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# MICHIGAN WILDLIFE CONTAMINANT TREND MONITORING

# YEAR 2007 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 Natural Resources and Environment (DNRE) in the January 1997 report entitled, "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters (Strategy)." This document serves as the ninth 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.

- In 2007, bald eagle productivity for the entire state of Michigan was 0.99 young per occupied nest. The success rate (percent of nests producing at least one young) was 66.5%. Five hundred twenty eight occupied nests were observed via ground and aerial surveys. Inland and Great Lakes breeding area productivities were not significantly different (P=0.3611). Anadromous breeding areas were greater, but not significantly different from inland and Great Lakes sites (P=0.2769). Productivity did not vary significantly among subpopulations and was ranked in order by location: Inland Upper Peninsula (n=134) > Lake Superior (n=51) > inland Lower Peninsula (n=182) > Lake Huron (n=76) > Lake Michigan (n=78) > Lake Erie (n=7) breeding areas.

- One hundred two nestling bald eagle blood plasma samples were analyzed for organochlorine contaminants, dichlorodiphenyltrichloroethane (DDT) and its metabolites, hexachlorobenzene (HCB), *alpha*-hexachlorocyclohexane, *gamma*-hexachlorocyclohexane, heptachlor, heptachlor epoxide, *alpha*-chlordane, *gamma*-chlordane, dieldrin, toxaphene, and 20 polychlorinated biphenyl (PCB) congeners.

- Significant differences were found among Great Lakes, anadromous, and inland breeding areas and between Great Lakes and anadromous pooled and inland breeding areas for both 4,4'-dichlorodiphenyldichloroethylene (DDE) (P=0.0004) and total DDT (P≤0.0001). Significant differences were found among Lake Michigan, Lake Superior, Lake Huron, Lake Erie, inland Upper Peninsula, and inland Lower Peninsula breeding areas for 4,4'-DDE (P=0.0003) and total DDT (P≤0.0001). Geometric mean 4,4'-DDE concentrations were ranked in the following order by location from highest to lowest: Lake Michigan (n=19) > Lake Superior (n=17) > inland Lower Peninsula (n=26) > Lake Huron (n=17) > inland Upper Peninsula (n=22) > Lake Erie (n=1) breeding areas.

- Twenty PCB congeners were quantified and summed to determine total PCBs in nestling bald eagle blood plasma samples. Four congeners (118, 138, 153, and 180) contributed significantly (i.e., consisting of ≥ 77% of the total PCBs) to the total PCB concentrations. At least one of the targeted PCB congeners was detected in 68 of the 102 nestlings sampled (67%). Total PCB concentrations for Great Lakes and anadromous breeding areas were greater than inland breeding areas (P<0.0001), and Lake Michigan breeding areas were significantly greater than inland Upper Peninsula and inland Lower Peninsula breeding areas (P<0.0001). Geometric mean PCB concentrations were ranked in the following order by location from highest to lowest: Lake Michigan (n=19) > Lake Huron (n=17) > Lake Erie (n=1) > Lake Superior (n=17) > inland Lower Peninsula (n=26) > inland Upper Peninsula (n=22) breeding areas.

- *alpha*-Chlordane was quantified in 19 samples, with concentrations ranging from 2.1-9.6 nanograms per gram (ng/g). Seventeen of the samples were from Great Lakes breeding areas and two were from inland breeding areas. Regionally, samples were from Lake Huron (n=3), Lake Superior (n=6), Lake Michigan (n=8), and inland Upper Peninsula (n=2) breeding areas. Since *alpha*-chlordane was detected in less than 50% of the samples, statistical analyses were not conducted.

- HCB was quantified in 6 samples, with values ranging from 1.0-2.3 ng/g. All but one sample were from Great Lakes breeding areas. Regionally, samples were from Lake Superior (n=5) and inland Lower Peninsula (n=1). Since HCB was detected in less than 50% of the samples, statistical analyses were not conducted.

- Dieldrin was quantified in 39 samples, with concentrations ranging from 1.0-9.8 ng/g. Twenty-one samples were from Great Lakes breeding areas and 18 were from inland breeding areas. Regionally, samples were from Lake Huron (n=6), Lake Michigan (n=7), Lake Superior (n=8), inland Lower Peninsula (n=8), and inland Upper Peninsula (n=10) breeding areas. Since dieldrin was detected in less than 50% of the samples, statistical analyses were not conducted.

- Mercury data for 2007 are available in the Michigan Wildlife Contaminant Trend Monitoring report (DNRE, 2009).

# SECTION 2.0

# INTRODUCTION

In April 1999, the DNRE, Water Resources Division, began monitoring environmentally persistent and toxic contaminants in bald eagles. This study is part of the wildlife contaminant monitoring project component of the DNRE's Strategy (DNRE, 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 ninth 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 ninth annual report for the bald eagle element of the Strategy. The first (DNRE, 2002), second (DNRE, 2003), third (DNRE, 2004a), fourth (DNRE, 2004b), fifth (DNRE, 2008a), sixth (DNRE, 2008b), seventh (DNRE, 2010a), and eighth (DNRE, 2010b) reports contained results of the samples collected in 1999, 2000, 2001, 2002, 2003, 2004, 2005, and 2006, respectively. This report contains the analytical results for organic contaminants that were measured in nestling bald eagle blood samples, and statistical, temporal, and spatial trend analyses of the data. Feather analyses for mercury concentrations have previously been reported in a five-year report (DNRE, 2009).

# 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. At the time of writing this report, there were 790 breeding areas in the state of Michigan.

To facilitate the DNRE'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 channels nests are sampled annually because nesting success is highly uncertain for these sites.

The following basin year watersheds were the focus of sampling in 2007: Menominee, Galien, Black, Looking Glass, Maple, White, AuSable, Tittabawassee, St. Clair, and Huron (Figure 2). In addition to the basin year watersheds for 2007, nests associated with the Great Lakes and connecting channels were sampled. Great Lakes-associated nests are defined as those nests within 8.0 kilometers of the shorelines of the Great Lakes and along tributaries where anadromous fish are accessible.

### 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 (Bowerman and Roe, 2002).

Blood and feather samples were collected from five- to nine-week old nestling bald eagles from May through June 2007. The approximate age of nestling eagles is visually estimated from two aerial survey flights that are piloted by a DNRE 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-inch 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. After sampling is completed, the nestlings are banded with a Size 9 United States Fish and Wildlife Service (USFWS) rivet 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 DNRE, United States Forest Service, or USFWS field stations. At the end of the sampling effort, all samples are collected and transferred to the USFWS's 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, Standard Operating Procedures 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 August 29, 2007. All extractions and analyses were conducted according to procedures detailed in CIET Standard Operating Procedures. 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 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 and ENTOX, 1996; CIET, 1999) were met. Average recoveries of 70%-130% for matrix spikes were required under the Quality Assurance Project Plan (CIET and ENTOX, 1996; CIET, 1999). Correlation coefficients ($r^2$) 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 2004 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 and Upper Peninsulas). 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 of causing ecological effects. Total PCBs were examined as the sum of the 16 PCB congeners found. Heptachlor epoxide, *alpha*-Chlordane, and Dieldrin were all analyzed independently.

Statistical analyses were performed using nonparametric rank converted ANOVA tests. Nonparametric pair-wise comparisons, least significant difference, 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. Differences in order (i.e., highest concentration to lowest concentration) between rank converted ANOVA and geometric mean results were observed and are the result of a combination of factors. The two factors are the assignment of the value of 0.0001 ng/g (see Section 4.2) to all nondetects, and sample size, with the former having the greatest effect on the results. These two factors have also resulted is very large standard errors for some analysis; in these cases the later is suspected to have had the greatest effect.

# SECTION 4.0

## RESULTS AND DISCUSSION

### 4.1 REPRODUCTIVE SUCCESS

Reproductive success (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 2007 breeding season (Table 1): (1) Statewide total for all nests (n=528); (2) Great Lakes (n=210) and inland nests (n=318); (3) Great Lakes (n=181), anadromous (n=29), and inland nests (n=318); and (4) Lake Erie (n=7), Lake Huron (n=76), Lake Michigan (n=78), Lake Superior (n=51), and inland Upper (n=134)and Lower (n=182) 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 Analysis 3.

The productivity for bald eagles in the state of Michigan in 2007 was 0.99 young per occupied nest. The success rate (percent of nests producing at least one young) was 66.5%.

Based on the year 2007 aerial and ground surveys, there were 528 occupied nests in the state of Michigan. Different category comparisons showed only slight differences among areas of the state (Table 1). Inland breeding area productivity (1.01) was not found to be significantly different from Great Lakes breeding area productivity (0.95) (F=0.84, P=0.3611). Productivity in anadromous (1.14) breeding areas was greater, but not significantly different from inland (1.02) or Great Lakes (0.92) breeding areas (F=1.29, P=0.2769). Breeding area productivities did not vary significantly by Subpopulations (F=0.90, P=0.4809). Inland Upper Peninsula had the greatest Subpopulation productivity (1.09) followed by Lake Superior (1.02), inland Lower Peninsula and Lake Huron (0.96), Lake Michigan (0.92), and Lake Erie (0.57). No differences were found for success rates of Subpopulations ($p \geq 0.05$).

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 2007, 102 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 0.0001 ng/g.

Of the 102 samples analyzed, 32 were from breeding areas in the 2007 basin year watersheds. Regionally, the analyzed samples were from 22 inland Upper Peninsula, 26 inland Lower Peninsula, 17 Lake Superior, 19 Lake Michigan, 17 Lake Huron, and 1 Lake Erie breeding areas. The no-observed-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 and 36.4 ng/g, respectively.

### 4.21 DDT and Metabolites

Concentrations of 2,4'- and 4,4'-DDE; and 2,4'- and 4,4'- DDT; and 2,4'- and 4,4'-dichlorodiphenyldichloroethane (DDD) were measured in nestling bald eagle blood samples (Table 3). The most ubiquitous compound, 4,4'-DDE, was detected in 68 (62%) samples and on average made up 86% of the total DDT quantified. Statewide concentrations of 4,4'-DDE ranged from < 1.0-135.9 ng/g. Total DDT concentrations were calculated as the sum of 2,4'- and 4,4'-DDE; 2,4'- and 4,4'-DDD; and 2,4'- and 4,4'-DDT.

Concentrations of 4,4'-DDE in Great Lakes (n=38) breeding areas were greater than inland (n=48) breeding areas. Anadromous (n=16) breeding areas were not significantly different from Great Lakes or inland breeding areas. Concentrations of total DDT for Great Lakes and Anadromous breeding areas were greater than inland breeding areas. Concentrations of 4,4'-DDE and total DDT for Great Lakes and Anadromous (n=54) breeding areas combined were greater than inland breeding areas. Geometric mean 4,4'-DDE concentrations were ranked in the following order by location from highest to lowest: Great Lakes > inland > anadromous. Geometric mean total DDT concentrations were ranked in the following order by location from highest to lowest: Great Lakes > anadromous > inland (Figure 3).

Concentrations of 4,4'-DDE and total DDT varied among Lake Michigan, Lake Superior, Lake Huron, Lake Erie, inland Upper Peninsula, and inland Lower Peninsula. Concentrations of 4,4'-DDE for Lake Michigan were greater than inland Upper Peninsula and Lake Erie. Concentrations of total DDT for Lake Michigan were greater than inland Upper Peninsula. Geometric mean 4,4'-DDE concentrations were ranked in the following order by location from highest to lowest: Lake Michigan (n=19) > Lake Superior (n=17) > inland Lower Peninsula (n=26) > Lake Huron (n=17) > inland Upper Peninsula (n=22) > Lake Erie (n=1) breeding areas. Geometric mean total DDT concentrations were ranked in the following order by location from highest to lowest: Lake Michigan > Lake Erie > Lake Superior > Lake Huron > inland Lower Peninsula > inland Upper Peninsula breeding areas (Figure 3).

No significant differences were found between Great Lakes watersheds for total DDT and 4,4'-DDE. Mean 4,4'-DDE concentrations were ranked in the following order by Great Lakes watershed from highest to lowest: Lake Michigan (n=41) > Lake Huron (n=38) > Lake Superior (n=22) > Lake Erie (n=1). Mean total DDT concentrations were ranked in the following order by Great Lakes watershed from highest to lowest: Lake Erie > Lake Superior > Lake Michigan > Lake Huron (Figure 4).

The greatest 4,4'-DDE concentration (136.0 ng/g) was measured in a nestling from Huron City breeding area (Table 3). 4,4'-DDE made up 98% of the total DDT (139.0 ng/g) found in that eaglet. In past reports, an arbitrary “high total DDT” has been considered to be ≥ 100 ng/g. The only other eaglet sampled that attained this threshold had a total DDT concentration of 109 ng/g and was from the Huron Islands National Wildlife Refuge.

The NOAEL for 4,4'-DDE in the blood of nestling bald eagles was determined to be 11.4 ng/g based on data presented in Bowerman et al. (2003). Of the 102 nestling plasma samples analyzed in 2007, 15 (15%) exceeded the NOAEL. Of these eaglets exceeding the NOAEL, 13 (87%) were in Great Lakes breeding areas. 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 the state of 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, one was not found in any eaglets. Four congeners (118, 138, 153, and 180) made up 77% of all PCBs detected in samples. In 10 of the eaglets sampled, only one PCB congener was found.

Statewide total PCB concentrations ranged from nondetect to 400.0 ng/g (Table 4). No PCBs were found in 37 (36%) of the nestlings sampled. Thirty-one of the 34 nestlings in which no PCB congeners were detected were from inland breeding areas. 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 for Great Lakes (n=38) and anadromous (n=16) breeding areas were greater than inland (n=46) 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 Michigan breeding areas were significantly greater than inland Upper Peninsula and inland Lower Peninsula breeding areas (Figure 5). The greatest concentration of total PCBs (400.0 ng/g) was found in a Lake Superior eaglet from the Huron Islands National Wildlife Refuge MQ-21b; Table 4) in Marquette County. Geometric mean PCB concentrations were ranked in the following order by location from highest to lowest: Lake Michigan (n=19) > Lake Huron (n=17) > Lake Erie (n=1) > Lake Superior (n=17) > inland Lower Peninsula (n=26) > inland Upper Peninsula (n=22) breeding areas.

No significant differences were found between Great Lakes watersheds for total PCB concentrations (Figure 6). Geometric mean total PCB concentrations were ranked in the following order by Great Lakes watershed from highest to lowest: Lake Erie (n=1) > Lake Superior (n=22) > Lake Michigan (n=41)> Lake Huron (n=38).

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 102 nestling plasma samples analyzed in 2007, 19 (19%) of the samples exceed 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 health 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 the state of Michigan.

### 4.23 Other Organics

The other organic contaminants that were detected in 2007 nestling samples were: *alpha*-chlordane, HCB, and dieldrin (Table 5). Concentrations of *alpha*-hexachlorocyclohexane (*alpha*-HCH), *gamma*-HCH, heptachlor, heptachlor epoxide, *gamma*-chlordane, and toxaphene were not detected in any of the year 2007 samples. However, because *alpha*-chlordane, HCB, and dieldrin were detected in only 19%, 38%, and 6% of the samples, respectively, statistical analyses were not conducted. The data are summarized below.

*alpha*-Chlordane was quantified in 19 samples, with concentrations ranging from 2.1-9.6 ng/g. Seventeen of the samples were from Great Lakes breeding areas and two were from inland breeding areas. Regionally, samples were from Lake Huron (n=3), Lake Superior (n=6), Lake Michigan (n=8), and inland Upper Peninsula (n=2) breeding areas.

HCB was quantified in six samples, with concentrations ranging from 1.0-2.3 ng/g. All but one sample was from Great Lakes breeding areas. Regionally, samples were from Lake Superior (n=5) and inland Lower Peninsula (n=1).

Dieldrin was quantified in 39 samples, with concentrations ranging from 1.0-9.8 ng/g. Twenty-one samples were from Great Lakes breeding areas and 18 were from inland breeding areas. Regionally, samples were from Lake Huron (n=6), Lake Michigan (n=7), Lake Superior (n=8), inland Lower Peninsula (n=8), and inland Upper Peninsula (n=10) breeding areas.

# SECTION 5.0

## FUTURE STUDIES

Several potential areas of future study were identified following the first nine 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.
- Analysis of global climate change on egg laying dates.

## SECTION 6.0

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# SECTION 7.0

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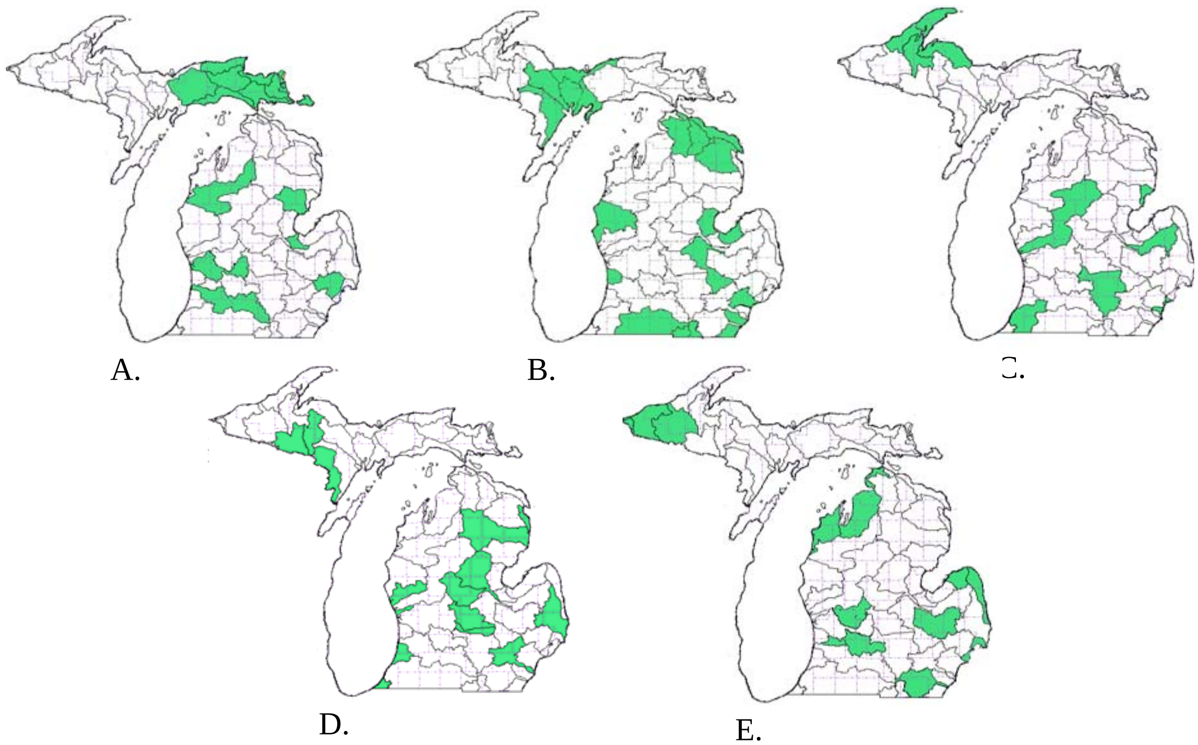


Figure 1. Michigan's watershed delineations and monitoring 'basin years'. A.) 1999, 2004 basin year watersheds (shaded); B.) 2000, 2005 basin year watersheds (shaded); C.) 2001, 2006 basin year watersheds (shaded); D.) 2002, 2007 basin year watersheds (shaded); and E.) 2003, 2008 basin year watersheds (shaded).

# YEAR 2007 MONITORING WATERSHEDS
(Basin Year 9)

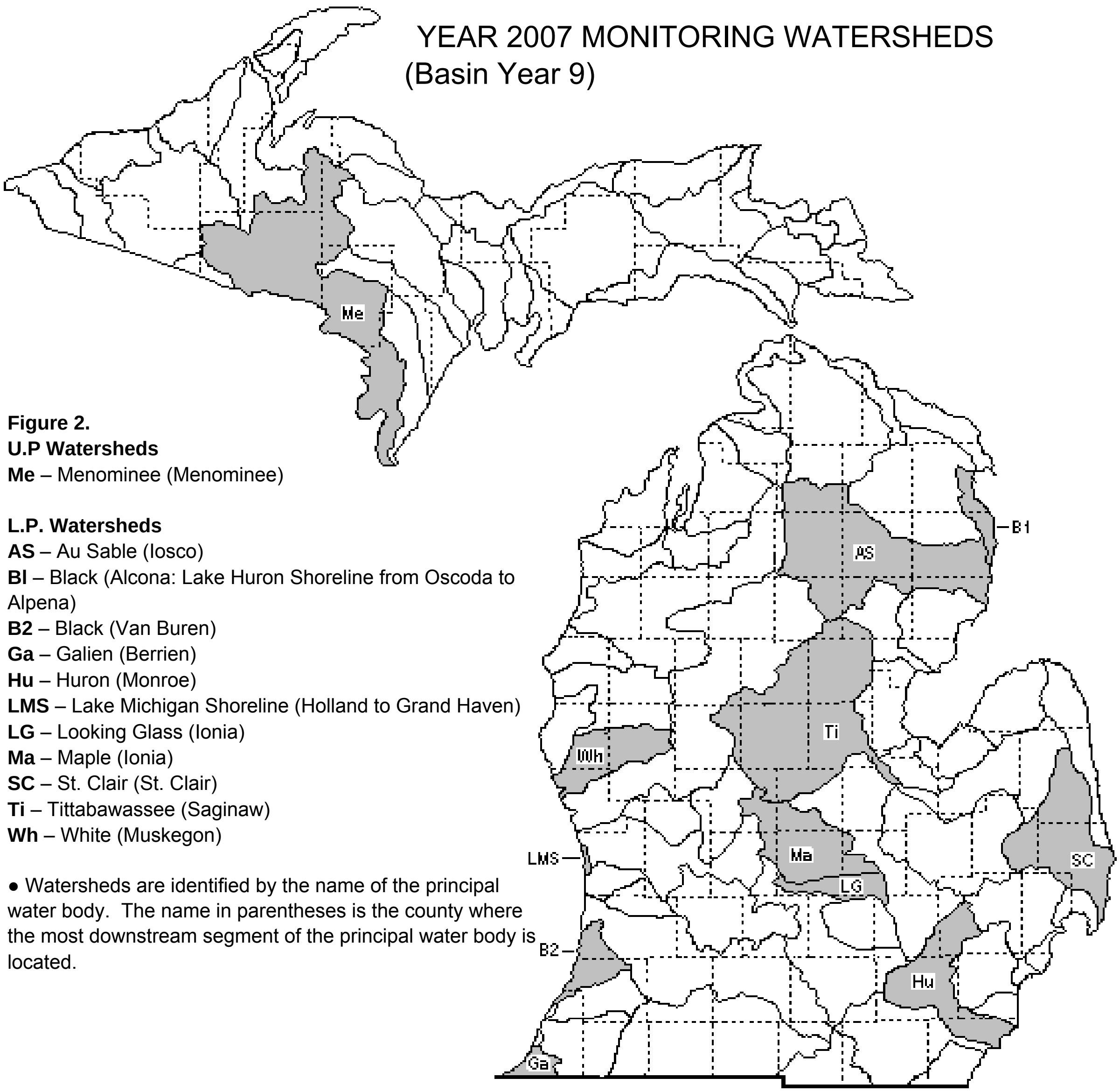


**Figure 2.**
**U.P Watersheds**
**Me** – Menominee (Menominee)

**L.P. Watersheds**
**AS** – Au Sable (Iosco)
**Bl** – Black (Alcona: Lake Huron Shoreline from Oscoda to Alpena)
**B2** – Black (Van Buren)
**Ga** – Galien (Berrien)
**Hu** – Huron (Monroe)
**LMS** – Lake Michigan Shoreline (Holland to Grand Haven)
**LG** – Looking Glass (Ionia)
**Ma** – Maple (Ionia)
**SC** – St. Clair (St. Clair)
**Ti** – Tittabawassee (Saginaw)
**Wh** – White (Muskegon)

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

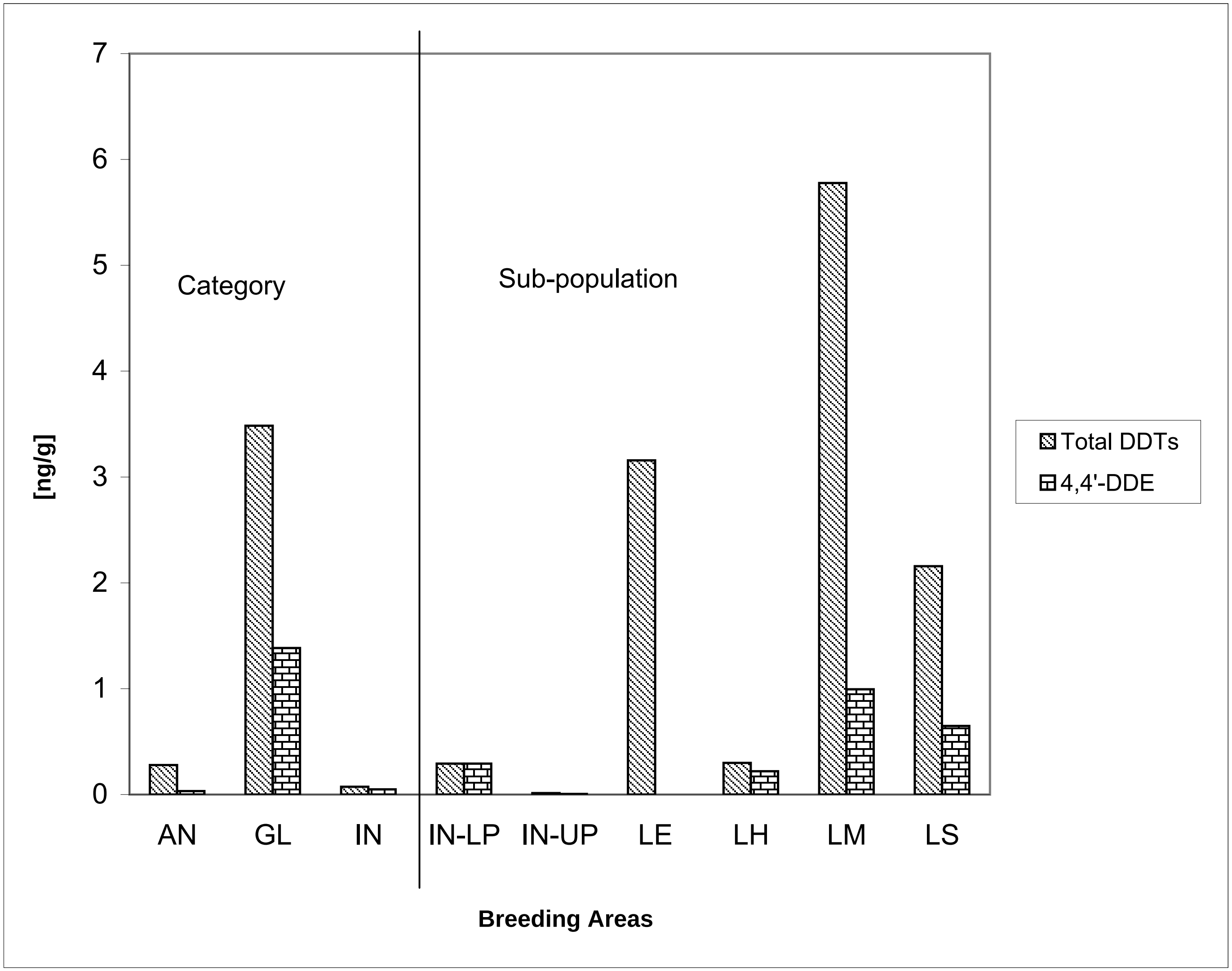


Figure 3: Geometric mean Total DDT and 4,4'-DDE concentrations (ng/g) in nestling bald eagles in 2007 by categories and subpopulations. Error bars have not been included because the number of non-detects makes them too large to display.

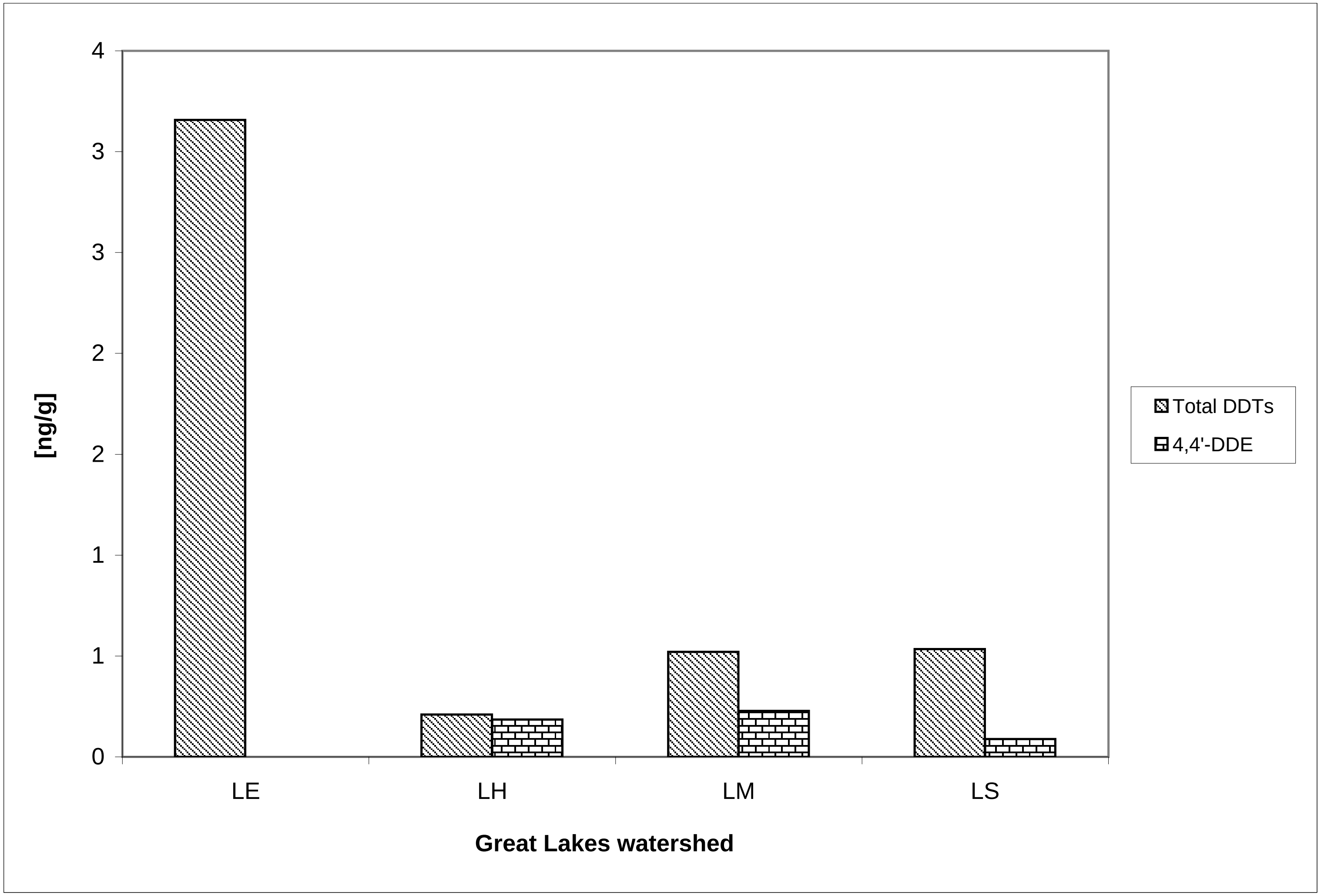


Figure 4: Geometric mean Total DDT and 4,4'-DDE concentrations (ng/g) in nestling bald eagles in 2007 by Great Lakes watersheds. Error bars have not been included because the number of non-detects makes them too large to display.


Figure 5: Geometric mean Total PCB concentrations (ng/g) in nestling bald eagles in 2007 by categories and subpopulations. Error bars have not been included because the number of non-detects makes them too large to display.

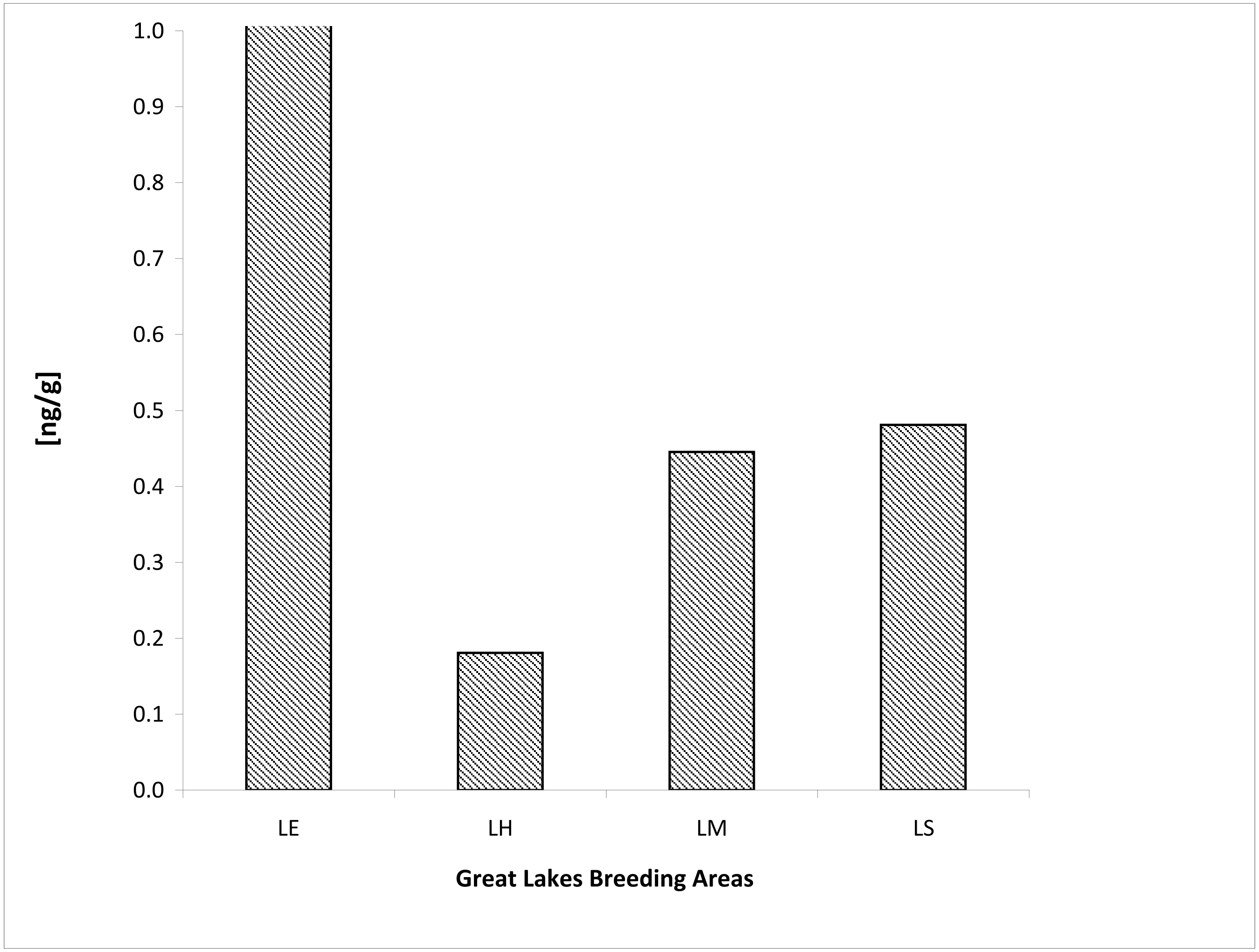


Figure 6: Geometric mean Total PCB concentrations (ng/g) in nestling bald eagles in 2007 by Great Lakes watersheds. The geometric mean for LE was 15.9 (n=1) because it was so much greater than the other results it has been truncated to better show other data points. Error bars have not been included because the number of non-detects makes them too large to display.

Table 1. Productivity and success of bald eagles nesting in Michigan 2007. Comparisons include: Statewide; Great Lakes (those within 8.0 km of a Great Lake or nesting along a river open to Great Lakes fish runs) vs. Inland; Great Lakes (nesting along the shoreline) vs. Anadromous (those nesting along a river) vs. Inland; and Subpopulations comprised of eagles nesting in the inland upper peninsula or lower peninsula, and Great Lakes sites along Lakes Superior, Michigan, Huron, and Erie.

| **Comparison** | **N=** | **Productivity (Young/Occupied Nest)** | **Success (% Nests producing young)** |
|---|---|---|---|
| Statewide | 528 | 0.99 | 66.5 |
| Great Lakes | 210 | 0.95a | 63.8a |
| Inland | 318 | 1.01a | 68.1a |
| Anadromous | 29 | 1.14a | 65.5a |
| Great Lakes | 181 | 0.92a | 63.5a |
| Inland | 318 | 1.02a | 68.2a |
| Inland Lower Peninsula | 182 | 0.96a | 67.0a |
| Lake Superior | 51 | 1.02a | 60.8a |
| Lake Erie | 7 | 0.57a | 42.9a |
| Lake Huron | 76 | 0.96a | 67.1a |
| Inland Upper Peninsula | 134 | 1.09a | 70.1a |
| Lake Michigan | 78 | 0.92a | 64.1a |

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 2007, with parameter-specific Method Detection Levels and Quantification Levels.

| Organochlorine Contaminant Analyte List | Method Detection Level (MDL) | Quantification Level (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 2007. 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'-DDD | 2,4'-DDE | 2,4'-DDT | 4,4'-DDD | 4,4'-DDE | 4,4'-DDT | DDE+DDT+DDD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AG-13b | GL | LS | BAEA-MI-2007-A-033 | Au Sable Pt | ND | ND | ND | ND | 3.0 | ND | 3.0 |
| AG-18a | IN | UP | BAEA-MI-2007-A-049 | Forest L Basin N | ND | ND | ND | ND | ND | ND | ND |
| AL-02j | IN | LP | BAEA-MI-2007-B-016 | Alcona-Bamfield Pd | ND | ND | ND | ND | 5.0 | ND | 5.0 |
| AL-05a | IN | LP | BAEA-MI-2007-B-009 | Sprinkler L | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| AN-04b | AN | LM | BAEA-MI-2007-C-008 | Shiawassee Rookery | ND | 4.5 | ND | 3.3 | 17.9 | ND | 25.7 |
| AP-08e | GL | LH | BAEA-MI-2007-A-014 | Devil's L | ND | ND | ND | ND | 7.1 | ND | 7.1 |
| AR-05b | GL | LH | BAEA-MI-2007-A-013 | Pt AuGres S | ND | 1.0 | ND | ND | 9.1 | 2.8 | 12.9 |
| AR-09b | GL | LH | BAEA-MI-2007-D-008 | Passage Isd | ND | 2.8 | 3.6 | ND | 1.0 | 6.7 | 14.1 |
| BG-02f | IN | UP | BAEA-MI-2007-A-043 | King L | ND | ND | ND | ND | ND | ND | ND |
| BG-07b | IN | UP | BAEA-MI-2007-A-034 | Net R Fldg | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| BG-11a | GL | LS | BAEA-MI-2007-A-037 | Reeds Pt | ND | ND | 2.2 | ND | 2.7 | ND | 4.9 |
| BG-11a | GL | LS | BAEA-MI-2007-A-038 | Reeds Pt | ND | ND | ND | ND | 3.6 | ND | 3.6 |
| BG-11a | GL | LS | BAEA-MI-2007-A-039 | Reeds Pt | ND | ND | ND | ND | ND | ND | ND |
| BG-14c | IN | UP | BAEA-MI-2007-A-044 | Vermilac L | ND | ND | 1.0 | ND | ND | ND | 1.0 |
| BG-14c | IN | UP | BAEA-MI-2007-A-045 | Vermilac L | ND | ND | 2.2 | ND | ND | ND | 2.2 |
| BG-18b | GL | LS | BAEA-MI-2007-A-035 | Aura | ND | ND | ND | ND | ND | ND | ND |
| BY-02f | GL | LH | BAEA-MI-2007-C-001 | Tower S-Onaway | ND | 1.0 | ND | 3.1 | 8.0 | ND | 12.1 |
| CB-03b | IN | LP | BAEA-MI-2007-B-033 | Reeses Bog-UMBS | ND | ND | ND | ND | 3.7 | ND | 3.7 |
| CB-10b | IN | LP | BAEA-MI-2007-C-016 | Shiawassee NWR #1 | ND | ND | ND | ND | ND | ND | ND |
| CB-13b | IN | LP | BAEA-MI-2007-C-017 | Shiawassee NWR #2 | ND | ND | ND | ND | 2.4 | ND | 2.4 |
| CB-17a | IN | LP | BAEA-MI-2007-C-015 | Shiawassee R SGA #1 | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| CP-26d | GL | LH | BAEA-MI-2007-B-053 | Gravel Isd/L | ND | ND | ND | ND | 8.2 | ND | 8.2 |
| CP-27a | GL | LS | BAEA-MI-2007-B-049 | Pendills L | ND | ND | ND | ND | 4.5 | ND | 4.5 |
| CP-27a | GL | LS | BAEA-MI-2007-B-050 | Pendills L | ND | ND | ND | ND | 9.6 | ND | 9.6 |
| CP-33a | GL | LH | BAEA-MI-2007-A-055 | Sand Isd-Dunbar | ND | ND | ND | ND | 7.0 | ND | 7.0 |
| CP-34a | GL | LH | BAEA-MI-2007-A-054 | Cedar Isd | ND | ND | ND | ND | 8.4 | ND | 8.4 |
| CP-44a | GL | LH | BAEA-MI-2007-B-052 | Sugar Isd NE | ND | ND | ND | ND | 2.4 | ND | 2.4 |
| CR-02d | IN | LP | BAEA-MI-2007-B-018 | Wakeley L | ND | ND | ND | ND | ND | ND | ND |
| CR-02d | IN | LP | BAEA-MI-2007-B-019 | Wakeley L | ND | ND | ND | ND | ND | ND | ND |
| CR-04b | IN | LP | BAEA-MI-2007-B-021 | Chub L | ND | ND | ND | ND | ND | ND | ND |
| CR-08c | IN | LP | BAEA-MI-2007-A-002 | Lovells | ND | ND | ND | ND | 7.3 | ND | 7.3 |
| CR-10b | IN | LP | BAEA-MI-2007-A-001 | Shellenbarger L | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| DE-29 | GL | LM | BAEA-MI-2007-B-038 | Masonville | ND | ND | ND | ND | 6.6 | ND | 6.6 |
| DE-30b | GL | LM | BAEA-MI-2007-A-032 | Wells | ND | ND | ND | ND | ND | ND | ND |
| DI-04a | IN | UP | BAEA-MI-2007-A-023 | Fumee L | ND | ND | ND | ND | ND | ND | ND |
| DI-14b | IN | UP | BAEA-MI-2007-A-021 | L Antoine | ND | ND | ND | ND | 2.1 | ND | 2.1 |
| DI-16a | IN | UP | BAEA-MI-2007-A-019 | Sturgeon Falls Dam N | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| DI-16a | IN | UP | BAEA-MI-2007-A-020 | Sturgeon Falls Dam N | ND | ND | ND | ND | ND | ND | ND |
| GT-06a | GL | LM | BAEA-MI-2007-B-031 | Yuba Valley | ND | ND | ND | 2.5 | 17.4 | ND | 19.8 |
| GT-08a | GL | LM | BAEA-MI-2007-B-028 | Cherry City Airport | ND | ND | ND | ND | 6.1 | ND | 6.1 |
| HU-08a | GL | LH | BAEA-MI-2007-C-006 | Shiawassee Rookery | ND | ND | ND | 2.5 | 12.6 | ND | 15.0 |
| IO-06b | GL | LH | BAEA-MI-2007-A-012 | Tawas L SW | ND | ND | ND | ND | 8.8 | ND | 8.8 |
| IR-09g | IN | UP | BAEA-MI-2007-B-045 | Paint R-Lower Hemlock Rpd | ND | ND | ND | ND | 1.0 | ND | 1.0 |
| IR-13g | IN | UP | BAEA-MI-2007-B-043 | Dog L-L St Kathryn | ND | ND | ND | ND | ND | ND | ND |
| IR-20b | IN | UP | BAEA-MI-2007-A-029 | Iron L | ND | ND | ND | ND | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-030 | Brule L | ND | ND | ND | ND | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-031 | Brule L | ND | ND | ND | ND | 1.00 | ND | 1.0 |
| IR-28b | IN | UP | BAEA-MI-2007-A-053 | Smokey L | ND | ND | ND | ND | 1.00 | ND | 1.0 |
| IR-33b | IN | UP | BAEA-MI-2007-A-027 | Buck/Armstrong L | ND | ND | ND | ND | 1.00 | ND | 1.0 |
| KA-04e | IN | LP | BAEA-MI-2007-B-027 | Big Blue/Bass L | ND | ND | ND | ND | 1.00 | ND | 1.0 |
| KW-IR | GL | LS | BAEA-MI-2007-E-001 | Caro | ND | ND | ND | ND | 49.36 | ND | 49.4 |
| KW-IR | GL | LS | BAEA-MI-2007-E-002 | Huron City | ND | 2.99 | ND | ND | 135.97 | ND | 139.0 |
| KW-IR | GL | LS | BAEA-MI-2007-E-003 | New Richmond | ND | 2.24 | ND | ND | ND | ND | 2.2 |
| KW-IR | GL | LS | BAEA-MI-2007-E-004 | Stoney Ck Fldg | ND | 2.38 | ND | ND | 62.88 | ND | 65.3 |
| KW-IR | GL | LS | BAEA-MI-2007-E-005 | Tower N-Kleber Pd | 2.21 | ND | ND | ND | 5.46 | ND | 7.7 |
| LU-15a | GL | LS | BAEA-MI-2007-B-054 | Culhane L | ND | ND | ND | ND | 2.53 | ND | 2.5 |
| MM-05h | IN | UP | BAEA-MI-2007-C-019 | Knoll View | ND | ND | ND | ND | ND | ND | ND |
| MM-10c | IN | UP | BAEA-MI-2007-A-025 | Pemebonwon Falls/R | ND | ND | ND | ND | ND | ND | ND |
| MM-10c | IN | UP | BAEA-MI-2007-A-026 | Pemebonwon Falls/R | ND | ND | ND | ND | ND | ND | ND |
| MM-15a | IN | UP | BAEA-MI-2007-A-017 | Ten Mile Ck-Whitney | ND | 2.06 | 5.05 | 2.30 | 19.63 | ND | 29.0 |
| MM-23a | GL | LM | BAEA-MI-2007-B-039 | Vetorts Pt. | ND | ND | ND | 2.10 | 13.50 | ND | 15.6 |

Table 3. Continued.

| Territory | Breeding Area Location | Territory Location | Blood Sample Number | Breeding Area Name | 2,4'-DDD | 2,4'-DDE | 2,4'-DDT | 4,4'-DDD | 4,4'-DDE | 4,4'-DDT | DDE+DDT+DDD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MN-04c | AN | LM | BAEA-MI-2007-A-011 | Tippy Dam | ND | ND | 4.64 | 2.10 | 22.21 | ND | 28.9 |
| MN-05e | GL | LM | BAEA-MI-2007-B-004 | Manistee R SGA | ND | ND | ND | ND | 7.47 | ND | 7.5 |
| MN-05e | GL | LM | BAEA-MI-2007-B-005 | Manistee R SGA | ND | ND | ND | ND | 5.10 | ND | 5.1 |
| MN-08f | IN | LP | BAEA-MI-2007-A-009 | Pine/Timmerman L | ND | ND | ND | ND | 10.41 | ND | 10.4 |
| MN-10a | AN | LM | BAEA-MI-2007-A-006 | Little Manastee R | ND | ND | 3.78 | 1.00 | 20.16 | ND | 24.9 |
| MQ-02g | GL | LS | BAEA-MI-2007-A-046 | Conway L-Salmon Trout R | ND | ND | 1.00 | ND | ND | ND | 1.0 |
| MQ-10d | GL | LS | BAEA-MI-2007-B-046 | L Ind.-Yellowdog Swamp | ND | ND | ND | ND | 2.80 | ND | 2.8 |
| MQ-10d | GL | LS | BAEA-MI-2007-B-047 | L Ind.-Yellowdog Swamp | ND | ND | ND | ND | 3.49 | ND | 3.5 |
| MQ-19a | IN | UP | BAEA-MI-2007-A-040 | L Michigamme | ND | ND | ND | ND | ND | ND | ND |
| MQ-21b | GL | LS | BAEA-MI-2007-A-050 | Huron Isds NWR W | ND | 3.85 | 12.76 | 1.00 | 87.66 | 3.73 | 109.0 |
| MS-04a | AN | LM | BAEA-MI-2007-B-011 | Pere Marquette L | ND | ND | ND | ND | 8.62 | ND | 8.6 |
| MS-04a | AN | LM | BAEA-MI-2007-B-012 | Pere Marquette L | ND | ND | ND | 2.41 | 11.01 | ND | 13.4 |
| MS-05c | AN | LM | BAEA-MI-2007-B-013 | Walhalla E | ND | ND | ND | 2.55 | 15.94 | ND | 18.5 |
| MS-07a | GL | LM | BAEA-MI-2007-A-007 | Pere Marquette L | ND | ND | ND | ND | 9.67 | ND | 9.7 |
| MS-07a | GL | LM | BAEA-MI-2007-A-008 | Pere Marquette L | ND | ND | 2.59 | 1.00 | 15.80 | ND | 19.4 |
| MY-10b | IN | LP | BAEA-MI-2007-A-015 | Tomahawk Ck Fldg | ND | ND | ND | ND | 3.77 | ND | 3.8 |
| MY-10b | IN | LP | BAEA-MI-2007-A-016 | Tomahawk Ck Fldg | ND | ND | ND | ND | 3.88 | ND | 3.9 |
| MY-12b | IN | LP | BAEA-MI-2007-B-037 | Foch Ls Fldg | ND | ND | ND | ND | 4.59 | ND | 4.6 |
| NE-01l | AN | LM | BAEA-MI-2007-B-023 | Anderson Bayou | ND | ND | ND | 1.00 | 13.60 | ND | 14.6 |
| NE-03m | IN | LP | BAEA-MI-2007-B-025 | Croton Prairie | ND | ND | ND | ND | 4.49 | ND | 4.5 |
| OG-08b | IN | LP | BAEA-MI-2007-B-006 | Devoe L | ND | ND | ND | ND | 5.37 | ND | 5.4 |
| OS-01h | IN | LP | BAEA-MI-2007-A-005 | Reed Ranch | ND | ND | ND | ND | 10.41 | ND | 10.4 |
| OS-03e | IN | LP | BAEA-MI-2007-B-003 | McKinley | ND | ND | ND | ND | ND | ND | ND |
| OS-05a | IN | LP | BAEA-MI-2007-B-015 | Garland Golf Course | ND | ND | ND | ND | 1.00 | ND | 1.0 |
| OS-08e | IN | LP | BAEA-MI-2007-B-022 | Mio Pd E | ND | ND | ND | ND | ND | ND | ND |
| OW-04b | AN | LM | BAEA-MI-2007-D-012 | Quanicassee | ND | 3.29 | ND | ND | ND | ND | 3.3 |
| OW-04b | AN | LM | BAEA-MI-2007-D-010 | Pickerel Cove | ND | 4.07 | ND | ND | ND | ND | 4.1 |
| OW-04b | AN | LM | BAEA-MI-2007-D-011 | Pickerel Cove | ND | 1.00 | ND | 3.36 | ND | ND | 4.4 |
| PI-07b | IN | LP | BAEA-MI-2007-B-032 | N Br Thunder Bay R | ND | ND | ND | ND | 4.40 | ND | 4.4 |
| RO-05d | IN | LP | BAEA-MI-2007-A-003 | Higgins L | ND | ND | ND | ND | 3.51 | ND | 3.5 |
| SC-06b | IN | UP | BAEA-MI-2007-A-042 | E1 Pool (Seney NWR) | ND | ND | 1.00 | ND | 17.29 | ND | 18.3 |
| SG-01f | AN | LH | BAEA-MI-2007-D-004 | Bass R | ND | ND | ND | ND | ND | ND | ND |
| SG-02c | AN | LH | BAEA-MI-2007-D-005 | Hoovers Corners-Mich. Peat | ND | 2.87 | ND | ND | 1.00 | ND | 3.9 |
| SG-02c | AN | LH | BAEA-MI-2007-D-006 | Passage Isd | ND | ND | ND | ND | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-001 | Campau Rd | ND | ND | ND | ND | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-002 | Bass R | ND | ND | ND | ND | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-003 | Bass R | ND | ND | ND | ND | ND | ND | ND |
| SH-01b | IN | LP | BAEA-MI-2007-D-013 | Dinsmoore | ND | ND | ND | ND | 4.39 | ND | 4.4 |
| TU-01c | GL | LH | BAEA-MI-2007-C-002 | Grand Rpds Dam N | ND | ND | ND | 2.02 | 10.22 | ND | 12.2 |
| TU-03c | IN | LP | BAEA-MI-2007-C-005 | Shiawassee Rookery | ND | ND | ND | ND | 3.40 | ND | 3.4 |
| WA-03b | GL | LE | BAEA-MI-2007-D-009 | Todd Harbor-L Harvey | ND | ND | ND | ND | ND | 3.16 | 3.2 |

Table 4. Concentrations of individual PCB congeners and Total PCBs (ng/g wet weight (ppb)) in nestling bald eagle plasma samples analyzed in 2007. 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. PCB congener 8 is not shown because it was not found in any samples.

| Territory | Breeding Area Location | Territory Location | Blood Sample Number | Breeding Area Name | # 018 | # 028 | # 044 | # 052 | # 066 | # 101 | # 105 | # 110 | # 118 | # 128 | # 138 | # 153 | # 156 | # 170 | # 180 | # 187 | # 195 | # 206 | # 209 | SUM PCBs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AG-13b | GL | LS | BAEA-MI-2007-A-033 | Au Sable Pt | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.45 | ND | ND | ND | ND | ND | ND | ND | ND | 2.45 |
| AG-18a | IN | UP | BAEA-MI-2007-A-049 | Forest L Basin N | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| AL-02j | IN | LP | BAEA-MI-2007-B-016 | Alcona-Bamfield Pd | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 6.00 | ND | ND | ND | ND | ND | ND | ND | 6.00 |
| AL-05a | IN | LP | BAEA-MI-2007-B-009 | Sprinkler L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| AN-04b | AN | LM | BAEA-MI-2007-C-008 | Shiawassee Rookery | 2.51 | 7.08 | 6.24 | 5.08 | 12.85 | 11.38 | 5.61 | 9.29 | 23.04 | 5.26 | 31.40 | 34.56 | ND | 4.52 | 12.17 | 6.92 | ND | ND | ND | 177.90 |
| AP-08e | GL | LH | BAEA-MI-2007-A-014 | Devil's L | ND | ND | ND | ND | 2.11 | 2.11 | 1.00 | ND | 4.57 | 1.00 | 6.44 | 5.71 | ND | ND | 2.77 | 1.00 | ND | ND | ND | 26.71 |
| AR-05b | GL | LH | BAEA-MI-2007-A-013 | Pt AuGres S | ND | ND | ND | ND | 2.71 | 4.00 | 2.46 | 2.87 | 5.53 | 1.00 | 10.41 | 9.94 | ND | ND | 6.47 | 3.72 | ND | ND | 1.00 | 50.10 |
| AR-09b | GL | LH | BAEA-MI-2007-D-008 | Passage Isd | ND | ND | ND | ND | ND | ND | ND | ND | 21.87 | ND | ND | ND | ND | 9.47 | 28.91 | ND | ND | 5.56 | 5.07 | 70.87 |
| BG-02f | IN | UP | BAEA-MI-2007-A-043 | King L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| BG-07b | IN | UP | BAEA-MI-2007-A-034 | Net R Fldg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| BG-11a | GL | LS | BAEA-MI-2007-A-037 | Reeds Pt | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.54 | 2.88 | ND | ND | ND | ND | ND | ND | ND | 5.42 |
| BG-11a | GL | LS | BAEA-MI-2007-A-038 | Reeds Pt | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.32 | 3.58 | ND | ND | ND | ND | ND | ND | ND | 6.90 |
| BG-11a | GL | LS | BAEA-MI-2007-A-039 | Reeds Pt | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.20 | 3.62 | ND | ND | ND | ND | ND | ND | ND | 6.82 |
| BG-14c | IN | UP | BAEA-MI-2007-A-044 | Vermilac L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| BG-14c | IN | UP | BAEA-MI-2007-A-045 | Vermilac L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| BG-18b | GL | LS | BAEA-MI-2007-A-035 | Aura | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 10.87 | 3.66 | ND | ND | ND | 14.53 |
| BY-02f | GL | LH | BAEA-MI-2007-C-001 | Tower S-Onaway | ND | ND | 3.19 | 3.90 | 5.75 | 4.78 | 3.73 | 3.65 | 10.87 | ND | 13.08 | 11.41 | ND | ND | 5.85 | 3.99 | ND | ND | ND | 70.19 |
| CB-03b | IN | LP | BAEA-MI-2007-B-033 | Reeses Bog-UMBS | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CB-10b | IN | LP | BAEA-MI-2007-C-016 | Shiawassee NWR #1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CB-13b | IN | LP | BAEA-MI-2007-C-017 | Shiawassee NWR #2 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CB-17a | IN | LP | BAEA-MI-2007-C-015 | Shiawassee R SGA #1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CP-26d | GL | LH | BAEA-MI-2007-B-053 | Gravel Isd/L | ND | ND | ND | ND | ND | ND | ND | ND | 3.19 | ND | 6.74 | 9.13 | ND | ND | 3.62 | ND | ND | ND | ND | 22.68 |
| CP-27a | GL | LS | BAEA-MI-2007-B-049 | Pendills L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.15 | ND | ND | ND | ND | ND | ND | ND | 5.15 |
| CP-27a | GL | LS | BAEA-MI-2007-B-050 | Pendills L | ND | ND | ND | ND | ND | ND | ND | ND | 3.11 | ND | 8.85 | 10.20 | ND | ND | 5.34 | 2.82 | ND | ND | ND | 30.32 |
| CP-33a | GL | LH | BAEA-MI-2007-A-055 | Sand Isd-Dunbar | ND | ND | ND | ND | ND | ND | ND | 1.00 | 3.27 | ND | ND | 6.15 | ND | ND | ND | ND | ND | ND | ND | 10.42 |
| CP-34a | GL | LH | BAEA-MI-2007-A-054 | Cedar Isd | ND | ND | ND | ND | 1.00 | ND | ND | ND | 4.18 | ND | ND | 8.40 | ND | ND | ND | ND | ND | ND | ND | 13.58 |
| CP-44a | GL | LH | BAEA-MI-2007-B-052 | Sugar Isd NE | ND | ND | ND | ND | 2.18 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.18 |
| CR-02d | IN | LP | BAEA-MI-2007-B-018 | Wakeley L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CR-02d | IN | LP | BAEA-MI-2007-B-019 | Wakeley L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CR-04b | IN | LP | BAEA-MI-2007-B-021 | Chub L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| CR-08c | IN | LP | BAEA-MI-2007-A-002 | Lovells | ND | ND | ND | ND | ND | ND | ND | ND | 2.47 | ND | 4.13 | 5.19 | ND | ND | 2.71 | 1.00 | ND | ND | ND | 15.50 |
| CR-10b | IN | LP | BAEA-MI-2007-A-001 | Shellenbarger L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| DE-29 | GL | LM | BAEA-MI-2007-B-038 | Masonville | ND | ND | ND | ND | 3.65 | ND | ND | ND | 4.39 | ND | 6.56 | 6.12 | ND | ND | ND | ND | ND | ND | ND | 20.73 |
| DE-30b | GL | LM | BAEA-MI-2007-A-032 | Wells | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 4.99 | 4.92 | ND | ND | 1.00 | ND | ND | ND | ND | 10.91 |
| DI-04a | IN | UP | BAEA-MI-2007-A-023 | Fumee L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| DI-14b | IN | UP | BAEA-MI-2007-A-021 | L Antoine | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.00 | 2.04 | ND | ND | ND | ND | ND | ND | ND | 3.04 |
| DI-16a | IN | UP | BAEA-MI-2007-A-019 | Sturgeon Falls Dam N | ND | ND | ND | ND | ND | 1.00 | ND | ND | ND | ND | 5.92 | 5.96 | ND | ND | 5.45 | 1.00 | ND | ND | ND | 19.33 |
| DI-16a | IN | UP | BAEA-MI-2007-A-020 | Sturgeon Falls Dam N | ND | ND | ND | ND | ND | 2.98 | ND | ND | ND | ND | 6.38 | 6.59 | ND | ND | 4.74 | 1.00 | ND | ND | ND | 21.70 |
| GT-06a | GL | LM | BAEA-MI-2007-B-031 | Yuba Valley | ND | ND | ND | ND | ND | ND | ND | 3.13 | 6.09 | ND | 12.04 | 14.75 | ND | ND | 7.45 | 3.71 | ND | ND | ND | 47.18 |
| GT-08a | GL | LM | BAEA-MI-2007-B-028 | Cherry City Airport | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 4.31 | ND | ND | ND | ND | ND | ND | ND | 4.31 |
| HU-08a | GL | LH | BAEA-MI-2007-C-006 | Shiawassee Rookery | ND | ND | ND | ND | 3.32 | ND | 3.76 | ND | ND | ND | 13.63 | 12.54 | ND | ND | 6.57 | ND | ND | ND | ND | 39.83 |
| IO-06b | GL | LH | BAEA-MI-2007-A-012 | Tawas L SW | ND | ND | ND | ND | 2.60 | 1.00 | ND | ND | 5.22 | ND | 6.33 | 6.04 | ND | ND | 3.30 | 1.00 | ND | ND | ND | 25.49 |
| IR-09g | IN | UP | BAEA-MI-2007-B-045 | Paint R-Lower Hemlocl | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-13g | IN | UP | BAEA-MI-2007-B-043 | Dog L-L St Kathryn | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-20b | IN | UP | BAEA-MI-2007-A-029 | Iron L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-030 | Brule L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-031 | Brule L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-28b | IN | UP | BAEA-MI-2007-A-053 | Smokey L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| IR-33b | IN | UP | BAEA-MI-2007-A-027 | Buck/Armstrong L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Table 4. Continued.

| Territory | Breeding Area Location | Territory Location | Blood Sample Number | Breeding Area Name | # 018 | # 028 | # 044 | # 052 | # 066 | # 101 | # 105 | # 110 | # 118 | # 128 | # 138 | # 153 | # 156 | # 170 | # 180 | # 187 | # 195 | # 206 | # 209 | SUM PCBs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KA-04e | IN | LP | BAEA-MI-2007-B-027 | Big Blue/Bass L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| KW-IR | GL | LS | BAEA-MI-2007-E-001 | Caro | ND | ND | ND | ND | 3.21 | ND | 3.67 | ND | 10.84 | 5.13 | 28.93 | 38.25 | 2.08 | ND | 18.71 | 9.73 | 2.76 | 3.29 | ND | 126.58 |
| KW-IR | GL | LS | BAEA-MI-2007-E-002 | Huron City | ND | ND | ND | ND | 7.50 | 4.37 | 8.08 | 2.03 | 25.43 | 13.37 | 66.78 | 88.79 | 4.87 | ND | 42.05 | 22.25 | ND | ND | ND | 285.51 |
| KW-IR | GL | LS | BAEA-MI-2007-E-003 | New Richmond | ND | ND | ND | ND | ND | 2.14 | 1.00 | ND | 4.69 | ND | 11.64 | 16.39 | ND | ND | 8.29 | 4.06 | 2.00 | 2.01 | ND | 52.22 |
| KW-IR | GL | LS | BAEA-MI-2007-E-004 | Stoney Ck Fldg | ND | ND | ND | ND | 3.91 | 2.05 | 4.71 | ND | 16.36 | 6.91 | 35.07 | 53.02 | 3.03 | ND | 25.54 | 14.64 | ND | ND | ND | 165.23 |
| KW-IR | GL | LS | BAEA-MI-2007-E-005 | Tower N-Kleber Pd | ND | ND | ND | ND | 4.25 | 1.00 | 5.09 | ND | 16.95 | 6.82 | 36.69 | 51.90 | 2.94 | ND | 24.73 | 14.47 | ND | ND | ND | 164.83 |
| LU-15a | GL | LS | BAEA-MI-2007-B-054 | Culhane L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| MM-05h | IN | UP | BAEA-MI-2007-C-019 | Knoll View | ND | ND | ND | ND | ND | ND | ND | ND | 4.42 | ND | 10.03 | 10.67 | ND | ND | 5.50 | ND | ND | ND | ND | 30.62 |
| MM-10c | IN | UP | BAEA-MI-2007-A-025 | Pemebonwon Falls/R | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.58 | 3.98 | ND | ND | 2.57 | ND | ND | ND | ND | 10.13 |
| MM-10c | IN | UP | BAEA-MI-2007-A-026 | Pemebonwon Falls/R | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| MM-15a | IN | UP | BAEA-MI-2007-A-017 | Ten Mile Ck-Whitney | ND | ND | ND | 1.00 | 4.89 | 4.04 | 3.33 | ND | 9.70 | ND | 11.83 | 13.94 | 2.36 | ND | 7.78 | 1.00 | ND | ND | ND | 59.88 |
| MM-23a | GL | LM | BAEA-MI-2007-B-039 | Vetorts Pt. | ND | ND | 2.17 | ND | 6.31 | 3.18 | 3.50 | 2.97 | 8.56 | ND | 11.01 | 11.31 | ND | ND | 5.66 | 3.38 | ND | ND | ND | 58.04 |
| MN-04c | AN | LM | BAEA-MI-2007-A-011 | Tippy Dam | ND | ND | ND | 1.00 | 4.09 | 3.16 | 2.96 | 3.08 | 7.09 | 1.00 | 13.50 | 12.46 | ND | 1.00 | 5.99 | 3.02 | ND | ND | ND | 58.35 |
| MN-05e | GL | LM | BAEA-MI-2007-B-004 | Manistee R SGA | ND | ND | ND | ND | 2.18 | ND | ND | 1.00 | 4.00 | ND | 6.05 | 5.88 | ND | ND | ND | ND | ND | ND | ND | 19.11 |
| MN-05e | GL | LM | BAEA-MI-2007-B-005 | Manistee R SGA | ND | ND | ND | ND | 1.00 | ND | ND | ND | 2.28 | ND | ND | 4.15 | ND | ND | ND | ND | ND | ND | ND | 7.43 |
| MN-08f | IN | LP | BAEA-MI-2007-A-009 | Pine/Timmerman L | ND | ND | ND | ND | ND | 2.37 | 1.00 | ND | 2.60 | ND | 5.05 | 4.78 | ND | ND | ND | ND | ND | ND | ND | 15.80 |
| MN-10a | AN | LM | BAEA-MI-2007-A-006 | Little Manastee R | ND | ND | ND | ND | 2.65 | 2.62 | 2.47 | ND | 6.15 | 1.00 | 11.58 | 12.55 | ND | 1.00 | 7.58 | 3.50 | ND | ND | ND | 51.10 |
| MQ-02g | GL | LS | BAEA-MI-2007-A-046 | Conway L-Salmon Trou | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 7.17 | ND | ND | ND | ND | 7.17 |
| MQ-10d | GL | LS | BAEA-MI-2007-B-046 | L Ind.-Yellowdog Swan | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| MQ-10d | GL | LS | BAEA-MI-2007-B-047 | L Ind.-Yellowdog Swan | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 4.92 | ND | ND | ND | ND | ND | ND | ND | 4.92 |
| MQ-19a | IN | UP | BAEA-MI-2007-A-040 | L Michigamme | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| MQ-21b | GL | LS | BAEA-MI-2007-A-050 | Huron Isds NWR W | ND | 3.27 | ND | ND | 9.10 | ND | 13.83 | 12.20 | 37.88 | 17.64 | 80.97 | 115.20 | 7.64 | ND | 59.89 | 33.00 | 3.39 | 5.95 | ND | 399.96 |
| MS-04a | AN | LM | BAEA-MI-2007-B-011 | Pere Marquette L | ND | ND | ND | ND | ND | ND | ND | ND | 2.88 | ND | 6.31 | 6.38 | ND | ND | ND | ND | ND | ND | ND | 15.57 |
| MS-04a | AN | LM | BAEA-MI-2007-B-012 | Pere Marquette L | ND | ND | ND | ND | ND | ND | ND | 2.40 | 4.49 | ND | 7.84 | 7.67 | ND | ND | ND | ND | ND | ND | ND | 22.40 |
| MS-05c | AN | LM | BAEA-MI-2007-B-013 | Walhalla E | ND | ND | ND | ND | ND | ND | ND | 2.52 | 4.75 | ND | 8.62 | 8.36 | ND | ND | ND | ND | ND | ND | ND | 24.24 |
| MS-07a | GL | LM | BAEA-MI-2007-A-007 | Pere Marquette L | ND | ND | ND | 1.00 | 2.83 | 1.00 | ND | ND | 3.92 | 1.00 | 6.48 | 6.33 | ND | ND | 3.18 | 1.00 | ND | ND | ND | 26.73 |
| MS-07a | GL | LM | BAEA-MI-2007-A-008 | Pere Marquette L | ND | 1.00 | ND | 1.00 | 3.57 | 1.00 | 2.62 | ND | 6.09 | ND | 10.02 | 9.78 | ND | 1.00 | 5.58 | 2.82 | ND | ND | ND | 44.48 |
| MY-10b | IN | LP | BAEA-MI-2007-A-015 | Tomahawk Ck Fldg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.00 | 1.00 | ND | ND | ND | ND | ND | ND | ND | 2.00 |
| MY-10b | IN | LP | BAEA-MI-2007-A-016 | Tomahawk Ck Fldg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.09 | 1.00 | ND | ND | ND | ND | ND | ND | ND | 3.09 |
| MY-12b | IN | LP | BAEA-MI-2007-B-037 | Foch Ls Fldg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| NE-01l | AN | LM | BAEA-MI-2007-B-023 | Anderson Bayou | ND | ND | ND | ND | ND | ND | ND | 3.24 | 4.26 | ND | 8.29 | 8.35 | ND | ND | 3.15 | ND | ND | ND | ND | 27.30 |
| NE-03m | IN | LP | BAEA-MI-2007-B-025 | Croton Prairie | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| OG-08b | IN | LP | BAEA-MI-2007-B-006 | Devoe L | ND | ND | ND | ND | ND | ND | ND | ND | 3.23 | ND | 11.39 | 13.79 | ND | ND | 9.12 | 4.73 | ND | ND | ND | 42.26 |
| OS-01h | IN | LP | BAEA-MI-2007-A-005 | Reed Ranch | ND | ND | ND | ND | ND | 2.40 | ND | ND | ND | ND | 3.60 | 3.38 | ND | ND | ND | ND | ND | ND | ND | 9.38 |
| OS-03e | IN | LP | BAEA-MI-2007-B-003 | McKinley | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| OS-05a | IN | LP | BAEA-MI-2007-B-015 | Garland Golf Course | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| OS-08e | IN | LP | BAEA-MI-2007-B-022 | Mio Pd E | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| OW-04b | AN | LM | BAEA-MI-2007-D-012 | Quanicassee | ND | ND | ND | ND | ND | ND | ND | ND | 8.04 | ND | ND | ND | ND | ND | 5.14 | ND | ND | ND | ND | 13.18 |
| OW-04b | AN | LM | BAEA-MI-2007-D-010 | Pickerel Cove | ND | ND | ND | ND | ND | ND | ND | ND | 8.83 | ND | ND | ND | ND | ND | 7.84 | ND | ND | ND | ND | 16.68 |
| OW-04b | AN | LM | BAEA-MI-2007-D-011 | Pickerel Cove | ND | ND | 2.00 | 7.40 | 5.15 | 4.88 | 1.00 | 3.16 | 6.08 | 1.00 | 10.30 | 9.89 | ND | ND | 4.27 | 2.96 | ND | ND | ND | 58.08 |
| PI-07b | IN | LP | BAEA-MI-2007-B-032 | N Br Thunder Bay R | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| RO-05d | IN | LP | BAEA-MI-2007-A-003 | Higgins L | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.00 | 3.44 | ND | ND | 2.04 | ND | ND | ND | ND | 6.48 |
| SC-06b | IN | UP | BAEA-MI-2007-A-042 | E1 Pool (Seney NWR) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 7.38 | 8.89 | ND | ND | 6.65 | ND | ND | ND | ND | 22.93 |
| SG-01f | AN | LH | BAEA-MI-2007-D-004 | Bass R | ND | ND | ND | ND | ND | ND | ND | ND | 7.81 | ND | ND | ND | ND | ND | 6.39 | ND | ND | ND | ND | 14.20 |
| SG-02c | AN | LH | BAEA-MI-2007-D-005 | Hoovers Corners-Mich. | ND | ND | 2.40 | ND | ND | ND | ND | ND | 11.00 | ND | ND | ND | ND | ND | 6.14 | ND | ND | ND | ND | 19.54 |
| SG-02c | AN | LH | BAEA-MI-2007-D-006 | Passage Isd | ND | ND | 2.01 | ND | ND | ND | ND | ND | 7.77 | ND | ND | ND | ND | ND | 4.09 | ND | ND | ND | ND | 13.86 |
| SG-06a | AN | LH | BAEA-MI-2007-D-001 | Campau Rd | ND | ND | ND | ND | ND | ND | ND | ND | 6.51 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 6.51 |
| SG-06a | AN | LH | BAEA-MI-2007-D-002 | Bass R | ND | ND | ND | ND | ND | ND | ND | ND | 7.45 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 7.45 |
| SG-06a | AN | LH | BAEA-MI-2007-D-003 | Bass R | ND | ND | ND | ND | ND | ND | ND | ND | 7.79 | ND | ND | ND | ND | ND | 4.44 | ND | ND | ND | ND | 12.23 |
| SH-01b | IN | LP | BAEA-MI-2007-D-013 | Dinsmoore | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| TU-01c | GL | LH | BAEA-MI-2007-C-002 | Grand Rpds Dam N | ND | ND | ND | ND | 3.36 | ND | 3.05 | ND | ND | ND | 8.54 | 8.03 | ND | ND | 4.22 | ND | ND | ND | ND | 27.21 |
| TU-03c | IN | LP | BAEA-MI-2007-C-005 | Shiawassee Rookery | ND | ND | ND | ND | ND | ND | ND | ND | 8.65 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 8.65 |
| WA-03b | GL | LE | BAEA-MI-2007-D-009 | Todd Harbor-L Harvey | ND | ND | ND | ND | ND | ND | ND | ND | 6.28 | ND | ND | ND | ND | ND | 9.58 | ND | ND | ND | ND | 15.86 |

Table 5. Concentrations of individual organochlorine compounds (ng/g wet weight (ppb)) in nestling bald eagle plasma samples analyzed in 2007. 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 | a-Chlordane | Dieldrin | HCB |
|---|---|---|---|---|---|---|---|
| AG-13b | GL | LS | BAEA-MI-2007-A-033 | Au Sable Pt | 2.13 | 3.37 | ND |
| AG-18a | IN | UP | BAEA-MI-2007-A-049 | Forest L Basin N | ND | ND | ND |
| AL-02j | IN | LP | BAEA-MI-2007-B-016 | Alcona-Bamfield Pd | ND | ND | ND |
| AL-05a | IN | LP | BAEA-MI-2007-B-009 | Sprinkler L | ND | ND | ND |
| AN-04b | AN | LM | BAEA-MI-2007-C-008 | New Richmond | 6.79 | 3.99 | ND |
| AP-08e | GL | LH | BAEA-MI-2007-A-014 | Devil's L | ND | 2.53 | ND |
| AR-05b | GL | LH | BAEA-MI-2007-A-013 | Pt AuGres S | 2.45 | 4.59 | ND |
| AR-09b | GL | LH | BAEA-MI-2007-D-008 | Knoll View | ND | ND | ND |
| BG-02f | IN | UP | BAEA-MI-2007-A-043 | King L | ND | 1.00 | ND |
| BG-07b | IN | UP | BAEA-MI-2007-A-034 | Net R Fldg | ND | 2.07 | ND |
| BG-11a | GL | LS | BAEA-MI-2007-A-037 | Reeds Pt | 2.74 | 3.19 | ND |
| BG-11a | GL | LS | BAEA-MI-2007-A-038 | Reeds Pt | ND | 4.24 | ND |
| BG-11a | GL | LS | BAEA-MI-2007-A-039 | Reeds Pt | ND | ND | ND |
| BG-14c | IN | UP | BAEA-MI-2007-A-044 | Vermilac L | ND | ND | ND |
| BG-14c | IN | UP | BAEA-MI-2007-A-045 | Vermilac L | ND | ND | ND |
| BG-18b | GL | LS | BAEA-MI-2007-A-035 | Aura | ND | ND | ND |
| BY-02f | GL | LH | BAEA-MI-2007-C-001 | Quanicassee | ND | 2.38 | ND |
| CB-03b | IN | LP | BAEA-MI-2007-B-033 | Reeses Bog-UMBS | ND | ND | ND |
| CB-10b | IN | LP | BAEA-MI-2007-C-016 | Tower N-Kleber Pd | ND | ND | ND |
| CB-13b | IN | LP | BAEA-MI-2007-C-017 | Tower S-Onaway | ND | ND | ND |
| CB-17a | IN | LP | BAEA-MI-2007-C-015 | Stoney Ck Fldg | ND | ND | ND |
| CP-26d | GL | LH | BAEA-MI-2007-B-053 | Gravel Isd/L | ND | ND | ND |
| CP-27a | GL | LS | BAEA-MI-2007-B-049 | Pendills L | ND | ND | ND |
| CP-27a | GL | LS | BAEA-MI-2007-B-050 | Pendills L | 2.49 | ND | ND |
| CP-33a | GL | LH | BAEA-MI-2007-A-055 | Sand Isd-Dunbar | ND | ND | ND |
| CP-34a | GL | LH | BAEA-MI-2007-A-054 | Cedar Isd | ND | ND | ND |
| CP-44a | GL | LH | BAEA-MI-2007-B-052 | Sugar Isd NE | ND | ND | ND |
| CR-02d | IN | LP | BAEA-MI-2007-B-018 | Wakeley L | ND | ND | ND |
| CR-02d | IN | LP | BAEA-MI-2007-B-019 | Wakeley L | ND | ND | ND |
| CR-04b | IN | LP | BAEA-MI-2007-B-021 | Chub L | ND | ND | ND |
| CR-08c | IN | LP | BAEA-MI-2007-A-002 | Lovells | ND | 3.28 | ND |
| CR-10b | IN | LP | BAEA-MI-2007-A-001 | Shellenbarger L | ND | 2.55 | ND |
| DE-29 | GL | LM | BAEA-MI-2007-B-038 | Masonville | ND | ND | ND |
| DE-30b | GL | LM | BAEA-MI-2007-A-032 | Wells | ND | ND | ND |
| DI-04a | IN | UP | BAEA-MI-2007-A-023 | Fumee L | ND | ND | ND |
| DI-14b | IN | UP | BAEA-MI-2007-A-021 | L Antoine | ND | 2.84 | ND |
| DI-16a | IN | UP | BAEA-MI-2007-A-019 | Sturgeon Falls Dam N | ND | 4.26 | ND |
| DI-16a | IN | UP | BAEA-MI-2007-A-020 | Sturgeon Falls Dam N | ND | 5.10 | ND |
| GT-06a | GL | LM | BAEA-MI-2007-B-031 | Yuba Valley | 2.59 | ND | ND |
| GT-08a | GL | LM | BAEA-MI-2007-B-028 | Cherry City Airport | ND | ND | ND |
| HU-08a | GL | LH | BAEA-MI-2007-C-006 | Huron City | 2.50 | 2.62 | ND |
| IO-06b | GL | LH | BAEA-MI-2007-A-012 | Tawas L SW | 3.02 | 4.00 | ND |
| IR-09g | IN | UP | BAEA-MI-2007-B-045 | Paint R-Lower Hemlock Rpd | ND | ND | ND |
| IR-13g | IN | UP | BAEA-MI-2007-B-043 | Dog L-L St Kathryn | ND | ND | ND |
| IR-20b | IN | UP | BAEA-MI-2007-A-029 | Iron L | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-030 | Brule L | ND | ND | ND |
| IR-26c | IN | UP | BAEA-MI-2007-A-031 | Brule L | ND | 2.11 | ND |
| IR-28b | IN | UP | BAEA-MI-2007-A-053 | Smokey L | ND | ND | ND |
| IR-33b | IN | UP | BAEA-MI-2007-A-027 | Buck/Armstrong L | ND | 2.46 | ND |
| KA-04e | IN | LP | BAEA-MI-2007-B-027 | Big Blue/Bass L | ND | ND | 1.00 |
| KW-IR | GL | LS | BAEA-MI-2007-E-001 | Passage Isd | ND | 5.18 | 1.00 |
| KW-IR | GL | LS | BAEA-MI-2007-E-002 | Passage Isd | 9.57 | 8.83 | 1.00 |
| KW-IR | GL | LS | BAEA-MI-2007-E-003 | Todd Harbor-L Harvey | ND | 2.97 | ND |
| KW-IR | GL | LS | BAEA-MI-2007-E-004 | Pickerel Cove | 6.89 | 8.39 | 1.00 |
| KW-IR | GL | LS | BAEA-MI-2007-E-005 | Pickerel Cove | 7.88 | 9.75 | 1.00 |
| LU-15a | GL | LS | BAEA-MI-2007-B-054 | Culhane L | ND | ND | ND |
| MM-05h | IN | UP | BAEA-MI-2007-C-019 | Grand Rpds Dam N | ND | 1.00 | ND |
| MM-10c | IN | UP | BAEA-MI-2007-A-025 | Pemebonwon Falls/R | ND | ND | ND |
| MM-10c | IN | UP | BAEA-MI-2007-A-026 | Pemebonwon Falls/R | ND | ND | ND |
| MM-15a | IN | UP | BAEA-MI-2007-A-017 | Ten Mile Ck-Whitney | 3.52 | 7.12 | ND |
| MM-23a | GL | LM | BAEA-MI-2007-B-039 | Vetorts Pt. | 3.03 | 1.00 | ND |
| MN-04c | AN | LM | BAEA-MI-2007-A-011 | Tippy Dam | 3.02 | 4.29 | ND |
| MN-05e | GL | LM | BAEA-MI-2007-B-004 | Manistee R SGA | ND | ND | ND |

Table 5. Continued.

| Territory | Breeding Area Location | Territory Location | Blood Sample Number | Breeding Area Name | a-Chlordane | Dieldrin | HCB |
|---|---|---|---|---|---|---|---|
| MN-05e | GL | LM | BAEA-MI-2007-B-005 | Manistee R SGA | ND | ND | ND |
| MN-08f | IN | LP | BAEA-MI-2007-A-009 | Pine/Timmerman L | ND | 4.27 | ND |
| MN-10a | AN | LM | BAEA-MI-2007-A-006 | Little Manastee R | 3.46 | 4.99 | ND |
| MQ-02g | GL | LS | BAEA-MI-2007-A-046 | Conway L-Salmon Trout R | ND | ND | ND |
| MQ-10d | GL | LS | BAEA-MI-2007-B-046 | L Ind.-Yellowdog Swamp | ND | ND | ND |
| MQ-10d | GL | LS | BAEA-MI-2007-B-047 | L Ind.-Yellowdog Swamp | ND | ND | ND |
| MQ-19a | IN | UP | BAEA-MI-2007-A-040 | L Michigamme | ND | ND | ND |
| MQ-21b | GL | LS | BAEA-MI-2007-A-050 | Huron Isds NWR W | ND | ND | 2.27 |
| MS-04a | AN | LM | BAEA-MI-2007-B-011 | Pere Marquette L | ND | ND | ND |
| MS-04a | AN | LM | BAEA-MI-2007-B-012 | Pere Marquette L | ND | ND | ND |
| MS-05c | AN | LM | BAEA-MI-2007-B-013 | Walhalla E | ND | ND | ND |
| MS-07a | GL | LM | BAEA-MI-2007-A-007 | Pere Marquette L | 3.01 | 4.97 | ND |
| MS-07a | GL | LM | BAEA-MI-2007-A-008 | Pere Marquette L | 3.45 | 4.68 | ND |
| MY-10b | IN | LP | BAEA-MI-2007-A-015 | Tomahawk Ck Fldg | ND | 2.91 | ND |
| MY-10b | IN | LP | BAEA-MI-2007-A-016 | Tomahawk Ck Fldg | ND | 2.21 | ND |
| MY-12b | IN | LP | BAEA-MI-2007-B-037 | Foch Ls Fldg | ND | ND | ND |
| NE-01l | AN | LM | BAEA-MI-2007-B-023 | Anderson Bayou | ND | ND | ND |
| NE-03m | IN | LP | BAEA-MI-2007-B-025 | Croton Prairie | ND | ND | ND |
| OG-08b | IN | LP | BAEA-MI-2007-B-006 | Devoe L | ND | ND | ND |
| OS-01h | IN | LP | BAEA-MI-2007-A-005 | Reed Ranch | ND | 3.82 | ND |
| OS-03e | IN | LP | BAEA-MI-2007-B-003 | McKinley | ND | ND | ND |
| OS-05a | IN | LP | BAEA-MI-2007-B-015 | Garland Golf Course | ND | ND | ND |
| OS-08e | IN | LP | BAEA-MI-2007-B-022 | Mio Pd E | ND | ND | ND |
| OW-04b | AN | LM | BAEA-MI-2007-D-010 | Bass R | ND | ND | ND |
| OW-04b | AN | LM | BAEA-MI-2007-D-011 | Bass R | ND | ND | ND |
| OW-04b | AN | LM | BAEA-MI-2007-D-012 | Bass R | 3.70 | 4.27 | ND |
| PI-07b | IN | LP | BAEA-MI-2007-B-032 | N Br Thunder Bay R | ND | ND | ND |
| RO-05d | IN | LP | BAEA-MI-2007-A-003 | Higgins L | ND | 2.69 | ND |
| SC-06b | IN | UP | BAEA-MI-2007-A-042 | E1 Pool (Seney NWR) | 2.12 | 2.46 | ND |
| SG-01f | AN | LH | BAEA-MI-2007-D-004 | Shiawassee R SGA #1 | ND | ND | ND |
| SG-02c | AN | LH | BAEA-MI-2007-D-005 | Shiawassee NWR #1 | ND | ND | ND |
| SG-02c | AN | LH | BAEA-MI-2007-D-006 | Shiawassee NWR #2 | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-001 | Shiawassee Rookery | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-002 | Shiawassee Rookery | ND | ND | ND |
| SG-06a | AN | LH | BAEA-MI-2007-D-003 | Shiawassee Rookery | ND | ND | ND |
| SH-01b | IN | LP | BAEA-MI-2007-D-013 | Hoovers Corners-Mich. Peat | ND | 2.50 | ND |
| TU-01c | GL | LH | BAEA-MI-2007-C-002 | Dinsmoore | ND | 2.24 | ND |
| TU-03c | IN | LP | BAEA-MI-2007-C-005 | Caro | ND | ND | ND |
| WA-03b | GL | LE | BAEA-MI-2007-D-009 | Campau Rd | ND | ND | ND |