2018

Exposure of bald eagle nestlings to contaminants on National Park Service lands within the Chesapeake Bay

B. D. Watts
The Center for Conservation Biology, bdwatt@wm.edu

B. J. Paxton
The Center for Conservation Biology, bjpaxt@wm.edu

M. L. Pitts
The Center for Conservation Biology

Recommended Citation
Watts, B. D., B. J. Paxton, and M. L. Pitts. 2018. Exposure of bald eagle nestlings to contaminants on National Park Service lands within the Chesapeake Bay. The Center for Biology Technical Report Series, CCBTR-18-13. College of William and Mary and Virginia Commonwealth University. 57 pp.

EXPOSURE OF BALD EAGLE NESTLINGS TO CONTAMINANTS ON NATIONAL PARK SERVICE LANDS WITHIN THE CHESAPEAKE BAY

THE CENTER FOR CONSERVATION BIOLOGY

COLLEGE OF WILLIAM AND MARY

VIRGINIA COMMONWEALTH UNIVERSITY

Exposure of bald eagle nestlings to contaminants on National Park Service lands within the Chesapeake Bay

Bryan D. Watts, PhD
Barton J. Paxton
Marie L. Pitts
The Center for Conservation Biology
College of William and Mary & Virginia Commonwealth University

Recommended Citation:

Watts, B. D., B. J. Paxton, and M. L. Pitts. 2018. Exposure of bald eagle nestlings to contaminants on National Park Service lands within the Chesapeake Bay. The Center for Biology Technical Report Series, CCBTR-18-13. College of William and Mary and Virginia Commonwealth University. 57 pp.

Project Partners:

National Park Service
U.S. Department of Defense
U.S. Fish and Wildlife Service
Virginia Department of Transportation
The Center for Conservation Biology

Front Cover: Eaglet along the James River after blood collection. Photo by Bryan Watts.

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

Table of Contents

Contents

EXECUTIVE SUMMARY

We examined breeding performance (N=921) and nestling exposure (N=25 nests) to heavy metals (cadmium, lead, mercury), polychlorinated biphenyls (PCBs - 91 congeners) and organochlorine pesticides (OCPs - 11 compounds) for bald eagles nesting on National Park Service (NPS) and associated lands within the Chesapeake Bay (2016-2018). Nesting pairs on NPS lands were consistently more successful and had higher reproductive rates compared to other pairs along the James/York River study area but these differences were not statistically significant. Mean reproductive rates were above the level believed to be required for population maintenance for all areas examined. Blood concentrations of heavy metals were generally low and varied between metals examined. Cadmium did not exceed the level-of-detection (LOD) for any sample. Detection frequencies for Lead and Mercury were 86 and 100% respectively. Lead concentrations (range = 0.21-0.88, geometric mean = 0.49 ųg/g ww) were low and no sample exceeded the level (<10 ųg/dL) believed to represent background for raptors. Blood concentrations (range = 0.106-0.903, geometric mean = 0.335 ųg/g ww) of mercury were toward the lower to middle range of values reported from other studies of nestlings. Broods reared around lakes or tidal-fresh reaches had higher concentrations than broods reared around high-saline waters. No samples approached the general threshold (>3.0 ųg/g ww) believed to result in possible reproductive impacts. Total PCB concentrations estimated during this study (range = 1.35-23.51, geometric mean = 6.34 ng/g ww) were on the low end of values reported from other regions. A cluster of the highest values were found within the lower James River. However, the highest values represented approximately 10% of the threshold (190 ng/g ww) suggested for reproductive impairment and 50% of the threshold (36 µg/kg) suggested for no-observed-adverse-effect-level (NOEL). Total OCP concentrations (range = 0.87-8.78, geometric mean = 2.68 ng/g ww) were lower than those reported from most other populations. p,p'-DDE was the most widespread pesticide compound and accounted for 93% of the total OCP values. Concentrations of p,p'-DDE (range = 0.6-8.78, geometric mean of 2.41 ng/g ww) were all below the level suggested for reproductive impairment (28 ng/g ww) and below the NOEL (11.4 ng/g ww) for productivity. Total concentrations of PCBs and OCPs were positively correlated (r=0.62, P<0.01) suggesting that these classes of compounds have common exposure pathways.

BACKGROUND

The Chesapeake Bay is one of the most productive aquatic ecosystems in the world and provides significant habitat to many species of aquatic and terrestrial consumers (Lippson and Lippson 1984). The Bay supports several top predators that may be susceptible to biomagnification of contaminants and so represent potential biosentinels for ecosystem health. Bald eagles (*Haliaeetus Leucocephalus*) are particularly well suited for this role because they are tertiary consumers that feed on a range of taxa throughout the year (Mersman 1989, Markham 2004), have been monitored extensively for several decades (Watts et al. 2007, 2008) and have known demographic responses to major classes of contaminants (Elliott and Harris, 2001, Bowerman et al., 2003, Dykstra et al., 2005, DeSorbo et al., 2018). Nestlings are of particular interest for contaminant monitoring because any contaminants that they receive are provided by parents directly from the territory they defend making a link between contaminants and the locality (Olsson et al., 2000). Nestlings have become a common unit for assessing the availability of contaminants throughout North America.

The bald eagle population within the Chesapeake Bay has experienced dramatic swings over the past century (Tyrrell 1936, Watts et al., 2008). During the post World War II era the population experienced catastrophic declines (Abbott 1963, Watts et al. 2007) reaching a low of approximately 60 breeding pairs by the early 1970s (Abbott 1978). The primary cause of the decline has been attributed to exposure to persistent organic pollutants (POPs) including polychlorinated biphenyls (PCBs) and particularly p,p'-dichlorodiphenyltrichloroethylene (p,p'-DDE) which is a main degradation product of dichlorodiphenyltrichloroethane (DDT) (Wiemeyer et al., 1984, 1993). Since the 1970s the population has experienced exponential recovery reaching 646 pairs by 2001 (Watts et al., 2007, 2008) and is now believed to include more than 2,000 breeding pairs (Watts et al., unpublished data). Recovery has included an increase in the number of breeding territories, an increase in reproductive rate, and an expansion in geographic distribution. Growth rate has been exponential with an average doubling time of 8.2 years. Reproductive rate has increased from 0.2 in the early 1960s to more than 1.5 young per pair by the early 2000s and is now comparable to pre-DDT levels (Watts et al., 2008). Reproductive rates have exceeded that believed to be required for a stable population in every year since 1984.

Unlike some other populations such as the Great Lakes, there has been no attempt to establish a bald eagle biosentinel program to monitor contaminant levels within the Chesapeake Bay. With the exception of some targeted efforts (Mojica and Watts 2011, Watts et al., 2012), we have very little recent information on bald eagle exposure to contaminants within the Bay. Federal, state and other conservation lands are critical to the long-term maintenance of the Chesapeake Bay bald eagle population. These lands may also represent an opportunity to use bald eagles to monitor contaminant levels in the broader Bay.

OBJECTIVES

The primary objectives of this project are 1) to assess exposure of nestling eagles reared within and around National Park Service properties within the lower Chesapeake Bay to contaminants (heavy metals, legacy classes of organochlorine compounds, Polybrominated diphenyl ethers, etc.) and 2) to compare reproductive rates of pairs within and around parks to the populations within the estuarine systems (James River, York River, Potomac River) in which they are embedded.

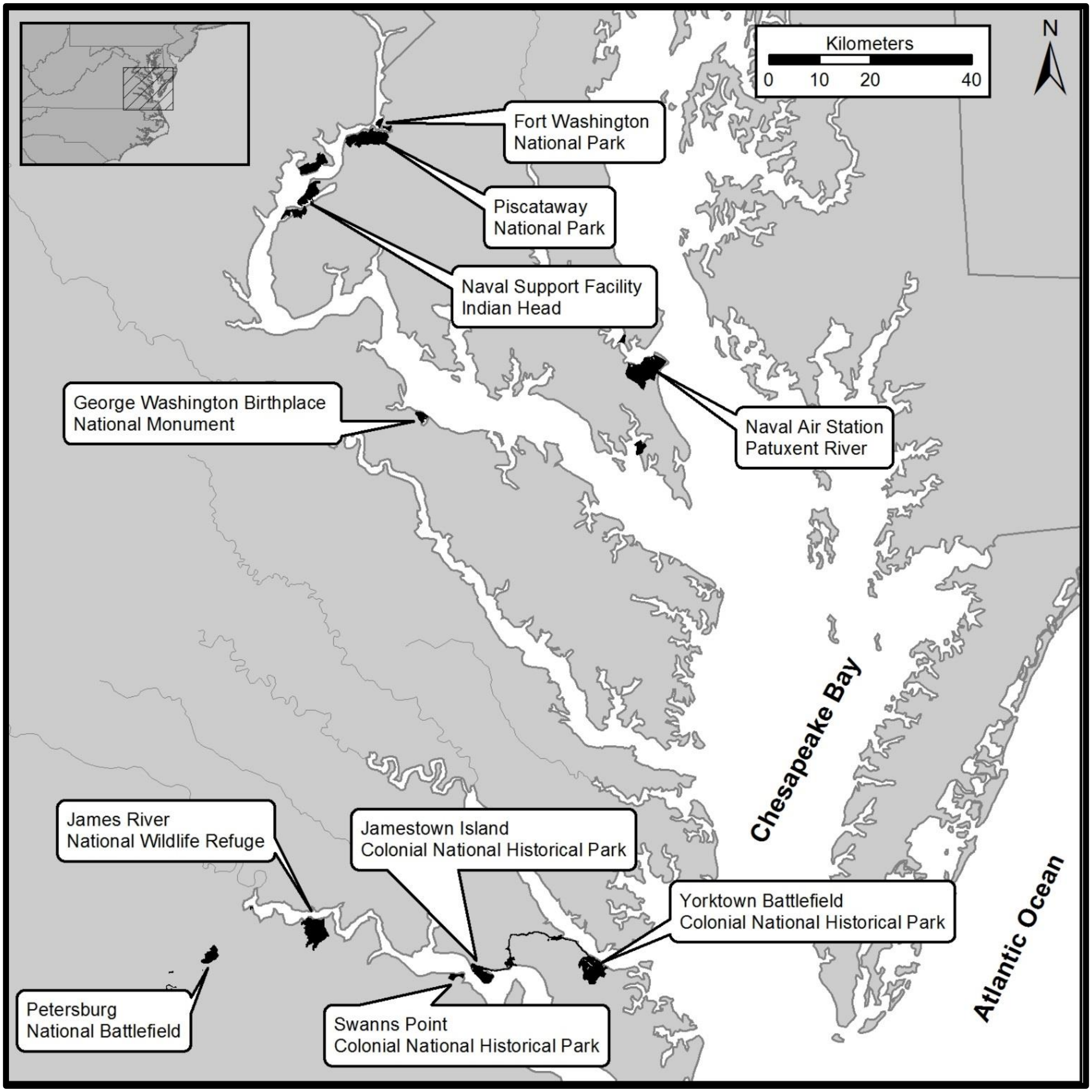
METHODS

Study Area

We examined the exposure of bald eagle nestlings to contaminants within the Chesapeake Bay. The Chesapeake Bay is the largest estuary in the United States, containing more than 19,000 km of tidal shoreline. The Bay's wide salinity gradient, shallow water and climate have made it one of the most productive aquatic ecosystems in North America. Bald Eagles breed throughout the estuary from the Atlantic Ocean to the fall line. The population using the Bay declined throughout the 1950s and 1960s due primarily to exposure to organochlorine pesticides (Byrd et al., 1990). The breeding population reached a low in the early 1970s but has been growing exponentially over the past four decades with an average doubling time of less than 8 years (Watts et al., 2007, 2008). Despite recoveries, the exposure to contaminants continues to be a concern for wildlife populations throughout the Chesapeake Bay (e.g., Rattner and McGowan 2007, Chen et al., 2010).

We collected blood samples from nestling bald eagles on federal lands and near private lands from the James River north to the Potomac River (Figure 1). Our study area included selected properties within the National Capital and Northeast regions of the National Park Service and tributaries of the Chesapeake Bay in which they are embedded. We surveyed all eagle habitat within the boundaries of selected properties including Colonial National Historical Park, Washington's Birthplace National Monument, National Colonial Farm and Piscataway Park, Fort Washington and Petersburg Battlefield. Nearby U.S. Department of Defense (Indian Head and Patuxent Naval Air Station) and U.S. Fish and Wildlife Service (James River National Wildlife Refuge, Mason Neck National Wildlife Refuge) lands were also sampled. In addition to targeted National Park Service properties, we surveyed portions of the tributaries (Potomac, York and James) in which they are embedded as part of ongoing monitoring programs being conducted by The Center for Conservation Biology.

Figure 1. Map of properties within the Chesapeake Bay where eagle nestling blood samples (N=25 nests) were collected (2016-2018).



Breeding Performance

We systematically surveyed study areas for breeding eagles using a standard 2-flight approach (Fraser et al., 1983) including 1) a survey flight and 2) a productivity fight. The survey flight was conducted from late February through late March to coincide with the peak of incubation. The productivity flight was conducted from mid-April through early May to take advantage of later brood ages.

Nest Survey

We used aerial surveys to locate and map bald eagle nests throughout the NPS targeted properties and portions of the broader James, York (2016-2018) and Potomac rivers (2017). We used a high-wing Cessna 172 aircraft to systematically overfly the land surface at an altitude of approximately 100 m to detect eagle nests. Flights covered all lands within the boundaries of the national parks. Throughout the broader tributaries the survey plane was maneuvered systematically between the shoreline and a distance of approximately 1 km to cover the most probable breeding locations. Because bald eagles often nest near the headwaters of small streams, a special attempt was made to follow all waterways to their headwaters. All nests detected were plotted on 7.5 min topographic maps or a GPS-enabled laptop loaded with recent aerial imagery and assigned a unique, 3-part code that conforms to national standards.

Productivity Survey (Survey 2)

Active Bald Eagle nests were rechecked between mid-April and mid-May for productivity. A Cessna 172 aircraft was used to fly low over nests, allowing observers to examine nest contents. All eaglets were counted and aged by sight. Following national conventions (USFWS 2007, Watts et al. 2008), we considered a breeding territory to be "occupied" if a pair of birds was observed in association with the nest and there was evidence of recent nest maintenance (e.g., well-formed cup, fresh lining, structural maintenance). We considered a nest to be "active" if a bird was observed in an incubating posture or if eggs or young were detected in the nest. We defined breeding success as the percentage of occupied nests that contained ≥ one young, reproductive rate as the number of young per occupied territory, and average brood size as the number of young per successful nest.

Banding

We accessed nests using standard arborist equipment when broods were between 32 and 45 days old. Young were captured in the nest and lowered to the ground in cloth bags for banding, measurement and tissue collection. Nestlings were marked with #9 aluminum rivet bands with engraved, unique numeric codes (USGS Bird Banding Lab, Laurel, MD) on the right tarsus and purple alpha-numeric auxiliary bands (ACRAFT Sign and Nameplate, Edmonton, Alberta) on the left tarsus. We collected morphometric measurements including mass (± 1 g), wing length (± 1 mm) measured from the bend of the wing to the tip of the longest primary, tail length (± 1 mm) measured from the insertion of retrices to the tip of the longest retrix, culmen length (± 0.1 mm) measured from the feather line along the base of the upper mandible to the tip, culmen depth (± 0.1 mm) measured from the feather line along the base of the upper mandible to the feather line of the lower mandible, and hallux length (± 0.1 mm) measured from the emergence from skin to the tip. Nestlings were weighed on a digital scale. Wing and tail length were measured using a metric wing ruler. Culmen and hallux were measured using metric dial calipers. All banding was conducted with authorizations under Bird Banding Permit #21567.

Blood Collection

We assumed that brood mates experienced identical exposure to contaminants and so collected blood samples from a single young per brood. In most cases, the largest young in the brood was sampled. We collected blood samples from the brachial vein using 23-guage butterfly needles and 4-cc heparinized BD Vacutainers©. We used leather hoods to calm birds, swabbed the vein with alcohol, inserted the needle and used vacuum tubes to draw blood. After blood was drawn, we used a cotton swab to apply pressure on the wound site for 1-2 minutes until the bleeding stopped. A maximum of 6cc of blood was collected in three vials. We collected a purple-topped vial for metals assay, a green-topped vial for a broad-spectrum assessment of persistent organic pollutants and a tan-topped vial to be sent to West Virginia University for inclusion in a lead isotope study. We labeled all samples with the nestling's band number, unique nest code and date of collection. We immediately packed blood samples on ice and froze them within four hours of collection. Methodology for eagle handling and tissue collection was in compliance with protocols approved by the Institutional Animal Care and Use Committee at the College of William and Mary (protocol IACUC-2017-04-18-12065).

Laboratory Analysis

Heavy Metals

Heavy metals including cadmium (Cd), Mercury (Hg) and Lead (Pb) were analyzed by the Wisconsin State Laboratory of Hygiene (Environmental Health Division). The analytical methods used were adapted from the U.S. Centers for Disease Control and Prevention (CDC) laboratory procedure manual CTL-TMS-3.01 (Wisconsin State Laboratory of Hygiene 2016). Whole blood concentrations were assessed using the Perkin Elmer Elan DCR II inductively coupled plasma-mass spectrometer and the Perkin Elmer Nexion 350D, inductively coupled plasma-mass spectrometer. Limits of quantification include 0.21 ug/L for Cd, 0.12 ug/L for Hg and 0.20 ug/dL for Pb.

Persistent Organic Pollutants

Persistent organic pollutants (POPs) were analyzed at the Virginia Institute of Marine Science, College of William and Mary (Rob Hale's Lab). Procedures of sample preparation were similar to those previously described (Chen et al., 2010). Blood samples were weighed, mixed with diatomaceous earth, spiked with known amount of surrogate recovery standards (PCB-30, -65, and -204 for PCBs, PCB-204 for OCPs) and subjected to accelerated solvent extraction (Dionex ASE 200, Sunnyvale, CA), employing two 5-min extraction cycles with dichloromethane (DCM) at 100 oC and 1000 psi. Samples were analyzed for pesticides including trans-chlordane, cis-chlordane, trans-nonachlor, cis-nonachlor, methoxy-triclosan, o,p'-DDE, o,p'-DDD, o,p'-DDT, p,p'-DDE, p,p'-DDD, p,p'-DDT. These pesticides were analyzed on a Varian 3400 GC (Varian, Walnut reek, CA), coupled with a Varian Saturn 4-D MS, in the EI mode. Samples were also tested for polychlorinated biphenyls (PCBs) including PCB-16/32, PCB-17, PCB-18, PCB-22, PCB-25, PCB-26, PCB-28/31, PCB-20/33, PCB-40, PCB-41/64, PCB-42/59, PCB-44, PCB-45, PCB-46, PCB-47/48, PCB-49, PCB-52, PCB-53, PCB-56/60, PCB-63, PCB-66, PCB-67, PCB-70, PCB-74, PCB-77, PCB-82, PCB-83, PCB-84, PCB-85, PCB-87/115, PCB-90-101, PCB-92, PCB-97, PCB-99, PCB-105, PCB-107, PCB-118, PCB-123, PCB-128, PCB-129, PCB-130, PCB-131/165, PCB-132/153, PCB-134, PCB-135, PCB-136, PCB-137, PCB-138/158, PCB-141/179, PCB-146, PCB-149, PCB-151, PCB-156, PCB-163/164, PCB-167, PCB-170/190, PCB-171, PCB-172,

PCB-174, PCB-175, PCB-176, PCB-177, PCB-178, PCB-180/193, PCB-183, PCB-185, PCB-187, PCB-191, PCB-195, PCB-200, PCB-201, PCB-206, PCB-208, and PCB-209. The analysis of 91 PCB congeners was performed on a Varian CP-3800 GC (Varian, Walnut Creek, CA) coupled with a Varian Saturn 2000 MS (Varian, Walnut Creek, CA) operated in the electron ionization (EI) mode. Laboratory QA/QC procedures included the examination of procedural blanks, target analyte recoveries in spiking experiments, and surrogate standard recoveries in authentic samples.

Statistical Analysis

We compared breeding performance (success rate and reproductive rate) between nests on National Park Service lands and their associated tributaries. Success rates were compared using frequency statistics (G-test for independence using Yates correction). We tested for possible differences in reproductive rates using a simple one-way ANOVA where property (NPS vs other) was the grouping parameter. We examined possible relationships between classes of POPs using Pearson Product Moment correlations.

Results of contaminant analyses were highly skewed with many samples falling below the level of detection (LOD). For this reason, we presented results as detection frequencies (% of samples above LOD), ranges and geometric means.

RESULTS

Breeding Performance

We monitored 921 "territory years" on the James/York and Potomac River tributaries (2016-2018) including 42 on focal properties managed by the National Park Service (Appendices 1-4). Pairs were documented to make 790 (85.8%) breeding attempts and 609 (77.1%) of these were successful (Table 1). Overall breeding success was higher (86.8% vs 76.6%) on NPS properties compared to other nests on associated tributaries (Table 1). This difference was driven by consistently higher performance on NPS properties along the James/York Rivers. Breeding performance along the Potomac River was comparable between NPS and other nests. Despite higher performance on NPS lands the difference was not statistically significant (all G-statistics <2.6, P>0.1).

As with breeding success, reproductive rates were consistently higher for pairs on NPS lands compared to others along the James River but not along the Potomac River (Figure 2). All reproductive rates were well above 1 young/pair. Despite these differences, none of the comparisons were significant due to the low sample sizes on NPS lands (Table 2).

Table 1. Nesting success for breeding pairs on target National Park Service (NPS) lands and pairs on other properties along associated tributaries. Values are number of occupied territories monitored and (number of pairs that produced) >1 young.

Tributary	Year	NPS	NPS%	Other	Other%
James/York River	2016	12(10)	83.3	243(173)	71.2
James/York River	2017	8(7)	87.5	228(179)	78.5
James/York River	2018	11(10)	90.9	233(181)	77.7
Potomac	2017	7(6)	85.7	48(43)	89.6
Total		**38(33)**	**86.8**	**752(576)**	**76.6**

Figure 2. Reproductive rates for bald eagles (N=921) monitored by aerial surveys (2016-2018). Figure compares nests on National Park Serve lands (black bars) and nests on tributaries (open bars) in which the parks are embedded.

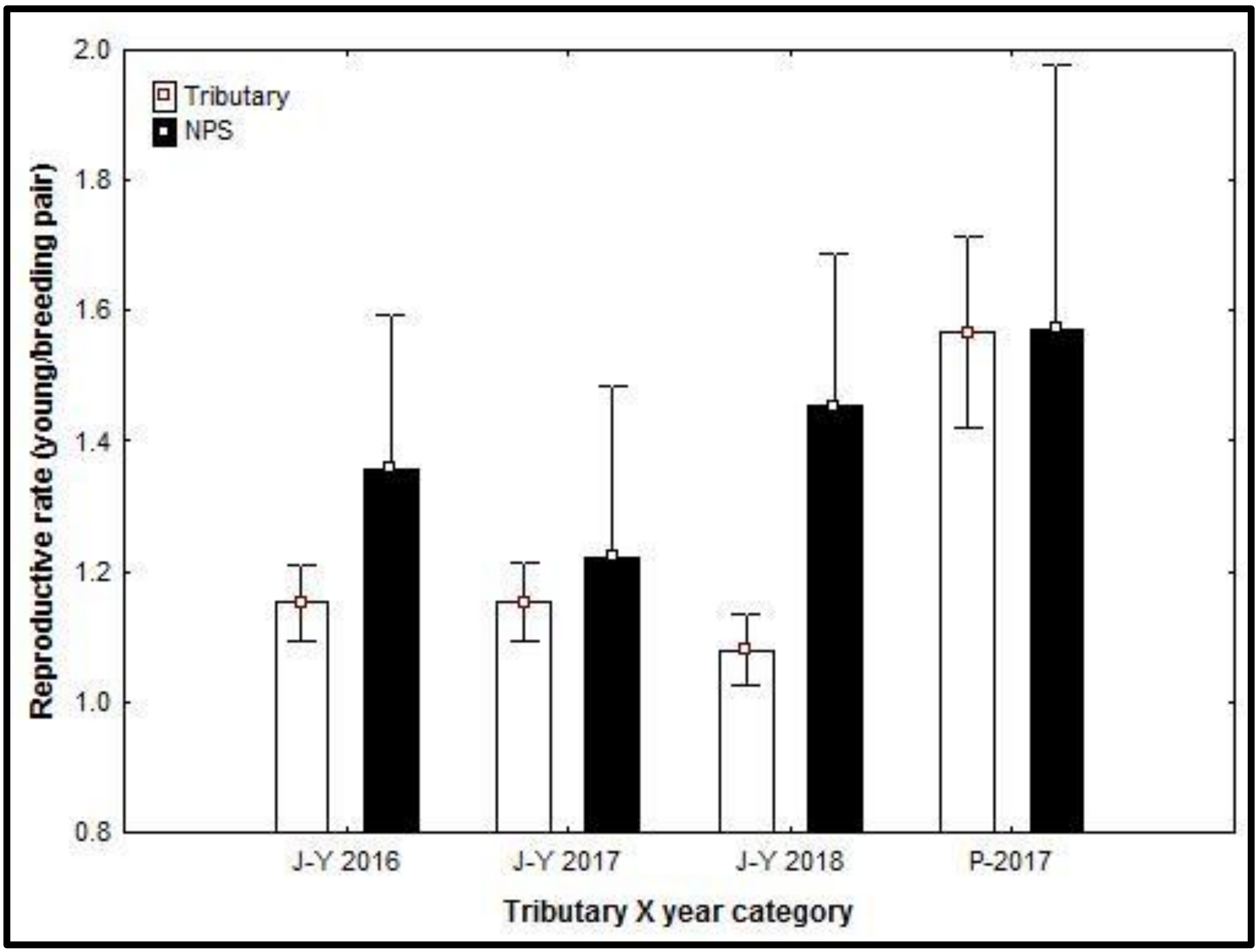


Table 2. Results of one-way ANOVAs comparing bald eagle reproductive rates (2016-2018) between National Park Service properties and associated tributaries within the Chesapeake Bay.

Source	DF	SS	MS	F	P
James-York 2016					
Intercept	1	83.9	83.9	79.5	<0.001
Property	1	0.6	0.6	0.5	0.466
Error	295	311.7	1.1		
James-York 2017					
Intercept	1	49.1	49.1	51.1	<0.001
Property	1	0.1	0.1	<0.1	0.836
Error	261	250.6	0.9		
James-York 2018					
Intercept	1	67.9	67.9	75.3	<0.001
Property	1	1.5	1.5	1.7	0.199
Error	287	311.7	0.9		
Potomac 2017					
Intercept	1	58.1	58.1	62.8	<0.001
Property	1	<0.01	<0.01	<0.01	0.992
Error	42	258.9	0.9		

Heavy Metals

We banded and measured 56 eaglets from 25 nests (2016-2018) on NPS and associated lands (Table 3, Appendix 5). We collected blood samples (N=25) from a single young within each nest. Blood concentrations varied widely between metals evaluated (Appendix 6). Cadmium levels were not above LOD for any sample collected. All but three samples had lead levels above LOD. Lead levels in nestlings were generally very low. One sample from Petersburg Battlefield was an order of magnitude higher than most of the remaining samples (Appendix 5). Mercury was the most widespread of the metals with concentrations above LOD within all samples. In general, broods reared around fresh-water lakes or tidal-fresh reaches (e.g. Owl Creek, Newport News Reservoir, Piscataway, Mason Neck, James River Refuge) had higher concentrations than broods reared around higher saline reaches (e.g. Yorktown Battlefield, Jamestown Island, Patuxent River, NAS, Kingsmill, Lawnes Creek, Washington's Birthplace) (Appendix 5).

Table 3. List of nests and locations where bald eagle nestling blood samples were taken for contaminant analysis.

Nest Name	Year	Date	Location	Latitude	Longitude	County	State
IW0802	2016	4/23/2016	Lawnes Creek	37.139173	-76.668017	Isle of Wight	VA
JC0501	2016	4/23/2016	NPS nr Kingsmill	37.223787	-76.686643	James City	VA
JC0803	2016	5/8/2016	Jamestown Island	37.196927	-76.756874	James City	VA
JC1105	2016	4/18/2016	Gospel Spreading Farm	37.221063	-76.726244	James City	VA
JC1202	2016	4/18/2016	Jamestown Island	37.208628	-76.767483	James City	VA
SU1404	2016	4/15/2016	Swan Point	37.204837	-76.805537	Surry	VA
SU1602	2016	4/15/2016	Scotland West	37.185700	-76.789893	Surry	VA
VB1501	2016	5/11/2016	Owl Creek	36.823300	-75.984630	Virginia Beach	VA
YK0701	2016	5/8/2016	Newport News Reservoir	37.193489	-76.520892	Newport News	VA
YK1503	2016	4/15/2016	Yorktown Battlefield	37.224238	-76.494181	York	VA
YK1601	2016	4/18/2016	Yorktown Creek	37.231119	-76.516167	York	VA
FF1610	2017	5/4/2017	Mason Neck NWR	38.624588	-77.174891	Fairfax	VA
FF1611	2017	5/4/2017	Mason Neck NWR	38.621108	-77.189308	Fairfax	VA
IH-12	2017	5/3/2017	Indian Head	38.602903	-77.170288	Charles	MD
IH-18	2017	5/3/2017	Indian Head	38.550179	-77.228536	Charles	MD
IH-26	2017	5/3/2017	Indian Head	38.566365	-77.177560	Charles	MD
PAX-11 Pine Hill Run	2017	5/2/2017	Patuxen River NAS	38.266633	-76.426179	Saint Mary's	MD
PAX-13 Golf Course	2017	5/2/2017	Patuxen River NAS	38.305733	-76.393560	Saint Mary's	MD
PAX-5 Goose Creek	2017	5/2/2017	Patuxen River NAS	38.298713	-76.383305	Saint Mary's	MD
Piscataway Park West	2017	5/9/2017	Piscataway NP	38.688620	-77.080295	Charles	MD
WE1109	2017	5/8/2017	George Washington's Birthplace NP	38.191146	-76.915450	Westmoreland	VA
WE1110	2017	5/8/2017	George Washington's Birthplace NP	38.175437	-76.922633	Westmoreland	VA
PB1701	2018	4/26/2018	Petersburg Battlefield	37.230493	-77.373455	Petersburg	VA
PG0603	2018	4/26/2018	Nr Blairs	37.294780	-77.135217	Prince George	VA
PG0902	2018	4/26/2018	James River, NWR	37.290741	-77.136860	Prince George	VA

Persistent Organic Pollutants

Among the suites of PCB and OCP congeners, 14 PCB substances and six OCP congeners had concentrations above LOD (Table 4, Appendix 7). Among the two classes of POPs measured total PCBs (Σ91PCBs) exhibited the highest concentrations (nd – 23.51 ng/g ww) with a geometric mean of 6.34 compared to OCPs (Σ11OCPs) with a concentration range of nd – 8.775 ng/g 11) and a geometric mean of 2.678. Despite the different sources of these compounds, their concentrations were positively correlated (r=0.62, P<0.01). This relationship among different groups of organic pollutants has been previously observed in eagles from the Great Lakes region (Venier et al., 2010). Exposure of bald eagles to POPs is mainly from the diet. Biomagnification factors for these groups are generally of the same order of magnitude and they are generally resistant to metabolism (Dahmardeh Behrooz et al., 2009; Gao et al., 2015). Significant correlations among the studied POPs have been attributed to common exposure pathways and similar environmental behavior of the target contaminants.

Table 4. Sample sizes, detection frequencies (%) and concentrations (range, mean±SE, geometric means for detected values) for heavy metals (ųg/g ww), PCBs and OCPs (ng/g ww) for blood samples collected from nestling bald eagles on National Park Service and associated lands within the Chesapeake Bay. Refer to the main text for definitions of Σ91PCBs, Σ6DDT, and Σ11OCPs.

	% Det	Range	Mean ± SE	Geo Mean
Heavy Metals				
Pb	86	0.021-0.084	0.088±0.039	0.049
Hg	100	0.106-0.903	0.377±0.037	0.335
Polychlorinated biphenyls (PCBs)				
PCB-90/101	5	0.098	-----	0.098
PCB-99	9	0.217-0.612	0.432±0.178	0.392
PCB-135	5	0.217	-----	0.217
PCB-149	23	0.917-2.424	1.488±0.178	0.292
PCB-118	18	0.376-1.886	1.352±0.488	1.084
PCB-146	14	0.469-1.156	0.705±0.225	0.643
PCB-153/132	86	1.348-8.923	4.435±0.531	3.876
PCB-141/179	5	0.133	-----	0.133
PCB-163/164	14	0.327-0.919	0.721±0.197	0.651
PCB-138/158	36	1.137-2.964	1.697±0.248	1.592
PCB-187	50	0.510-3.046	1.750±0.278	1.499
PCB-180/193	36	1.338-4.439	2.756±0.355	2.586
PCB-170/190	9	0.523-1.445	0.984±0.461	0.870
PCB-209	14	1.157-2.009	1.583±0.178	1.525
Σ_{91}PCBs	**86**	**1.350-23.510**	8.548±1.533	**6.340**

	% Det	Range	Mean ± SE	Geo Mean
Organochlorine pesticides				
trans-chlordane	9	0.037-0.108	0.073±0.0.36	0.063
cis-chlordane	14	0.140-0.149	0.145±0.005	0.145
trans-nonachlor	36	0.108-1.930	0.477±0.220	0.288
o,p'-DDD	5	0.123	-----	0.123
p,p'-DDD	5	0.216	-----	0.216
p,p'-DDE	86	0.595-8.775	3.183±0.528	2.411
Σ_{11}OCPs	**86**	**0.870-8.775**	3.426±0.0.562	**2.678**

Polychlorinated biphenyls

We detected only 14 of the 91 PCB congeners within any samples (Table 4, Appendix 7). The 14 congeners that were found above LOD varied widely in detection frequency with three (PCB-90/10, PCB-135, PCB-141/179), two (PCB-99, PCB-170/190) and three (PCB-146, PCB-163/164) being detected in only one, two and three samples respectively. Collectively, this group of eight congeners accounted for less than 7% of the total concentration. The compositional profile of PCB congeners in blood was dominated by PCB- 132/153 (19 of 25 samples) with a geometric mean composition of 61% of the Σ91PCBs. Second was PCB-180/193 with a geometric mean composition of 16%. Territories with the highest Σ91PCB concentrations were Owl Creek and the area on the lower James around Fort Eustis including Lawnes Creek and Gospel-spreading farm. All of these sites had values >19 ng/g ww.

Organochlorine pesticides

Other than p,p'-DDE and trans-nonachor, pesticides were not commonly detected within blood samples (Table 4, Appendix 7). These two compounds were detected in 19 and 9 of the 25 samples respectively and collectively account for nearly 99% of the total concentration. Territories with the highest Σ11OCP concentrations were Owl Creek and the area on the lower James around Fort Eustis including Lawnes Creek, Gospel-spreading Farm and Kingsmill. All of these sites had values >6 ng/g ww that was driven by the highest values of p,p'-DDE.

DISCUSSION

Breeding Performance

Overall breeding performance for pairs monitored was high and well above values (0.7-1.0 young/pair) believed to be required for population maintenance (Sprung et al., 1973, Elliott and Harris 2001, Bowerman et al., 2002). Breeding success and reproductive rates along the James/York Rivers were consistently higher on NPS lands compared to background levels along the tributaries. This result is consistent with the pattern of higher breeding performance on government-owned lands compared to privately-owned lands documented throughout the lower Chesapeake Bay (Watts, unpublished data). The Potomac River was an exception within this study due to the limited mixture of lands monitored during the 2017 breeding season. No private lands were surveyed along the Potomac during 2017. Pairs on other lands surveyed and compared to NPS breeding pairs were on U.S. Fish and Wildlife Service refuges and U.S. Department of Defense installations only.

Heavy Metals

Blood concentrations of heavy metals were low and varied between metals examined. Cadmium did not exceed the level-of-detection (LOD) for any sample. Lead and Mercury levels were generally above LOD with detection frequencies of 86 and 100% respectively. Lead concentrations (range = 0.21-0.88, geometric mean = 0.49) in nestlings sampled here were generally low compared to levels reported from other portions of the range (Wiemeyer et al., 1989) and much lower than that detected in free-flying eagles (Stauber et al., 2010, Bedrosian et al., 2012). Much of the lead exposure for bald eagles is believed to coincide with the fall hunting season when eagles forage on hunter-killed ungulates or their offal piles containing lead fragments (Hunt et al., 2006, Craighead and Bedrosian 2007, Bedrosian et al., 2012). Nestlings have had a very short time to accumulate lead burdens and generally express lower loads (Wiemeyer et al., 1989). Although our understanding of adverse-effect levels for nestling bald eagles is inadequate, the general consensus suggests that for raptors levels <10 ug/dL are considered background (Church et al., 2006, Cade 2007), levels >20 ug/dL but <60 ug/dL are considered to be elevated but subclinical, levels >60 ug/dL typically show clinical signs of poisoning and levels >120 ug/dL are often lethal (Fallon et al., 2017). None of the samples examined here were above suggested background levels.

Mercury was the most widespread of the metals with concentrations above LOD within all samples. Blood concentrations (range = 0.106-0.903, geometric mean = 0.335) were toward the lower to middle range of values reported from other studies of nestlings (Table 5). The finding here that broods reared around freshwater areas had higher mercury exposure compared to areas in more saline waters is consistent with findings in Maine (DeSorbo et al., 2018). Despite the documented impact of mercury on many bird species, the impact of levels on bald eagles is poorly understood. This is partly due to the fact that other contaminants have confounded the examination of mercury effects (e.g., Bowerman et al., 1994, Wiemeyer 1993). However, a general threshold based on other species for possible reproductive impacts would be >3.0 ug/g. None of the samples examined here approached this level.

Table 5. Concentrations (ug/g wet weight) of Hg in bald eagle blood measured in this study in comparison with previously reported data (modified from DeSorbo et al., 2018).

Year	Region	Habitat Type	N	Range	Mean±SD	Geo Mean	Study
2016-2018	Chesapeake Bay	Mixed	25	0.106-0.903	0.377±0.037	0.335	this study
Marine Influenced							
1980-87	Columbia River Estuary, Oregon/Washington	Estuarine	15	0.19-1.4	0.47		Anthony et al., 1993
2003-15	Maine, Penobscot River Watershed	Estuarine	8	0.12-0.45	0.27±0.10	0.25	DeSorbo et al, 2018
2003-15	Maine, Penobscot River Watershed	Marine	8	0.07-0.60	0.23±0.18	0.18	DeSorbo et al, 2018
2007-13	Maine	Marine/Estuarine	43	0.031-0.42	0.15±0.089	0.089	DeSorbo et al, 2018
1991-92	Maine, statewide	Estuarine	9-10	0.014-0.34	0.15±0.061	0.061	Welch 1994
1998-99	South Carolina	Marine/Inland	8-10	0.02-0.25	0.10±0.073	0.073	Jagoe et al., 2002
1996-97	Newfoundland	Marine	23	0.05-0.25			Dominguez et al, 2003
1991-92	Maine, statewide	Marine	22-25	0.016-0.46	0.096±0.073	0.079	Welch 1994
Freshwater River							
2004-15	Maine, Penobscot River Watershed	River	21	0.27-0.79	0.48±0.16	0.45	DeSorbo et al., 2018
2004-06	Maine, statewide	River	36	0.11-0.98		0.39	DeSorbo 2007
2007-08	Wyoming (northwestern)	River/Lake	18	0.11-0.80	0.37±0.22		Carlson et al., 2012
1991-92	Maine, statewide	River	5-6	0.15-0.58	0.28±0.12	0.26	Welch 1994
2007-08	Montana (southeastern)	River	15	0.10-0.85	0.22±0.17		Carlson et al., 2012
2006-08	Montana (southwestern)	River	17			0.1	Harmata 2011
Lake							
1979-81	Oregon (western)	Lake	82	nd-4.2		1.2	Wiemeyer et al., 1989
2003-15	Maine, Penobscot River Watershed	Lake	51	0.13-1.51	0.62±0.27	0.57	DeSorbo et al, 2018
2000-02	British Columbia (Pinchi Lake)	Lake	12	0.37-0.79	0.57±0.16		Weech et al. 2006

Year	Region	Habitat Type	N	Range	Mean±SD	Geo Mean	Study
1998-06	New York (southeastern), Catskill Park	Lake	12		0.52±0.25		DeSorbo et al., 2008
2004-06	Maine, statewide	Lake	112	0.084-1.51		0.52	DeSorbo 2007
1991-92	Maine, statewide	Lake	14-16	0.070-1.46	0.58±0.30	0.48	Welch 1994
2000-02	British Columbia (central)	Lake	31	0.12-0.60	0.27±0.083		Weech et al. 2006
1998-06	New York, statewide	Lake	19		0.26±0.16		DeSorbo et al., 2008
1979-81	Washington (western)	Lake	9	0.075-0.65		0.23	Wiemeyer et al., 1989
1991-93	Florida (central)	Lake	21	0.02-0.61	0.20±0.17	0.17	Wood et al., 1995
1991-93	Florida (central)	Lake	26	0.04-0.48	0.13±0.11	0.11	Wood et al., 1995

Polychlorinated Biphenyls

Total PCB concentrations estimated during this study (geometric mean = 6.34 ng/g ww) were relatively low in comparison to other regions where concentrations have been measured (Table 6). For example, PCB concentrations in nestling samples collected in 2006-2008 from the Mississippi River and Lower St. Croix River had a geometric mean of 88 and 48 ng/g and samples collected in 2002 from Lakes Superior, Michigan, Huron, and Erie had a geometric mean of 127, 154, 105, and 199 ng/g, respectively (Bowerman et al., 2003). Levels from nestlings within both the Great Lakes and Voyageurs National Park have been shown to have declined significantly in recent years (Dykstra et al., 2005, Pittman et al., 2015). Values reported here are lower than other recent samples collected from the upper Chesapeake Bay. Samples collected from two study areas in the upper Bay between 2008 and 2009 had a range of 16 to 110 ng/g ww and a geometric mean of 48 ng/g ww (Mojica and Watts 2011, Watts et al., 2012). The diversity of PCB congeners was much less in the samples reported here compared to those from the upper Bay that reported a detection frequency of 100% for 13 compounds. Despite the higher concentrations in the earlier samples, there were some similarities. Congeners PC-153/132, PC-187 and PC 180/193 represented the highest concentrations within both sample series.

A threshold of 190 ng/g of blood PCB level has been suggested to be associated with significant productivity impairment (Elliott and Harris, 2001; Dykstra et al., 2005). A threshold of 36.4 μg/kg has been suggested for no-observed-adverse-effect-level (NOEL) for productivity (Pittman et al., 2015). The estimated geometric mean for Σ91PCBs sampled here was 6.34. Most of the sites that expressed the highest PCB levels were clustered around the lower James River, an area where addled eagle eggs tested for PCB have shown high levels in the past (Watts, unpublished data). However, even these pairs had concentrations that were approximately 10% of the reported threshold for impairment and were just over 50% of the threshold for NOEL. Based on these results it does not appear that current PCB exposure represents a population-level concern for bald eagles nesting on National Park Service lands.

Table 6. Concentrations (ng/g wet weight) of PCBs and p,p'-DDE in bald eagle blood measured in this study in comparison with previously reported data. CNF and SNF are the abbreviations of Chippewa National Forest and Superior National Forest, respectively.

Region	Sampling Time	No.	Range	Median	Mean ± St. Err	Geomean	References
Polychlorinated biphenyls (PCBs)							
Chesapeake Bay	2016-2018	22	<10-23	5		6.3	this study
Upper Chesapeake Bay	2008 & 2009	48	16–106	47	52 ± 2.9	48	(Liu et al. 2018)
Great Lakes	2005.05-06	15	5.5–250	42	74 ± 23	45	(Venier et al., 2010)
British Columbia	2001 & 2003	22	0.9–97				(McKinney et al., 2006)
Southern California	2003	3	6.5–22		12.3 ± 4.8	10	(McKinney et al., 2006)
Lake Superior	1989-2001	51			86.7		(Dykstra et al., 2005)
Lake Superior	2006-2008	29				55	(Dykstra et al., 2005)
Mississippi river	2006-2008	51				88	(Dykstra et al., 2005)
Lower St. Croix river	2006-2008	14				80	(Dykstra et al., 2005)
Upper St. Croix river	2006-2008	19				2.67	(Dykstra et al., 2005)
Lake Erie	1990-1994 & 1996	30	9.9–326		130		(Donaldson et al., 1999)
Lake Nipigon	1993	7	21–197		47.1		(Donaldson et al., 1999)
Lake Superior	1992 & 1994	11	36–290		94		(Donaldson et al., 1999)
Lake of the Woods	1992	2	115–196		150		(Donaldson et al., 1999)
CNF of Minnesota	1987-1992	43	<10–67			7	(Bowerman et al., 2003)
SNF of Minnesota	1987-1992	15	<10–18			5	(Bowerman et al., 2003)
Voyageurs National Park	1987-1992	21	<10–1615			47	(Bowerman et al., 2003)
Lower peninsula	1987-1992	49	<10–200			31	(Bowerman et al., 2003)
Eastern upper peninsula	1987-1992	16	<10–146			32	(Bowerman et al., 2003)
Western upper peninsula	1987-1992	48	<10–177			25	(Bowerman et al., 2003)
Lake Superior	1987-1992	45	12–640			127	(Bowerman et al., 2003)
Lake Michigan	1987-1992	25	14–628			154	(Bowerman et al., 2003)
Lake Huron	1987-1992	12	5–928			105	(Bowerman et al., 2003)
Lake Erie	1987-1992	35	81–1325			199	(Bowerman et al., 2003)

Region	Sampling Time	No.	Range	Median	Mean ± St. Err	Geomean	References
1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene (p,p'-DDE)							
Chesapeake Bay	2016-2018	22	0.6-8.8			2.4	this study
Upper Chesapeake Bay	2008 & 2009	48	6.8–30	13	13 ± 0.6	13	(Liu et al. 2018)
Great Lakes	2005.05-06	15	2.9–63	18	20 ± 4.9		(Venier et al., 2010)
British Columbia	2003		3.5–58				(Cesh et al., 2008)
Southern California	2003	3	18–123			41	(Cesh et al., 2008)
Lake Superior	1989-2001	54			21.7		(Dykstra et al., 2005)
Lake Superior	2006-2008	29				16.2	(Dykstra et al., 2005)
Mississippi river	2006-2008	51				9.03	(Dykstra et al., 2005)
Lower St. Croix river	2006-2008	14				6.73	(Dykstra et al., 2005)
Upper St. Croix river	2006-2008	19				2.6	(Dykstra et al., 2005)
Lake Erie	1990-1994 & 1996	30	3.6–139.4		22.4		(Donaldson et al., 1999)
Lake Nipigon	1993	7	12.6–85		23.9		(Donaldson et al., 1999)
Lake Superior	1992 & 1994	11	7.6–148.4		28		(Donaldson et al., 1999)
Lake of the Woods	1992	2	40.1–72.6		54		(Donaldson et al., 1999)
CNF of Minnesota	1987-1992	43	<5–29			3	(Bowerman et al., 2003)
SNF of Minnesota	1987-1992	15	<5–8			3	(Bowerman et al., 2003)
Voyageurs National Park	1987-1992	21	<5–206			20	(Bowerman et al., 2003)
Lower peninsula	1987-1992	49	<5–193			10	(Bowerman et al., 2003)
Eastern upper peninsula	1987-1992	16	<5–24			12	(Bowerman et al., 2003)
Western upper peninsula	1987-1992	48	<5–245			10	(Bowerman et al., 2003)
Lake Superior	1987-1992	45	<5–306			25	(Bowerman et al., 2003)
Lake Michigan	1987-1992	25	<5–235			35	(Bowerman et al., 2003)
Lake Huron	1987-1992	12	<5–78			25	(Bowerman et al., 2003)
Lake Erie	1987-1992	35	<5–429			22	(Bowerman et al., 2003)

Organochlorine Pesticides

Most of the organochlorine pesticides were not commonly detected in blood samples and total OCPs were on the low end of concentrations reported throughout the range (Table 6). The compositional profile of the group was dominated by p,p'-DDE (93%) and trans-nonachor (6%). p,p'-DDE is a main degradation product of dichlorodiphenyltrichloroethane (DDT) and is believed to be one of the primary compounds responsible for bald eagle population declines during the mid-1900s (Wiemeyer et al. 1984, 1993). Concentrations of p,p'-DDE (range = 0.6-8.78, geometric mean of 2.41 ng/g ww) were toward the low end of those reported elsewhere throughout the breeding range (Table 6). The highest values (>4 ng/g ww) recorded for nests sampled were the same nests clustered within the lower James River and the single nest on Owl Creek that measured high for PCBs. The Owl Creek nest had the highest level (8.8 ng/g ww). Elliott and Harris (2001) estimated the threshold for significant impairment of productivity (<0.7 young per occupied territory) to be 28 ųg/kg of plasma and Pittman et al. (2015) estimated the NOEL for productivity to be 11.4 ng/g). None of the nests sampled here reached the NOEL threshold.

ACKNOWLEDGMENTS

The contaminants investigation portion of this project has been funded by the National Park Service. Aerial survey efforts included in the project have been funded by the U.S. Department of Defense, the U.S. Fish and Wildlife Service, the Virginia Department of Transportation and The Center for Conservation Biology. We thank the biologists and staff of the national parks who have participated in the project including Tim Blumenschine, Dorothy Geyer, Adam Gresek, Mikaila Milton, Diane Pavek, Christine Smith and Tim Sveum. We thank Jim Latane, Jackie Morris and Paul Smith for allowing access to nests on their properties. Seth Berry obtained permission to access nests on Naval Support Facility Indian Head and assisted with fieldwork. Kyle Rambo provided access to Patuxent Naval Air Station and Jackie Smith assisted with fieldwork. Mike Wright obtained permission to access nests on Oceana Naval Air Station and assisted with fieldwork. Christopher Wicker provided access to Mason Neck National Wildlife Refuge. Bill Crouch and Cyrus Brame provided access to the James River National Wildlife Refuge and Lauren Cruz assisted with fieldwork. Shane Lawler and Steve Connally climbed trees to access broods. We thank Elaine Leslie for assistance during all aspects of this project. Dave Treviño provided technical support. We also thank Erica Lawler, Jane Lopez, Cindy Corbet, and Michael Cole from the William and Mary Sponsored Programs office for fiscal and administrative assistance.

LITERATURE CITED

Abbott, J. M. 1963. Bald Eagle survey for the Chesapeake Bay, 1962. Atlantic Naturalist 18: 22-27.

Abbott, J. M. 1978. Chesapeake Bay Bald Eagles. Delaware Conservationist 22: 3-9.

Bedrosian, B., D. Craighead, and R. Crandall. 2012. Lead exposure in bald eagles from big game399 hunting, the continental implications and successful mitigation efforts. PLoS ONE 12:e51978.

Bowerman, W. W., A. S. Roe, M. J. Gilbertson, D. A. Best, J. G. Sikarski, R. S. Mitchell et al. 2002. Using bald eagles to indicate the health of the Great Lakes' environment. Resource Management 7:183-187.

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 polychlorinated biphenyls and dichlorodiphenyldichloroethylene in blood of nestling bald eagles and reproductive productivity. Environmental Toxicology and Chemistry 22:371-376.

Byrd, M. A., G. D. Therres, S. N. Wiemeyer, and M. Parkin. 1990. Chesapeake Bay region Bald Eagle recovery plan: first revision. U.S. Department of the Interior, Fish and Wildlife Service. Newton Corner, MA.

Cade, T. J. 2007. Exposure of California condors to lead from spent ammunition. Journal of Wildlife Management 71:2125–2133.

Chen, D., R. C. Hale, B. D. Watts, M. J. La Guardia, E. Harvey, and E. K. Mojica. 2010. Species-specific accumulation of polybrominated diphenyl ether flame retardants in birds of prey from the Chesapeake Bay region, USA. Environmental Pollution 158:1883-1889.

Church, M. E., R. Gwiazda, R. W. Risebrough, K. Sorenson, C. P. Chamberlain, S. Farry, W. Heinrich, B. A. Rideout, and D. R. Smith. 2006. Ammunition is the principal source of lead accumulated by California condors re-introduced to the wild. Environmental Science and Technology 40:6143–6150.

Craighead, D. and B. Bedrosian. 2007. Blood lead levels of common ravens with access to big-game offal. The Journal of Wildlife Management 72:240-245.

Dahmardeh Behrooz, R., A. Esmaili Sari, N. Bahramifar, F. Naghdi, and A. R. Shahriyari. 2009. Organochlorine pesticide and polychlorinated biphenyl residues in human milk from Tabriz, Iran. Toxicology and Environmental Chemistry 91:1455-1468.

DeSorbo, C. R., N. M. Burgess, C. S. Todd, D. C. Evers, R. A. Bodaly, B. H. Massey, S. E. Mierzykowski, C. P. Persico, R. B. Gray, W. E. Hanson, D. E. Meattey, and K. J. Regan. 2018. Mercury concentrations in bald eagles across an impacted watershed in Maine, USA. Science of the Total Environment 627:1515-1527.

Dykstra, C. R., M. W. Meyer, P. W. Rasmussen, and D. K. Warnke. 2005. Contaminant concentrations and reproductive rate of Lake Superior bald eagles, 1989–2001. Journal of Great Lakes Research 31:227-235.

Elliott, J. E. and M. L. Harris. 2001. An ecotoxicological assessment of chlorinated hydrocarbon effects on bald eagle populations. Review of Toxicology 4:1-60.

Fallon, J. A., P. Redig, T. A. Miller, M. Lanzone, and T. E. Katzner. 2017. Guidelines for evaluation and treatment of lead poisoning of wild raptors. Wildlife Society Bulletin 41:205–211.

Fraser J. D., L. D. Frenzel, J. E. Mathisen, F. Martin, and M. E. Shough. 1983. Scheduling Bald Eagle reproductive surveys. Wildlife Society Bulletin 11:13-16.

Gao, S., Y. Wan, G. Zheng, K. Luo, K., Kannan, J. P. Giesy, M. H. W. Lam, and J. Hu. 2015. Organobromine compound profiling in human adipose: Assessment of sources of bromophenol. Environmental Pollution 204:81-89.

Hunt, W. G., W. Burnham, C. N. Parish, K. K. Burnham, B. Mutch, and J. L. Oaks. 2006. Bullet fragments in 467 deer remains: Implications for lead exposure in avian scavengers. Wildlife Society Bulletin 34:167–170.

International Joint Commission. 1991. Report of the Ecological Committee's Biological Effects Subcommittee to the Great Lakes Science Advisory Board. Proceedings, Expert Consultation Meeting on Bald Eagles, Windsor, ON, Canada, Februzry 12-13, 1990, p 33.

Lippson, A. J. and R. L. Lippson. 1984. Life in the Chesapeake Bay. The Johns Hopkins University Press, Baltimore, MD, USA.

Markham, A. C. 2004. The influence of salinity on diet composition, provisioning patterns, and nestling growth in Bald Eagles in the lower Chesapeake Bay. M. A. Thesis, College of William and Mary, Williamsburg, Virginia.

Mersmann, T. J. 1989. Foraging ecology of Bald Eagles on the northern Chesapeake Bay with an examination of techniques used in the study of Bald Eagle food habits. M.S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Mojica, E. K. and B. D. Watts. 2011. Bald Eagle Nest Productivity and Contaminant Monitoring at Naval Support Facility Indian Head, Maryland: Final Report. Center for Conservation Biology Technical

Report Series, CCBTR-11-01. College of William and Mary and Virginia Commonwealth University, Williamsburg, VA. 28 pp.

Olsson, A., K. Ceder, A. Bergman, and B. Helander. 2000. Nesting blood of the white-tailed sea eagle (Haliaeetus albicilla) as an indicator of territorial exposure to organohalogen compounds – an evaluation. Environmental Science and Techology 34:2733-2740.

Pittman, H. T., W. W. Bowerman, L. H. Grim, T. G. Grubb, W. C. Bridges, M. R. Wierda. 2015. Using nestling plasma to assess long-term spatial and temporal concentrations of organochlorine compounds in bald eagles within Voyageurs National Park, Minnesota, USA. Chemosphere 123:79-86.

Rattner, B. A. and P. C. McGowan. 2007. Potential hazards of environmental contaminants to avifauna residing in the Chesapeake Bay estuary. Waterbirds 30: 63-81.

Sprunt IV, A., W. B. Robertson Jr., S. Postupalsky, R. J. Hensel, C. E. Knoder, and F. J. Ligas. 1973. Comparative productivity of six bald eagle populations. Transactions of North American Wildlife Natural Resource Conference 38:96-106.

Stauber, E., N. Finch, P. A. Talcott, and J. M. Gay. 2010. Lead poisoning of bald (Haliaeetus leucocephalus) and golden (Aquila chrysaetos) eagles in the US inland Pacific Northwest region—an 18-year retrospective study: 1991–2008. Journal of Avian Medicine and Surgery 24:279–287.

Tyrrell, W. B. 1936. Unpublished report of bald eagle nest survey of the Chesapeake Bay region. National Audubon Society, Washington, D.C.

Venier, M., M. Wierda, W. W. Bowerman, and R. A. Hites. 2010. Flame retardants and organochlorine pollutants in bald eagle plasma from the Great Lakes region. Chemosphere 80:1234-1240.

Watts, B. D., G. D. Therres, and M. A. Byrd. 2007. Status, distribution and the future of Bald Eagles in the Chesapeake Bay. Waterbirds 30:25-38.

Watts, B. D., G. D. Therres, and M. A. Byrd. 2008. Recovery of the Chesapeake Bay bald eagle nesting population. Journal of Wildlife Management 72:152-158.

Watts, B. D., E. K. Mojica, and B. J. Paxton. 2012. Use of satellite telemetry to delineate bald eagle activity centers for hazard mitigation and land planning within Aberdeen Proving Ground and the upper Chesapeake Bay. Final Report. Center for Conservation Biology Technical Report Series, CCBTR-12-05. College of William and Mary and Virginia Commonwealth University, Williamsburg, VA. U.S.A 402 pp.

Wiemeyer, S. N., R. W. Frenzel, R. G. Anthony, and B. Riley. 1989. Environmental contaminants in blood of western bald eagles. Journal of Raptor Research. 23:140–146.

Wiemeyer, S. N., T. G. Lamont, C. M. Bunck, C. R. Sindelar, F. J. Gramlich, J. D. Fraser, and M. A. Byrd. 1984. Organochlorine pesticide, polychlorobiphenyl, and mercury residues in bald eagle eggs -1969-79- and their relationships to shell thinning and reproduction. Archives of Environmental Contamination and Toxicology 13:529-549.

Wiemeyer, S. N., C. M. Bunck, and C. J. Stafford. 1993. Environmental contaminants in bald eagle eggs – 1980-1984 – and further interpretations of relationships to productivity and shell thickness. Archives of Environmental Contamination and Toxicology 24:213-227.

Wisconsin State Laboratory of Hygiene. 2016. EHD CER METHOD 1200:
Blood Metals by Inductively Coupled Plasma Mass Spectrometry. Wisconsin State Laboratory of Hygiene, Madison, WI.

APPENDICES

Appendix I. Bald eagle occupancy, activity, and productivity data for the James River and York River during the 2016 breeding season.

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	CC0202	Y	Y	2
James/York River	2016	CC0303	Y	Y	2
James/York River	2016	CC0305	Y	Y	1
James/York River	2016	CC0401	Y	Y	2
James/York River	2016	CC0402	Y	Y	2
James/York River	2016	CC0407	Y	Y	0
James/York River	2016	CC0501	Y	Y	2
James/York River	2016	CC0503	Y	N	----
James/York River	2016	CC0504	Y	Y	0
James/York River	2016	CC0601	Y	N	----
James/York River	2016	CC0604	Y	Y	1
James/York River	2016	CC0607	Y	Y	0
James/York River	2016	CC0705	Y	Y	3
James/York River	2016	CC0802	Y	Y	2
James/York River	2016	CC0803	Y	Y	2
James/York River	2016	CC0901	Y	Y	1
James/York River	2016	CC0902	Y	N	----
James/York River	2016	CC0903	Y	Y	2
James/York River	2016	CC1001	Y	Y	1
James/York River	2016	CC1003	Y	Y	2
James/York River	2016	CC1005	Y	Y	1
James/York River	2016	CC1006	Y	Y	0
James/York River	2016	CC1007	Y	Y	2
James/York River	2016	CC1101	Y	Y	0
James/York River	2016	CC1104	Y	Y	0
James/York River	2016	CC1105	Y	Y	0
James/York River	2016	CC1106	Y	Y	2
James/York River	2016	CC1107	Y	Y	1
James/York River	2016	CC1108	Y	Y	1
James/York River	2016	CC1201	Y	Y	2
James/York River	2016	CC1202	Y	Y	3
James/York River	2016	CC1203	Y	Y	2
James/York River	2016	CC1204	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	CC1205	Y	N	----
James/York River	2016	CC1206	Y	N	----
James/York River	2016	CC1207	Y	Y	1
James/York River	2016	CC1301	Y	Y	1
James/York River	2016	CC1303	Y	Y	2
James/York River	2016	CC1305	Y	Y	0
James/York River	2016	CC1401	Y	Y	0
James/York River	2016	CC1402	Y	Y	0
James/York River	2016	CC1501	Y	Y	2
James/York River	2016	CC1502	Y	Y	2
James/York River	2016	CC1503	Y	N	----
James/York River	2016	CC1504	Y	Y	2
James/York River	2016	CC1506	Y	Y	0
James/York River	2016	CC1507	Y	Y	2
James/York River	2016	CC1508	Y	Y	2
James/York River	2016	CC1601	Y	Y	0
James/York River	2016	CC1602	Y	Y	0
James/York River	2016	CC1603	Y	Y	2
James/York River	2016	CC1604	Y	Y	2
James/York River	2016	CC1605	Y	Y	2
James/York River	2016	CC9102	Y	Y	1
James/York River	2016	CC9602	Y	Y	0
James/York River	2016	CC9805	Y	Y	0
James/York River	2016	CC9904	Y	Y	2
James/York River	2016	CD0202	Y	Y	2
James/York River	2016	CD0302	Y	Y	2
James/York River	2016	CD0403	Y	N	----
James/York River	2016	CD0604	Y	Y	2
James/York River	2016	CD0701	Y	Y	3
James/York River	2016	CD0702	Y	N	----
James/York River	2016	CD0804	Y	Y	2
James/York River	2016	CD0903	Y	Y	2
James/York River	2016	CD1102	Y	Y	2
James/York River	2016	CD1203	Y	N	----
James/York River	2016	CD1301	Y	Y	3
James/York River	2016	CD1302	Y	N	----
James/York River	2016	CD1401	Y	Y	2
James/York River	2016	CD1402	Y	Y	2
James/York River	2016	CD1601	Y	Y	1
James/York River	2016	CD1601	Y	Y	0

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	CD1602	Y	Y	0
James/York River	2016	CD1603	Y	Y	0
James/York River	2016	CD1604	Y	Y	0
James/York River	2016	CD1605	Y	Y	1
James/York River	2016	CD9802	Y	Y	2
James/York River	2016	DW1001	Y	Y	2
James/York River	2016	GL0401	Y	N	----
James/York River	2016	GL0502	Y	N	----
James/York River	2016	GL1001	Y	Y	0
James/York River	2016	GL1101	Y	N	----
James/York River	2016	GL1601	Y	Y	0
James/York River	2016	GL1602	Y	Y	2
James/York River	2016	GL1603	Y	Y	2
James/York River	2016	HE0602	Y	Y	0
James/York River	2016	HE0604	Y	Y	2
James/York River	2016	HE0801	Y	Y	2
James/York River	2016	HE0802	Y	Y	2
James/York River	2016	HE1001	Y	Y	0
James/York River	2016	HE1301	Y	Y	2
James/York River	2016	HE1302	Y	Y	2
James/York River	2016	HE1303	Y	Y	0
James/York River	2016	HE1502	Y	Y	2
James/York River	2016	HE1601	Y	Y	0
James/York River	2016	HE9501	Y	Y	1
James/York River	2016	HO0401	Y	Y	0
James/York River	2016	IW0201	Y	Y	2
James/York River	2016	IW0401	Y	Y	2
James/York River	2016	IW0501	Y	Y	0
James/York River	2016	IW0701	Y	N	----
James/York River	2016	IW0702	Y	Y	0
James/York River	2016	IW0802	Y	Y	2
James/York River	2016	IW0902	Y	Y	0
James/York River	2016	IW1001	Y	Y	2
James/York River	2016	IW1002	Y	Y	0
James/York River	2016	IW1202	Y	Y	2
James/York River	2016	IW1301	Y	Y	0
James/York River	2016	IW1402	Y	Y	2
James/York River	2016	IW1403	Y	Y	0
James/York River	2016	IW1404	Y	Y	2
James/York River	2016	IW1502	Y	Y	3

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	IW1503	Y	Y	2
James/York River	2016	IW1601	Y	N	----
James/York River	2016	IW1602	Y	Y	2
James/York River	2016	IW1603	Y	N	----
James/York River	2016	IW1604	Y	Y	2
James/York River	2016	IW1605	Y	Y	0
James/York River	2016	IW1606	Y	N	----
James/York River	2016	IW1607	Y	Y	2
James/York River	2016	IW1608	Y	Y	2
James/York River	2016	IW8601	Y	Y	2
James/York River	2016	JC0001	Y	Y	0
James/York River	2016	JC0101[A]	Y	N	----
James/York River	2016	JC0105[A]	Y	Y	1
James/York River	2016	JC0403	Y	Y	1
James/York River	2016	JC0404	Y	Y	2
James/York River	2016	JC0405	Y	Y	2
James/York River	2016	JC0407	Y	Y	1
James/York River	2016	JC0501[A]	Y	Y	2
James/York River	2016	JC0502	Y	Y	3
James/York River	2016	JC0503	Y	Y	1
James/York River	2016	JC0604[A]	Y	Y	0
James/York River	2016	JC0605	Y	Y	0
James/York River	2016	JC0703	Y	Y	0
James/York River	2016	JC0802	Y	Y	2
James/York River	2016	JC0803[A]	Y	Y	2
James/York River	2016	JC0805	Y	Y	2
James/York River	2016	JC0903	Y	Y	3
James/York River	2016	JC0904	Y	Y	3
James/York River	2016	JC0905	Y	Y	1
James/York River	2016	JC1001	Y	Y	0
James/York River	2016	JC1102	Y	Y	1
James/York River	2016	JC1103	Y	Y	2
James/York River	2016	JC1104	Y	Y	0
James/York River	2016	JC1105	Y	Y	1
James/York River	2016	JC1109	Y	Y	3
James/York River	2016	JC1202[A]	Y	Y	2
James/York River	2016	JC1301	Y	Y	2
James/York River	2016	JC1303	Y	N	----
James/York River	2016	JC1304	Y	Y	3

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	JC1305	Y	Y	2
James/York River	2016	JC1306	Y	Y	2
James/York River	2016	JC1307	Y	Y	2
James/York River	2016	JC1308	Y	Y	0
James/York River	2016	JC1309	Y	Y	3
James/York River	2016	JC1401	Y	Y	2
James/York River	2016	JC1402	Y	Y	1
James/York River	2016	JC1403	Y	Y	2
James/York River	2016	JC1501	Y	Y	2
James/York River	2016	JC1502	Y	Y	2
James/York River	2016	JC1504	Y	Y	0
James/York River	2016	JC1505	Y	Y	0
James/York River	2016	JC1506	Y	Y	0
James/York River	2016	JC1601	Y	Y	1
James/York River	2016	JC1604	Y	Y	3
James/York River	2016	JC1605	Y	Y	1
James/York River	2016	JC1606[A]	Y	N	----
James/York River	2016	JC1607	Y	Y	2
James/York River	2016	JC1608	Y	Y	3
James/York River	2016	JC1609	Y	N	----
James/York River	2016	KQ1003	Y	Y	2
James/York River	2016	KQ1004	Y	N	0
James/York River	2016	KQ1604	Y	N	----
James/York River	2016	NK0302	Y	Y	2
James/York River	2016	NK0701	Y	Y	2
James/York River	2016	NK0703	Y	N	----
James/York River	2016	NK0902	Y	Y	2
James/York River	2016	NK0903	Y	Y	2
James/York River	2016	NK0904	Y	Y	1
James/York River	2016	NK1001	Y	Y	0
James/York River	2016	NK1102	Y	Y	2
James/York River	2016	NK1103	Y	Y	2
James/York River	2016	NK1501	Y	Y	1
James/York River	2016	NK1601	Y	Y	2
James/York River	2016	NK1602	Y	N	----
James/York River	2016	NK1603	Y	Y	0
James/York River	2016	NK1604	Y	N	----
James/York River	2016	NK1607	Y	Y	1
James/York River	2016	NN0202	Y	Y	0
James/York River	2016	NN0301	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	NN0701	Y	Y	3
James/York River	2016	NN0801	Y	Y	3
James/York River	2016	NN0802	Y	Y	2
James/York River	2016	NN1001	Y	Y	2
James/York River	2016	NN1301	Y	Y	0
James/York River	2016	NN1501	Y	N	----
James/York River	2016	NN1502	Y	N	----
James/York River	2016	PB0401	Y	Y	2
James/York River	2016	PG0002	Y	Y	2
James/York River	2016	PG0401	Y	Y	0
James/York River	2016	PG0502	Y	Y	1
James/York River	2016	PG0503	Y	Y	0
James/York River	2016	PG0602	Y	Y	2
James/York River	2016	PG0603	Y	Y	2
James/York River	2016	PG0702	Y	N	----
James/York River	2016	PG0902	Y	Y	2
James/York River	2016	PG1001	Y	N	----
James/York River	2016	PG1003	Y	Y	3
James/York River	2016	PG1005	Y	N	----
James/York River	2016	PG1105	Y	N	----
James/York River	2016	PG1201	Y	Y	2
James/York River	2016	PG1202	Y	Y	0
James/York River	2016	PG1203	Y	Y	2
James/York River	2016	PG1204	Y	N	----
James/York River	2016	PG1206	Y	Y	3
James/York River	2016	PG1301	Y	Y	1
James/York River	2016	PG1303	Y	Y	2
James/York River	2016	PG1304	Y	Y	0
James/York River	2016	PG1401	Y	Y	3
James/York River	2016	PG1402	Y	Y	1
James/York River	2016	PG1601	Y	Y	0
James/York River	2016	PG1602	Y	Y	0
James/York River	2016	PG8901	Y	Y	0
James/York River	2016	PG9101	Y	Y	2
James/York River	2016	PG9201	Y	Y	0
James/York River	2016	PG9401	Y	Y	1
James/York River	2016	PG9402	Y	Y	3
James/York River	2016	PO9801	Y	Y	2
James/York River	2016	RM1001	Y	Y	1
James/York River	2016	RM1301	Y	Y	0

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	RM1501	Y	Y	0
James/York River	2016	SK0301	Y	Y	2
James/York River	2016	SK0401	Y	N	0
James/York River	2016	SK1101	Y	Y	3
James/York River	2016	SK1102	Y	Y	3
James/York River	2016	SK1201	Y	Y	2
James/York River	2016	SK1301	Y	N	----
James/York River	2016	SK1302	Y	Y	2
James/York River	2016	SK1303	Y	Y	0
James/York River	2016	SK1304	Y	Y	1
James/York River	2016	SK1401	Y	Y	2
James/York River	2016	SK1601	Y	Y	2
James/York River	2016	SK1602	Y	Y	0
James/York River	2016	SK1603	Y	N	----
James/York River	2016	SK9101	Y	Y	0
James/York River	2016	SU0303	Y	Y	1
James/York River	2016	SU0406	Y	Y	0
James/York River	2016	SU0504	Y	Y	2
James/York River	2016	SU0803	Y	Y	1
James/York River	2016	SU0901	Y	Y	0
James/York River	2016	SU0905	Y	Y	0
James/York River	2016	SU0906	Y	Y	0
James/York River	2016	SU1001	Y	N	----
James/York River	2016	SU1004	Y	Y	1
James/York River	2016	SU1005	Y	N	----
James/York River	2016	SU1006	Y	Y	3
James/York River	2016	SU1007	Y	N	----
James/York River	2016	SU1008	Y	Y	1
James/York River	2016	SU1102	Y	Y	1
James/York River	2016	SU1104	Y	Y	2
James/York River	2016	SU1201	Y	Y	2
James/York River	2016	SU1203	Y	Y	0
James/York River	2016	SU1205	Y	Y	2
James/York River	2016	SU1206	Y	Y	1
James/York River	2016	SU1301	Y	Y	2
James/York River	2016	SU1302	Y	N	----
James/York River	2016	SU1303	Y	Y	2
James/York River	2016	SU1304	Y	Y	1
James/York River	2016	SU1401	Y	Y	0
James/York River	2016	SU1402	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2016	SU1403	Y	N	----
James/York River	2016	SU1404[A]	Y	Y	2
James/York River	2016	SU1405	Y	Y	1
James/York River	2016	SU1406	Y	N	----
James/York River	2016	SU1501	Y	Y	2
James/York River	2016	SU1502	Y	Y	2
James/York River	2016	SU1505	Y	Y	0
James/York River	2016	SU1601	Y	Y	2
James/York River	2016	SU1602	Y	Y	2
James/York River	2016	YK0204	Y	Y	0
James/York River	2016	YK0301	Y	Y	2
James/York River	2016	YK0403	Y	Y	1
James/York River	2016	YK0601	Y	Y	2
James/York River	2016	YK0701[A]	Y	Y	2
James/York River	2016	YK0703	Y	Y	0
James/York River	2016	YK0901[A]	Y	Y	0
James/York River	2016	YK1003	Y	Y	0
James/York River	2016	YK1102	Y	Y	2
James/York River	2016	YK1105	Y	Y	1
James/York River	2016	YK1302	Y	Y	1
James/York River	2016	YK1503[A]	Y	Y	2
James/York River	2016	YK1602	Y	Y	2
James/York River	2016	YK1603[A]	Y	Y	2
James/York River	2016	YK1604	Y	Y	0
James/York River	2016	YK1605	Y	Y	2

[A] National Park Service Property

Appendix II. Bald eagle occupancy, activity, and productivity data for the Potomac during the 2017 breeding season.

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
Potomac River	2017	BP-08	Y	Y	1
Potomac River	2017	BP-11	Y	Y	2
Potomac River	2017	BP-13	Y	Y	>=1
Potomac River	2017	BP-16	Y	Y	>=1
Potomac River	2017	FF0702	Y	Y	2
Potomac River	2017	FF0703	Y	Y	0
Potomac River	2017	FF0705	Y	Y	2
Potomac River	2017	FF0901	Y	Y	2
Potomac River	2017	FF0902	Y	Y	2
Potomac River	2017	FF1401	Y	Y	>=1
Potomac River	2017	FF1606	Y	Y	1
Potomac River	2017	FF1608	Y	Y	U
Potomac River	2017	FF1610	Y	Y	>=1
Potomac River	2017	FF1611	Y	Y	2
Potomac River	2017	FF1612	Y	Y	>=1
Potomac River	2017	FF1613	Y	Y	U
Potomac River	2017	FF1614	Y	Y	>=1
Potomac River	2017	FF1701	Y	Y	>=1
Potomac River	2017	FF9401	Y	Y	U
Potomac River	2017	Fort Washington 1[A]	Y	Y	2
Potomac River	2017	Fort Washington 2[A]	Y	Y	0
Potomac River	2017	IH-01	Y	N	----
Potomac River	2017	IH-03	Y	Y	1
Potomac River	2017	IH-12	Y	Y	>=1
Potomac River	2017	IH-15	Y	Y	2
Potomac River	2017	IH-17	Y	Y	3
Potomac River	2017	IH-18	Y	Y	2
Potomac River	2017	IH-20	Y	Y	1
Potomac River	2017	IH-23	Y	N	----
Potomac River	2017	IH-25	Y	Y	2
Potomac River	2017	IH-26	Y	Y	3
Potomac River	2017	IH-27	Y	Y	2
Potomac River	2017	KG-06-06	Y	Y	0
Potomac River	2017	KG-07-10	Y	Y	3
Potomac River	2017	KG-09-06	Y	Y	2
Potomac River	2017	KG-11-09	Y	Y	1
Potomac River	2017	KG-14-01	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
Potomac River	2017	KG-14-02	Y	Y	>=1
Potomac River	2017	KG-16-16	Y	Y	2
Potomac River	2017	KG-16-17	Y	Y	>=1
Potomac River	2017	KG-17-01	Y	Y	2
Potomac River	2017	KG-97-05	Y	Y	2
Potomac River	2017	Pax-11	Y	Y	2
Potomac River	2017	Pax-13	Y	Y	2
Potomac River	2017	Pax-2	Y	Y	0
Potomac River	2017	Pax-5	Y	Y	1
Potomac River	2017	Piscataway 1[A]	Y	Y	2
Potomac River	2017	Piscataway 2[A]	Y	Y	2
Potomac River	2017	Piscataway 3[A]	Y	Y	>=1
Potomac River	2017	Piscataway West[A]	Y	Y	3
Potomac River	2017	PW0701	Y	Y	3
Potomac River	2017	PW1302	Y	Y	>=1
Potomac River	2017	PW1401	Y	Y	>=1
Potomac River	2017	PW1402	Y	Y	>=1
Potomac River	2017	PW1701	Y	Y	0
Potomac River	2017	WE0308[A]	Y	N	0
Potomac River	2017	WE0411	Y	Y	0
Potomac River	2017	WE1109[A]	Y	Y	2
Potomac River	2017	WE1110	Y	Y	2
Potomac River	2017	WE1602	Y	Y	2
Potomac River	2017	WE1612	Y	Y	2

[A] National Park Service Property

Appendix III. Bald eagle occupancy, activity, and productivity data for the James River and York River during the 2017 breeding season.

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	CC0202	Y	Y	2
James/York River	2017	CC0303	Y	Y	2
James/York River	2017	CC0305	Y	N	--
James/York River	2017	CC0501	Y	Y	2
James/York River	2017	CC0503	Y	Y	U
James/York River	2017	CC0504	Y	N	--
James/York River	2017	CC0601	Y	N	--
James/York River	2017	CC0607	Y	Y	0
James/York River	2017	CC0705	Y	Y	1
James/York River	2017	CC0802	Y	Y	0
James/York River	2017	CC0803	Y	Y	0
James/York River	2017	CC0901	Y	Y	2
James/York River	2017	CC1001	Y	Y	1
James/York River	2017	CC1003	Y	Y	1
James/York River	2017	CC1005	Y	Y	2
James/York River	2017	CC1006	Y	N	--
James/York River	2017	CC1007	Y	Y	2
James/York River	2017	CC1101	Y	Y	2
James/York River	2017	CC1104	Y	N	--
James/York River	2017	CC1106	Y	Y	2
James/York River	2017	CC1107	Y	Y	1
James/York River	2017	CC1108	Y	Y	1
James/York River	2017	CC1201	Y	Y	2
James/York River	2017	CC1202	Y	Y	U
James/York River	2017	CC1203	Y	Y	0
James/York River	2017	CC1204	Y	Y	2
James/York River	2017	CC1207	Y	Y	2
James/York River	2017	CC1301	Y	N	--
James/York River	2017	CC1303	Y	Y	2
James/York River	2017	CC1305	Y	Y	2
James/York River	2017	CC1402	Y	N	--
James/York River	2017	CC1501	Y	Y	3
James/York River	2017	CC1502	Y	N	--
James/York River	2017	CC1503	Y	Y	0
James/York River	2017	CC1504	Y	Y	1
James/York River	2017	CC1506	Y	Y	1
James/York River	2017	CC1507	Y	Y	U
James/York River	2017	CC1508	Y	Y	3

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	CC1601	Y	Y	1
James/York River	2017	CC1602	Y	Y	2
James/York River	2017	CC1604	Y	Y	1
James/York River	2017	CC1605	Y	Y	2
James/York River	2017	CC1701	Y	Y	1
James/York River	2017	CC1702	Y	Y	2
James/York River	2017	CC1703	Y	Y	3
James/York River	2017	CC1704	Y	Y	2
James/York River	2017	CC1705	Y	Y	0
James/York River	2017	CC1706	Y	Y	3
James/York River	2017	CC1707	Y	Y	0
James/York River	2017	CC1708	Y	Y	1
James/York River	2017	CC1709	Y	Y	2
James/York River	2017	CC1710	Y	Y	2
James/York River	2017	CC9102	Y	N	--
James/York River	2017	CC9602	Y	Y	2
James/York River	2017	CC9805	Y	Y	2
James/York River	2017	CC9904	Y	N	--
James/York River	2017	CD0302	Y	Y	U
James/York River	2017	CD0403	Y	N	--
James/York River	2017	CD0604	Y	N	--
James/York River	2017	CD0701	Y	Y	2
James/York River	2017	CD0702	Y	N	--
James/York River	2017	CD0804	Y	Y	2
James/York River	2017	CD0903	Y	Y	3
James/York River	2017	CD1102	Y	Y	2
James/York River	2017	CD1203	Y	N	--
James/York River	2017	CD1301	Y	Y	3
James/York River	2017	CD1302	Y	Y	1
James/York River	2017	CD1401	Y	Y	3
James/York River	2017	CD1402	Y	Y	2
James/York River	2017	CD1601	Y	Y	2
James/York River	2017	CD1602	Y	Y	2
James/York River	2017	CD1603	Y	Y	1
James/York River	2017	CD1605	Y	Y	3
James/York River	2017	CD1606	Y	Y	1
James/York River	2017	CD9802	Y	Y	1
James/York River	2017	DW1001	Y	Y	U
James/York River	2017	HE0602	Y	Y	2
James/York River	2017	HE0604	Y	Y	1
James/York River	2017	HE0801	Y	Y	1

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	HE0802	Y	Y	2
James/York River	2017	HE0902	Y	N	--
James/York River	2017	HE1001	Y	Y	2
James/York River	2017	HE1301	Y	Y	2
James/York River	2017	HE1302	Y	Y	2
James/York River	2017	HE1303	Y	Y	U
James/York River	2017	HE1502	Y	Y	0
James/York River	2017	HE1503	Y	Y	U
James/York River	2017	HE1601	Y	Y	3
James/York River	2017	HE1701	Y	Y	2
James/York River	2017	HE1702	Y	Y	U
James/York River	2017	HE9501	Y	Y	0
James/York River	2017	HE9902	Y	Y	0
James/York River	2017	HN1301	Y	Y	U
James/York River	2017	HO0401	Y	Y	3
James/York River	2017	IW0201	Y	Y	2
James/York River	2017	IW0401	Y	Y	1
James/York River	2017	IW0701	Y	N	--
James/York River	2017	IW0802	Y	Y	1
James/York River	2017	IW0902	Y	Y	1
James/York River	2017	IW1001	Y	Y	1
James/York River	2017	IW1202	Y	N	--
James/York River	2017	IW1301	Y	Y	0
James/York River	2017	IW1403	Y	Y	1
James/York River	2017	IW1404	Y	Y	2
James/York River	2017	IW1502	Y	Y	3
James/York River	2017	IW1503	Y	Y	1
James/York River	2017	IW1602	Y	Y	2
James/York River	2017	IW1603	Y	Y	2
James/York River	2017	IW1604	Y	Y	0
James/York River	2017	IW1606	Y	Y	0
James/York River	2017	IW1607	Y	Y	0
James/York River	2017	IW1608	Y	Y	0
James/York River	2017	IW1701	Y	Y	3
James/York River	2017	IW1702	Y	Y	U
James/York River	2017	IW1703	Y	Y	1
James/York River	2017	IW1704	Y	N	--
James/York River	2017	IW8601	Y	N	--
James/York River	2017	JC0105[A]	Y	Y	1
James/York River	2017	JC0403	Y	Y	2
James/York River	2017	JC0404	Y	Y	1

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	JC0405	Y	Y	2
James/York River	2017	JC0407	Y	Y	2
James/York River	2017	JC0501[A]	Y	Y	2
James/York River	2017	JC0503	Y	Y	2
James/York River	2017	JC0605	Y	Y	2
James/York River	2017	JC0701	Y	N	--
James/York River	2017	JC0703	Y	Y	3
James/York River	2017	JC0802	Y	Y	1
James/York River	2017	JC0803[A]	Y	Y	2
James/York River	2017	JC0903	Y	Y	0
James/York River	2017	JC0905	Y	Y	2
James/York River	2017	JC1001	Y	Y	2
James/York River	2017	JC1102	Y	Y	2
James/York River	2017	JC1104	Y	Y	0
James/York River	2017	JC1105	Y	Y	2
James/York River	2017	JC1109	Y	Y	2
James/York River	2017	JC1202[A]	Y	N	--
James/York River	2017	JC1204	Y	Y	1
James/York River	2017	JC1301	Y	Y	2
James/York River	2017	JC1303	Y	N	--
James/York River	2017	JC1304	Y	Y	3
James/York River	2017	JC1305	Y	Y	2
James/York River	2017	JC1306	Y	Y	1
James/York River	2017	JC1307	Y	Y	0
James/York River	2017	JC1309	Y	Y	2
James/York River	2017	JC1401	Y	Y	2
James/York River	2017	JC1402	Y	Y	0
James/York River	2017	JC1403	Y	Y	0
James/York River	2017	JC1504	Y	Y	1
James/York River	2017	JC1506	Y	Y	1
James/York River	2017	JC1601	Y	N	--
James/York River	2017	JC1604	Y	Y	1
James/York River	2017	JC1605	Y	Y	0
James/York River	2017	JC1606[A]	Y	Y	1
James/York River	2017	JC1701	Y	Y	2
James/York River	2017	JC1702	Y	N	--
James/York River	2017	JC1703	Y	N	--
James/York River	2017	JC1704	Y	Y	2
James/York River	2017	JC1706	Y	Y	1
James/York River	2017	JC1707	Y	Y	1
James/York River	2017	JC1708	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	NK0701	Y	Y	1
James/York River	2017	NK0902	Y	Y	1
James/York River	2017	NK0903	Y	Y	1
James/York River	2017	NK0904	Y	Y	2
James/York River	2017	NK1001	Y	Y	2
James/York River	2017	NK1101	Y	N	--
James/York River	2017	NK1103	Y	N	--
James/York River	2017	NK1301	Y	Y	1
James/York River	2017	NK1501	Y	N	--
James/York River	2017	NK1601	Y	Y	0
James/York River	2017	NK1607	Y	Y	0
James/York River	2017	NN0202	Y	Y	1
James/York River	2017	NN0701	Y	Y	0
James/York River	2017	NN0801	Y	N	--
James/York River	2017	NN0802	Y	Y	0
James/York River	2017	NN1001	Y	Y	1
James/York River	2017	NN1501	Y	Y	0
James/York River	2017	NN1701	Y	Y	1
James/York River	2017	NN1702	Y	Y	0
James/York River	2017	NN1703	Y	Y	0
James/York River	2017	NN1704	Y	Y	U
James/York River	2017	NN1705	Y	Y	1
James/York River	2017	NN1706	Y	Y	2
James/York River	2017	PB1701[A]	Y	Y	2
James/York River	2017	PG0002	Y	Y	2
James/York River	2017	PG0502	Y	Y	3
James/York River	2017	PG0503	Y	N	--
James/York River	2017	PG0602	Y	Y	2
James/York River	2017	PG0603	Y	Y	1
James/York River	2017	PG0702	Y	Y	3
James/York River	2017	PG0902	Y	Y	2
James/York River	2017	PG1003	Y	Y	3
James/York River	2017	PG1005	Y	Y	2
James/York River	2017	PG1105	Y	Y	2
James/York River	2017	PG1201	Y	Y	0
James/York River	2017	PG1202	Y	Y	1
James/York River	2017	PG1204	Y	Y	2
James/York River	2017	PG1205	Y	Y	2
James/York River	2017	PG1206	Y	Y	2
James/York River	2017	PG1301	Y	Y	1
James/York River	2017	PG1302	Y	Y	0

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	PG1303	Y	N	--
James/York River	2017	PG1304	Y	Y	1
James/York River	2017	PG1401	Y	Y	2
James/York River	2017	PG1402	Y	Y	0
James/York River	2017	PG1601	Y	Y	0
James/York River	2017	PG1602	Y	Y	1
James/York River	2017	PG1701	Y	Y	2
James/York River	2017	PG1702	Y	Y	1
James/York River	2017	PG1703	Y	Y	0
James/York River	2017	PG1704	Y	Y	1
James/York River	2017	PG1705	Y	N	--
James/York River	2017	PG8901	Y	Y	2
James/York River	2017	PG9101	Y	Y	0
James/York River	2017	PG9201	Y	Y	2
James/York River	2017	PG9401	Y	Y	0
James/York River	2017	PG9402	Y	N	--
James/York River	2017	PO9801	Y	Y	1
James/York River	2017	RM1001	Y	Y	2
James/York River	2017	RM1301	Y	Y	0
James/York River	2017	RM1501	Y	Y	0
James/York River	2017	SK0301	Y	Y	2
James/York River	2017	SK0401	Y	Y	2
James/York River	2017	SK1101	Y	Y	1
James/York River	2017	SK1102	Y	Y	0
James/York River	2017	SK1201	Y	Y	2
James/York River	2017	SK1302	Y	Y	2
James/York River	2017	SK1303	Y	Y	0
James/York River	2017	SK1304	Y	Y	1
James/York River	2017	SK1401	Y	Y	2
James/York River	2017	Sk1601	Y	Y	0
James/York River	2017	Sk1602	Y	Y	1
James/York River	2017	SK1701	Y	Y	0
James/York River	2017	SK1702	Y	Y	1
James/York River	2017	SK1703	Y	Y	0
James/York River	2017	SK1704	Y	Y	2
James/York River	2017	SK9101	Y	Y	0
James/York River	2017	SU0303	Y	Y	2
James/York River	2017	SU0406	Y	N	--
James/York River	2017	SU0504	Y	Y	2
James/York River	2017	SU0703	Y	Y	1
James/York River	2017	SU0803	Y	Y	2

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2017	SU0901	Y	N	--
James/York River	2017	SU0905	Y	Y	0
James/York River	2017	SU1001	Y	Y	2
James/York River	2017	SU1004	Y	Y	0
James/York River	2017	SU1005	Y	N	--
James/York River	2017	SU1006	Y	Y	2
James/York River	2017	SU1007	Y	Y	1
James/York River	2017	SU1008	Y	Y	1
James/York River	2017	SU1102	Y	Y	2
James/York River	2017	SU1104	Y	Y	1
James/York River	2017	SU1201	Y	Y	1
James/York River	2017	SU1205	Y	Y	2
James/York River	2017	SU1206	Y	Y	1
James/York River	2017	SU1301	Y	Y	2
James/York River	2017	SU1302	Y	Y	0
James/York River	2017	SU1303	Y	Y	1
James/York River	2017	SU1304	Y	Y	1
James/York River	2017	SU1402	Y	Y	0
James/York River	2017	SU1403	Y	N	--
James/York River	2017	SU1404[A]	Y	Y	0
James/York River	2017	SU1405	Y	Y	2
James/York River	2017	SU1406	Y	Y	1
James/York River	2017	SU1501	Y	Y	1
James/York River	2017	SU1502	Y	N	--
James/York River	2017	SU1505	Y	Y	0
James/York River	2017	SU1602	Y	Y	3
James/York River	2017	SU1701	Y	Y	3
James/York River	2017	SU1702	Y	Y	3
James/York River	2017	SU1703	Y	Y	0
James/York River	2017	SU1704	Y	Y	2
James/York River	2017	SU1705	Y	Y	1

[A] National Park Service Property

Appendix IV. Bald eagle occupancy, activity, and productivity data for the James River and York River during the 2018 breeding season.

Geographic Area	Year	Nest Name	Occupied Territory	Active Nest	Productivity
James/York River	2018	CC0202	Y	Y	2
James/York River	2018	CC0303	Y	Y	1
James/York River	2018	CC0305	Y	Y	3
James/York River	2018	CC0402	Y	Y	1
James/York River	2018	CC0501	Y	N	--
James/York River	2018	CC0503	Y	Y	0
James/York River	2018	CC0504	Y	N	--
James/York River	2018	CC0601	Y	Y	2
James/York River	2018	CC0607	Y	Y	2
James/York River	2018	CC0705	Y	Y	0
James/York River	2018	CC0802	Y	N	--
James/York River	2018	CC0803	Y	Y	2
James/York River	2018	CC1001	Y	Y	2
James/York River	2018	CC1003	Y	Y	2
James/York River	2018	CC1005	Y	Y	0
James/York River	2018	CC1006	Y	Y	1
James/York River	2018	CC1007	Y	Y	2
James/York River	2018	CC1101	Y	Y	3
James/York River	2018	CC1104	Y	Y	2
James/York River	2018	CC1106	Y	Y	1
James/York River	2018	CC1107	Y	Y	0
James/York River	2018	CC1108	Y	Y	0
James/York River	2018	CC1201	Y	Y	1
James/York River	2018	CC1202	Y	Y	0
James/York River	2018	CC1203	Y	Y	1
James/York River	2018	CC1204	Y	Y	2
James/York River	2018	CC1207	Y	Y	1
James/York River	2018	CC1301	Y	N	--
James/York River	2018	CC1303	Y	Y	0
James/York River	2018	CC1305	Y	Y	1
James/York River	2018	CC1402	Y	Y	3
James/York River	2018	CC1501	Y	Y	1
James/York River	2018	CC1502	Y	Y	2
James/York River	2018	CC1503	Y	N	--
James/York River	2018	CC1506	Y	Y	2
James/York River	2018	CC1508	Y	Y	2
James/York River	2018	CC1601	Y	Y	1
James/York River	2018	CC1602	Y	Y	0

James/York River	2018	CC1604	Y	Y	3
James/York River	2018	CC1605	Y	Y	0
James/York River	2018	CC1701	Y	N	--
James/York River	2018	CC1702	Y	Y	1
James/York River	2018	CC1703	Y	Y	0
James/York River	2018	CC1704	Y	Y	2
James/York River	2018	CC1705	Y	Y	0
James/York River	2018	CC1706	Y	Y	1
James/York River	2018	CC1708	Y	Y	1
James/York River	2018	CC1709	Y	Y	2
James/York River	2018	CC1710	Y	N	--
James/York River	2018	CC1801	Y	Y	2
James/York River	2018	CC1802	Y	Y	2
James/York River	2018	CC1803	Y	N	--
James/York River	2018	CC1804	Y	Y	1
James/York River	2018	CC1805	Y	Y	1
James/York River	2018	CC1806	Y	Y	2
James/York River	2018	CC1807	Y	Y	0
James/York River	2018	CC1808	Y	Y	1
James/York River	2018	CC1809	Y	Y	2
James/York River	2018	CC9102	Y	N	--
James/York River	2018	CC9602	Y	Y	1
James/York River	2018	CC9805	Y	Y	0
James/York River	2018	CD0202	Y	Y	2
James/York River	2018	CD0302	Y	Y	1
James/York River	2018	CD0604	Y	Y	2
James/York River	2018	CD0701	Y	N	--
James/York River	2018	CD0702	Y	N	--
James/York River	2018	CD0804	Y	Y	2
James/York River	2018	CD0903	Y	Y	0
James/York River	2018	CD1102	Y	Y	2
James/York River	2018	CD1203	Y	Y	1
James/York River	2018	CD1301	Y	Y	2
James/York River	2018	CD1302	Y	N	--
James/York River	2018	CD1401	Y	Y	2
James/York River	2018	CD1402	Y	Y	2
James/York River	2018	CD1601	Y	Y	2
James/York River	2018	CD1602	Y	Y	3
James/York River	2018	CD1603	Y	Y	1
James/York River	2018	CD1605	Y	Y	2
James/York River	2018	CD1606	Y	Y	1
James/York River	2018	CD1801	Y	Y	1
James/York River	2018	CD1802	Y	Y	0

James/York River	2018	CD1803	Y	Y	1
James/York River	2018	CD1804	Y	Y	2
James/York River	2018	CD9802	Y	Y	2
James/York River	2018	DW1001	Y	Y	0
James/York River	2018	HE0602	Y	Y	3
James/York River	2018	HE0604	Y	Y	0
James/York River	2018	HE0801	Y	Y	2
James/York River	2018	HE0802	Y	Y	2
James/York River	2018	HE0902	Y	Y	2
James/York River	2018	HE1001	Y	Y	2
James/York River	2018	HE1301	Y	Y	0
James/York River	2018	HE1302	Y	Y	0
James/York River	2018	HE1502	Y	Y	0
James/York River	2018	HE1601	Y	Y	1
James/York River	2018	HE1702	Y	Y	0
James/York River	2018	HE1703	Y	N	--
James/York River	2018	HE1801	Y	Y	1
James/York River	2018	HE1802	Y	Y	0
James/York River	2018	HE9501	Y	Y	0
James/York River	2018	HE9902	Y	N	--
James/York River	2018	HN1301	Y	Y	1
James/York River	2018	HN1801	Y	Y	2
James/York River	2018	HO0401	Y	Y	0
James/York River	2018	IW0201	Y	N	--
James/York River	2018	IW0401	Y	Y	1
James/York River	2018	IW0701	Y	N	--
James/York River	2018	IW0802	Y	N	--
James/York River	2018	IW0902	Y	Y	1
James/York River	2018	IW1001	Y	Y	1
James/York River	2018	IW1202	Y	Y	1
James/York River	2018	IW1402	Y	N	--
James/York River	2018	IW1403	Y	Y	2
James/York River	2018	IW1404	Y	Y	2
James/York River	2018	IW1501	Y	Y	2
James/York River	2018	IW1502	Y	Y	3
James/York River	2018	IW1503	Y	Y	2
James/York River	2018	IW1602	Y	Y	2
James/York River	2018	IW1603	Y	N	--
James/York River	2018	IW1604	Y	Y	1
James/York River	2018	IW1606	Y	Y	0
James/York River	2018	IW1701	Y	Y	1
James/York River	2018	IW1703	Y	Y	2
James/York River	2018	IW1801	Y	Y	1

James/York River	2018	IW1802	Y	Y	0
James/York River	2018	IW8601	Y	Y	1
James/York River	2018	JC0105[A]	Y	Y	1
James/York River	2018	JC0403	Y	N	--
James/York River	2018	JC0404	Y	Y	1
James/York River	2018	JC0405	Y	Y	0
James/York River	2018	JC0407	Y	N	--
James/York River	2018	JC0501[A]	Y	Y	2
James/York River	2018	JC0503	Y	Y	2
James/York River	2018	JC0604[A]	Y	Y	0
James/York River	2018	JC0605	Y	Y	0
James/York River	2018	JC0701	Y	Y	1
James/York River	2018	JC0703	Y	Y	0
James/York River	2018	JC0802	Y	Y	0
James/York River	2018	JC0803[A]	Y	N	--
James/York River	2018	JC0903	Y	Y	1
James/York River	2018	JC0905	Y	Y	2
James/York River	2018	JC1001	Y	Y	3
James/York River	2018	JC1102	Y	Y	2
James/York River	2018	JC1103	Y	N	--
James/York River	2018	JC1105	Y	Y	0
James/York River	2018	JC1109	Y	Y	2
James/York River	2018	JC1202[A]	Y	Y	2
James/York River	2018	JC1204	Y	N	--
James/York River	2018	JC1301	Y	Y	2
James/York River	2018	JC1305	Y	Y	1
James/York River	2018	JC1306	Y	Y	2
James/York River	2018	JC1307	Y	Y	2
James/York River	2018	JC1308	Y	Y	1
James/York River	2018	JC1309	Y	Y	2
James/York River	2018	JC1401	Y	N	--
James/York River	2018	JC1402	Y	Y	0
James/York River	2018	JC1403	Y	Y	1
James/York River	2018	JC1501	Y	Y	3
James/York River	2018	JC1504	Y	Y	1
James/York River	2018	JC1506	Y	Y	2
James/York River	2018	JC1604	Y	Y	2
James/York River	2018	JC1606[A]	Y	Y	2
James/York River	2018	JC1701	Y	Y	2
James/York River	2018	JC1704	Y	Y	2
James/York River	2018	JC1706	Y	N	--
James/York River	2018	JC1707	Y	Y	2
James/York River	2018	JC1708	Y	Y	1

James/York River	2018	JC1709	Y	Y	0
James/York River	2018	JC1801	Y	N	--
James/York River	2018	JC1802	Y	Y	1
James/York River	2018	JC1803	Y	N	--
James/York River	2018	JC1804	Y	Y	0
James/York River	2018	JC1805	Y	Y	2
James/York River	2018	JC1806[A]	Y	Y	1
James/York River	2018	NK0701	Y	N	--
James/York River	2018	NK0902	Y	Y	1
James/York River	2018	NK0903	Y	Y	2
James/York River	2018	NK0904	Y	N	--
James/York River	2018	NK1001	Y	Y	1
James/York River	2018	NK1103	Y	Y	3
James/York River	2018	NK1301	Y	Y	2
James/York River	2018	NK1601	Y	Y	1
James/York River	2018	NK1607	Y	Y	1
James/York River	2018	NK1801	Y	Y	1
James/York River	2018	NN0202	Y	Y	1
James/York River	2018	NN0802	Y	Y	1
James/York River	2018	NN1001	Y	Y	0
James/York River	2018	NN1301	Y	Y	0
James/York River	2018	NN1701	Y	Y	3
James/York River	2018	NN1702	Y	Y	2
James/York River	2018	NN1703	Y	N	--
James/York River	2018	NN1704	Y	Y	0
James/York River	2018	NN1705	Y	Y	2
James/York River	2018	NN1706	Y	Y	0
James/York River	2018	NN1801	Y	Y	1
James/York River	2018	NN1802	Y	Y	0
James/York River	2018	NN1803	Y	Y	0
James/York River	2018	NN1804	Y	Y	2
James/York River	2018	PB1701[A]	Y	Y	2
James/York River	2018	PG0002	Y	Y	1
James/York River	2018	PG0502	Y	Y	3
James/York River	2018	PG0503	Y	Y	1
James/York River	2018	PG0602	Y	Y	1
James/York River	2018	PG0603	Y	Y	2
James/York River	2018	PG0702	Y	Y	1
James/York River	2018	PG0902	Y	Y	1
James/York River	2018	PG1003	Y		--
James/York River	2018	PG1005	Y	Y	2
James/York River	2018	PG1105	Y	N	--
James/York River	2018	PG1201	Y	N	--

James/York River	2018	PG1202	Y	Y	2
James/York River	2018	PG1203	Y	Y	1
James/York River	2018	PG1205	Y	Y	2
James/York River	2018	PG1206	Y	Y	1
James/York River	2018	PG1303	Y	Y	2
James/York River	2018	PG1304	Y	Y	1
James/York River	2018	PG1401	Y	Y	1
James/York River	2018	PG1602	Y	Y	2
James/York River	2018	PG1701	Y	Y	3
James/York River	2018	PG1702	Y	Y	0
James/York River	2018	PG1703	Y	N	--
James/York River	2018	PG1704	Y	Y	2
James/York River	2018	PG1705	Y	N	--
James/York River	2018	PG1801	Y	N	--
James/York River	2018	PG1802	Y	Y	1
James/York River	2018	PG1803	Y	Y	0
James/York River	2018	PG1804	Y	Y	1
James/York River	2018	PG8901	Y	Y	1
James/York River	2018	PG9101	Y	Y	0
James/York River	2018	PG9201	Y	Y	3
James/York River	2018	PG9401	Y	Y	0
James/York River	2018	PG9402	Y	Y	3
James/York River	2018	PO9801	Y	Y	1
James/York River	2018	RM1001	Y	Y	1
James/York River	2018	RM1301	Y	N	--
James/York River	2018	RM1501	Y	Y	1
James/York River	2018	SK0301	Y	Y	2
James/York River	2018	SK0401	Y	Y	1
James/York River	2018	SK1201	Y	Y	2
James/York River	2018	SK1302	Y	Y	2
James/York River	2018	SK1303	Y	Y	2
James/York River	2018	SK1304	Y	Y	2
James/York River	2018	SK1401	Y	Y	2
James/York River	2018	Sk1601	Y	Y	2
James/York River	2018	Sk1602	Y	Y	2
James/York River	2018	SK1703	Y	Y	1
James/York River	2018	SK1704	Y	Y	2
James/York River	2018	SK1801	Y	Y	2
James/York River	2018	SK1802	Y	Y	0
James/York River	2018	SK9101	Y	Y	2
James/York River	2018	SU0303	Y	Y	3
James/York River	2018	SU0504	Y	Y	3
James/York River	2018	SU0703	Y	Y	1

James/York River	2018	SU0803	Y	Y	1
James/York River	2018	SU0905	Y	N	--
James/York River	2018	SU1001	Y	Y	2
James/York River	2018	SU1004	Y	Y	0
James/York River	2018	SU1005	Y	Y	1
James/York River	2018	SU1006	Y	Y	2
James/York River	2018	SU1007	Y	Y	2
James/York River	2018	SU1008	Y	N	--
James/York River	2018	SU1102	Y	Y	0
James/York River	2018	SU1104	Y	Y	1
James/York River	2018	SU1201	Y	Y	1
James/York River	2018	SU1205	Y	Y	1
James/York River	2018	SU1206	Y	N	--
James/York River	2018	SU1301	Y	Y	2
James/York River	2018	SU1302	Y	N	--
James/York River	2018	SU1303	Y	Y	0
James/York River	2018	SU1304	Y	Y	2
James/York River	2018	SU1401	Y	N	--
James/York River	2018	SU1402	Y	N	--
James/York River	2018	SU1404[A]	Y	Y	2
James/York River	2018	SU1405	Y	Y	2
James/York River	2018	SU1406	Y	Y	1
James/York River	2018	SU1501	Y	Y	0
James/York River	2018	SU1502	Y	Y	2
James/York River	2018	SU1503	Y	N	--
James/York River	2018	SU1505	Y	Y	1
James/York River	2018	SU1601	Y	Y	1
James/York River	2018	SU1602	Y	Y	2
James/York River	2018	SU1701	Y	Y	0
James/York River	2018	SU1702	Y	Y	0
James/York River	2018	SU1703	Y	Y	0
James/York River	2018	SU1704	Y	Y	1
James/York River	2018	SU1705	Y	Y	3
James/York River	2018	SU1801	Y	N	--
James/York River	2018	SU1802	Y	Y	2
James/York River	2018	SU1803	Y	N	--

[A] National Park Service Property

Appendix V. Morphometrics of bald eagle nestlings banded on or near NPS lands in VA and MD during the 2016 - 2018 breeding seasons.

Band Number	Color Band[1]	Nest Name	Year	Sex	Weight (g)	Culmen Length with Cere (mm)	Culmen Length without Cere (mm)	Culmen Depth (mm)	Halux Length (mm)	Tail Length (cm)	Wing Chord (cm)
0629-12153	RH	VB1501	2016	M	2892	52.3	42.1	27.9	34.5	14.8	33.6
0629-12154	RK	VB1501	2016	M	3368	54.5	42.8	29.9	33.8	12.4	29.3
0629-12155	RM	VB1002	2016	F	4270	62.6	50.4	34.5	38.2	20.0	42.0
0629-12156	RN	VB1002	2016	F	3998	62.3	50.2	32.8	37.7	20.2	44.0
0629-12157	RP	VB1002	2016	F	4326	60.2	48.4	33.4	38.2	21.7	43.7
0629-47631	PB	SU1404	2016	F	4400	61.4	48.0	32.5	37.8	20.0	43.3
0629-47632	PC	SU1404	2016	M	3650	48.6	45.0	30.5	34.8	20.5	40.5
0629-47633	PD	SU1602	2016	F	4178	62.5	48.0	33.7	36.9	17.5	39.0
0629-47634	PE	SU1602	2016	M	3300	52.9	41.1	28.0	30.0	16.2	34.5
0629-47635	PH	YK1503	2016	M	3384	53.2	42.9	28.9	31.4	18.7	37.5
0629-47636	PK	YK1503	2016	M	3260	55.1	43.1	28.5	30.9	16.9	35.4
0629-47637	PM	JC1105	2016	M	3116	50.7	37.8	27.4	30.0	10.8	26.7
0629-47638	PN	JC1202	2016	U	3030	49.6	39.0	27.8	31.0	65.0	26.4
0629-47639	PP	JC1202	2016	U	3404	53	40.7	29.0	32.8	40.0	23.0
0629-47640	PR	YK1601	2016	F	3716	51.5	40.4	29.9	32.1	50.0	24.6
0629-47641	PS	YK1601	2016	M	2520	50	36.1	25.8	25.9	31.0	18.8
0629-47642	PU	JC0501	2016	M	3550	56.6	44.0	30.4	36.5	91.0	28.5
0629-47643	PV	IW0802	2016	M	2814	40.3	36.5	27.5	28.4	53.0	21.7
0629-47644	PW	IW0802	2016	U							
0629-47645	PX	JC0803	2016	F	4492	62	48.9	32.7	37.0	15.7	38.5
0629-47646	PZ	JC0803	2016	F	4672	60.4	48.4	33.6	37.2	21.8	42.7
0629-47647	RA	YK0701	2016	M	3740	54	42.4	29.5	33.8	17.5	36.5
0629-47648		YK0701	2016	M	2336	54.2	41.6	28.8	30.1	10.2	31.0
0679-01403	UA	PAX-11 Pine Hill Run	2017	M	2808	51.9	40.0	28.2	31.4	10.5	28.5

Band Number	Color Band[1]	Nest Name	Year	Sex	Weight (g)	Culmen Length with Cere (mm)	Culmen Length without Cere (mm)	Culmen Depth (mm)	Halux Length (mm)	Tail Length (cm)	Wing Chord (cm)
0679-01404	UB	PAX-11 Pine Hill Run	2017	F	3650	56.7	44.5	30.6	32.4	10.5	29.5
0679-01405	UC	PAX-13 Golf Course	2017	F	5020	61.4	49.8	33.5	37.5	20.4	40.5
0679-01406	UD	PAX-13 Golf Course	2017	F	4670	56.5	46.5	32.8	36.0	16.1	36.5
0679-01407	UE	IH-12	2017	M	2908	52.7	41.9	28.5	31.0	10.8	29.0
0679-01408	UH	IH-12	2017	F	3662	56.4	44.1	31.4	34.2	8.5	28.2
0679-01409	UK	IH-18	2017	F	4120	58.7	46.3	20.4	35.7	13.3	34.3
0679-01410	UM	IH-18	2017	F	4560	61.9	49.3	34.0	37.3	17.5	38.2
0679-01411	UN	IH-18	2017	M	3566	56.8	44.3	29.8	32.6	15.4	37.4
0679-01412	UP	IH-26	2017	M	2698	50.8	38.9	27.9	29.4	6.1	24.1
0679-01413	UR	IH-26	2017	F	3610	56.0	43.8	31.5	31.9	6.4	25.5
0679-01414	US	IH-26	2017	M	3118	51.7	40.9	28.5	30.1	9.3	27.2
0679-01415	UU	FF1611	2017	M	3140	53.7	44.5	29.5	33.1	9.8	27.6
0679-01416	UV	FF1611	2017	M	3160	56.8	45.1	30.6	33.2	11.9	30.7
0679-01417	UW	FF1610	2017	M	2896	53.5	41.7	28.0	30.6	10.0	26.5
0679-01418	UX	FF1610	2017	M	3850	58.2	45.5	32.0	35.1	11.6	31.5
0679-01419	UZ	PAX-5 Goose Creek	2017	M	2700	51.4		27.2	28.9	6.9	21.2
0679-01420	17/D	WE1109	2017	M	3306	54.2	44.2	29.5	33.2	14.0	34.0
0679-01421	25/D	WE1109	2017	M	3214	56.4	44.2	31.8	33.4	13.8	33.4
0679-01422	23/D	WE1110	2017	M	2766	52.4	42.5	29.8	32.8	13.3	33.5
0679-01423	37/D	Piscataway Park West	2017	M	3450	55.9	44.4	31.1	33.0	12.1	32.2
0679-01424	38/D	Piscataway Park West	2017	F	3698	53.4	41.2	31.5	33.7	10.4	30.5
0679-01425	39/D	Piscataway Park West	2017	M	2870	53.6	40.0	27.5	30.5	6.8	26.5
0679-01426	40/D	PB1701	2018	F	4006	55.2	45.7	31.9	35.5	12.2	32.2

Band Number	Color Band[1]	Nest Name	Year	Sex	Weight (g)	Culmen Length with Cere (mm)	Culmen Length without Cere (mm)	Culmen Depth (mm)	Halux Length (mm)	Tail Length (cm)	Wing Chord (cm)
0679-01427	41/D	PB1701	2018	M	3310	53.6	41.4	29.2	31.9	12.8	30.1
0679-01428	42/D	PG0902	2018	F	4428	60.5	47.5	33.0	37.9	23.3	44.5
0679-01429	43/D	PG0603	2018	M	3210	54.3	41.9	28.6	32.9	16.0	34.0
0679-01430	45/D	PG0603	2018	F	4380	58.0	45.9	32.7	35.6	16.3	36.5
0679-01431	46/D	PG0603	2018	M	3390	56.1	46.2	31.0	35.3	19.4	37.5
0679-01432	47/D	PAX-10 PAX Golf Course 3	2018	M	3426	53.5	42.8	30.0	33.4	15.8	33.7
0679-01433	48/D	PAX-10 PAX Golf Course 3	2018	M	3335	54.0	41.8	29.3	33.9	14.8	32.8
0679-01434	50/D	PAX-11 Pine Hill Run	2018		4310	60.7	48.4	34.0	38.5	16.8	38.5
0679-01435	51/D	PAX-11 Pine Hill Run	2018		3330	53.0	40.7	28.0	32.5	10.8	31.0

Appendix VI. Lab results of bald eagle nestling blood analysis for cadmium, lead, and mercury.

Band Number	Nest Name	Year	Collection Date	Sample Location	Cadmium (µg/g)	Lead (µg/g)	Mercury (µg/g)
0629-12153	VB1501	2016	5/11/2016	Owl Creek	nd	0.041	0.726
0629-47631	SU1404	2016	4/15/2016	Swan Point	nd	0.026	0.427
0629-47633	SU1602	2016	4/15/2016	Scotland West	nd	nd	0.217
0629-47635	YK1503	2016	4/15/2016	Yorktown Battlefield	nd	0.027	0.217
0629-47637	JC1105	2016	4/18/2016	Gospel Spreading Farm	nd	0.04	0.274
0629-47638	JC1202	2016	4/18/2016	Jamestown Island	nd	0.028	0.574
0629-47640	YK1601	2016	4/18/2016	Yorktown Creek	nd	0.032	0.312
0629-47642	JC0501	2016	4/23/2016	NPS near Kingsmill	nd	nd	0.106
0629-47643	IW0802	2016	4/23/2016	Lawnes Creek	nd	0.027	0.233
0629-47645	JC0803	2016	5/8/2016	Jamestown Island	nd	0.021	0.244
0629-47647	YK0701	2016	5/8/2016	Newport News Reservoir	nd	0.067	0.474
0679-01404	PAX-11 Pine Hill Run	2017	5/2/2017	Patuxent River NAS	nd	0.212	0.268
0679-01405	PAX-13 Golf Course	2017	5/2/2017	Patuxent River NAS	nd	nd	0.257
0679-01408	IH-12	2017	5/3/2017	Indian Head	nd	0.055	0.419
0679-01410	IH-18	2017	5/3/2017	Indian Head	nd	0.04	0.318
0679-01414	IH-26	2017	5/3/2017	Indian Head	nd	0.05	0.289
0679-01416	FF1611	2017	5/4/2017	Mason Neck NWR	nd	0.062	0.540
0679-01418	FF1610	2017	5/4/2017	Mason Neck NWR	nd	0.024	0.483
0679-01419	PAX-5 Goose Creek	2017	5/2/2017	Patuxent River NAS	nd	0.092	0.383
0679-01420	WE1109	2017	5/8/2017	George Washington's Birthplace NP	nd	0.044	0.284
0679-01422	WE1110	2017	5/8/2017	George Washington's Birthplace NP	nd	0.056	0.120
0679-01424	Piscataway Park West	2017	5/9/2017	Piscataway NP	nd	0.031	0.903
0679-01426	PB1701	2018	4/26/2018	Petersburg Battlefield	nd	0.884	0.298
0679-01428	PG0902	2018	4/26/2018	James River, NWR	nd	0.046	0.473
0679-01430	PG0603	2018	4/26/2018	James River, NWR	nd	0.035	0.579

Appendix VII. PCBs & OC pesticides found in 2016 eagle blood samples, corrected for PCB204 recovery (ng/g).

Band Number	0629-12153	0629-47631	0629-47633	0629-47635	0629-47637	0629-47638	0629-47640	0629-47642	0629-47643	0629-47645	0629-47647
PCB 18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 17	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 16, 32	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 26	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 25	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 28, 31	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 53	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 33, 20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 46	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 47, 48	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 42, 59	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 41, 64	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 67	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 95	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 66	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 56, 60	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 92	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 84	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 101, 90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Band Number	0629-12153	0629-47631	0629-47633	0629-47635	0629-47637	0629-47638	0629-47640	0629-47642	0629-47643	0629-47645	0629-47647
PCB 99	nd	nd	nd	nd	0.61	nd	nd	nd	nd	nd	nd
PCB 83	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 97	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 87, 115	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 85	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 136	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 77	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 82	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 135	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 107	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 149	nd	2.42	nd	nd	nd	1.90	nd	nd	nd	nd	nd
PCB 123	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 118	nd	1.79	nd	nd	nd	nd	nd	nd	nd	1.89	nd
PCB 134	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 131, 165	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 146	nd	1.16	nd	nd	nd	nd	nd	nd	nd	0.47	nd
PCB 153, 132	nd	8.92	4.75	5.10	8.70	8.20	2.35	4.39	4.99	5.86	6.42
PCB 105	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 141, 179	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 137	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 176	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 130	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 163, 164	nd	nd	0.92	nd	nd	nd	nd	nd	nd	0.92	nd
PCB 138, 158	nd	2.96	nd	nd	nd	nd	nd	nd	nd	2.61	nd
PCB 178	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 129	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 175	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 187	nd	2.78	1.56	nd	2.74	2.60	0.51	0.70	nd	3.05	1.92
PCB 183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Band Number	0629-12153	0629-47631	0629-47633	0629-47635	0629-47637	0629-47638	0629-47640	0629-47642	0629-47643	0629-47645	0629-47647
PCB 128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 167	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 185	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 174	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 171	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 156	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 172	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 180, 193	nd	3.47	2.57	nd	4.44	3.15	nd	1.34	nd	3.14	nd
PCB 191	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 170, 190	nd	nd	nd	nd	nd	1.44	nd	nd	nd	0.52	nd
PCB 208	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 195	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 209	nd	nd	nd	nd	nd	2.01	nd	nd	nd	1.16	nd
cis-chlordane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-nonachlor	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
methoxy-triclosan	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-ddd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-dde	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-ddt	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-ddd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-dde	nd	8.77	nd	3.97	5.98	6.49	3.32	2.63	5.95	4.73	nd
p,p'-ddt	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
trans-chlordane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
trans-nonachlor	nd	nd	nd	nd	1.93	0.75	nd	nd	nd	nd	nd

Appendix VIII. PCBs & OC pesticides found in 2017 eagle blood samples, corrected for PCB204 recovery (ng/g).

Band Number	0679-01408	0679-01410	0679-01414	0679-01416	0679-01419	0679-01404	0679-01405	0679-01418	0679-01420	0679-01422	0679-01424
PCB 18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 17	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 16, 32	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 26	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 25	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 28, 31	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 53	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 33, 20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 46	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 47, 48	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 42, 59	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 41, 64	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 67	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 95	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 66	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 56, 60	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 92	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 84	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 101, 90	nd	nd	nd	nd	nd	nd	nd	0.10	nd	nd	nd

Band Number	0679-01408	0679-01410	0679-01414	0679-01416	0679-01419	0679-01404	0679-01405	0679-01418	0679-01420	0679-01422	0679-01424
PCB 99	0.25	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 83	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 97	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 87, 115	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 85	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 136	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 77	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 82	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 135	0.22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 107	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 149	1.22	nd	nd	nd	nd	nd	nd	0.98	0.92	nd	nd
PCB 123	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 118	1.06	nd	nd	nd	nd	nd	nd	0.38	nd	nd	nd
PCB 134	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 131, 165	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 146	0.49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 153, 132	4.01	2.81	2.66	3.59	nd	1.51	nd	3.38	2.29	1.35	2.99
PCB 105	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 141, 179	nd	nd	nd	nd	nd	nd	nd	0.13	nd	nd	nd
PCB 137	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 176	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 130	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 163, 164	0.33	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 138, 158	1.67	1.46	1.17	nd	nd	nd	nd	1.34	1.22	nd	1.14
PCB 178	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 129	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 175	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 187	1.48	nd	nd	nd	nd	nd	nd	1.10	nd	nd	0.82
PCB 183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Band Number	0679-01408	0679-01410	0679-01414	0679-01416	0679-01419	0679-01404	0679-01405	0679-01418	0679-01420	0679-01422	0679-01424
PCB 128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 167	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 185	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 174	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 171	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 156	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 172	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 180, 193	2.20	nd	nd	nd	nd	nd	nd	1.73	nd	nd	nd
PCB 191	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 170, 190	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 208	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 195	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB 209	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-chlordane	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.14
cis-nonachlor	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
methoxy-triclosan	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-ddd	nd	nd	nd	nd	nd	nd	0.12	nd	nd	nd	nd
o,p'-dde	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-ddt	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-ddd	0.22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-dde	0.60	1.24	0.93	1.49	3.49	2.54	2.99	0.70	1.30	0.93	2.44
p,p'-ddt	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
trans-chlordane	0.11	nd	nd	nd	nd	nd	nd	0.04	nd	nd	nd
trans-nonachlor	0.19	nd	0.21	0.20	nd	nd	nd	0.13	0.11	nd	0.30