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Bald Eagle Nest Productivity and Contaminant Monitoring at Naval Support Facility Indian Head, Maryland

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**BALD EAGLE NEST PRODUCTIVITY AND
CONTAMINANT MONITORING AT NAVAL SUPPORT
FACILITY INDIAN HEAD, MARYLAND: 2008 REPORT**



Center for Conservation Biology

Bald Eagle Nest Productivity and Contaminant Monitoring at Naval Support Facility Indian Head, Maryland

Annual Report

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EXECUTIVE SUMMARY

Bald Eagles were monitored at Naval Support Facility Indian Head, Maryland in compliance with a 2007 Biological Opinion prepared by the US Fish and Wildlife Service. Eagle nests were surveyed for breeding activity and productivity using a standard 2-flight protocol. A Cessna 172 aircraft was used to systematically survey the property to locate eagle nests and determine nesting activity. Nests were climbed with arborist equipment or accessed with a bucket truck. Eagle nestlings were banded and measured. Blood and feather samples were collected from 18 nestlings to test for Encephalitis viruses and mercury and organochloride contaminants. One addled egg was collected for contaminant testing.

Nine nests were active during the 2008 breeding season. Productivity rates were estimated at 2.0 chicks/active nest (nest observed with eggs or chicks) and 2.25 chicks/productive nest (chicks reached fledging age). All nestlings tested negative for encephalitis viruses including West Nile Virus. Mercury levels were subacute in blood ($\bar{x} = 0.05$ mg/kg) and feathers ($\bar{x} = 1.22$ mg/kg). The single addled egg had a mercury value of 0.09 mg/kg. Contaminant levels in blood were also subacute for total PCBs ($\bar{x} = 0.044$ μ g/g), total Chlordane ($\bar{x} = 0.010$ μ g/g), and DDE ($\bar{x} = 0.013$ μ g/g). Values for the addled egg approached toxicity thresholds for PCBs and DDE.

Productivity rates were not significantly higher at Indian Head than at nearby Virginia nests along the Potomac River. Forty-four percent fledged 3 chick broods indicating high prey-availability on the Upper Potomac and on Mattawoman Creek. All contaminant levels were low in nestling blood and feathers. High levels of PCB and DDE contaminants likely contributed to reproductive failure at the Extrusion nest but results are inconclusive. High levels of these contaminants are present in nearby foraging areas along the Potomac River with point and non-point source contamination documented upstream of NSF Indian Head.

BACKGROUND

Content

Bald Eagle (*Haliaeetus leucocephalus*) populations across the lower 48 states have rebounded from 417 breeding pairs in 1963 (Sprunt 1963) to an estimated 5,478 in 1998 (Millar 1999). The Chesapeake Bay population grew exponentially from 73 pairs in 1977 to 601 pairs in 2001 (Watts et al. 2008). The population has continued to grow and now is estimated at over 1,000 breeding pairs (Maryland Department of Natural Resources 2004, Watts and Byrd 2008).

The recovery of eagle populations throughout most of their range prompted the US Fish and Wildlife Service (USFWS) to remove the species from the Endangered Species List in 2007 (USFWS 2007a, Watts and Byrd 2008). Eagles remain protected under the federal Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act, and Lacey Act (Millar 1999). Although breeding populations have recovered, there are many threats affecting breeding and non-breeding eagles. Current threats include electrocutions, line strikes, disease, contaminants, habitat loss, and vehicle collisions (Millar 1999, Millsap et al. 2004).

A series of Bald Eagle electrocutions and line strikes at Naval Support Facility (NSF) Indian Head since 2001 initiated a formal consultation with the USFWS under section 7 of the Endangered Species Act. A Biological Opinion (BO) was issued by the USFWS based on the Biological Assessment prepared by NSF Indian Head (USFWS 2007b). In compliance with the BO, the Navy contracted with the Center for Conservation Biology to monitor the breeding population of eagles on NSF Indian Head for 3 breeding seasons beginning in 2008. Monitoring was designed to address concerns in the BO that eagles may have contaminant problems.

Objectives

Our objectives in studying the Bald Eagle population at NSF Indian Head are:

1. to document the status, distribution, and productivity of eagles on NSF Indian Head
2. to test for the presence of West Nile Virus and other encephalitis viruses
3. to measure levels of environmental contaminants in addled eggs, nestling blood and feather samples.

METHODS

Study Area

NSF Indian Head is located on the shores of the upper Potomac River in Charles County, Maryland. The tidal fresh reaches of the Potomac are a documented eagle concentration area supporting a resident population of eagles and large numbers of migrant eagles (Watts *et al.* 2007). This study focused on the Stump Neck and Cornwallis Neck sections of NSF Indian Head which straddle Mattawoman Creek (Figure 1). Mattawoman Creek is rich in eagle prey and supports abundant fish and waterfowl (BDW per obs.). A communal roost is located on Mattawoman Creek in a ravine bordering NSF Indian Head and Governor Smallwood State Park (S. Berry pers comm.).

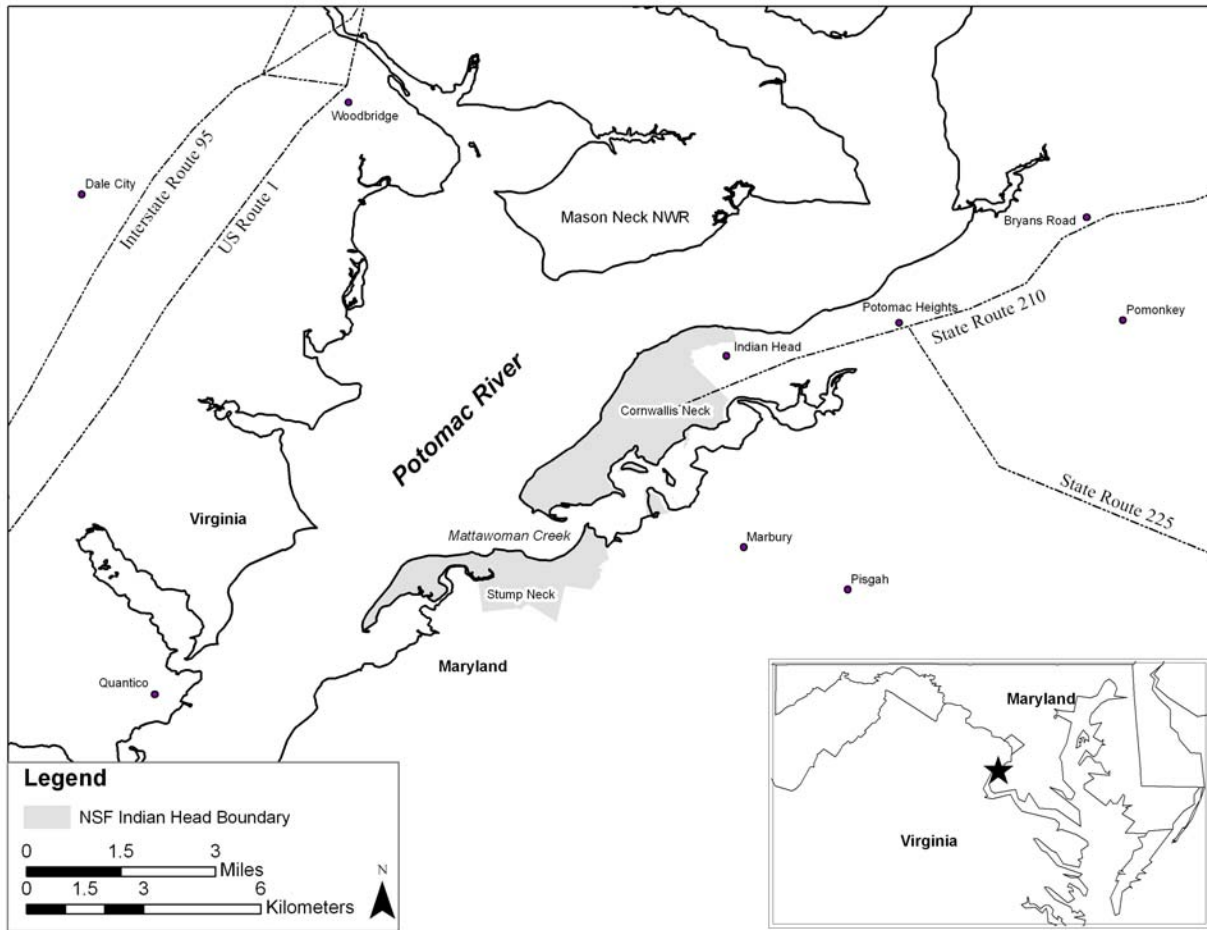


Figure 1. NSF Indian Head is located on the Potomac River in Charles Co, MD. The main study area consisted of two peninsulas at Cornwallis Neck and Stump Neck.

Survey

Aerial surveys were used to locate and map bald eagle nests throughout NSF Indian Head, determine condition and activity status of nests, and determine productivity of active nests during the 2008 breeding season. A high-wing Cessna 172 aircraft was used to systematically overfly the land surface at an altitude of approximately 100 m enabling detection of eagle nests and nest contents. Flights covered all forested habitat supported by the property. Detected nests were plotted on 7.5 min topographic maps, assigned a unique alphanumeric code, and plotted in ArcGIS 9.3 (Figure 2, Appendix A). The initial nest survey was conducted in mid-March. A second survey in mid-April and a third in early May were conducted to document the productivity status of active nests found during the first survey. Following national conventions, a breeding territory was considered “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, and structural maintenance). Nests were considered “active” if a bird was observed in an incubating posture or if eggs or young were detected in the nest. A “productive” nest has young present until fledging age (11-14 weeks old). Productivity rates were compared with results of the 2008 Virginia Bald Eagle Nest Survey.

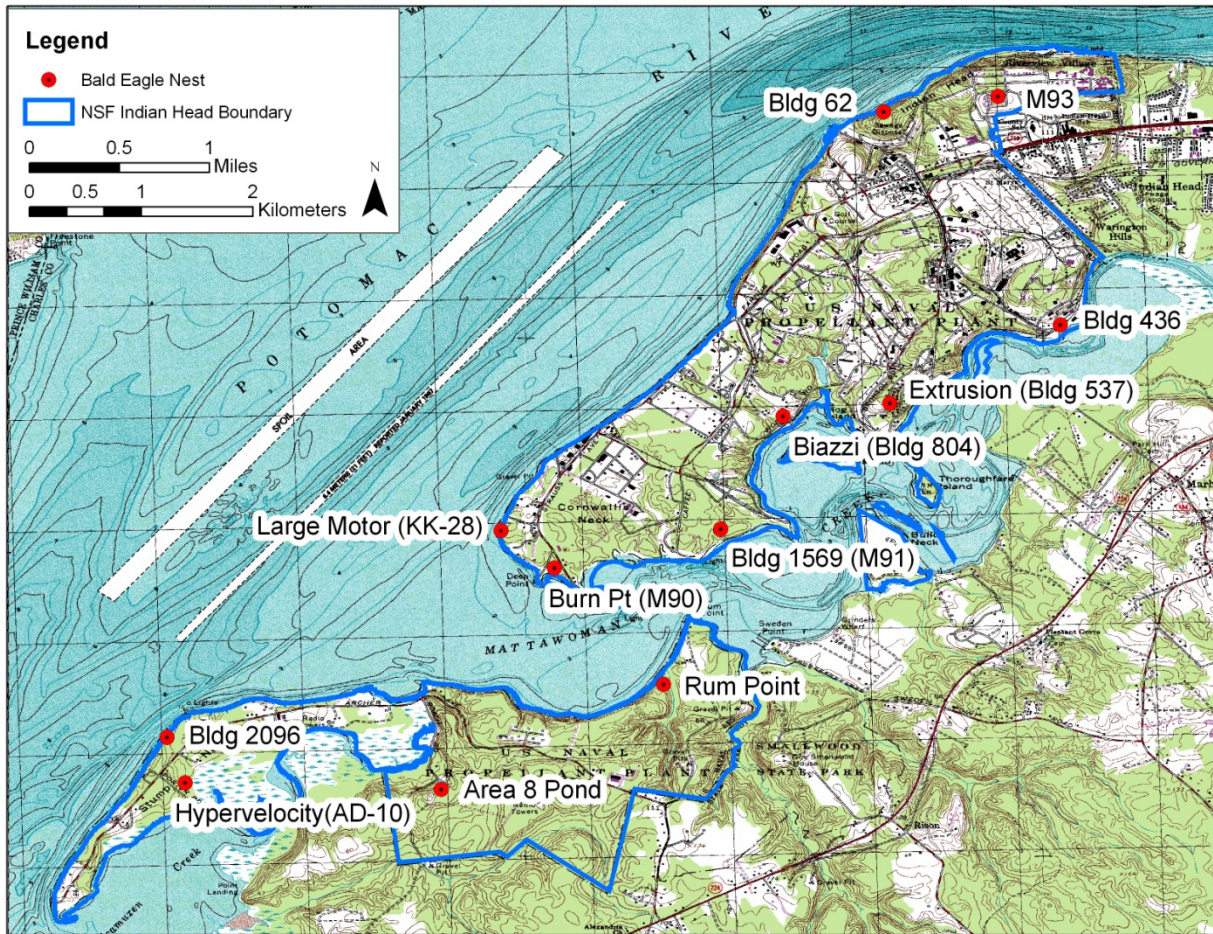


Figure 2. Bald Eagle nests monitored during the 2008 breeding season at NSF Indian Head, MD.

Banding

Nests were accessed using standard arborist equipment when the chicks were between 32 and 45 days old. Chicks were lowered to the ground for banding, measurements, and tissue collection. The following morphometric measurements were taken on all chicks: weight, wing length, tail length, culmen length, culmen depth, hallux length, and tarsus length. Wing and tail length were measured with a ruler (± 1 mm) and culmen length, culmen depth, hallux length, and tarsus length were measured with dial calipers (± 0.1 mm). Eagles were weighed on a digital scale (± 1 g). Nestlings were marked with numeric federal bands (USGS Bird Banding Lab, Laurel, MD) on the right tarsus and purple alpha-numeric color bands (ACRAFT, Edmonton, Alberta) on the left tarsus. Banding and tissue collection was in accordance with state and federal permits.

Blood Sampling

Blood samples were collected from the brachial vein in the wing using 23 gauge butterfly needles and 4cc heparinized BD Vacutainers©. A maximum of 6cc of blood was collected from each eagle. Blood samples were immediately packed on ice and frozen within 4 hours of collection. Two feathers were pulled from the breast area and stored in a paper envelope. All samples were labeled with the eagle's

band number and unique nest code. Eggs were washed with tap water and allowed to air dry, then wrapped in aluminum foil and frozen. Methodology for tissue collection was in compliance with protocols approved by the Institutional Animal Care and Use Committee at the College of William and Mary.

Encephalitis Viruses

Blood plasma was tested for the presence of Immunoglobulin M antibodies using an enzyme-linked immunosorbent assay (Ebel *et al.*, 2002) and the presence of Immunoglobulin M and G antibodies using a serum-virus neutralization test (Komar *et al.*, 2001). Samples were tested for West Nile Virus (WNV), Eastern Encephalitis, and Eastern Equine Encephalitis viruses. All analyses were performed at The University of Georgia's Veterinary Diagnostic and Investigational Laboratory, Tifton, GA.

Mercury

Mercury (Hg) analysis took place in the Cristol Lab at the Department of Biology, College of William and Mary. Total mercury values of whole blood, breast feathers, and freeze-dried egg were analyzed using a Milestone® DMA 80 (direct mercury analyzer) using cold vapor atomic absorption spectroscopy (Brasso & Cristol, 2008). Two replicates from each sample were analyzed to validate homogeneity of Hg in samples. A blank was run every 20 samples to standardize equipment (Cristol *et al.*, 2008). Methyl mercury (MeHg), the form most available for uptake by birds, was assumed to compose 95% of the total Hg present in samples (Evers *et al.*, 2005) and was not analyzed separately. Feather mercury levels represent total body burden from the time of the last molt, which in nestlings was 2-3 weeks prior to sampling. Blood mercury represents recent dietary uptake (DeSorbo *et al.*, 2008). All mercury data are reported as wet or fresh weight values.

Persistent organic pollutants

Persistent organic pollutants were analyzed at the Hale Lab at the Virginia Institute of Marine Science, College of William and Mary. Whole blood and egg samples were freeze-dried for 48 hours before compound extraction. Extracts were analyzed using gas chromatography and mass spectrometry (Chen *et al.*, 2008). Blood and egg samples were analyzed for the following pesticides: *trans*-chlordane, MC5, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor, DDMU, *p,p'*-DDE, *p,p'*-DDD, *p,p'*-DDT. Egg samples were additionally tested for heptachlore epoxide isomer B, oxychlordane, MC6, MC8, and MC3. Samples were also tested for polychlorinated biphenyls (PCBs) including: PCB-28/31, PCB-33/20, PCB-22, PCB-52, PCB-49, PCB-47/48/75, PCB-44, PCB-42/59, PCB-71, PCB-103, PCB-100, PCB-63, PCB-74, PCB-70/95/66, PCB-91, PCB-56/60, PCB-92, PCB-84, PCB-101/90, PCB-99, PCB-119, PCB-83, PCB-97, PCB-117, PCB-87/115, PCB-85, PCB-136, PCB-110, PCB-77, PCB-151, PCB-135, PCB-144, PCB-147, PCB-107/123, PCB-149, PCB-118, PCB-134, PCB-114, PCB-165, PCB-146, PCB-153/132, PCB-105, PCB-179, PCB-141, PCB-137, PCB-176, PCB-130, PCB-164/163, PCB-138/158, PCB-178, PCB-175, PCB-187, PCB-183, PCB-128, PCB-167, PCB-185, PCB-174, PCB-177, PCB-202, PCB-171, PCB-156, PCB-201, PCB-172, PCB-197, PCB-180/193, PCB-191, PCB-200, PCB-170/190, PCB-199, PCB-203/196, PCB-189, PCB-208, PCB-195, PCB-207, PCB-194, PCB-205, PCB-206, and PCB-209.



Photos from top left to right – Seth Berry bands an eagle nestling at Rum Point, M93 eaglet being interviewed by Navy media, Navy bucket truck crew with eaglet at Building 436 nest, eaglet at Rum Point nest, Ryan Galligan descending from Hypervelocity nest, Libby Mojica and Bryan Watts sampling blood from an eagle at Building 1569 nest, 3 siblings in the Biazzi nest.

Prey Remains

All prey remains that were of no further use to the brood were collected from the nest and from the ground around the base of the nest tree and identified. All viable prey were identified and left in the nest.

RESULTS

Productivity

A total of 9 Bald Eagle nests at NSF Indian Head were active during the 2008 breeding season (Table 1). Eleven existing nests were checked for occupancy and one new nest was discovered during the breeding season (Appendix A). Estimated productivity rates were 2.0 chicks/active nest and 2.25 chicks/productive nest.

Table 1. Summary of 2008 NSF Indian Head Bald Eagle survey results by nesting territory.

Nest Code	Nest Territory	Occupied	Active	Chicks Produced
IH-01	Large Motor	No	No	----- ^a
IH-02	Burn Point	Yes	Yes	3
IH-03	Bldg 1569	Yes	Yes	3
IH-04	Biazzi	Yes	Yes	3
IH-05	Extrusion	Yes	Yes	0 ^b
IH-06	Bldg 436	Yes	Yes	1
IH-07	Rum Point	Yes	Yes	3
IH-08	Area 8 Pond	Yes	Yes	2
IH-09	Hypervelocity	Yes	Yes	2
IH-10	Bldg 2096	No	No	----- ^a
IH-11	Bldg 62	No	No	-----
IH-12	M93	Yes	Yes	1
TOTAL CHICKS				18

^a Nest occupied by Great-horned Owls raising 2 chicks.

^b Nest failed. Two addled eggs present on last survey flight. Only one egg was present during nest visit.

Banding

A total of 18 nestling eagles were banded and processed during the 2008 breeding season (Appendix B). Chicks in 3 nests exhibited symptoms of poor nutrition or health (M93, Hypervelocity, Area 8 Pond; Appendix C). All 18 chicks survived to fledging age (60-75 days old).

Encephalitis Viruses

All eagle nestlings tested seronegative for WNV, Eastern Encephalitis, and Eastern Equine Encephalitis viruses.

Contaminants

Mercury

Mercury (Hg) levels were subacute in all eagles sampled. Individual Hg blood values ranged from 0.03-0.07 ($\bar{x} = 0.05$) mg/kg (ppm). Individual feather mercury values ranged from 0.84-1.80 ($\bar{x} = 1.22$) mg/kg (Appendix D). The single addled egg had a mercury value of 0.09 mg/kg (Table 2).

Table 2. Mean mercury values in nestling blood by nest territory. Values are in mg/kg (ppm) fresh wet weight.

Nest Territory	<i>n</i>	Feather Hg	Blood Hg	Egg Hg
Area 8 Pond	2	1.46	0.06	-----
Biazzi	3	1.28	0.04	-----
Bldg 1569	3	0.94	0.05	-----
Bldg 436	1	1.04	0.04	-----
Burn Point	3	1.28	0.04	-----
Extrusion	1	-----	-----	0.09
Hypervelocity	2	0.94	0.04	-----
M93	1	0.39	0.05	-----
Rum Point	3	1.40	0.06	-----

Persistent organic pollutants

Total PCB levels (sum of all congeners) in nestling blood ranged from 0.021-0.080 ($\bar{x} = 0.044$) $\mu\text{g/g}$ (ppm) wet weight (Table 3). Total Chlordane levels in blood ranged from 0.004-0.018 ($\bar{x} = 0.010$) $\mu\text{g/g}$ (ppm) wet weight. DDE values ranged 0.009-0.021 ($\bar{x} = 0.013$) $\mu\text{g/g}$ (ppm) wet weight. Egg levels were higher with total PCB levels at 18.44 ppm and DDE at 3.78 ppm (Table 4).

Table 3. Mean organic pollutant values in nestling blood by nest territory. Values in $\mu\text{g/g}$ (ppm) wet weight.

Nest Territory	No. chicks	Σ PCBs	Σ chlordane	p,p'-DDE
Area 8 Pond	2	0.045	0.008	0.014
Biazzi	3	0.060	0.014	0.017
Bldg 1569	3	0.033	0.007	0.010
Bldg 436	1	0.036	0.012	0.012
Burn Point	3	0.055	0.011	0.016
Hypervelocity	2	0.022	0.004	0.009
M93	1	0.054	0.018	0.015
Rum Point	3	0.040	0.009	0.012

Table 4. Contaminants detected in a single Bald Eagle egg from NSF Indian Head, Charles Co, MD during the 2008 breeding season. All values in mg/kg (ppm) wet weight.

Contaminant	ppm
Heptachlore epoxide isomer B	0.034
Oxychlordane	0.090
<i>trans</i> -chlordane	0.035
MC5	0.435
MC6	0.028
<i>cis</i> -chlordane	0.176
<i>trans</i> -nonachlor	0.998
MC8	0.016
<i>cis</i> -nonachlor	0.208
MC3	0.095
Σ chlordane	2.116
Σ PCBs	18.439
DDMU	0.301
p,p'-DDE	3.776
p,p'-DDD	0.245
p,p'-DDT	0.071
Σ DDT	4.392
Hg	0.092

Prey Remains

The remains of catfish (*Ictalurus* spp.), Eastern Mud Turtles (*Kinosternon subrubrum subrubrum*), and muskrats (*Ondatra zibethicus*) were found in and around the base of nests. This was consistent with prey remains found in other Chesapeake Bay eagle nests (Markham & Watts, 2008).

DISCUSSION

Productivity

Eagle nest success and average brood size were at record highs in parts of the Chesapeake Bay during the 2008 breeding season. The productivity rate at NSF Indian Head (2.0 chicks/active nest) was high but not significantly different ($t = -1.06$, $df = 134$, $p = 0.29$) from the 1.66 chicks/active nest estimated for the Virginia side of the Potomac River (Watts & Byrd, 2008). The success of four 3-chick broods suggests waters surrounding NSF Indian Head provide abundant food resources to support these large broods.

Encephalitis Viruses

WNV and other encephalitis viruses were not detected in eagle nestling blood during the 2008 breeding season. WNV was present in Maryland during 2008 and found in mosquito pools, 1 horse, and 13 humans. No birds tested positive for WNV in Maryland this year (Maryland Community Health Administration, 2008). Eagle nestlings were unlikely to be exposed to WNV in the nest because they were sampled before the seasonal increase in mosquito activity from June to October.

Contaminants

Bald Eagles are one of many raptor species documented to suffer adverse effects of environmental contaminants like DDE, PCBs, and Mercury. Eagles are at high risk from these contaminants because they are long-lived (can bioaccumulate toxins) and are at the top of the food chain (biomagnification of toxins at each trophic level) (Evers et al 2005). Contaminants in dietary lipids are transferred to the yolk during egg formation and can ultimately reach levels high enough to impact productivity. DDE and PCBs can be lethally toxic to embryos (Elliot and Harris 2002, Wiemeyer et al. 1993), reduce egg shell thickness (Elliot and Harris 2002, Wiemeyer et al. 1993), and negatively affect liver function (Elliot et al. 1996). Prolonged mercury exposure in birds can have neurological and reproductive effects (Evers et al 2005).

Contaminant levels in blood of eagle nestlings represent a short-term view of overall contaminant exposure because ingested contaminants are quickly deposited in growing feathers, organs, and other tissues (DeSorbo *et al.*, 2008). Mercury contamination in nestling blood and feathers was minimal and less than values reported from other nestling studies in North America (Table 5). The single egg had a mercury level of 0.09 ppm, less than the 0.5-1.5 ppm historically thought to reduce productivity rates in eagles (Wiemeyer *et al.*, 1984). Toxicity thresholds are unknown for nestling eagles based on blood and feathers and the threshold is uncertain in adult eagles. A recent Bald Eagle study near a mercury mine in British Columbia, observed no reproductive effects or signs of methylmercury (MeHg) toxicity in adults with blood concentrations near 10 $\mu\text{g}/\text{ml}$ (ppm) (Weech *et al.*, 2006). A similar study in the Great Lakes did not find a relationship between elevated mercury levels (3.7-66.0 mg/kg) in adult eagle feathers and reproduction, productivity rates or nesting success (Bowerman *et al.*, 1994). The egg from NSF Indian Head had a mercury level of <0.1 mg/kg, suggesting the adult female also had low levels of mercury at the time of laying.

Table 5. Comparable mercury values from Bald Eagle nestlings and eggs in North America. All values in mg/kg (ppm) wet weight.

Tissue	Region	n	Mean	Range
Feathers	NSFIH	18	1.22	0.84-1.80
	APG ^a	19	0.82	0.47-1.19
	Klamath River Basin ^b	5	2.17	
	South Carolina ^c	34	3.08	0.61-6.67
	Florida ^d	61	4.05	0.76-14.3
	Great Lakes ^e	115	9	1.50-27.0
Blood	NSFIH	18	0.05	0.03-0.07
	APG ^a	10	0.03	0.01-0.04
	South Carolina ^c	34	0.10	0.02-0.25
	Florida ^d	48	0.17	0.02-0.61
	Klamath River Basin ^b	9	0.23	0.075-0.65
	Columbia River ^f	15	0.47	0.19-1.40
	New York ^g	16	0.52	0.12-1.19
	Oregon ^h	82	1.2	nd - 4.20
Egg	NSFIH	1	0.09	-----
	APG ^a	1	0.10	-----
	Chesapeake Bay ⁱ	26	0.07	0.00 - 0.17
	Columbia River ^f	13	0.2	0.13-0.36
	<i>Toxicity thresholdⁱ</i>			<i>0.5-1.5</i>

nd = contaminant not detected

^a (Mojica & Watts 2008), ^b (Frenzel & Anthony, 1989), ^c (Jagoe *et al.*, 2002), ^d (Wood *et al.*, 1996), ^e (Bowerman *et al.*, 1994), ^f (Anthony *et al.*, 1993), ^g (DeSorbo *et al.*, 2008), ^h (Wiemeyer *et al.*, 1989), ⁱ (Wiemeyer *et al.*, 1984)

Organochloride blood levels at NSF Indian Head were within the range of values reported by other eagle nestling studies (Table 6) and below toxicity thresholds for the species (Elliott & Harris, 2002; Henny & Elliott, 2007). The single addled egg collected from the Extrusion nest, however, had levels approaching known toxicity thresholds for both DDE and PCBs (Elliott & Harris, 2002; Henny & Elliott, 2007). Although the egg was slightly below the embryo lethality level for DDE (5.5 mg/kg) and reproductive impairment level for PCB (20 ppm) (Elliott & Harris, 2002; Henny & Elliott, 2007), these levels likely contributed to reproductive failure. Because these contaminants bioaccumulate over time, it is unknown whether the Extrusion adult female ingested the contaminants near the nest or elsewhere.

The egg from NSF Indian Head had lower PCB and DDE values compared to eagle eggs collected from the Chesapeake Bay in the 1970s (Wiemeyer *et al.*, 1984). A nest at Mason Neck, directly across the Potomac River from NSF Indian Head had the highest reported PCB level in an egg at 218 ppm in 1977. It is unclear where the PCB contamination for the 1977 Mason Neck nest originated since the adult female could have ingested the PCB while foraging outside of the nest territory. The same level of contamination does not appear to be occurring in the Bald Eagle population in the upper Potomac based on results from this study. However, there is still potential that PCB and DDE levels could affect Bald Eagle productivity at NSF Indian Head and on the upper Potomac River.

Table 6. Comparable organochloride contaminant levels in Bald Eagle nestling blood and eggs. All values in mg/kg (ppm) wet weight.

Tissue	Region	<i>n</i>	DDE Mean	DDE Range	<i>n</i>	PCB Mean	PCB Range
Blood	NSFIH	18	0.013	0.01-0.02	18	0.043	0.021-0.080
	APG ^a	10	0.016	0.009-0.300	10	0.055	0.037-0.106
	Newfoundland ^b	23	0.005	0.002-0.041	23	0.025	0.008-0.133
	British Columbia ^c	31	0.014	0.003-0.057	31	0.029	0.001-0.097
	Oregon ^d	75	0.015	nd-0.15			
	California ^c	3	0.041	0.018-0.123	3	0.011	0.065-0.021
				0.050			
	Columbia River ^e	15		0.01-0.24	15	0.040	nd-0.130
	Great Lakes ^f				30	0.130	0.009-0.326
	<i>Toxicity threshold</i> ^g		41.000		189.000		
Egg	NSFIH	1	3.8	-----	1	18.43	-----
	APG ^a	1	8.1	-----	1	33.69	-----
	Florida ^h	15	4.7	2.0-18.0	8	7.89	5.7-22.0
	Columbia River ^e	17	9.7	4.0-20.0	17	12.70	4.8-26.7
	Great Lakes ^f	6	10.8	2.7-22.2	6	26.40	11.7-43.7
	Chesapeake Bay ⁱ	26	11.9	3.3-26.0	26	25.00	8.9-218.0
		<i>Toxicity threshold</i> ^g		5.5		20.00	

nd = contaminant not detected

^a(Mojica and Watts 2008), ^b(Dominguez *et al.*, 2003), ^c(Cesh *et al.*, 2008), ^d(Wiemeyer *et al.*, 1989), ^e(Anthony *et al.*, 1993), ^f(Donaldson *et al.*, 1999), ^g(Elliott & Harris, 2002; Henny & Elliott, 2007), ^h(Forrester & Spalding, 2003), ⁱ(Wiemeyer *et al.*, 1984)

The tidal reaches of the Potomac River were listed as impaired by the Maryland Department of the Environment in 2006 because of high PCB levels in fish (Haywood and Buchannan 2007). The highest levels of PCBs are reported at Chain Bridge (divides tidal and non-tidal portions of the river) upstream of NSF Indian Head suggesting point and nonpoint sources in the District of Columbia (Haywood and

Buchanan 2007). The home range of eagles in the Chesapeake Bay is unknown but estimates from other regions range from 7 km² (Gerrard et al 1992) to 21.6 km² (Garrett et al 1993). Because all 9 nests on NSF Indian Head are within 1 km of foraging habitat on the Potomac River, we can estimate eagle home ranges would be on the lower end of that range. PCB levels in nestling blood at NSF Indian Head are likely from dietary intake of PCB laden fish from the Potomac since fish are a main portion of their diet during the nesting season. PCBs in adult eagles (and their eggs) are an accumulation of PCBs during their lifetime, including recent dietary intake from the PCB-impaired Potomac River.

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APPENDIX A.

Coordinates for Bald Eagle nests monitored at NSF Indian Head during the 2008 breeding season. Coordinates are in GCS North American 1983 and projected into State Plane Maryland 1900 (feet).

Nest Code	Tree Type	Nest Location	Latitude	Longitude
IH-01	Hardwood	Large Motor	38.5680	-77.2100
IH-02	Hardwood	Burn Point	38.5650	-77.2057
IH-03	Hardwood	Bldg 1569	38.5681	-77.1923
IH-04	Hardwood	Biazzi	38.5772	-77.1873
IH-06	Hardwood	Extrusion	38.5845	-77.1649
IH-07	Platform	Bldg 436	38.5556	-77.1969
IH-08	Hardwood	Rum Point	38.5472	-77.2148
IH-08	Hardwood	Area 8 Pond	38.5782	-77.1787
IH-09	Hardwood	Hypervelocity	38.5477	-77.2354
IH-10	Hardwood	Bldg 2096	38.5513	-77.2369
IH-11	Hardwood	Bldg 62	38.6016	-77.1792
IH-12	Loblolly	M93	38.6029	-77.1700

APPENDIX B.

Morphometrics of Bald Eagle nestlings banded at NSF Indian Head, Charles Co, MD during the 2008 breeding season. Morphometrics were within normal ranges and comparable to other nestlings in the Chesapeake Bay.

Federal Band	SEX	Age (days)	Weight (g)	Culmen length with cere (mm)	Culmen length without cere (mm)	Culmen depth (mm)	Halux (mm)	Outer tarsus (mm)	Inner tarsus (mm)	Tail (cm)	Wing Chord (cm)
0679-01235	F	32	3525	57.2	42.0	33.2	34.0	107.9	81.1	7.0	28.6
0679-01230	M	33	3144	53.5	41.2	31.3	32.0	107.8	72.3	10.2	32.5
0679-01231	M	33	3415	54.5	42.4	32.3	32.5	114.0	77.4	15.8	35.2
0679-01232	M	33	3305	56.2	43.3	31.2	33.9	105.5	75.8	14.8	38.6
0679-01236	F	32	3356	56.8	42.9	33.7	32.8	111.2	74.1	8.0	27.0
0679-01237	M	35	2997	55.6	41.1	27.5	32.5	102.7	73.2	9.0	27.4
0679-01238	F	35	3582	55.5	40.7	29.3	34.3	108.0	74.0	8.5	25.0
0679-01241	M	45	3163	52.7	39.0	27.4	31.6	101.1	73.8	13.8	32.8
0679-01243	U	42	2623	50.9	36.7	25.9	29.6	99.7	69.1	7.0	24.4
0679-01244	F	45	3970	59.9	45.2	32.1	36.2	114.4	75.1	18.0	36.7
0679-01302	F	40	3650	60.2	46.5	30.7	35.2	109.6	82.4	11.5	34.8
0679-01303	M	37	3065	54.2	43.0	29.0	32.0	108.5	71.4	10.8	29.6
0679-01304	M	37	3300	59.5	45.5	30.4	33.6	111.7	81.5	13.3	33.1
0679-01305	M	37	3075	60.6	44.7	30.4	32.5	102.7	83.9	12.2	33.1
0679-01242	F	45	3727	59.1	43.2	31.3	34.7	108.4	85.8	14.1	34.1
0679-01309	M	41	2628	49.7	40.1	27.9	31.3	90.6	77.7	8.2	24.2
0679-01310	M	41	2940	56.9	42.1	29.0	32.2	110.0	80.5	9.9	30.2
0679-01311	F	41	2685	56.1	40.6	27.3	31.9	102.8	81.1	10.8	29.6

APPENDIX C.

Bald Eagle nestlings banded at NSF Indian Head, Charles Co, MD during the 2008 breeding season.

Federal Band	Nest Name	Sex	Color Band	Date	Health Status
0679-01230	Bldg 1569	M	S4	3/31/2008	Good health
0679-01231	Bldg 1569	M	U4	3/31/2008	Good health
0679-01232	Bldg 1569	M	V4	3/31/2008	Good health
0679-01235	Area 8 Pond	F	Z4	4/17/2008	Postnasal drip
0679-01236	Area 8 Pond	F	D5	4/17/2008	Postnasal drip
0679-01237	Hypervelocity	M	E5	4/17/2008	Good health
0679-01238	Hypervelocity	F	H5	4/17/2008	Postnasal drip and pox lesions on mouth/head.
0679-01241	Burn Point	M	N5	4/30/2008	Good health
0679-01242	Burn Point	F	P5	4/30/2008	Good health
0679-01243	Burn Point	U	R5	4/30/2008	Good health
0679-01244	Bldg 436	F	S5	4/30/2008	Good health
0679-01302	M93	F	H7	5/7/2008	Heavy feather lice infestation, postnasal drip, pale complexion.
0679-01303	Rum Point	M	K7	5/7/2008	Good health
0679-01304	Rum Point	M	M7	5/7/2008	Good health
0679-01305	Rum Point	M	N7	5/7/2008	Good health
0679-01309	Biazzi	M	U7	5/15/2008	Good health
0679-01310	Biazzi	M	V7	5/15/2008	Good health
0679-01311	Biazzi	F	W7	5/15/2008	Good health

APPENDIX D.

Contaminant data for individual eagle nestlings sampled during the 2008 breeding season at NSF Indian Head, Charles Co, MD.

Federal Band	Nest Territory	Feather Hg	Blood HG	Total PCBs	Σ chlordane	p,p'-DDT	p,p'-DDE
0679-01230	Bldg 1569	0.961	0.049	0.030	0.007	0.001	0.010
0679-01231	Bldg 1569	0.967	0.045	0.031	0.006	0.000	0.009
0679-01232	Bldg 1569	0.878	0.044	0.039	0.008	0.001	0.012
0679-01235	Area 8 Pond	1.799	0.063	0.044	0.008	0.002	0.013
0679-01236	Area 8 Pond	1.119	0.065	0.047	0.008	0.001	0.014
0679-01237	Hypervelocity	0.844	0.040	0.021	0.005	0.000	0.009
0679-01238	Hypervelocity	1.028	0.041	0.023	0.004	0.001	0.009
0679-01241	Burn Point	1.237	0.061	0.046	0.010	0.003	0.014
0679-01242	Burn Point	1.222	0.035	0.057	0.012	0.002	0.016
0679-01243	Burn Point	1.390	0.029	0.061	0.012	0.002	0.018
0679-01244	Bldg 436	1.036	0.041	0.036	0.012	0.001	0.012
0679-01302	M93	1.385	0.054	0.054	0.018	0.001	0.015
0679-01303	Rum Point	1.151	0.058	0.038	0.009	0.000	0.011
0679-01304	Rum Point	1.614	0.061	0.034	0.009	0.000	0.010
0679-01305	Rum Point	1.448	0.048	0.047	0.009	0.001	0.013
0679-01309	Biazzi	1.457	0.056	0.045	0.012	0.001	0.014
0679-01310	Biazzi	1.254	0.035	0.054	0.014	0.001	0.014
0679-01311	Biazzi	1.143	0.043	0.080	0.017	0.001	0.021