LETTERS

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Mercury Exposure in Bald Eagles (*Haliaeetus leucocephalus*) Admitted for Rehabilitation in Iowa, USA

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ABSTRACT: To gain insight into mercury exposure in Bald Eagles (*Haliaeetus leucocephalus*) in Iowa, US we collected blood from 22 rehabilitation eagles in 2012–13. The geometric mean blood mercury level was 0.144 μg/g (95% confidence interval: 0.066–0.314) and was at the lower end of the range of levels reported elsewhere.

Bald Eagles (*Haliaeetus leucocephalus*) have undergone a remarkable recovery after their decline in the early 20th century (Broley 1947). After a ban on the use of DDT and associated recovery efforts, eagles across the lower 48 states increased from an estimated 417 nesting pairs in 1963 to 9,789 nesting pairs in 2007 (USFWS 2007). There is continuing concern about Bald Eagle exposure to environmental contaminants (Harmata 2011; Rutkiewicz et al. 2011). Mercury, for example, is a neurotoxin with negative effects on bird health (Eisler 1987; Rutkiewicz et al. 2011). High levels of mercury in birds have been associated with neuronal degradation, impaired motor skills, and decreased reproductive success (Spalding et al. 2000; Burgess and Meyer 2008). Evers et al. (2005) found that Bald Eagles were among the species with highest risk in aquatic systems. We assessed mercury exposure in Bald Eagles in Iowa, US.

The Bald Eagle is resident in Iowa year-round. It is most common along stretches of major rivers where a series of locks and dams prevents the water from freezing and fish remain available. Nesting Bald Eagles in Iowa have increased from one nesting pair in 1977 to >256 active territories in 2015 and the number of wintering eagles is in the thousands (Shepherd 2015). Bald Eagle numbers peak in Iowa between November and February, when migrants arrive from their breeding grounds to the north (Jackson et al. 1996). Bald Eagles nest in Iowa from late January through July, with nests concentrated in the northeast along the Mississippi River. Eagles also nest at lower densities along river corridors throughout the remainder of Iowa (Shepherd 2015).

From 2012 through 2013, three raptor rehabilitation centers in Iowa collected blood samples from Bald Eagles using Capiject T-MQK 500-μL tubes with 0.78-mg of K_2-ethylenediaminetetraacetic acid (Terumo Medical Products, Somerset, New Jersey, USA) regardless of the reason for admittance and before treatment. Two vials of blood were collected from the ulnar vein. Blood samples were stored frozen until tested by the Iowa State Hygienic Laboratory (SHL). Sampling was conducted under the permission of the rehabilitators' licenses.

To determine mercury concentrations in blood, approximately 0.5 mL of whole blood was combined with 10 mL of deionized water and 2.5 mL of concentrated nitric acid in a 50-mL polypropylene digestion tube and heated in a hot block at approximately 95 C until volume was reduced to 5 mL. Samples were removed from the hot block and allowed to cool to room temperature before adding 0.5 mL of hydrogen peroxide (35%). Samples were reheated until volume was reduced to 2 mL. After cooling, samples were diluted to 25 mL using deionized water. Inductively coupled plasma mass spectrometry (Perkin-Elmer ELAN DRC II, Waltham, Massachusetts, USA) was used to analyze the blood samples. Calibration of instrument response was accomplished using external standards. Check standards, reference materials, and reagent blanks were used to evaluate accuracy. Mercury concentrations for blood were reported in micrograms per gram wet weight with a quantitation limit of 0.002 μg/g, below which mercury could not be reliably mea-

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sured. For analysis, we assigned samples with mercury levels below the quantitation limit a value equal to one-half the quantitation limit following Wiemeyer et al. (1989). We calculated the geometric mean, 95% confidence interval (CI), and range for blood mercury levels.

We obtained blood mercury levels for 22 rehabilitation Bald Eagles in Iowa in 2012 and 2013. Samples were collected in January (6), February (5), March (5), June (1), November (1), and December (4). All but one eagle (95%) had mercury levels above the quantitation limit. The geometric mean blood mercury level was 0.144 μg/g (95% CI: 0.066–0.314, range <0.002–2.071). All 95% CI for months in which we had more than one sample overlapped.

Mercury levels in blood from rehabilitation Bald Eagles in Iowa were at the lower end of the range detected in Bald Eagles elsewhere (e.g., Wiemeyer et al. 1989; Anthony et al. 1993; Harmata 2011). For example, blood mercury levels in rehabilitation and free-flying Bald Eagles from Montana were higher (geometric mean=0.544 μg/g; Harmata 2011). Mean blood mercury levels in free-flying Bald Eagles from California, Montana, and Oregon were also higher (geometric mean=1.2–3.0 μg/g; Wiemeyer et al. 1989). However, these studies took place in different areas of the country and, in two cases, more than 2 decades before ours. Environmental and land use differences and changes over time might explain the differences in findings. No adverse effect levels have been defined for Bald Eagles. General mercury toxicity criteria for birds developed by Ackerman et al. (2016) on the basis of a synthesis of toxicity studies suggest that blood mercury levels <0.2 μg/g (11/22 of our samples, 50%) are below any known effects. Levels of 0.2–1.0 μg/g (8/22, 36%) and 1.0–3.0 μg/g (3/22, 14%) are considered to have a lower and moderate risk of mercury toxicity, respectively. None of our samples had mercury levels that would place them in the high or severe risk categories. Weech et al. (2006) found blood mercury levels higher than we observed in nesting eagles in British Columbia in good body condition exhibiting no obvious signs of impairment.

Although Harmata (2011) did not find a difference in blood mercury levels between free-flying and rehabilitation eagles in Montana, mercury levels in rehabilitation birds may not be representative of the free-flying population. Rehabilitation birds are already compromised and their exposure to contaminants and the impacts of those contaminants may differ from healthy free-flying birds. In addition, our small sample size limited our ability to draw inferences about the larger, free-flying Iowa Bald Eagle population. Additional samples, particularly from free-flying eagles, will be important for future monitoring of mercury exposure.

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