Florida Scientist

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

THOMAS J. MANNING, *Editor* DONNA L. GOSNELL, *Co-Editor*

Volume 76 Winter, 2013 Number 1

Biological Sciences

TOTAL MERCURY CONCENTRATIONS IN FLORIDA BLACK BEARS (*URSUS AMERICANUS FLORIDANUS*)

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ABSTRACT: *Increased anthropogenic loading of mercury (Hg) has caused elevated levels in biota. Tissue samples were collected from Apalachicola in 1995 and Chassahowitzka in 1997 and analyzed by Florida Department of Environmental Protection for total mercury. Hair collected from four individuals within the Chassahowitizka subpopulation had a mean mercury concentration of 0.673 ± 0.281 µg/g and a body-weight weighted mean concentration of 0.712 µg/g. Whole blood collected from 21 Apalachicola bears had a mean mercury concentrations of 0.050 ± 0.003 µg/g with a body-weight weighted mean concentration of 0.052 µg/g. To our knowledge this is the first report of Florida black bear blood and hair Hg concentrations. A baseline for Hg levels in Florida bears is important to assess potential risk of mercury exposure to other populations of black bears throughout its range.*

Key Words: Florida black bear, mercury, pollutants, *Ursus americanus floridanus*

METALS, particularly mercury (Hg) are non-biodegradable and do not breakdown in the environment; however, heavy metals can be transformed through microbial bio-transformation, oxidation or reduction. This often makes them more bioavailable and more toxic. Once Hg and Hg compounds have been deposited to the sediment they potentially have long residence times before they are transported out of the system, and depending on what form

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they are in, tend to be highly bio-available in aquatic habitats (Hopkins et al. 2007). Furthermore, mercury biomagnfiies, increasing in concentration from one trophic level (e.g. prey) to the next (e.g. predator) due to accumulation from multiple contaminated food items (Wren 1986).

A sub-species of the black bear (*Ursus americanus floridanus*) occurs in Florida and southern portions of Alabama and Georgia; in Florida it has been isolated in nine disjoint populations throughout the state. The general diet of black bears is predominately vegetation, hard mast (reproductive parts of woody plants) and fruits (Florida Fish and Wildlife Conservation Commission [FWC] 2010); which potentially contains very little Hg (Felicetti et al. 2004). A vegetative dominate diet places black bears at a lower trophic level than other bear species and potentially lower exposure to Hg with the expectation that black bears would exhibit relatively lower concentrations of Hg in tissue samples.

This note presents the Hg concentration in bear tissue samples collected as part of larger studies of the Chassahowitzka (Maehr et al., 2003), and Apalachicola (FWC, unpublished data) sub-populations.

STUDY AREA—Samples were collected by FWC from two areas within Florida. The Chassahowitzka subpopulation (hereafter identified as CH) is located in west central Florida, existing mainly on contiguous public lands composed primarily of pine (*Pinus* spp.) flatwoods, hardwood hammocks, wetland forests, scrub and herbaceous (both freshwater and saltwater marshes) communities (Maher et al. 2003). The Chassahowitzka area supports a very small and isolated black bear population of approximately 20 bears covering 374.8 km^2 of primary habitat (breeding) and 609.8 km^2 of secondary habitat (non-breeding) (FWC 2005, FWC 2010).

The Apalachicola subpopulation (hereafter identified as AP) is located in northern Florida and is predominately pine (*Pinus* spp.) flatwoods interspersed with hardwood swamps, ericaceous shrub dominated by titi (*Cliftonia monophylla*) and scrub habitat. Additionally the area that the Apalachicola subpopulation inhabits is surrounded by industrial timberlands extensively used for silviculture (Seibert 1995). The Apalachicola area supports approximately 438–695 bears covering 9898.7 km^2 of primary habitat (breeding) and 1538.8 km^2 of secondary habitat (non-breeding) (FWC 2005, FWC 2010).

MATERIALS AND METHODS—Whole blood samples were collected from live-captured AP bears between June and August of 1995 and hair samples from CH bears were collected between October and December of 1997. Age in years was estimated by extracting the first premolar tooth and aged by cementum analysis (Matson's Laboratory, LLC, Milltown, Montana). Hg concentrations were determined by the Florida Department of Environmental Protection (FDEP) Chemistry Laboratory in Tallahassee, Florida. Samples were digested and analyzed using United State Environmental Protection Agency Method 245.6 (United State Environmental Protection Agency 1991). Descriptive statistics including mean and standard error as well as body-weight weighted mean concentrations were computed by multiplying each individuals Hg concentration by bodyweight, totaling all individuals, then dividing by the total bodyweight of all individuals.

RESULTS—Hair samples were collected from four CH black bears (1 Male, 3 Female) ranging in approximate age between five and eleven years of ages and ranged in bodyweight between 83.9 kg to 111.1 kg. Mean hair Hg concentrations for CH black bears ranged from 0.270 μg/g to 1.50 μg/g with a mean of 0.673 ± 0.281 μg/g (n = 4, Range = 1.230 μg/g) and body-weight weighted mean hair Hg concentration was 0.712 μg/g. Whole blood samples were collected from 21 AP black bears (14 Male, 7 Female) ranging in approximate age between one and ten years of age, and ranged in bodyweight between 33.6 kg to 175.1 kg. Mean whole blood Hg concentration for AP bears was 0.050 ± 0.003 μg/g (n = 21, Range = 0.068 μg/g) and body-weight weighted mean whole blood Hg concentration was 0.052 μg/g.

DISCUSSION—To our knowledge, there are no published reports of tissue Hg concentrations from the Florida black bear and very few reports of mercury concentrations from other black bear populations (Benson et al. 1974). Mean hair Hg concentrations from Florida black bear were higher than values reported from Idaho (0.182 ± 0.035 μg/g, n = 4; Benson et al., 1974); however, these results can only be used to qualitatively compare Hg concentrations because of small samples sizes in both studies (this study N = 4, Benson et al. 1974 N = 4), potentially differences in ages and samples were taken during different periods. However, when comparing black bear hair mercury concentrations from west-central Florida to other wildlife within southern Florida, one can see differences in hair Hg concentrations (raccoon, (*Procyon lotor*): mean 10.6 μg/g Porcella et al. 2004; Florida panther (*Puma concolor coryi*): mean 2.45 μg/g Newman et al. 2004; Florida panther: range 0.20–82.00 μg/g Roelke et al. 1991), which could be explained by reduced Hg loading and methylation potential to north Florida in relation to southern Florida (Guentzel et al. 2001, Hammerschmidt, et al. 2005), potential reduced exposure to Hg, or both of these factors.

Hair or fur Hg concentrations provides an estimate of prolonged Hg exposure and typically is higher than any other sample type, however blood Hg concentrations provide a snapshot of short term exposure (Wren 1986). Unfortunately comparison of Florida black bear blood mercury concentrations to other bear populations is not possible. Blood Hg concentrations in black bear are relative low in comparison to Florida panthers occupying the northern areas of its range (1978–1991: 0.10 ± 1.15 μg/g, 2000–2007: 0.13 ± 0.03 μg/g; Axelrad et al. 2011) and other wildlife species elsewhere (Shenandoah River, Virginia: Wren (*Thyrothorus ludovicianus*) 8.76 ± 2.12 μg/g, woodpeckers (*Picidae* spp.) 2.38 ± 1.31 μg/g; Cristol et al. 2008). Low blood Hg concentration is most likely due to limited exposure to Hg within it environment. Relatively low atmospheric deposition (Guentzel et al. 2001, Hammerschmidt, et al. 2005) in combination with a reduced risk of excessive Hg exposure within the environment (Hemming and Brim 2002) explains the relatively low blood Hg concentrations.

Generally it is understood that methyl Hg (MeHg) is the chemical species of Hg that readily bioaccumulates in wildlife through trophic transfer and direct exposure. However Hg methylation and bioaccumulation dynamics are still loosely understood (Rumbold et al. 2002). Bioaccumulation of Hg in lake ecosystems tends to be dependent on lake chemistry (pH, alkalinity and trophic state; Lange et al. 1993 and Wood et al. 1996). North Florida lake Hg fish tissue concentrations from largemouth bass (*Micropterus salmoides*) are relatively lower than values reported for central and southern Florida lakes (Lange et al 1993). Similar to lake ecosystems bioaccumulation of Hg in wetland ecosystems is dependent upon water column and sediment chemistry (sulfur and organic carbon concentrations) as well as sediment structure, and microbial communities (Selin 2009).

Between species variations in tissue Hg concentrations often represent differences in trophic levels or diet (i.e. carnivore, herbivore, piscavore, etc.; Wren 1986). Additionally trophic transfer of mercury typically is indicated by a strong relationship between mercury concentrations in lower trophic level organisms and top level predators (Lange et al. 1994). Generally, black bears feed at both the lower and upper level of the food chain by relying on insects and small mammals for most protein sources in most areas of their range. The Florida black bear's diet is generally weighted toward vegetation and is seasonally driven, with hard mast consumption dominating in the fall, herbaceous vegetation and insects during the spring and soft mast food items consumed during summer months (Ulrey 2008, and Maher et al. 1984). Studies have determined that little mercury accumulates within plant (United States Geological Survey 1970, Felicetti et al. 2004) and insect (Cristol et al. 2008) species and north Florida exhibits significantly less Hg atmospheric deposition (Guentzel et al. 2001, United States Environmental Protection Agency 2008). Thus black bears located within northern and west-central Florida have very little exposure to mercury and exhibit a small range of mercury concentrations within tissues.

Acknowledgments—We would like to acknowledge both past and current Florida Fish and Wildlife staff that collect and continue to collect valuable data on Florida's wildlife. We would like to thank Dr Darren Rumbold for his critical review of the draft version of this manuscript.

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Florida Scient. 76(1): 1–6. 2013