Mercury (Hg) Accumulation in Insectivorous Birds and Invertebrates in Southeast Missouri

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Despite the knowledge of high mercury (Hg) availability in the fish of Missouri and the ability of mercury to transfer to terrestrial food chains, no studies have been published documenting Hg exposure in terrestrial organisms in the state. In an effort to fill this gap in knowledge, my project compared concentrations of mercury in songbirds and invertebrates in wetland and non-wetland habitats, the effects of mercury concentrations on songbird reproductive success, and mercury concentrations of invertebrates between three geographically distinct wetland sites.

My project focused on songbirds that breed in nest boxes due to the ability to monitor nests in known locations and the ease of collecting samples from nest boxes. Tree swallows (*Tachycineta bicolor;* TRES) were selected as a study organism because of their affinity to feed on emergent aquatic insects, such as damselflies and mayflies. While eastern bluebirds (*Sialia sialis;* EABL) were selected because they can inhabit similar habitats as tree swallows, but feed primarily on ground invertebrates, such as caterpillars and grasshoppers. Blood and feather samples were collected from the songbirds to examine mercury concentrations and nests were monitored to study the effects of mercury concentrations on reproductive success. Invertebrates were also collected to examine the availability of mercury at a lower trophic level.

The project began in the spring of 2016 when songbird nest boxes, built according to the standard eastern/western bluebird nest box design, were erected at a wetland site: Duck Creek Conservation Area in Puxico County, Missouri. Seventy-seven nest boxes were distributed between three distinct geographic locations at Duck Creek: Moist Soil A, Field 1, and Pool 1/ Pool 2 in hopes of comparing mercury concentrations among songbirds in the three sites. However, uneven distribution of occupied nest boxes between subsites prevented the comparison of bird mercury concentrations among the subsites at Duck Creek. In 2017, a non-wetland site close to Duck Creek, in Wayne County, Missouri, was added to the project. The site belonging to a private land owner and referred to as the “Hams” was composed of actively managed forests, cow pastures,

patches of un-grazed grasslands, and small ponds. When the property was added to this research project, it already had existing nest boxes that had been established for 5 to 15 years. With the addition of new nest boxes, the Hams site had a total of 42 nest boxes. In addition to these sites, I was able to opportunistically collect samples from 22 nest boxes that were part of an unrelated research project, located at a non-wetland site, Johnson's Shut-in State Park in Reynolds County, Missouri.

Invertebrates were collected from both terrestrial and aquatic ecosystems at Duck Creek and the Hams. At Duck Creek, the invertebrates were collected from three subsites: Moist Soil A, Field 1, and Pool 1/ Pool 2. Moist Soil A is a marsh that is seasonally flooded, Pool 1 is largely composed of a permanent lake with seasonally flooded bottomland forest in its northern portion and in Pool 2, and Field 1 is a meadow that contains several small seasonal wetlands. There were 11 orders of invertebrates collected: spiders, beetles, flies, mayflies, true bugs, butterflies/moths, dobsonflies, dragonflies/ damselflies, grasshoppers and close allies, stoneflies, and caddisflies. These orders were further broken down into 24 families.

Analysis of bird tissue over the two seasons found songbirds had higher mercury concentrations at the wetland site compared to the

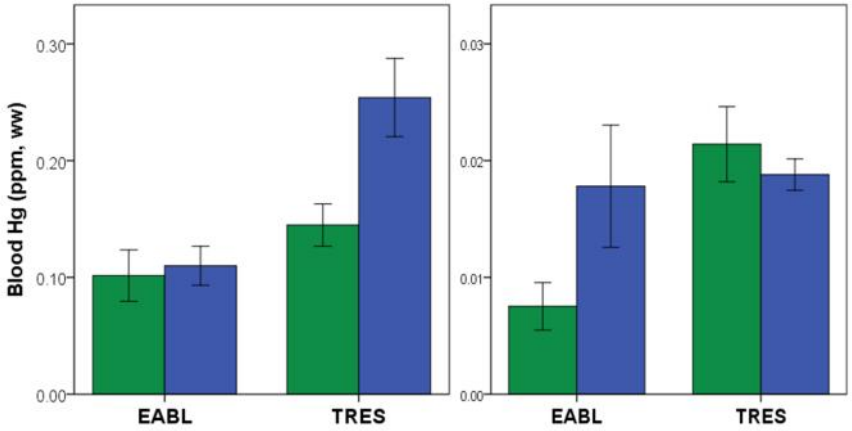

Figure 1. Blood mercury concentrations in adult EABL and nestling TRES did not differ by habitat type (non-wetland = green; wetland = blue). However, blood mercury concentrations in adult TRES and nestling EABL were significantly higher in wetlands compared to non-wetlands ($p<0.001$). The same letter over two bars indicates similar Hg concentrations. Error bars show 95% CI.

non-wetland sites, adult songbirds had higher concentrations than nestlings, and tree swallows had higher concentrations than eastern bluebirds (Fig. 1) All mercury concentrations were below the established lowest observable adverse effects levels of mercury for songbirds, of 0.7 ppm blood mercury associated with a 10% reduction in nest success (Jackson et al. 2011). As expected with the low concentrations of mercury found in the songbirds, it was found that there was no significant relationship between mercury concentrations and reproductive success.

Analysis of invertebrates found that mercury concentrations did not differ between wetland and non-wetlands. However, concentrations did differ among the three wetland subsites at Duck Creek. Concentrations tended to be highest in the Moist Soil A area when

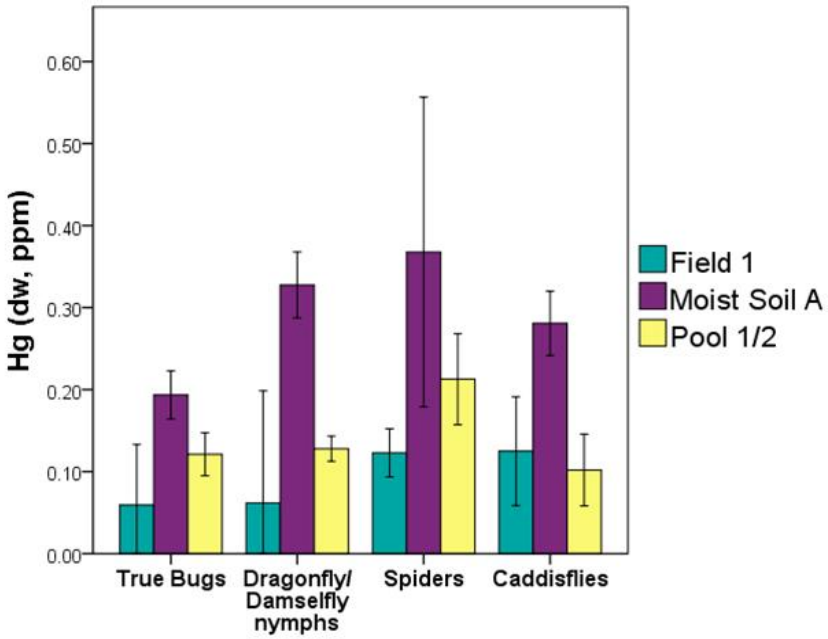

Figure 2. Mercury concentrations in true bugs (Order: Hemiptera), dragonfly/ damselfly nymphs (Order: Odonata), spiders (Order: Araneae) and caddisflies (Order: Trichoptera) varied among the subsites at Duck Creek ($p<0.001$). The invertebrates in these orders were found to have the highest mercury concentrations when they were collected from the Moist Soil A subsite. Error bars show 95% CI.

compared to the Pool 1/ Pool 2 and Field 1 subsites (Fig. 2). Another finding among the invertebrates was that predaceous orders and

families of invertebrates tended to have higher mercury concentrations compared to herbivorous invertebrates. This is likely due to herbivores having shorter food chains and predators having longer food chains, resulting in more opportunities for mercury to be biomagnified. The order with the highest average mercury concentration was the dragonfly/damselfly juveniles, and the order with the lowest concentrations was the order with grasshoppers and their allies. At the family level, giant water bugs, damselflies, Japanese beetles, and nursery web spiders had the highest mercury concentrations, while shield bugs, grasshoppers, katydids, leafhoppers, and soldier beetles had the lowest average mercury concentrations.

This project assessed the availability of mercury at a few sites in southeast Missouri and found mercury concentrations to vary in songbirds between wetland and non-wetland sites. Invertebrates did not show a difference in mercury concentrations between sites, but did have varying concentrations of mercury based on the subsite they were collected from in Duck Creek. Overall the mercury concentrations found in songbirds and invertebrates in my study are comparable to those from previous research at uncontaminated sites. This is good news for the birds at this project's study sites in southeast Missouri, as they are likely not being negatively impacted by the mercury in the area. However, this project did open up some ideas that warrant further study such as the need to collect environmental samples (i.e. water and soil) to begin to understand the total availability of mercury at each site and the need for further research on the driving forces behind the variation in mercury concentrations among the subsites at Duck Creek.

Literature Cited

Jackson AK, Evers DC, Etterson MA, Condon AM, Folsom SB, Detweiler J, Schmerfeld J, Cristol DA (2011) Mercury exposure affects the reproductive success of a free-living terrestrial songbird, the Carolina Wren (Thryothorus ludovicianus). Auk 128:759–769.

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