DATA REPORT FOR THE COLLECTION OF EGGS FROM SPOTTED SANDPIPERS, AMERICAN WOODCOCK, BELTED KINGFISHER, AMERICAN ROBIN, RED-WINGED BLACKBIRD, AND EASTERN PHOEBE ASSOCIATED WITH THE HUDSON RIVER FROM HUDSON FALLS TO SCHODACK ISLAND, NEW YORK

HUDSON RIVER NATURAL RESOURCE DAMAGE ASSESSMENT

HUDSON RIVER NATURAL RESOURCE TRUSTEES

STATE OF NEW YORK

U.S. DEPARTMENT OF COMMERCE

U.S. DEPARTMENT OF THE INTERIOR

FINAL

SEPTEMBER 17, 2004

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EXECUTIVE SUMMARY

Natural resources of the Hudson River have been contaminated through past and ongoing discharges of polychlorinated biphenyls (PCBs). As a means of evaluating regional avian contamination, a screening level survey of avian eggs was conducted from April - June 2002. The investigation entailed collection of eggs from six primary species: belted kingfisher (*Ceryle alcyon*), American robin (*Turdus migratorius*), Eastern phoebe (*Sayornis phoebe*), spotted sandpiper (*Actitis macularia*), red-winged blackbird (*Agelaius phoenicius*), and American woodcock (*Scolopax minor*), along a contamination gradient in the Upper Hudson River Valley, from Hudson Falls to Lower Schodack Island, New York. Active nests of these birds in and near the Hudson River and its floodplain were identified and eggs were collected for PCB analysis. The collection of egg samples from five additional avian species was based solely on the opportunities for survey team members to locate the nests of these species and consisted of: Eastern screech owl (*Otus asio*), common grackle (*Quiscalus quiscula*), northern rough-winged swallow (*Stelgidopteryx serripennis*), barn swallow (*Hirundo rustica*), and Eastern bluebird (*Sialia sialis*). A total of 168 egg samples were analyzed for 48 selected PCB congeners, PCB homologue groups, total PCBs, percent lipids, and percent moisture. Total PCB concentrations ranged from 20 parts per billion (ppb) to about 56,200 ppb (fresh weight basis) and varied by species and collection location.

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1.0 INTRODUCTION

Past and continuing discharges of polychlorinated biphenyls (PCBs) have contaminated the natural resources of the Hudson River. The Hudson River Natural Resource Trustees - New York State, the U.S. Department of Commerce, and the U.S. Department of the Interior - are conducting a natural resource damage assessment (NRDA) to assess and restore those natural resources injured by PCBs (Hudson River Natural Resource Trustees 2002a). This Data Report provides the results of a preliminary investigation of PCB contamination of select Hudson River avian species conducted pursuant to the NRDA.

The Hudson River and surrounding area support more than 150 species of birds, including waterfowl, wading birds, shorebirds, songbirds, and rare species such as the bald eagle, peregrine falcon, and osprey (Andrle and Carroll 1988). Birds are an integral part of the ecosystem and provide a number of important ecosystem services such as seed distribution, plant pollination, and insect control. Birds are also an important source of prey to other species. Birds may be exposed to PCBs through direct ingestion of contaminated water, sediment, and soil. A more important exposure pathway is likely their consumption of food items that contain PCBs derived from the Hudson River and its floodplain. PCB contaminated food items linked to the river may include fish, amphibians, benthic invertebrates, adult insects that develop from aquatic larvae, plants growing in or near the river, and mammals that forage in the floodplain.

From April 2002 through June 2002, the Trustees conducted an avian egg exposure preliminary investigation for the Hudson River. The investigation entailed collection of eggs from six primary species: belted kingfisher (*Ceryle alcyon*), American robin (*Turdus migratorius*), Eastern phoebe (*Sayornis phoebe*), spotted sandpiper (*Actitis macularia*), red-winged blackbird (*Agelaius phoenicius*), and American woodcock (*Scolopax minor*). Active nests of these birds in and near the Hudson River and its floodplain were identified and eggs were collected for PCB analysis.

Locating and collecting eggs from the six primary avian species provided an opportunity for collection of eggs from other avian species, particularly from avian species with habitats in common with the primary avian species. The collection of egg samples from five additional avian species was based solely on the opportunities for survey team members to locate the nests of these species. The five species for which egg samples were opportunistically collected for PCB analysis are Eastern screech owl (*Otus asio*), common grackle (*Quiscalus quiscula*), northern rough-winged swallow (*Stelgidopteryx serripennis*), barn swallow (*Hirundo rustica*), and Eastern bluebird (*Sialia sialis*).

This preliminary investigation was undertaken to assist the Trustees in determining the extent to which avian species in the Hudson River are currently contaminated with PCBs, and to determine if additional pathway and injury assessment studies focused on avian species should be conducted as part of the Hudson River NRDA. This work will potentially be used to design future studies to assess the health of these animals in the Hudson River.

As noted in the Work Plan for this preliminary investigation (Hudson River Natural Resource Trustees, 2002b), the six primary avian species in this investigation together provide a balanced approach in that these species use different types of habitats common to the Hudson River, they consume different types of foods and they generally represent different ecological guilds. Further, all six of these avian species are reported to be relatively common breeders in the Hudson River floodplain (Andrle and Carroll 1988) and use wetlands for some portion of their life cycle (DeGraaf and Yamasaki 2000). Finally, many of the prey species consumed by these six avian species include those for which PCB accumulation has been documented in other areas, and for which PCB accumulation in prey items from the Hudson River is likely to exist.

2.0 SAMPLING

Collection and processing of avian eggs were conducted in accordance with the Trustees' Work Plan for the Collection of Eggs from Spotted Sandpipers, American Woodcock, Belted Kingfisher, American Robin, Red-Winged Blackbird, and Eastern Phoebe Associated With the Hudson River from Hudson Falls to Schodack Island, New York (Appendix A), including the Protocol for Avian Egg Collection and Removal of Contents for Contaminants Analysis (Hudson River Natural Resource Trustees, 2002b). Chemical analyses were conducted pursuant to the Trustees' Analytical Quality Assurance Plan (Hudson River Natural Resource Trustees, 2002c).

This preliminary investigation focused on four areas of the Hudson River between Bakers Falls on the Hudson River (in Hudson Falls, New York) and Schodack Island, New York. Avian eggs were collected from these four geographic areas to provide samples from various portions of the river which are known to be contaminated with PCBs at various levels. These four areas are described as follows, and are shown on Figure 1.

> Region 1: the area from Bakers Falls (at River Mile (RM) 196.9) downstream to the Fort Miller Dam (Lock 6) at RM 186.2 (Champlain Canal); this includes the Thompson Island Pool.
>
> Region 2: the area from the Fort Miller Dam (Lock 6) at RM 186.2 downstream to the Stillwater Dam (Lock 4) at RM 168.2; this includes the Stillwater Pool.
>
> Region 3: the area below the Stillwater Dam (Lock 4) at RM 168.2 downstream to the Federal Dam at Troy (RM 153.9), excluding Troy and its urban vicinity (approximately from Peebles Island State Park downstream to the Federal Dam).
>
> Region 4: the area below the Federal Dam at Troy (RM 153.9) extending south to Lower Schodack Island (RM 132), excluding Albany and its urban vicinity.

Note that these Regions are slightly modified from those specified in the Trustees' Work Plan for this avian egg investigation (Hudson River Natural Resource Trustees, 2002b). The avian egg exposure investigation Regions were realigned to be consistent with the segmentation used in other work being conducted by the Trustees.

2.1 EGG COLLECTION

Before egg collection began, the appropriate State and Federal permits were obtained. Field work began in April 2002. At each nest suspected of being active, a survey team member checked the nest (using a peeper probe or mirror and extension pole to peer inside the nest, when necessary) to determine the status of the nest. After determining that eggs were available for collection, a survey team member reached into the nest and collected an egg. Scientists wore nitrile gloves to reduce exposure to any parasites and diseases that may have been present in the nest or on an egg. Egg collection was documented using the Avian Egg Data Sheet specified in the Trustees' Work Plan for this investigation.

For four of the smaller avian species in this investigation -- Eastern phoebe, Eastern bluebird, barn swallow, and northern rough-winged swallow - it was necessary to collect two eggs from each nest to provide the desired total sample mass (minimum of 2 grams) for analysis. One egg sample (containing either one or two eggs depending on the species and size of the eggs) was thus collected from each nest of the six primary avian species identified and from each nest of the five opportunistically sampled avian species identified.

In one instance, two eggs (BK-506-507 and BK-506-508) were collected from a single belted kingfisher nest in Region 2. These eggs were processed and analyzed individually. In that instance, two eggs were inadvertently extracted from the nest burrow, and both were saved and subsequently processed and analyzed individually, as it was not possible to return one of the eggs to the nest without potentially endangering the remaining eggs.

The collected egg(s) were marked with the sample collection nest identification (ID) number using a graphite pencil and wrapped in a protective manner with aluminum foil that was also labeled with the nest number. Wrapped eggs were securely placed in an egg container then into a cooler or secure box with ice and transported to a New York State Department of Environmental Conservation (NYSDEC) facility for processing.

The first avian egg for this investigation was collected on April 16, 2002, and the final egg for this investigation was collected on June 20, 2002.

2.2 Egg Processing

Once in the processing facility, i.e. laboratory building, each egg was measured, processed and stored according to the Work Plan and the Protocol for Avian Egg Collection and Removal of Contents for Contaminants Analysis (Hudson River Natural Resource Trustees, 2002b).

The majority of the eggs were processed within 24 hours and the remaining eggs were stored at approximately 40 degrees Fahrenheit and processed within 48 hours. All eggs were processed at a laboratory maintained by the NYSDEC.

Upon processing, egg contents were stored at -20 Celsius in a freezer at the processing facility. The samples were transported in a cooler with ice to the NYSDEC Hale Creek laboratory, where they were again stored at -20 Celsius until they were shipped to the program analytical laboratory for chemical analysis.

Log forms were created for each egg collected documenting the specifics of the collection and processing. Chain of custody forms were prepared with the appropriate signatures as the samples were transferred from the field crew to NYSDEC staff.

2.3 Egg Analyses

A total of 220 eggs were submitted for analysis. Due to the small size of some of the eggs, compositing of two eggs to form a single sample was necessary for several species (Eastern phoebe, Eastern bluebird, barn swallow, and northern rough-winged swallow), as noted earlier. The total number of egg samples (either one egg or a composite of two eggs, as noted) analyzed was 168.

The egg samples were grouped into 12 analytical batches by the laboratory. The eggs were analyzed for 48 PCB congeners (Table 3 of this report contains a list of the congeners), PCB homologue groups, total PCBs, percent lipids, and percent moisture. The egg tissue was prepped, extracted, and analyzed using laboratory Standard Operating Procedures (SOPs) approved by the Trustees prior to sample receipt.

Sample analysis began on August 26, 2002, and concluded on November 15, 2002.

2.4 Quality Assurance/Quality Control

Data validation was conducted by the Trustees and was based on the quality assurance/quality control (QA/QC) criteria documented in the Trustees' Analytical Quality Assurance Plan for the Hudson River Natural Resource Damage Assessment (Hudson River Natural Resource Trustees, 2002c), USEPA (1999), and the following laboratory SOPs:

- SOP # HR NRDA Project Tissue Prep: Tissue Preparation and Homogenization, Revision #1.0, 9/25/02
- SOP # OP-004: Extraction of Soil, Tissue, Vegetation, and Sediment by Pressurized Fluid Extraction, Revision #2.0, 8/15/02
- SOP # O-010: Determination of PCB Homologues and Individual Congeners by GC/MS - SIM, Revision # 2.2, 10/24/02
- SOP # HR NRDA % Lipids: Percent Lipids Determination, Revision # 0.0, 9/9/02
- SOP # W-001: Percent Solids Determination, Revision # 2.1, 9/25/02
- Additional cleanup, sample handling, storage, custody SOPs as necessary.

The data packages submitted by the laboratory were reviewed to determine whether the analytical data quality objectives (ADQO) specified in the Analytical Quality Assurance Plan (Hudson River Natural Resource Trustees, 2002c) were met.

Table 1.1 of the Trustees' Analytical Quality Assurance Plan (Hudson River Natural Resource Trustees, 2002c) specifies the target Method Detection Limits (MDLs) for PCB congeners, homologues and total PCBs. For tissue, such as avian egg samples, the target MDLs are 0.1 ng/g wet weight (equivalent to 0.1 ppb wet weight) for individual congeners, and 10 ng/g (equivalent to 10 ppb) for PCB homologues and total PCBs. Actual MDLs for each PCB analyte were established by the analytical laboratory as specified in the Analytical Quality Assurance Plan. Actual MDLs are reported on the Avian Egg Data Sheets (Appendix C) in the "Detection Limit" column.

Appendix B contains the Data Quality Assessment Report (Hudson River Natural Resource Trustees, 2003) for the avian egg exposure study. Table 1A to that appendix is a summary of standard reference material (SRM) analytical results for each sample delivery group (SDG) that was analyzed. A statistical evaluation of the SRM analytical results is found in Table 1B of that appendix. Table 2 of that appendix summarizes the relative percent difference in duplicates from the analyses.

Out of 10,248 individual analytical results reported by the laboratory (168 egg samples, each with 48 congeners, ten homologue groups, total PCBs, percent lipids and percent moisture), a total of 1,016 (9.91%) data points were qualified as estimated (J/UJ) because of laboratory accuracy and precision outliers, continuing calibration percent difference outliers, and internal standard area outliers, and 110 data points were tentatively identified (NJ) due to potential interferences (see Appendix B) (Hudson River Natural Resource Trustees, 2003). One data point was rejected based on an accuracy outlier and is thus not included in this report. For all other data, the overall quality of the data is acceptable and all results, as qualified, are considered usable (Hudson River Natural Resource Trustees, 2003). The completeness level attained for the analysis of the field samples is greater than 99.9%.

A quality control table was developed. That table includes Nest ID Number, Laboratory ID, Analytical Batch Number, Analyte, Value, Interpretive Qualifier, Value Units, Detection Limit, Analysis Group, Basis, Extraction Date, Analysis Date, Dilution Factor, Sample Size, Sample Size Unit, and Quality Control Types for all samples, duplicates, SRMs and rinse blanks. Due to the size of this table, it has not been included in this report, but will be made available upon request. The quality control table is part of the Trustees' Avian Egg Database (Hudson River Natural Resource Trustees, 2004a).

3.0 RESULTS

The Avian Egg Data Sheets (Appendix C) provide the results of the analyses. These Data Sheets contain information that has been extracted from the Trustees' Avian Egg Database (Hudson River Natural Resource Trustees, 2004a). That complete database and the accompanying Database User Manual (Hudson River Natural Resource Trustees, 2004b) are not included in this report due to the size of the database, but will be made available upon request.

The Avian Egg Data sheets contain the following fields:

Sampling Date - Sampling Date (mm/dd/yy format)

Field ID - The field IDs were created using the following format:

CC-NNN-EEE

where CC is the code for the common name (e.g., AR is American Robin), NNN is the nest number, and EEE is the egg ID number. For example, AR-007-101 indicates egg ID number 101 in nest number 007, associated with an American Robin.

Due to limited sample size, some of the eggs were composited prior to analysis. For composite egg samples, the following field ID format was used:

CC-NNN COMP XXX/YYY

where CC is the code for the common name (e.g., EP is Eastern phoebe), NNN is the nest number, and XXX/YYY represents the egg' ID numbers included in the composite. For example, a composite of Eastern Phoebe eggs from nest 232 would be: EP-232 COMP 236/237.

Decimal latitude readings as reported by the GPS system.

Easting - NAD83 Universal Transverse Mercator easting coordinates (meters) Zone 18N.

Northing - NAD83 Universal Transverse Mercator northing coordinates (meters) Zone 18N.

Region - Region as delineated in section 2 of this report.

Lab ID - Laboratory IDs were created using the following format:

Sample delivery group - run sequence number (e.g., 0208031-01)

Analyte - self-explanatory.

Value, Interpretive Qualifier -

Value - Analytical result (3 significant figures).

Interpretive Qualifier - This field contains qualifiers applied to each data point after the data validation process. Data validation qualifiers were assigned to data points when associated QC sample results indicated the data did not meet the data quality objectives. The following definitions provide brief explanations of the qualifiers applied to the Hudson River NRDA data. Reasons for qualifications are explained further in the Data Quality Assessment Report (Appendix B).

U Not detected. The analyte was not detected. The associated value represents the detection limit.

J Estimated: The associated numerical value is an estimated quantity. The analyte was detected, but the reported value may not be accurate or precise. The "J" qualification indicates the data fell outside the QC limits, but the exceedance was not sufficient to cause rejection of the data.

UJ Estimated/Not detected: An analysis was performed for the compound or analyte, but it was not detected and the sample quantitation or detection limit may be inaccurate or imprecise. The associated numerical result is the detection limit.

NJ The analyte was tentatively identified and the associated numerical value is an estimated quantity.

R Rejected: Unreliable result. Data should not be used. The values associated with R qualifiers have been removed from the database.

The unit of measurement of the analytical result is provided (for example, μg/kg).

Detection Limit - self-explanatory; this column includes units.

Fresh Weight - results (analyte value in earlier column) corrected for moisture loss, as discussed below.

A brief description of some of the features of these data follows in sections 3.1 and 3.2 of this Data Report. Please note that the unit "μg/kg" used in the Data Sheets is equivalent to parts per billion (ppb) used in the discussion of these data in this Data Report.

Data fields, and data collected by the Trustees, that are not reported in this Data Report but that are contained within the Trustees' Avian Egg Database consist of the following: Nest ID Number, Study Name, Laboratory ID, Analytical Batch Number, Laboratory Flag, Data Validation Qualifier, Data Validation Qualifier Reason Code, Analysis Group, Analytical Method, Extraction Date, Analysis Date, Dilution Factor, Sample Size and Units, Biota Type, Egg Contents Weight, Whole Egg Weight, Egg Volume, Eggshell Thickness, Nonconformance Notes, Eastings, Northings, and Region Name.

All PCB results reported below and in the figures attached to this report have been corrected for moisture loss. This is an adjustment to compensate for the loss of moisture in avian eggs (Stickel et al. 1973). Valid interpretation of contaminant residue data for avian eggs depends upon adjustment for moisture loss.

To correct for moisture loss, per the method of Stickel et al. (1973), a correction factor is determined as follows:

$$\text{Correction factor (CF)} = \frac{\text{Egg contents weight (g)}}{\text{Egg volume (cm}^3\text{)}}$$

The contaminant value adjusted for moisture loss is then derived by multiplying the laboratory determined contaminant concentration by the correction factor.

For example:

$$\text{CF} = \frac{\text{Egg contents weight}}{\text{Egg volume}} = \frac{6.32 \text{ grams}}{6.67 \text{ cm}^3} = 0.9475$$

CF x PCB concentration = corrected PCB concentration

0.9475 x 1,820 ppb PCBs = 1,724 ppb PCBs

In this example, the PCB value corrected for moisture loss is 1,724 ppb.

When it was not possible to determine a CF for a specific sample (because of the lack of information on egg contents weight and/or egg volume), an average CF was determined based on CFs determined for eggs of the same species from the same Region, and that average CF was applied to that sample as its CF.

For composited samples (Eastern phoebe, Eastern bluebird, barn swallow, and northern rough-winged swallow), egg volume and egg contents weight were determined by averaging the respective sample characteristics; those averages were used in deriving the correction factor.

Where it was impossible to determine average egg volume or contents weight for a composited sample (e.g., RS-640 COMP 660_661), the measured egg volume and contents weight of one of the eggs in that composite (e.g., RS-640-660) was used to calculate the CF for the composite sample.

All calculated CFs were used, and all samples were included in calculating species and Regional average PCB concentrations. For "J" qualified results (J/UJ/NJ), the estimated value was used in the calculations.

For the purpose of reporting PCB results below and in the figures attached to this report, all values flagged with either a U or UJ interpretive qualifier (that is, not detected; see Appendix B) were considered to be zero. Using zero, rather than the value reported by the laboratory for the analyte, which represents the detection limit for the analysis, potentially underreports the true value, but avoids overreporting the true value. This is thus a conservative result; the actual PCB concentration could be higher.

3.1 TOTAL PCB CONCENTRATIONS

Total PCB concentrations of avian egg samples, by species, are detailed in Table 1. Total PCB concentrations of avian egg samples, by Region, are detailed in Table 2. Values in Tables 1 and 2 are reported to three significant figures.

Table 1. Summary of Total PCBs (as sum of homologues) in Hudson River Avian Eggs, by Species.

Species	Number of Samples	Concentration Range (ppb)	Concentration Average ±1 SD (ppb)
American robin	40	20 - 11,200	1,120 ± 2,170
American woodcock	2	91 - 101	96 ± 7
Belted kingfisher[A]	10	2,030 - 42,700	13,900 ± 12,500
Common grackle	10	702 - 16,400	4,360 ± 4,880
Eastern bluebird	5	196 - 1,140	520 ± 385
Eastern phoebe	27	144 - 17,300	2,040 ± 3,350
Barn swallow	10	663 - 5,140	2,990 ± 1,730
Red winged blackbird	40	65 - 35,000	3,670 ± 6,870
Norhtern rough winged swallow	10	2,140 - 13,900	7,240 ± 4,170
Screeech owl	1	8,010	-
Spotted sandpiper	13	488 - 56,200	15,200 ± 17,700

[A]Includes two eggs (BK-506-507 and BK-506-508) collected from a single belted kindfisher nest in Region 2 (See Section 2.1). Individual results for these two eggs are reported in Appendix C.

Table 2. Summary of Total PCBs (as sum of homologues) in Hudson River Avian Eggs, by Region.

Region	Number of Samples	Concentration Range (ppb)	Concentration Average ±1 SD (ppb)
Region 1	51	65 - 56,200	7,620 ± 11,300
Region 2[A]	48	44 - 15,100	3,320 ± 3,870
Region 3	39	20 - 42,700	4,450 ± 8,860
Region 4	30	36 - 2,990	607 ± 718

[A]Includes two eggs (BK-506-507 and BK-506-508) collected from a single belted kindfisher nest in Region 2 (See Section 2.1). Individual results for these two eggs are reported in Appendix C.

Figures 2 through 12 graphically represent the ranges and averages of avian egg total PCBs for each species by Region. Figures 13 through 16 graphically represent avian egg total PCB concentrations by species by Region.

Please note that on these figures the vertical axis (PCB concentration (µg/kg)) is a logarithmic scale. On a logarithmic scale, steps increase in a multiplicative fashion, not in an additive fashion as on a linear scale. The increase of one unit on a logarithmic scale represents a tenfold increase in the value. For instance, the first value on the scale is 10^1 which is equivalent to 10 µg/kg or 10 ppb; the next value on the scale is 10^2, which is equivalent to 100 µg/kg or 100 ppb (note that the unit "µg/kg" used on the figures is equivalent to ppb used in the discussion of these data in this Data Report).

For some avian species, such as American robin, barn swallow, and northern rough winged swallow, total average PCB concentrations in eggs display a decreasing concentration gradient moving downstream from Region 1 (Figures 2, 8 and 10).

For other avian species, such as common grackle, Eastern phoebe, red winged blackbird and spotted sandpiper, total average PCB concentrations in eggs do not display a consistently decreasing concentration gradient moving downstream from Region 1 (Figures 5, 7, 9 and 12). For common grackle and red winged blackbird, the average PCB concentration in eggs from Region 3 is greater than that for eggs from Region 1.

3.2 PCB HOMOLOGUES AND CONGENERS

PCBs are synthetic (man-made) chemicals that form a group of 209 individual compounds that have similar chemical structures based on a biphenyl core with 1 to 10 chlorine atoms attached. PCBs have the generic formula $C_{12}H_{(10-x)}Cl_x$, where x is an integer from 1 to 10.

Each individual PCB compound, called a congener, is identified by the unique number and location of chlorine atoms that attach to the compound's base structure. Congeners differ both in their physical properties and in their effects on fish and wildlife (Safe 1994; Van den Berg et al. 1998).

For this investigation, the avian eggs were analyzed for 48 specific target PCB congeners listed in Table 3. In addition, a total concentration for each homologue group was determined by summing all target and non-target congener concentrations within each homologue group. For any congener reported as non-detected, zero was used in the summation.

Table 3. PCB Congeners for which Avian Eggs were Analyzed.

Current Ballschmiter and Zell (1994) and International Union of Pure and Applied Chemistry (IUPAC) Number	IUPAC Name
8	2,4'-Dichlorobiphenyl
18	2,2',5-Trichlorobiphenyl
28	2,4,4'-Trichlorobiphenyl
31	2,4',5-Trichlorobiphenyl
44	2,2',3,5'-Tetrachlorobiphenyl
45	2,2',3,6-Tetrachlorobiphenyl
47	2,2',4,4'-Tetrachlorobiphenyl
49	2,2',4,5'-Tetrachlorobiphenyl
52	2,2',5,5'-Tetrachlorobiphenyl
56	2,3,3',4'-Tetrachlorobiphenyl
66	2,3',4,4'-Tetrachlorobiphenyl
70	2,3',4',5-Tetrachlorobiphenyl
74	2,4,4',5-Tetrachlorobiphenyl
77	3,3',4,4'-Tetrachlorobiphenyl
81	3,4,4',5-Tetrachlorobiphenyl
87	2,2',3,4,5'-Pentachlorobiphenyl
95	2,2',3,5',6-Pentachlorobiphenyl
99	2,2',4,4',5-Pentachlorobiphenyl
101	2,2',4,5,5'-Pentachlorobiphenyl
105	2,3,3',4,4'-Pentachlorobiphenyl
110	2,3,3',4',6-Pentachlorobiphenyl
114	2,3,4,4',5-Pentachlorobiphenyl
118	2,3',4,4',5-Pentachlorobiphenyl
123	2,3',4,4',5'-Pentachlorobiphenyl
126	3,3',4,4',5-Pentachlorobiphenyl
128	2,2',3,3',4,4'-Hexachlorobiphenyl
138	2,2',3,4,4',5'-Hexachlorobiphenyl
146	2,2',3,4',5,5'-Hexachlorobiphenyl
149	2,2',3,4',5',6-Hexachlorobiphenyl
151	2,2',3,5,5',6-Hexachlorobiphenyl
153	2,2',4,4',5,5'-Hexachlorobiphenyl
156	2,3,3',4,4',5-Hexachlorobiphenyl

Table 3. PCB Congeners for which Avian Eggs were Analyzed (continued).

Current Ballschmiter and Zell (1994) and International Union of Pure and Applied Chemistry (IUPAC) Number	IUPAC Name
157	2,3,3',4,4',5'-Hexachlorobiphenyl
158	2,3,3',4,4',6-Hexachlorobiphenyl
167	2,3',4,4',5,5'-Hexachlorobiphenyl
169	3,3',4,4',5,5'-Hexachlorobiphenyl
170	2,2',3,3',4,4',5-Heptachlorobiphenyl
174	2,2',3,3',4,5,6'-Heptachlorobiphenyl
177	2,2',3,3',4,5',6'-Heptachlorobiphenyl
180	2,2',3,4,4',5,5'-Heptachlorobiphenyl
183	2,2',3,4,4',5',6-Heptachlorobiphenyl
187	2,2',3,4',5,5',6-Heptachlorobiphenyl
189	2,3,3',4,4',5,5'-Heptachlorobiphenyl
194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl
195	2,2',3,3',4,4',5,6-Octachlorobiphenyl
201	2,2',3,3',4,5',6,6'-Octachlorobiphenyl
206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
209	Decachlorobiphenyl

Figures 17 through 27 display the PCB homologue distributions for each sampled species by its respective Region of collection.

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FIGURES

Figure 1. Location of avian egg collection sites depicted with triangles. Lines across the river represent dams or locks on the Hudson River. Stars represent select cities and towns.

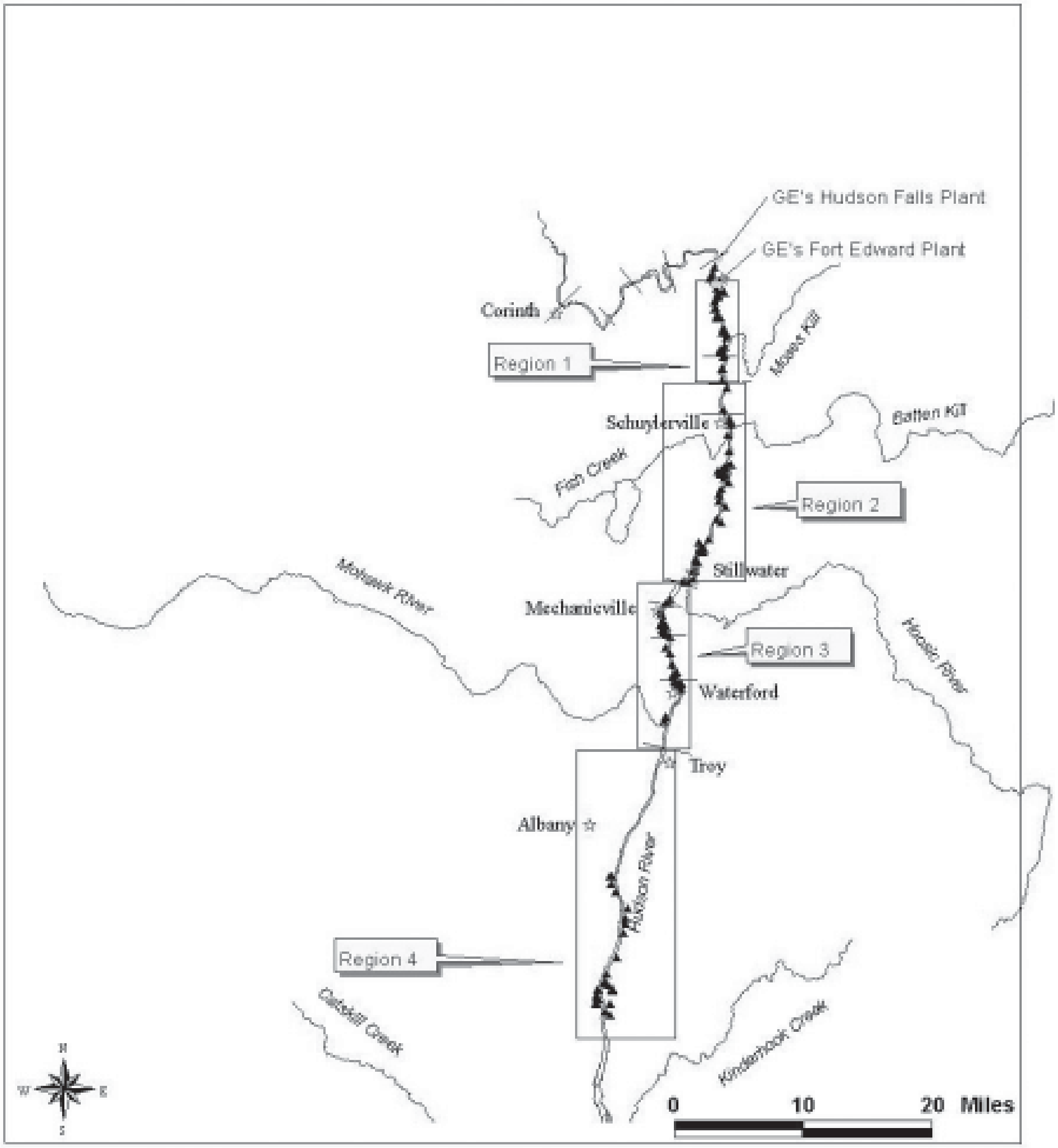


Figure 2. American robin egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

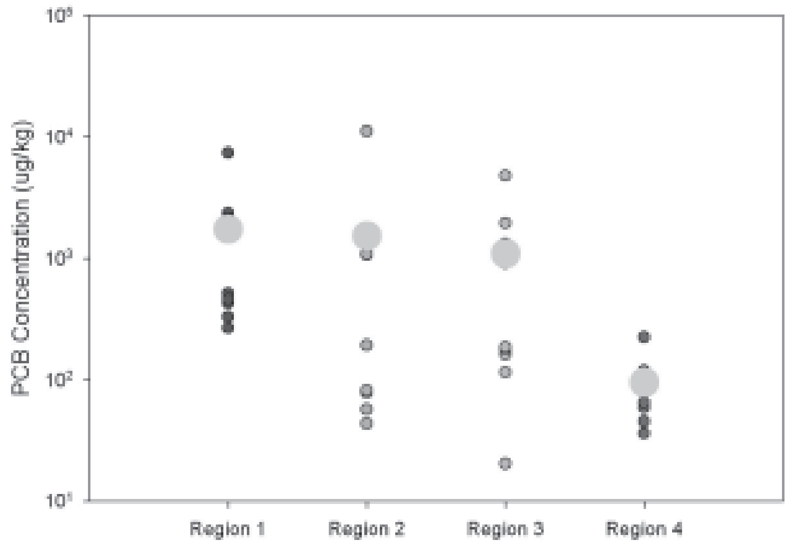


Figure 3. American woodcock egg total PCB concentrations by region.

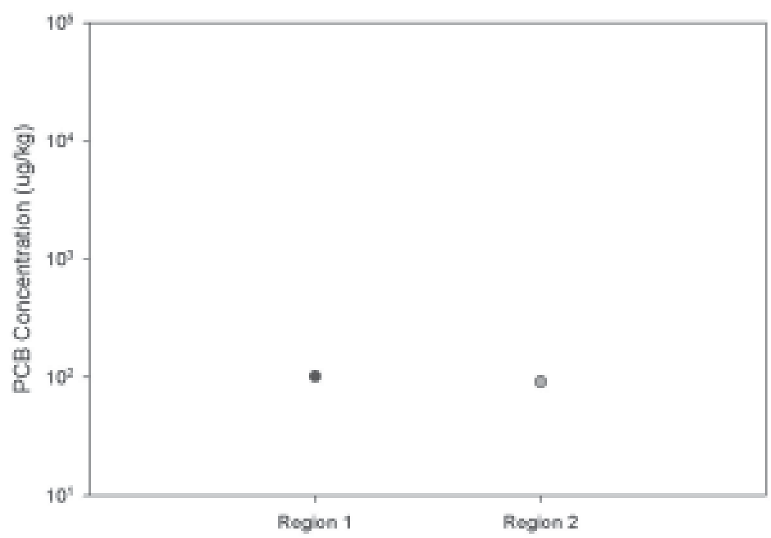


Figure 4. Belted kingfisher egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

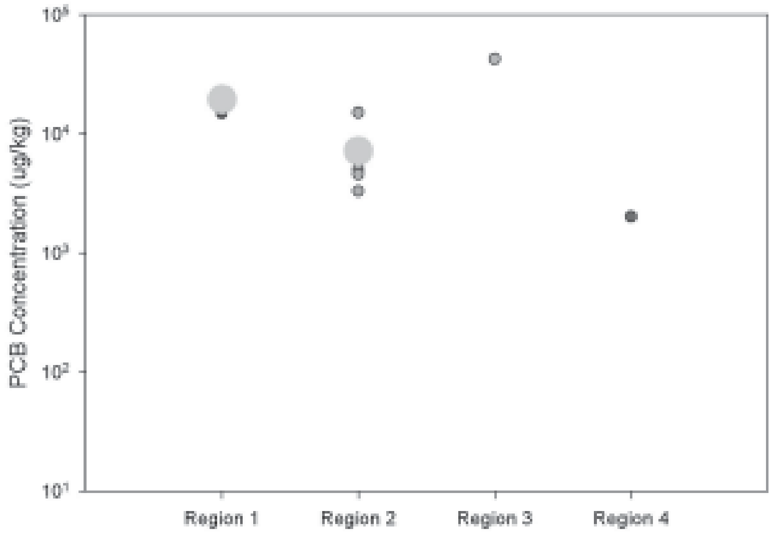


Figure 5. Common grackle egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

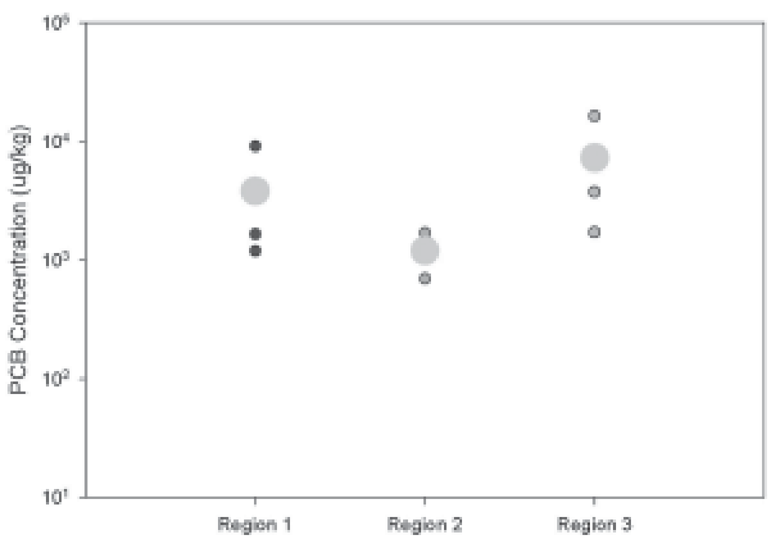


Figure 6. Eastern bluebird egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

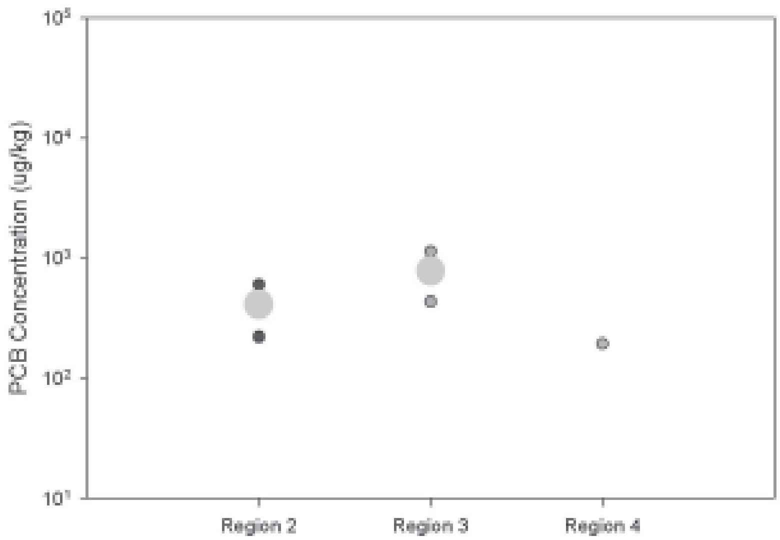


Figure 7. Eastern phoebe egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

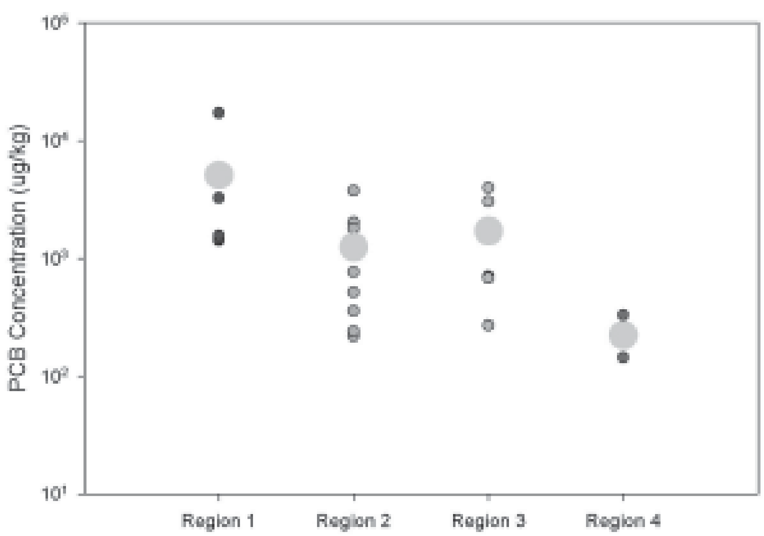


Figure 8. Barn sallow egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

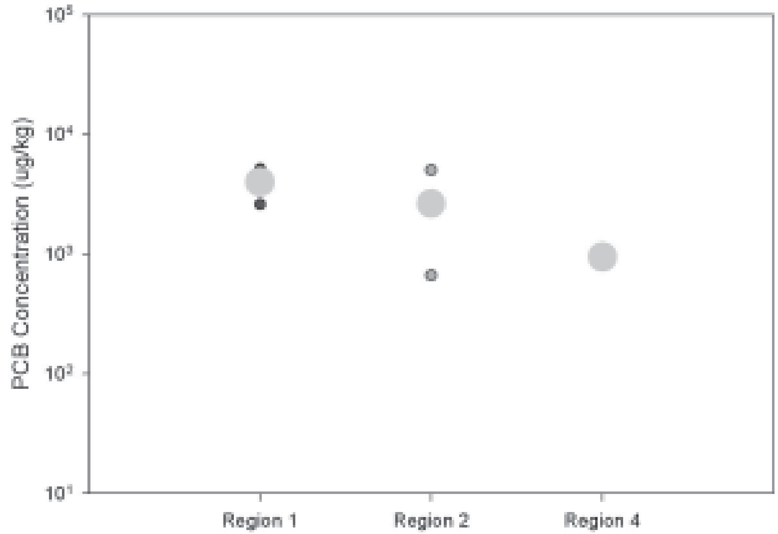


Figure 9. Red winged blackbird egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

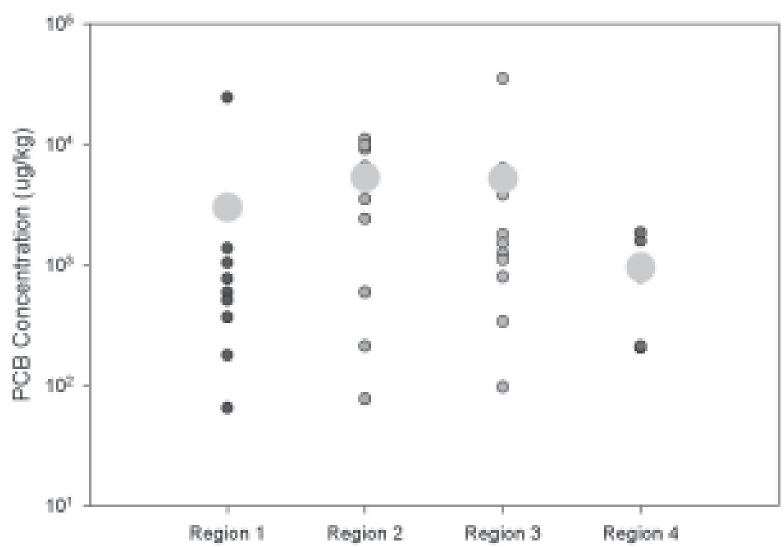


Figure 10. Rough winged swallow egg total PCB concentrations by region. The small dots represent individual samples, the large dots are regional averages.

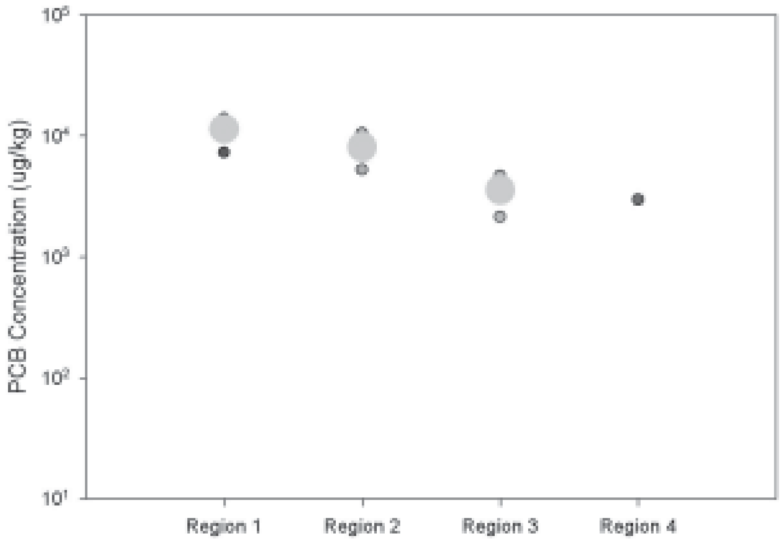


Figure 11. Screech owl egg total PCB concentrations by region.

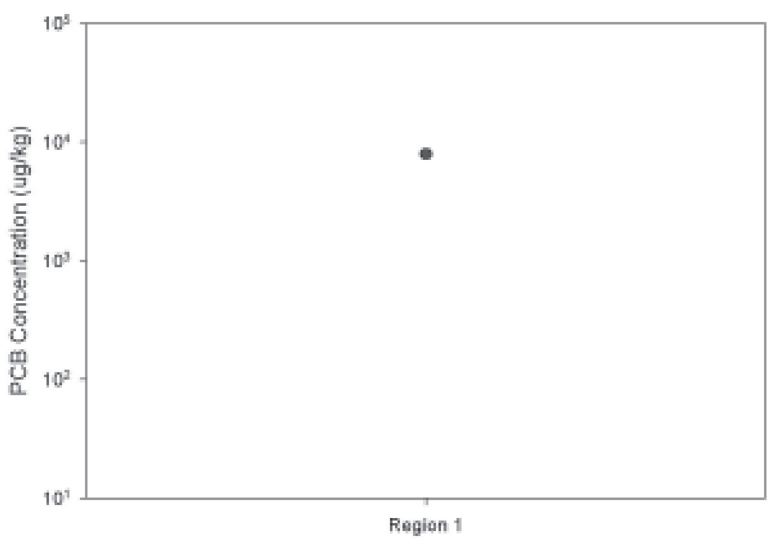


Figure 12. Spotted sandpiper egg total PCB concentrations by region. The small dots represent individual samples, the large dots are species averages.

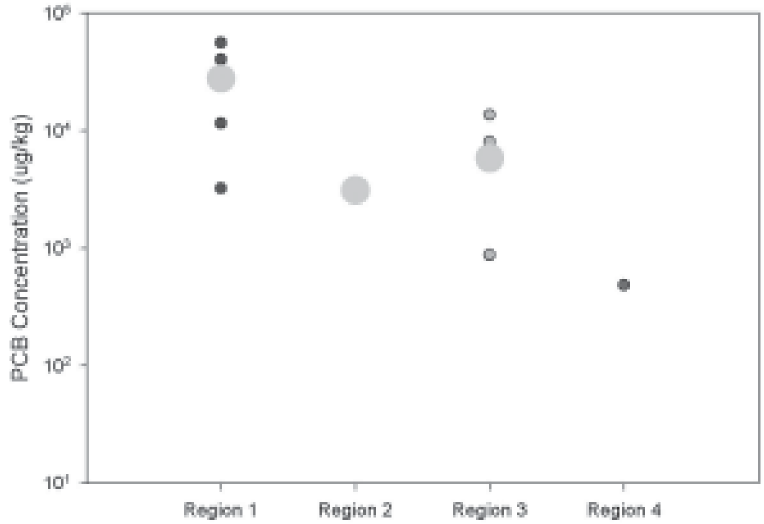


Figure 13. Region 1 avian egg total PCB concentrations by species. The small dots represent individual samples, the large dots are species averages.

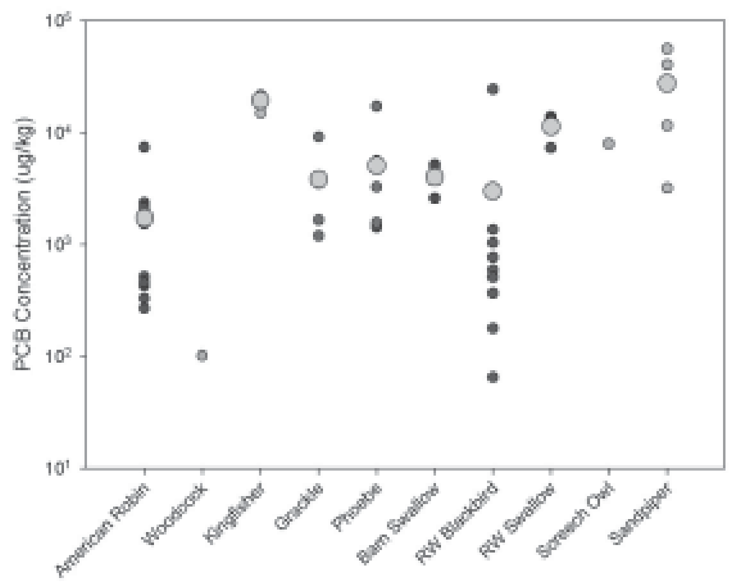


Figure 14. Region 2 avian egg total PCB concentrations by species. Small dots represent individual samples, the large dots are species averages.

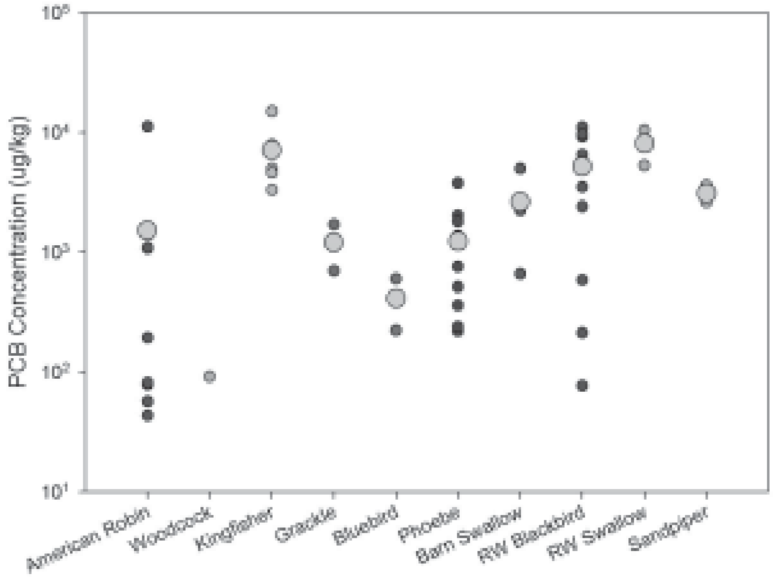


Figure 15. Region 3 avian egg total PCB concentrations by species. Small dots represent individual samples, the large dots are species averages.

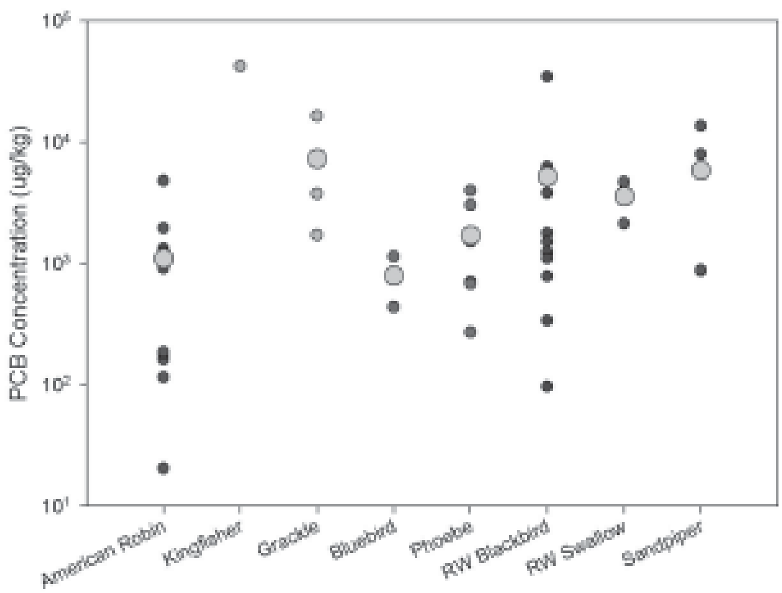


Figure 16. Region 4 avian egg total PCB concentrations by species. Small dots represent individual samples, the large dots are species averages.

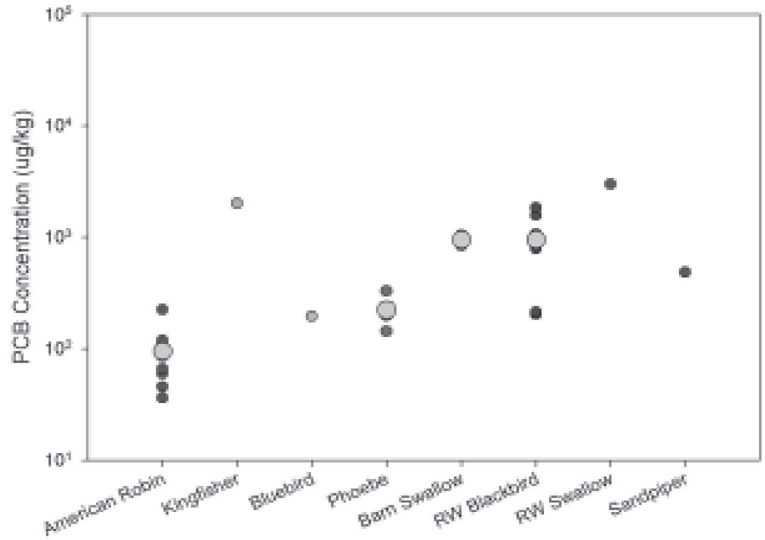


Figure 17. American robin egg PCB homologue distributions by region (+/- 1 SD).

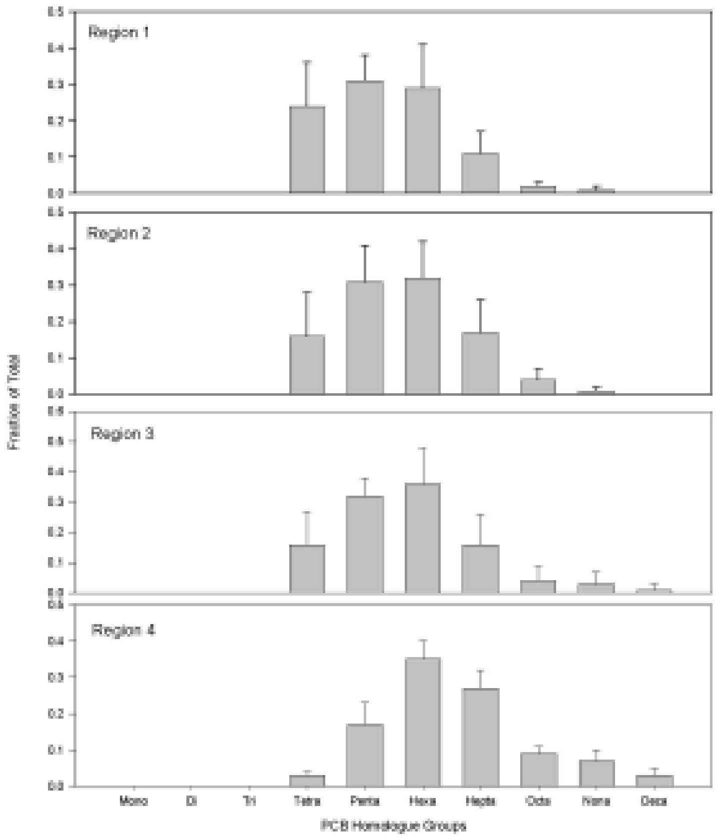


Figure 18. American woodcock egg PCB homologue by region.

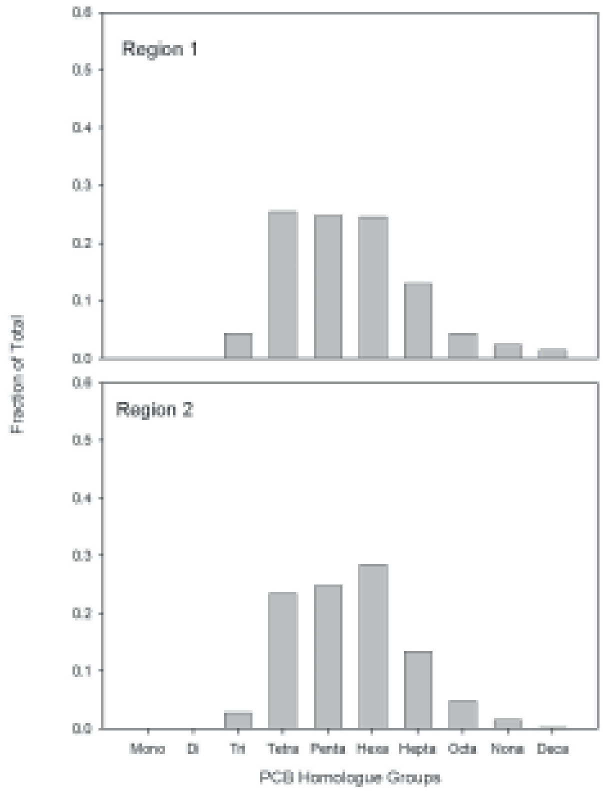


Figure 19. Belted kingfisher egg PCB homologue distributions by region (+/- 1 SD).

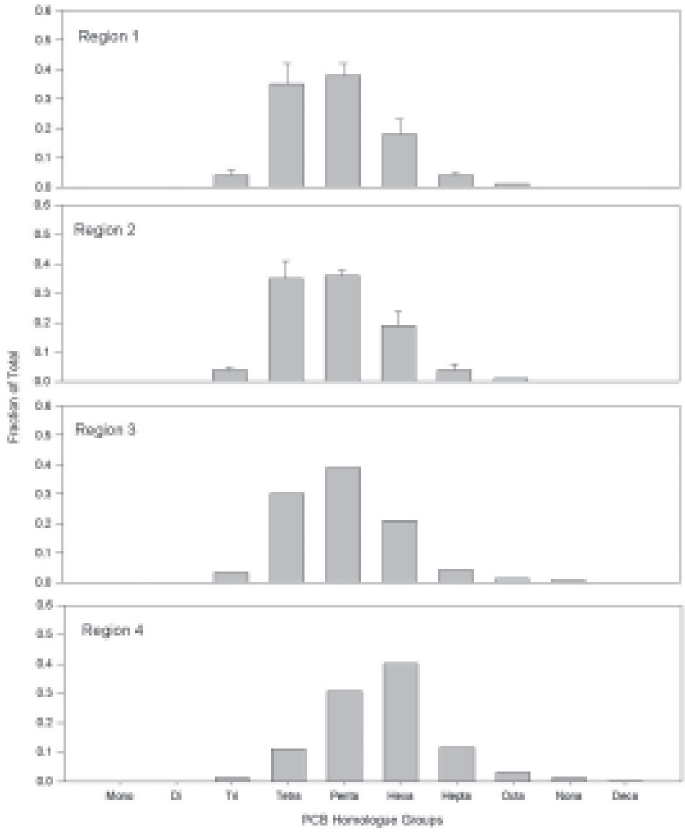


Figure 20. Common grackle egg homologue distributions by region (+/- 1 SD).

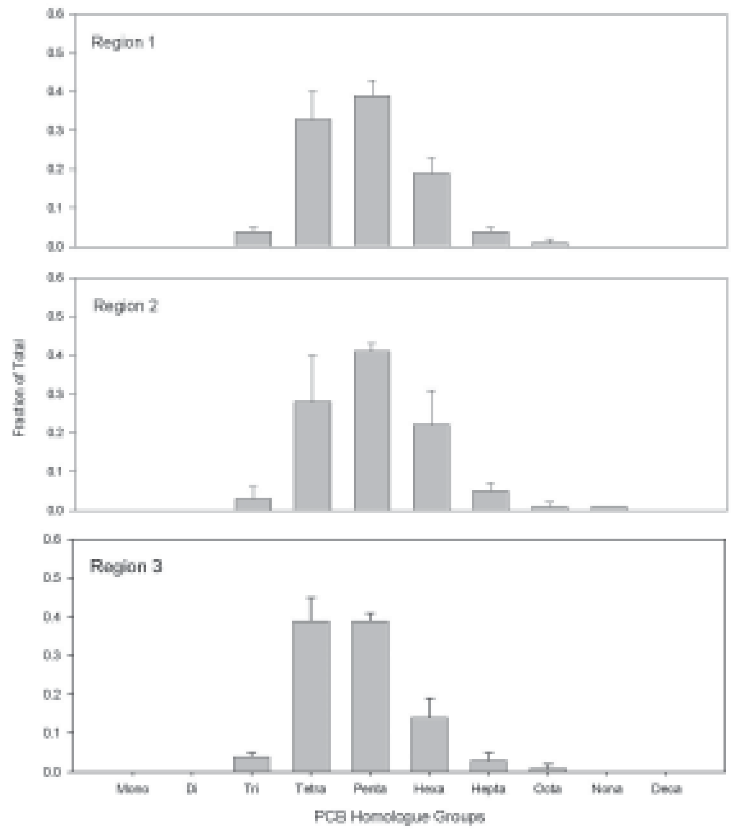


Figure 21. Eastern bluebird egg PCB homologue distributions by region (+/- 1 SD).

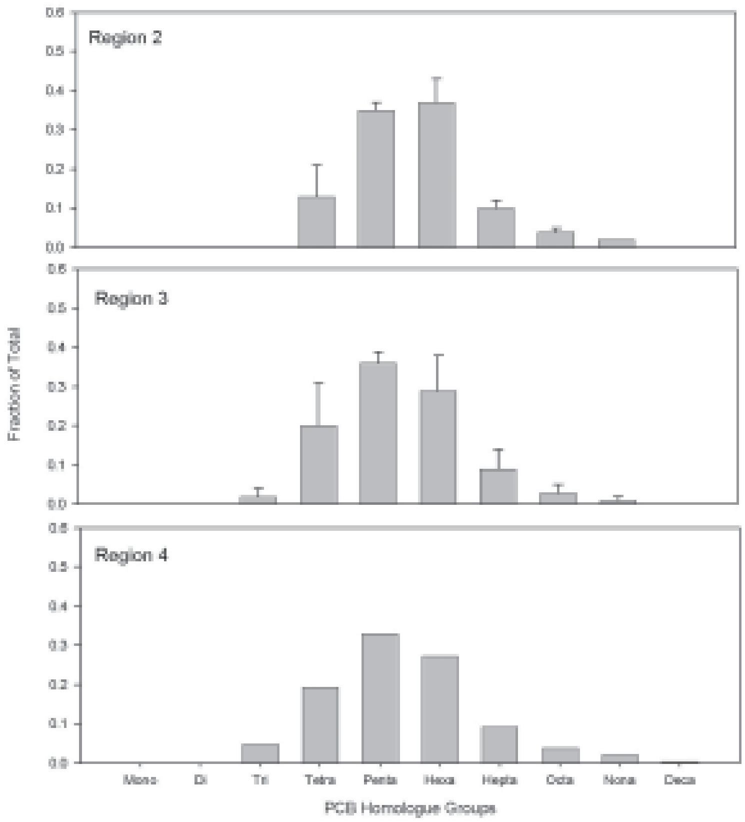


Figure 22. Eastern phoebe egg PCB homologue distributions by region (+/- 1 SD).

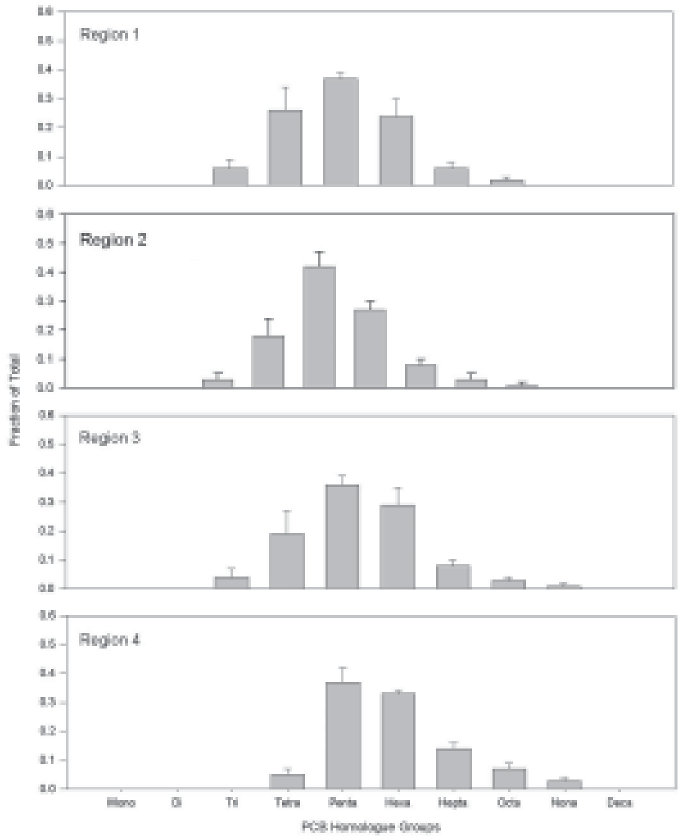


Figure 23. Barn swallow egg PCB homologue distributions by region (+/- 1 SD).

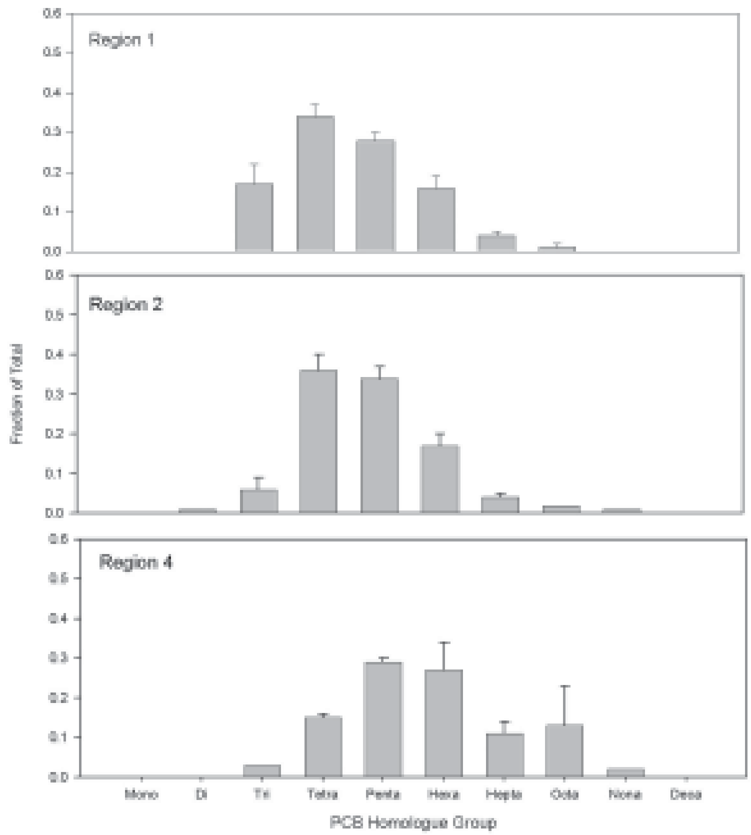


Figure 24. Red winged blackbird egg PCB homologue distributions by region (+/- 1 SD).

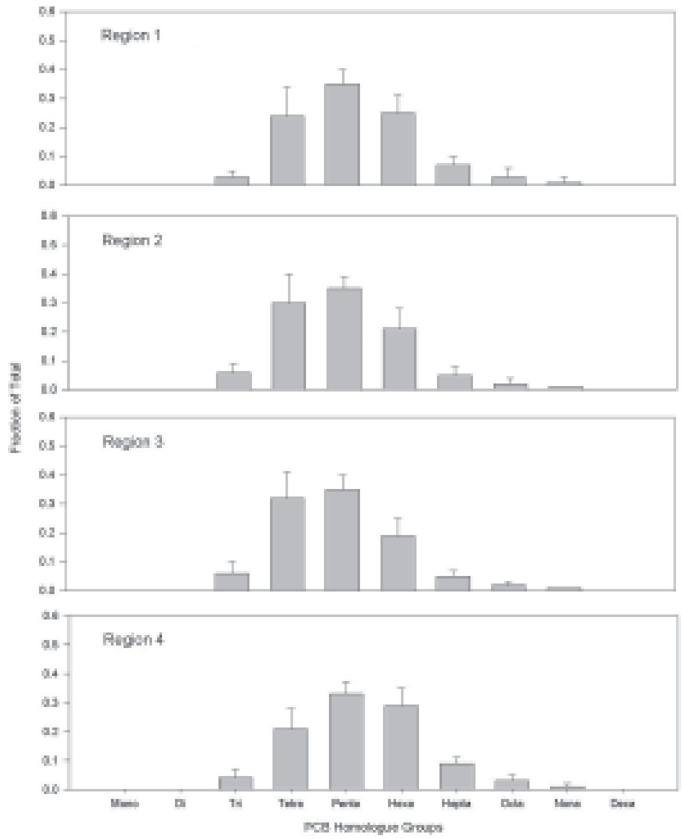


Figure 25. Rough winged swallow egg PCB homologue distributions by region (+/- 1 SD).

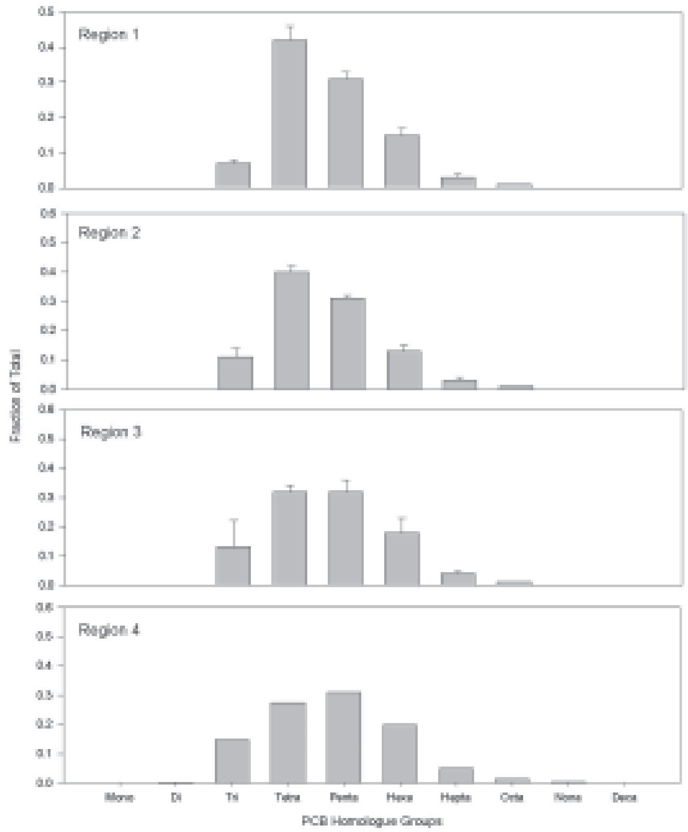


Figure 26. Screech owl egg PCB homologue distributions by region.

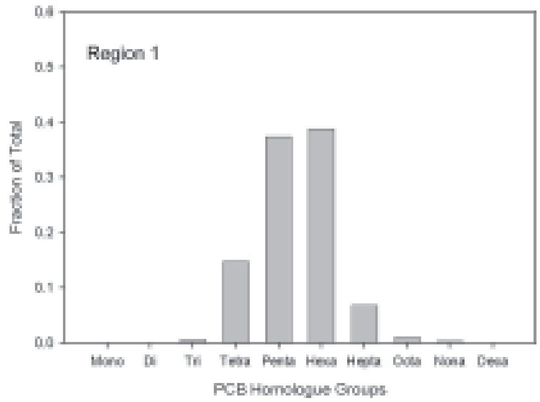
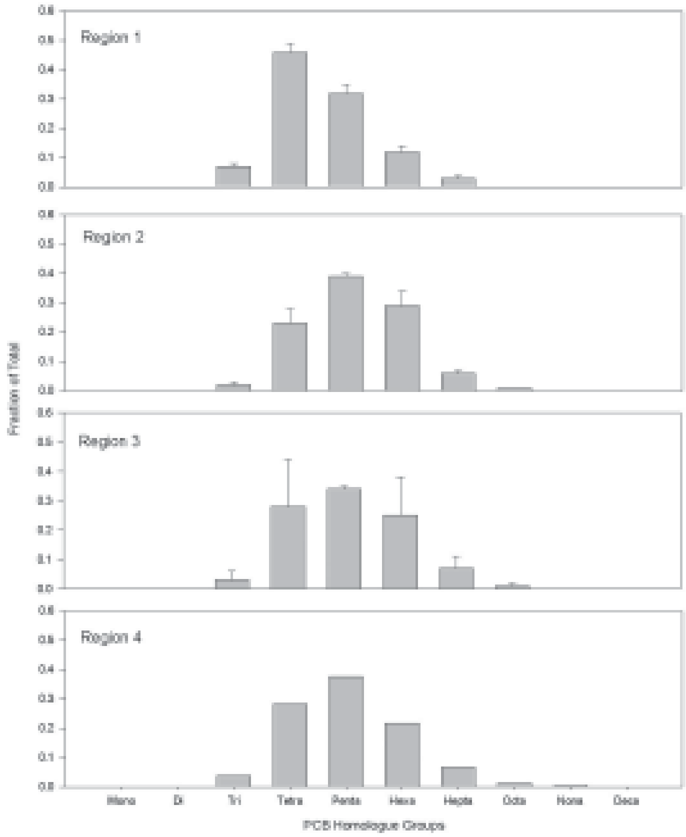


Figure 27. Spotted sandpiper egg PCB homologue distributions by region (+/- 1 SD).



Appendix A

Work Plan for the Collection of Eggs from Spotted Sandpipers, American Woodcock, Belted Kingfisher, American Robin, Red-Winged Blackbird and Eastern Phoebe Associated with the Hudson River from Hudson Falls to Schodack Island, New York