SEX				
Female	573	31.3	26.5 - 36.9	X
Male	563	52.1	48.3 - 56.1	X

AT = Albany/Troy RM 153; CAT = Catskill RM 115; POU = Poughkeepsie RM 73; PEK = Peekskill area RM 40; TZ = Tappan Zee RM 27; GW = George Washington Bridge RM 12; NYH = New York Harbor, Area I; WSN = Western Long Island Sound, Area II; WLI = Western Long Island South Shore, Area III; ESN = Eastern Long Island Sound, Area IV; ELI = Eastern Long Island South Shore, Area V.

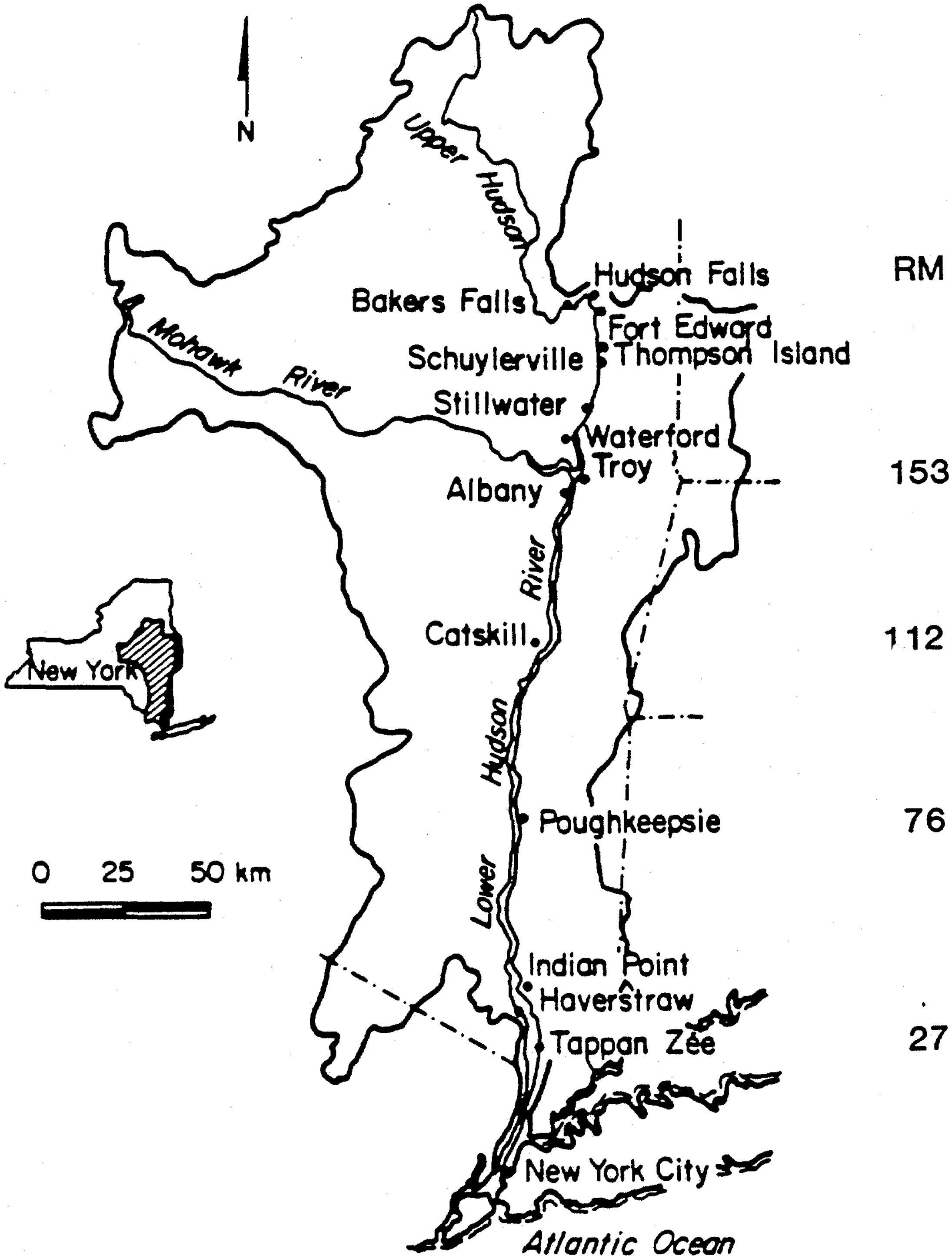

Figure 1. Outline map of features of the Hudson River watershed. River Mile index (RM) is calculated from the Battery on Manhattan Island.

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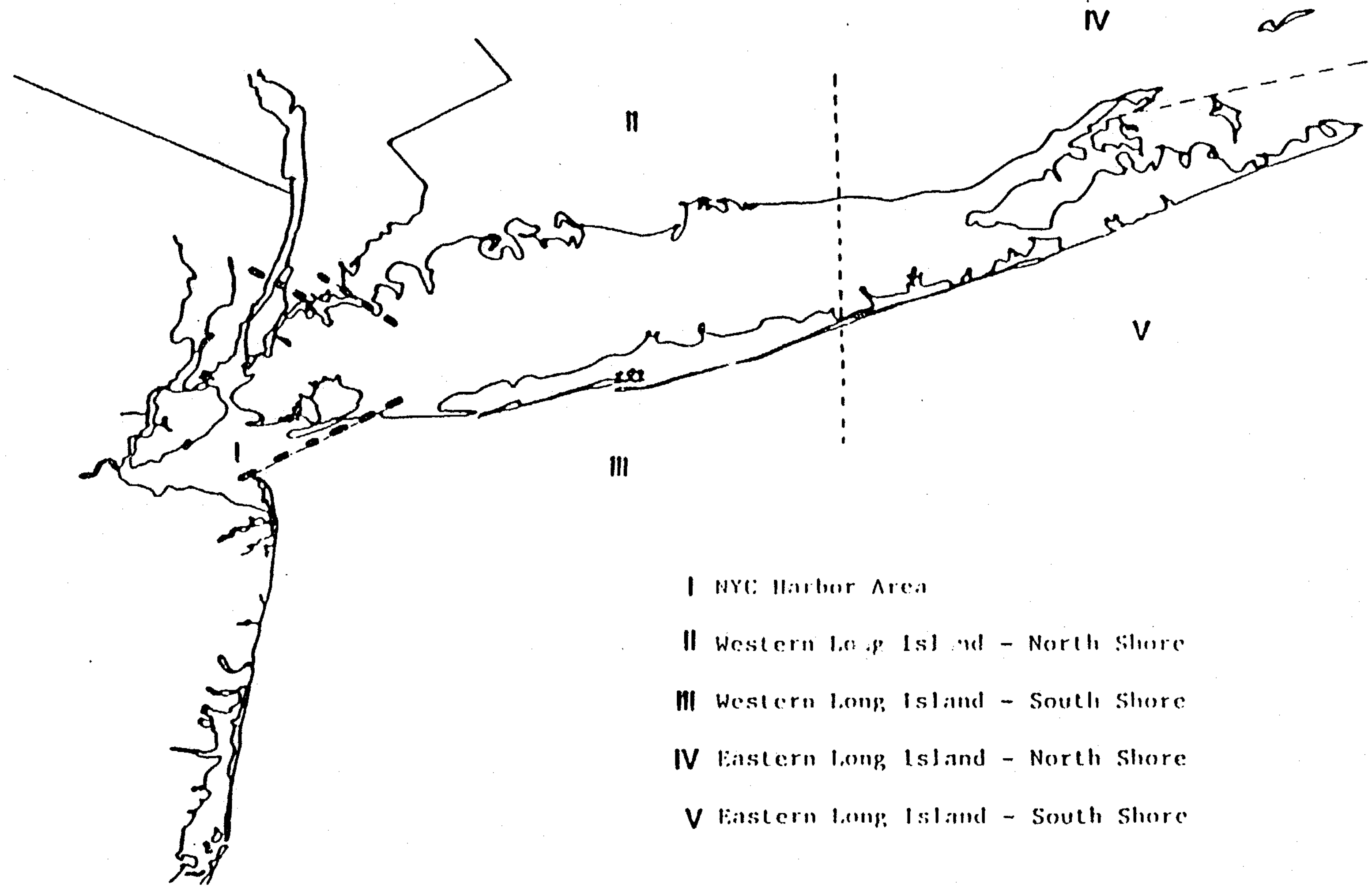

Figure 2. Designated geographic areas for sampling striped bass from marine waters of Long Island and the New York Harbor.

SCALE 1:40,000
Habitat Inventory Unit

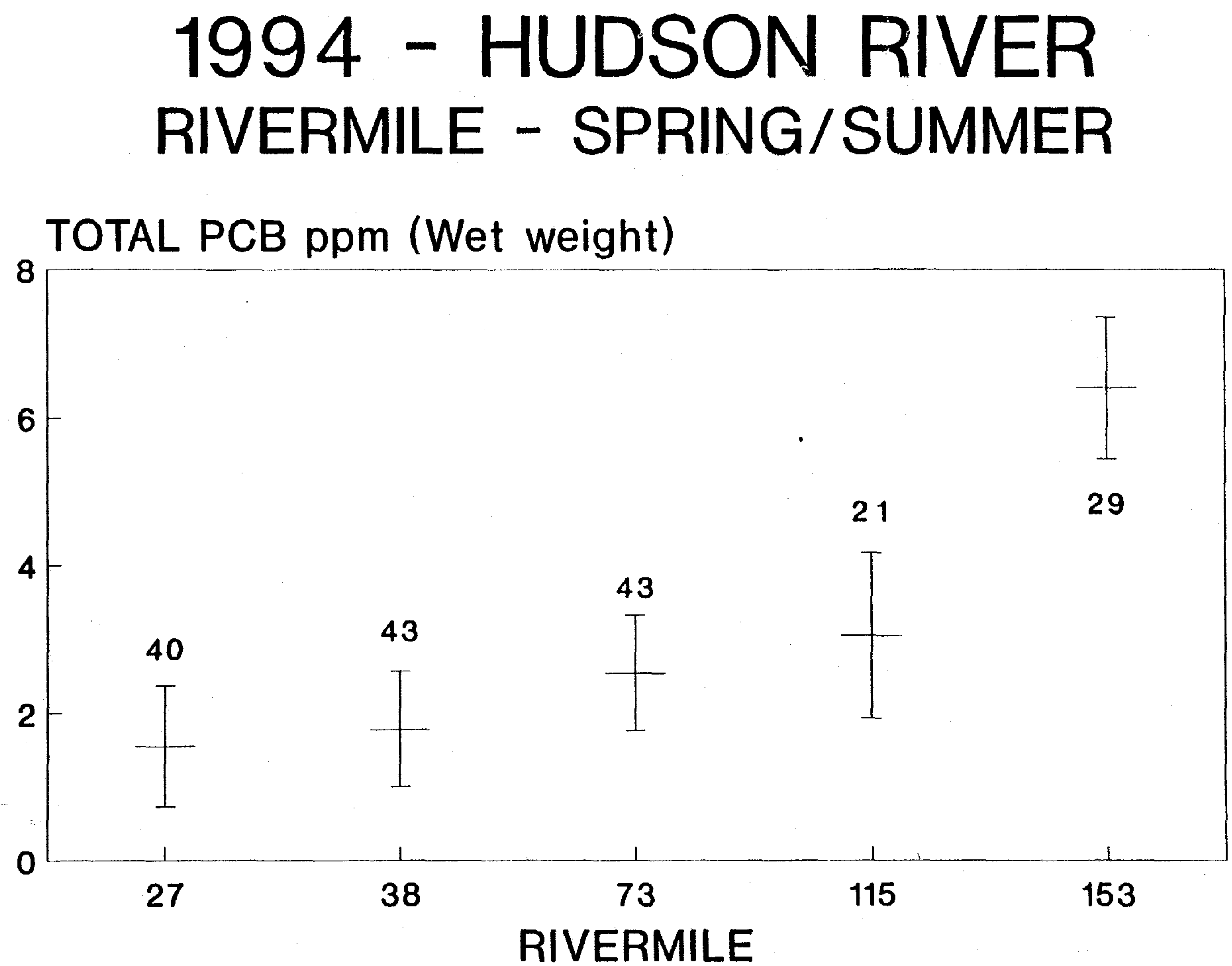

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Figure 3. **Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations in striped bass by rivermile (RM) locations collected in the spring and

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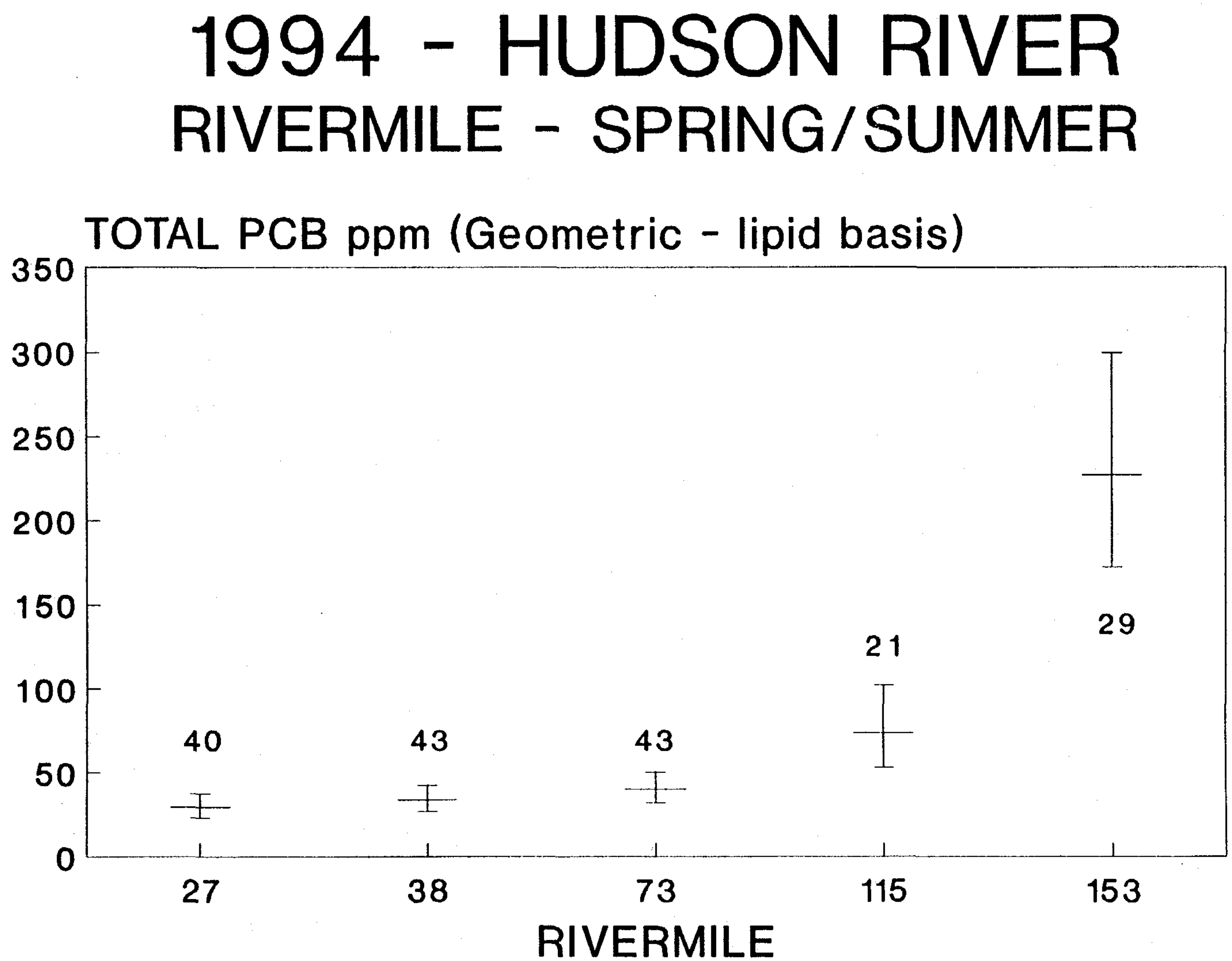
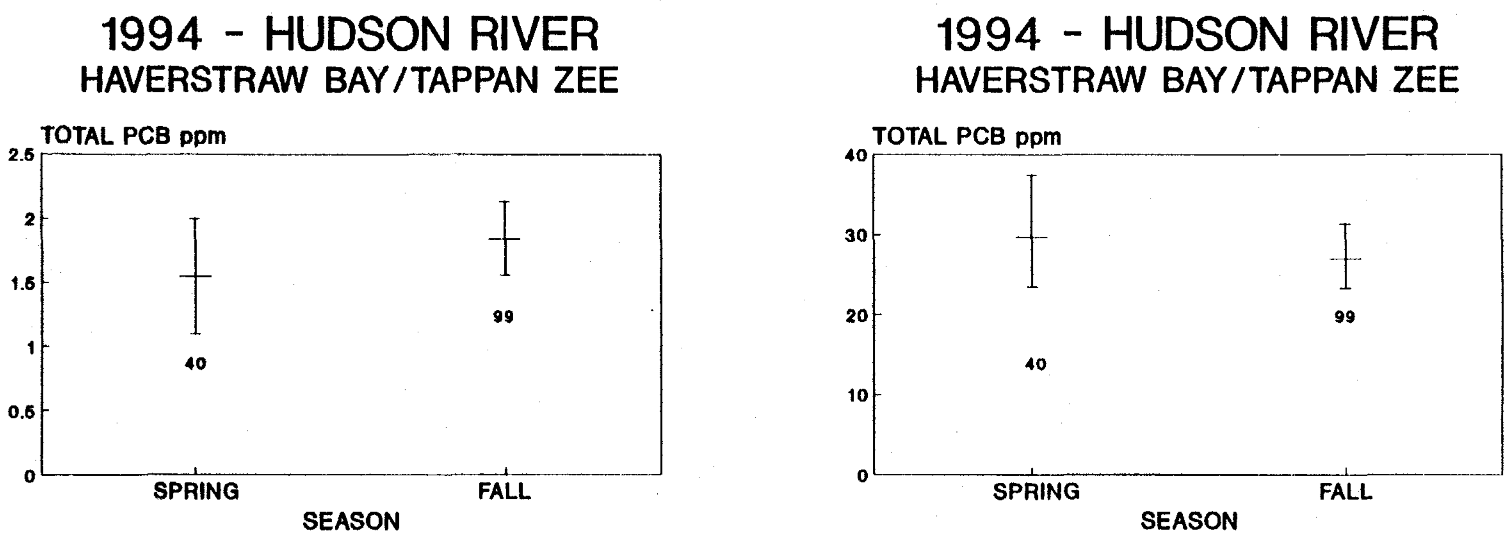


Figure 4. **Lipid-based Geometric** means and 95 percent confidence intervals for **total PCB** concentrations in striped bass by rivermile (RM) locations collected in the spring and summer of 1994 from the Hudson River.



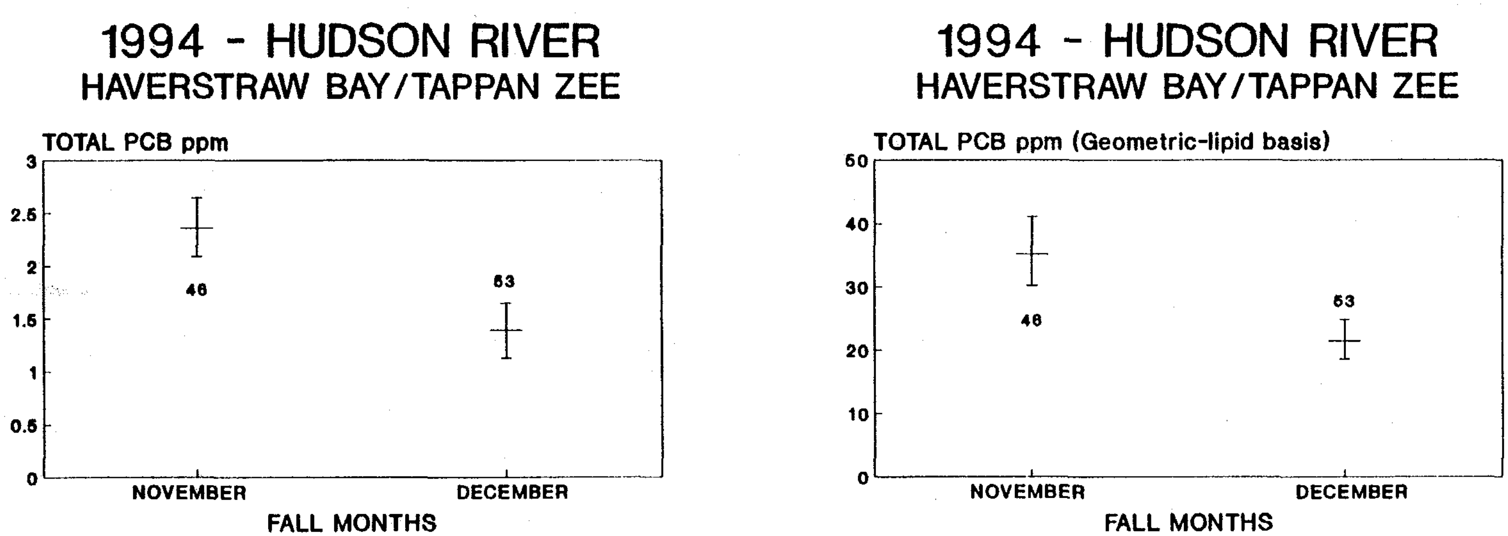
a) Wet weight basis (Arithmetic)

b) Log10-lipid based (Geometric)

Figure 5. **Seasonal** differences for striped bass collected from the **Haverstraw Bay/Tappan Zee** area (RM 27-38) in 1994 from the Hudson River for a)**Arithmetic** and b)**Geometric lipid-based** total PCB concentration means and 95 percent confidence intervals.

318002

318003



a) Wet weight basis (Arithmetic)

b) Log10-lipid based (Geometric)

Figure 6. **November vs. December** differences for striped bass collected from the **Haverstraw Bay/Tappan Zee** area (RM 27-38) in 1994 from the Hudson River for a)**Arithmetic** and b)**Geometric lipid-based** total PCB concentration means and 95 percent confidence intervals.

1994 - HUDSON RIVER
RIVERMILE - SPRING/SUMMER

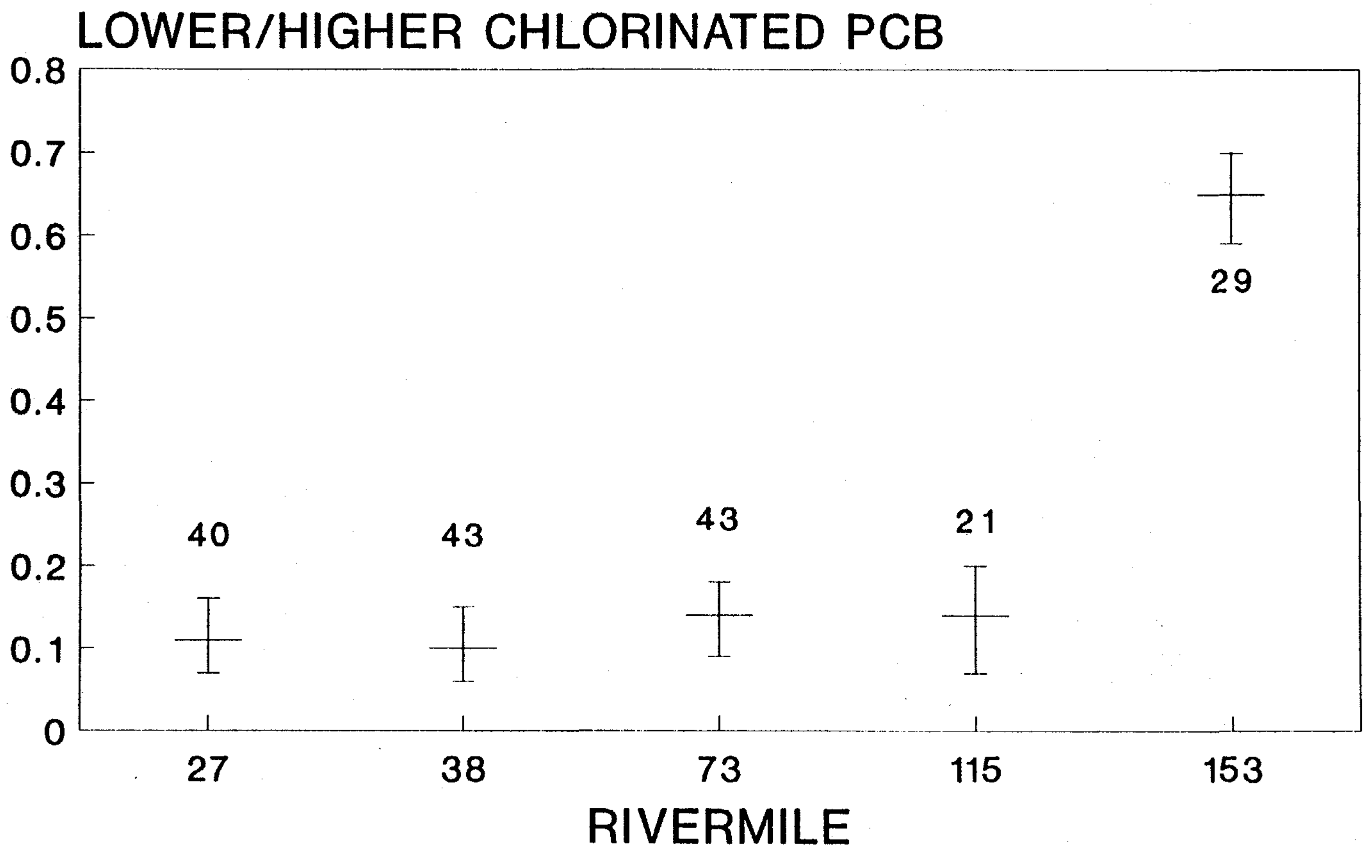
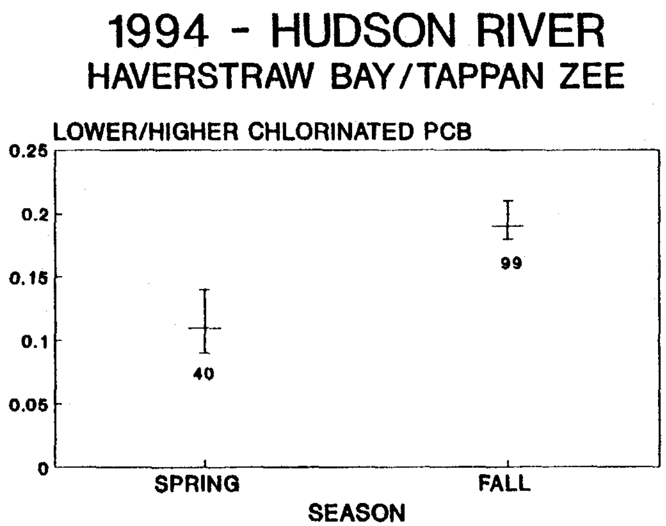
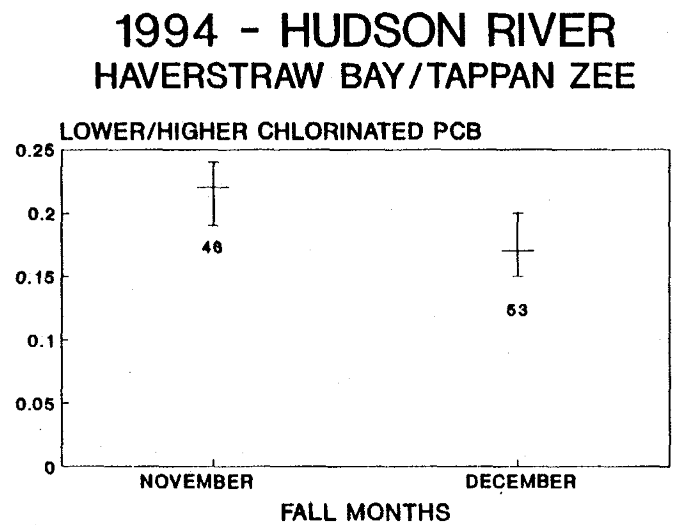


Figure 7. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals in striped bass by rivermile (RM) locations collected in the spring and summer of 1994 from the Hudson River.

318004

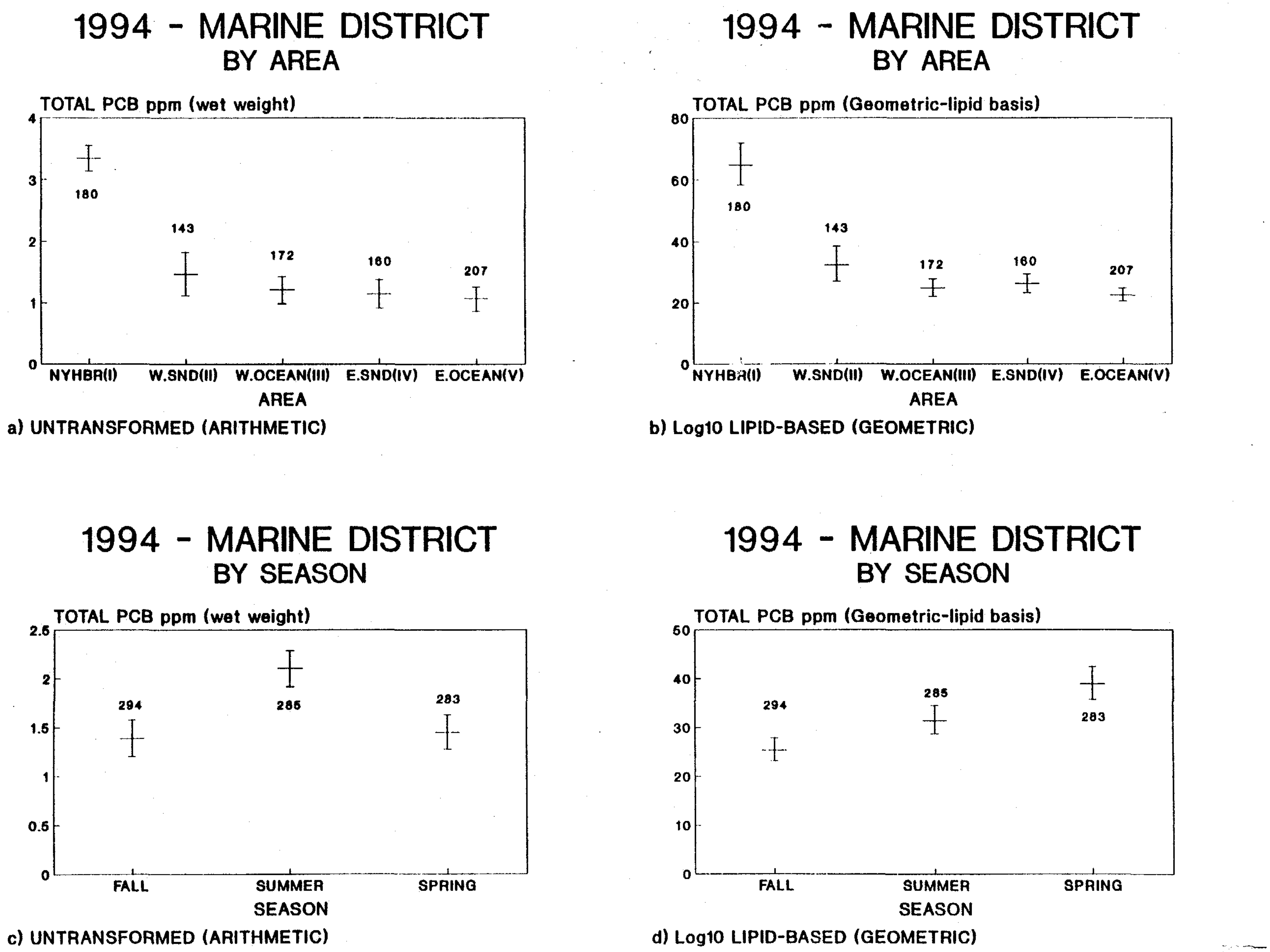


a) Season



b) Fall Months

Figure 8. **Seasonal** and **November vs. December** differences for striped bass collected from the **Haverstraw Bay/Tappan Zee** area (RM 27-38) in 1994 from the Hudson River for **ratios of lower /higher chlorinated PCB** means and 95 percent confidence intervals.



318006

Figure 9. **Area** and **season** differences in a) and c) **Arithmetic** and b) and d) **Geometric** means and 95 percent confidence intervals for total PCB in striped bass collected from

318007

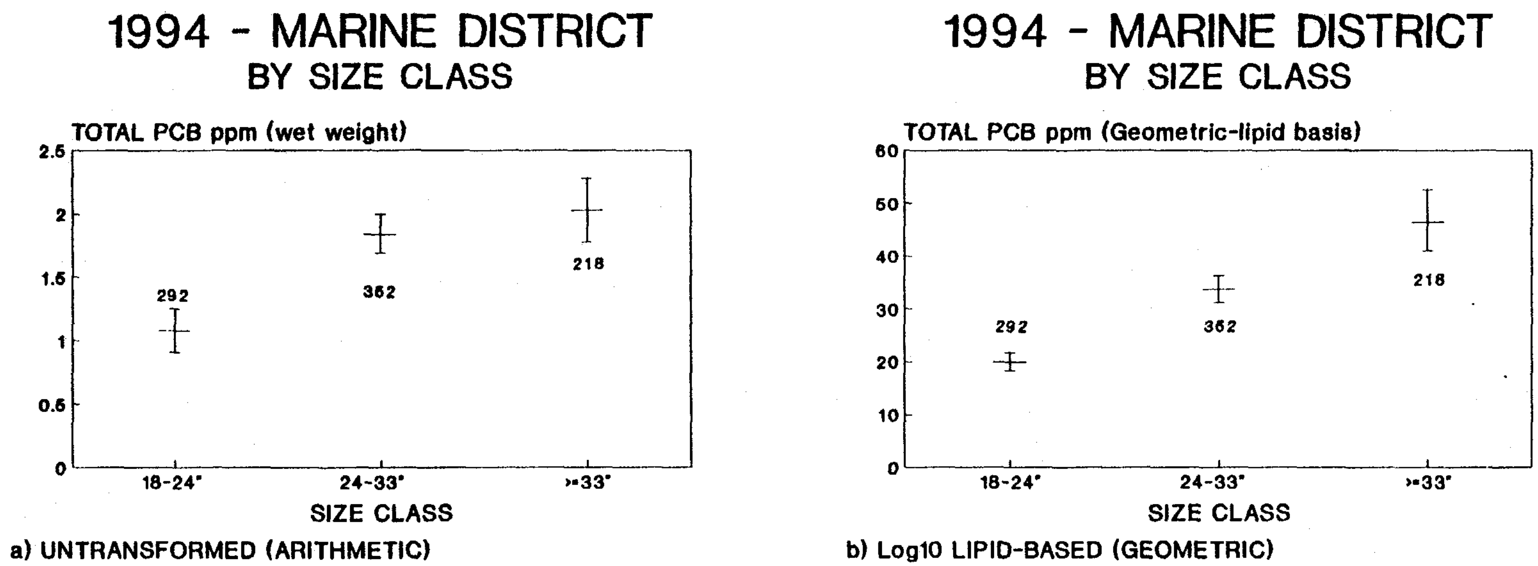
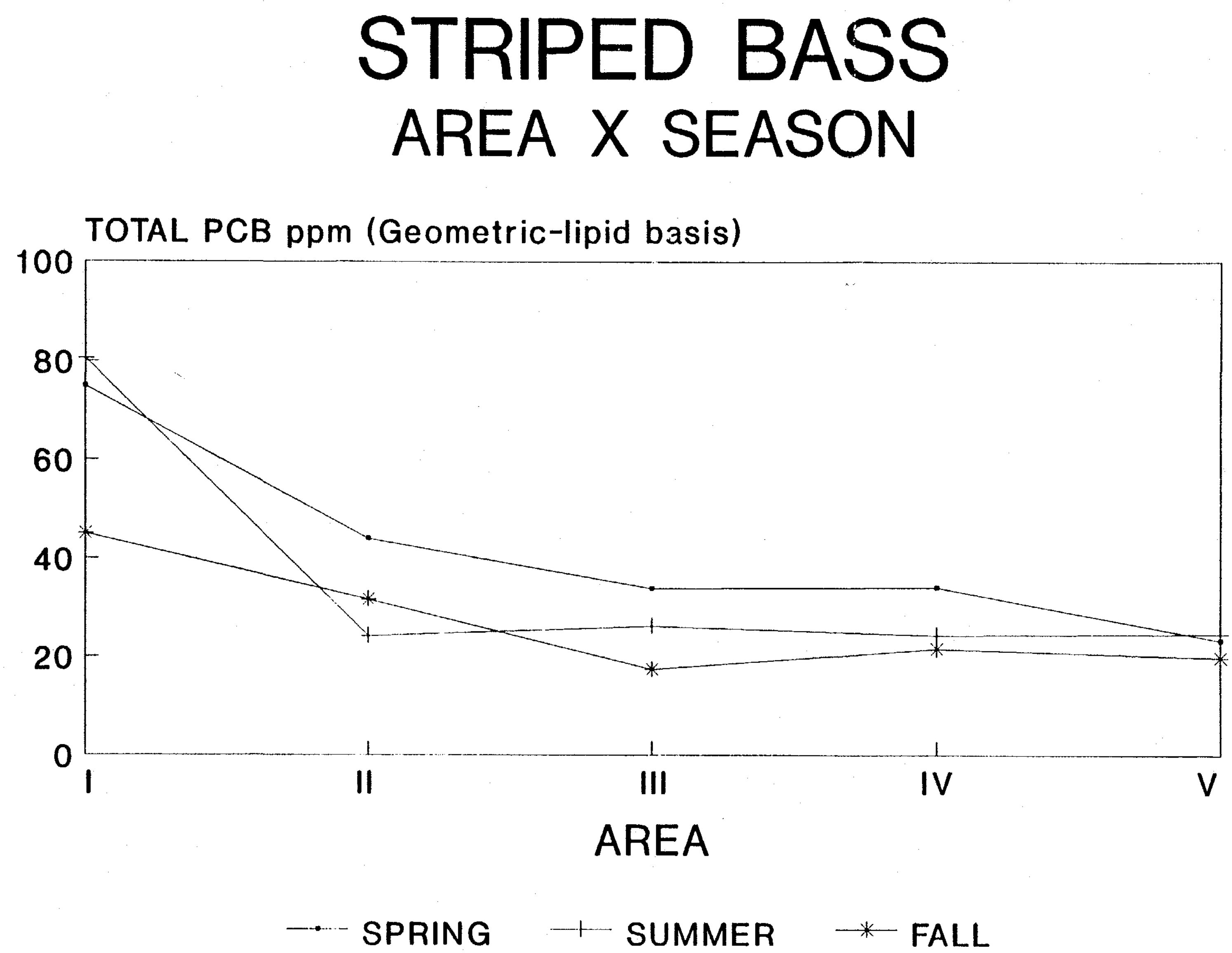


Figure 10. **Size class** differences in a) **Arithmetic** and b) **Geometric** means and 95 percent confidence intervals for total PCB in striped bass collected from the Marine District of New York State in 1994.



318008

Figure 11. Interaction of **Area X Season** for $\log_{10}$-transformed lipid-based total PCB in striped bass collected from the Marine District in 1994.

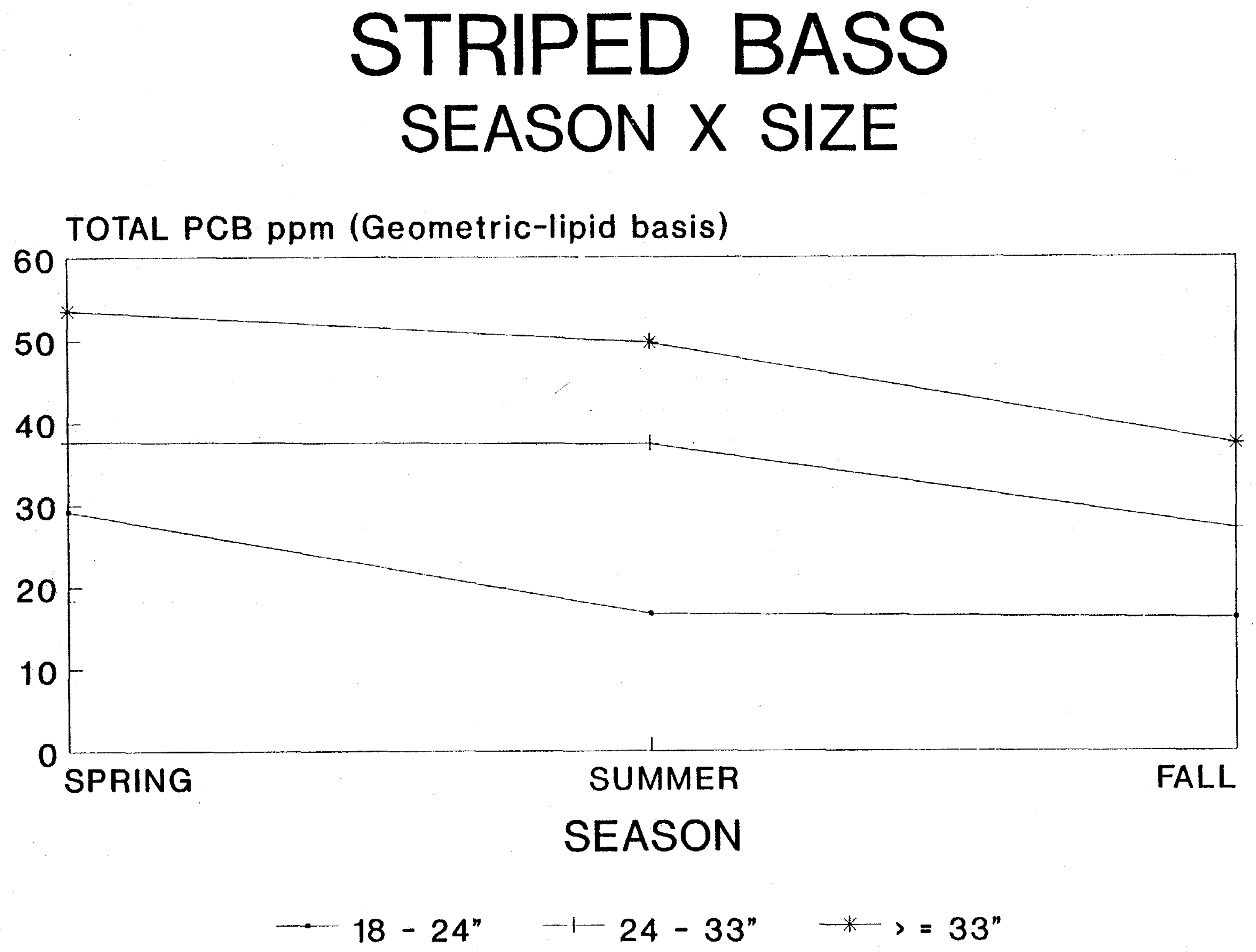
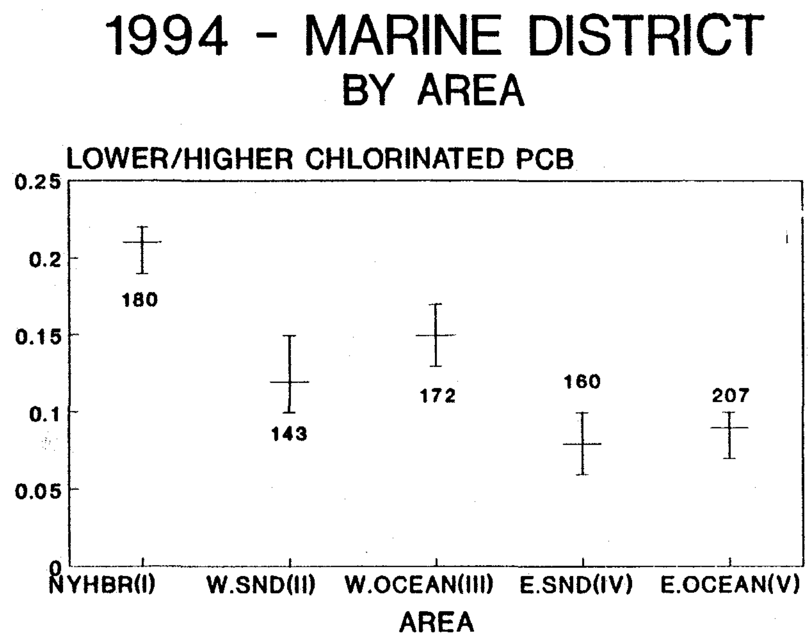
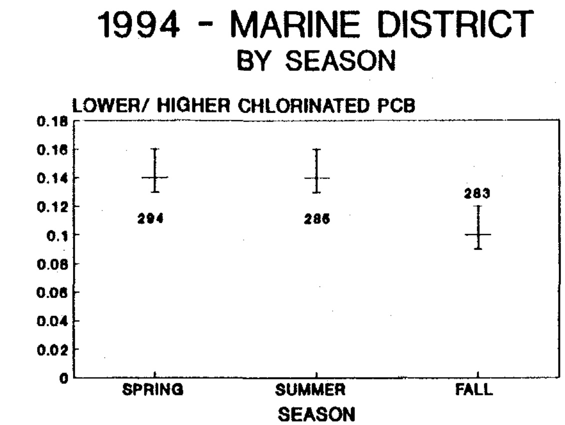


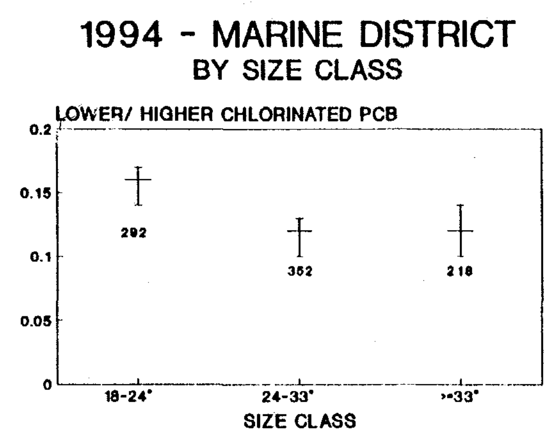
Figure 12. Interaction of **Season X Size** for $\log_{10}$-transformed lipid-based total PCB in striped bass collected from the Marine District in 1994.



a)AREA



b) SEASON



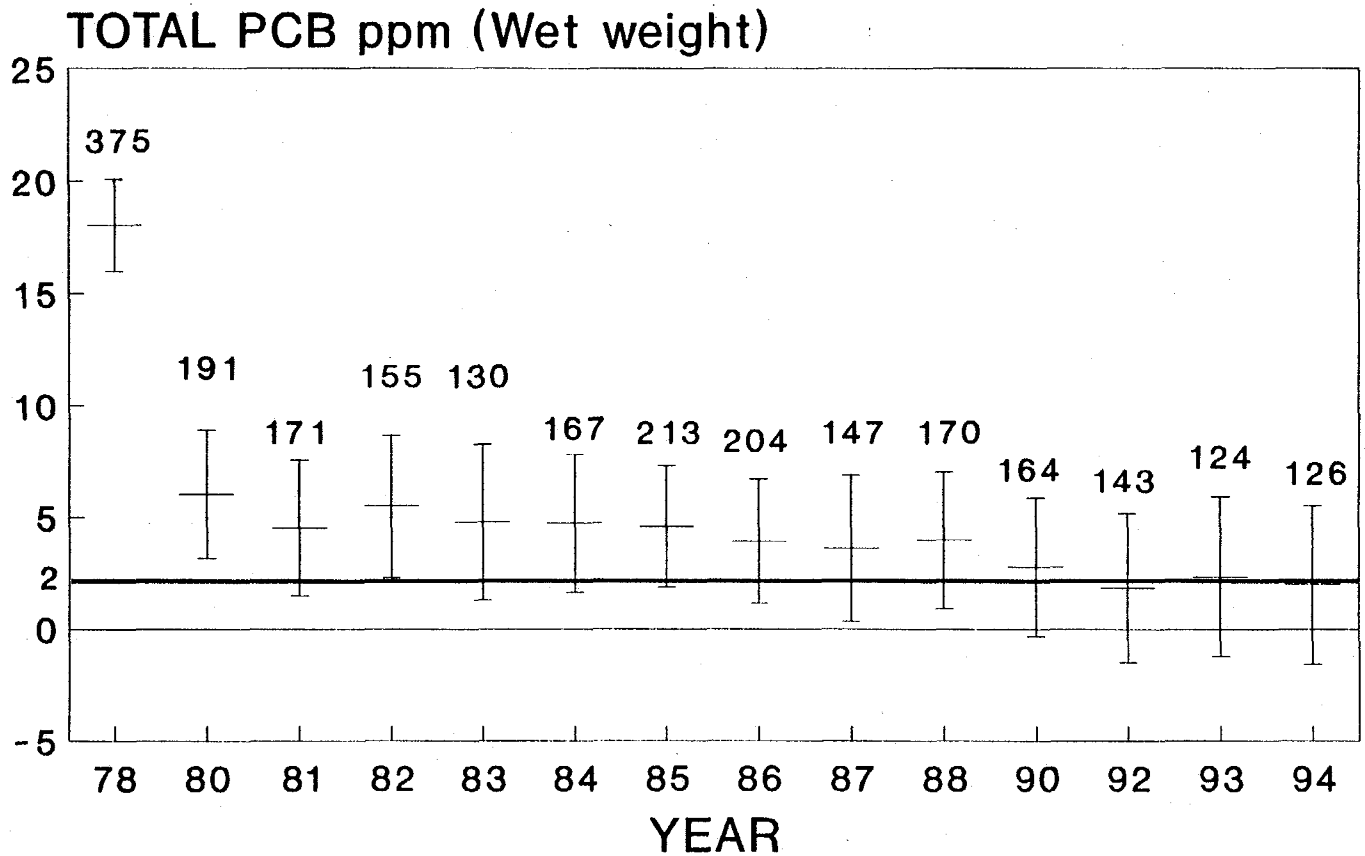
c) SIZE CLASS

Figure 13. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals in striped bass collected from the Marine District in 1994 for a)**Area**, b)**Season** and c)**Size Class**.

318010

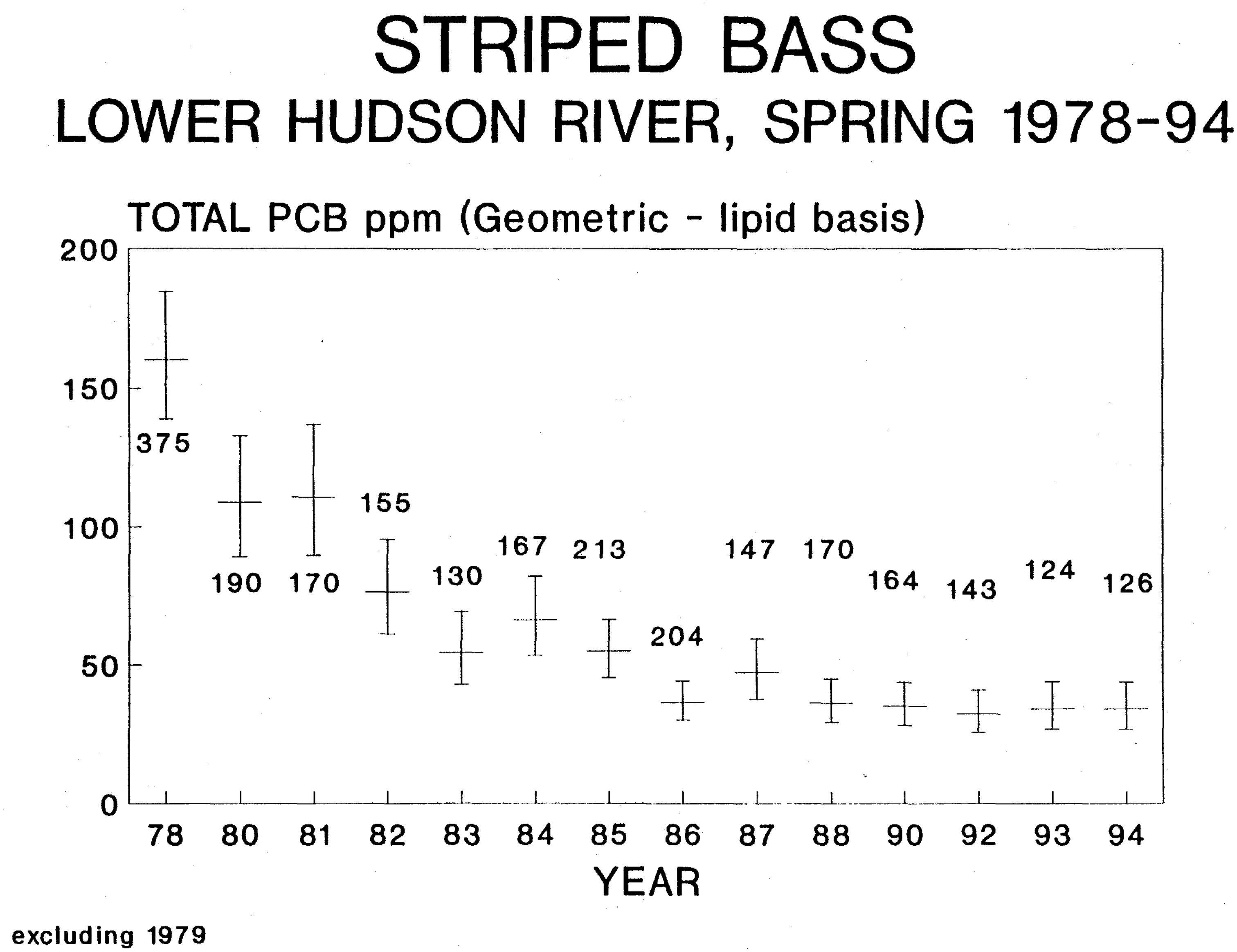
STRIPED BASS

LOWER HUDSON RIVER, SPRING 1978-94



excluding 1979

Figure 14. **Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1978 - 1994** in spring collected striped bass from the lower Hudson River below RM 80.



318012

Figure 15. **Lipid-based Geometric** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1978 - 1994** in spring collected striped bass from the lower Hudson River below RM 80.

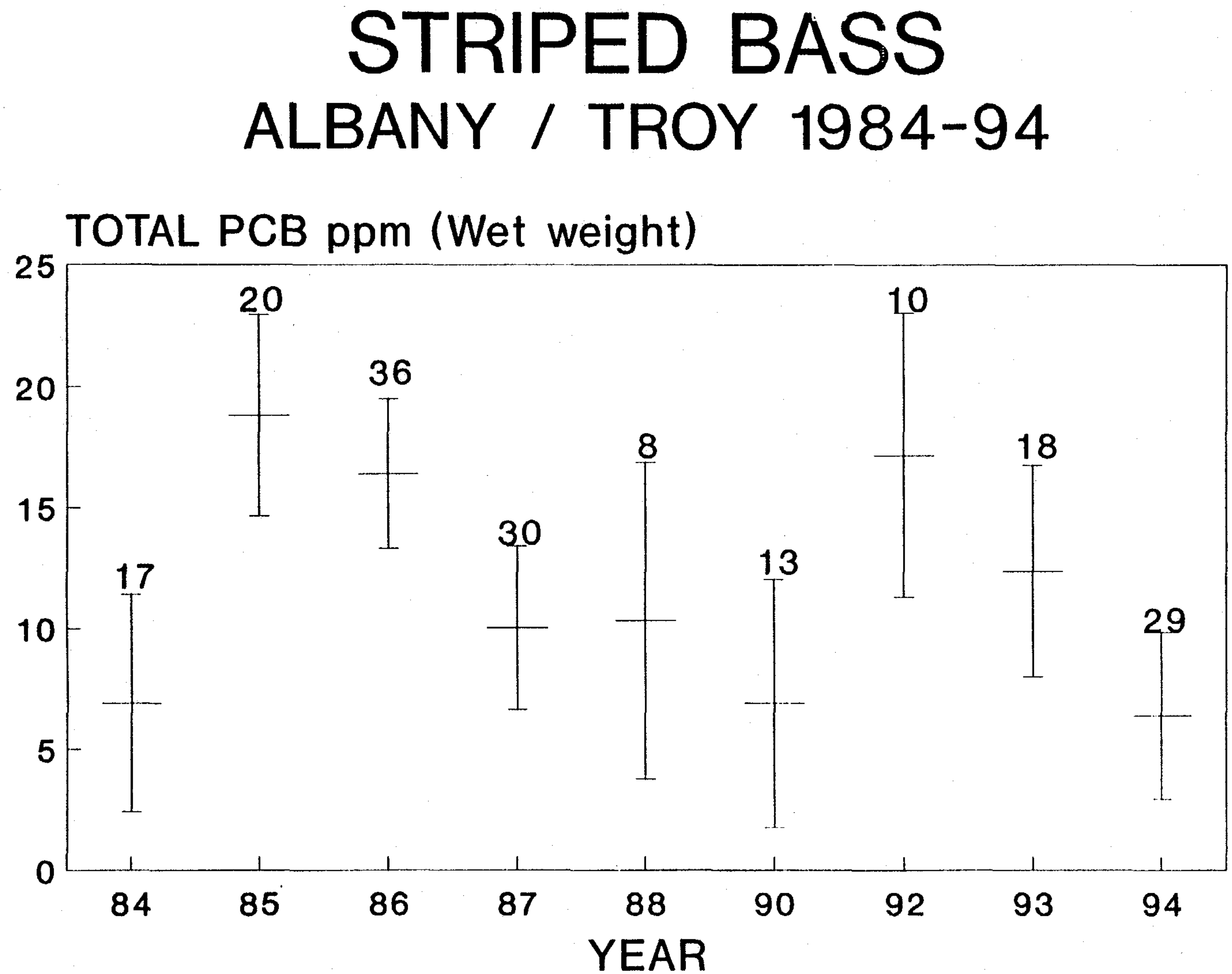


Figure 16.**Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in striped bass collected from the **Albany/Troy** area (RM153) of the Hudson River.

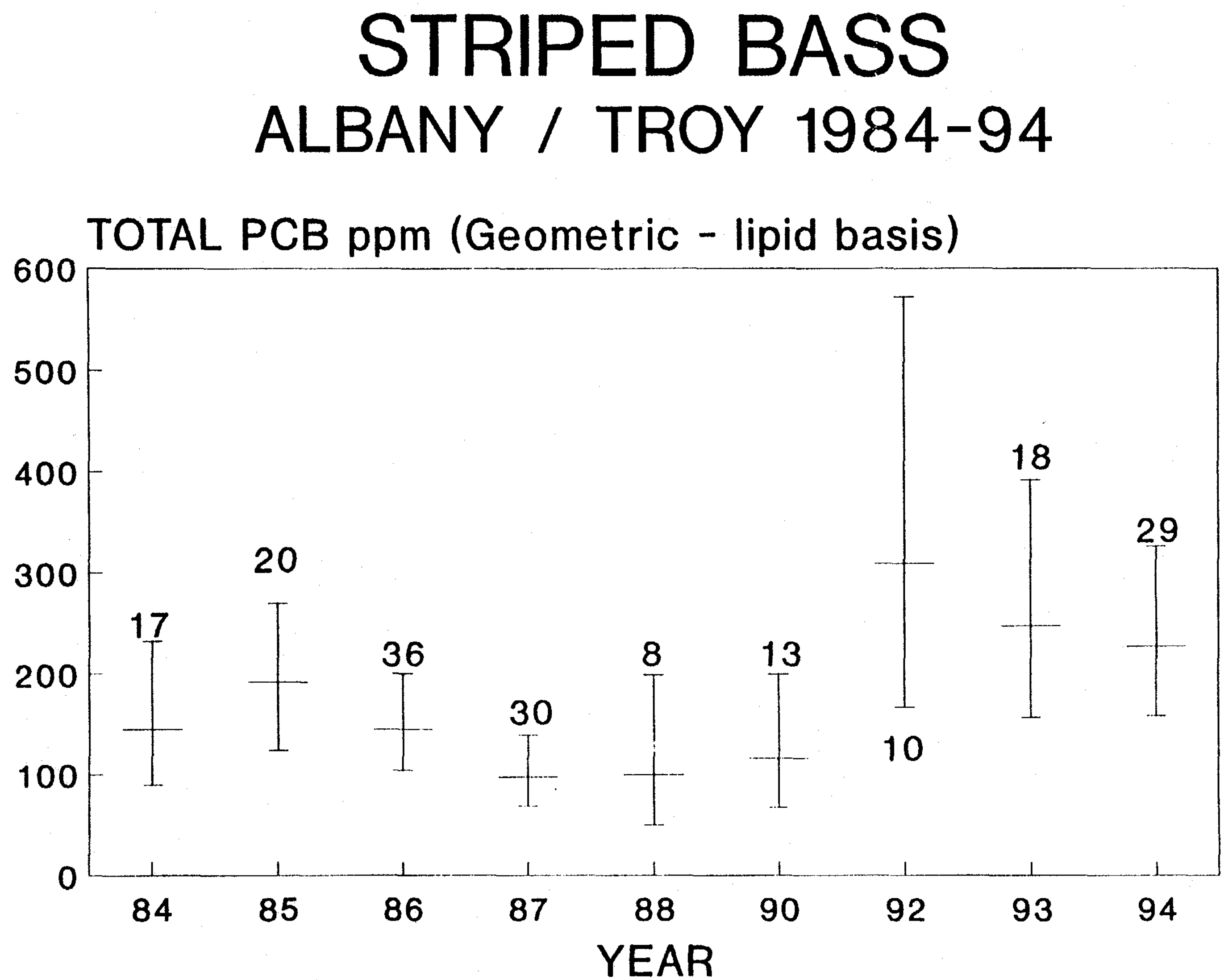


Figure 17. **Lipid-based Geometric** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in striped bass collected from the **Albany/Troy** area (RM153) of the Hudson River.

318014

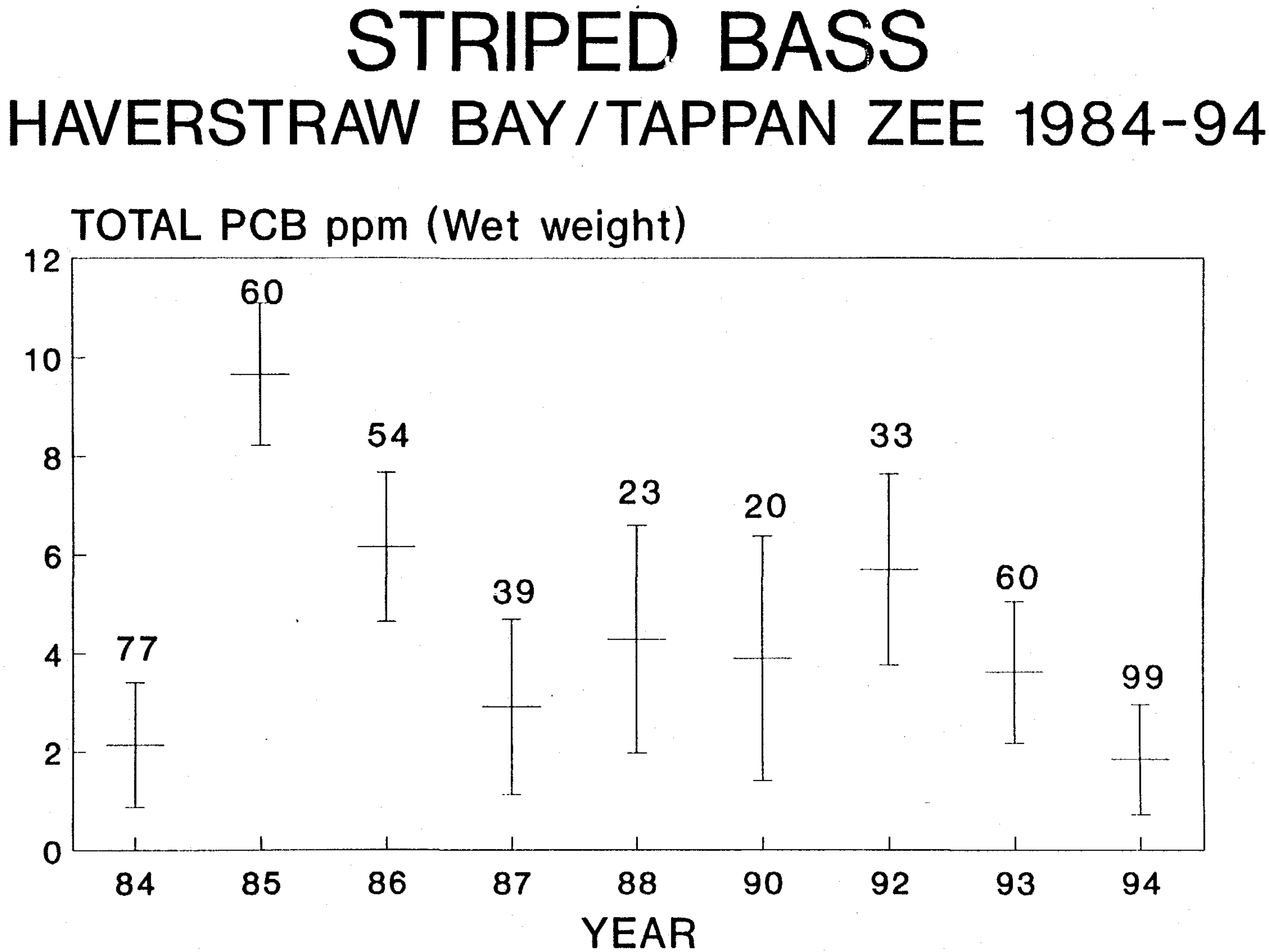


Figure 18. **Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in fall collected striped bass from the **Haverstraw Bay/Tappan Zee** area (RM 27-38) of the Hudson River.

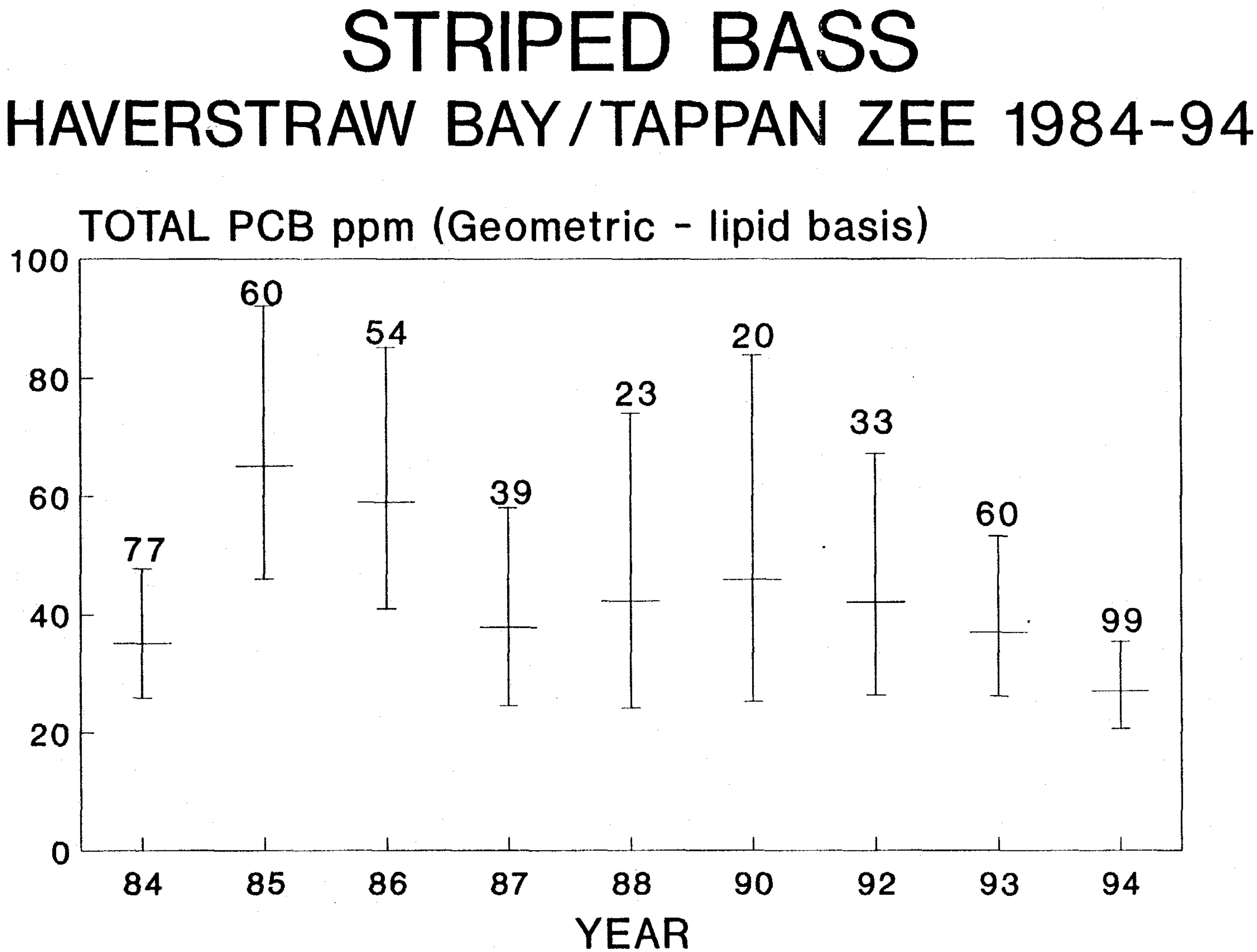


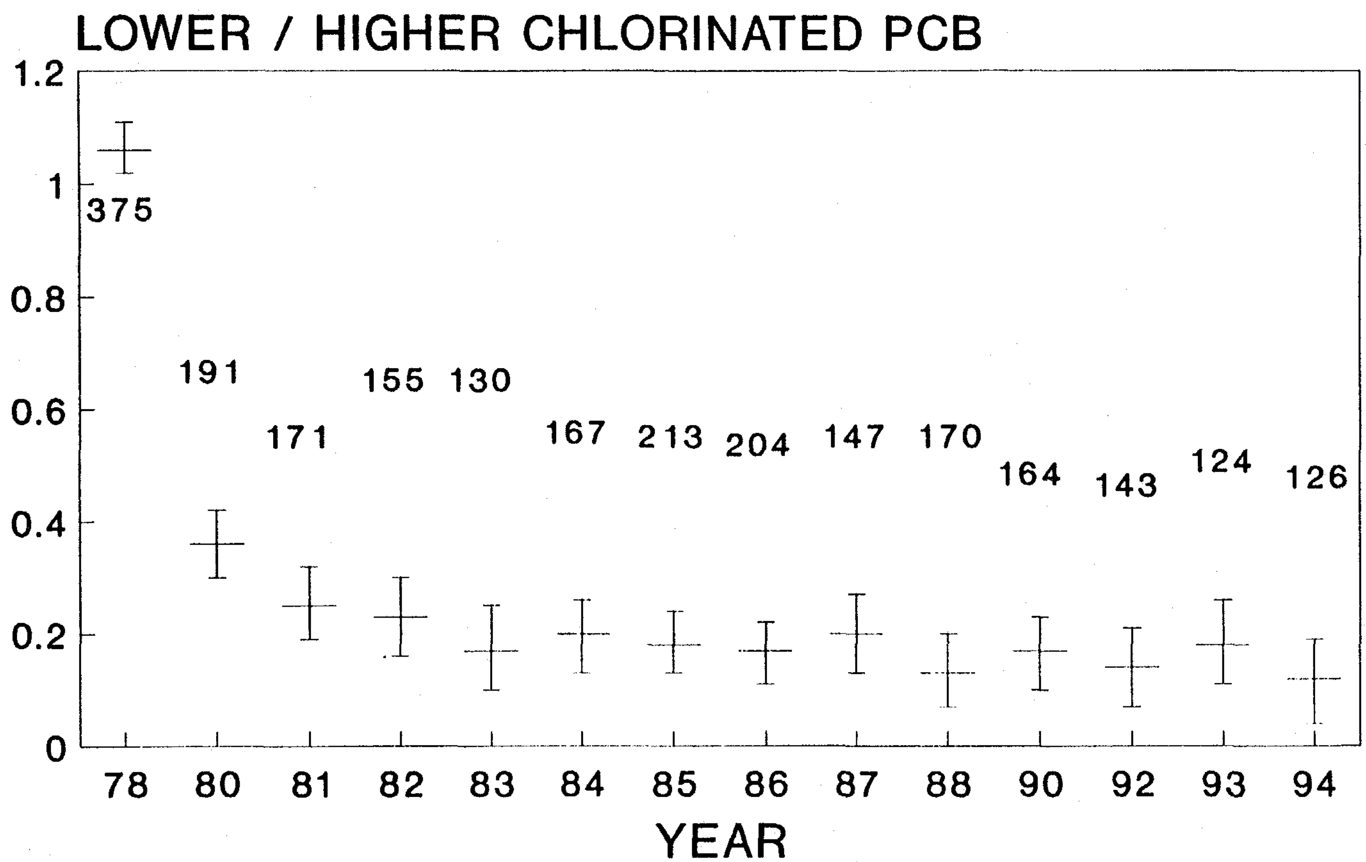
Figure 19. **Lipid-based Geometric** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in fall collected striped bass from the **Haverstraw Bay/Tappan Zee** area (RM 27-38) of the Hudson River.

318016

318017

STRIPED BASS

LOWER HUDSON RIVER, SPRING 1978-94



excluding 1979

Figure 20. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals for the **years 1978 - 1994** in spring collected striped bass from the lower Hudson River below RM 80.

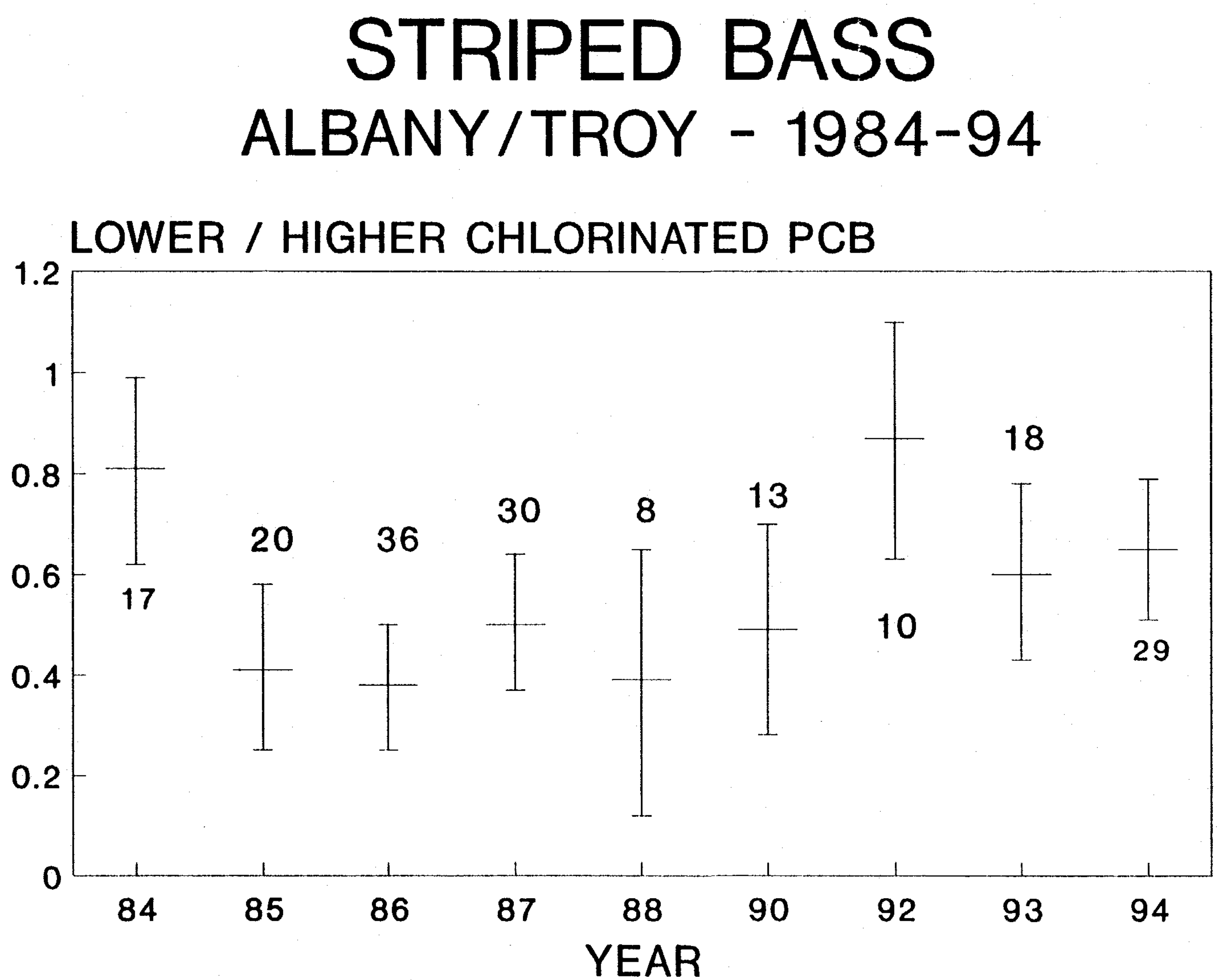


Figure 21. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals for the **years 1984 - 1994** in striped bass collected from the Hudson River in the **Albany/Troy** area (RM 153).

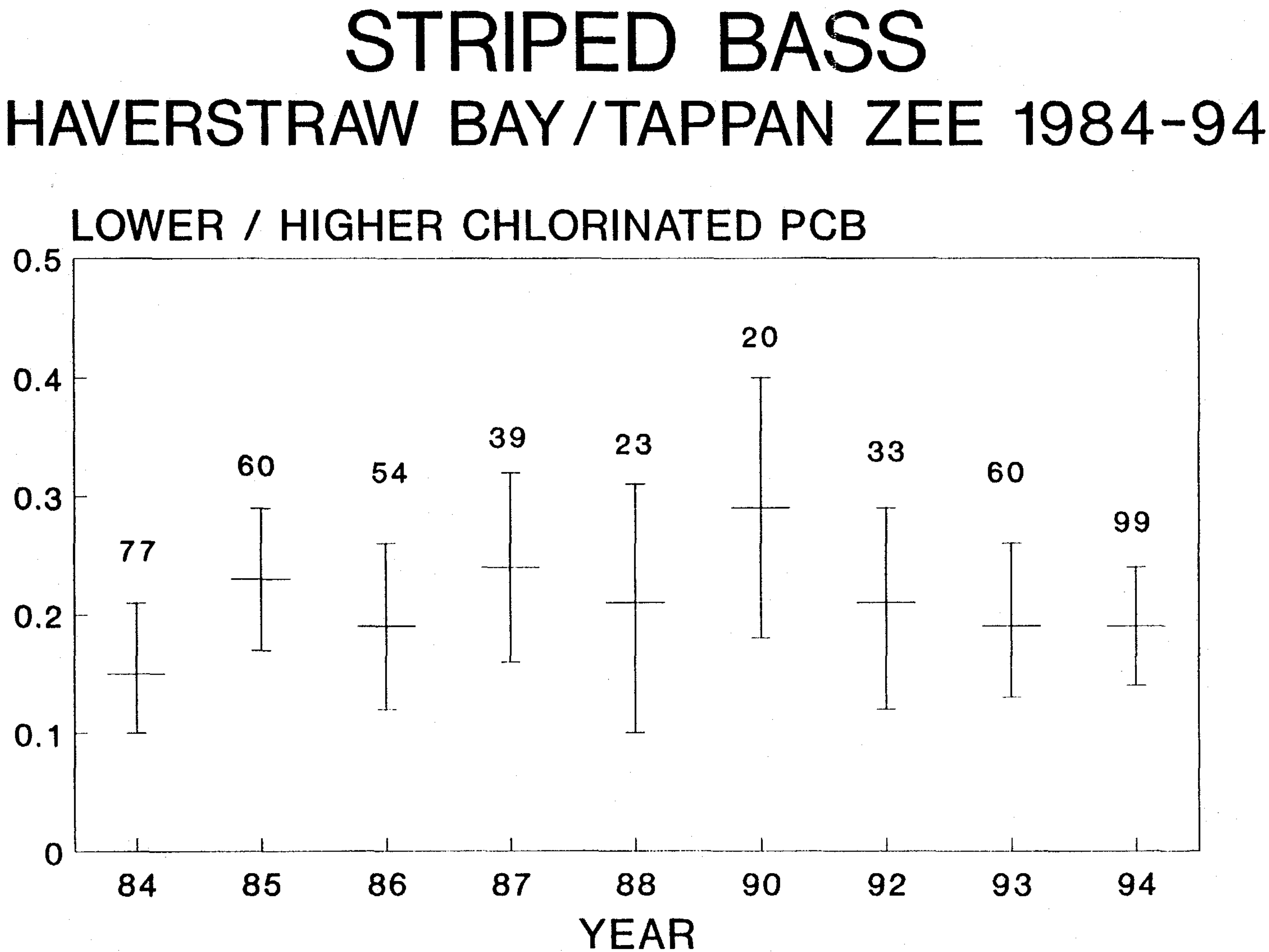


Figure 22. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals for the **years 1984 - 1994** in fall collected striped bass from the Hudson River in the **Haverstraw Bay/Tappan Zee** area (RM 27-38).

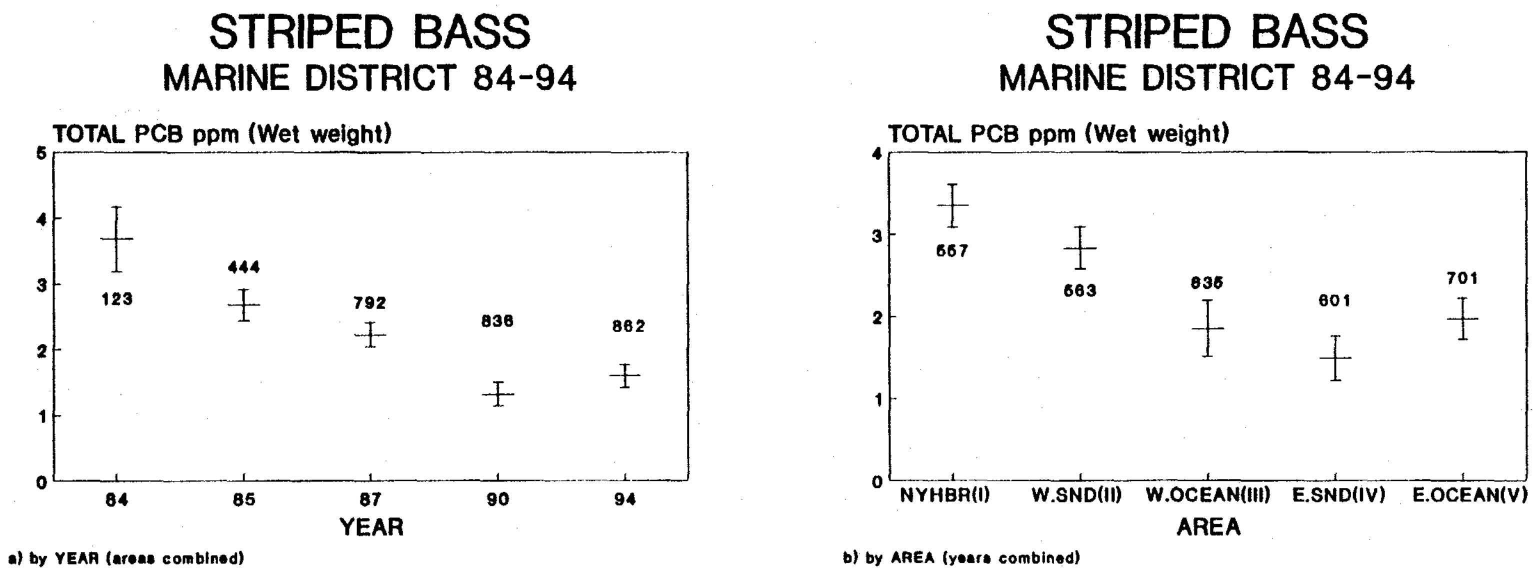


Figure 23. **Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in striped bass collected from the **Marine District** of New York State for a) **years**, and b) **areas.**

318020

318021

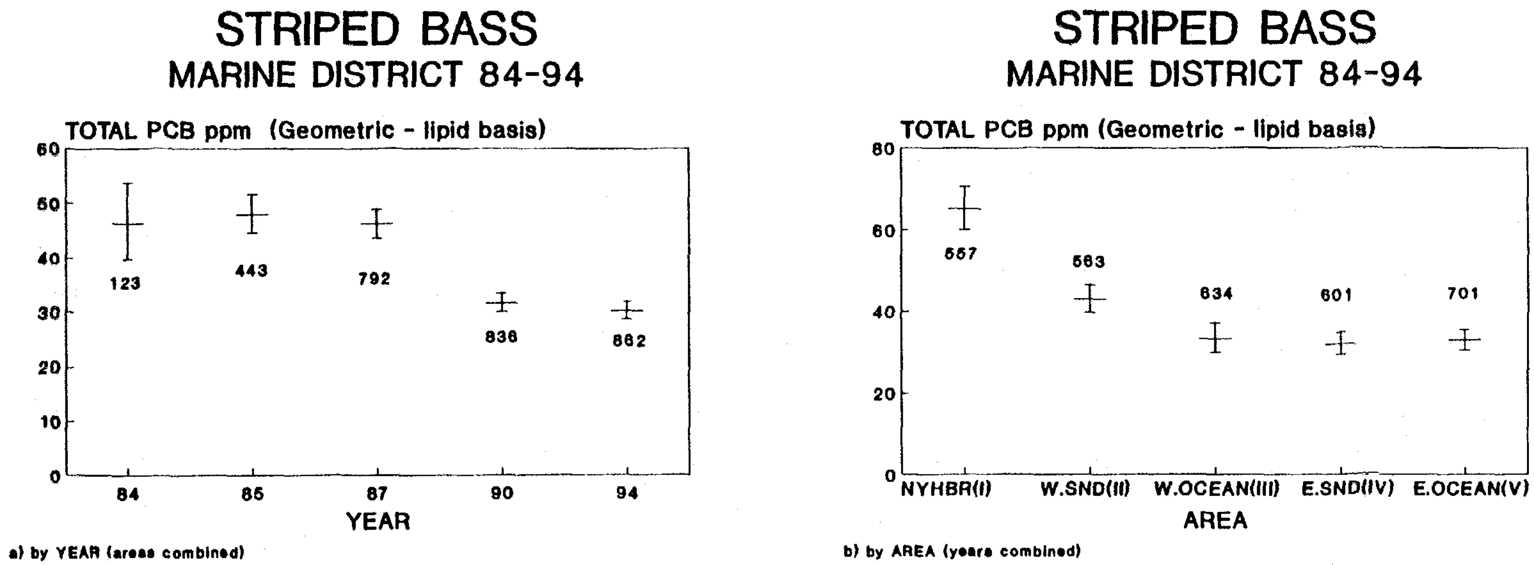


Figure 24. **Geometric** means and 95 percent confidence intervals for **total PCB** concentrations for the **years 1984 - 1994** in striped bass collected from the **Marine District** of New York State for a) **years**, and b) **areas**.

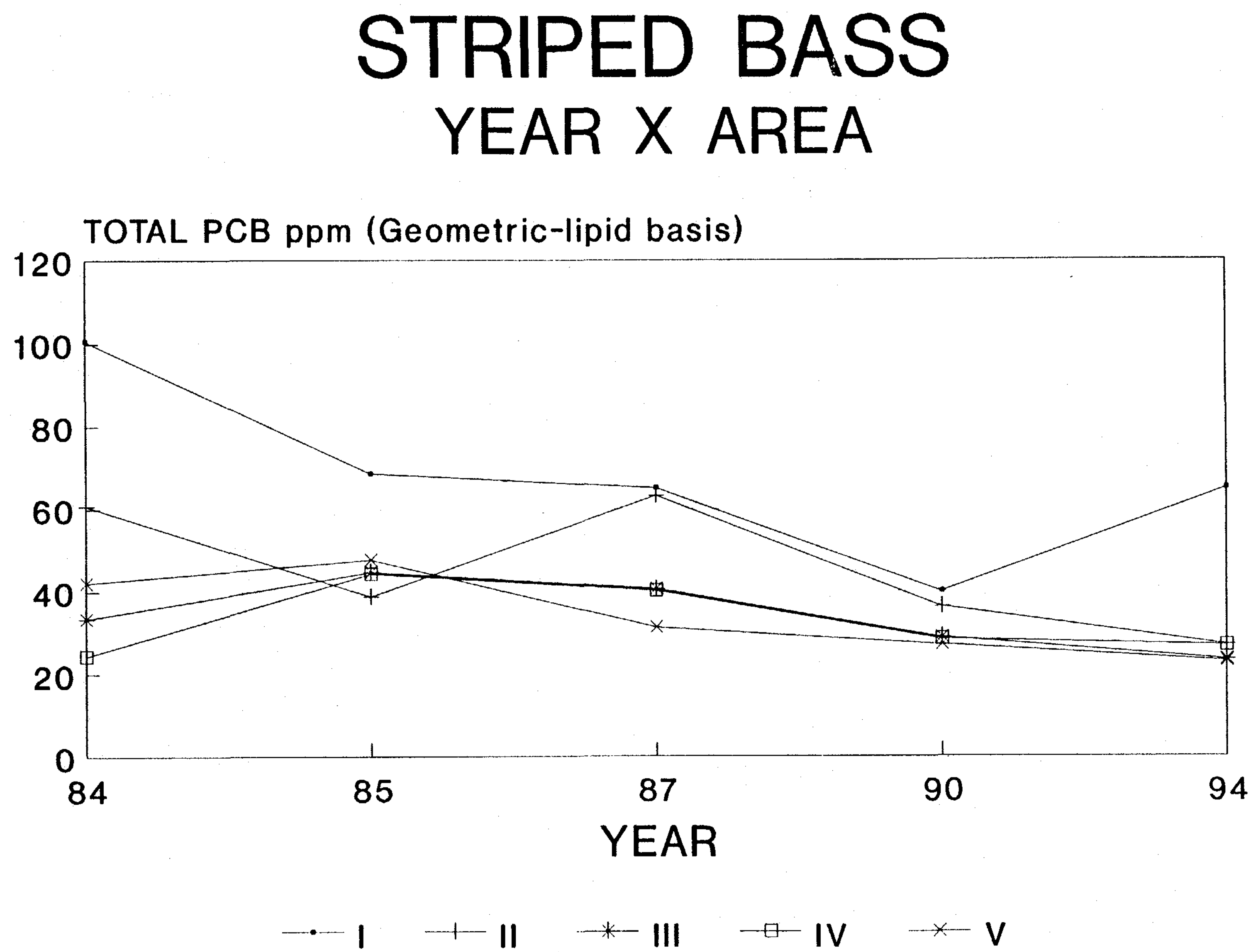
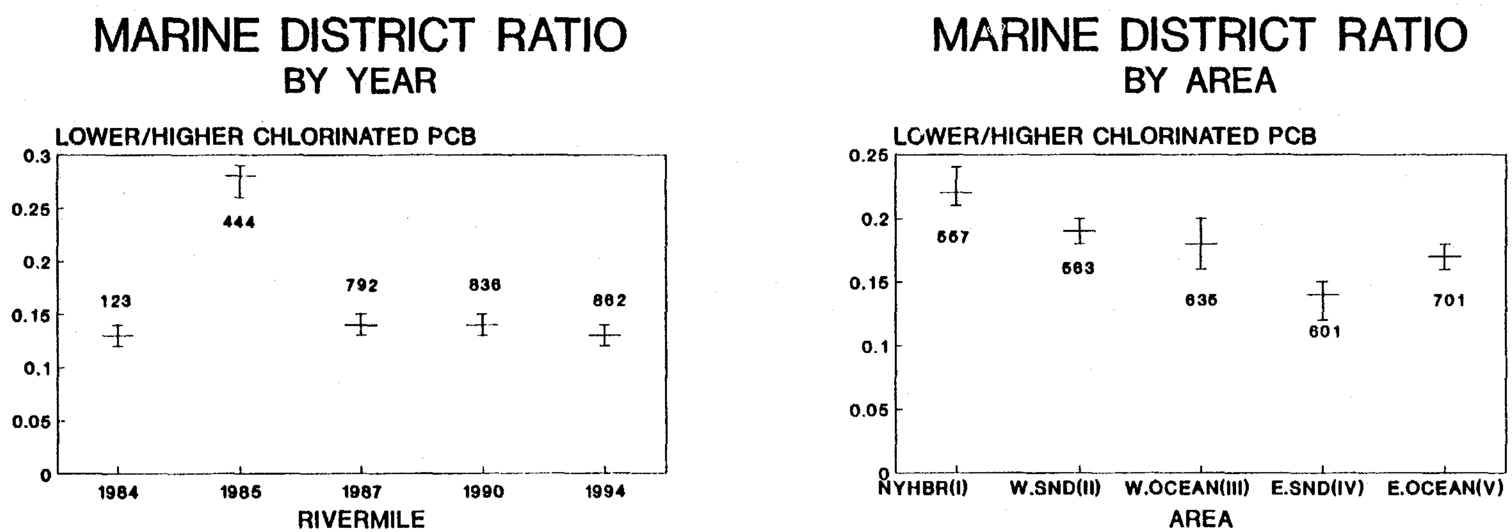


Figure 25. Interaction of **Year X Area** for log_{10}-transformed lipid--based total PCB in striped bass colllected from the Marine District for the **years 1984, 1985, 1987, 1990** and **1994.**

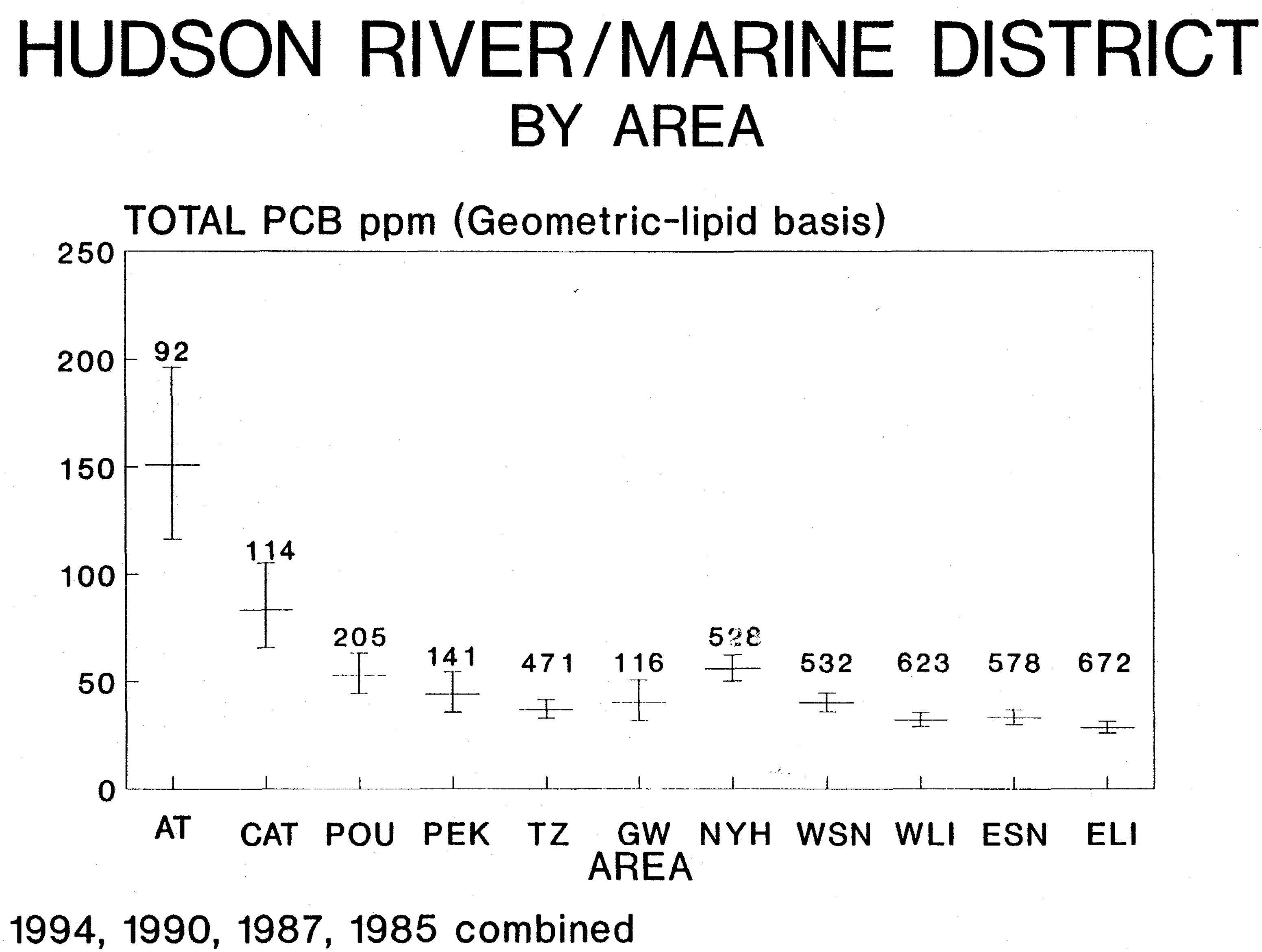
318022



a)by YEAR (areas combined)

b)by AREA (years combined)

Figure 26. Mean **ratios of lower /higher chlorinated PCB** and 95 percent confidence intervals for the a) **years** and b) **areas** in striped bass from the **Marine District** for the **years 1984 - 1994.**



318024

Figure 27. **Geometric** means and 95 percent confidence intervals for **total PCB** concentrations in the years of **1985, 1987, 1990 and 1994** combined for striped bass collected from 11 locations in the Hudson River, and the Marine

318025

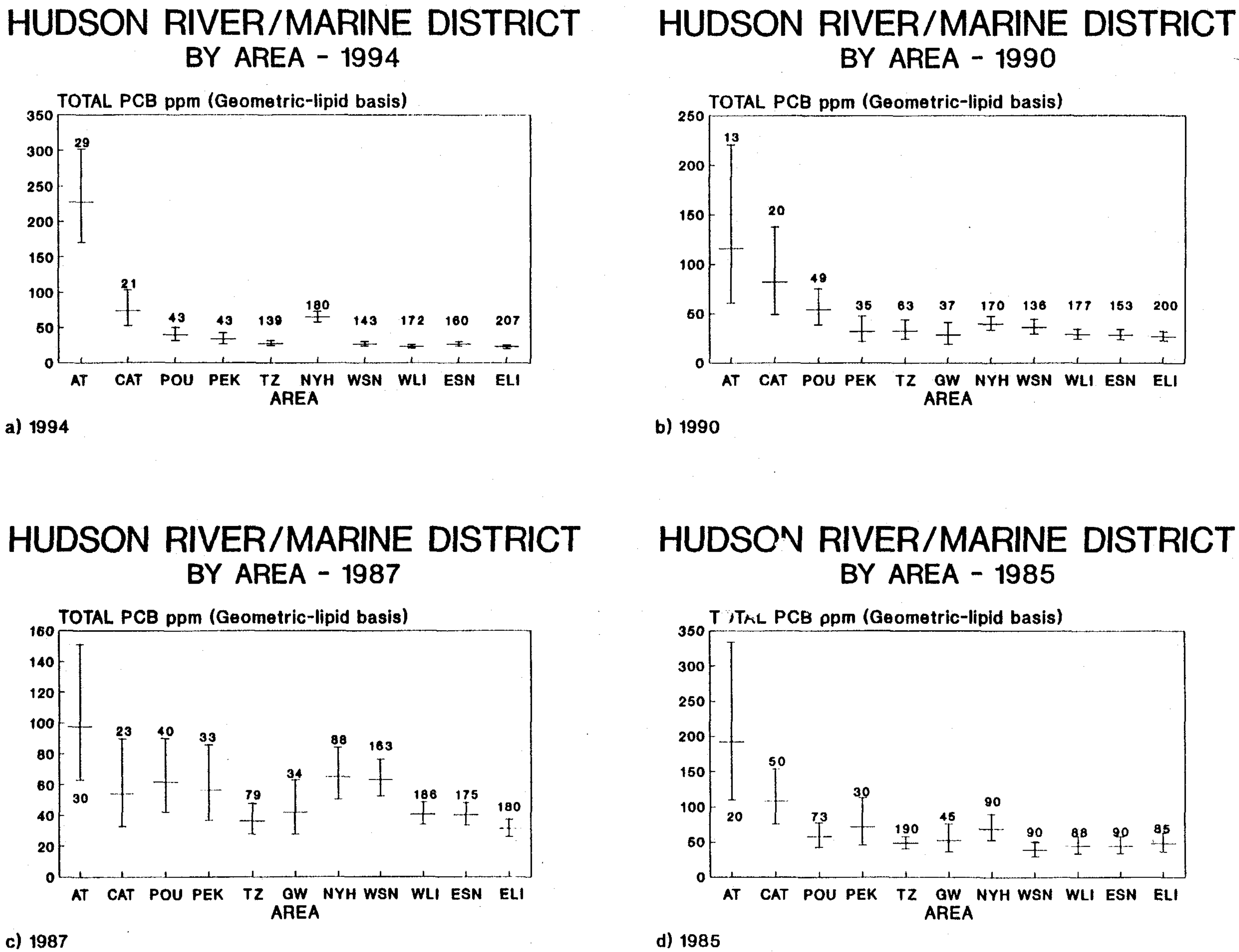


Figure 28. **Geometric** means and 95 percent confidence intervals for **total PCB** concentrations in the years of **a) 1994, b) 1990, c) 1987, and d) 1985** combined for striped bass collected from 1 locations in the **Hudson River** and

Map of New York City Harbor Region

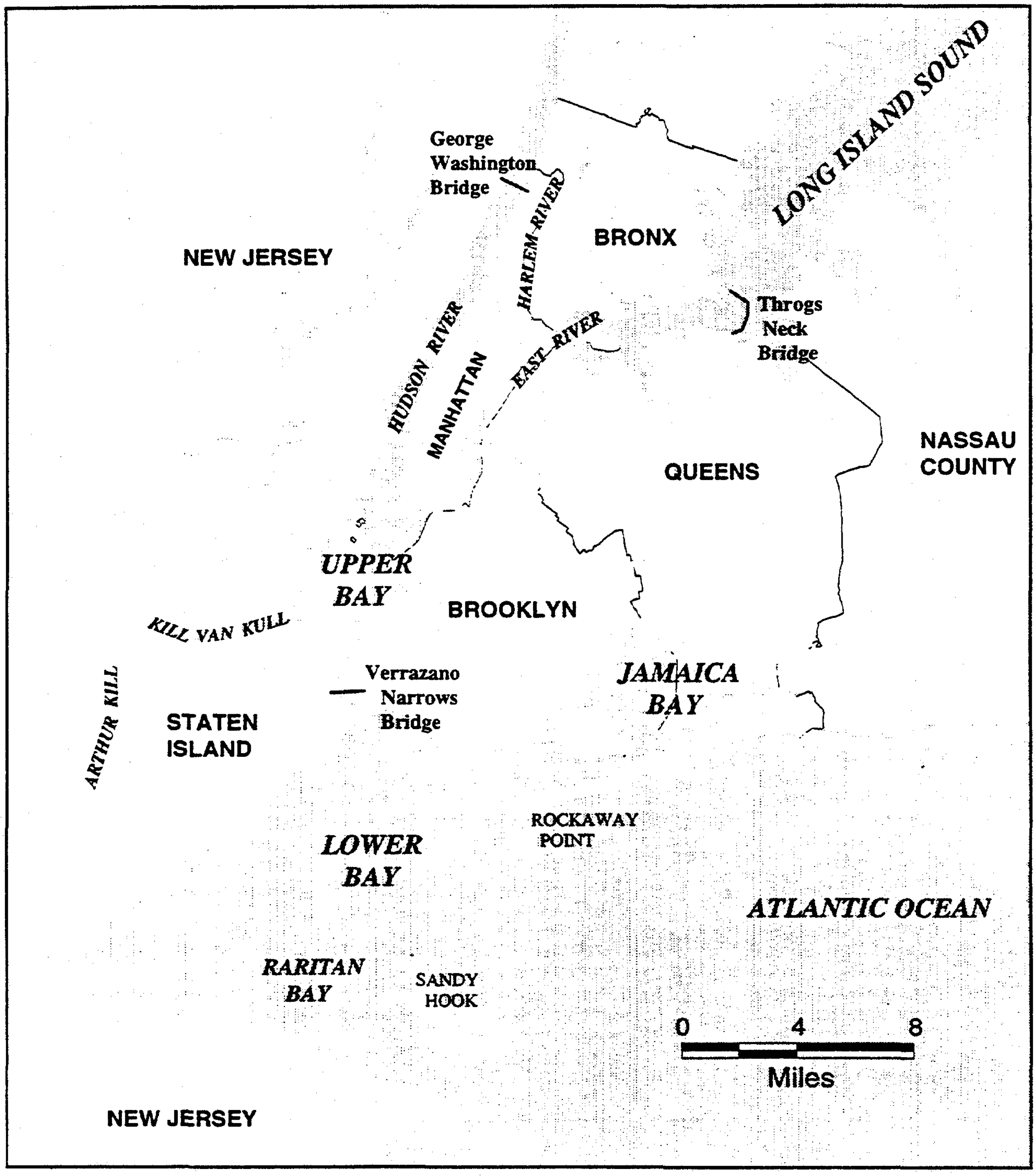


Figure 29. Outline map of the New York Harbor (Area I) showing general locations for sampling of striped bass.

318027

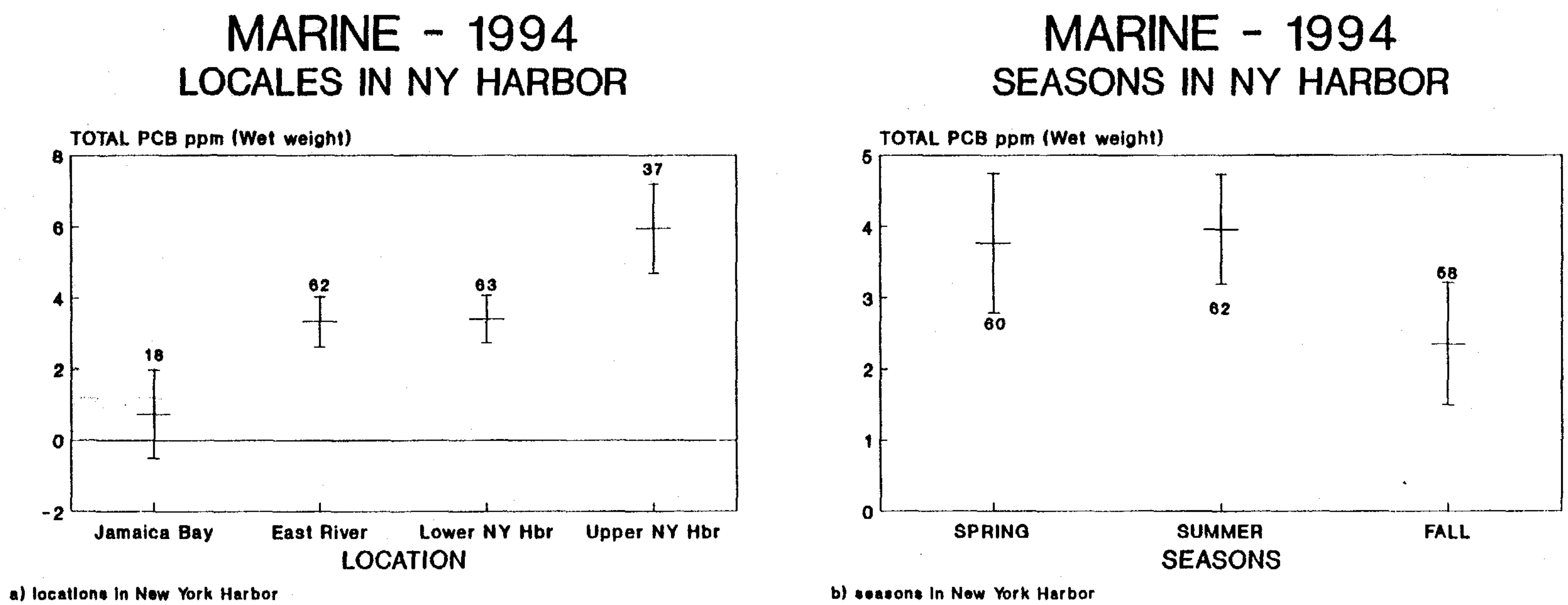
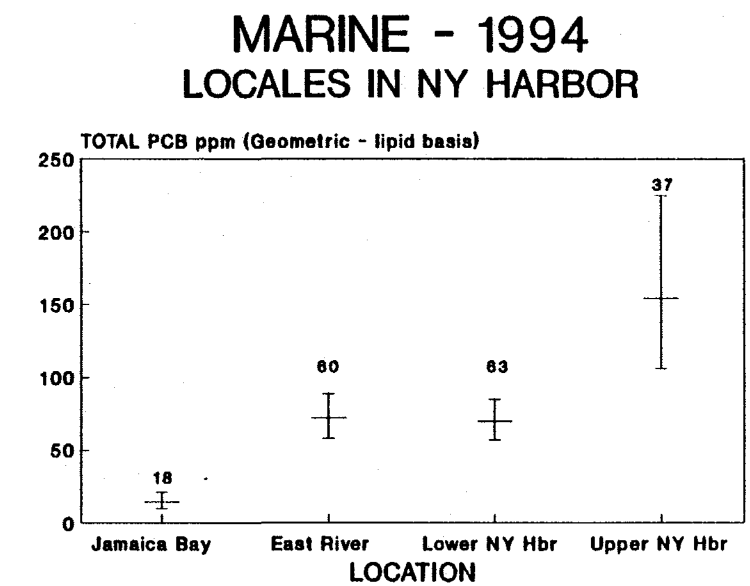
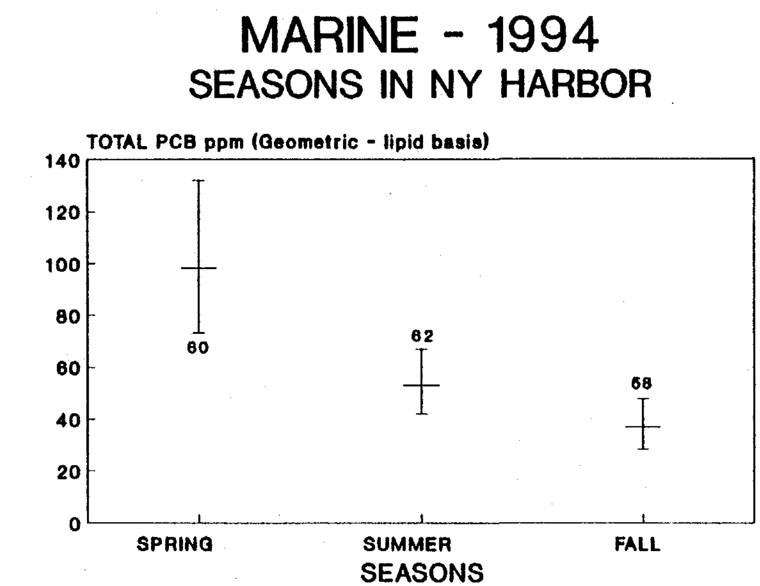


Figure 30. **Arithmetic** means and 95 percent confidence intervals for **total PCB** concentrations in **1994** for several (four) locations within the **New York Harbor** for striped bass from the Marine District by **a) locations** and **b) seasons.**



a) locations in New York Harbor



b) seasons in New York Harbor

Figure 31. **Geometric** means and 95 percent confidence intervals for **total PCB** concentrations in **1994** for several (four) locations within the **New York Harbor** for striped bass from the Marine District by **a) locations** and **b) seasons.**

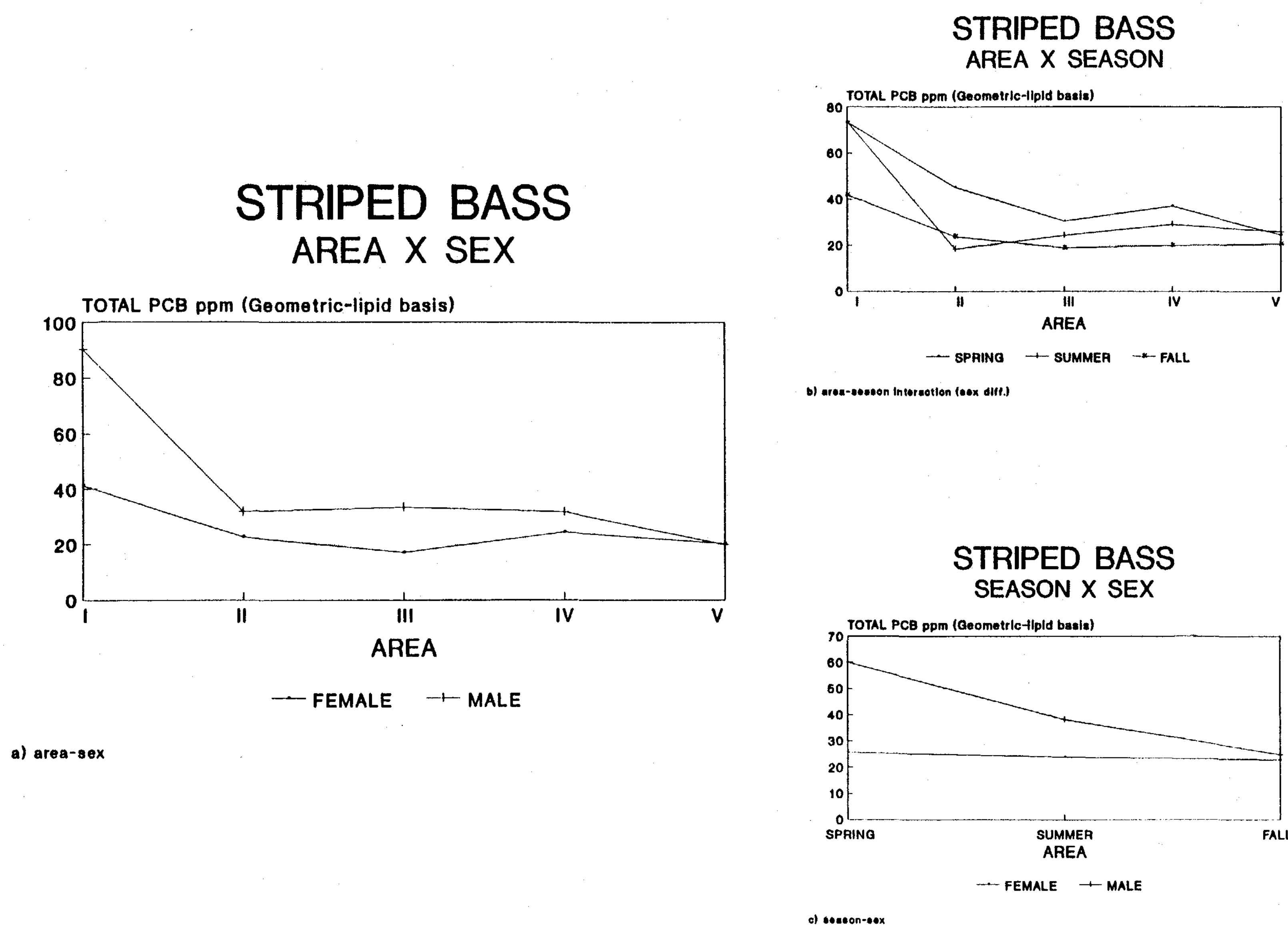


Figure 32. Interactions of **a) Area X Sex, b) Area X Season**, and **c) Season X Sex** for $\log_{10}$-transformed lipid-based total PCB in striped bass colllected from the Marine District in **1994.**

STRIPED BASS
AREA X SEX

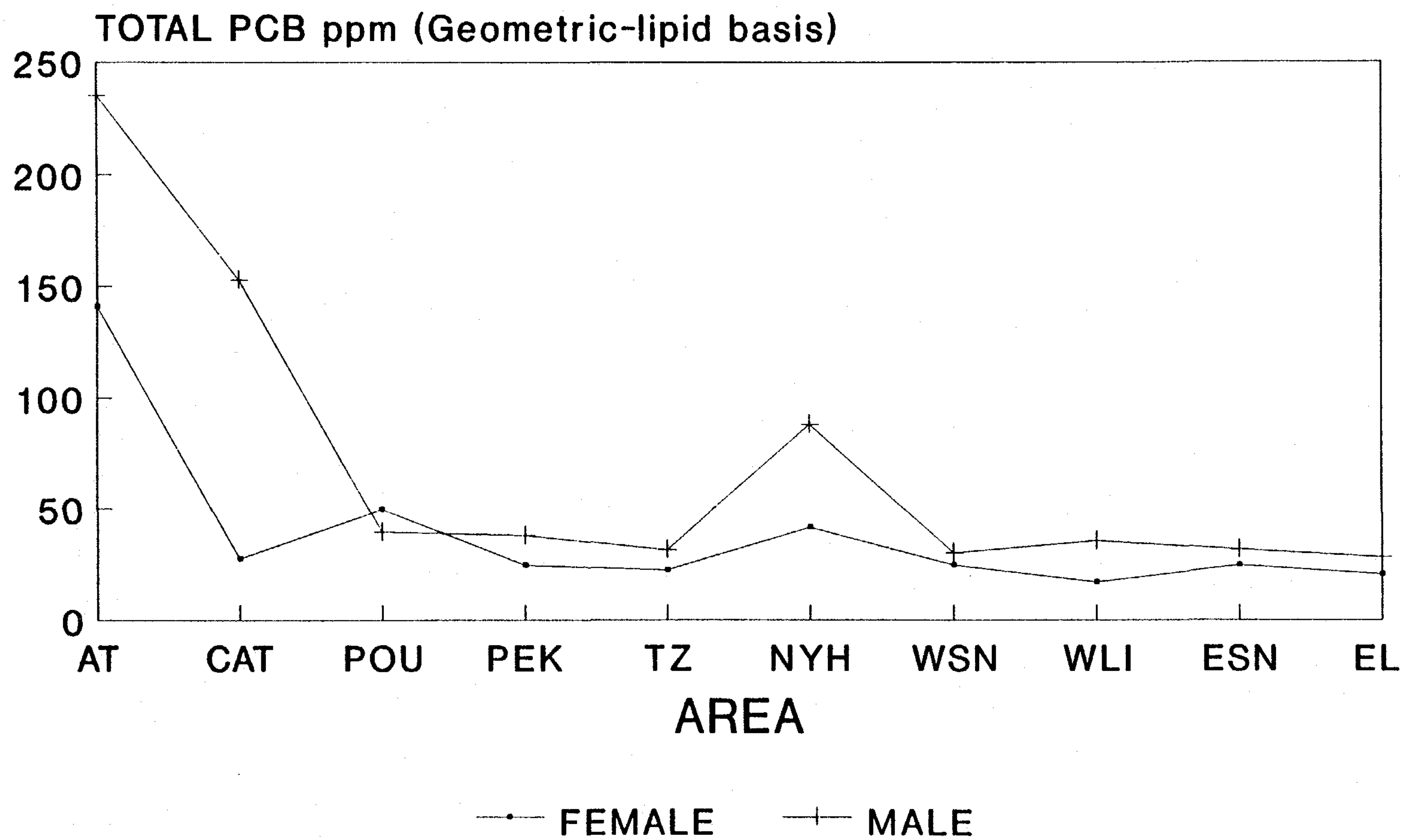


Figure 33. Interaction of **Area X Sex** for log_{10}-transformed lipid-based total PCB in striped bass colllected from 10 locations in the **Hudson River** and the **Marine District** in **1994.**

318030