

Determining Sources of Mercury Contamination within Terrestrial Habitats in the Adirondack Park of New York State

Principal Investigator: David Evers

Affiliation/Institution: Biodiversity Research Institute

Email: david.evers@briwildlife.org

Mailing address: 276 Canco Rd., Portland, ME 04103

Co-Principal Investigators: Evan Adams and Amy Sauer

Affiliations/Institutions: Biodiversity Research Institute

Emails: evan.adams@briwildlife.org, amy.sauer@briwildlife.org

Collaborators and Affiliations:

Jason Demers, University of Michigan

Completion date: Pending

Key Findings:

- Mercury exposure risk varies with elevation and food web in songbirds
 - More information is needed on sources of mercury

Funding support for this project was provided by the Northeastern States Research Cooperative (NSRC), a partnership of Northern Forest states (New Hampshire, Vermont, Maine, and New York), in coordination with the USDA Forest Service.

<http://www.nsrcforest.org>

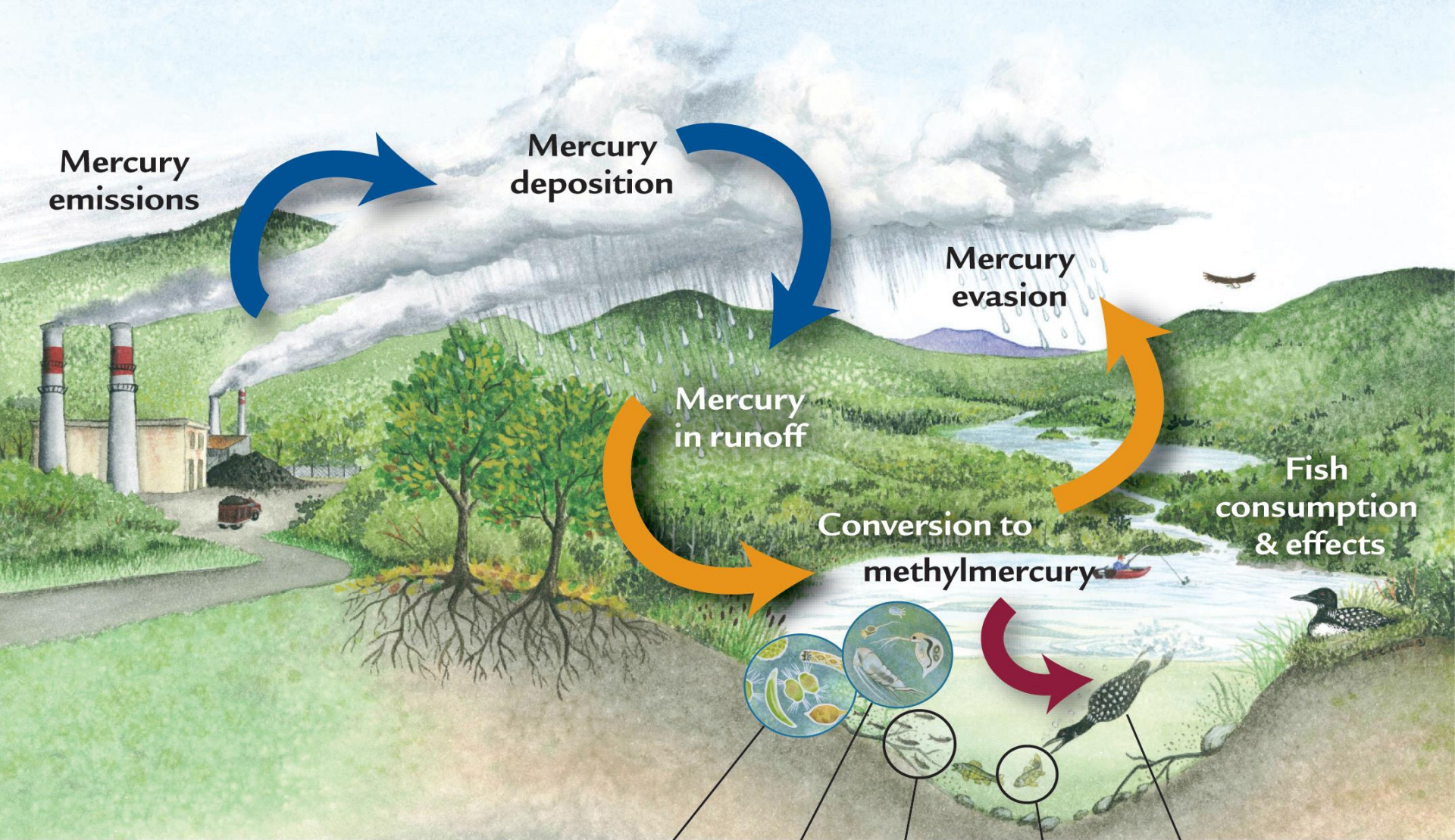
Project Summary

Mercury is a global contaminant that adversely affects both humans and wildlife through neurological, immunological, and endocrinological mechanisms. After 50 years of studying the effects of mercury on birds, fish, and the environment, scientists have begun to understand how mercury moves through ecosystems and species at greatest risk. Past research has found that mercury exposure increases through the food chain, thus having the greatest effects on predators. Habitat also contributes to mercury exposure with wetlands and other wet habitats associated with elevated concentrations.

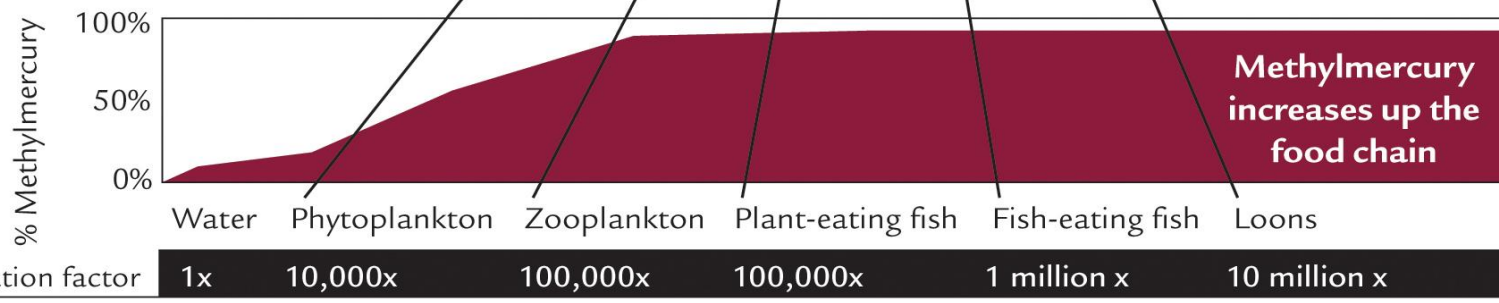
However, scientists have less information on songbird species and the types of conditions that affect their exposure risk. Using data from 81 songbird species, NSRC researchers focused on how habitat, climate, and food chain influenced mercury exposure across New York State. In sum, they found that all of these things mattered to mercury exposure in songbirds. While exposure could vary by region and species, wetlands were linked to increased mercury exposure. Furthermore, climate at sites also affected these processes with increased mercury exposure associated with warmer temperatures. Finally, an individual eating higher on the food chain was exposed to more mercury. Thus, a combination of factors contributes to mercury exposure across the songbird community, and local conditions are critical to determining adverse effects.

More research is ongoing on the importance of food webs and mercury origins in the Adirondack mountains. Mercury exposure risk is high in these habitats for aquatic birds like Common Loons as well as wetland specialists like Palm Warblers. We also found mercury exposure varied across elevation gradients in the Adirondacks, with the highest exposure levels occurring at middle elevations for various thrush species. Taken together, we find these results suggest that local habitat is an important determinant for songbird mercury exposure and exposure rates changes across the mountains.

A missing component of this research is understanding how mercury enters these ecosystems and makes its way into these diverse communities. Mercury arrives from distant sources in the Adirondacks, so understanding how mercury enters the system and where it is methylated to bioaccumulate is essential to understanding how to limit mercury exposure for wildlife. With more research on mercury origins via stable isotopes, we hope to answer these questions in the future.



Bioaccumulation of methylmercury in fish & wildlife



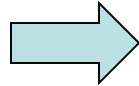
Methylmercury increases up the food chain

Invertivore wildlife as indicators of Hg

High Hg-methylating wetlands

High MeHg invertebrates

High trophic level wildlife



Study Objectives

1. Determine the relationship between Hg exposure in northern forest songbirds with habitat and food webs
2. Identify the local and regional origins of songbird Hg exposure and how Hg exposure moves through northern forest ecosystems

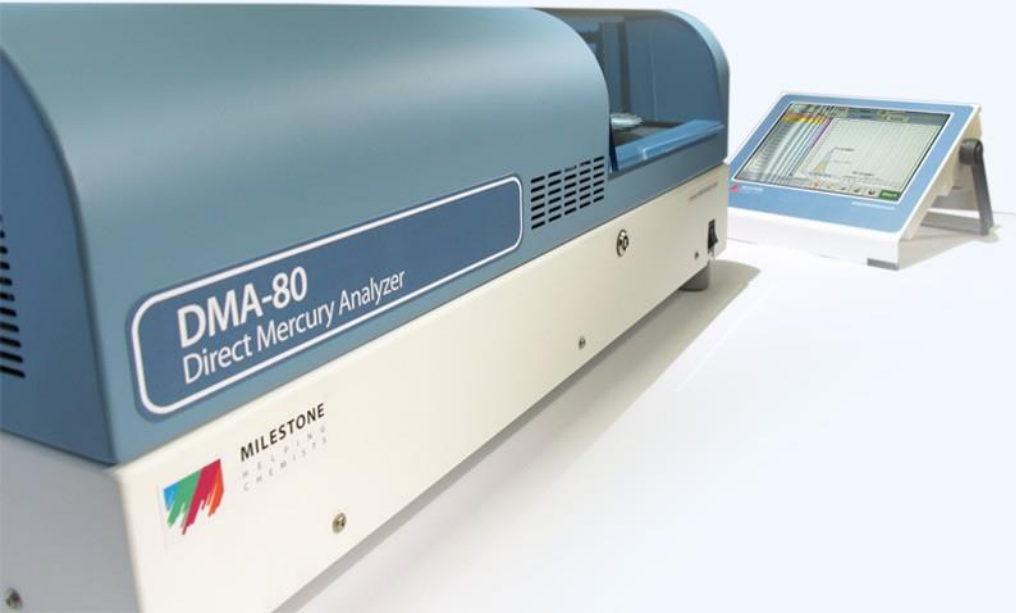
Sampling Methods

- Study sites are sampled for birds to maximize capture rate and species diversity
 - Once captured, tissue samples are collected for each individual
- Water, leaf litter, and invertebrates are also collected at each site
 - Different methods for each to target specific species and prevent matrix contamination



Laboratory Methods

- Mercury determination
 - EPA Method 7473(SW-846)
- Mercury stable isotope determine (in



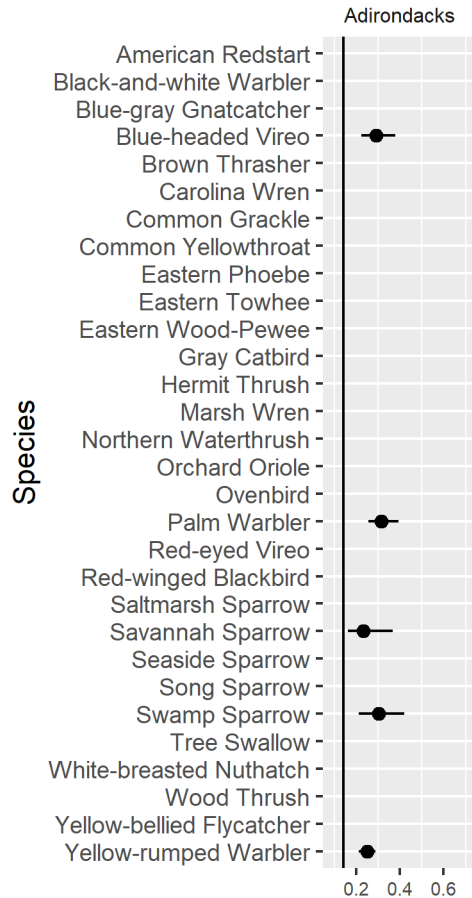
Statistical Methods

- General linear mixed modeling
 - Determines how tissue Hg levels are related to habitat, elevation, and Hg in other sampled endpoints
 - Allows us to capture uncertainty in avian Hg exposure from unknown sources of variation (i.e., unobserved differences in sites) as well as known sources (differences in elevation or habitat among sites)
 - Integrates information across species such that we can assess Hg exposure and origins across the songbird community

Provisional Results

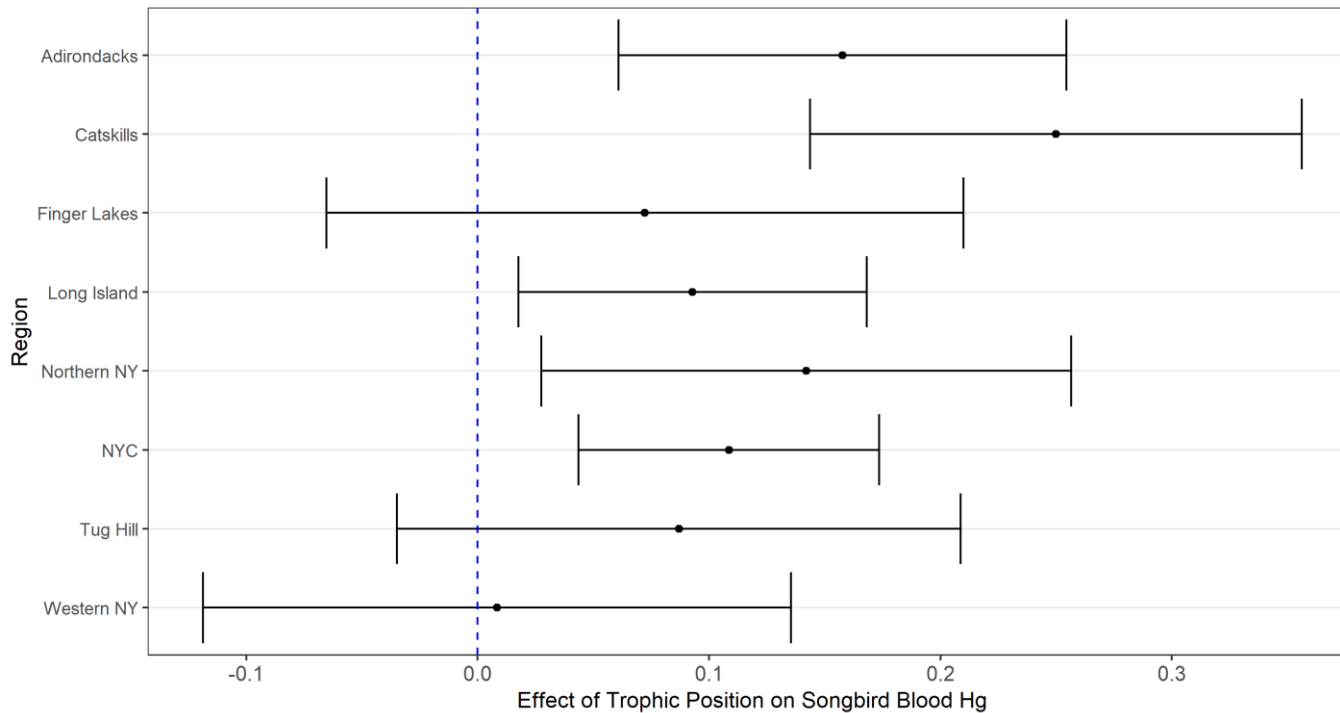
- Bulleted lists and tables are fine
- Include the level of detail you would give in a presentation for a town meeting
- Use the notes feature for additional detail if needed
- We encourage the use of illustrations (photographs, maps, graphs, diagrams, etc.) - include descriptive captions
- Include citations (as footnotes if you wish)
- Include up to 6 slides for this section
- 1-2 slides should address outreach efforts

Provisional Results



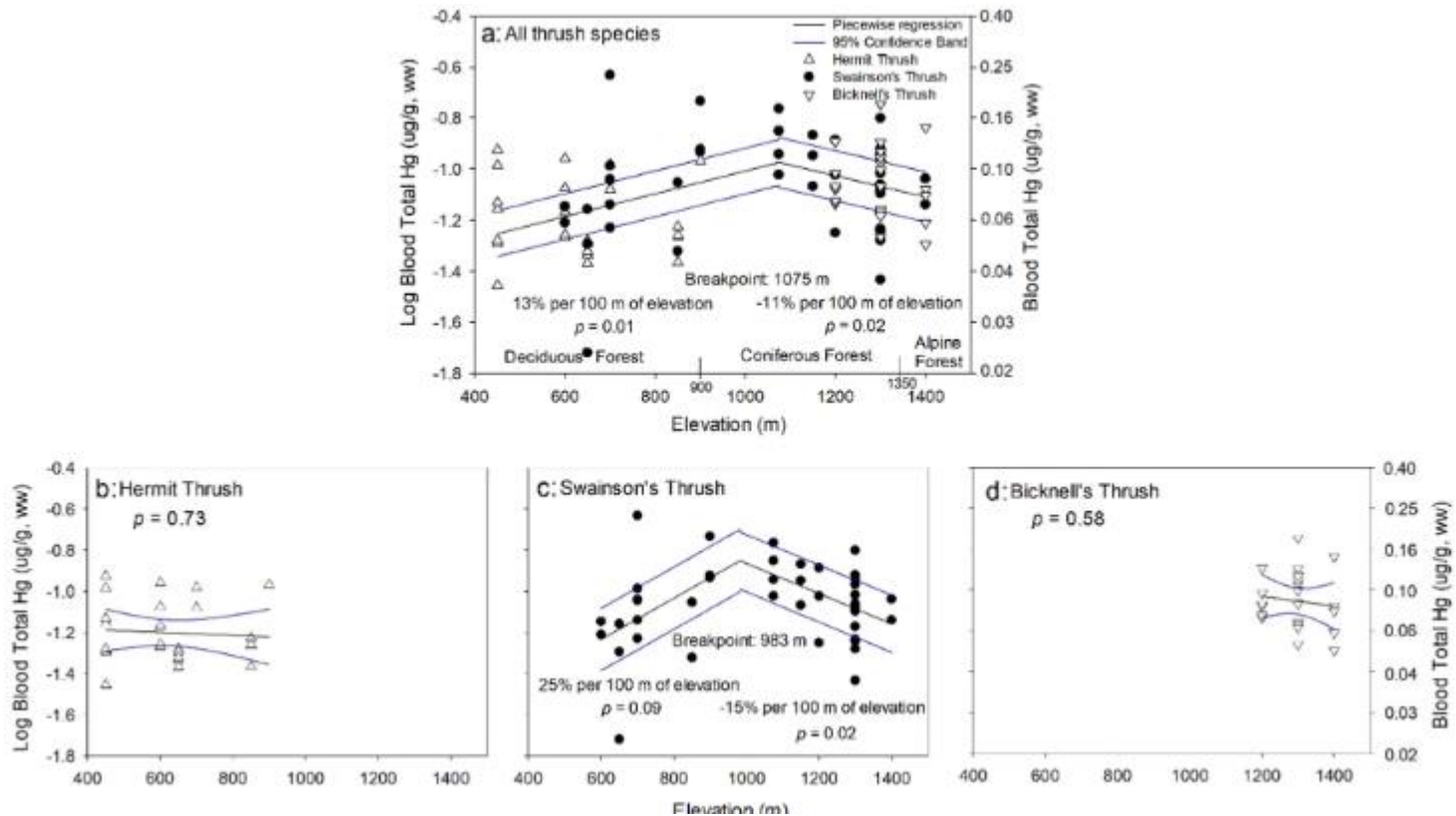
- In statewide surveys, we found that several songbird species showed higher than average exposure
- Most of these species occupied wetland habitats and suggested links between upland bogs and high mercury exposure

Provisional Results



- In a statewide comparison, we found that trophic position was strongly associated with mercury exposure in the Adirondack Mountains
- This suggested that biomagnification was an important effect in this region

Provisional Results



- We found that Adirondack thrush species showed changes in mercury exposure across an elevational gradient
- Exposure peaked at middle elevations that was likely linked to habitat methylation potential and mercury input

Provisional Results

- Results from mercury stable isotope data will be added once analysis is complete
- We expect these data to provide more information on biomagnification and the factors that promote it as well as identifying sources of mercury for these birds

Outreach Efforts

- BRI conducts outreach efforts with local conservation groups where we discuss the effects of Hg on birds and how we can improve avian health
- As a part of the Minamata Convention on Mercury, BRI is working to include songbirds and songbird habitat in future mercury monitoring and effects research

Implications and applications in the Northern Forest region

- These results show the extent of mercury exposure to northern forest songbirds
 - Many invertivores were affected, particularly if they inhabited wetland bogs
- Using these data we can better estimate risk for songbird populations in the northern forest and incorporate mercury exposure risk into population viability models
- As we become better at identifying local and global sources of mercury in ecosystems, we can more informed decisions about what management actions can be take to limit exposure in remote regions like the northern forest

Future Directions

- Mercury remains a persistent issue in high-elevation and wetland habitats in the northern forest
- More information is needed on how smaller scale changes in habitat or elevation affect Hg exposure risk in songbirds
- There is evidence that climate can influence these processes (see Adams et al. 2020), but need more information on the temporal scale of these effects and what the dominant climatic processes are that influences songbirds in different habitats
- After Hg stable isotope work is complete, we suggest that further work on discriminating Hg sources in the northeastern United States

List of products

- Related peer-reviewed publications

- Sauer, A.K., C.T. Driscoll, D.C. Evers, E.M. Adams, and Y. Yang. 2020. Mercury exposure in songbird communities within Sphagnum bog and upland forest ecosystems in the Adirondack Park (New York, USA). *Ecotoxicology* 29:1815-1829.
- Sauer, A.K., C.T. Driscoll, D.C. Evers, E.M. Adams, and Y. Yang. 2020. Mercury exposure in songbird communities along an elevational gradient on Whiteface Mountain, Adirondack Park (New York, USA). *Ecotoxicology* 29:1830-1842.
- Adams EM, Sauer AK, Lane O, Regan K, Evers DC. The effects of climate, habitat, and trophic position on methylmercury bioavailability for breeding New York songbirds. *Ecotoxicology*. 2020 Dec; 29(10):1843-1861. doi: 10.1007/s10646-019-02151-w.

- Leveraged grants

- Monitoring Spatial Gradients and Temporal Trends of Mercury in Songbird in New York State, 2013-2017 (NYSERDA, 2013-2017)
- Synthesizing on mercury exposure and effects on wildlife in New York State (NYSERDA, 2017-2019)