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MICHIGAN WILDLIFE CONTAMINANT TREND MONITORING

YEAR 2003 ANNUAL REPORT NESTLING BALD EAGLES

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SECTION 1.0

Executive Summary

- The bald eagle monitoring project is one component of Michigan's water quality monitoring program that was summarized by the Michigan Department of Environmental Quality (MDEQ) in the January 1997 report entitled, "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters (Strategy)." This document serves as the fifth annual report for the bald eagle element of the Strategy. The following are the goals of the bald eagle monitoring project:

    1. Assess the current status and condition of individual waters of the state and determine whether standards are being met.

    2. Determine temporal and spatial trends in the quality of Michigan's surface waters.

- The reproductive productivity (i.e., the total number of fledged young per occupied nest) for bald eagles in the state of Michigan in 2003 was 0.86. Statewide eagle productivity has not been this low since the 1970s when it ranged from 0.66 in 1970 to 0.93 in 1979. The productivity of inland (0.88), Great Lakes (0.79), and anadromous (1.05) breeding areas were not significantly different. Lake Superior had the greatest subpopulation productivity (1.02), followed by Lake Erie (1.00), the inland Upper Peninsula (0.90), Lake Huron (0.88), inland Lower Peninsula (0.86), and Lake Michigan (0.60). No differences were found for any category for success rate, with the exception of subpopulation. Multiple comparisons showed that success rate for Lake Erie (80%) was significantly greater than success rate for Lake Michigan (46.2%) ($P=0.0249$).

- In 2003, 91 nestling bald eagle blood plasma samples were analyzed for organochlorine contaminants, such as dichlorodiphenyltrichloroethane (DDT) and its metabolites, 20 polychlorinated biphenyl (PCB) congeners, chlordane, and dieldrin.

- Significant differences in total DDT and 4,4'-Dichlorodiphenyldichloroethylene (4,4'-DDE) concentrations were found between inland, Great Lakes, and anadromous breeding areas ($P<0.0001$); and also between inland Lower Peninsula and inland Upper Peninsula, Lake Huron, Lake Michigan, and Lake Superior breeding areas ($P<0.0001$). Geometric mean total DDT and 4,4'-DDE concentrations were ranked in the following order by location from highest to lowest: Lake Michigan > Lake Huron > Lake Superior > Lake Erie > inland Upper Peninsula > inland Lower Peninsula breeding areas. 4,4'-DDE was quantified in 96% of the samples and was the most common DDT metabolite found in eaglet blood plasma. Significant differences in total DDT concentrations were also found between Great Lake and basin watersheds ($P<0.0001$).

- Twenty PCB congeners were quantified and summed to determine total PCBs in nestling bald eagle blood plasma samples. Four congeners (153,138, 118, and 180) contributed significantly to the total PCB concentrations. At least one of the targeted PCB congeners was detected in 68 of the 91 nestlings sampled. A significant difference in total PCB concentrations was found between inland, Great Lakes, and anadromous breeding areas ($P<0.0001$), and among the inland Lower Peninsula, inland Upper Peninsula, Lake Huron, Lake Michigan, and Lake Superior breeding areas ($P<0.0001$). Geometric mean PCB concentrations were ranked in the following order by location from highest to lowest: Lake

Erie (n=1) > Lake Michigan > Lake Huron > Lake Superior > inland Upper Peninsula > inland Lower Peninsula breeding areas.

- Quantifiable concentrations of α-chlordane were measured in six blood plasma samples. Five of those samples were from Great Lakes breeding areas and one sample was from an anadromous breeding area. Five of the six Great Lakes samples were Lake Huron Breeding areas with the remaining one a Lake Superior breeding area. Statistical analyses could not be conducted due to sample size.

- Quantifiable concentrations of heptachlor epoxide were quantified in three Great Lakes samples and one inland sample. The three Great Lake samples were from Lake Superior breeding areas and the inland sample was from a Lake Michigan breeding area. Statistical analyses could not be conducted due to sample size.

- Quantifiable concentrations of dieldrin were measured in 27 blood plasma samples. One sample was from Lake Erie breeding areas, 8 samples were from Lake Huron breeding areas, 9 samples were from Lake Michigan breeding areas, and the remaining 9 were from Lake Superior breeding areas. Significant differences occurred between Great Lakes breeding areas ($P<0.0001$).

- Hexachlorobenzene (HCB), α-hexachlorocyclohexane (α-HCH), *gamma* (γ)-HCH, heptachlor, γ-chlordane, and toxaphene were not detected in any nestling bald eagle 2003 blood plasma samples.

- Due to analytical difficulties, the 2003 mercury data will be presented in a future report.

SECTION 2.0

INTRODUCTION

In April 1999, the MDEQ, Water Division, began monitoring environmentally persistent and toxic contaminants in bald eagles. This study is part of the wildlife contaminant monitoring component of the MDEQ's Strategy (MDEQ, 1997).

The November 1998 passage of the Clean Michigan Initiative-Clean Water Fund (CMI-CWF) bond proposal resulted in a substantial increase in annual funding for statewide surface water quality monitoring beginning in 2000. The CMI-CWF offers reliable funding for the monitoring of surface water quality over a period of approximately 15 years. This is important since one of the goals of the Strategy is to measure temporal and spatial trends in contaminant levels in Michigan's surface waters.

The bald eagle (*Haliaeetus leucocephalus*) was selected as a biosentinel species for monitoring contaminants in Michigan for the following reasons:

1. As a top-level predator, the bald eagle has a significant reliance on the aquatic food web and feeds primarily on fish and waterbirds. Specific dietary preferences of bald eagles include species of northern pike, suckers, bullheads, carp, catfish, bowfin, ducks, gulls, and deer (winter carrion and road-killed deer).

2. Past monitoring has shown that eagles accumulate organic and inorganic environmental contaminants and those contaminants may be quantified in blood, feather, and egg samples.

3. There is a viable population of bald eagles that provides sufficient sampling opportunities for a long-term monitoring program.

4. The large body size of nestling eagles allows monitoring to be conducted by blood sampling techniques and sufficient sample volumes are available to attain low quantification levels (QLs).

5. Mature bald eagles display great fidelity to their chosen nesting territory and often return to the same nest tree year after year. Although some eagles may move away from their nesting territories in the winter months, bald eagles generally reside within the state's waters throughout the year. Therefore, contaminants found in nestling bald eagles will represent the uptake of available contaminants within a particular territory.

The primary objectives of this project were to gather the fifth year of data on eaglets, evaluate temporal trends between these data and historical data available in the scientific literature, and evaluate spatial trends of contaminant concentrations among watersheds and the Great Lakes basins. Because the methods for sample collection required nest visits and handling nestling eagles, other biological measures were obtained. Therefore, the secondary objectives of the project included determining reproductive success and collecting nestling morphological data. Both spatial and temporal trends of reproductive success were also assessed in this project.

In accordance with one of the key principles of the CMI-CWF, the bald eagle monitoring protocol was planned and conducted in partnership with outside organizations. In 1999, this partnership included Lake Superior State University and Clemson University, and since 2000, this partnership included Michigan State University and Clemson University.

This document serves as the fifth annual report for the bald eagle element of the Strategy. The first (MDEQ, 2002), second (MDEQ, 2003), third (MDEQ, 2004a), and fourth (MDEQ, 2004b) reports contained results of the samples collected in 1999, 2000, 2001, and 2002, respectively. This report contains the analytical results for organic contaminants that were measured in nestling bald eagle blood samples, and statistical spatial trend analyses of the data. Also included in this report are the data for reproductive success. Feather analyses for mercury concentrations have not been conducted at this time due to analytical difficulties. The feather mercury data for 2003 will be presented to the MDEQ in a separate report.

Section 3.0

STUDY DESIGN AND METHODS

3.1 SITE SELECTION

The bald eagle monitoring project is designed to provide monitoring coverage of both the coastal Great Lakes and inland waters. Nesting eagles are found along the shorelines and on islands of each of the four Great Lakes surrounding Michigan. Further, the distribution of breeding eagles across much of Michigan provides monitoring coverage for many of the major river systems. Currently, active bald eagle breeding areas are well distributed across the Upper Peninsula and northern Lower Peninsula of Michigan.

The establishment of breeding areas in southern Michigan is relatively recent, and the number of active breeding areas continues to increase as eagles either establish new breeding areas or reoccupy historical territories. For example, the breeding areas in Arenac, Barry, Ottawa, and Wayne Counties were established in 1998 or 1999. One breeding area in Monroe County was established in 1988 and the other three breeding areas were first occupied in 1998 or 1999. The first breeding areas in Allegan and Saginaw Counties were established in 1993.

To facilitate the MDEQ's National Pollutant Discharge Elimination System permitting process, Michigan's watersheds, as delineated by eight-digit hydrologic unit codes (HUCs), are divided into five basin years for monitoring (Figure 1). Therefore, approximately 20% of Michigan's surface waters are assessed each year. The bald eagle sample collection schedule is consistent with the basin year delineation and complements the other monitoring activities conducted during each basin year. In addition to the basin year sampling, nests associated with the Great Lakes, the connecting channels, and 12 inland territories are sampled annually. Great Lakes and connecting channel nests are sampled annually because nesting success is highly uncertain for these sites. Twelve inland territories with consistently high productivity were selected to track annual trends in contaminant concentrations, assess variability in contaminant concentrations from one year to the next, and determine the frequency that nests need to be sampled to evaluate trends.

The following basin year watersheds were the focus of sampling in 2003 (Figure 2): Bad-Montreal, Black-Presque Isle, and Ontonagon of the Upper Peninsula, and the Rouge-Flat, Thornapple-Rabbit, Betsie-Platte, Boardman-Charlevoix, Pigeon, Birch-Willow, Tittabawassee, Flint, Lake St. Clair, and Raisin watersheds of the Lower Peninsula. In addition to the basin year watersheds for 2003, nests associated with the Great Lakes and connecting channels were sampled. Great Lakes-associated nests are defined as those nests within 8.0 kilometers (km) of the shorelines of the Great Lakes and along tributaries where anadromous fish are accessible. Lastly, the 12 inland territories selected for annual sampling were located within the Ontonagon, Michigamme, Au Sable, and Thunder Bay River watersheds.

3.2 FIELD METHODS

The methods used to collect blood and breast feather samples from nestling bald eagles are designed to avoid injury and undue stress to the birds. Sample collection and morphometric methods are adapted from Bortolotti (1984a, 1984b, 1984c), Henny and Meeker (1981), Henny *et al*. (1981) and Morizot *et al*. (1985). The methods are summarized below, but details of the procedures are published in a standard operating procedure (SOP) (Bowerman and Roe, 2002).

Blood and feather samples were collected from five to nine-week old nestling bald eagles from May 15 through June 21, 2003. The approximate age of nestling eagles is visually estimated from two aerial survey flights that are piloted by a Michigan Department of Natural Resources (MDNR) pilot or contracted private pilot. An observer on each flight makes notes of the nest tree and location, determines an aerial latitude and longitude for the nest, and notes the reproductive status of each nest (e.g., eggs, chicks, or adult brooding behavior). From the observer's notes, field crews are directed to the nests at the appropriate time for sampling. Field staff ground truth the latitude/longitude coordinates using Global Positioning System units.

Once at the nest, a trained crewmember climbs the nest tree and secures a nestling. The nestling is placed in a restraining bag, lowered to the ground, weighed by spring scale, and prepared for sampling. Morphological measurements of the culmen, hallux claw, and bill depth are derived by using calipers. The eighth primary feather and the footpad are measured by using a ruler. Procedures developed by Bortolotti (1984b) are used to determine the age and sex of the nestlings. Sex is determined by the relationship of hallux claw length, footpad length, and bill depth. Once sex is determined, the length of the eighth primary feather is used to make a sex-specific estimation of age.

Sterile techniques are used to collect blood from the brachial vein of nestling bald eagles. Syringes fitted with 22 or 25 gauge x 1" needles are used for the veinipuncture. Up to 12 cc of blood are drawn from the brachial vein and are then transferred to heparinized vacuum tubes and placed on ice in coolers for transfer out of the field. Samples of whole blood are centrifuged within 48 hours of collection and the plasma is decanted and transferred to another vacuum tube and frozen at approximately -20^{o} C for storage. Three to four feather samples also are collected from the nestling eagles. Feathers are plucked from the breast and stored in small sealed envelopes. The vacutainers and feather envelopes are sealed with tamper-proof chain-of-custody tape. After sampling is completed, the nestlings are banded with a size 9 United States Fish and Wildlife Service (USFWS) rivet band and an appropriate color band. The nestling is then placed back in the restraining bag, raised, and released to the nest.

From the field, samples are transferred to prearranged collection points at various MDNR, United States Forest Service, or USFWS field stations. At the end of the sampling effort, all samples are collected and transferred to the USFWS East Lansing Field Office, entered into sample storage through a chain-of-custody tracking system, and stored frozen at approximately -20^{o} C. Upon request to the USFWS chain-of-custody officer, samples are transferred to the Clemson Institute of Environmental Toxicology (CIET) for analysis. Upon receipt at the CIET, SOPs direct that samples be logged in, checked for sample integrity, and again stored frozen at approximately -20^{o} C until prepared for instrumental analysis (CIET and ENTOX, 1996; CIET, 1999).

3.3 LABORATORY METHODS

All plasma samples were received at the CIET laboratory under chain-of-custody by April 12, 2005. All extractions and analyses were conducted according to procedures detailed in CIET SOPs. Plasma samples were extracted in six batches. Chicken plasma was used for laboratory control samples in all analytical batches. In addition to the eagle plasma samples, each analytical batch contained a reagent blank, a chicken plasma matrix blank, a chicken plasma matrix spike, and a chicken plasma matrix spike duplicate.

Organochlorine pesticide and PCB concentrations were quantified by capillary gas chromatography with an electron capture detector using the United States Environmental

Protection Agency approved methods. All reported results were confirmed by dual column analysis. The QL for the organic compounds was 2 nanograms per gram (ng/g) (parts per billion) with the exception of toxaphene which had a QL of 125 ng/g. Method validation studies were conducted on chicken plasma as a surrogate matrix to ensure that the data quality objectives of the Quality Assurance Project Plan (CIET, 1996; 1999) were met. Average recoveries of 70-130% for matrix spikes were required under the Quality Assurance Project Plan (CIET, 1996; 1999). Correlation coefficients for calibration curves consisting of five concentrations of standards were at least >0.99 for all target analytes in all batches. The average detector response for the instrumental calibration checks was within 20% of the initial calibration for each batch. The average Relative Percent Difference for the spiked analytes in the chicken plasma matrix spike and chicken plasma matrix spike duplicate were less than 30% for all batches.

3.4 STATISTICAL DESIGN

For the purposes of reporting and statistical analysis of the 2003 data, and in keeping with reporting conventions in the scientific literature, the data were broadly grouped by breeding area location. At the broadest level, Great Lakes and inland breeding areas were compared. The breeding areas located on anadromous rivers were examined separately from other Great Lakes breeding areas for organic contaminants to better assess the concentrations that may be affecting bald eagle productivity along the Great Lakes. The Great Lakes-associated nests were evaluated further by lake basin (Superior, Michigan, Huron, and Erie). Inland breeding areas were also evaluated further by peninsula (inland Lower Peninsula and Upper Peninsula). Lastly, breeding areas were also grouped by watershed (HUC).

Contaminates were analyzed independently or grouped as follows: Total DDTs were analyzed as the sum of all DDT and DDT metabolites found. 4,4'-DDE was analyzed independently because of its pervasiveness in samples and history as an ecological factor. Total PCBs were examined as the sum of the 16 PCB congeners found. Heptachlor epoxide, α-Chlordane, and Dieldrin were all analyzed independently.

Statistical analyses were performed using nonparametric rank converted ANOVA tests. Nonparametric pair-wise comparisons, least square design, were used to determine where significant differences occurred within regions. Nonparametric statistics were employed as neither the assumptions of normality nor of linear regressions were met. All analyses were performed using the SAS Institute, Inc. (1999) statistical package. A probability level = 95% ($\alpha = 0.05$) was used to determine statistical significance.

SECTION 4.0

RESULTS AND DISCUSSION

4.1 REPRODUCTIVE SUCCESS

The reproductive productivity (i.e., the total number of fledged young per occupied nest) was calculated for bald eagles for all breeding areas in Michigan using the method of Postupalsky (1974). The following four comparisons were made of productivity for the 2003 breeding season (Table 1): (1) Statewide total for all nests; (2) Great Lakes and inland nests; (3) Great Lakes, anadromous, and inland nests; and (4) Lake Erie, Lake Huron, Lake Michigan, Lake Superior, and inland Upper and Lower Peninsulas. Breeding areas were classified as inland nests if they were >8.0 km from a Great Lakes shoreline and not situated along a river open to Great Lakes fish runs (i.e., anadromous). Great Lakes breeding areas were within 8.0 km of a Great Lakes shoreline and included those situated along anadromous rivers with the exception of comparison 3.

The productivity for bald eagles in the state of Michigan in 2003 was 0.86 young per occupied nest. Statewide eagle productivity has not been this low since the 1970s when statewide eagle productivity ranged from 0.66 in 1970 to 0.93 in 1979. The success rate (percent of nests producing at least one young) was 60.1%.

Based on the year 2003 aerial and ground surveys, there were 393 occupied nests in Michigan. Different category comparisons showed only slight differences among areas of the state (Table 1). Inland breeding area productivity (0.88) was not found to be significantly different from Great Lakes breeding area productivity (0.83) (F=0.35, P=0.5529). Inland (0.88), Great Lakes (0.79), and anadromous (1.05) breeding areas were also not found to be significantly different (F=1.12, P=0.3266). Breeding area productivities did not vary significantly by subpopulations (F=1.56, P=0.1706). Lake Superior had the greatest subpopulation productivity (1.02), followed by Lake Erie (1.00), the inland Upper Peninsula (0.90), Lake Huron (0.88), inland Lower Peninsula (0.86), and Lake Michigan (0.60). No differences were found for any category for success rate, with the exception of subpopulation. Multiple comparisons showed that success rate for Lake Erie (80%) was significantly greater than success rate for Lake Michigan (46.2%) (P=0.0249).

Caution must be used when using statewide productivity from only one year to determine the health of the Michigan bald eagle population. A number of factors, including weather, sample size, and which nests are occupied annually, can greatly affect this determination. Individual breeding area productivities can be affected by weather, adult turnover rates, and other factors including longevity and patterns of occupancy. Furthermore, the 1.0 young per occupied nest is a recovery goal (Grier et al., 1983), derived from an early modeling effort.

4.2 ORGANIC CONTAMINANTS IN NESTLING BALD EAGLE BLOOD SAMPLES

In 2003, 91 nestling bald eagle blood samples were analyzed for organochlorine contaminants. The target list of analytes included historical organochlorine pesticides such as chlordane, dieldrin, and DDT and its metabolic products, and 20 PCB congeners. The complete list of analytes and the parameter-specific Method Detection Levels and QLs are shown in Table 2. For statistical analysis, concentrations less than the QL were reported as one-half the QL (1.00 ng/g) and nondetects were set at zero.

Of the 91 samples analyzed, 23 were from breeding areas in the 2003 basin year watersheds. Regionally, the analyzed samples were from 27 inland Upper Peninsula, 12 inland Lower Peninsula, 21 Lake Superior, 12 Lake Michigan, 17 Lake Huron, and 1 Lake Erie breeding areas. The no-observable-adverse-effect levels (NOAELs) in blood of bald eagle nestlings for DDE and PCBs that are associated with a healthy bald eagle population (i.e., an average of one young per occupied nest) were determined using data from Bowerman et al., (2003). The NOAELs for DDE and PCBs in nestling blood are 11.4 ng/g and 36.4 ng/g, respectively.

4.21 DDT AND METABOLITES

Concentrations of 2,4'- and 4,4'-DDT and their metabolites, 2,4'- and 4,4'-DDE and 2,4'- and 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD), were measured in nestling bald eagle blood samples (Table 3). The most ubiquitous compound was 4,4'-DDE, which was detected in 85 (93%) of the samples. Statewide concentrations of 4,4'-DDE ranged from <1.0-191.8 ng/g. 2,4'-DDE and 4,4'-DDD were quantified in 3 (3%) and 6 (7%) of the samples, respectively. Concentrations of 2,4'-DDE ranged from <2.2-3.6 ng/g and concentrations of 4,4'-DDD ranged from <2.2-7.7 ng/g. 2,4'-DDD, 2,4'-DDT and 4,4'-DDT were not detected in any of the 2003 bald eagle plasma samples.

Total DDT concentrations were calculated as the sum of 2,4'- and 4,4'- DDE, and 4,4'-DDD. Of the metabolites, 4,4'-DDE contributed the most to the total DDT concentrations (Table 3). Total DDT concentrations in Great Lakes (n=47) and anadromous (n=5) breeding areas were greater than inland (n=37) breeding areas (Figure 2). Total DDT concentrations for Great Lakes and anadromous breeding areas pooled (n=52) were greater than inland breeding areas. Total DDT concentrations in Lake Michigan (n=11) breeding areas were greater than Lake Erie (n=1), inland Lower Peninsula (n=11), and inland Upper Peninsula (n=26) breeding areas (Figure 3).

Concentrations of 4,4'-DDE in Great Lakes (n=47) and anadromous (n=5) breeding areas were greater than inland (n=37) breeding areas (Figure 3). Concentrations of 4,4'-DDE for Great Lakes and anadromous breeding areas pooled (n=52) were greater than inland breeding areas. Concentrations of 4,4'-DDE in Lake Michigan (n=11) breeding areas were greater than inland Upper Peninsula (n=26), inland Lower Peninsula (n=11), and Lake Erie (n=1) breeding areas (Figure 3).

Five plasma samples from anadromous breeding areas were collected in 2003 (Table 3). Of the anadromous breeding areas, the nestling at Anderson Bayou in Newaygo County (NE-01j) had the greatest total DDT concentration (27.5 ng/g). The remaining anadromous sites sampled were Bootjack (HO-10, Houghton County), Sanford Lake (MD-01, Midland County), Santiago (AR-03, Arenac County), and Bridgeport (SG-05, Saginaw County) with concentrations of 15.6 ng/g, 9.5 ng/g, 3.4 ng/g, and 2.4 ng/g, respectively.

Geometric mean total DDT and 4,4'-DDE concentrations were ranked in the following order by location from highest to lowest: Lake Michigan > Lake Huron > Lake Superior > Lake Erie > inland Upper Peninsula > inland Lower Peninsula breeding areas.

The greatest total DDT concentration (191.8 ng/g) in an individual breeding area was measured in a nestling from Seney NWR D-1 Pool breeding area, which is located centrally in the Upper Peninsula in Schoolcraft County (SC-06) (Table 3). Two other breeding areas had high total DDT concentrations, one from the Lake Superior breeding area and one from the Lake Huron breeding area. Total DDT concentrations of 132.8 ng/g were found for the Lake Superior

Partridge Island breeding area (MQ-04) in Marquette County and 104.9 ng/g for the Lake Huron Caribou Lake breeding area (CP-29) in Chippewa County (Table 3).

Significant differences were also found for Great Lakes watersheds for total DDT and 4,4'-DDE. However post-hoc pair-wise analysis did not show any significant differences. This is probably due to loss of degrees of freedom related to a sample size of one for Lake Erie. Mean total DDT and 4,4'-DDE concentrations were ranked in the following order by Great Lakes watershed from highest to lowest: Lake Michigan (n=27) > Lake Huron (n=25) > Lake Superior (n=36) > Lake Erie (n=1) (Figure 4).

Significant differences in total DDT and 4,4'-DDE concentrations were found between basin watersheds also. Post-hoc pair-wise comparisons were not conducted for these 2003 data due to low sample size.

The NOAEL for 4,4'-DDE in the blood of nestling bald eagles was determined to be11.4 ng/g based on data presented in Bowerman et al., (2003). Of the 91 nestling plasma samples analyzed in 2003, 41 of the samples exceeded the NOAEL. It is therefore possible that once some of these nestlings reach breeding age, they may not be able to reproduce at a level considered to support a healthy population due to elevated concentrations of 4,4'-DDE. The finding that some nestlings have concentrations of 4,4'-DDE in their blood above the NOAEL, further stresses the importance of the long-term monitoring program to track fluctuations in annual bald eagle productivity within Michigan.

4.22 PCBs

Twenty PCB congeners were quantified and summed to determine total PCBs in nestling bald eagle plasma samples (Table 4). Of these 20 congeners, 16 were found in multiple eaglets and one (195) was found in only one eaglet. The latter congener was also at levels low enough to be considered unreliable with the current quantification techniques. The most ubiquitous congener was PCB congener 153, which was detected in 68 (75%) samples. Statewide concentrations of congener 153 ranged from <1.0-75.7 ng/g. Other notable congeners with greater than 50% detection, included congener 138 (66%), congener 118 (55%), and congener 180 (54%). Statewide ranges for the congeners with greater than 50% detection, included congener 138 (<1.0-58.6 ng/g), congener 118 (<1.0-22.8 ng/g), and congener 180 (<1.0-42.0 ng/g). PCB congeners 8, 18, and 28 were not detected in any plasma sample analyzed in year 2003.

Statewide total PCB concentrations ranged from nondetect to 259.3 ng/g (Table 4). At least one of the targeted PCB congeners was detected in 73 (80%) of the 91 nestlings sampled. Of the 17 nestlings in which no PCB congeners were detected, 16 were found in inland breeding areas and one was found in a Lake Superior breeding area. PCB congeners were detected in nestlings from inland, Great Lakes, and anadromous breeding areas (Table 4).

Total PCB concentrations were calculated as the sum of all PCB congeners (Table 4). Total PCB concentrations in Great Lakes (n=49) and anadromous (n=5) breeding areas were greater than inland (n=36) breeding areas (Figure 5). Total PCB concentrations for Great Lakes and anadromous breeding areas pooled (n=54) were greater than inland breeding areas. Total PCB concentrations for Lake Erie (n=1), Lake Michigan (n=12), and Lake Huron (n=17) breeding areas were greater than inland Upper Peninsula (n=27) and inland Lower Peninsula breeding areas (n=12; Figure 5).

Five plasma samples from anadromous breeding areas were collected in 2003 (Table 4). Of the anadromous breeding areas, the nestling at Santiago in Arenac County (AR-03) had the greatest total PCB concentration (49.79 ng/g). The remaining anadromous sites sampled were Anderson Bayou (NE-01j, Newaygo County), Sanford Lake (MD-01, Midland County), Bootjack (HO-10, Houghton County), and Bridgeport (SG-05, Saginaw County) with concentrations of 27.6 ng/g, 19.6 ng/g, 17.7 ng/g, and 12.6 ng/g, respectively.

Geometric mean PCB concentrations were ranked in the following order by location from highest to lowest: Lake Erie (n=1) > Lake Michigan (n=11) > Lake Huron (n=15) > Lake Superior (n=20) > inland Upper Peninsula (n=26) > inland Lower Peninsula (n=11) breeding areas.

The greatest total concentration of PCBs (259.3 ng/g) was found in Marquette County (MQ-04) on Partridge Island (Table 4). Partridge Island is located in Lake Superior approximately one-half mile offshore and is owned by Middle Island Point Association. An active gull rookery is located one mile southeast of the island on Middle Island. Judging from the prey remains in the nest, gulls made up the majority of this eaglet's diet. Two PCB congeners, 153 (75.75 ng/g) and 138 (58.56 ng/g), made up over 50% of the total PCB concentrations measured in the plasma of the Partridge Island eaglet. The remaining total PCB concentrations were from congeners 209 (2.19 ng/g), 66 (5.27 ng/g), 105 (7.05 ng/g), 128 (7.6 ng/g), 170 (16.02 ng/g), 118 (21.73 ng/g), 187 (23.05 ng/g), and 180 (42.01 ng/g). Eight other breeding areas had high total PCB concentrations (three Lake Huron breeding areas, two Lake Michigan breeding areas, two Lake Superior breeding areas, and one inland Upper Peninsula breeding area). Total PCB concentrations for the individual breeding areas were as follows: Lake Huron breeding areas - 102.1 ng/g, 158.7 ng/g, and 167.1 ng/g for Pt. Augres (AR-05, Arenac County), Devils Lake (AP-08, Alpena County), and Caribou Lake (CP-29, Chippewa County), respectively; Lake Michigan breeding areas - 110.8 ng/g and 114.0 ng/g for Vetorts Point (MM-23a, Menominee County) and Paradise Lake (ET-08b, Emmet County), respectively; Lake Superior breeding areas - 110.3 ng/g and 121.6 ng/g for Lake Kawbawgam (MQ-08, Marquette County) and Passage Island (KW-ISR, Isle Royale); and inland Upper Peninsula breeding area - 146.1 ng/g for Seney NWR D-1 Pool (SC-06, Schoolcraft County).

The NOAEL for total PCBs in the blood of nestling bald eagles was determined to be 36.4 ng/g based on data presented in Bowerman et al., (2003). Of the 91 nestling plasma samples analyzed in 2003, 30 of the samples exceeded the NOAEL. It is therefore possible that once some of these nestlings reach breeding age, they may not be able to reproduce at a level considered to support a healthy population due to elevated concentrations of PCBs. The finding that some nestlings have concentrations of PCBs in their blood above the NOAEL, further stresses the importance of the long-term monitoring program that is needed to track fluctuations in annual bald eagle productivity within Michigan.

No significant differences were found between Great Lake watersheds for total PCB concentrations (p=0.06). Geometric mean total PCB concentrations were ranked in the following order by Great Lakes watershed from highest to lowest: Lake Erie (n=1) > Lake Huron (n=25) > Lake Michigan (n=27) > Lake Superior (n=36) (Figure 6).

Significant differences in total PCB concentrations were also found between basin watersheds. Post-hoc pair-wise comparisons were not conducted for these 2003 data due to sample size issues.

4.23 Other Organics

The other organic contaminants that were analyzed in the 2003 nestling samples included: HCB, *α*-HCH, *γ*-HCH, heptachlor, heptachlor epoxide, *α*-chlordane, *γ*-chlordane, and dieldrin. Concentrations of *α*-HCH, *γ*-HCH, heptachlor, and *γ*-chlordane were not detected in any of the year 2003 samples. The analytical results for HCB, heptachlor epoxide, *α*-chlordane, and dieldrin are shown in Table 5.

Heptachlor epoxide was quantified in three Great Lakes samples and one inland sample. The three Great Lake samples were from Lake Superior breeding areas (MQ-04 Partridge Island, 1.6 ng/g; MQ-08 Lake Kawbawgam, 2.9 ng/g; and KW-ISR Passage Island, 1.0 ng/g). The inland sample was from a Lake Michigan breeding area (SC-04 Seney NWR C-2 Pool, 1.0 ng/g) (Table 5).

α-Chlordane was quantified in six samples ranging from 1.0-3.4 ng/g, with five of those samples from Great Lakes breeding areas and 1 sample from an anadromous breeding area. Five of the six Great Lakes samples were Lake Huron Breeding areas with the remaining one a Lake Superior breeding area. The greatest concentration of *α*-chlordane (3.4 ng/g) measured in any region was found in a nestling from the Pt. Augres breeding area (AR-05) in Arenac County (Table 5).

Due to small sample sizes, statistical analysis of heptachlor epoxide and α-chlordane were not possible.

Dieldrin was quantified in 27 samples ranging from 1.0-9.2 ng/g, with all but two samples coming from Great Lakes breeding areas. One sample was from a Lake Erie breeding area, seven samples were from Lake Huron breeding areas, eight samples were from Lake Michigan breeding areas, nine were from Lake Superior breeding areas, and the remaining two were from inland Upper Peninsula breeding areas. The greatest concentration of dieldrin (9.2 ng/g) was found in a nestling from the Lake Kawbawgam breeding area (MQ-08) in Marquette County (Table 5).

Statistical analysis for dieldrin was only possible between Great Lakes breeding areas (Figure 7). Rank converted ANOVA analysis showed a difference existed between the Great Lakes breeding areas. However, post-hoc pair-wise analysis showed no differences. This loss of significant difference is likely related to the loss of degrees of freedom related to a sample size of one for Lake Erie.

SECTION 5.0

FUTURE STUDIES

Several potential areas of future study were identified following the first five years of this monitoring study:

- Determine if it is possible to locate key sources of mercury contamination in bald eagles by modeling air releases.
- Conduct further investigations to determine the source of PCBs found in hotspots such as Lake Superior in northwest Marquette County.
- Examine contaminant data to assess the partitioning of contaminants between various media and biota.
- Analyze archived eagle samples to enhance our ability to assess trends.
- Analyze some of the blood samples for new and emerging chemicals of concern (a subset of the samples collected in 2003 will be analyzed for polybrominated diphenyl ethers).

SECTION 6.0

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SECTION 7.0

REFERENCES

Bortolotti, G.R. 1984a. Physical Development of Nestling Bald Eagles with Emphasis on the Timing of Growth Events. Wilson Bulletin 96:524-542.

Bortolotti, G.R. 1984b. Sexual Size Dimorphism and Age-Related Variation in Bald Eagles. J. Wildl. Manage. 48:72-81.

Bortolotti, G.R. 1984c. Criteria for Determining Age and Sex of Nestling Bald Eagles. J. Field Ornithol. 55:467-481.

Bowerman, W.W., D.A. Best, J.P. Giesy, M.C. Shieldcastle, M.W. Meyer, S. Postupalsky, and J.G. Sikarskie. 2003. Associations between Regional Differences in PCBs and DDE in Blood of Nestling Bald Eagles and Reproductive Productivity. Environ. Toxicol. Chem. 22:371-376.

Bowerman, W.W. and A.S. Roe. 2002. SOP. Nestling Bald Eagle Handling, Measuring, Blood, and Feather Collection. SOP No. 302-21-02. 7 pp.

CIET and Department of Environmental Toxicology (ENTOX). 1996. Quality Assurance Manual. Version Final 1.1. Clemson University, QA Manager, CIET, P.O. Box 709, Pendleton, SC 29670.

CIET. 1999. Quality Assurance Project Plan for CIET Project No. 9903: Bald Eagle Biosentinel Monitoring of Inland Watersheds, Connecting Channels, and Great Lakes Shorelines for Trends and Effects of Bioaccumulative Chemicals of Concern. October 21, 1999. 19 pp.

Grier, J.W., J.B. Elder, F.J. Gramlich, N.F. Green, J.B. Kussman, J.E Mathisen, and J.P. Mattsson. 1983. Northern States Bald Eagle Recovery Plan. USFWS, Washington, DC. 105 pp.

Henny, C.J. and D.L. Meeker. 1981. An Evaluation of Blood Plasma for Monitoring DDE in Birds of Prey. Environ. Pollut. (Series A) 25:291-304.

Henny, C.J., C.R. Griffin, D.W. Stahlecker, A.R. Harmata, and E. Cromartie. 1981. Low DDT Residues in Plasma of Bald Eagles (*Haliaeetus leucocephalus*) Wintering in Colorado and Missouri. Can. Field Naturalist 95:249-252.

MDEQ. 1997. A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters. Michigan Department of Environmental Quality. Staff Report #MI/DEQ/SWQ-96/152. January 1997.

MDEQ. 2002. Michigan Wildlife Contaminant Trend Monitoring. Year 1999 Annual Report Nestling Bald Eagles. Staff Report #MI/DEQ/SWQ-02/023.

MDEQ. 2003. Michigan Wildlife Contaminant Trend Monitoring. Year 2000 Annual Report Nestling Bald Eagles. Staff Report #MI/DEQ/WD-03/088.

MDEQ. 2004a. Michigan Wildlife Contaminant Trend Monitoring. Year 2001 Annual Report Nestling Bald Eagles. Staff Report #MI/DEQ/WD-04/012.

MDEQ. 2004b. Michigan Wildlife Contaminant Trend Monitoring. Year 2002 Annual Report. Nestling Bald Eagles. Staff Report #MI/DEQ/WD-04/024.

Morizot, D.C., R.G. Anthony, T.G. Grubb, S.W. Hoffman, M.E. Schmidt, and R.E. Ferrell. 1985. Clinical Genetic Variation at Enzyme Loci in Bald Eagles (Haliaeetus leucocephalus) from the Western United States. Biochem. Genet. 23(3-4):337-345.

Postupalsky, S. 1974. Raptor Reproductive Success: Some Problems with Methods, Criteria, and Terminology. In: Hamerstrom Jr., F.N., Harrell, B.E., Ohlendorff, R.R. (eds). Management of Raptors. Proceedings of Conference on Raptor Conservation Techniques, Raptor Research Report No. 2, pp. 21-31.

SAS Institute, Inc. 1999. SAS/STAT Release 8.00 Version. Cary, North Carolina.

Table 1. Productivity and success of bald eagles nesting in Michigan in 2003. Comparisons include: (1) Statewide; (2) Great Lakes (eagles nesting within 8.0 km of a Great Lake or along a river open to Great Lakes fish runs) vs. Inland; (3) Great Lakes (eagles nesting along the shoreline) vs. Anadromous (eagles nesting along a river) vs. Inland; and (4) Subpopulations of eagles nesting in the inland Upper Peninsula, inland Lower Peninsula, Lakes Superior, Michigan, Huron, and Erie.

Comparison	**N=**	**Productivity (Young/Occupied Nest)**	**Success (% Nests Producing Young)**
Statewide	393	0.86	60.1
Great Lakes	150	0.83	57.3 A
Inland	243	0.88	61.7 A
Great Lakes	128	0.79	54.7 A
Anadromous	243	1.05	72.7 A
Inland	22	0.88	61.7 A
Inland Upper Peninsula	111	0.9	64.9 AB
Inland Lower Peninsula	132	0.86	59.1 AB
Lake Superior	42	1.02	64.3 AB
Lake Michigan	52	0.6	46.2 B
Lake Huron	51	0.88	60.8 AB
Lake Erie	5	1	80.0 A

Same letters within a column are not significantly different from one another (P>0.05).

Table 2. Organochlorine contaminant analytes measured in nestling bald eagle blood samples in 2003, with parameter-specific Method Detection Levels (MDLs) and Quantification Levels (QLs).

Organochlorine Contaminant Analyte List	MDL	QL
Hexachlorobenzene	0.54	2.01
alpha -Hexachlorocyclohexane	1.94	2.01
gamma -Hexachlorocyclohexane (Lindane)	1.84	2.01
Heptachlor	1.74	2.00
Heptachlor Epoxide	0.77	2.00
alpha -Chlordane	0.75	2.01
gamma -Chlordane	0.55	2.01
Dieldrin	0.97	2.01
Toxaphene	---	125.0
2,4'-Dichlorodiphenyldichloroethylene (2,4'-DDE)	0.86	2.01
4,4'-DDE	0.61	2.01
2,4'-Dichlorodiphenyldichloroethane (2,4'-DDD)	1.55	2.01
4,4'-DDD	1.18	2.00
2,4'-Dichlorodiphenyltrichloroethane (2,4'-DDT)	1.57	2.01
4,4'-DDT	1.95	2.01
PCB Congener 8	1.94	1.98
PCB Congener 18	1.21	1.98
PCB Congener 28	1.23	1.99
PCB Congener 44	1.52	1.98
PCB Congener 52	0.64	1.98
PCB Congener 66	0.87	2.00
PCB Congener 101	0.38	2.00
PCB Congener 105	1.44	1.98
PCB Congener 110	1.91	2.01
PCB Congener 118	0.58	1.99
PCB Congener 128	0.75	1.99
PCB Congener 138	0.65	2.00
PCB Congener 153	0.57	1.99
PCB Congener 156	1.84	2.01
PCB Congener 170	1.28	1.98
PCB Congener 180	1.62	2.00
PCB Congener 187	1.12	1.98
PCB Congener 195	1.03	2.00
PCB Congener 206	1.19	1.98
PCB Congener 209	1.03	1.99

Table 3. Concentrations of DDE, DDD, and Total DDT compounds (ng/g wet weight (ppb)) in nestling bald eagle plasma samples analyzed in 2003. Breeding areas were located in either inland Lower Peninsula (LP), inland Upper Peninsula (UP), Lake Huron (LH), Lake Michigan (LM), or Lake Superior (LS) watersheds. Territories were associated with either inland (IN), Great Lakes (GL), or anadromous (AN) water bodies.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	2,4'-DDE	4,4'-DDE	4,4'-DDD	DDE + DDD
AG-08e	LS	GL	BAEA-MI-D-03-03	Autrain Lake	ND	2.3	ND	2.3
AG-09e	LS	GL	BAEA-MI-C-03-18	Trout Bay/Grand Island	ND	17.2	ND	17.2
AG16	LS	GL	BAEA-MI-A-03-57	Beaver Basin	ND	8.2	ND	8.2
AG17	LS	GL	BAEA-MI-A-03-59	Grand Sable Lake	ND	5.5	ND	5.5
AG-20	UP	IN	BAEA-MI-C-03-22	Hovey	ND	7.8	ND	7.8
AL-08c	LM	GL	BAEA-MI-C-03-04	Black River- Negwegon S	ND	38.1	ND	38.1
AP-08c	LH	GL	BAEA-MI-C-03-15	Devils Lake	ND	60.7	3.8	64.6
AR-03	LH	AN	BAEA-MI-C-03-02	Santiago	ND	11.6	1.0	12.6
AR-05	LH	GL	BAEA-MI-C-03-03	Pt AuGres	ND	21.3	1.0	22.3
BG04	LS	GL	BAEA-MI-A-03-46	Vou Zellans Camp	ND	20.0	ND	20.0
BG10	LS	GL	BAEA-MI-A-03-47	Huron Bay	ND	7.4	ND	7.4
BG11	LS	GL	BAEA-MI-A-03-45	Reeds Point	ND	11.2	ND	11.2
BG12	LS	GL	BAEA-MI-A-03-43	Pequaming	ND	18.2	ND	18.2
BG16	LS	GL	BAEA-MI-A-03-41	Keweenaw	ND	8.4	ND	8.4
BY-03	LH	GL	BAEA-MI-B-03-09	Nayanquing Point	ND	1.0	ND	1.0
CP-02e	LH	GL	BAEA-MI-D-03-05	Sugar Island south	ND	20.7	ND	20.7
CP29	LH	GL	BAEA-MI-A-03-60	Caribou Lake	ND	104.9	ND	104.9
CP-30a	LH	GL	BAEA-MI-D-03-04	Neebish Island	ND	17.4	ND	17.4
CR-04b	LP	IN	BAEA-MI-C-03-12	Chub Lake	ND	1.0	ND	1.0
DE-17	LM	GL	BAEA-MI-D-03-08	Fish Dam River	ND	19.9	ND	19.9
DE23	LM	GL	BAEA-MI-A-03-05	Escanaba River Gladstone	ND	31.3	ND	31.3
DE25	UP	IN	BAEA-MI-A-03-32	Honters Brook	ND	50.1	ND	50.1
DI11	UP	IN	BAEA-MI-A-03-52	Hardwood Impoundment	ND	22.6	ND	22.6
DI15	UP	IN	BAEA-MI-A-03-34	Blomqren Marsh	ND	4.1	ND	4.1
ET-05b	LM	GL	BAEA-MI-C-03-06	Wallon Lake	ND	18.8	ND	18.8
ET-06b	LM	GL	BAEA-MI-C-03-07	Paradise Lake	ND	38.8	ND	38.8
GO01	UP	IN	BAEA-MI-A-03-38	Langford Lake	ND	3.9	ND	3.9
GO03	UP	IN	BAEA-MI-A-03-14	Gsco Lake East	ND	ND	ND	ND
GO05	UP	IN	BAEA-MI-A-03-20	Thousand Island Lake	ND	ND	ND	ND
GO-06d	UP	IN	BAEA-MI-A-03-25	Lake Mamie Belle	ND	6.1	ND	6.1
GO08	UP	IN	BAEA-MI-A-03-40	Bass Lake	ND	5.8	ND	5.8
GO15	UP	IN	BAEA-MI-A-03-53	Beatons Lake	ND	9.5	ND	9.5
GO18	UP	IN	BAEA-MI-A-03-23	Montogomery Creek	ND	2.7	ND	2.7
GO22	UP	IN	BAEA-MI-A-03-12	Pomeroy	ND	1.0	ND	1.0
GO26	UP	IN	BAEA-MI-A-03-08	Mill Lake	ND	ND	ND	ND
GO27	UP	IN	BAEA-MI-A-03-06	Morrison Creek	ND	1.0	ND	1.0
GO35	UP	IN	BAEA-MI-A-03-19	White Fish Lake	ND	1.0	ND	1.0
GO36	UP	IN	BAEA-MI-A-03-01	West Bay Lake	ND	5.3	ND	5.3
GO37	MS	IN	BAEA-MI-A-03-39	Big Bateau Lake	ND	19.8	ND	19.8
GO38	LS	GL	BAEA-MI-A-03-61	Black River Park	ND	11.1	ND	11.1
GO45	UP	IN	BAEA-MI-A-03-54	Watersmeet	ND	3.2	ND	3.2
GO46	UP	IN	BAEA-MI-A-03-22	State Line Lake	ND	ND	ND	ND
GT-02b	LP	IN	BAEA-MI-C-03-05	Brown Bridge Pond	ND	40.2	ND	40.2
HO10	LS	AN	BAEA-MI-A-03-50	Bootjack	ND	10.6	ND	10.6
HO16	LS	GL	BAEA-MI-A-03-49	Portage Canal	ND	15.6	ND	15.6

Table 3. cont.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	2,4'-DDE	4,4'-DDE	4,4'-DDD	DDE + DDD
IO-11B	LH	GL	BAEA-MI-B-03-08	Solitude Lake	ND	14.6	ND	14.6
IR20	UP	IN	BAEA-MI-A-03-17	Iron Lake	ND	10.3	ND	10.3
IR33	UP	IN	BAEA-MI-A-03-15	Buck Lake/Armstrong Lake	ND	1.0	ND	1.0
IR43	UP	IN	BAEA-MI-A-03-35	Stager Lake	ND	1.0	ND	1.0
KA-02	LP	IN	BAEA-MI-C-03-08	Lake Skegemog	ND	7.5	ND	7.5
KW01	LS	GL	BAEA-MI-A-03-55	Gratiot lake	ND	3.4	ND	3.4
KW03	LS	GL	BAEA-MI-A-03-56	Betsy/Burnette Park	ND	16.0	ND	16.0
KW-ISRO	LS	GL	BAEA-MI-C-03-42	Hay PT.	ND	10.3	ND	10.3
KW-ISRO	LS	GL	BAEA-MI-C-03-44	Chippewa harbor	ND	13.2	ND	13.2
KW-ISRO	LS	GL	BAEA-MI-C-03-45	Passage Island	ND	53.9	ND	53.9
LL-07c	LM	GL	BAEA-MI-C-03-14	Cat Head Bay	ND	20.3	ND	20.3
LL-09	UP	IN	BAEA-MI-C-03-13	Lake Leelanaw	ND	9.8	ND	9.8
MC-22a	LH	GL	BAEA-MI-C-03-20	Brulee PT	ND	27.3	ND	27.3
MD-01	LH	AN	BAEA-MI-B-03-01	Sanford Lake	ND	16.1	5.5	21.6
ML-01	LP	IN	BAEA-MI-B-03-06	Stanford	ND	18.7	3.5	22.2
MM07	UP	IN	BAEA-MI-A-03-33	Hermansville Pond	2.2	68.6	ND	70.9
MM-23a	LM	GL	BAEA-MI-A-03-04	Vetorts Point	3.6	41.0	ND	44.5
MQ04	LS	GL	BAEA-MI-A-03-27	Partridge Island	2.8	130.1	ND	132.8
MQ-08	LS	GL	BAEA-MI-C-03-21	L Kawbawbam	ND	46.7	ND	46.7
MQ09	UP	IN	BAEA-MI-A-03-31	Deer Lake	ND	1.0	ND	1.0
MQ15	LS	GL	BAEA-MI-A-03-29	Saux Head	ND	11.2	ND	11.2
MS-05	LM	GL	BAEA-MI-B-03-02	Walhalla East	ND	37.9	ND	37.9
MS-06	LM	GL	BAEA-MI-B-03-05	Walhalla West	ND	6.1	ND	6.1
NE-01J	LM	AN	BAEA-MI-C-03-01	Anderson Bayou	ND	27.5	ND	27.5
ON03	UP	IN	BAEA-MI-A-03-10	Interior	ND	ND	ND	ND
ON20	LS	GL	BAEA-MI-A-03-37	Carp River/Laudlookers Creek	ND	6.8	ND	6.8
OS-01	LP	IN	BAEA-MI-C-03-11	Reed Ranch	ND	6.6	ND	6.6
OS-08a	LP	IN	BAEA-MI-C-03-10	Mio Pond East	ND	2.2	ND	2.2
PI-09A	LH	GL	BAEA-MI-B-03-11	Lake Augusta	ND	16.1	ND	16.1
PI-10B	LH	GL	BAEA-MI-B-03-10	Hoeft Park	ND	11.0	ND	11.0
RO-11C	LP	IN	BAEA-MI-B-03-12	Woods/Twin Lake	ND	2.2	ND	2.2
RO-13b	LP	IN	BAEA-MI-C-03-09	Prudenville	ND	2.4	ND	2.4
SC-04	UP	IN	BAEA-MI-D-03-07	Seney C-2 Pool	ND	93.1	ND	93.1
SC-20	UP	IN	BAEA-MI-D-03-06	Seney D-1 Pool	ND	191.8	ND	191.8
SG-05	LP	AN	BAEA-MI-B-03-07	Bridgeport	ND	5.7	1.0	6.7
WX-02	LP	GL	BAEA-MI-D-03-01	Lake Mitchell	ND	10.7	ND	10.7
NA	LP	IN	BAEA-MI-B-03-13	NA	ND	2.6	ND	2.6
NA	LM	GL	BAEA-MI-C-03-16	NA	ND	19.5	ND	19.5
NA	LM	GL	BAEA-MI-C-03-19	NA	ND	23.7	ND	23.7
NA	LH	GL	BAEA-MI-D-03-02	NA	ND	22.9	ND	22.9
NA	LH	GL	BAEA-MI-E-03-01	NA	ND	15.2	7.7	23.0
NA	LH	GL	BAEA-MI-E-03-02	NA	ND	5.0	ND	5.0
NA	LE	GL	BAEA-MI-E-03-03	NA	ND	5.0	2.2	7.2
NA	LH	GL	BAEA-MI-E-03-04	NA	ND	14.5	1.0	15.5
NA	LH	GL	BAEA-MI-E-03-05	NA	ND	5.3	3.3	8.6
NA	LP	GL	BAEA-MI-E-03-06	NA	ND	ND	ND	ND

Table 4. Concentrations of individual PCB congeners and Total PCBs (ng/g wet weight (ppb)) in nestling bald eagle plasma samples analyzed in 2003. Breeding areas were located in either inland Lower Peninsula (LP), inland Upper Peninsula (UP), Lake Huron (LH), Lake Michigan (LM), or Lake Superior (LS) watersheds. Territories were associated with either inland (IN), Great Lakes (GL), or anadromous (AN) water bodies.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	# 52	# 44	# 66	# 101	# 110	# 118	# 153	# 105	# 138	# 187	# 128	# 156	# 180	# 170	# 195	# 206	# 209	Total PCBs
AG-08e	LS	GL	BAEA-MI-D-03-03	Autrain Lake	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
AG-09e	LS	GL	BAEA-MI-C-03-18	Trout Bay/Grand Island	ND	ND	ND	ND	ND	3.5	10.0	ND	9.2	2.7	ND	ND	5.3	ND	ND	ND	ND	30.7
AG16	LS	GL	BAEA-MI-A-03-57	Beaver Basin	ND	ND	ND	ND	ND	1.0	6.3	ND	5.6	ND	ND	ND	1.0	ND	ND	ND	ND	13.9
AG17	LS	GL	BAEA-MI-A-03-59	Grand Sable Lake	ND	ND	ND	ND	ND	ND	1.0	ND	2.7	ND	ND	ND	ND	ND	ND	ND	ND	3.7
AG-20	UP	IN	BAEA-MI-C-03-22	Hovey	ND	ND	ND	ND	ND	1.0	ND	ND	5.0	ND	ND	ND	3.9	ND	ND	ND	ND	9.9
AL-08c	LM	GL	BAEA-MI-C-03-04	Black River- Negwegon S	ND	ND	2.3	4.2	2.1	10.7	10.4	ND	10.1	9.1	1.0	ND	15.3	5.8	ND	ND	ND	71.0
AP-08c	LH	GL	BAEA-MI-C-03-15	Devils Lake	ND	ND	8.3	18.4	ND	20.1	33.2	7.6	29.0	12.7	4.3	ND	18.0	7.0	ND	ND	ND	158.7
AR-03	LH	AN	BAEA-MI-C-03-02	Santiago	ND	ND	5.6	6.9	4.3	10.1	9.2	ND	10.7	3.0	ND	ND	ND	ND	ND	ND	ND	49.8
AR-05	LH	GL	BAEA-MI-C-03-03	Pt AuGres	ND	2.1	8.0	9.2	5.2	13.8	18.5	ND	18.8	7.9	ND	ND	11.9	4.6	ND	1.0	1.0	102.1
BG04	LS	GL	BAEA-MI-A-03-46	Vou Zellans Camp	ND	ND	ND	2.1	ND	1.0	19.1	ND	16.2	ND	ND	ND	10.3	1.0	ND	ND	ND	49.8
BG10	LS	GL	BAEA-MI-A-03-47	Huron Bay	ND	ND	ND	ND	ND	ND	5.9	ND	5.2	ND	ND	ND	2.1	ND	ND	ND	ND	13.1
BG11	LS	GL	BAEA-MI-A-03-45	Reeds Point	ND	ND	ND	ND	ND	1.0	10.6	ND	9.3	1.0	ND	ND	5.2	ND	ND	ND	ND	27.0
BG12	LS	GL	BAEA-MI-A-03-43	Pequaming	ND	ND	ND	1.0	ND	ND	14.5	ND	13.0	ND	1.0	ND	6.9	2.3	ND	ND	ND	38.7
BG16	LS	GL	BAEA-MI-A-03-41	Keweenaw	ND	ND	ND	ND	ND	1.0	7.3	ND	6.5	ND	ND	ND	3.5	ND	ND	ND	ND	18.3
BY-03	LH	GL	BAEA-MI-B-03-09	Nayanquing Point	ND	ND	ND	1.0	ND	1.0	1.0	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	4.0
CP-02e	LH	GL	BAEA-MI-D-03-05	Sugar Island south	ND	ND	1.0	2.4	ND	6.6	17.5	1.0	10.8	5.0	ND	ND	11.9	2.8	ND	ND	ND	58.9
CP29	LH	GL	BAEA-MI-A-03-60	Caribou Lake	ND	ND	7.9	8.3	ND	22.8	51.2	0.0	ND	19.0	7.6	3.2	33.4	11.8	ND	2.0	ND	167.1
CP-30a	LH	GL	BAEA-MI-D-03-04	Neebish Island	ND	ND	ND	2.7	ND	7.7	27.0	2.2	16.4	8.3	2.1	ND	16.0	5.1	ND	ND	ND	87.5
CR-04b	LP	IN	BAEA-MI-C-03-12	Chub Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DE-17	LM	GL	BAEA-MI-D-03-08	Fish Dam River	ND	1.0	ND	4.2	ND	6.9	11.6	ND	9.5	2.5	ND	ND	4.8	ND	ND	ND	ND	40.4
DE23	LM	GL	BAEA-MI-A-03-05	Escanaba River Gladstone	ND	ND	ND	ND	ND	ND	4.6	ND	4.4	ND	ND	ND	ND	ND	ND	ND	ND	9.0
DE25	UP	IN	BAEA-MI-A-03-32	Honters Brook	ND	ND	1.0	ND	ND	1.0	11.8	ND	ND	2.3	ND	ND	4.7	ND	ND	ND	ND	20.8
DI11	UP	IN	BAEA-MI-A-03-52	Hardwood Impoundment	ND	ND	ND	ND	ND	1.0	5.5	ND	4.2	ND	ND	ND	3.0	ND	ND	ND	ND	13.7
DI15	UP	IN	BAEA-MI-A-03-34	Blomqren Marsh	ND	ND	ND	ND	ND	1.0	2.6	ND	2.0	ND	ND	ND	ND	ND	ND	ND	ND	5.6
ET-05b	LM	GL	BAEA-MI-C-03-06	Wallon Lake	ND	ND	ND	1.0	ND	2.7	7.9	ND	8.0	1.0	ND	ND	4.3	ND	ND	ND	ND	24.9
ET-06b	LM	GL	BAEA-MI-C-03-07	Paradise Lake	ND	ND	ND	ND	ND	11.3	37.9	ND	24.8	12.4	2.7	ND	18.8	6.2	ND	ND	ND	114.0
GO01	UP	IN	BAEA-MI-A-03-38	Langford Lake	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
GO03	UP	IN	BAEA-MI-A-03-14	Gsco Lake East	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO05	UP	IN	BAEA-MI-A-03-20	Thousand Island Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO-06d	UP	IN	BAEA-MI-A-03-25	Lake Mamie Belle	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO08	UP	IN	BAEA-MI-A-03-40	Bass Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO15	UP	IN	BAEA-MI-A-03-53	Beatons Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO18	UP	IN	BAEA-MI-A-03-23	Montogomery Creek	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO22	UP	IN	BAEA-MI-A-03-12	Pomeroy	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO26	UP	IN	BAEA-MI-A-03-08	Mill Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO27	UP	IN	BAEA-MI-A-03-06	Morrison Creek	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO35	UP	IN	BAEA-MI-A-03-19	White Fish Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GO36	UP	IN	BAEA-MI-A-03-01	West Bay Lake	ND	ND	ND	ND	ND	ND	3.0	ND	2.2	ND	ND	ND	ND	ND	ND	ND	ND	5.3
GO37	MS	IN	BAEA-MI-A-03-39	Big Bateau Lake	ND	ND	ND	ND	ND	2.0	5.9	ND	4.9	ND	ND	ND	ND	ND	ND	ND	ND	12.8
GO38	LS	GL	BAEA-MI-A-03-61	Black River Park	ND	ND	ND	ND	ND	ND	8.0	ND	ND	ND	ND	ND	4.6	ND	ND	ND	ND	12.6
GO45	UP	IN	BAEA-MI-A-03-54	Watersmeet	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
GO46	UP	IN	BAEA-MI-A-03-22	State Line Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GT-02b	LP	IN	BAEA-MI-C-03-05	Brown Bridge Pond	ND	ND	ND	ND	ND	9.8	19.1	3.5	14.2	5.6	1.0	ND	9.2	3.5	ND	ND	ND	65.9
HO10	LS	AN	BAEA-MI-A-03-50	Bootjack	ND	ND	ND	1.0	ND	1.0	5.9	ND	6.8	ND	ND	ND	2.9	ND	ND	ND	ND	17.6
HO16	LS	GL	BAEA-MI-A-03-49	Portage Canal	ND	ND	ND	ND	ND	4.7	12.6	ND	12.2	ND	ND	ND	7.5	1.0	ND	ND	ND	38.1
IO-11B	LH	GL	BAEA-MI-B-03-08	Solitude Lake	ND	ND	1.0	3.0	ND	5.8	1.0	2.2	13.9	9.3	ND	ND	22.1	6.4	ND	2.1	ND	66.9
IR20	UP	IN	BAEA-MI-A-03-17	Iron Lake	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0

Table 4. cont.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	# 52	# 44	# 66	# 101	# 110	# 118	# 153	# 105	# 138	# 187	# 128	# 156	# 180	# 170	# 195	# 206	# 209	Total PCBs
IR33	UP	IN	BAEA-MI-A-03-15	Buck Lake/Armstrong Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
IR43	UP	IN	BAEA-MI-A-03-35	Stager Lake	ND	ND	ND	ND	ND	ND	3.9	ND	3.1	ND	ND	ND	ND	ND	ND	ND	ND	6.9
KA-02	LP	IN	BAEA-MI-C-03-08	Lake Skegemog	ND	ND	1.0	ND	ND	2.9	5.4	ND	3.4	ND	ND	ND	2.4	ND	ND	ND	ND	15.1
KW01	LS	GL	BAEA-MI-A-03-55	Gratiot lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
KW03	LS	GL	BAEA-MI-A-03-56	Betsy/Burnette Park	ND	ND	ND	2.5	ND	3.2	10.4	ND	11.5	ND	ND	ND	4.3	ND	ND	ND	ND	31.9
KW-ISRO	LS	GL	BAEA-MI-C-03-42	Hay PT.	ND	ND	ND	ND	ND	2.9	10.1	ND	7.7	1.0	ND	ND	6.9	ND	ND	ND	ND	28.5
KW-ISRO	LS	GL	BAEA-MI-C-03-44	Chippewa harbor	ND	ND	ND	ND	ND	1.0	7.3	ND	6.4	ND	ND	ND	ND	ND	ND	ND	ND	14.7
KW-ISRO	LS	GL	BAEA-MI-C-03-45	Passage Island	ND	ND	1.0	3.3	ND	12.5	35.3	ND	30.0	9.6	4.5	ND	19.4	5.9	ND	ND	ND	121.6
LL-07c	LM	GL	BAEA-MI-C-03-14	Cat Head Bay	ND	ND	ND	3.0	ND	2.9	8.7	ND	8.6	1.0	ND	ND	4.5	ND	ND	ND	ND	28.8
LL-09	UP	IN	BAEA-MI-C-03-13	Lake Leelanaw	ND	ND	ND	ND	ND	ND	3.5	ND	3.2	ND	ND	ND	ND	ND	ND	ND	ND	6.6
MC-22a	LH	GL	BAEA-MI-C-03-20	Brulee PT	ND	ND	3.5	5.7	ND	9.6	15.4	2.4	14.0	6.0	1.0	ND	9.6	2.9	ND	ND	ND	70.1
MD-01	LH	AN	BAEA-MI-B-03-01	Sanford Lake	ND	ND	ND	ND	ND	3.2	6.4	ND	7.1	ND	ND	ND	3.0	ND	ND	ND	ND	19.6
ML-01	LP	IN	BAEA-MI-B-03-06	Stanford	ND	ND	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	1.0
MM07	UP	IN	BAEA-MI-A-03-33	Hermansville Pond	4.1	5.4	8.0	4.8	ND	6.9	18.4	3.1	15.3	3.3	ND	ND	6.4	1.0	ND	ND	ND	76.7
MM-23a	LM	GL	BAEA-MI-A-03-04	Vetorts Point	2.5	7.5	12.5	9.7	3.3	11.8	19.8	4.8	22.3	5.5	1.0	ND	7.7	2.5	ND	ND	ND	110.8
MQ04	LS	GL	BAEA-MI-A-03-27	Partridge Island	ND	ND	5.3	ND	ND	21.7	75.7	7.1	58.6	23.1	7.6	ND	42.0	16.1	ND	ND	2.2	259.3
MQ-08	LS	GL	BAEA-MI-C-03-21	L Kawbawbam	ND	ND	ND	4.7	ND	8.3	29.4	ND	27.2	12.0	4.8	ND	17.8	6.0	ND	ND	ND	110.3
MQ09	UP	IN	BAEA-MI-A-03-31	Deer Lake	ND	ND	ND	ND	ND	ND	3.9	ND	ND	ND	ND	ND	2.6	ND	ND	ND	ND	6.5
MQ15	LS	GL	BAEA-MI-A-03-29	Saux Head	ND	ND	ND	ND	ND	1.0	13.8	ND	8.0	2.3	ND	ND	7.0	ND	ND	ND	ND	32.1
MS-05	LM	GL	BAEA-MI-B-03-02	Walhalla East	ND	ND	3.3	5.8	4.1	ND	14.5	4.2	ND	ND	ND	ND	6.7	1.0	ND	ND	ND	39.5
MS-06	LM	GL	BAEA-MI-B-03-05	Walhalla West	ND	ND	3.0	ND	ND	ND	13.6	ND	14.9	ND	1.0	ND	5.7	1.0	ND	ND	ND	39.2
NE-01J	LM	AN	BAEA-MI-C-03-01	Anderson Bayou	ND	ND	ND	3.1	ND	3.0	8.6	ND	9.1	ND	ND	ND	3.7	ND	ND	ND	ND	27.6
ON03	UP	IN	BAEA-MI-A-03-10	Interior	ND	ND	ND	ND	ND	ND	0.0	ND	ND	ND	ND	ND	0.0	ND	ND	ND	ND	0.0
ON20	LS	GL	BAEA-MI-A-03-37	Carp River/Laudlookers Creek	ND	ND	ND	ND	ND	ND	5.2	ND	4.8	ND	ND	ND	3.2	ND	ND	ND	ND	13.2
OS-01	LP	IN	BAEA-MI-C-03-11	Reed Ranch	ND	ND	ND	ND	ND	3.2	4.5	ND	2.6	ND	ND	ND	ND	ND	ND	ND	ND	10.3
OS-08a	LP	IN	BAEA-MI-C-03-10	Mio Pond East	ND	ND	ND	ND	ND	ND	0.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
PI-09A	LH	GL	BAEA-MI-B-03-11	Lake Augusta	ND	ND	ND	2.2	ND	3.9	1.0	ND	7.4	ND	ND	ND	2.6	ND	1.0	ND	ND	18.3
PI-10B	LH	GL	BAEA-MI-B-03-10	Hoeft Park	ND	ND	ND	ND	ND	1.0	ND	ND	5.6	ND	ND	ND	ND	ND	ND	ND	ND	6.6
RO-11C	LP	IN	BAEA-MI-B-03-12	Woods/Twin Lake	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
RO-13b	LP	IN	BAEA-MI-C-03-09	Prudenville	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
SC-04	UP	IN	BAEA-MI-D-03-07	Seney C-2 Pool	ND	ND	ND	1.0	ND	6.6	16.3	ND	11.8	2.7	ND	ND	6.1	1.0	ND	ND	ND	45.4
SC-20	UP	IN	BAEA-MI-D-03-06	Seney D-1 Pool	ND	ND	ND	ND	ND	15.4	48.8	ND	29.0	12.6	4.0	2.6	24.8	9.0	ND	ND	ND	146.1
SG-05	LP	AN	BAEA-MI-B-03-07	Bridgeport	ND	ND	1.0	2.7	ND	ND	4.0	ND	4.9	ND	ND	ND	ND	ND	ND	ND	ND	12.6
WX-02	LP	GL	BAEA-MI-D-03-01	Lake Mitchell	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
NA	LP	IN	BAEA-MI-B-03-13	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0
NA	LM	GL	BAEA-MI-C-03-16	NA	ND	ND	ND	2.3	ND	4.8	11.8	ND	10.4	3.7	ND	ND	6.4	1.0	ND	ND	ND	40.3
NA	LM	GL	BAEA-MI-C-03-19	NA	ND	ND	2.5	4.8	ND	6.9	12.7	ND	12.2	4.4	1.0	ND	8.2	1.0	ND	ND	ND	53.8
NA	LH	GL	BAEA-MI-D-03-02	NA	ND	ND	1.0	6.0	ND	6.9	10.8	ND	10.7	2.0	ND	ND	4.8	ND	ND	ND	ND	42.3
NA	LH	GL	BAEA-MI-E-03-01	NA	3.4	4.4	5.0	6.9	3.2	7.7	12.3	ND	11.5	4.0	ND	ND	6.1	1.0	ND	ND	ND	65.4
NA	LH	GL	BAEA-MI-E-03-02	NA	ND	ND	ND	1.0	ND	1.0	2.7	ND	3.4	ND	ND	ND	0.0	ND	ND	ND	ND	8.0
NA	LE	GL	BAEA-MI-E-03-03	NA	6.2	7.7	6.5	5.4	4.5	2.5	9.3	ND	8.2	2.1	ND	ND	4.3	ND	ND	ND	ND	56.6
NA	LH	GL	BAEA-MI-E-03-04	NA	ND	ND	3.7	ND	ND	8.1	11.2	ND	10.0	3.7	ND	ND	4.7	1.0	ND	ND	ND	42.4
NA	LH	GL	BAEA-MI-E-03-05	NA	ND	ND	ND	3.6	ND	2.3	3.0	ND	4.2	ND	ND	ND	ND	ND	ND	ND	ND	13.1
NA	LP	GL	BAEA-MI-E-03-06	NA	ND	ND	ND	ND	ND	ND	2.7	ND	3.2	ND	ND	ND	ND	ND	ND	ND	ND	5.9

Table 5. Concentrations of individual organochlorine compounds (ng/g wet weight (ppb)) in nestling bald eagle plasma samples analyzed in 2003. Breeding areas were located in either inland Lower Peninsula (LP), inland Upper Peninsula (UP), Lake Huron (LH), Lake Michigan (LM), or Lake Superior (LS) watersheds. Territories were associated with either inland (IN), Great Lakes (GL), or anadromous (AN) water bodies.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	HCB	Heptachlor epoxide	a-Chlordane	Dieldrin
AG-08e	LS	GL	BAEA-MI-D-03-03	Autrain Lake	ND	ND	ND	1.0
AG-09e	LS	GL	BAEA-MI-C-03-18	Trout Bay/Grand Island	ND	ND	ND	3.7
AG16	LS	GL	BAEA-MI-A-03-57	Beaver Basin	ND	ND	ND	ND
AG17	LS	GL	BAEA-MI-A-03-59	Grand Sable Lake	ND	ND	ND	ND
AG-20	UP	IN	BAEA-MI-C-03-22	Hovey	ND	ND	ND	ND
AL-08c	LM	GL	BAEA-MI-C-03-04	Black River- Negwegon S	ND	ND	ND	3.6
AP-08c	LH	GL	BAEA-MI-C-03-15	Devils Lake	ND	ND	3.4	1.0
AR-03	LH	AN	BAEA-MI-C-03-02	Santiago	ND	ND	1.0	ND
AR-05	LH	GL	BAEA-MI-C-03-03	Pt AuGres	ND	ND	1.0	ND
BG04	LS	GL	BAEA-MI-A-03-46	Vou Zellans Camp	ND	ND	ND	ND
BG10	LS	GL	BAEA-MI-A-03-47	Huron Bay	ND	ND	ND	ND
BG11	LS	GL	BAEA-MI-A-03-45	Reeds Point	ND	ND	ND	ND
BG12	LS	GL	BAEA-MI-A-03-43	Pequaming	ND	ND	ND	ND
BG16	LS	GL	BAEA-MI-A-03-41	Keweenaw	ND	ND	ND	ND
BY-03	LH	GL	BAEA-MI-B-03-09	Nayanquing Point	ND	ND	ND	ND
CP-02e	LH	GL	BAEA-MI-D-03-05	Sugar Island south	ND	ND	ND	2.1
CP29	LH	GL	BAEA-MI-A-03-60	Caribou Lake	ND	ND	1.0	3.7
CP-30a	LH	GL	BAEA-MI-D-03-04	Neebish Island	ND	ND	ND	1.0
CR-04b	LP	IN	BAEA-MI-C-03-12	Chub Lake	ND	ND	ND	ND
DE-17	LM	GL	BAEA-MI-D-03-08	Fish Dam River	ND	ND	ND	1.0
DE23	LM	GL	BAEA-MI-A-03-05	Escanaba River Gladstone	ND	ND	ND	ND
DE25	UP	IN	BAEA-MI-A-03-32	Honters Brook	ND	ND	ND	ND
DI11	UP	IN	BAEA-MI-A-03-52	Hardwood Impoundment	ND	ND	ND	ND
DI15	UP	IN	BAEA-MI-A-03-34	Blomqren Marsh	ND	ND	ND	ND
ET-05b	LM	GL	BAEA-MI-C-03-06	Wallon Lake	ND	ND	ND	ND
ET-06b	LM	GL	BAEA-MI-C-03-07	Paradise Lake	ND	ND	ND	ND
GO01	UP	IN	BAEA-MI-A-03-38	Langford Lake	ND	ND	ND	ND
GO03	UP	IN	BAEA-MI-A-03-14	Gsco Lake East	ND	ND	ND	ND
GO05	UP	IN	BAEA-MI-A-03-20	Thousand Island Lake	ND	ND	ND	ND
GO-06d	UP	IN	BAEA-MI-A-03-25	Lake Mamie Belle	ND	ND	ND	ND
GO08	UP	IN	BAEA-MI-A-03-40	Bass Lake	ND	ND	ND	ND
GO15	UP	IN	BAEA-MI-A-03-53	Beatons Lake	ND	ND	ND	ND
GO18	UP	IN	BAEA-MI-A-03-23	Montogomery Creek	ND	ND	ND	ND
GO22	UP	IN	BAEA-MI-A-03-12	Pomeroy	ND	ND	ND	ND
GO26	UP	IN	BAEA-MI-A-03-08	Mill Lake	ND	ND	ND	ND
GO27	UP	IN	BAEA-MI-A-03-06	Morrison Creek	ND	ND	ND	ND
GO35	UP	IN	BAEA-MI-A-03-19	White Fish Lake	ND	ND	ND	ND
GO36	UP	IN	BAEA-MI-A-03-01	West Bay Lake	ND	ND	ND	ND
GO37	MS	IN	BAEA-MI-A-03-39	Big Bateau Lake	ND	ND	ND	ND
GO38	LS	GL	BAEA-MI-A-03-61	Black River Park	ND	ND	ND	ND
GO45	UP	IN	BAEA-MI-A-03-54	Watersmeet	ND	ND	ND	ND
GO46	UP	IN	BAEA-MI-A-03-22	State Line Lake	ND	ND	ND	ND
GT-02b	LP	IN	BAEA-MI-C-03-05	Brown Bridge Pond	ND	ND	ND	ND
HO10	LS	AN	BAEA-MI-A-03-50	Bootjack	ND	ND	ND	ND
HO16	LS	GL	BAEA-MI-A-03-49	Portage Canal	ND	ND	ND	ND
IO-11B	LH	GL	BAEA-MI-B-03-08	Solitude Lake	ND	ND	ND	ND
IR20	UP	IN	BAEA-MI-A-03-17	Iron Lake	ND	ND	ND	ND

Table 5. Continued.

Territory	Breeding Area Location	Territory Location	Blood Sample Number	Breeding Area Name	HCB	Heptachlor epoxide	a-Chlordane	Dieldrin
IR33	UP	IN	BAEA-MI-A-03-15	Buck Lake/Armstrong Lake	ND	ND	ND	ND
IR43	UP	IN	BAEA-MI-A-03-35	Stager Lake	ND	ND	ND	ND
KA-02	LP	IN	BAEA-MI-C-03-08	Lake Skegemog	ND	ND	ND	ND
KW01	LS	GL	BAEA-MI-A-03-55	Gratiot lake	ND	ND	ND	ND
KW03	LS	GL	BAEA-MI-A-03-56	Betsy/Burnette Park	ND	ND	ND	1.0
KW-ISRO	LS	GL	BAEA-MI-C-03-42	Hay PT.	ND	ND	ND	2.3
KW-ISRO	LS	GL	BAEA-MI-C-03-44	Chippewa harbor	ND	ND	ND	1.0
KW-ISRO	LS	GL	BAEA-MI-C-03-45	Passage Island	ND	1.0	ND	4.2
LL-07c	LM	GL	BAEA-MI-C-03-14	Cat Head Bay	ND	ND	ND	2.2
LL-09	UP	IN	BAEA-MI-C-03-13	Lake Leelanaw	ND	ND	ND	ND
MC-22a	LH	GL	BAEA-MI-C-03-20	Brulee PT	ND	ND	ND	2.4
MD-01	LH	AN	BAEA-MI-B-03-01	Sanford Lake	ND	ND	ND	ND
ML-01	LP	IN	BAEA-MI-B-03-06	Stanford	ND	ND	ND	ND
MM07	UP	IN	BAEA-MI-A-03-33	Hermansville Pond	ND	ND	ND	ND
MM-23a	LM	GL	BAEA-MI-A-03-04	Vetorts Point	ND	ND	1.0	4.1
MQ04	LS	GL	BAEA-MI-A-03-27	Partridge Island	ND	1.6	ND	6.2
MQ-08	LS	GL	BAEA-MI-C-03-21	L Kawbawbam	ND	2.9	2.8	9.2
MQ09	UP	IN	BAEA-MI-A-03-31	Deer Lake	ND	ND	ND	ND
MQ15	LS	GL	BAEA-MI-A-03-29	Saux Head	ND	ND	ND	2.7
MS-05	LM	GL	BAEA-MI-B-03-02	Walhalla East	ND	ND	ND	2.5
MS-06	LM	GL	BAEA-MI-B-03-05	Walhalla West	ND	ND	ND	3.1
NE-01J	LM	AN	BAEA-MI-C-03-01	Anderson Bayou	ND	ND	ND	ND
ON03	UP	IN	BAEA-MI-A-03-10	Interior	ND	ND	ND	ND
ON20	LS	GL	BAEA-MI-A-03-37	Carp River/Laudlookers Creek	ND	ND	ND	ND
OS-01	LP	IN	BAEA-MI-C-03-11	Reed Ranch	ND	ND	ND	ND
OS-08a	LP	IN	BAEA-MI-C-03-10	Mio Pond East	ND	ND	ND	ND
PI-09A	LH	GL	BAEA-MI-B-03-11	Lake Augusta	ND	ND	ND	ND
PI-10B	LH	GL	BAEA-MI-B-03-10	Hoeft Park	ND	ND	ND	ND
RO-11C	LP	IN	BAEA-MI-B-03-12	Woods/Twin Lake	ND	ND	ND	ND
RO-13b	LP	IN	BAEA-MI-C-03-09	Prudenville	ND	ND	ND	ND
SC-04	UP	IN	BAEA-MI-D-03-07	Seney C-2 Pool	ND	1.0	ND	4.0
SC-20	UP	IN	BAEA-MI-D-03-06	Seney D-1 Pool	ND	ND	ND	3.2
SG-05	LP	AN	BAEA-MI-B-03-07	Bridgeport	ND	ND	ND	ND
WX-02	LP	GL	BAEA-MI-D-03-01	Lake Mitchell	ND	ND	ND	ND
NA	LP	IN	BAEA-MI-B-03-13	NA	ND	ND	ND	ND
NA	LM	GL	BAEA-MI-C-03-16	NA	ND	ND	ND	2.7
NA	LM	GL	BAEA-MI-C-03-19	NA	ND	ND	ND	3.6
NA	LH	GL	BAEA-MI-D-03-02	NA	ND	ND	ND	1.0
NA	LH	GL	BAEA-MI-E-03-01	NA	1.0	ND	ND	1.0
NA	LH	GL	BAEA-MI-E-03-02	NA	ND	ND	ND	ND
NA	LE	GL	BAEA-MI-E-03-03	NA	ND	ND	ND	1.0
NA	LH	GL	BAEA-MI-E-03-04	NA	ND	ND	ND	ND
NA	LH	GL	BAEA-MI-E-03-05	NA	ND	ND	ND	ND
NA	LP	GL	BAEA-MI-E-03-06	NA	ND	ND	ND	ND

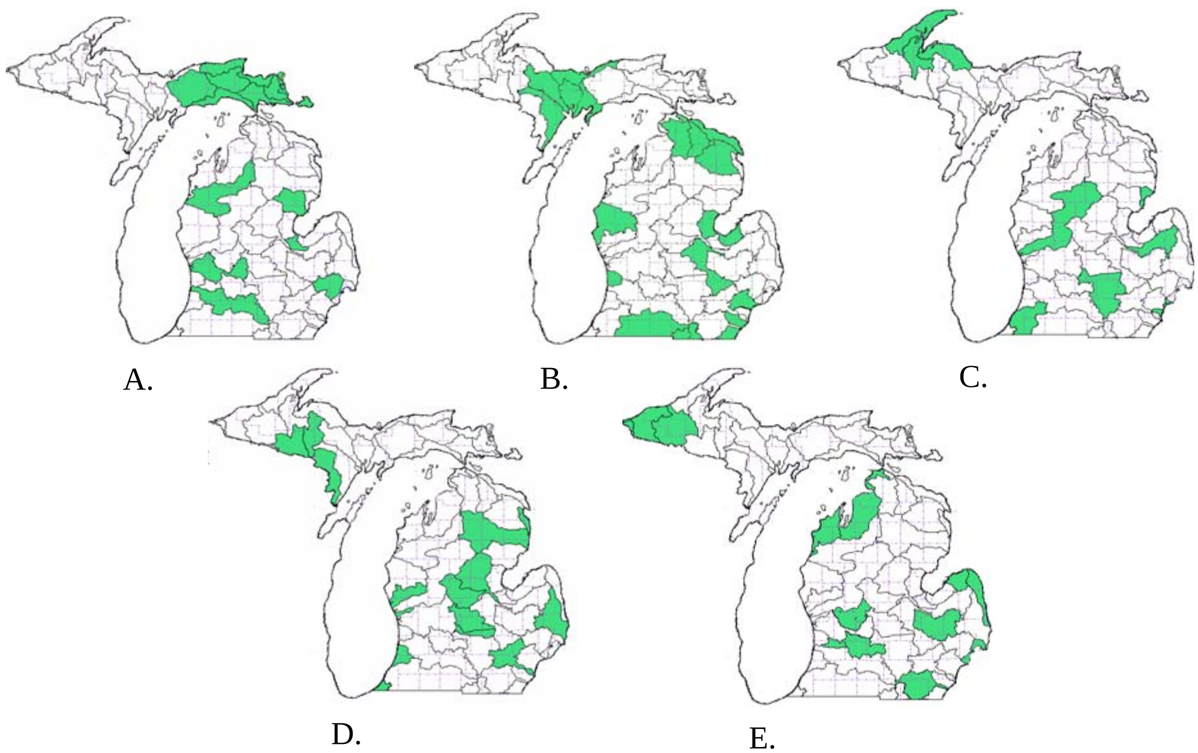
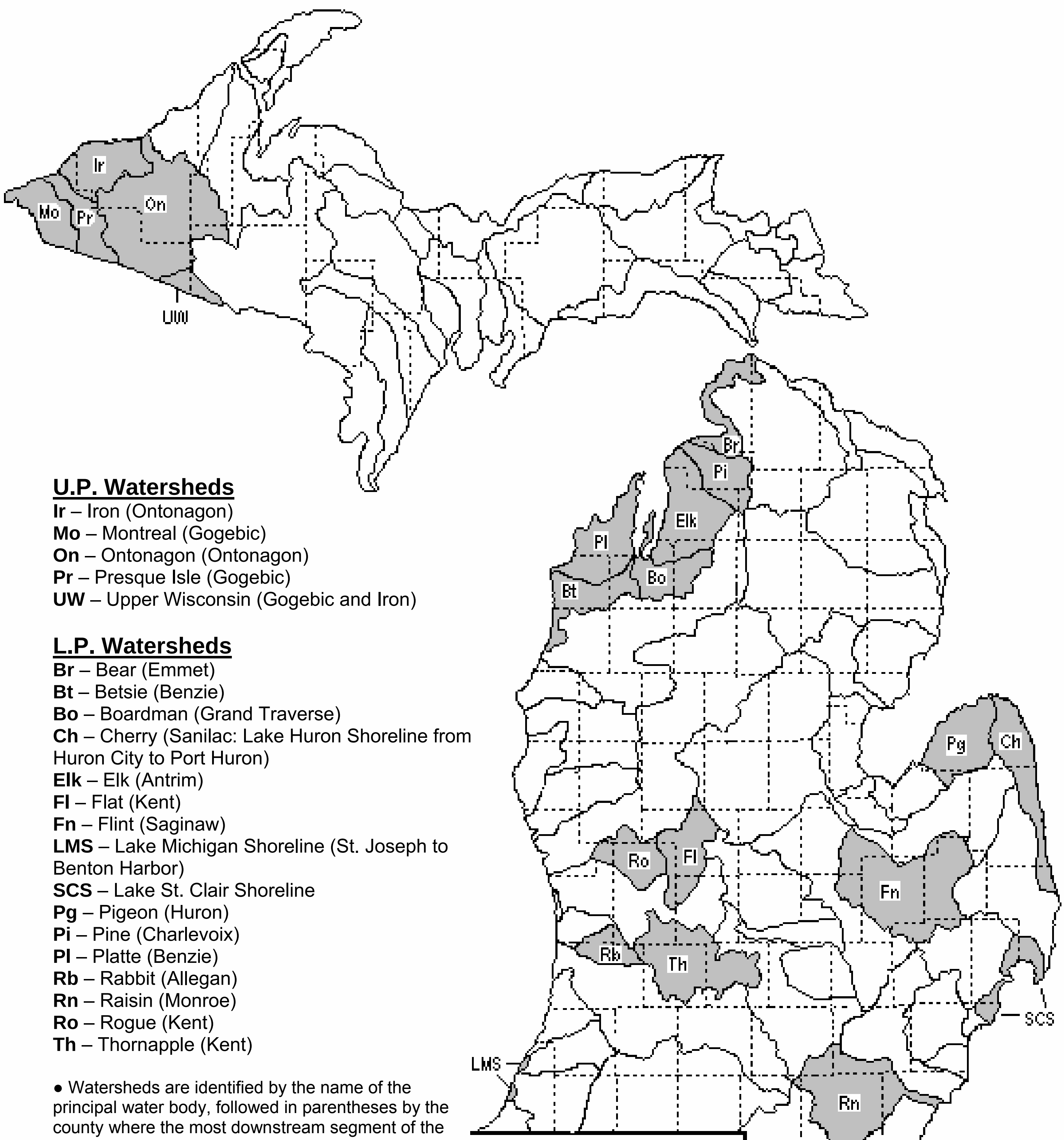


Figure 1. Michigan's watershed delineations and monitoring 'basin years'. A.) 1999 basin year watersheds (shaded); B.) 2000 basin year watersheds (shaded); C.) 2001 basin year watersheds (shaded); D.) 2002 basin year watersheds (shaded); and E.) 2003 basin year watersheds (shaded).

Figure 2. Monitoring cycle year 2003 watersheds.



U.P. Watersheds

Ir – Iron (Ontonagon)
Mo – Montreal (Gogebic)
On – Ontonagon (Ontonagon)
Pr – Presque Isle (Gogebic)
UW – Upper Wisconsin (Gogebic and Iron)

L.P. Watersheds

Br – Bear (Emmet)
Bt – Betsie (Benzie)
Bo – Boardman (Grand Traverse)
Ch – Cherry (Sanilac: Lake Huron Shoreline from Huron City to Port Huron)
Elk – Elk (Antrim)
Fl – Flat (Kent)
Fn – Flint (Saginaw)
LMS – Lake Michigan Shoreline (St. Joseph to Benton Harbor)
SCS – Lake St. Clair Shoreline
Pg – Pigeon (Huron)
Pi – Pine (Charlevoix)
Pl – Platte (Benzie)
Rb – Rabbit (Allegan)
Rn – Raisin (Monroe)
Ro – Rogue (Kent)
Th – Thornapple (Kent)

● Watersheds are identified by the name of the principal water body, followed in parentheses by the county where the most downstream segment of the principal water body is located.

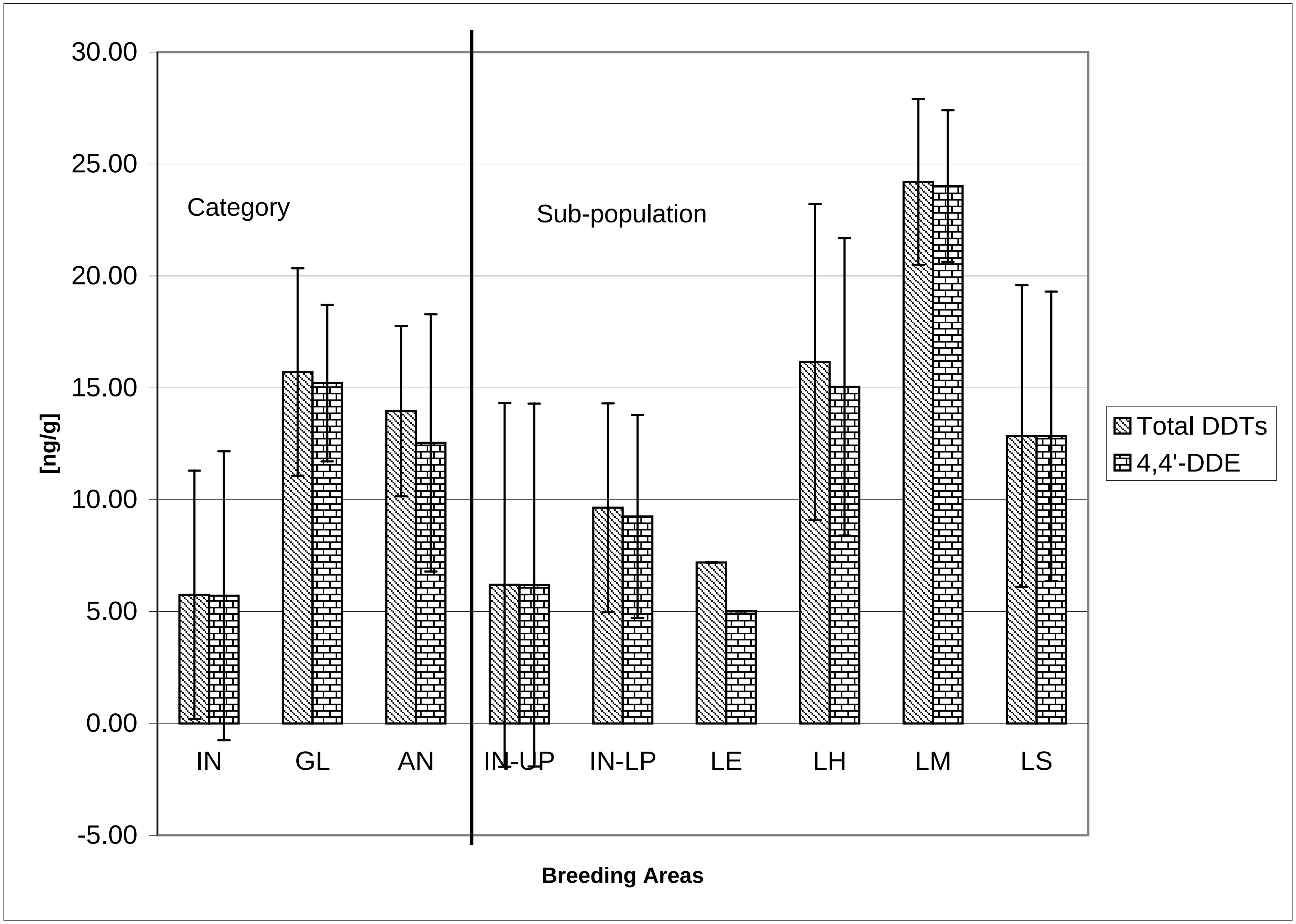


Figure 3: Geometric mean Total DDT and 4,4'-DDE concentrations (ng/g) in nestling bald eagles in 2003 by categories and subpopulations.

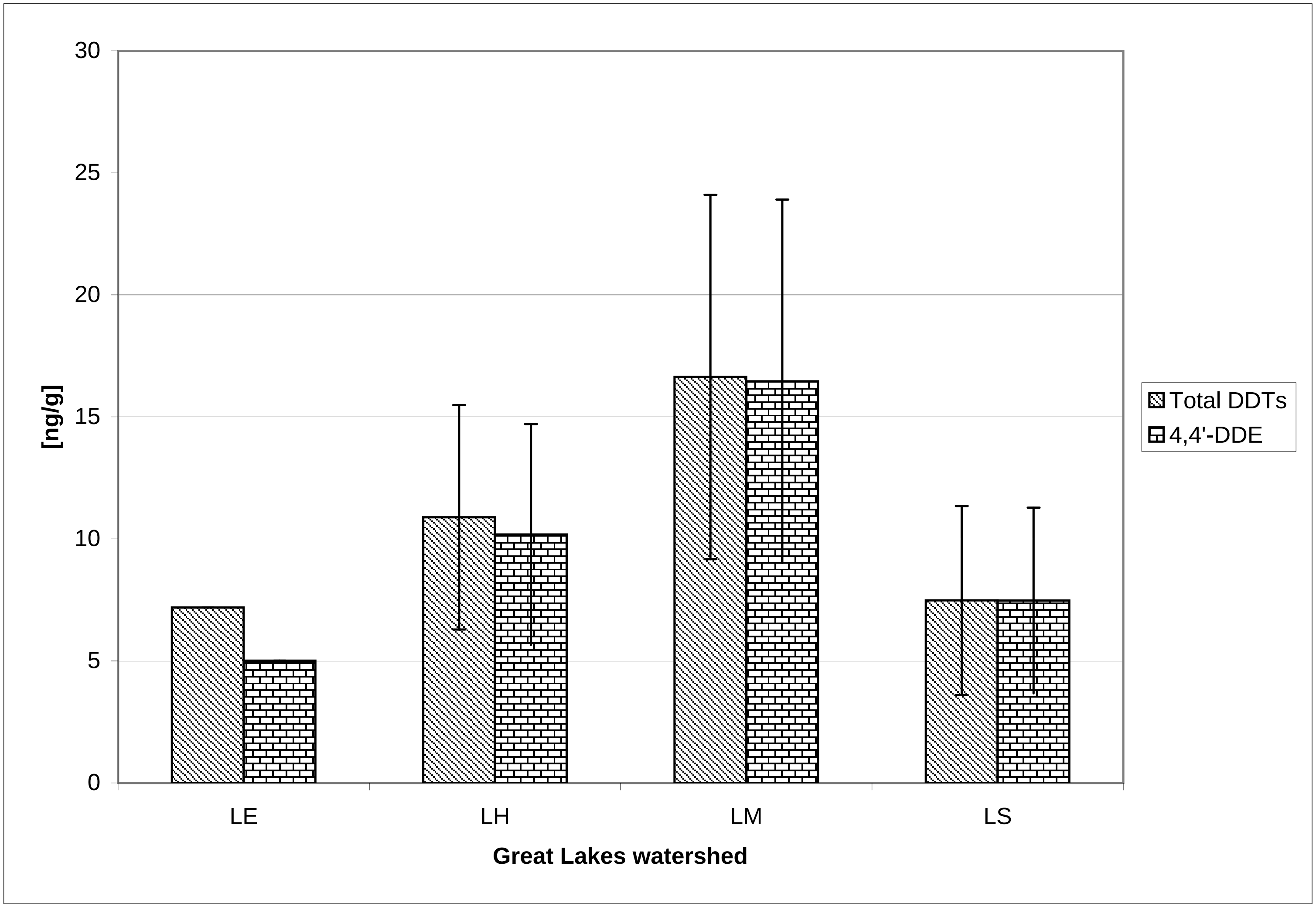


Figure 4: Geometric mean Total DDT and 4,4'-DDE concentrations (ng/g) in nestling bald eagles in 2003 by Great Lakes watersheds.

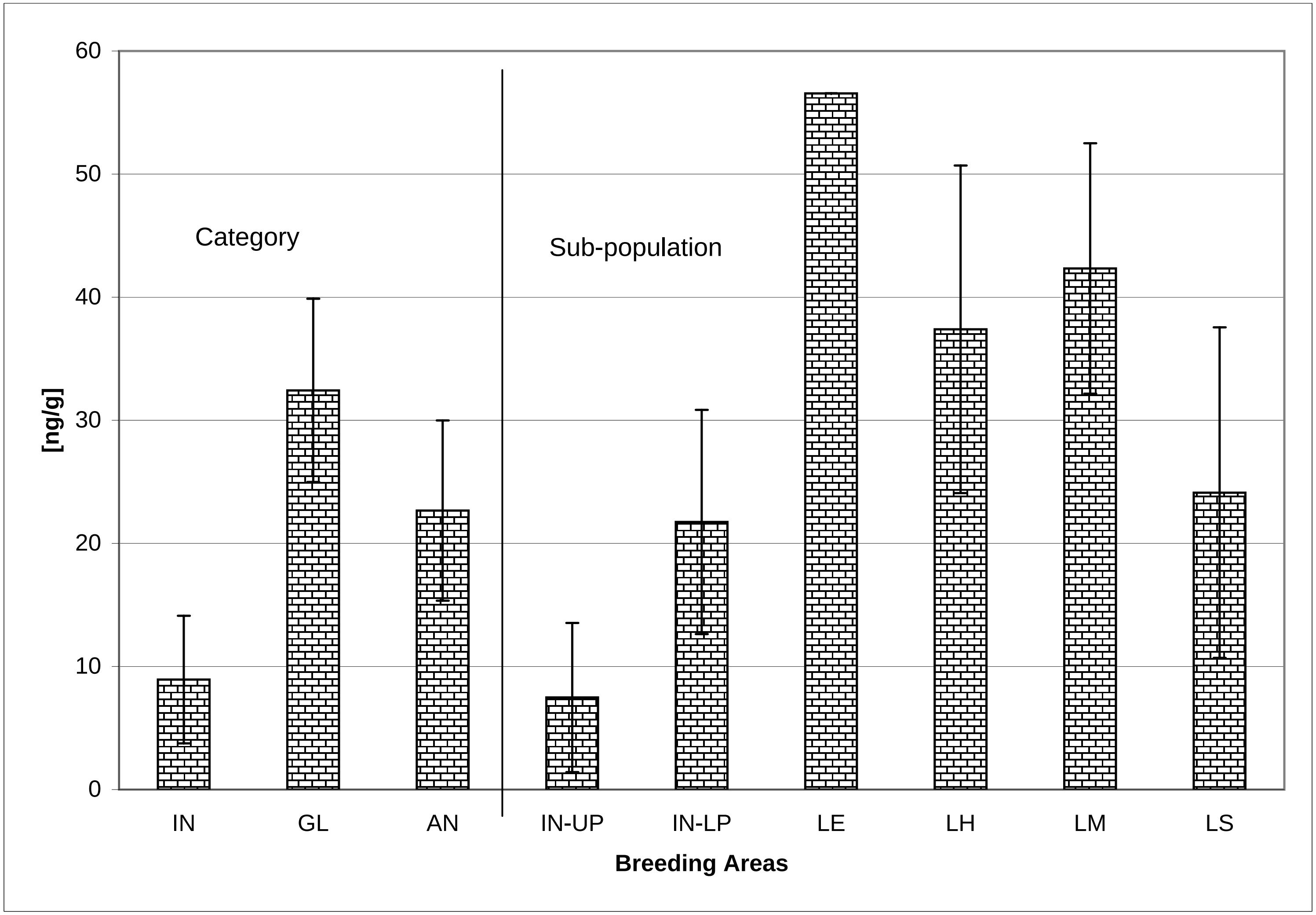


Figure 5: Geometric mean Total PCB concentrations (ng/g) in nestling bald eagles in 2003 by categories and subpopulations.

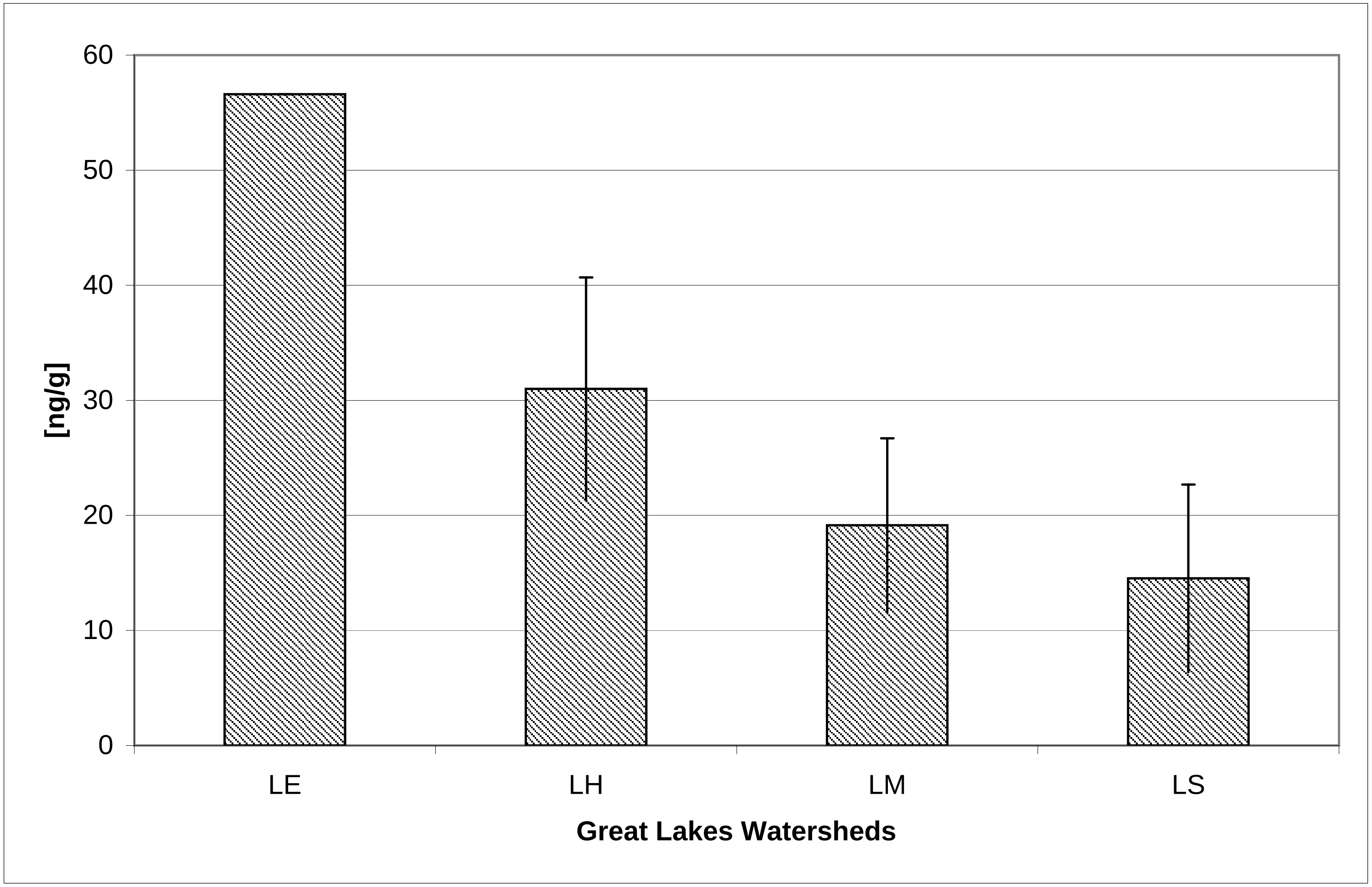


Figure 6: Geometric mean Total PCB concentrations (ng/g) in nestling bald eagles in 2003 by Great Lakes watersheds.

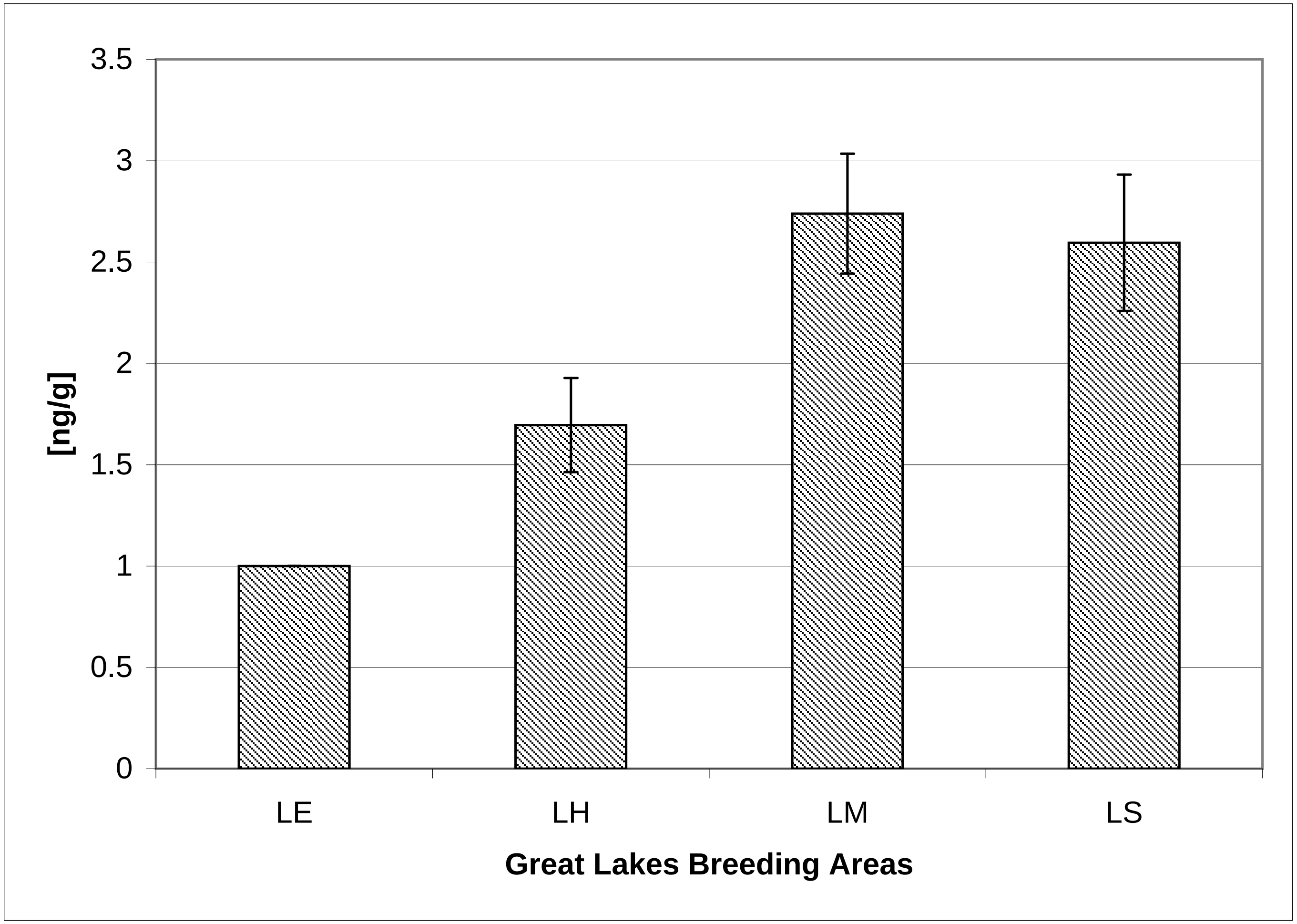


Figure 7: Geometric mean Dieldrin concentrations (ng/g) in nestling bald eagles in 2003 by Great Lakes watersheds.