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ASSESSING MERCURY ACCUMULATION IN WINTERING SEA DUCKS AND ATLANTIC BRANT AT PARKER RIVER NATIONAL WILDLIFE REFUGE 2009

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2009

WILDLIFE SCIENCE CHANGING OUR WORLD

SUBMITTED BY:

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FRONT PHOTO CAPTION: Common Eider (*Somateria mollissima*). Photo provided by BRI.

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EXECUTIVE SUMMARY

This project was conducted in an effort to determine mercury (Hg) exposure in three species of waterfowl wintering at Parker River National Wildlife Refuge. Parker River National Wildlife Refuge is comprised of 4,662 acres of quality coastal salt marsh, tidal flat, and beach habitat located in northeastern Massachusetts. Numerous species and large numbers of migratory shorebirds and wintering waterfowl species utilize the diverse habitat of Parker River NWR during the fall and winter months. Previous studies have shown elevated levels of Hg in whole blood samples collected from saltmarsh sharp-tailed sparrows (*Ammodramus caudacutus*) at Parker River NWR (Lane et al. 2008). This study aims to provide an aquatic, marine ecosystem comparison. Common eider (*Somateria mollissima*) and white-winged scoter (*Melanitta fusca deglandi*) were captured between the months of January and March. Atlantic brant (*Branta bernicala*) were captured during the months of April and May. Common eider and white-winged scoter were captured using floating mist-nets, while atlantic brant were captured by use of decoys and cannon nets. All birds captured were banded and morphometric measurements were taken.

A total of 25 birds (12 common eider, 10 atlantic brant, 3 white-winged scoter) were captured as part of an HPAI (Highly Pathenogenic Avian Influenza) surveillance effort targeting waterfowl species determined by the Atlantic Flyway Council to be of primary and secondary concern. Blood and feather samples were subsequently taken from each individual for total mercury (THg) analysis. Blood Hg concentrations were recorded as parts per million (ppm) wet weight (ww). Feather Hg concentrations were recorded as parts per million (ppm) fresh weight (fw). Blood Hg concentrations in these three species varied, with atlantic brant containing the lowest mean blood Hg concentration of 0.03 (±0.01) ppm (ww), White-winged scoters containing a mean blood Hg concentration of 0.28 (±0.12) ppm (ww), and common eiders containing the highest mean blood Hg concentration of 0.97 (±0.47) ppm (ww). Total mercury concentrations in the feather tissue of the three species were also varied. White-winged scoter contained the highest mean feather Hg concentrations of 2.59 (±1.49) ppm. Common eider sampled contained a mean feather Hg concentration of 1.75 (±1.09) ppm, while atlantic brant contained the lowest mean feather Hg concentration of 0.28 (±0.15) ppm. No individuals captured tested positive for HPAI.

Also included in this report, for comparison purposes, are mean blood Hg concentrations (ppm,ww) for similar waterfowl species live-captured and sampled in Alaska, as part of a collaborative bird Hg study between BRI, U.S. Fish and Wildlife Service, U.S. Geological Survey, and the University of Alaska, Fairbanks (Folsom et al. 2009). Very few studies exist that explore Hg residues in whole blood of wintering sea ducks. Likewise, while there are studies that focus on environmental contaminants in black brant, to our knowledge there have been none to date that discuss Hg exposure and contamination in atlantic brant.

1.0 INTRODUCTION

Atmospheric mercury (Hg) deposition has emerged as an important environmental issue across the globe. Pollutant levels tend to be higher in marine environments due to run-off, point-source pollution, and rivers, along with atmospheric deposition. Similarly, species that forage in aquatic environments are at higher risk of increased levels of contamination because of the potential of rapid movement of contaminants in aquatic food chains and the ability of pollutants in intertidal and shallow marine environments to be stored in bottom sediments (Burger and Gochfeld 2008). Following deposition, inorganic Hg may be converted to its more bioavailable and toxic form, methylmercury (MeHg). Towards the top of aquatic food chains, MeHg accumulates to toxic levels through bioaccumulation (Driscoll et al. 2007).

Particularly for long-lived species feeding at higher trophic levels, biomagnification of Hg presents a greater risk of neurological and reproductive impact (Evers et al. 2005). In North America and Europe, sea duck species have long served as important indicators of ecological health and inshore marine pollution. Serious declines in several of these species have led to increased investigations into the effects of environmental contaminants on their populations and physiology. Trace elements in sea ducks have typically been determined in liver or kidney samples, while non-lethal sampling using feather and blood samples has recently been used with increased frequency (Wayland et al. 2000). With increased sampling efforts and a better understanding of the dynamics of mercury contamination in the aquatic environments, waterfowl species have become increasingly important bioindicators of both freshwater and marine ecosystem health.

2.0 STUDY AREA

Parker River National Wildlife Refuge is comprised of 4,662 acres of quality coastal salt marsh, tidal flat, and beach habitat located in northeastern Massachusetts. Numerous species and large numbers of migratory shorebirds and wintering waterfowl species utilize the diverse habitat of Parker River NWR.

Sampling sites were generally located within Plum Island Sound and the Merrimack River outlet (Figure 1). Actual capture sites were chosen based on availability of target species and marine conditions (i.e. tide, wind, etc.).

Figure 1. Map of bird sampling locations within Plum Island Sound and Merrimack River outlet.

3.0 METHODS

Bird sampling efforts occurred from 6 January to 8 May, 2009. Non-lethal capture methods were used for the sampling of all birds. Blood and feather samples were collected using published BRI protocols (Evers 2008). Blood was drawn using a small gauge needle to puncture either the cutaneous ulner vein in the wing or the tarsal vein on the leg. Heparinized capillary tubes collected blood, and no more than 1% of the bird's body weight in blood was collected. The tubes were sealed on both ends with Critocaps® and placed in a labeled 10 cc plastic vacutainer. Additional blood samples were stored in heparinized and/or no-additive microtainers and placed on ice in a cooler and frozen within six hours of collection. The second secondary flight feather from each wing and two tail feathers were clipped from each bird. Collected feathers were then placed in a clean, labeled, envelope and stored in a refrigerator. All samples were labeled with the date of collection, age and sex of the bird, USFWS band number, and capture location.

3.1 Sample Analysis

Samples were shipped to the Utah Veterinary Diagnostic Laboratory, Logan, Utah. Blood and feather samples were analyzed for total mercury (THg). Blood results are reported in parts per million (ppm) and on a wet weight (ww) basis. Feather results are reported in parts per million on a fresh weight (fw) basis.

4.0 RESULTS AND DISCUSSION

A total of 25 birds, representing three species, had blood and feather tissues collected for Hg analysis. Along with Hg concentration comparisons between species, each species was then tested for statistical differences in Hg concentrations based on age and sex.

4.1 Blood

Blood is the primary tissue for evaluating recent dietary uptake and there is strong evidence that Hg levels in bird blood reflect prey Hg levels (Evers et al. 2005; Burgess and Hobson 2006; Burgess and Meyer 2008; Evers et al. 2008). Over 95% of the Hg in blood is in the methyl form (Wolfe et al. 2007). Whole blood collected from sea ducks and brant wintering at Parker River NWR would reflect Hg accumulated through local food sources.

Mercury concentrations in these three species varied, with atlantic brant containing the lowest mean blood Hg concentration of 0.03 ± (0.01) ppm (ww), White-winged scoters containing a mean blood Hg concentration of 0.28 (±0.12) ppm (ww), and common eiders containing the highest mean blood Hg concentration of 0.97 (±0.47) ppm (ww) (Figure 2).

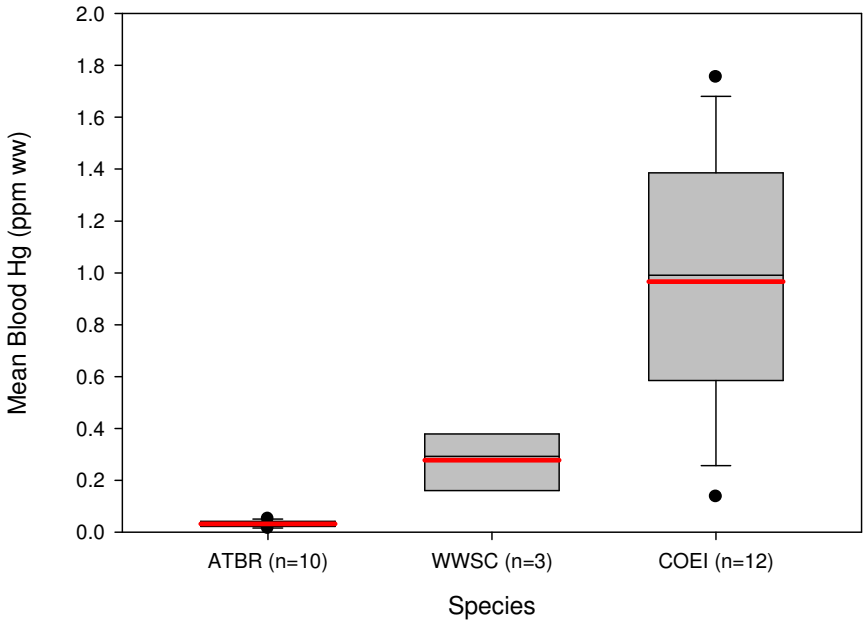

Figure 2. Mean blood Hg concentrations in three species of waterfowl sampled in 2009.

As expected, scoters and eiders contained higher Hg levels that atlantic brant. The two sea ducks are likely feeding on mollusks, while brant would likely be feeding on eelgrass or other saltwater vegetation, which contain less Hg than mollusks.

4.2 Feather

Mercury in feathers provides a more long-term accumulation rate of Hg. Feather Hg can represent 70-93% of the total body burden of Hg (Burger 1993). Feathers reflect a chronic bioaccumulation of MeHg because the entire Hg body burden is not depurated each year, particularly for high risk individuals. Feather Hg reflects blood Hg levels at the time of feather growth (Bearhop et al. 2000), during the molt in adult birds.

Total Hg concentrations in the feather tissue of the three species were also varied. White-winged scoter contained the highest mean feather Hg concentrations of 2.59 (± 1.49) ppm (fw). Common eider sampled contained a mean feather Hg concentration of 1.75 (± 1.09) ppm (fw), while atlantic brant contained the lowest mean feather Hg concentration of 0.28 (± 0.15) ppm (fw) (Figure 3).

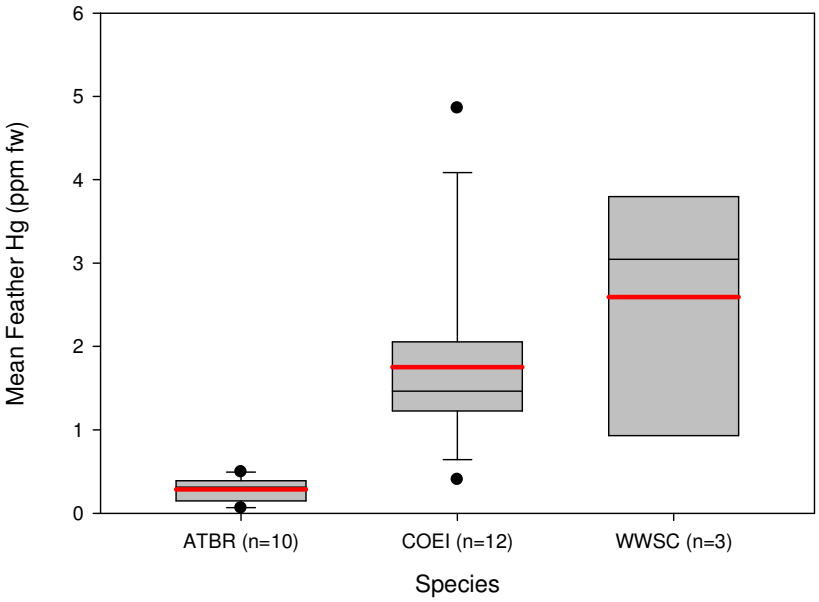

Figure 3. Mean feather Hg concentrations in three species of waterfowl sampled in 2009.

4.3 Common Eider

Blood and feather samples were collected from 12 common eiders (7 male and 5 female). Male eiders contained higher mean Hg levels than females, but were not significantly different (p=0.08). All eiders were aged as after hatch year (AHY) birds and thus no statistical test could be performed between age classes. When analyzing total feather Hg concentrations, no significant difference was detected between sexes (p=0.46).

Table 1. Mean Hg ± standard deviation (SD) in common eider tissues from parker River NWR, MA (2009).

Sex	Blood Hg	Feather Hg
Male	1.12 ± 0.55	2.02 ± 1.29
Female	0.74 ± 0.23	1.37 ± 0.68
Combined	0.97 ± 0.47	1.75 ± 1.09

Table 2. Mean blood Hg concentrations (ppm, ww) of common eiders from Parker River NWR, MA (2009) along with comparison studies of other eider species in Alaska.

Species	Location	Sex	Period	n	Hg	SD	Min	Max	Study
SPEI	Y-K Delta	Combined	Pre-nesting	25	0.13	0.03	0.08	0.18	Folsom et al. 2009
		Female		10	0.12	0.03	0.08	0.16	
		Male		15	0.14	0.03	0.10	0.18	
SPEI	Y-K Delta	Female	Nesting	20	0.07	0.02	0.03	0.11	Folsom et al. 2009
SPEI	Prudhoe Bay	Female	Pre-nesting	6	0.12	0.02	-	-	Wilson et al. 2004
		Male	Pre-nesting	14	0.20	0.01	-	-	
		Female	Nesting	9	0.15	0.02	-	-	
		Female	Brooding	10	0.22	0.03	-	-	
SPEI	Y-K Delta,	Female	Nesting	46	0.14	-	-	-	Grand et al. 2002
		Male	Nesting	10	0.14	-	-	-	
		Female	Hatch	29	0.14	-	-	-	
		Female	Brooding	4	0.15	-	-	-	
COEI	Y-K Delta,	Female	Hatch	11	0.15	-	-	-	Grand et al. 2002
COEI	Plum Island Sound, MA	Combined	Wintering	12	0.97	0.47	0.14	1.76	This Study
COEI	Plum Island Sound, MA	Female	Wintering	5	0.74	0.23	0.54	1.01	
COEI	Plum Island Sound, MA	Male	Wintering	7	1.12	0.55	0.14	1.76	
KIEI	Prudhoe Bay	Female	Pre-nesting	4	0.22	-	-	-	Wilson et al. 2004

Mercury thresholds in eider blood and feather tissues, associated with adverse affects, have not been identified. Several field studies across North America have investigated the presence of Hg in blood and feather tissue of multiple species of eiders on their breeding grounds (Table 2). Results from these studies provide comparison data to levels we found in eiders at Parker River NWR.

Mercury levels in whole blood of common eiders sampled from Parker River NWR contained much higher Hg levels than eiders reported in published literature (Table 2).

4.4 White-winged Scoter

A total of three white-winged scoters were captured and sampled. All individuals captured were females and thus no statistical test could be performed between sexes. The two scoters were aged as after hatch year (AHY) while the other was a second-year (SY) bird.

Table 3. Mean Hg ± standard deviation (SD) in white-winged scoter tissues from Parker River NWR, MA (2009).

Sex	Blood Hg	Feather Hg
Female	0.28 ± 0.12	2.59 ± 1.49

Table 4. Mean blood and feather Hg concentrations (ppm) of white-winged scoters from Parker River NWR, MA (2009) along with comparison studies of other scoter species from Alaska, Maine, and Canada.

Species	Location	Sex	Period	Tissue	n	Hg	SD	Min	Max	Study
SUSC	Alaska	Combined	Molting	Blood	15	0.12	0.04	0.05	0.19	Folsom et al. 2009
				Feather	13	1.48	0.81	0.53	3.12	
		Female		Blood	3	0.16	0.04	0.11	0.19	
				Feather	3	2.48	0.59	1.96	3.12	
		Male		Blood	12	0.12	0.04	0.05	0.17	
				Feather	10	1.17	0.59	0.53	2.33	
WWSC	Alaska	Combined	Molting	Blood	15	0.12	0.03	0.06	0.21	Folsom et al. 2009
				Feather	14	1.60	1.31	0.50	5.08	
		Female		Blood	1	0.11	-	-	-	
				Feather	1	0.76	-	-	-	
		Male		Blood	14	0.12	0.04	0.06	0.21	
				Feather	13	1.66	1.34	0.50	5.08	
WWSC	SK, Canada	Female	Nesting	Blood	141	0.19	0.06	-	-	Wayland pers. com.
SUSC	Quebec	Combined	Pre-nesting	Blood	5	0.23	0.09	0.15	0.37	BRI unpubl. data
				Feather	5	7.42	4.64	2.28	13.93	
BLSC	Alaska	Female	Wintering	Blood	3	0.29	0.13	0.15	0.42	BRI unpubl. data

4.5 Atlantic Brant

A total of 10 atlantic brant (2 male and 8 female) were captured and sampled. There was no significant difference in blood Hg concentrations between sexes (p=0.19). Among the 10 individuals captured, nine were AHY, and one was a SY bird. Between these two age groups, there was no significant difference in blood Hg concentrations (p=0.86). When analyzing total feather Hg concentrations, no significant difference was detected between sex or age class (p=0.12 and 0.12 respectively). When comparing blood and feather Hg concentrations between the two capture locations, no significant difference was determined (p=0.33 and 0.52 respectively).

Table 5. Mean Hg ± standard deviation (SD) in atlantic brant tissues from Parker River NWR, MA (2009).

Sex	Blood Hg	Feather Hg
Male	0.02 ± 0.01	0.14 ± 0.10
Female	0.03 ± 0.01	0.32 ± 0.13
Combined	0.03 ± 0.01	0.28 ± 0.15

Table 6. Mean blood and feather Hg concentrations (ppm) of atlantic brant from Parker River NWR, MA (2009) along with comparison studies of black brant from Alaska.

Species	Location	Sex	Period	Tissue	n	Hg	SD	Min	Max	Study
BLBR	Alaska	Combined	Molt	Blood	15	0.01	0.006	0.004	0.024	Folsom et al. 2009
				Feather	15	0.13	0.06	0.06	0.26	
		Male	Molt	Blood	7	0.01	0.008	0.005	0.024	
				Feather	7	0.14	0.07	0.06	0.26	
		Female	Molt	Blood	8	0.01	0.005	0.004	0.018	
				Feather	8	0.12	0.06	0.06	0.21	
BLBR	Alaska	Female	Nesting	Blood	15	0.01	0.005	0.004	0.026	Folsom et al. 2009
				Feather	15	0.21	0.25	0.03	0.96	
ATBR	Plum Island, MA	Female	Wintering	Blood	8	0.03	0.01	0.02	0.05	This study
				Feather	8	0.32	0.13	0.11	0.49	
		Male	Wintering	Blood	2	0.02	0.01	0.02	0.03	
				Feather	2	0.14	0.10	0.06	0.21	

5.0 Conclusions and Recommendations

This study confirms that waterfowl species wintering in the Parker River and Plum Island Sound areas are accumulating Hg in their blood and feather tissues. While atlantic brant and white-winged scoter blood and feather Hg levels were comparable to those of similar species captured in other locations of North America, Hg levels in common eider captured in Plum Island Sound averaged much higher than any other individuals of the same or similar species captured in other locations cited in this report. As molluscivores, and availability of food, it is likely that common eider in Plum Island Sound are feeding primarily on blue mussels (*Mytilus edulis*). Future sampling of the prey base in the area could determine how Hg levels in eiders are correlated with Hg levels in their prey. Additionally, more extensive sampling throughout the winter season could not only increase sample size in order to better quantify Hg exposure, but potentially allow for comparison between months to determine if average Hg levels vary from the beginning to the end of the winter staging period.

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Appendix 1. List of individuals captured and corresponding total blood and feather Hg (ppm) values.