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

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



Center for Conservation Biology

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

Final Report

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College of William and Mary & Virginia Commonwealth University
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Cover Photo: Two nestlings at the Rum Point nest overlooking Mattawoman Creek.

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.

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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. Active nests were climbed with arborist equipment or accessed with a bucket truck. Forty-nine Eagle nestlings were banded and measured. Blood and feather samples were collected from nestlings from 2008-2010 to test for West Nile virus, mercury, heavy metals, PCB, and organochloride contaminants. Two addled eggs were collected for contaminant testing.

Ten breeding territories were active during the 2008 - 2010 breeding seasons. Productivity was 1.8 chicks/active nest (nest observed with eggs or chicks) and 2.07 chicks/productive nest (chicks reached fledging age). Two nestlings tested positive for exposure to West Nile Virus in 2009 but did not show signs of recent infection. Mercury levels were subacute in blood ($\bar{x} = 0.04$ mg/kg, $n= 48$) and feathers ($\bar{x} = 1.24$ mg/kg, $n= 48$). Contaminant levels in blood were also subacute for total PCBs ($\bar{x} = 0.039$ $\mu\text{g/g}$, $n= 48$), total Chlordane ($\bar{x} = 0.006$ $\mu\text{g/g}$, $n= 48$), and total DDT ($\bar{x} = 0.011$ $\mu\text{g/g}$, $n= 48$). The addled eggs had a mercury concentration of 0.07 mg/kg and 0.09 mg/kg, PCB levels of 18 ppm, and DDE of 3.7 and 5.6 ppm. Values for the addled eggs approached toxicity thresholds for polychlorinated biphenyls (PCB) and dichlorodiphenyldichloroethylene (DDE).

Productivity rates recorded for pairs nesting on Indian Head were not significantly different from nests monitored along the Virginia portion of the Potomac River. A snow storm in early March 2009 caused widespread nest failures along the Potomac River including the Indian Head nests at Burn Point and Building 1569. All contaminant levels were low in nestling blood and feathers. High levels of PCB and DDE contaminants likely contributed to reproductive failure of the addled eggs at the Biazzi and Extrusion nests. 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.

Two electrocutions occurred on NSF Indian Head during the study period. The breeding female at Burn Point was found dead during the 2008 breeding season after colliding with a powerline. The second electrocution occurred when a recently fledged chick from the 2009 Biazzi nest landed on an unprotected power pole approximately 730m from the nest.

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 1,200 breeding pairs (Maryland Department of Natural Resources 2004, Watts and Byrd 2010).

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, Mojica et al 2009).

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 were:

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 in nestling blood
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 2).

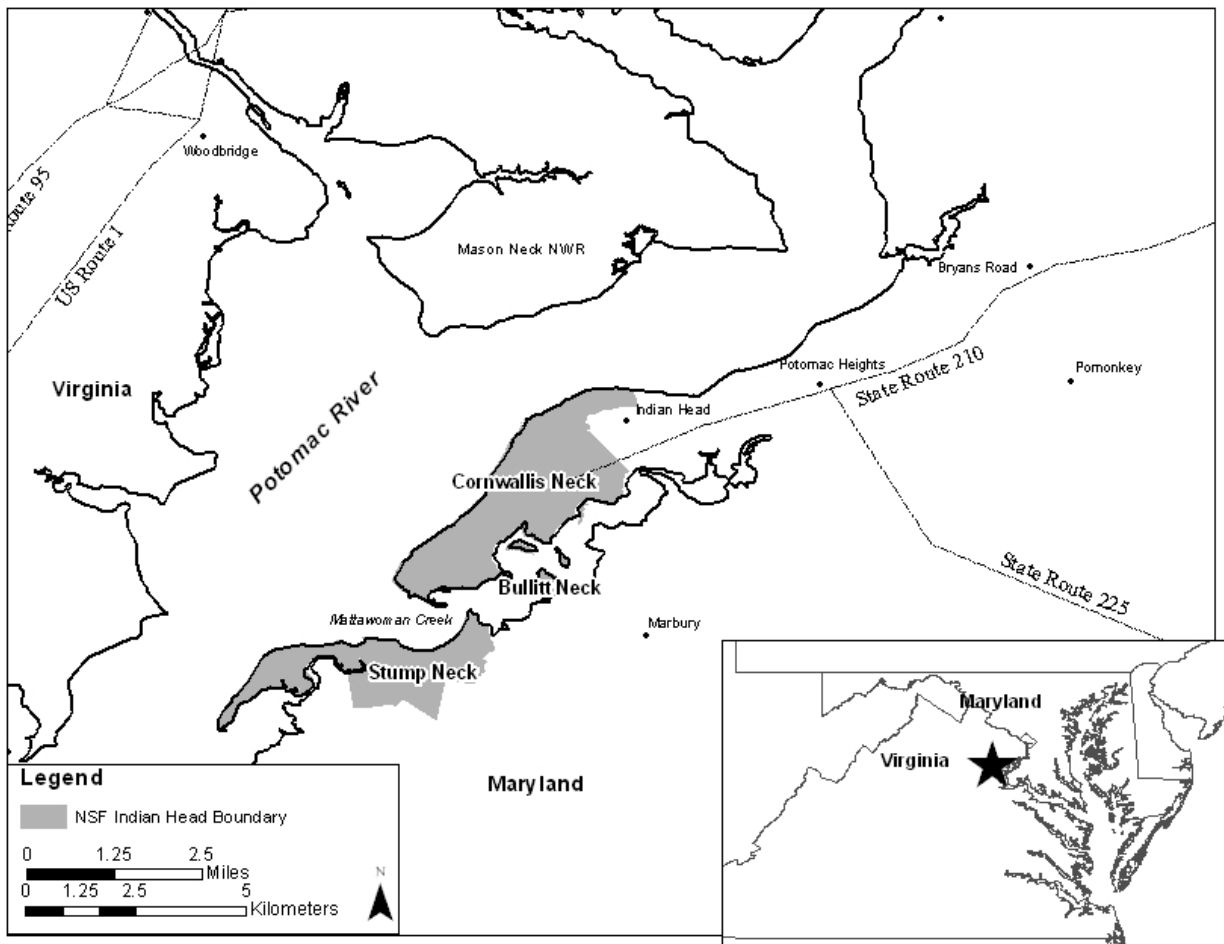


Figure 1. NSF Indian Head is located on the Potomac River in Charles Co, MD. The main study area consisted of three peninsulas on Cornwallis Neck, Stump Neck, and Bullitt Neck.

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 2008-2010 breeding seasons. 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 mid-May were conducted to document the productivity status of active nests found during the first survey. Following national conventions (USFWS 2007c), 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 2008-2010 Virginia Bald Eagle Nest surveys along the Potomac River.

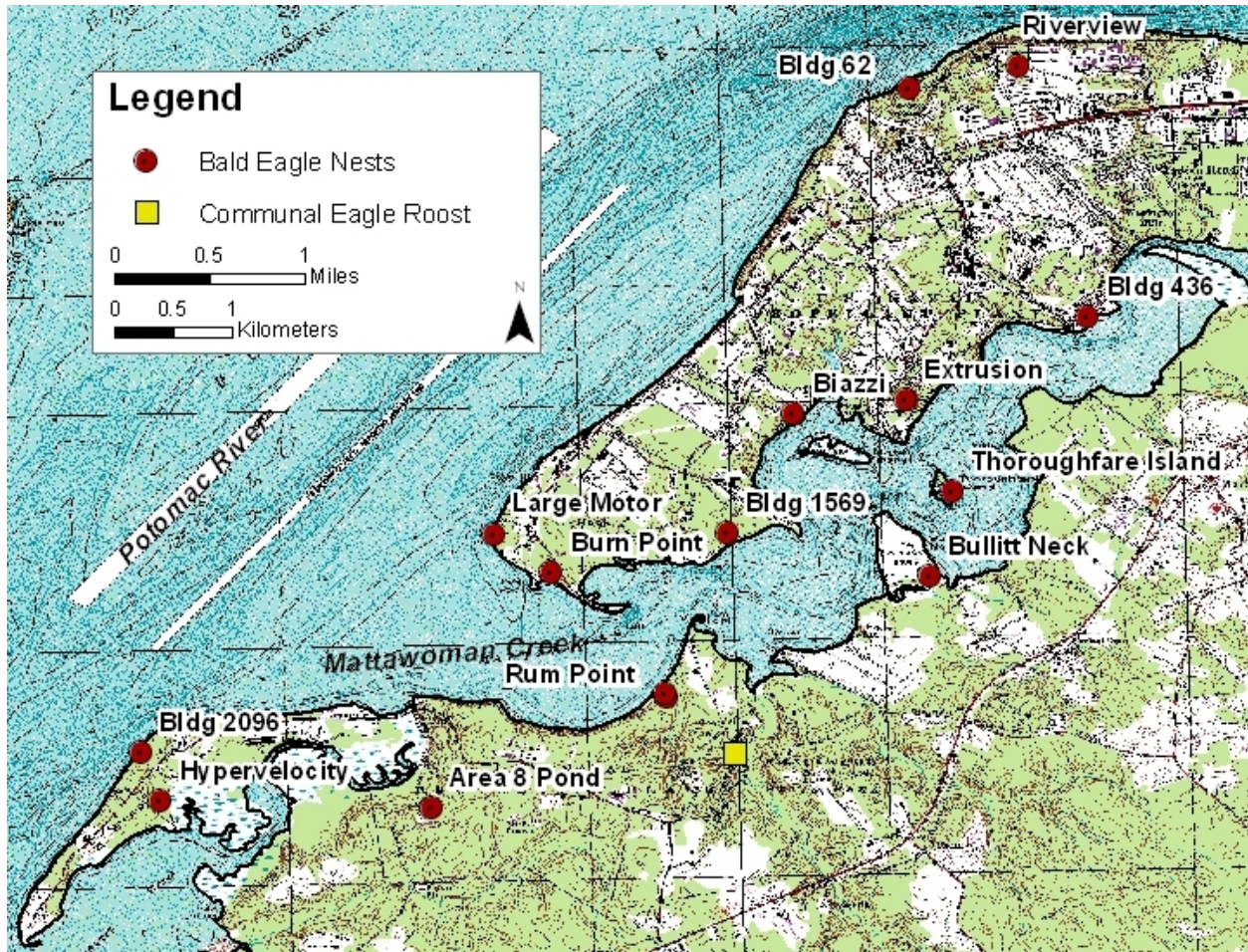


Figure 2. Bald Eagle nesting territories monitored at NSF Indian Head, MD.

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 silver numeric federal bands (USGS Bird Banding Lab, Laurel, MD) on the right tarsus and purple alpha-numeric color bands (ACRAFT Sign and Nameplate, Edmonton, Alberta) on the left tarsus. Banding and tissue collection was in accordance with state and federal permits.



Figure 3 Photos from top left to right – Seth Berry bands an eagle nestling at Rum Point, Riverview eaglet being interviewed by Navy media, Navy bucket truck crew with eaglet at Building 436 nest, eaglet at Rum Point nest, tree climber 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.

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. Added eggs were washed with tap water and allowed to air dry, then wrapped in aluminum foil and frozen. Eggs were later freeze dried by the lab in preparation for contaminants analysis. 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.

West Nile Virus

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 antibodies to West Nile Virus (WNV) and encephalitis. All analyses were performed at The University of Georgia's Veterinary Diagnostic and Investigational Laboratory, Tifton, GA. Blood was tested for viruses in 2008 and 2009.

Mercury and Other Metals

Mercury (Hg) analysis took place in Dan Cristol's Lab at the Department of Biology, College of William and Mary. Total mercury values of whole blood, breast feathers, and freeze-dried eggs 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 feather 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.

In 2010, a heavy metal and mineral panel was run on nestling blood samples at the Pennsylvania Animal Diagnostic Laboratory System, University of Pennsylvania. Whole blood samples were tested for Arsenic, Cadmium, Lead, Selenium, and Thallium. Serum samples were tested for Calcium, Copper, Iron, Magnesium, Molybdenum, Phosphorus, Potassium, Sodium, and Zinc.

Persistent Organic Pollutants

Persistent organic pollutants were analyzed at Rob Hale's 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.

RESULTS

Productivity

Thirteen breeding territories were monitored for occupancy during 2008-2010. New territories at Riverview and Bullitt Neck were discovered (S. Berry pers. comm.) at the beginning of the 2008 and 2009 breeding seasons respectively. New nests were built within existing territories at Extrusion (Thoroughfare Island) and Rum Point during 2010 (Appendix A). Productivity rates were comparable or higher than surrounding eagles nests on the Potomac River (Table 1; Watts and Byrd 2008, Watts and Byrd 2010). A maximum of 10 Bald Eagle nesting territories were occupied each year (Table 21).

Table 1. Productivity rates of eagles at NSF Indian Head were comparable or at higher rates than other nests monitored during the same time frame on the Potomac River.

	NSFIH		Potomac River (Virginia only)	
	chicks/active territory	chicks/productive territory	chicks/active territory	chicks/productive territory
2008	2.00	2.25	1.67	1.91
2009	1.40	1.75	1.59	1.78
2010	2.00	2.22	1.43	1.78

Table 2. Summary of NSF Indian Head Bald Eagle survey results by nesting territory.

Nest Code	Tree	Nest Name	2008			2009			2010		
			Occupied	Active	Young Produced	Occupied	Active	Young Produced	Occupied	Active	Young Produced
IH-01	Hardwood	Large Motor	No ^a	No	-----	No ^d	No	-----	No ^d	No	-----
IH-02	Hardwood	Burn Point	Yes	Yes	3	Yes	Yes	0 ^e	Yes	Yes	3
IH-03	Hardwood	Bldg 1569	Yes	Yes	3	Yes	Yes	0 ^f	Yes	No	-----
IH-04	Hardwood	Biazzi	Yes	Yes	3	Yes	Yes	1 ^g	Yes	Yes	3
IH-05	Hardwood	Extrusion	Yes	Yes	0 ^b	Yes	Yes	2	No ^h	No	-----
IH-06	Platform	Bldg 436	Yes	Yes	1	Yes	Yes	2	Yes	Yes	2
IH-07	Hardwood	Rum Point	Yes	Yes	3	Yes	Yes	2	No	No	-----
IH-08	Hardwood	Area 8 Pond	Yes	Yes	2	Yes	Yes	2	Yes	Yes	1
IH-09	Hardwood	Hypervelocity	Yes	Yes	2	Yes	Yes	2	Yes ⁱ	Yes	2
IH-10	Hardwood	Bldg 2096	No ^c	No	-----	No ^c	No	-----	No ^c	No	-----
IH-11	Hardwood	Bldg 62	No	No	-----	No ^d	No	-----	No ^d	No	-----
IH-12	Loblolly	Riverview	Yes	Yes	1	Yes	Yes	1	Yes	Yes	2
IH-13	Loblolly	Bullitt Neck				Yes	Yes	2	Yes	Yes	2
IH-14	Hardwood	Thoroughfare Island							Yes	Yes	3
IH-15	Hardwood	Rum Point							Yes ^j	Yes	2
Total Young Produced					18			13			20

^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.

^c Remnant nest.

^d Nest absent.

^e Nest failed. Adult was observed incubating two eggs in April. Nest was empty during May flight survey.

^f Nest failed. One addled egg present in April but nest empty on last flight.

^g One addled egg collected during banding of single nestling.

^h New nest tree established on Thoroughfare Island.

ⁱ Nest tree dead. Nest inaccessible.

^j Nest from 2008 and 2009 absent. New nest built a few trees NW of original tree. Only 1 of 2 chicks banded.

Banding

A total of 49 nestling eagles were banded and processed during the 2008-2010 breeding seasons (Appendix B). All chicks survived to fledging age (60-75 days old). One addled egg was sampled from the Extrusion nest and one from the Biazzi nest.

West Nile Virus

Two eagle nestlings tested positive for the West Nile virus antibodies during the 2009 breeding season; one chick from the Extrusion nest and one chick from the Hypervelocity nest. (Appendix C). The Extrusion chick showed symptoms of a compromised immune system (post-nasal drip, body lice infestation; Figure 4).



Figure 4. Two eagles from the Extrusion nest - the eagle in the foreground tested positive for West Nile Virus.

Contaminants

Mercury and Other Metals

Mercury (Hg) levels were subacute in all eagles sampled. Individual Hg blood values ranged from 0.025-0.079 ($\bar{x} = 0.043$) mg/kg (ppm). Individual feather mercury values ranged from 0.715-1.799 ($\bar{x} = 1.241$) mg/kg (Table 3; Appendix D). Addled eggs had mercury values of 0.092 mg/kg (Extrusion nest) and 0.070 mg/kg (Biazzi nest; Table 5). Low levels of other heavy metals were found in eagle blood including arsenic (<0.20 ppm), cadmium (≤ 0.005 ppm), lead (<0.05 ppm), and magnesium ($\bar{x} = 17$ ppm; Appendix E).

Table 3. Mean mercury values in nestlings by nest territory. Values are in mg/kg (ppm) wet weight.

Nest	Blood Mercury			Feather Mercury		
	2008	2009	2010	2008	2009	2010
Area 8 Pond	0.064	0.033	0.046	1.459	1.228	1.044
Biazzi	0.045	0.031	0.044	1.285	1.259	0.988
Building 436	0.041	0.026	0.039	1.036	0.850	1.224
Building 1569	0.046	-----	-----	0.935	-----	-----
Bullitt Neck	-----	0.044	0.041	-----	1.243	1.026
Burn Point	0.042	-----	0.039	1.283	-----	1.265
Extrusion	-----	0.032		-----	1.445	
Hypervelocity	0.040	0.035	-----	0.936	1.569	-----
Riverview	0.054	0.041	0.033	1.385	1.038	1.295
Rum Point	0.055	0.041	0.050	1.404	1.296	1.065
Thoroughfare Island	-----	-----	0.061	-----	-----	1.436

Persistent Organic Pollutants

Total PCB levels (sum of all congeners) in nestling blood ranged from 0.007-0.101 ($\bar{x} = 0.039$) $\mu\text{g/g}$ (ppm) wet weight (Table 4). Total Chlordane levels (sum of *trans*-chlordane, MC5, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor) in blood ranged from 0.000-0.018 ($\bar{x} = 0.006$) $\mu\text{g/g}$ (ppm) wet weight. Total DDT values (sum of DDMU, p,p'-DDE, p,p'-DDD, p,p'-DDT) ranged 0.003-0.025 ($\bar{x} = 0.011$) $\mu\text{g/g}$ (ppm) wet weight. Both added eggs had high levels with total PCB levels at 18 ppm and DDE ranging 3.7-5.6 ppm (Table 5).

Table 4. Mean organic pollutant values in nestling blood by nest territory sampled during 2008-2010. Values in $\mu\text{g/g}$ (ppm) wet weight.

Nest	Σ Chlordane ¹	Σ DDT ²	Σ PCB ³	Total No. Chicks
Area 8 Pond	0.006	0.014	0.058	5
Biazzi	0.008	0.013	0.039	7
Building 1569	0.007	0.012	0.033	3
Building 436	0.006	0.009	0.033	5
Bullitt Neck	0.004	0.008	0.026	4
Burn Point	0.006	0.012	0.034	6
Extrusion	0.007	0.013	0.046	2
Hypervelocity	0.005	0.013	0.032	4
Riverview	0.009	0.011	0.052	4
Rum Point	0.007	0.011	0.041	6
Thoroughfare Island	0.001	0.006	0.022	2

¹ Σ of *trans*-chlordane, MC5, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor

² Σ of DDMU, p,p'-DDE, p,p'-DDD, p,p'-DDT

³ Σ of all congeners

Table 5. Contaminants detected in Bald Eagle eggs from NSF Indian Head, Charles Co, MD during the 2008-2009 breeding seasons. All values in $\mu\text{g/g}$ (ppm) wet weight.

Contaminant	Extrusion Nest (2008)	Biazzi nest (2009)
Σ chlordanes	2.116	4.339
Heptachlore epoxide isomer B	0.034	0.155
Oxychlordanes	0.090	0.289
<i>trans</i> -chlordanes	0.035	0.075
MC5	0.435	0.851
MC6	0.028	0.053
<i>cis</i> -chlordanes	0.176	0.505
<i>trans</i> -nonachlor	0.998	1.677
MC8	0.016	0.053
<i>cis</i> -nonachlor	0.208	0.530
MC3	0.095	0.151
Σ PCBs	18.439	18.322
Σ DDT	4.392	6.273
DDMU	0.301	0.296
p,p'-DDE	3.776	5.614
p,p'-DDD	0.245	0.353
p,p'-DDT	0.071	0.010
Hg	92.000	70.000

DISCUSSION

Productivity

Eagle nest success and average brood size were at record highs in parts of the Chesapeake Bay, including NSF Indian Head, during the 2008 breeding season. However in spring 2009, a late snow storm with high winds early in the breeding season caused widespread nest failures. Productivity rates increased in 2010 to match the high nest success of 2008. Productivity rates at NSF Indian Head during 2008-2010 (1.8 chicks/active nest and 2.07 chicks/productive nest) were higher than productivity estimates for the Virginia side of the Potomac River (1.56 chicks/active nest $n=128$ and 1.82 chicks/productive nest; Watts & Byrd unpublished data).

Two eagles were electrocuted during the study period on NSF Indian Head. In spring 2008, an adult female was electrocuted in a mid-line strike near the Burn Point nest. On July 22 2009, a recently fledged juvenile from the Biazzi nest (federal band 0679-01360) was found electrocuted under a power pole approximately 730 meters from the nest (S. Berry pers. comm.). At the time of electrocution, the wires on this pole were not fitted with avian protection devices.



Figure 5. Sampling blood from the Biazzi chick (left) that was later electrocuted in its natal territory (right) shortly after fledging.

West Nile Virus

WNV was detected in eagle nestling blood during the 2009 breeding season but not in 2008. The serum-neutralization test found low levels of antibodies (immunoglobulin M and G) in eagles from two different nests. Both eagles tested negative in a second test that did not detect elevated levels of antibodies from a recent clinical infection.

WNV was present in Maryland during 2009 during routine testing of mosquito pools throughout the state (Maryland Community Health Administration 2009). Cases of WNV infections in eagles are rare and the virus is not considered high risk for this species.

Contaminants

Bald Eagles are one of many raptor species documented to suffer adverse effects of environmental contaminants like DDE, PCBs, Mercury, and heavy metals. 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 the dietary lipids of adult females 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 6). The two eggs had mercury levels of 0.07-0.09 ppm, well below 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 µg/ml (ppm) (Weech *et al.* 2006), over 10 times the level found in eagles at NSF Indian Head. 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 eggs from NSF Indian Head had a mercury level of <0.1 mg/kg, suggesting the adult females also had low levels of mercury at the time of egg laying.

Other heavy metals and minerals were at or below normal reference levels in the nestlings tested in 2010. Blood lead levels were less than the >0.2 µg/ml reported as acute and chronic level of the toxin (Miller *et al.* 1998). Lead contaminated food like waterfowl and hunter gut piles are not a main source of food for eagles in the spring months and most likely were not available to nestlings.

Organochloride blood levels at NSF Indian Head were within the range of values reported by other eagle nestling studies (Table 8) and below toxicity thresholds for the species (Elliott & Harris, 2002; Henny & Elliott, 2007). The addled eggs collected from the Extrusion and Biazzi nests, however, had toxic levels of both DDE and PCBs (Elliott & Harris 2002; Henny & Elliott 2007).

The eggs 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). In 1977, 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. 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, PCB and DDE levels are high enough in the 2 eggs sampled that these contaminants could be affecting Bald Eagle productivity at NSF Indian Head and at other sites on the upper Potomac River.

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 Potomac River) approximately 30 miles upstream of NSF Indian Head. This suggests point and nonpoint sources of PCBs in the District of Columbia (Haywood and Buchannan 2007).

Table 6. Comparable mercury values from Bald Eagle nestlings and eggs in North America. All values in mg/kg (ppm) wet weight.

Tissue	Region	<i>n</i>	Mean	Range
Feathers	NSFIH	32	1.23	0.72-1.80
	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	32	0.04	0.03-0.07
	APG ^a	10	0.03	0.01-0.04
	South Carolina ^c	34	0.1	0.02-0.25
	Florida ^d	48	0.17	0.02-0.61
	Klamath River Basin ^b	9	0.23	0.08-0.65
	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	2	0.08	0.07-0.09
	APG ^a	1	0.1	-----
	Chesapeake Bay ⁱ	4	0.07	0.02-0.10
	Chesapeake Bay ^j	26	0.07	0.00-0.17
	Columbia River ^f	13	0.2	0.13-0.36
	<i>Toxicity threshold^j</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 Mojica *et al.* unpublished data 2009, ^j Wiemeyer *et al.* 1984

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 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 contaminated fish from the Potomac since fish are a main portion of their diet during the nesting season (Markham & Watts 2008). 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.

In summary, the eagle population on NSF Indian Head is steadily increasing and productivity rates are comparable with other monitored eagle populations within the Chesapeake Bay. Legacy contaminants like PCBs and organochlorides continue to persist in the environment around NSF Indian Head but at this

time do not appear to have significant negative effects on eagle reproductive rates. West Nile Virus is present in Maryland and NSF Indian Head but is not prevalent enough in the eagle population to be a management concern. Levels of mercury and other metals are low and not a concern for this population.

Table 7. Normal reference ranges for eagle blood and the average blood value in NSFIH eagles during 2010.

	Reference	NSFIH	Type
Arsenic	<0.05	<0.20	Whole Blood
Calcium	98	117	Serum
Lead	<0.2	<0.05	Whole Blood
Magnesium	17	17	Serum
Phosphorus*	25	213	Serum

total phosphorus expected to be double this amount

Table 8. Comparable organochloride contaminant levels in Bald Eagle nestling blood and eggs. All values in µg/kg (ppm) wet weight.

Tissue	Region	<i>n</i>	DDE Mean	DDE Range	<i>n</i>	PCB Mean	PCB Range
Blood	NSFIH	49	0.010	0.002-0.021	49	0.039	0.007-0.101
	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
	Columbia River ^e	15	0.05	0.01-0.24	15	0.04	nd-0.130
	Great Lakes ^f				30	0.13	0.009-0.326
	<i>Toxicity threshold</i> ^g			41		189	
Egg	NSFIH	2	4.7	3.8-5.6	2	18.4	18-3-18.4
	APG ^a	1	8.1	-----	1	33.7	-----
	Chesapeake Bay ^h	5	3.6	2.0-5.6	5	11.0	8.5-16.9
	Florida ⁱ	15	4.7	2.0-18.0	8	7.9	5.7-22.0
	Columbia River ^e	17	9.7	4.0-20.0	17	12.7	4.8-26.7
	Great Lakes ^f	6	10.8	2.7-22.2	6	26.4	11.7-43.7
	Chesapeake Bay ^j	26	11.9	3.3-26.0	26	25	8.9-218.0
	Maine ^k				4		2.8-11.1
	<i>Toxicity threshold</i> ^g			5.5		20	

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(Chen *et al* unpublished data), ⁱ (Forrester & Spalding, 2003), ^j (Wiemeyer *et al.*, 1984), ^k (Goodale 2008).

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APPENDIX A.

Coordinates for Bald Eagle nests monitored at NSF Indian Head during the 2008-2010 breeding seasons. Coordinates are in GCS North American 1983.

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	Riverview	38.6029	-77.1700
IH-13	Loblolly	Bullitt Neck	38.5647	-77.1769
IH-14	Hardwood	Thoroughfare Island	38.5712	-77.1751
IH-15	Hardwood	Rum Point	38.5557	-77.19699

APPENDIX B.

Morphometrics of Bald Eagle nestlings banded at NSF Indian Head, Charles Co, MD during the 2008 - 2010 breeding seasons. Morphometrics were within normal ranges and comparable to other nestlings in the Chesapeake Bay.

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 (mm)	Wing Chord (mm)
0679-01235	Z4	Area 8 Pond	2008	F	3525	57.2	42.0	33.2	34.0	7.0	28.6
0679-01236	D5	Area 8 Pond	2008	F	3356	56.8	42.9	33.7	32.8	8.0	27.0
0679-01309	U7	Biazzi	2008	M	2628	49.7	40.1	27.9	31.3	8.2	24.2
0679-01310	V7	Biazzi	2008	M	2940	56.9	42.1	29.0	32.2	9.9	30.2
0679-01311	W7	Biazzi	2008	F	2685	56.1	40.6	27.3	31.9	10.8	29.6
0679-01230	S4	Building 1569	2008	M	3144	53.5	41.2	31.3	32.0	10.2	32.5
0679-01231	U4	Building 1569	2008	M	3415	54.5	42.4	32.3	32.5	15.8	35.2
0679-01232	V4	Building 1569	2008	M	3305	56.2	43.3	31.2	33.9	14.8	38.6
0679-01244	S5	Building 436	2008	F	3970	59.9	45.2	32.1	36.2	18.0	36.7
0679-01241	N5	Burn Point	2008	M	3163	52.7	39.0	27.4	31.6	13.8	32.8
0679-01242	P5	Burn Point	2008	F	3727	59.1	43.2	31.3	34.7	14.1	34.1
0679-01243	R5	Burn Point	2008	U	2623	50.9	36.7	25.9	29.6	7.0	24.4
0679-01237	E5	Hypervelocity	2008	M	2997	55.6	41.1	27.5	32.5	9.0	27.4
0679-01238	H5	Hypervelocity	2008	F	3582	55.5	40.7	29.3	34.3	8.5	25.0
0679-01302	H7	Riverview	2008	F	3650	60.2	46.5	30.7	35.2	11.5	34.8
0679-01303	K7	Rum Point	2008	M	3065	54.2	43.0	29.0	32.0	10.8	29.6
0679-01304	M7	Rum Point	2008	M	3300	59.5	45.5	30.4	33.6	13.3	33.1
0679-01305	N7	Rum Point	2008	M	3075	60.6	44.7	30.4	32.5	12.2	33.1
0679-01340	HA	Area 8 Pond	2009	U	2575	50.5	36.8	26.0	29.1	4.5	21.8
0679-01341	HB	Area 8 Pond	2009	U	2544	51.9	38.5	27.0	29.7	5.9	22.0
0679-01360	C1	Biazzi	2009	M	2879	55.9	41.4	28.5	33.0	11.6	32.0
0679-01338	U9	Building 436	2009	M	2988	52.5	38.9	27.9	31.6	9.5	27.0
0679-01339	V9	Building 436	2009	M	3066	54.7	39.8	26.8	32.4	10.6	28.6
0679-01356	HX	Bullitt Neck	2009	F	4040	62.3	45.9	31.5	37.8	13.9	34.8
0679-01357	HZ	Bullitt Neck	2009	M	3230	59.6	44.7	29.6	34.1	14.5	34.9
0679-01350	HR	Extrusion	2009	U	3330	57.9	44.8	30.3	34.0	9.5	27.3
0679-01351	HS	Extrusion	2009	U	3135	56.4	43.5	30.4	33.1	9.5	26.2
0679-01342	HC	Hypervelocity	2009	F	3515	54.7	40.8	-----	33.8	4.5	23.2
0679-01343	HD	Hypervelocity	2009	F	3988	60.3	43.8	31.5	33.5	9.0	29.5
0679-01355	HW	Riverview	2009	M	-----	56.3	43.2	29.0	34.0	15.1	36.0
0679-01358	A1	Rum Point	2009	F	3850	60.7	46.7	32.0	35.5	12.0	32.1
0679-01359	B1	Rum Point	2009	F	3740	59.7	45.9	31.3	35.1	11.0	31.9
0679-01275	DH	Area 8 Pond	2010	M	3105	55.9	41.7	28.0	31.4	11.8	31.0
0679-01287	NN	Biazzi	2010	M	2766	52.6	39.5	27.8	31.3	-----	19.5

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 (mm)	Wing Chord (mm)
0679-01288	NM	Biazzi	2010	M	2670	53.0	40.0	28.2	31.1	7.0	23.8
0679-01289	NP	Biazzi	2010	M	3247	56.9	42.3	30.4	33.7	6.0	24.0
0679-01276	DK	Building 436	2010	M	3345	57.8	42.2	29.4	34.1	15.5	35.2
0679-01277	DM	Building 436	2010	F	4070	62.2	45.7	32.0	35.7	11.0	33.2
0679-01290	NR	Bullitt Neck	2010	M	3409	60.5	45.9	29.5	34.8	18.8	38.0
0679-01291	NS	Bullitt Neck	2010	F	4360	66.0	50.8	34.0	39.7	18.7	42.5
0679-01284	EK	Burn Point	2010	M	3040	54.4	41.9	28.4	31.6	10.4	28.2
0679-01285	ES	Burn Point	2010	M	3715	56.4	44.3	30.9	35.9	12.8	33.2
0679-01286	NK	Burn Point	2010	F	3765	58.1	44.9	31.1	35.6	11.7	30.2
0679-01279	DS	Riverview	2010	M	3334	58.5	44.8	29.7	34.7	9.9	27.5
0679-01278	DN	Riverview	2010	M	3680	60.5	45.5	30.4	35.5	10.9	32.8
0679-01292	NU	Rum Point	2010	M	3000	59.8	46.1	29.6	33.9	16.6	33.1
0679-01280	DV	Thoroughfare Island	2010	M	2767	52.3	40.1	28.3	31.5	7.8	23.9
0679-01281	DX	Thoroughfare Island	2010	M	2804	52.5	39.6	28.0	29.8	5.2	22.9
0679-01282	EB	Thoroughfare Island	2010	U	2585	52.0	38.5	28.4	30.3	-----	18.1

¹ Color band text is the first character on top of the second character. All color bands were purple with silver text.

APPENDIX C.

Bald Eagle nestlings banded at NSF Indian Head, Charles Co, MD during the 2008-2010 breeding seasons.

Band Number	Nest Name	Sex	Color Band	Date	Health Comments
0679-01230	Building 1569	M	S4	3/31/2008	Good health.
0679-01231	Building 1569	M	U4	3/31/2008	Good health.
0679-01232	Building 1569	M	V4	3/31/2008	Postnasal drip
0679-01235	Area 8 Pond	F	Z4	4/17/2008	Good health.
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	Pox lesions on mouth and head. Postnasal drip.
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	Building 436	F	S5	4/30/2008	Good health.
0679-01302	Riverview	F	H7	5/7/2008	Good health.
0679-01303	Rum Point	M	K7	5/7/2008	Lice infestation, postnasal drip, pale complexion.
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.
0679-01338	Building 436	M	U9	4/13/2009	Good health.
0679-01339	Building 436	M	V9	4/13/2009	Good health.
0679-01340	Area 8 Pond	U	HA	4/17/2009	Good health.
0679-01341	Area 8 Pond	U	HB	4/17/2009	Good health.
0679-01342	Hypervelocity	F	HC	4/17/2009	Tested positive for WNV exposure.
0679-01343	Hypervelocity	F	HD	4/17/2009	Good health.
0679-01350	Extrusion	U	HR	5/1/2009	Lice infestation, postnasal drip, but healthy complexion. Tested positive for WNV exposure.
0679-01351	Extrusion	U	HS	5/1/2009	Lice infestation, postnasal drip, but healthy complexion.
0679-01355	Riverview	M	HW	5/11/2009	Received injury during removal from nest. A talon sheath on left foot pulled off. First aid applied and returned to nest.
0679-01356	Bullitt Neck	F	HX	5/14/2009	Good health.
0679-01357	Bullitt Neck	M	HZ	5/14/2009	Good health.
0679-01358	Rum Point	F	AI	5/15/2009	Good health.

Band Number	Nest Name	Sex	Color Band	Date	Health Comments
0679-01359	Rum Point	F	BI	5/15/2009	Good health.
0679-01360	Biazzi	M	CI	5/15/2009	Good health. 7/22/09 electrocuted on NSFIH power pole.
0679-01275	Area 8 Pond	M	DH	4/27/2010	Good Health.
0679-01289	Biazzi	M	NP	5/10/2010	Good Health.
0679-01288	Biazzi	M	NM	5/10/2010	Good Health.
0679-01287	Biazzi	M	NN	5/10/2010	Good Health.
0679-01277	Building 436	F	DM	4/27/2010	Good Health.
0679-01276	Building 436	M	DK	4/27/2010	Good Health.
0679-01291	Bullitt Neck	F	NS	5/11/2010	Good Health.
0679-01290	Bullitt Neck	M	NR	5/11/2010	Good Health.
0679-01286	Burn Point	F	NK	5/10/2010	Good Health.
0679-01284	Burn Point	M	EK	5/10/2010	Good Health.
0679-01285	Burn Point	M	ES	5/10/2010	Good Health.
0679-01279	Riverview	M	DS	4/28/2010	Good Health.
0679-01278	Riverview	M	DN	4/28/2010	Good Health.
0679-01292	Rum Point	M	NU	5/14/2010	Good Health.
0679-01281	Thoroughfare Island	M	DX	4/28/2010	Good Health.
0679-01280	Thoroughfare Island	M	DV	4/28/2010	Previous injury on lower belly. Area featherless but wound closed.
0679-01282	Thoroughfare Island	U	EB	4/28/2010	Good Health.

APPENDIX D.

Contaminant data for individual eagle nestlings sampled during the 2008-2010 breeding seasons at NSF Indian Head, Charles Co, MD.

Band Number	Blood Mercury¹	Feather Mercury¹	Σ PCBs²	Σ Chlordane²	p,p'-DDE²	p,p'-DDT²
0679-01230	0.049	0.961	0.030	0.007	0.010	0.001
0679-01231	0.045	0.967	0.031	0.006	0.009	0.000
0679-01232	0.044	0.878	0.039	0.008	0.012	0.001
0679-01235	0.063	1.799	0.044	0.008	0.013	0.002
0679-01236	0.065	1.119	0.047	0.008	0.014	0.001
0679-01237	0.040	0.844	0.021	0.005	0.009	0.000
0679-01238	0.041	1.028	0.023	0.004	0.009	0.001
0679-01241	0.061	1.237	0.046	0.010	0.014	0.003
0679-01242	0.035	1.222	0.057	0.012	0.016	0.002
0679-01243	0.029	1.390	0.061	0.012	0.018	0.002
0679-01244	0.041	1.036	0.036	0.012	0.012	0.001
0679-01275	0.046	1.044	0.035	0.001	0.003	0.000
0679-01276	0.041	1.036	0.031	0.002	0.004	0.000
0679-01277	0.038	1.413	0.029	0.003	0.004	0.000
0679-01278	0.031	1.268	0.029	0.001	0.004	0.000
0679-01279	0.035	1.323	0.042	0.001	0.004	0.000
0679-01280	0.043	1.253	0.021	0.002	0.005	0.000
0679-01281	0.079	1.619	0.024	0.001	0.004	0.000
0679-01284	0.029	1.359	0.022	0.001	0.003	0.000
0679-01285	0.050	1.352	0.009	0.000	0.002	0.000
0679-01286	0.040	1.085	0.012	0.000	0.003	0.000
0679-01287	0.046	0.000	0.013	0.000	0.004	0.000
0679-01288	0.041	1.378	0.011	0.000	0.003	0.000
0679-01289	0.046	1.585	0.007	0.000	0.003	0.000
0679-01290	0.041	1.053	0.013	0.000	0.005	0.000
0679-01291	0.041	0.999	0.011	0.000	0.004	0.000
0679-01292	0.050	1.065	0.016	0.001	0.005	0.000
0679-01302	0.054	1.385	0.054	0.018	0.015	0.001
0679-01303	0.058	1.151	0.038	0.009	0.011	0.000
0679-01304	0.061	1.614	0.034	0.009	0.010	0.000
0679-01305	0.048	1.448	0.047	0.009	0.013	0.001
0679-01309	0.056	1.457	0.045	0.012	0.014	0.001
0679-01310	0.035	1.254	0.054	0.014	0.014	0.001
0679-01311	0.043	1.143	0.080	0.017	0.021	0.001
0679-01338	0.025	0.715	0.044	0.008	0.010	0.000
0679-01339	0.027	0.985	0.029	0.005	0.007	0.000

Band Number	Blood Mercury¹	Feather Mercury¹	Σ PCBs²	Σ Chlordane²	p,p'-DDE²	p,p'-DDT²
0679-01340	0.026	1.328	0.101	0.007	0.016	0.000
0679-01341	0.039	1.129	0.065	0.005	0.011	0.000
0679-01342	0.036	1.606	0.047	0.006	0.014	0.000
0679-01343	0.035	1.532	0.035	0.006	0.011	0.000
0679-01350	0.027	1.126	0.035	0.005	0.010	0.000
0679-01351	0.036	1.764	0.056	0.008	0.014	0.000
0679-01355	0.041	1.038	0.082	0.016	0.015	0.000
0679-01356	0.045	1.380	0.033	0.006	0.009	0.000
0679-01357	0.043	1.106	0.047	0.009	0.011	0.000
0679-01358	0.036	1.278	0.062	0.005	0.010	0.000
0679-01359	0.047	1.315	0.051	0.008	0.011	0.000
0679-01360	0.031	1.259	0.064	0.010	0.016	0.000

¹ mg/kg ww

² µg/g ww

APPENDIX E.

Heavy metal and mineral data for individual eagle nestlings sampled during the 2010 breeding seasons at NSF Indian Head, Charles Co, MD.

Band Number	Arsenic	Cadmium	Lead	Selenium	Thallium	Calcium	Copper	Iron	Magnesium	Molybdenum	Total Phosphorus	Potassium	Sodium	Zinc
0679-01275	<0.20	<0.005	<0.05	0.493	<0.005	101	0.338	6.07	17.2	<0.01	210	161	3470	2.91
0679-01287	<0.20	<0.005	<0.05	0.405	<0.005	121	0.407	2.94	17.7	<0.01	215	155	3170	2.61
0679-01288	<0.20	<0.005	<0.05	0.444	<0.005	114	0.260	1.28	17.2	<0.01	205	137	3210	2.89
0679-01289	<0.20	<0.005	<0.05	0.453	<0.005	119	0.230	1.94	18.5	<0.01	213	152	3030	3.11
0679-01276	<0.20	<0.005	<0.05	0.688	<0.005	126	0.352	3.00	17.5	<0.01	244	146	3510	3.73
0679-01277	<0.20	<0.005	<0.05	0.595	<0.005	115	0.314	3.27	17.7	<0.01	228	141	3	3.25
0679-01290	<0.20	<0.005	<0.05	0.522	<0.005	119	0.368	2.34	16.2	<0.01	188	118	3320	2.77
0679-01291	<0.20	0.005	<0.05	0.443	<0.005	127	0.290	1.95	17.1	<0.01	183	125	3180	2.62
0679-01284	<0.20	<0.005	<0.05	0.558	<0.005	-----	-----	-----	-----	-----	-----	-----	-----	-----
0679-01285	<0.20	<0.005	<0.05	0.386	<0.005	120	0.342	2.81	17.5	<0.01	197	159	3270	3.25
0679-01286	<0.20	<0.005	<0.05	0.435	<0.005	116	0.382	2.65	18.4	<0.01	194	148	3090	3.70
0679-01278	<0.20	<0.005	<0.05	0.614	<0.005	113	0.362	3.81	17.3	<0.01	219	131	3220	3.33
0679-01279	<0.20	<0.005	<0.05	0.583	<0.005	120	0.307	1.59	17.4	<0.01	222	146	3250	2.80
0679-01292	<0.20	<0.005	<0.05	0.603	<0.005	110	0.344	2.07	16.1	<0.01	200	156	3090	2.07
0679-01280	<0.20	<0.005	<0.05	0.401	<0.005	122	0.385	4.07	17.2	<0.01	244	155	3400	2.61
0679-01281	<0.20	<0.005	<0.05	0.462	<0.005	122	0.489	2.18	17.9	<0.01	244	151	3250	2.54
0679-01282	-----	-----	-----	-----	-----	114	0.367	2.17	16.7	<0.01	200	172	3200	3.61