Introduction

Mercury (Hg) contamination in aquatic and terrestrial ecosystems is a widespread issue that poses considerable reproductive, behavioral and physiological risks to wildlife populations. Songbirds are now recognized as indicators of mercury in terrestrial ecosystems, where invertebrate foodwebs biomagnify methylmercury (MeHg) to levels that can adversely affect reproductive success. With changing trends to Hg emissions regulations, understanding how MeHg bioavailability currently varies across the landscape is important for quantifying the effects of these changes. Building upon 13 years of mercury research in New York State, a five-year project was initiated in 2013, to identify at-risk songbird species, classify sensitive habitat types, and to assess spatial and temporal trends of mercury across a variety of ecosystems. To date, a total of 1,347 blood and feather samples have been collected and analyzed from songbirds across the state. This project focuses on: (1) annual sampling and monitoring at established study sites (Adirondack Mountains, Catskill Mountains, and Long Island) to evaluate temporal patterns in songbird mercury exposure; (2) analysis of museum specimens to quantify trends in Hg exposure over the 20th Century; (3) sampling new sites statewide to identify additional mercury hotspots and inclusion into a predictive map documenting spatial gradients of methylmercury availability; and (4) linking mercury exposure with trophic position and diet using stable isotopes of carbon and nitrogen.

Preliminary Findings

1. Preliminary modeling efforts reveal that songbird blood Hg varies widely by species and region in New York State. From 2013-2015, a total of 1,347 songbird blood and feather samples, from 87 species, have been collected and analyzed to document mercury exposure from various regions and habitat types across New York State. Species estimates have documented the highest Hg levels in: Carolina Wren; Northern Waterthrush; Saltmarsh Sparrow; Eastern Phoebe; Red-winged Blackbird; and Yellow Palm Warblers. Alternatively, low Hg values were found in species, such as: Slate-colored Junco; Hairy and Downy Woodpecker; Purple and House Finch; and Cedar Waxwing. Utilizing these data to parameterize predictive models will aid regulators and researchers in their efforts to better identify and minimize the ecological risks that mercury poses to wildlife.

2. Establishing temporal trends in songbird mercury exposure will further assess the effectiveness of atmospheric Hg emissions regulations. Current blood Hg data indicate minimal variation among years across all sites. Our research will continue to monitor and evaluate changes at small spatial scales.

Study Sites

From 2013-2015, 33 sites were sampled across New York State at locations in the Adirondack Mountains, Catskill Mountains, Tug Hill/SI, Lawrence River Region, Lake Ontario/Finger Lakes, Albany Region, New York City suburbs and Long Island. Sites were selectively targeted based on data collected from previous Hg research, habitat type and sensitivity, and geographic location.

Methods

Mercury concentrations in songbird blood reflect recent dietary uptake. Therefore, samples collected during the breeding period represent a bird’s mercury exposure within its breeding habitat. All capture and sampling efforts were conducted using nonlethal, mist-netting techniques, which includes decoys and playback calls to encourage a territorial response. Once captured, each bird was banded, blood and feather samples were collected, and age, sex, reproductive status, wing chord length, tarsus length, mass and fat score were determined.

Songbird blood and feather samples were analyzed for Hg at BRRI’s Wildlife Mercury Research Lab in Portland, Maine. Bird blood was analyzed for stable carbon (13C) and nitrogen (15N) isotopic concentrations at Boston University, and archived museum feather specimens from the Harvard Museum of Natural History were analyzed by the Harvard School of Public Health in Boston, Massachusetts.

3. Mercury levels vary across the landscape based on environmental availability and habitat type. Preliminary results suggest that birds in New York City and Long Island salt marshes have the highest concentrations of mercury exposure in the state, followed by wetland and upland forested songbird species at Finger Lakes and Adirondack Mountain sites.

Future Directions

- Continued sampling efforts at core monitoring sites to assess spatial and temporal trends in songbird Hg levels
- Sampling of supplemental locations, targeting sensitive habitat types and avian species of concern, to identify new biological mercury hotspots
- Analysis of archived museum feather specimens to evaluate historical patterns and trends in mercury exposure
- Document and assess the food web links between mercury biomagnification and relative trophic position using carbon (13C) and nitrogen (15N) stable isotope signatures
- Utilize collected data to map gradients of methylmercury availability across New York State

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Figure 1. Locations of bird sampling in New York State: 2013 – 2015.

Figure 2. Conditional mean blood Hg concentrations (ppm) with 95% confidence intervals for songbird species by region in New York State.

Figure 3. Conditional mean blood Hg concentrations (ppm) with 95% confidence intervals for songbird species between regions in New York State.

Figure 4. Conditional mean log blood Hg concentrations (ppm) with 95% confidence intervals for songbird species regions in New York State.