SPECIAL PROJECT REPORT **FY13-MEFO-2-EC**

Maine Field Office – Ecological Services **April 2013**

Lead and Mercury Levels in Livers of Bald Eagles Recovered in New England

Fish and Wildlife Service

U.S. Department of the Interior

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Suggested citation: Mierzykowski S.E., C.S. Todd, M.A. Pokras and R.D. Oliveira. 2013. Lead and mercury levels in livers of bald eagles recovered in New England. USFWS. Spec. Proj. Rep. FY13-MEFO-2-EC. Maine Field Office. Orono, ME. 26 pp.

U.S Fish and Wildlife Service
Maine Field Office
Special Project Report: FY13-MEFO-2-EC

Lead and Mercury Levels in Livers of Bald Eagles Recovered in New England

Region 5 Project ID: 1130-Emergency Analytical
(filename: PbHg_BAEA_LiversNewEngland2013.pdf)

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April 2013

ME Congressional Districts #1 and #2
NH Congressional District #2
MA Congressional Districts #2 and #3
CT Congressional Districts #2 and #3

Executive Summary

In greater frequency, wildlife rehabilitators have been finding elevated lead (Pb) levels in bald eagles brought in for treatment. Lead ammunition and bullet fragments in hunter-killed, but unrecovered game animals, and bullets in carcasses of wildlife or other animals used as bait by trappers are suspected Pb sources to scavenging eagles.

Each year throughout New England, injured, moribund, or dead bald eagles are regularly reported to biologists and game wardens. Carcasses are immediately collected, while sick or injured birds are brought to rehabilitators for treatment. Birds are euthanized if they do not respond to treatment or their condition is too compromised for treatment. Carcasses of dead eagles are transferred to the National Eagle Repository.

Between 2001 and 2012, we collected liver samples from 127 bald eagles carcasses prior to their transfer to the National Eagle Repository. We analyzed liver tissue for lead (Pb) and for mercury (Hg), which is another regionally important contaminant. The vast majority of the bald eagles were recovered in Maine, but a few were recovered in Massachusetts (5), Connecticut (2) and New Hampshire (1).

Lead (Pb) – **In 127 New England bald eagle livers, 14% had Pb concentrations indicative of poisoning (> 30 ppm dry weight).** In other North America eagle studies, reported percentages of Pb-poisoned birds were either similar (e.g., 12%, 14%) or higher (39%). Four adult bald eagles from Maine had Pb liver levels in excess of 100 pm (max. 167 ppm). While legacy contaminants such as PCBs and DDT are exhibiting decline in wildlife tissues over the past two decades, Pb is one environmental contaminant that continues to adversely affect bald eagles and other scavenging birds.

Mercury (Hg) – **The average Hg level in New England bald eagle livers was 13.49 ppm dry weight, which was higher than average levels recorded in bald eagles from British Columbia (11.8 ppm), several Great Lake states (7.97 ppm), and Alaska (7.10 ppm).** In New England, 5% of the bald eagle livers in this study had highly elevated mercury levels (> 80 ppm), 24% had moderate levels (20 - 80 ppm), and 72% had low Hg levels (< 20 ppm). Three adult birds from Maine had Hg liver levels in excess of 100 ppm (max. 191 ppm).

The practice of having necropsies done for cause-of-death determinations, contaminant surveillance and disease monitoring before carcasses are sent to the National Eagle Repository should be continued and coordinated with state and federal wildlife agencies, Native American tribes, and the U.S. Geological Survey's Wildlife Health Center and Patuxent Wildlife Research Center.

PREFACE

This report documents lead and mercury residue levels in livers of bald eagles recovered in New England. The USFWS Region 5 Project Identification Number for this study is 53411-1130-Emergency Analytical. Samples were collected between 2001 and 2012. Analytical work was completed under the following USFWS Analytical Control Facility Catalogs and Purchase Orders:

Catalog Number	Year Submitted	Catalog Content	Purchase Order Number
5100007	2004	1 liver	92220-04-Y354
5100009	2004	3 livers	94420-04-Y481
5100017	2006	16 livers	94420-06-Y697
5100023	2007	12 livers	94420-07-Y843
5100030	2008	18 livers	94420-08-Y884
5100035	2008	1 liver	94420-08-Y944
5100048	2011	1 liver	CREDIT-12-02
5100050	2012	34 livers	AR069
5100051	2012	41 livers	F13PD00131

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY13-MEFO-2-EC and be directed to the principal investigator:

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This report complies with peer review and certification provisions of the Information Quality Act (Public Law 106-554, Section 515).

ACKNOWLEDGEMENTS

Analytical funding for this project was provided by the U.S. Fish and Wildlife Service. Peer review was provided by Barnett Rattner, Ph.D., Patuxent Wildlife Research Center, U.S. Geological Survey. Final editorial review was conducted by F. Timothy Prior, USFWS retired.

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1. Introduction

The bald eagle (*Haliaeetus leucocephalus*) was removed from the U.S. list of endangered species in June 2007. The post de-listing monitoring plan for bald eagles (USFWS 2009) requires periodic monitoring of populations and potential limiting factors for 20 years. Contaminants monitoring and tracking mortality causes are important components of the bald eagle post de-listing monitoring plan. Detailed, region-specific, baseline data will be needed to evaluate the impact of contaminants on the long-term recovery of the bald eagle in the northeastern United States.

Over the last decade, over 300 dead or moribund bald eagles have been recovered in New England with the majority coming from the State of Maine. Most carcasses are ultimately transferred to the National Eagle Repository for use by Native Americans. Samples from these eagle carcasses represent a valuable, under-utilized contaminant data source to evaluate factors potentially influencing bald eagle recovery: notably potential causes of death and contaminants residue levels in tissues.

In the present study, livers from archived carcasses and newly collected birds were removed and examined for lead (Pb) and mercury (Hg). The liver is a useful tissue for assessing contaminant exposure in wildlife. Contaminants readily accumulate and concentrate in the liver (Klaassen 1986). The organ is large in bald eagles and other fish-eating birds and provides sufficient mass for chemical analyses. Liver tissue has been used in numerous eagle studies to demonstrate organochlorine compound and trace element contaminant uptake and toxicity (Frenzel and Anthony 1989, Craig *et al*. 1990, Kozie and Anderson 1991, Elliott *et al*. 1996, Wood *et al*. 1996, Garcelon and Thomas 1997, Wayland and Bollinger 1999, Kumar *et al*. 2002, Weech *et al*. 2003, Helander *et al*. 2009).

Lead was the primary contaminant of concern for this investigation due to a spate of suspected lead-poisoning cases in eagles being reported by wildlife rehabilitators (Avian Haven 2012, Tri-State BRR 2013, Wildlife Center of Virginia 2013). Mercury is a regionally important contaminant of concern in New England, and it was also included in the liver analyses.

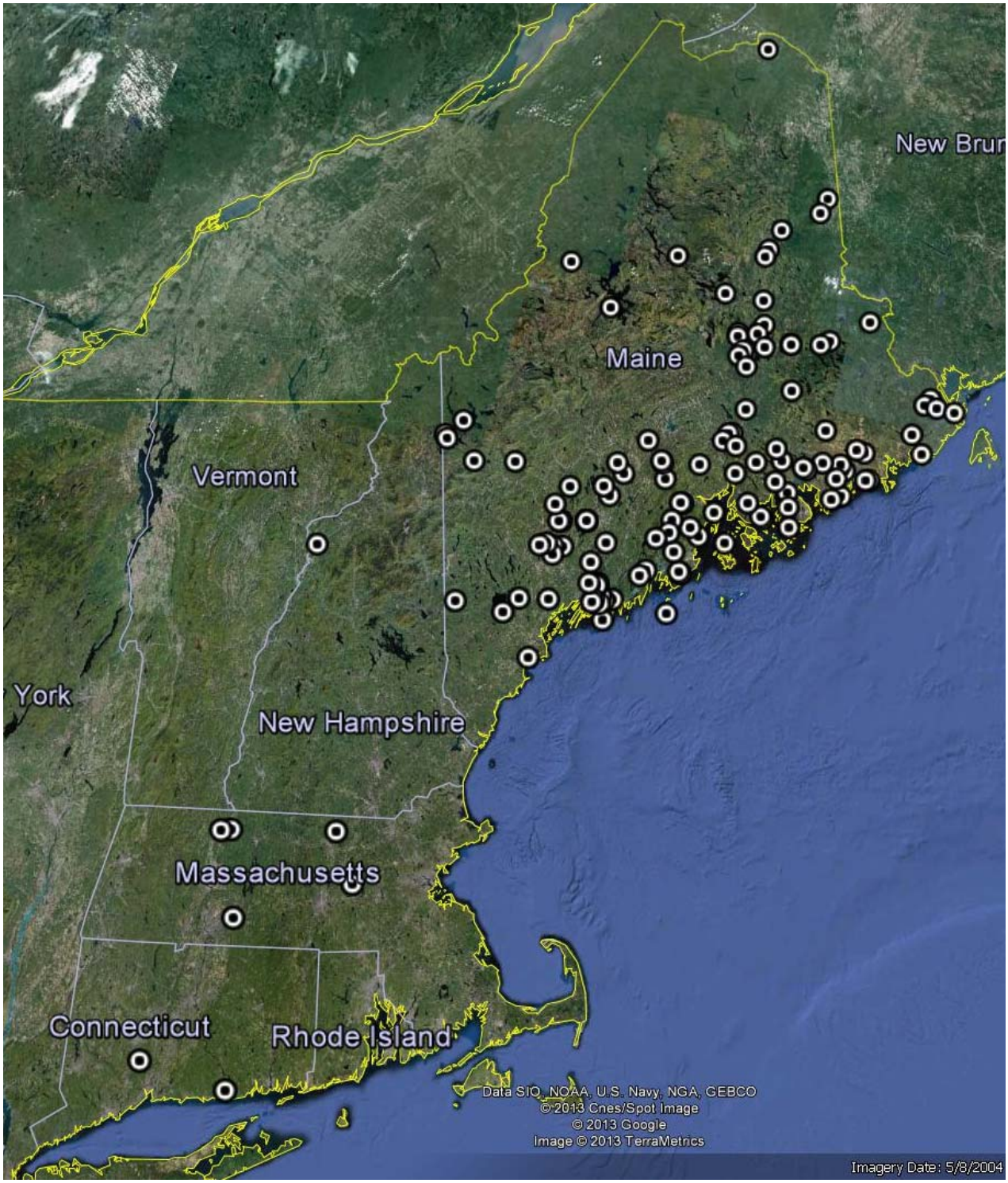
2. Study Objective

Measure liver Pb and Hg levels in bald eagle carcasses collected in New England to document the frequency of concentrations exceeding suggested toxicity thresholds.

3. Study Area

Bald eagle carcasses recovered throughout New England between 2001 and 2012 were included in the investigation (Figure 1, Appendix Table A-1).

Figure 1. Locations of bald eagle carcass recoveries in New England



4. Methods

4.1 Carcass Processing. Collection information was recorded from tags attached to bird carcasses. The information often included items such as date of recovery, description of collection location, age estimate, circumstances associated with carcass (e.g., found below tree stuck by lightning, vehicle collision, etc.). Similar information was collected by rehabilitators that logged in birds brought in for treatment. Coordinates for bird recoveries were estimated from descriptive information, so the information in Appendix Table A-1 should be considered approximate particularly for the locations in New Hampshire, Massachusetts, and Connecticut.

Prior to liver removals, birds were examined and, in some instances, biological measurements were recorded. Sex of fully grown birds capable of flight (i.e., adult, immature, and fledgling birds) was determined from measurements of the hallux claw and bill depth (Bortolotti 1984a) or from gonads viewed during necropsy. Nestlings were sexed by foot pad length and bill depth (Bortolotti 1984b) or by sex organs. Ages were determined from bill, head, and plumage characteristics (McCollough 1989) and banding data.

Various terms have been used to classify bald eagle age classes. In this report, terms for four age classes are: nestling, fledgling, immature, and adult (Buehler 2000).

- Nestling - Hatchlings or juvenile birds that have not fledged. These birds would be up to 8 or 14 weeks old.

- Fledgling - Birds that have recently departed the nest. Actual age for these birds may be 2 months to 1.5 years.

- Immature - Birds without definitive adult plumage. Actual age for these birds may be 1.5 years to 4.5 or 5.5 years.

- Adult - Birds with definitive adult plumage (i.e., head, tail, and upper- and lower-tailcoverts white with dark brown contour feathers). Actual age for these birds may begin at 4.5 or 5.5 years and run to 20+ years.

Livers were removed by staff of the USFWS and by veterinarians and veterinary students at Tufts University. USFWS staff processed 70 bald eagle carcasses. Since these 70 birds were destined for the National Eagle Repository, steps were taken to limit the damage to the carcasses during liver removals. Frozen carcasses were placed on clean[1] stainless steel trays and partially thawed to allow liver removals. Thawing typically took 24 hours. Once sufficiently thawed, the breast skin and feathers were pulled back from the sternum and upper abdomen, and an access hole was cut below the sternum with a scalpel. In some instances, lower portions of the sternum were removed with stainless steel shears or scissors to access the upper body

[1] The decontamination process for stainless steel scalpels, tools and trays used in the dissections was an initial wash with tap water and Alconox® soap, a tap water rinse, and a double rinse with de-ionized water.

cavity. Once access to the chest cavity was achieved, a scalpel was used to cut the entire liver from connective tissue. Liver lobes were weighed individually, placed together in labeled 250 mL, certified chemically-clean glass jars, and frozen until shipped to the analytical laboratory.

Tufts University students and staff necropsied 57 carcasses as part of various regional studies on bald eagles. Carcasses were received at the Tufts facility in different conditions - fresh, refrigerated, or frozen at 0°C. If frozen, carcasses were thawed at room temperature prior to processing. After thawing, digital radiographs were obtained (Summit Innovet Select, Chicago, IL; Carestream Directview CR, Rochester, NY). Radiographs were examined as an adjunct for assessing body condition, detecting pathology, and detecting metallic densities. Subsequently, birds were necropsied using standard techniques (Rae 2006). Sex was determined by direct visualization of the gonad if carcass condition allowed positive identification. Using chemically-clean stainless steel instruments, approximately 20 grams of liver tissue was collected for contaminant analysis. Liver aliquots were placed in certified chemically-clean glass vials and frozen until shipped to the USFWS.

4.2 Analytical. Liver samples were analyzed for total lead and total mercury at the Trace Element Research Laboratory (TERL) in College Station, Texas; a contract laboratory of the USFWS. Lead levels in 127 livers were quantified using Inductively Coupled Plasma Mass Spectrometry (ICPMS). Mercury was quantified in 51 samples using Cold Vapor Atomic Absorption (CVAA). In 76 livers samples, mercury was quantified using Direct Mercury Analysis (DMA). Detection limits on a dry weight basis were 0.20 µg/g for Hg and 0.50 µg/g for Pb.

4.3 Quality Assurance and Quality Control (QA/QC). QA/QC procedures performed by TERL included procedural blanks, duplicates, spike recoveries, and standard reference materials. Laboratory analytical packages and QA/QC results were reviewed and approved by the USFWS Analytical Control Facility in Shepherdstown, WV.

4.4 Data Presentations. Total lead and total mercury results are presented in µg/g (parts per million) on a dry weight basis. Contaminant residues were summarized by geometric mean, geometric standard deviation, range, arithmetic mean, and arithmetic standard deviation. Samples that were below analytical detection limits were assigned a value of one-half of the sample detection limit in the computations of means and standard deviations.

5. Results

5.1 Sex and Age of Birds. Over two-thirds of the carcasses were adults. Of all the birds that could be sexed, the ratio was 61 females to 49 males (Table 1).

Table 1. Age and sex distribution of 127 bald eagle carcasses from New England

Age Class	Number (%)	Sex	Number
Adults	86 (67.7)	Adult Male	36
		Adult Female	45
		Adult - Unknown	5
Immature	27 (21.2)	Immature Male	11
		Immature Female	14
		Immature - Unknown	2
Fledgling	4 (3.1)	Fledgling Male	2
		Fledgling Female	2
Nestlings	10 (7.8)	Nestling Male	4
		Nestling - Unknown	6

5.2 Analytical. Nine catalogs containing the 127 liver samples were submitted to the USFWS Analytical Control Facility for this project. Catalog numbers and purchase orders are listed on page 3. All liver samples were analyzed by the Trace Element Research Laboratory (TERL) in College Station, Texas; a contract laboratory of the USFWS. Table 2 summarizes lead and mercury results. Concentrations of both elements varied widely among samples and several outlier concentrations are reported. The variance was greatest in liver lead levels. In this report, we use geometric mean in the data summary to minimize the influence of outlier concentrations.

Table 2. Summary of Pb and Hg concentrations in 127 bald eagle livers from New England, µg/g dry weight

	Total Lead (Pb)	Total Mercury (Hg)
Geometric Mean	0.69	13.49
Geometric Standard Deviation	10.2	2.6
Range	< 0.01 - 167.00	1.06 - 191.00
Arithmetic Mean	12.72	21.98
Arithmetic Standard Deviation	32.23	29.26

6. Discussion

The liver can be a useful tissue for assessing contaminant exposure in wildlife. Contaminants readily accumulate and concentrate in the liver (Klaassen 1986). Contaminants sequestered in lipids are mobilized during migration, reproduction, molt, cold weather, disease, or other periods of stress when birds stop feeding for extended periods of time. The liver is large in bald eagles and other fish-eating birds and provides sufficient mass for multiple chemical analyses. Liver residue levels in avian carcasses, however, should be viewed with caution. Contaminants may be greatly concentrated in livers of emaciated, starving, or injured birds when fat reserves are being mobilized (Hela *et al*. 2006). Exposure to contaminants may result in enzymatic responses leading to liver enlargement or necrosis (Harris and Elliott 2011).

Since bald eagles are migrants or partial migrants, attributing contaminant uptake in bald eagle carcasses to a particular location or area is problematic. Bald eagle migration behavior is complex and varies by age of the individual, location of breeding site, severity of climate, and food availability (Buehler 2000). A few of the Maine birds were banded and recovered near their nest territories, so we can presume their contaminant uptake was locally derived. However, other eagles in the study, particularly younger non-breeding birds, could possibly be from distant areas – even areas outside of New England. Buehler *et al*. (1991) reported two radio-tagged non-breeding eagles from Chesapeake Bay, MD, had moved north in summer to Maine. Broley (1947) banded a hatch-year bird in Florida that was shot 32 days later in New Brunswick, nearly 1,600 miles away.

Differences in diet composition associated with habitat types may result in differential contaminant exposure rates in bald eagles. Welch (1994) reported that breeding eagles from inland Maine territories fed primarily on fish and tended to have greater Hg burdens compared to eagles on the coast. In contrast, breeding bald eagles from coastal Maine territories had a greater bird component in their diet and tended to have greater organochlorine burdens. Since resident Maine bald eagles may move from inland to coast during winter months and shift their diets from fish to birds, the origin of contaminant burdens in bald eagles sampled for the present study cannot be determined.

6.1 Season of Collection. Most of the carcasses used in this investigation were recovered in the spring (Figure 2) during the months of March and April (Figure 3). Some birds may have died during winter and were located only after loss of snow cover later in the spring.

Figure 2. Bald eagle carcass recoveries by season

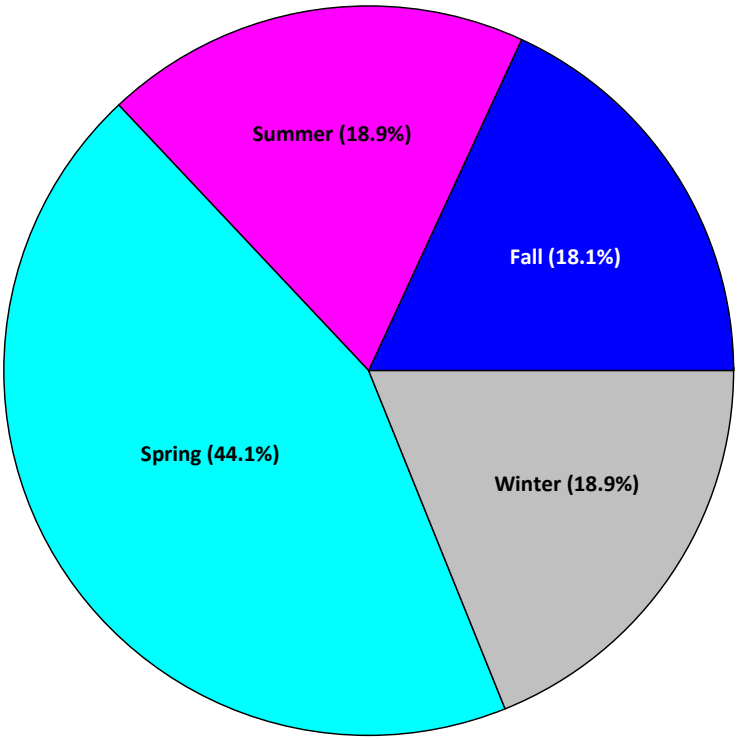
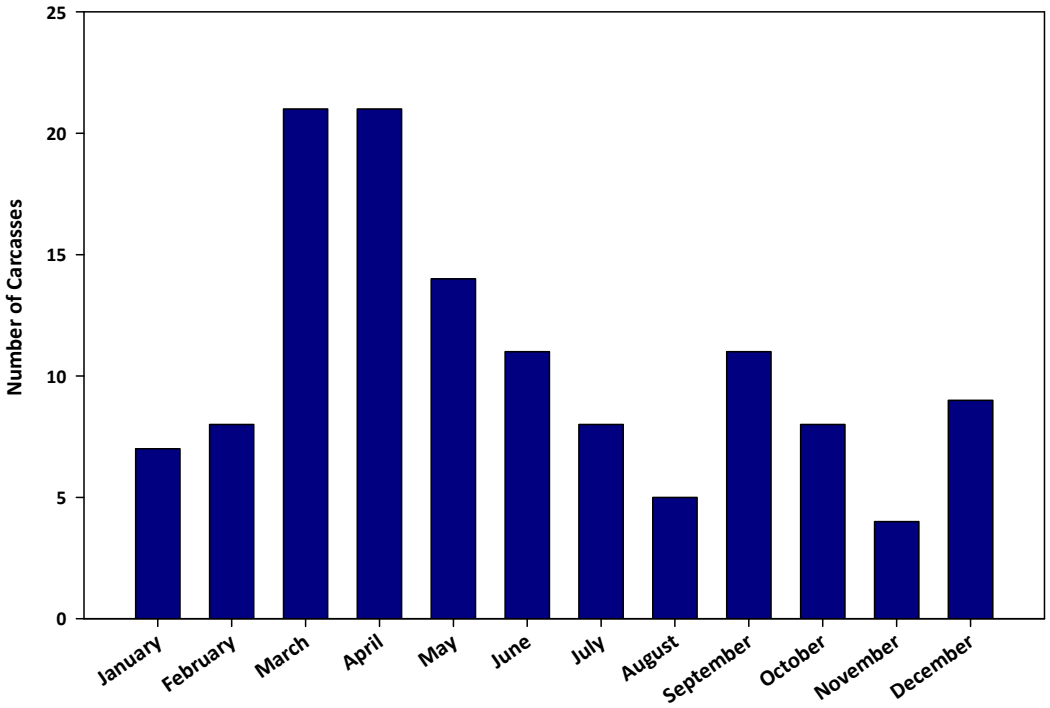


Figure 3. Bald eagle carcass recoveries by month



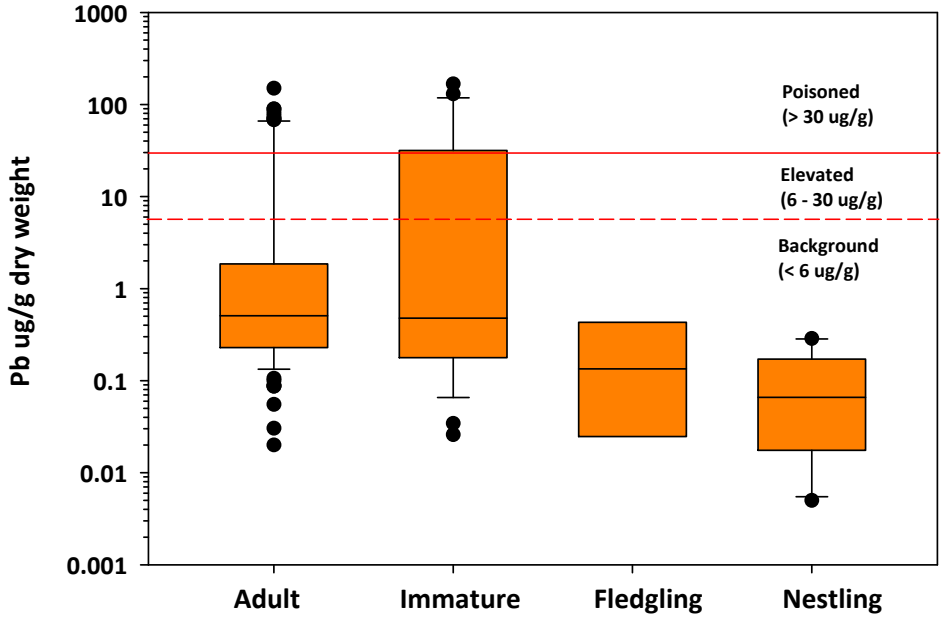
6.2 Lead (Pb). Despite a ban on Pb shot for waterfowl hunting, Pb continues to adversely affect bald eagles in the U.S. and Canada. Lead ammunition in hunter-killed, but unrecovered wild game, and bullet fragments in carcasses of wildlife used as bait by trappers are suspected Pb sources to scavenging eagles (Bedrosian and Craighead 2009, Hunt *et al*. 2009, Redig *et al*. 2009, Stauber *et al*. 2010). Lead exposure inhibits erythrocyte δ-aminolevulinic acid dehydratase activity in the synthesis of heme and causes peripheral neuropathy or "wing droop" in birds (Franson and Pain 2011, Pokras and Kneeland 2009).

The geometric mean concentration of Pb in livers of bald eagles recovered in Maine was 0.69 µg/g (range: <0.009 – 167.00 µg/g, Table 2). The bird with the highest Pb liver concentration was an immature female recovered along the Orland River in Orland, Hancock County, Maine in March 2010.

Wayland and Bollinger (1999) suggested three levels to classify Pb exposure in eagles. Using their classification levels, most of the livers from birds recovered in New England (107 of 127 samples or 84%, including six that did not have detectable levels of Pb) had low Pb levels (≤ 6 µg/g), two livers were in the elevated Pb range of 6 – 30 µg/g, and 18 livers (or 14%) had concentrations indicative of Pb poisoning (> 30 µg/g) (Figure 4). In other eagle studies, percentages of Pb-poisoned birds were lower (5.8%, Reichel *et al*. 1984), similar (e.g., 12%, Wayland and Bollinger 1999; 14% Helander *et al*. 2009), or higher (39%, Neumann 2009) than the present study (14%).

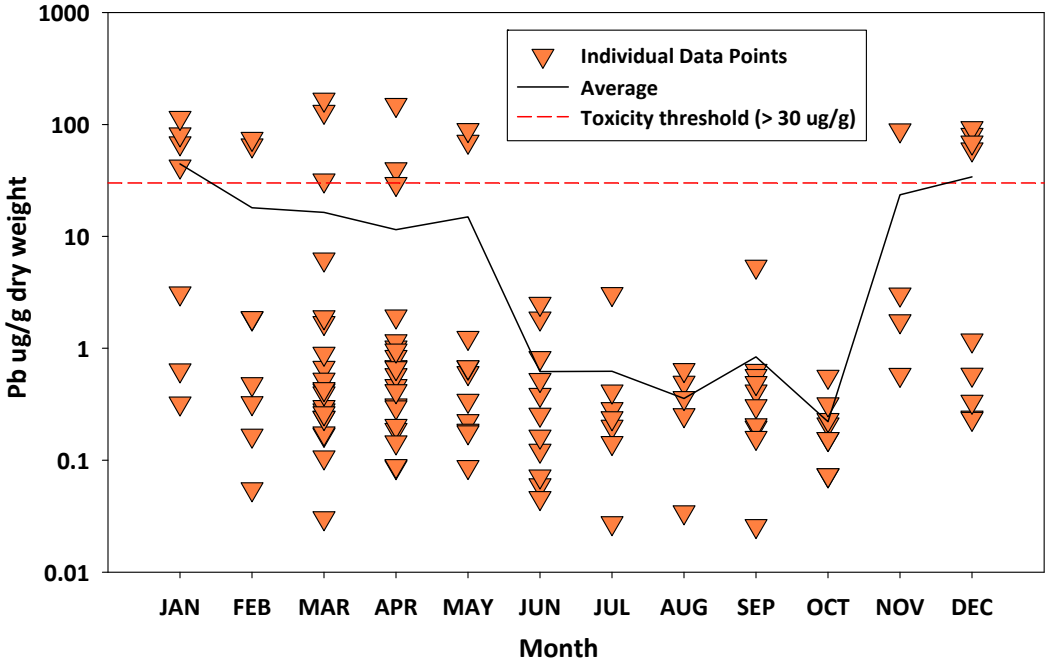
Highest Pb concentrations were detected in birds recovered during the winter and spring months (Figure 5). Scavenging behavior by eagles likely peaks during these seasons.

Figure 4. Lead (Pb) in bald eagle livers by age class, ug/g dry weight



Solid Line in Box Represents the Median (50th Percentile)
Top and Bottom Box Boundaries Represent the 25th and 75th Percentiles
Whiskers Above and Below the Box Represent the 10th and 90th Percentiles
Outliers Represented by Black Circles

Figure 5. Lead in bald eagle livers by month of collection



Graph format adapted from Elliott *et al*. 1996

6.3 Mercury (Hg). Compared to other regions of North America, New England and the Canadian Maritimes have elevated levels of mercury in fish and wildlife tissue (Evers *et al*. 1998, Evers *et al*. 2007, Scheuhammer *et al*. 2008).

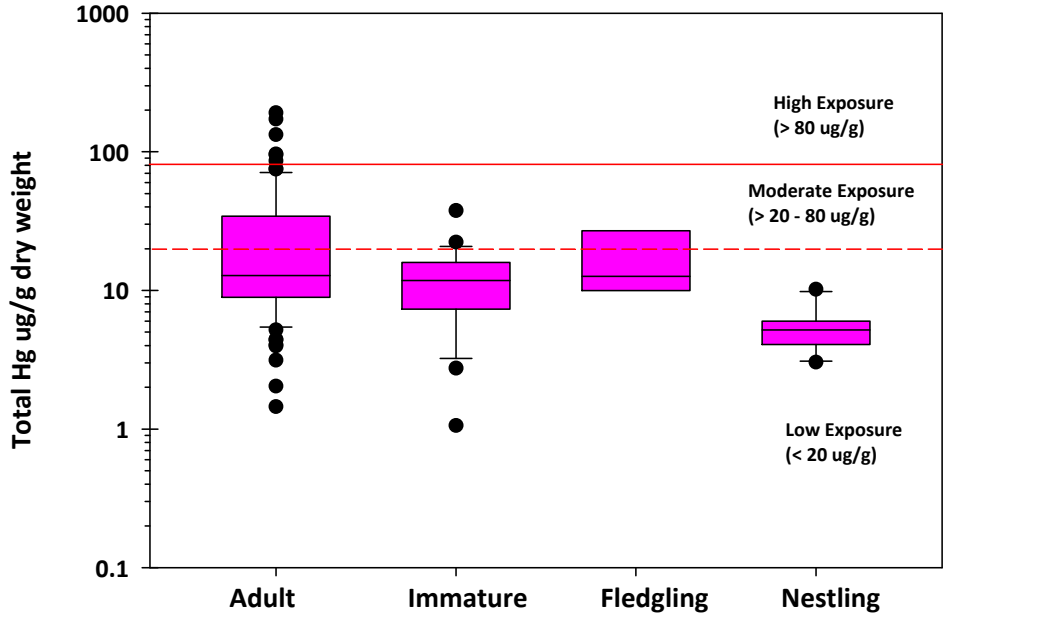
Geometric mean Total Hg in Maine eagle livers was 13.49 µg/g (range: 1.06 – 191.0 µg/g, Table 2), which was higher than mean levels recorded in bald eagles from British Columbia (11.8 µg/g, range: 0.5 – 130.0 µg/g, Weech *et al*. 2003), several Great Lake states (7.97 µg/g, range: 0.47 – 61.61 µg/g, Rutkiewicz *et al*. 2011), and Alaska (7.10 µg/g, range: 1.70 – 17.5 µg/g, Stout and Trust 2002). Mercury in 32 bald eagle livers from Florida in the early 1990s ranged from 0.48 to 42.07 µg/g (converted from wet weight based on 71% moisture, Wood *et al*. 1996). Eighty-nine bald eagle livers from seven Canadian provinces had Hg levels ranging from 0.5 to 104 µg/g (Scheuhammer *et al*. 2008).

In the present study, the highest recorded Hg value, 191 µg/g, came from an adult male bird recovered at South Branch Lake in Seboeis Plantation, Penobscot County, Maine, in February 2005. This level is higher than the 130.0 µg/g maximum for bald eagles in British Columbia reported by Weech *et al*. (2003). An unpublished record of an even higher concentration (Scheuhammer pers. comm.) was cited in Weech *et al*. (2003) with 670 µg/g Hg in a bald eagle liver sample from eastern Canada.

Classifications of Hg exposure levels in bald eagle livers were suggested by Weech *et al*. (2003). Using their classification levels, 91 livers from birds recovered in New England or 72% had low Hg levels (< 20 µg/g), 30 livers or 24% had moderate levels (20 - 80 µg/g dw) and six livers or 5% had high levels (> 80 µg/g) (Figure 6). There was no apparent pattern of Hg exposure by month of collection (Figure 7).

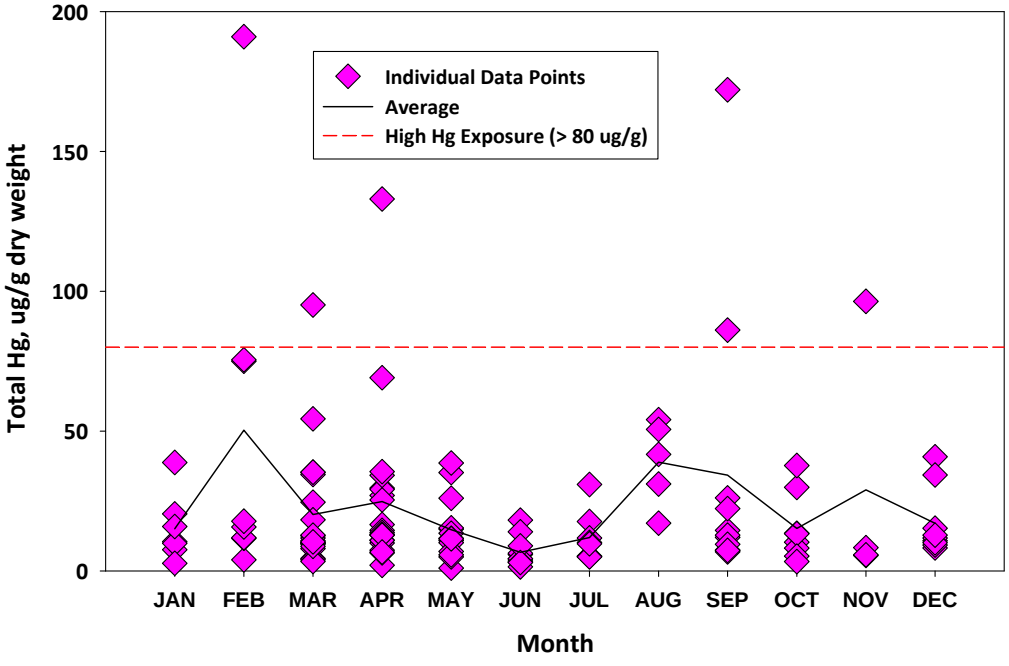
Methylmercury, MeHg, was measured and previously reported in a subset of the 127 livers. In 47 livers, mean MeHg in livers of bald eagle carcasses recovered in Maine was 5.85 µg/g (range: 0.55 – 29.00 µg/g) (Mierzykowski *et al*. 2011). An average of 51% of the Total Hg in the 47 livers was comprised of MeHg (range: 5 – 108%). Weech *et al*. (2003) reported similar results with MeHg constituting over 50% on average of the Total Hg in bald eagle livers from British Columbia. Rutkiewicz *et al*. (2011) found an average of 59% (range: 11 -107%) of the Total Hg in the organic form (i.e., MeHg).

Figure 6. Mercury (Hg) in bald eagle livers by age class, ug/g dry weight



Solid Line in Box Represents the Median (50th Percentile)
Top and Bottom Box Boundaries Represent the 25th and 75th Percentiles
Whiskers Above and Below the Box Represent the 10th and 90th Percentiles
Outliers Represented by Black Circles

Figure 7. Mercury in bald eagle livers by month of collection



Graph format adapted from Elliott *et al*. 1996

7. Summary and Management Recommendations

Toxic levels of Pb and Hg were found in 14% and 5%, respectively, of livers from 127 bald eagle carcasses recovered in New England. Bald eagle liver appears to be a suitable tissue for categorizing Pb and Hg exposure in carcasses, and a relatively easy tissue to obtain for contaminant analyses.

Additional necropsies and studies of bald eagle carcasses from New England are recommended to provide information regarding long term trends and possible patterns of Pb and Hg exposure. Subsets of carcasses should also be screened for newly emerging contaminant threats.

The practice of having necropsies done for cause-of- death determinations, contaminant surveillance and disease monitoring before carcasses are sent to the National Eagle Repository should be continued and coordinated with state and federal wildlife agencies, Native American tribes, and the U.S. Geological Survey's Wildlife Health Center and Patuxent Wildlife Research Center.

The issue of Pb in wildlife tissues is moving some groups to advocate for less toxic types of ammunition. Toxicological information relative to wildlife on the proposed ammunition alternatives should be gathered.

Additional outreach and education are necessary to alert hunters and trappers of the hazards of Pb ammunition to wildlife. Bullets in unrecovered shot animals, in gutpiles, and in carcasses used for bait by trappers are all sources of Pb to scavenging bald eagles and other wildlife.

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Appendix Table A-1. Bald eagle liver sample information

Sample No.	Township	County	Recovery Date	Latitude	Longitude	Age Class	Sex
ME277A	Old Town	Penobscot	15-Sep-03	44N 55' 54"	68W 38' 30"	Adult	Male
ME 075L	T39 MD	Hancock	10-May-04	45N 02' 09"	68W 16'09"	Adult	Female
ME 096L	Howland	Penobscot	21-Jul-04	45N 17' 06"	68W 38' 23"	Adult	Unknown
ME 403L	Waldoboro	Lincoln	26-Apr-04	44N 11' 40"	69W 22' 32"	Adult	Unknown
BELIV601	Magalloway Plt	Oxford	30-Jan-05	44N 46' 45"	70W 59' 45"	Adult	Female
BELIV602	Searsmont	Waldo	28-Jan-05	44N 23' 30"	69W 09' 45"	Adult	Female
BELIV603	Pittston Academy Grant	Somerset (+ NJ)	15-Dec-04	45N 50' 44"	70W 01' 15"	Fledgling	Male
BELIV604	Sebois Plt	Penobscot	3-Feb-05	45N 22' 15"	68W 40' 45"	Adult	Male
BELIV605	Appleton	Knox	26-Mar-05	44N 17' 45"	69W 15' 00"	Adult	Male
BELIV606	Prospect Harbor	Hancock	9-Sep-04	44N 23' 45"	68W 00' 45"	Adult	Male
BELIV607	Freedom	Waldo	5-Jan-05	44N 32' 00"	69W 17' 30"	Adult	Female
BELIV608	T3 R11 Wells	Piscataquis	2-May-05	45N 52' 30"	69W 08' 30"	Adult	Female
BELIV609	Gray	Cumberland	4-Oct-05	43N 52' 00"	70W 25' 00"	Adult	Male
BELIV610	Addison	Washington	9-May-02	44N 30' 00"	67W 44' 15"	Adult	Male
BELIV611	Whiting	Washington	6-May-03	44N 45' 30"	67W 20' 30"	Adult	Male
BELIV612	Eastport	Washington	6-May-01	44N 52' 45"	66W 59' 15"	Adult	Female
BELIV613	Pembroke	Washington	9-Dec-02	44N 54' 30"	67W 07' 30"	Adult	Female
BELIV614	Seboeis Plt	Penobscot	20-Apr-02	45N 23' 30"	68W 40' 30"	Adult	Female
BELIV615	T8 SD	Hancock	1-Nov-01	44N 37' 30"	68W 22' 45"	Adult	Male
BELIV616	Chester	Penobscot	10-Apr-02	45N 23' 04"	68W 31' 04"	Adult	Male
BELIV617	Codyville Plt	Washington	17-Jun-06	45N 26' 18"	67W 35' 58"	Nestling	Unknown
BELIV 701	Phippsburg	Sagadahoc	20-Apr-06	43N 44' 33"	69W 47' 19"	Adult	Male
BELIV 702	Sherman	Aroostook	29-Apr-03	45N 54' 12"	68W 23' 12"	Immature	Female
BELIV 703	Camden	Knox	11-Jul-04	44N 12' 06"	69W 03' 00"	Nestling	Unknown
BELIV 704	Richardsontown TWP	Oxford	12-Jun-02	44N 53' 00"	70W 52' 12"	Nestling	Unknown
BELIV 705	Ellsworth	Hancock	11-Jun-04	44N 37' 12"	68W 34' 52"	Nestling	Unknown
BELIV 706	Camden	Knox	3-Aug-05	44N 15' 09"	69W 06' 40"	Fledgling	Male
BELIV 707	West Bath	Sagadahoc	24-Mar-04	43N 50' 32"	69W 52' 07"	Adult	Female
BELIV 708	Orrington	Penobscot	28-Jul-01	44N 43' 02"	68W 43' 59"	Nestling	Unknown
BELIV 709	Northport	Waldo	2-Mar-07	44N 20' 09"	68W 55' 25"	Adult	Female
BELIV 710	T3 Indian Purchase	Penobscot	30-Nov-06	45N 38' 10"	68W 45' 49"	Adult	Male
BELIV 711	Arrowsic	Sagadahoc	7-Oct-06	43N 51' 07"	69W 46' 39"	Immature	Female
BELIV 712	T10 SD	Hancock	17-Dec-06	44N 36' 26"	68W 03' 39"	Adult	Female
BELIV801	Steuben	Sagadahoc	1-May-03	44N 24' 45"	67W 56' 15"	Adult	Male
BELIV802	Columbia Falls	Washington	15-Mar-06	44N 39' 30"	67W 43' 45"	Adult	Female
BELIV803	Brooklin	Hancock	23-Mar-07	44N 18' 30"	68W 34' 00"	Adult	Male
BELIV804	SW Harbor	Hancock	6-Aug-07	44N 14' 30"	68W 21' 15"	Adult	Female

Appendix Table A-1 (continued). Bald eagle liver sample information

Sample No.	Township	County	Recovery Date	Latitude	Longitude	Age Class	Sex
BELIV805	Unity	Waldo	30-Sep-07	44N 37' 30"	69W 18' 30"	Adult	Male
BELIV806	Chester	Penobscot	10-Apr-02	45N 26' 15"	68W 27' 30"	Adult	Female
BELIV807	Union	Knox	8-May-07	44N 13' 30"	69W 16' 30"	Adult	Female
BELIV808	Dennysville	Washington	30-Oct-04	44N 55' 45"	67W 13" 15"	Adult	Male
BELIV809	Passadumkeag	Penobscot	20-Apr-06	45N 11' 15"	68W 37' 15"	Adult	Male
BELIV810	Medway	Penobscot	7-Jun-07	45N 35' 15"	68W 27' 15"	Nestling	Unknown
BELIV811	Winthrop	Kennebec	27-May-05	44N 17' 45"	69W 54' 15"	Immature	Male
BELIV812	Hampden	Penobscot	13-Mar-06	44N 45' 00"	68W 50' 00"	Immature	Female
BELIV813	T6 R1 NBPP	Washington	9-Aug-06	45N 19' 45"	67W 56' 15"	Adult	Male
BELIV814	New Limerick	Aroostook	25-Feb-06	46N 07' 45"	67W 56' 15"	Adult	Female
BELIV815	Livermore Falls	Androscoggin	27-Dec-05	44N 23' 45"	70W 08' 45"	Immature	Male
BELIV816	Mariaville	Hancock	21-Mar-05	44N 41' 45"	68W 25' 00"	Immature	Male
BELIV817	Cutler	Washington	18-Apr-05	44N 38' 30"	67W 16' 45"	Adult	Male
BELIV818	Island Falls	Aroostook	4-Apr-07	46N 01' 35"	68W 17' 10"	Adult	Female
BELIV11CB	Scarborough	Cumberland	4-Sep-11	43N 32' 24"	70W 20' 34"	Fledgling	Female
TV11009	Orland	Hancock	6-Mar-10	44N 33' 30"	68W 44' 50"	Immature	Female
TV11010	Franklin	Hancock	6-Apr-08	44N 34' 59"	68W 12' 56"	Adult	Female
TV11012	Warren	Knox	23-Dec-10	44N 07' 00"	69W 14' 30"	Immature	Female
TV11013	Carthage	Franklin	25-Apr-10	44N 38' 30"	70W 27' 30"	Immature	Female
TV11014	Cherryfield	Washington	22-Oct-09	44N 35' 40"	67W 55' 20"	Adult	Male
TV11015	Auburn	Androscoggin	26-Aug-10	44N 09' 50"	70W 15' 50"	Adult	Female
TV11016	North Yarmouth	Cumberland	23-Feb-08	43N 51' 40"	70W 11' 40"	Adult	Female
TV11017	Pukakon Township	Penobscot	17-Apr-10	45N 18' 30"	68W 00' 50"	Adult	Male
TV11018	Monroe	Waldo	19-Apr-10	44N 36' 50"	69W 01' 20"	Adult	Female
TV11032	Phippsburg	Sagadahoc	19-Sep-08	43N 52' 44"	69W 48' 09"	Adult	Male
TV11033	North Haven	Knox	16-Nov-10	44N 09' 39"	68W 51' 05"	Adult	Male
TV11034	Sherman	Aroostook	6-Apr-09	45N 51' 35"	68W 25' 16"	Adult	Female
TV11035	Saint George	Knox	29-Dec-09	43N 59' 39"	69W 11' 37"	Immature	Male
TV11036	Phippsburg	Sagadahoc	13-Apr-10	43N 50' 00"	69W 48' 43"	Immature	Female
TV11037	Brooksville	Hancock	8-Jul-10	44N 23' 10"	68W 39' 40"	Adult	Female
TV11038	Ellsworth	Hancock	16-Jul-10	44N 30' 20"	68W 26' 23"	Adult	Female
TV11039	Twombly	Penobscot	31-Mar-09	45N 18' 50"	68W 15' 04"	Adult	Female
TV11040	Topsham	Sagadahoc	23-Mar-09	43N 56' 55"	69W 53' 18"	Immature	Male
TV11041	Bowdoinham	Sagadahoc	28-Jan-10	44N 03' 55"	69W 52' 27"	Adult	Male
TV11042	Big Moose	Piscataquis	8-Sep-10	45N 33' 32"	69W 42' 04"	Adult	Female
TV11044	Woolwich	Sagadahoc	14-Aug-07	43N 51' 24"	69W 51' 23"	Immature	Female
TV11087	Steuben	Washington	15-Sep-09	44N 30' 50"	67W 57' 51"	Adult	Female
TV11089	Saint George	Knox	14-May-11	44N 00' 20"	69W 12' 31"	Immature	Female

Appendix Table A-1 (continued). Bald eagle liver sample information

Sample No.	Township	County	Recovery Date	Latitude	Longitude	Age Class	Sex
TV11090	Addison	Washington	31-Mar-09	44N 30' 00"	67W 42' 30"	Adult	Male
TV11091	Bath	Grafton (NH)	17-May-10	44N 10' 01"	71W 58' 02"	Adult	Female
TV11092	Fairfield	Somerset	24-Mar-11	44N 37' 53"	69W 39' 42"	Adult	Male
TV11093	Beddington	Washington	2-Nov-11	44N 47' 46"	68W 01' 15"	Adult	Male
TV11095	Pembroke	Washington	17-Jun-11	44N 57' 53"	67W 10' 00"	Adult	Male
TV11098	Sidney	Kennebec	20-Mar-11	44N 29' 47"	69W 46' 11"	Adult	Female
TV11099	Leeds	Androscoggin	11-Feb-11	44N 17' 56"	70W 05' 57"	Adult	Female
TV11100	Gardiner	Kennebec	16-Jun-09	44N 10' 24"	69W 45' 26"	Adult	Male
W090124	Franklin	Hancock	17-Mar-09	44N 34' 14"	68W 11' 36"	Adult	Male
W110113	Westport Island	Lincoln	9-Feb-11	43N 51' 21"	69W 42' 46"	Adult	Unkown
W110772	Northfield	Franklin (MA)	12-Jun-12	42N 36' 48"	72W 28' 00"	Immature	Female
TV11043	Milbridge	Washington	8-Sep-08	44N 33' 30"	67W 53' 40"	Adult	Female
TV11080	Pittsfield	Somerset	7-Jan-11	44N 45' 30"	69W 25' 07"	Immature	Male
TV11094	Bangor	Penobscot	29-Apr-11	44N 47' 29"	68W 47' 15"	Adult	Male
TV11096	Columbia Falls	Washington	10-Mar-11	44N 40' 38"	67W 47' 16"	Immature	Male
TV11107	Bath	Sagadahoc	7-Oct-11	43N 56' 02"	69W 49' 56"	Immature	Unknown
TV11113	Unity	Waldo	25-Apr-11	44N 38' 22"	69W 19' 04"	Adult	Female
TV11114	Howland	Penobscot	29-Jul-11	45N 15' 15"	68W 40' 48"	Adult	Male
TV11115	Saint Agatha	Aroostook	4-Sep-11	47N 13' 33"	68W 17' 15"	Immature	Female
TV11116	Standish	Cumberland	25-Sep-11	43N 47' 26"	70W 32' 11"	Adult	Female
TV11119	Brewer	Penobscot	12-Oct-11	44N 47' 33"	68W 45' 29"	Adult	Female
TV11120	Porter	York	24-Feb-11	43N 51' 11"	70W 53' 47"	Adult	Female
TV11125	Bath	Sagadahoc	25-Oct-11	43N 56' 37"	69W 49' 20"	Immature	Male
TV11126	Bath	Sagadahoc	22-Oct-11	43N 56' 37"	69W 49' 20"	Immature	Male
TV12021	Monhegan Island Plt	Lincoln	3-Feb-12	43N 46' 25"	69W 18' 32"	Adult	Male
TV12022	Mount Desert	Hancock	20-Jun-11	44N 21' 24"	68W 21' 00"	Adult	Female
TV12028	Brooklin	Hancock	25-Jul-11	44N 17' 41"	68W 33' 08"	Nestling	Male
TV12036	Trenton	Hancock	16-Dec-11	44N 26' 26"	68W 21' 04"	Adult	Male
W09789	Lunenburg	Worcester (MA)	2-Jul-09	42N 36' 42"	71W 42' 29"	Fledgling	Female
W100750	Old Saybrook	Middlesex (CT)	10-Jun-10	41N 17' 43"	72W 23' 15"	Adult	Female
W120131	Marlboro	Middlesex (MA)	12-Mar-12	42N 20' 28"	71W 34' 31"	Adult	Female
W12196	Bethany	New Haven (CT)	4-Apr-12	41N 25' 48"	72W 59' 37"	Adult	Female
W12266	Belchertown	Hampshire (MA)	23-Apr-12	42N 09' 31"	72W 24' 30"	Immature	Unknown
W120136	Gill	Franklin (MA)	12-Mar-12	42N 36' 32"	72W 32' 21"	Adult	Male
BELIV-001	Winthrop	Kennebec	30-May-04	44N 18' 00"	69W 54' 17"	Nestling	Male
BELIV-002	Winthrop	Kennebec	30-May-04	44N 18' 00"	69W 54' 17"	Nestling	Male
BELIV-003	Magalloway Plt.	Oxford	11-Jan-09	44N 48' 05"	71W 00' 40"	Immature	Male
BELIV-004	Greene	Androscoggin	6-Mar-06	44N 09' 20"	70W 09' 41"	Adult	Unknown

Appendix Table A-1 (continued). Bald eagle liver sample information

Sample No.	Township	County	Recovery Date	Latitude	Longitude	Age Class	Sex
BELIV-005	Auburn	Androscoggin	24-Mar-08	44N 10' 30"	70W 12' 40"	Adult	Female
BELIV-006	Mt. Vernon	Kennebec	1-Jan-09	44N 29' 45"	70W 01' 50"	Immature	Female
BELIV-007	Lewiston	Androscoggin	25-Dec-08	44N 06' 39"	70W 09' 52"	Adult	Female
BELIV-008	Wales	Androscoggin	8-Sep-06	44N 09' 16"	70W 05' 14"	Immature	Male
BELIV-009	Lincoln	Penobscot	29-Dec-09	45N 18' 07"	68W 27' 58"	Adult	Male
BELIV-010	Bremen	Lincoln	3-May-09	44N 00' 55"	69W 27' 26"	Adult	Female
BELIV-011	Leeds	Androscoggin	31-Mar-09	44N 17' 58"	70W 07' 07"	Immature	Female
BELIV-012	Andover	Oxford	28-Jun-09	44N 38' 50"	70W 46' 43"	Adult	Unknown
BELIV-013	Littleton	Aroostook	2-May-09	46N 13' 14"	67W 51' 58"	Adult	Female
BELIV-014	Bristol	Lincoln	22-Mar-10	43N 59' 10"	69W 30' 20"	Adult	Female
BELIV-015	Twombly	Penobscot	16-Feb-10	45N 19' 05"	68W 15' 15"	Immature	Female
BELIV-016	Winslow	Kennebec	7-Apr-10	44N 34' 02"	69W 36' 46"	Adult	Female
BELIV-017	Sidney	Kennebec	7-Apr-10	44N 26' 26"	69W 43' 35"	Adult	Male
BELIV-018	Searsmont	Waldo	3-Jun-03	44N 23' 45"	69W 10' 48"	Nestling	Male

Coordinates estimated for CT, NH, and MA locations

Shaded cells indicate birds collected in CT, NH, and MA.

Sample BELIV603 was banded in ME, but recovered after dispersal to NJ