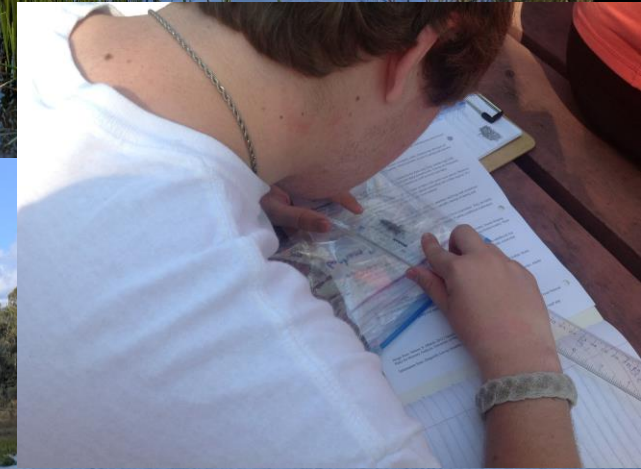




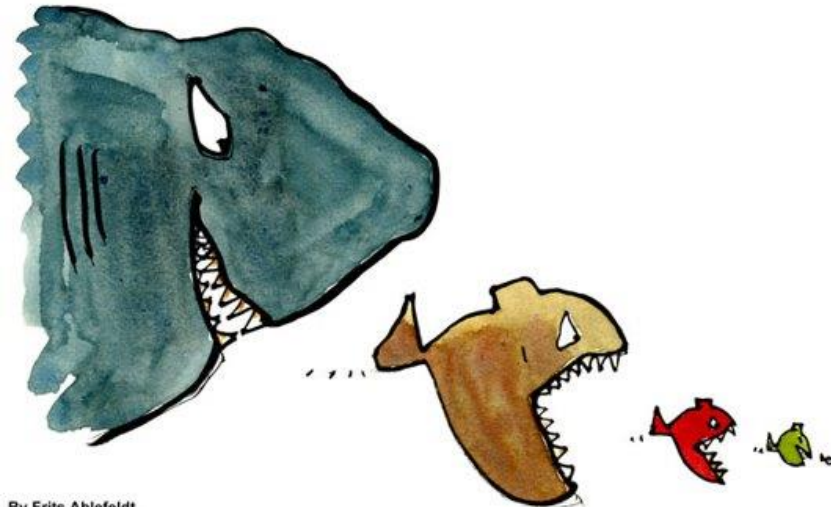
Community Science as a Tool for Understanding Mercury Contamination at National and Local Scales

- Celia Chen, Research Professor, Biological Sciences, Dartmouth College
- Sarah Nelson, Director of Research, Appalachian Mountain Club
- Christine Gardiner, Lab Manager, Biological Sciences, Dartmouth College
- Vivien Taylor, Research Scientist, Earth Sciences Dartmouth College



Why study mercury?

- **Ranked 3rd** on U.S. Agency for Toxic Substances and Disease Registry (ATSDR) priority list of contaminants.
- Mercury is a toxin with effects on humans and wildlife at **low levels** of exposure
- Pregnant women, children, and avid seafood consumers most at risk
- Human exposure to mercury in the US is largely through **consumption of fish.**
- **80%** of the US fish consumption advisories are for mercury

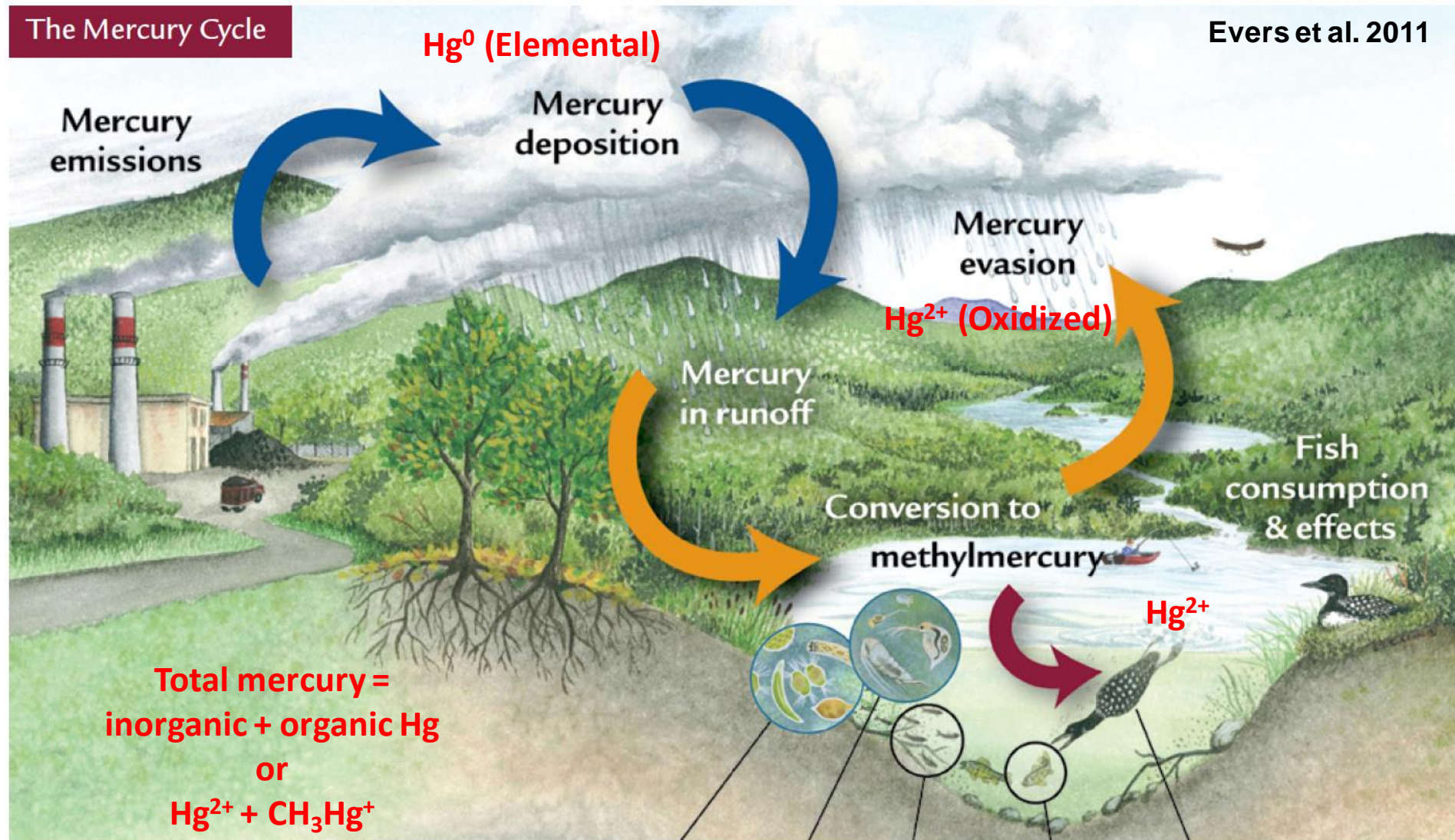


Hg Risk to (*piscivorous and insectivorous*) Wildlife

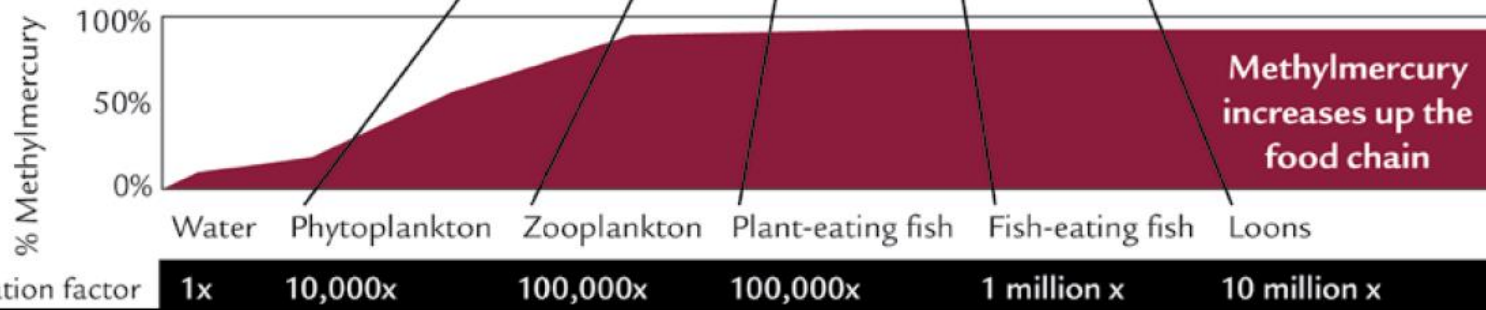


Effects: hormones, reproduction, motor skills

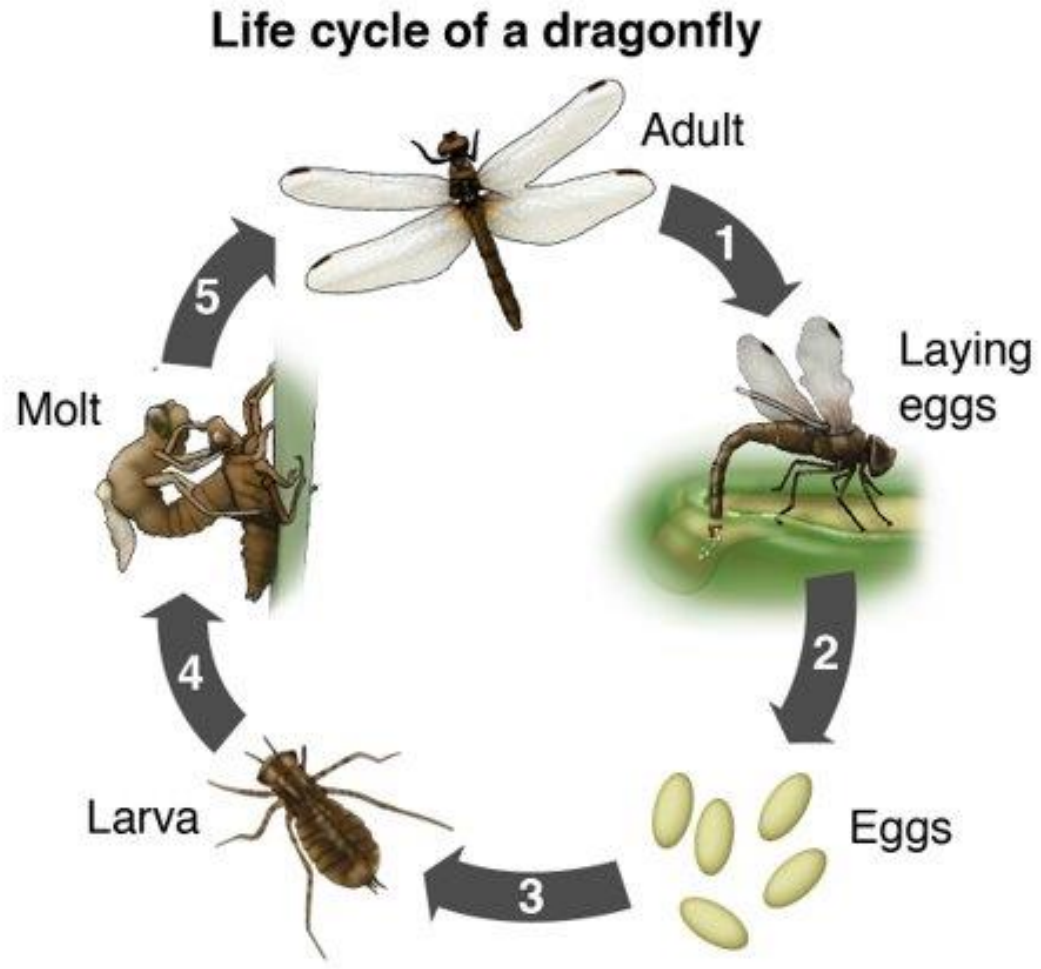
Photos from Biodiversity Research Institute



Bioaccumulation of methylmercury in fish & wildlife



Dragonflies as Bioindicators of Mercury Exposure

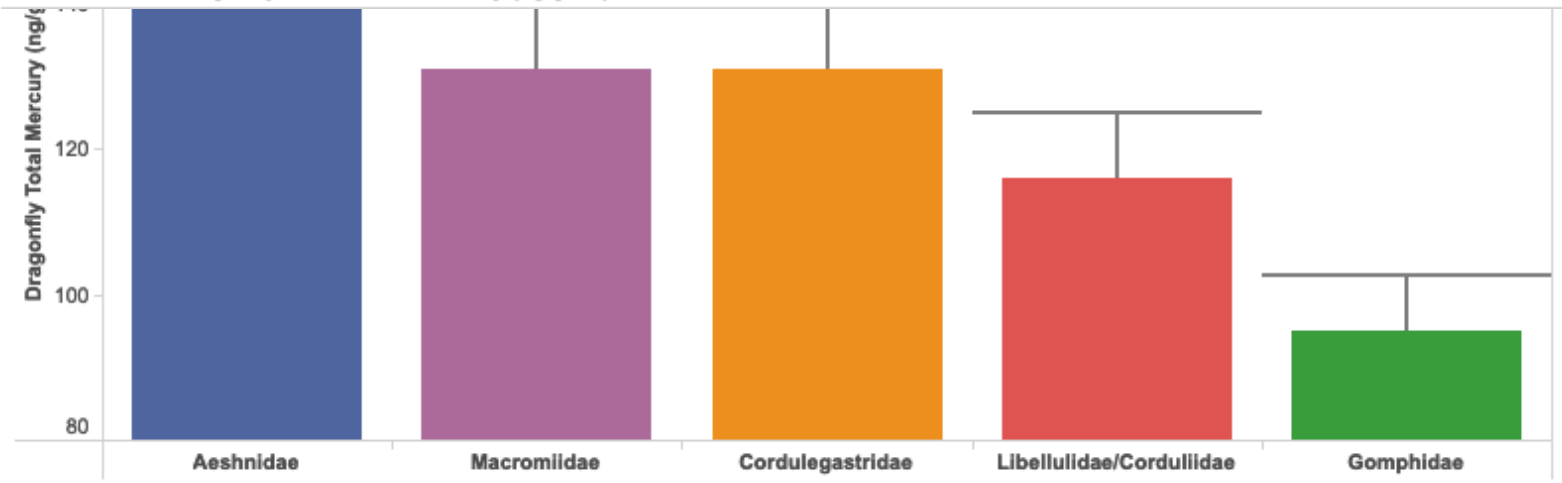
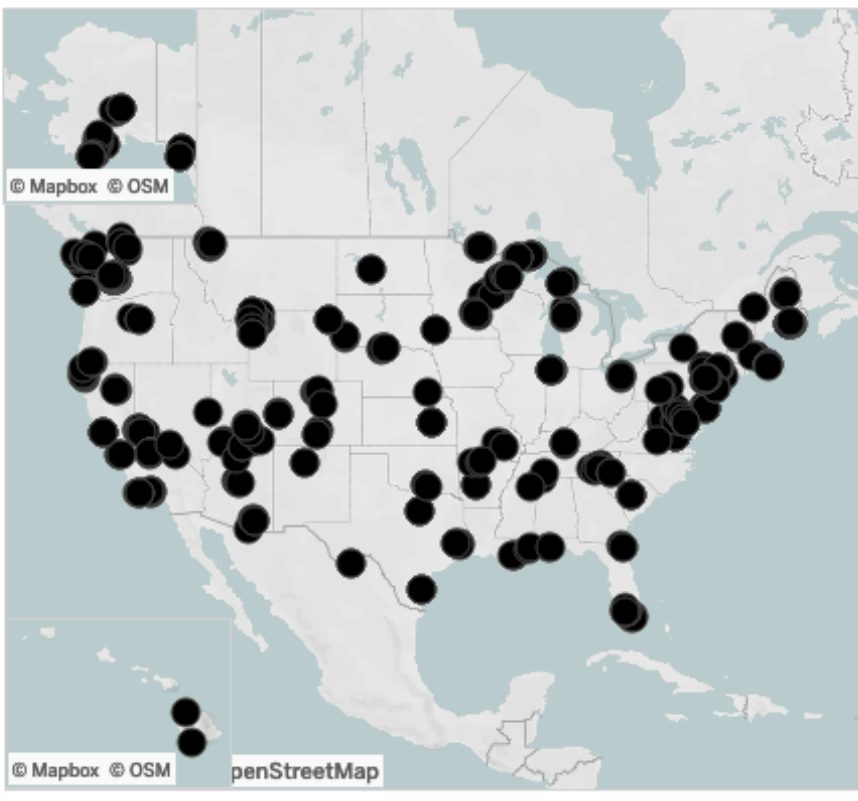
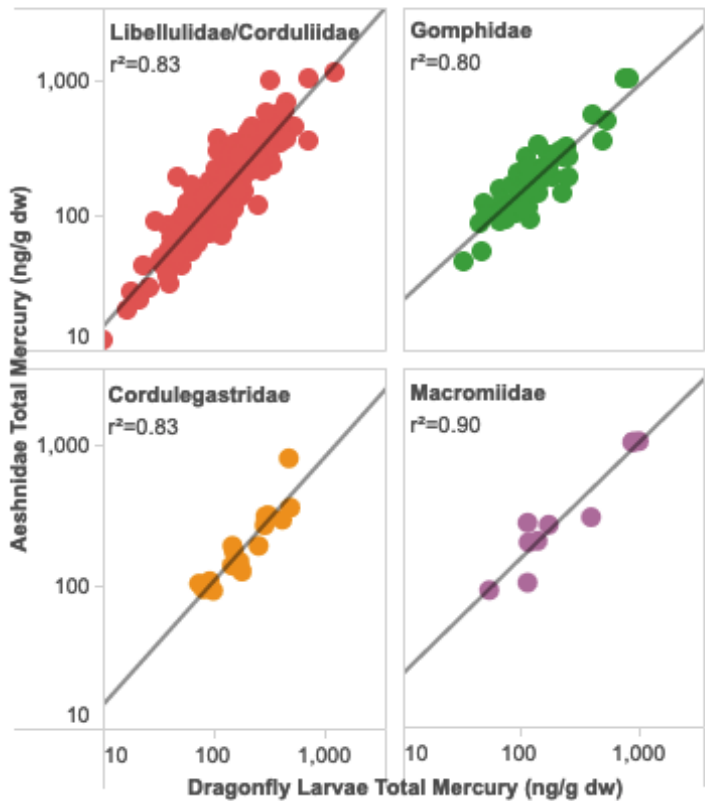


Filter by National Park Unit

(All) ▾

Filter by Family

(All) ▾



The Dragonfly Mercury Project

A citizen science framework for monitoring mercury pollution in U.S. national parks using dragonfly larvae as biosentinels.

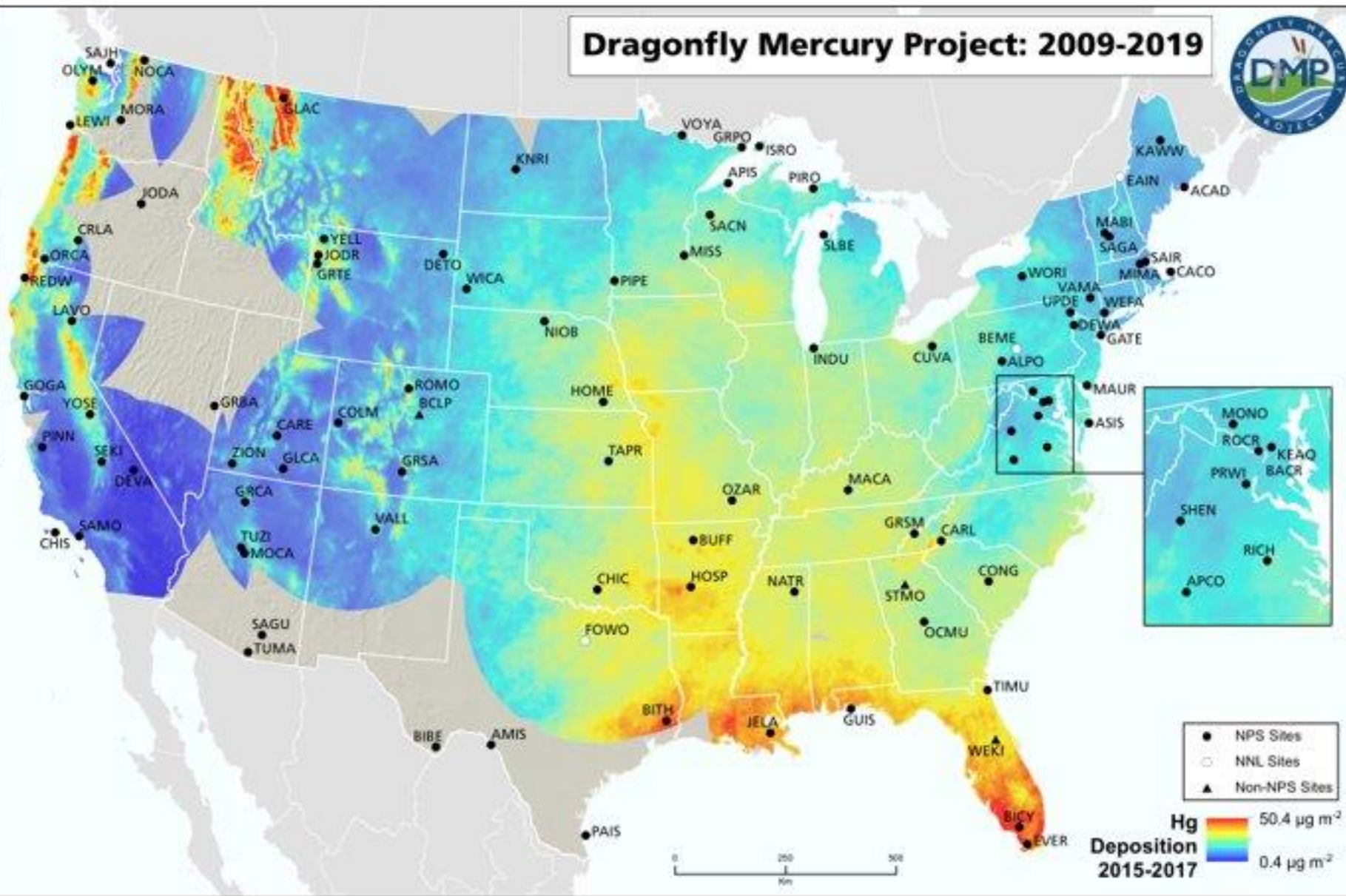
Published June 2020



https://www.nps.gov/articles/about-the-dmp.htm?utm_source=article&utm_medium=website&utm_campaign=experience_more&utm_content=small

DMP Storymap; <https://geonarrative.usgs.gov/dmp/>

Dragonfly Mercury Project: 2009-2019



- NPS Sites
- NNL Sites
- ▲ Non-NPS Sites

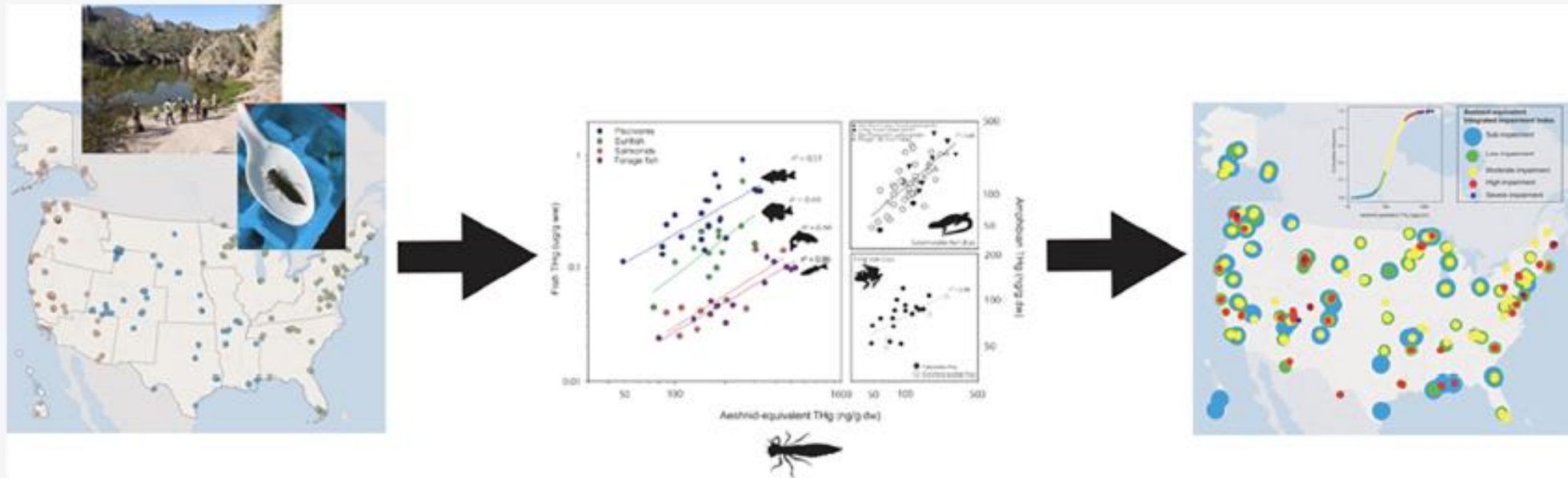


2019
Produced by NPS as Resources Division

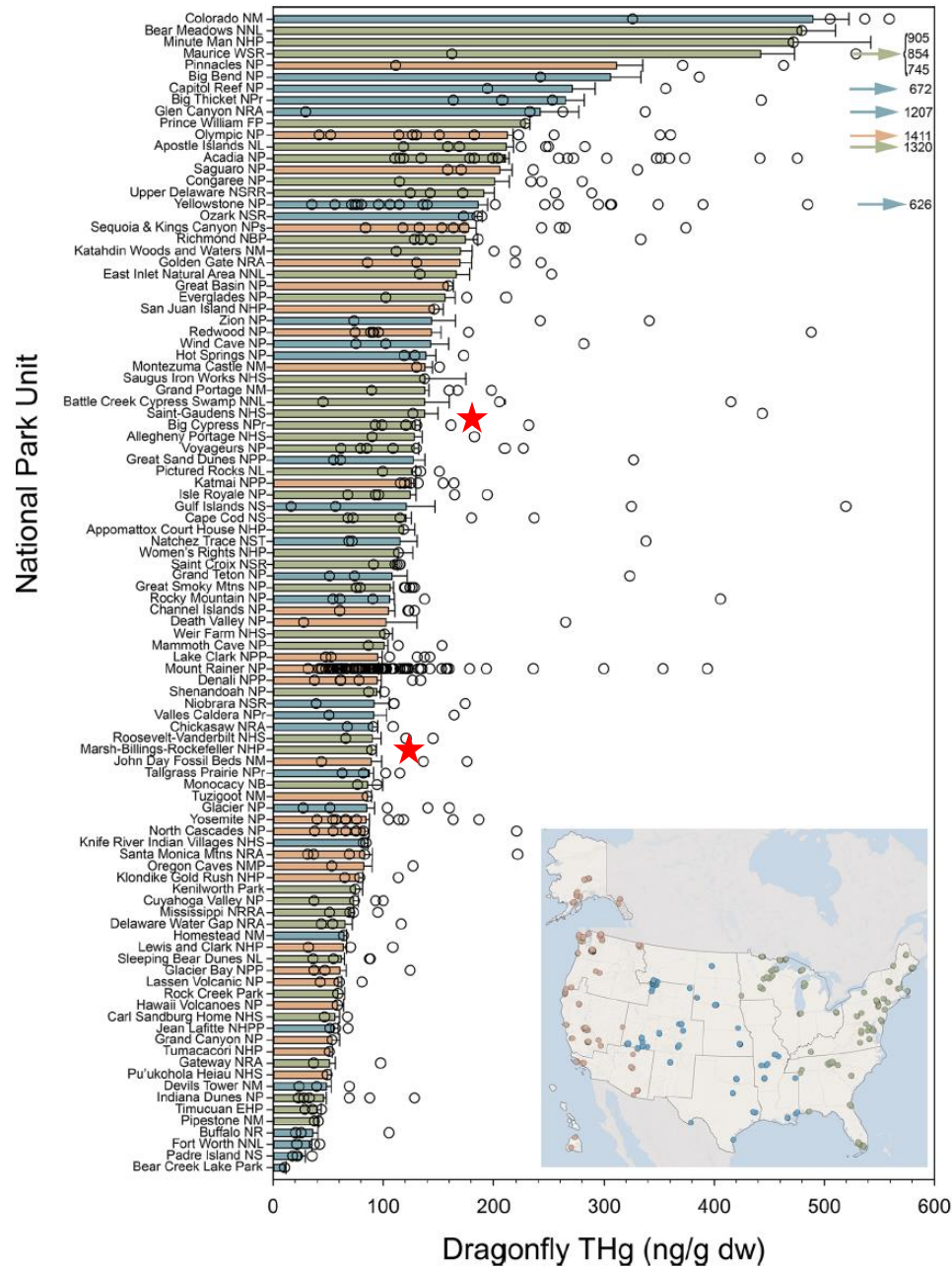
Distribution of Dragonfly/Fish Mercury

A National-Scale Assessment of Mercury Bioaccumulation in United States National Parks Using Dragonfly Larvae As Biosentinels through a Citizen-Science Framework

Collin A. Eagles-Smith,* James J. Willacker, Sarah J. Nelson, Colleen M. Flanagan Pritz, David P. Krabbenhoft, Celia Y. Chen, Joshua T. Ackerman, Evan H. Campbell Grant, and David S. Pilliod



Distribution of Dragonfly/Fish Mercury



➤ >450 sites spanning 100 National Parks across all 50 states

➤ Sample 2009-2018

➤ range of concentrations 10.4-1411 ng/g DW

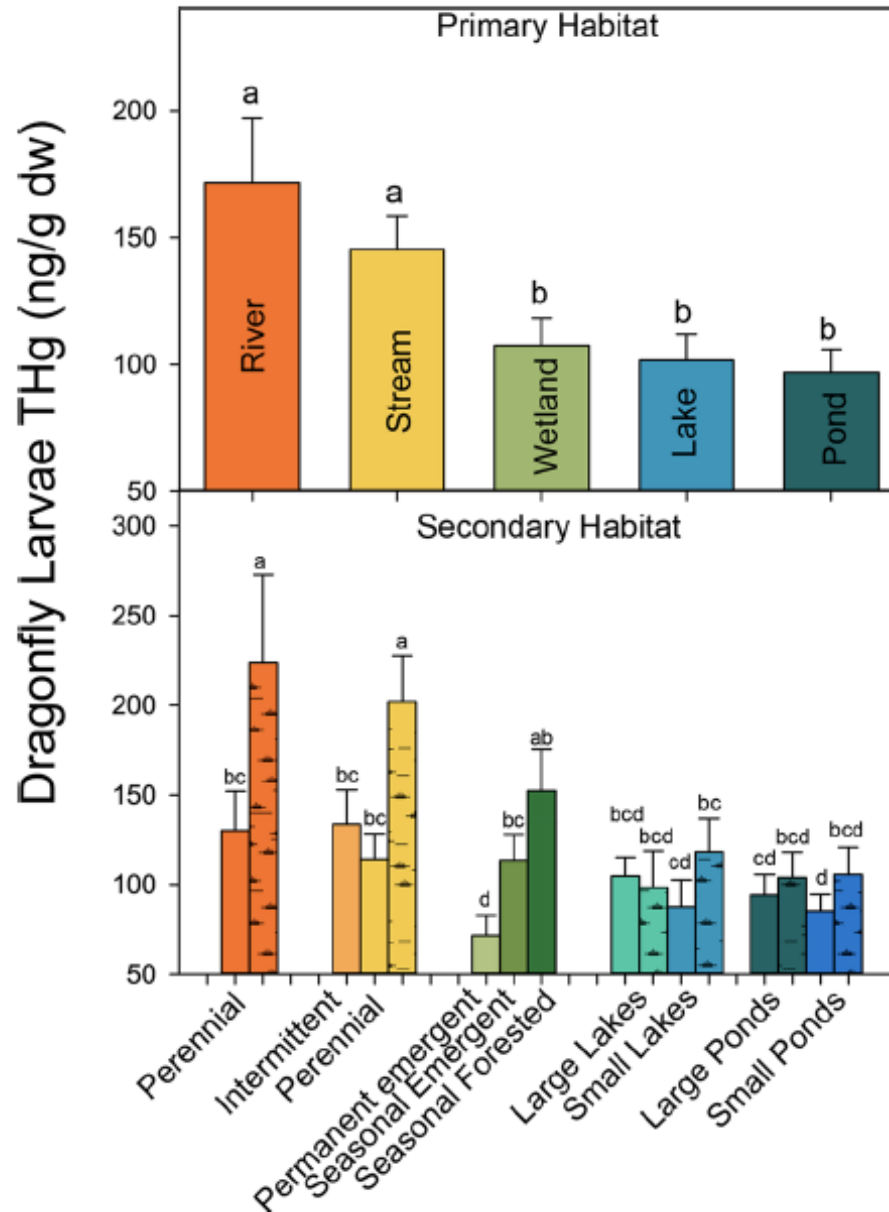
➤ Upper Valley sites at Marsh-Billings and St. Gaudens

➤ No regional pattern

➤ Colors:

- Western – orange
- Central – blue
- Eastern - green

Distribution of Dragonfly/Fish Mercury

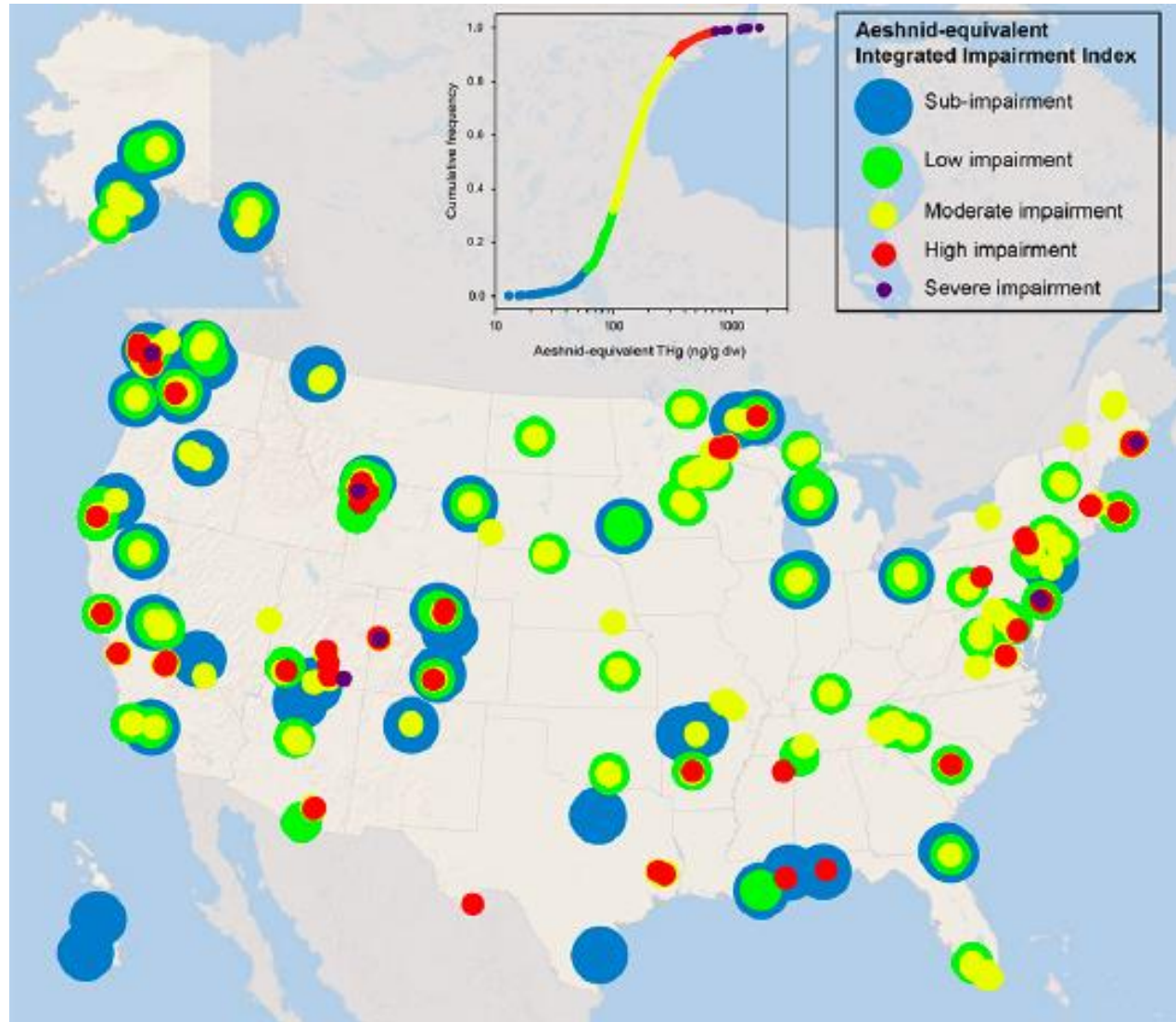


➤ Concentrations in flowing waters > still water

➤ Concentrations higher in waterbodies with wetlands

➤ Least square means accounts for effects of family, ecoregion site, and year

Integrated Impairment Indices

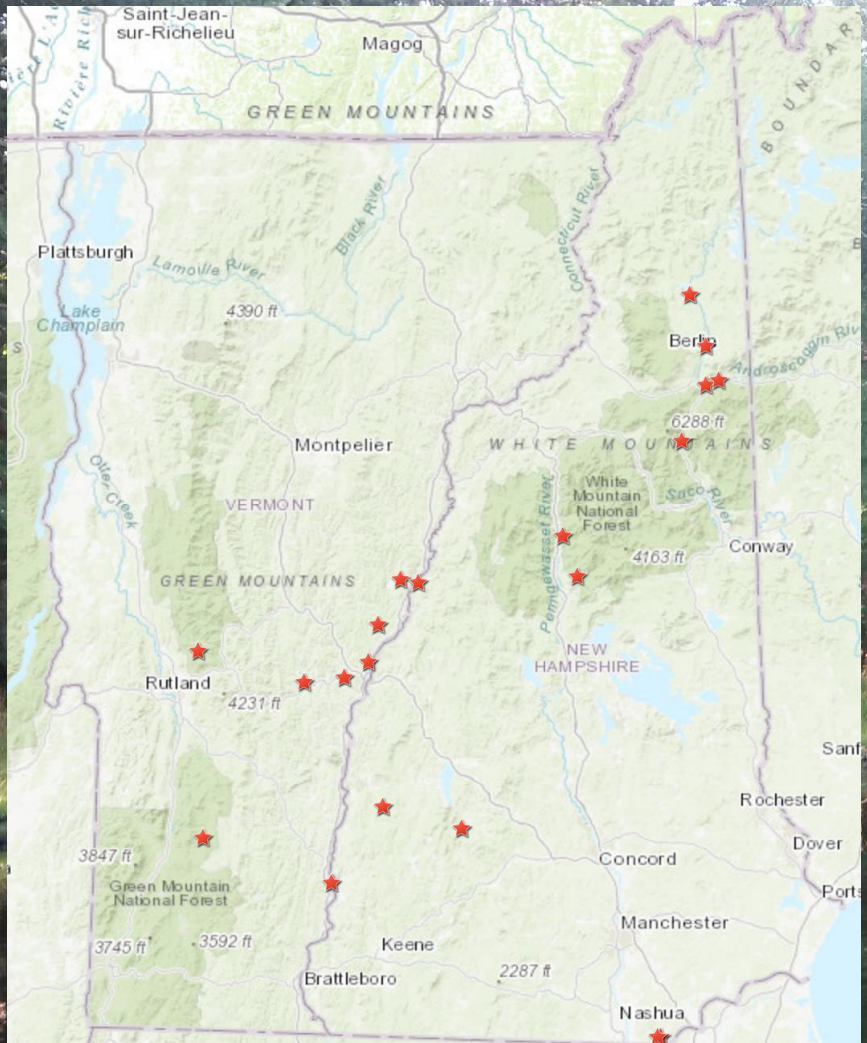


- Impairment indices based on:
 - Aeshnid-equivalent geometric mean THg
 - Site-year
 - Association with Hg exposure in fish and wildlife
- Cumulative frequency distribution = % of sites in each category
- High impairment throughout country and in remote places.

Dartmouth Dragonfly Mercury Project 2010 -2022



- Initial collaboration with Schoodic Institute and University of Maine in 2010
- NH and VT high schools
- Collaborate with teachers
 - Teach students sampling protocols
 - Help students develop testable questions
- Field sampling in September-October
- Data analysis in December
- Symposium held at Dartmouth in January:
 - Keynote speaker
 - Student poster presentations
 - Parents and families invited

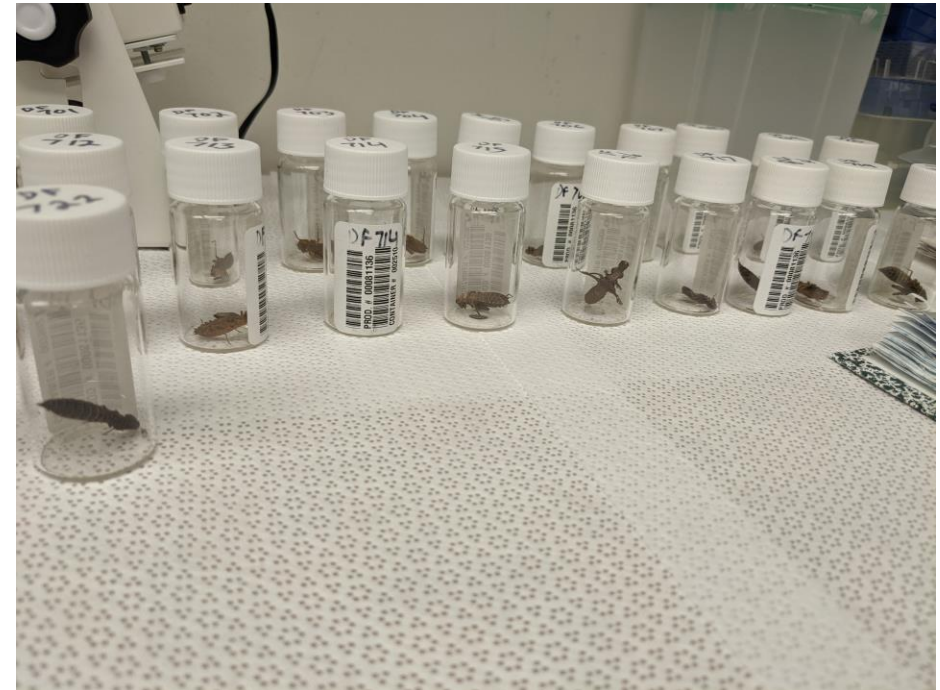
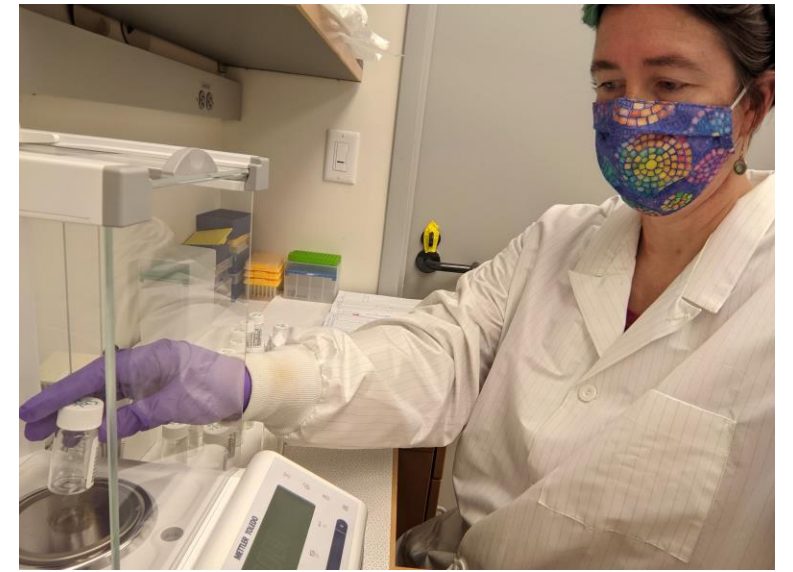


Forest Ecosystem Monitoring Cooperative

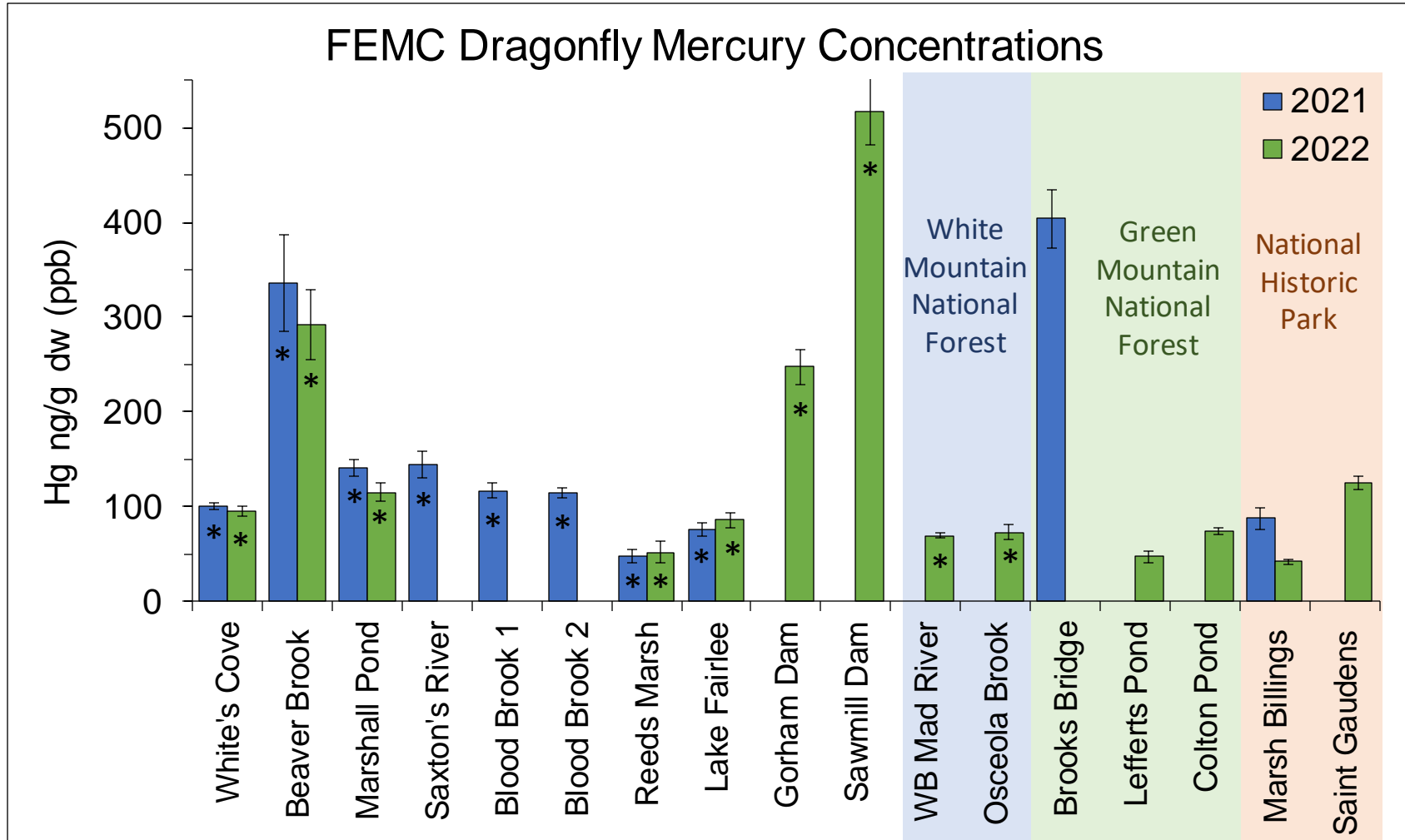
- ❖ Former sites in NH and VT high schools
- ❖ New sites in Green Mountain National Forest (VT) and White Mountain National Forest (NH)
- ❖ Addition of water quality data collection
- ❖ Collaboration with AMC and US Forest Service

Mercury Analysis at Dartmouth

- Taxonomy check
- Direct Mercury Analyser
- Intercalibration with USGS



Data from 2021-2022



* sampled with citizen science group

Over the two years:

- 17 sites sampled
- 5 within National Forests (GMNF and WMNF)
- 2 at National Historic Parks
- 6 K-12 schools
- 1 university
- 1 community group
- Engaged over 300 people in citizen science

Relationship between dragonfly size and mercury level

Richardson, Leah | Rivendell Academy | Rivendell Academics

Research Question

What is the connection between the amount of mercury in dragonflies when it comes to mass, length and the different species?

Methods

We took several dragonflies, which had been kept in a tank for 24 hours, and analyzed them for mercury levels. We used a mercury analyzer to measure the mercury levels in the dragonflies. We also measured their mass and length.

Dragonfly Family

Background Information

Mercury is a toxic element that is found in many different forms. It can be found in the air, water, and soil. It can also be found in food. Mercury is a neurotoxin that can cause damage to the brain and nervous system. It can also cause kidney damage and other health problems.

Dragonfly Munch

Conclusion

There is a positive correlation between the amount of mercury in dragonflies and their mass. This means that larger dragonflies have higher mercury levels. This is likely due to the fact that larger dragonflies have a longer lifespan and therefore have more time to accumulate mercury in their bodies.

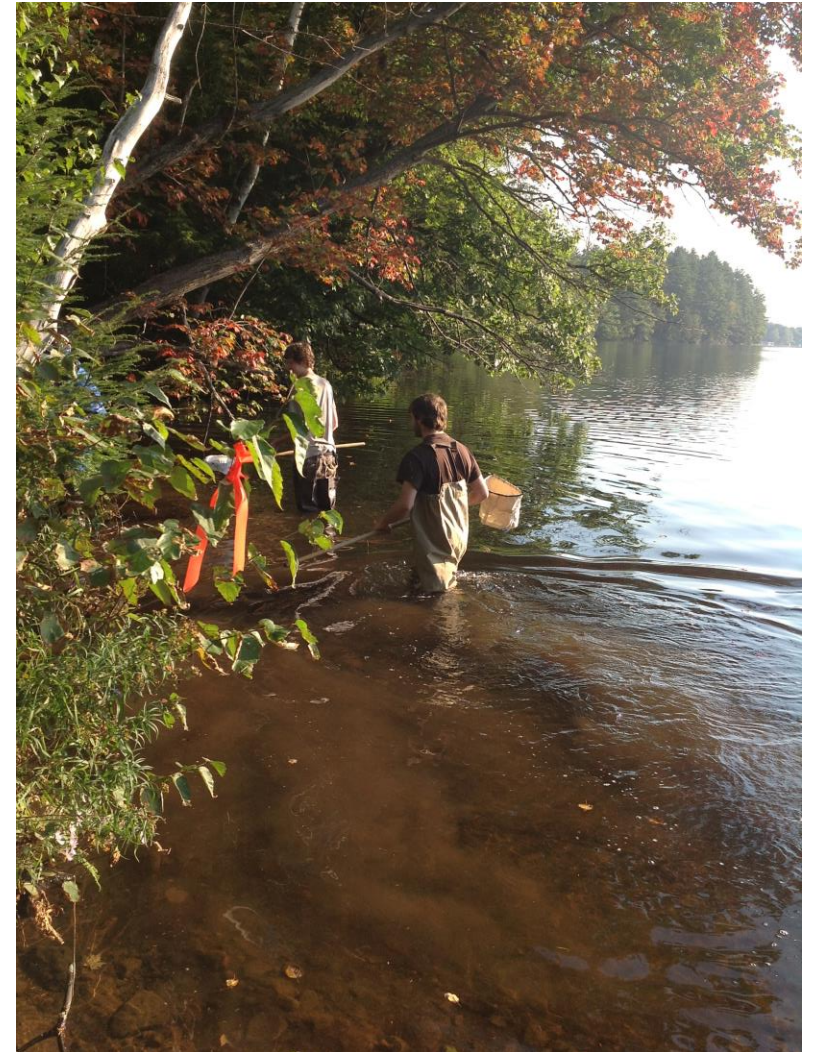
Hypothesis

I hypothesized that larger dragonflies would have higher mercury levels than smaller dragonflies.

Dry Dragonfly

Works Cited

Richardson, Leah. "Relationship between dragonfly size and mercury level." Rivendell Academy, 2023.



Environmental impact of land use on mercury in dragonflies.

Christina | Pierce, Kyle, Taylor, Kaitlyn | Rivendell Academy | Rivendell Academics

Research Question

Does land use have an impact on mercury levels in dragonflies?

Methods

- Travelled to Lake Fairfax (VT) to collect dragonfly larvae and water samples.
- Bagged the larvae using the clean-hand process.
- Drove back to the lab to measure dragonfly and identify each dragonfly larvae to family.
- Sort dragonflies to determine for mercury level testing.
- Test streamside of surrounding areas of bodies of water from which dragonflies were collected.
- Determined if they were Urban, Forest, and Farmland (see figure below).
- After measuring these locations we took Durham to data on mercury and calculated the average mercury amounts.

Results

Background Information

Mercury is a chemical element that is toxic to the body. Mercury is most commonly used in thermometers and fluorescent lamps. Mercury is also found in many different species of dragonflies.

Mercury is released from the factories into the atmosphere. From the atmosphere the mercury gets absorbed into the water body.

Examples of Surrounding Areas

Conclusion

We found urban areas had a higher mercury concentration than forest and farmland areas. This is likely due to the fact that urban areas have a higher population and number of factories. Factories release mercury into the air, which is then absorbed into the water. This is likely why the mercury levels are higher in urban areas than in forest and farmland areas.

Hypothesis

I hypothesized that urban areas will have more mercury remaining in the water stream causing the mercury levels in dragonflies to be higher. The fact that farmland will have less mercury in the water and forest will have more mercury than urban areas, but more than in forest areas.

Examples of Dragonfly Larvae

Works Cited

Christina, Pierce, Kyle, Taylor, Kaitlyn. "Environmental impact of land use on mercury in dragonflies." Rivendell Academy, 2023.

The Effect of Latitude on Methylmercury

Casey Chamberlin, Reese Patchen, Makana Truong
Palham High School, Palham, NH

Research Question: How are methylmercury levels affected by latitude?

Background

Methylmercury is a highly toxic form of mercury that is found in many different species of dragonflies. It is most commonly found in urban areas, but it can also be found in forest and farmland areas. Methylmercury is released from factories into the atmosphere, where it is absorbed into the water. This is why the mercury levels are higher in urban areas than in forest and farmland areas.

Results

Conclusion

We found that methylmercury levels are higher in urban areas than in forest and farmland areas. This is likely due to the fact that urban areas have a higher population and number of factories. Factories release methylmercury into the air, which is then absorbed into the water. This is likely why the methylmercury levels are higher in urban areas than in forest and farmland areas.

Methods

We collected dragonfly larvae from different locations at different latitudes. We then analyzed them for methylmercury levels. We also measured their mass and length.

Works Cited

Casey Chamberlin, Reese Patchen, Makana Truong. "The Effect of Latitude on Methylmercury." Palham High School, 2023.

Merrimack River Dragonfly Mercury Program

Deep community engagement for the success of this project



Lowell & Lawrence, MA are EJ communities

EPA EJScreen EPA's Environmental Justice Screening and Mapping Tool (Version 2.0) EJScreen 1.0 | EJScreen Website | Mobile | Glossary | Help

Lincoln Park


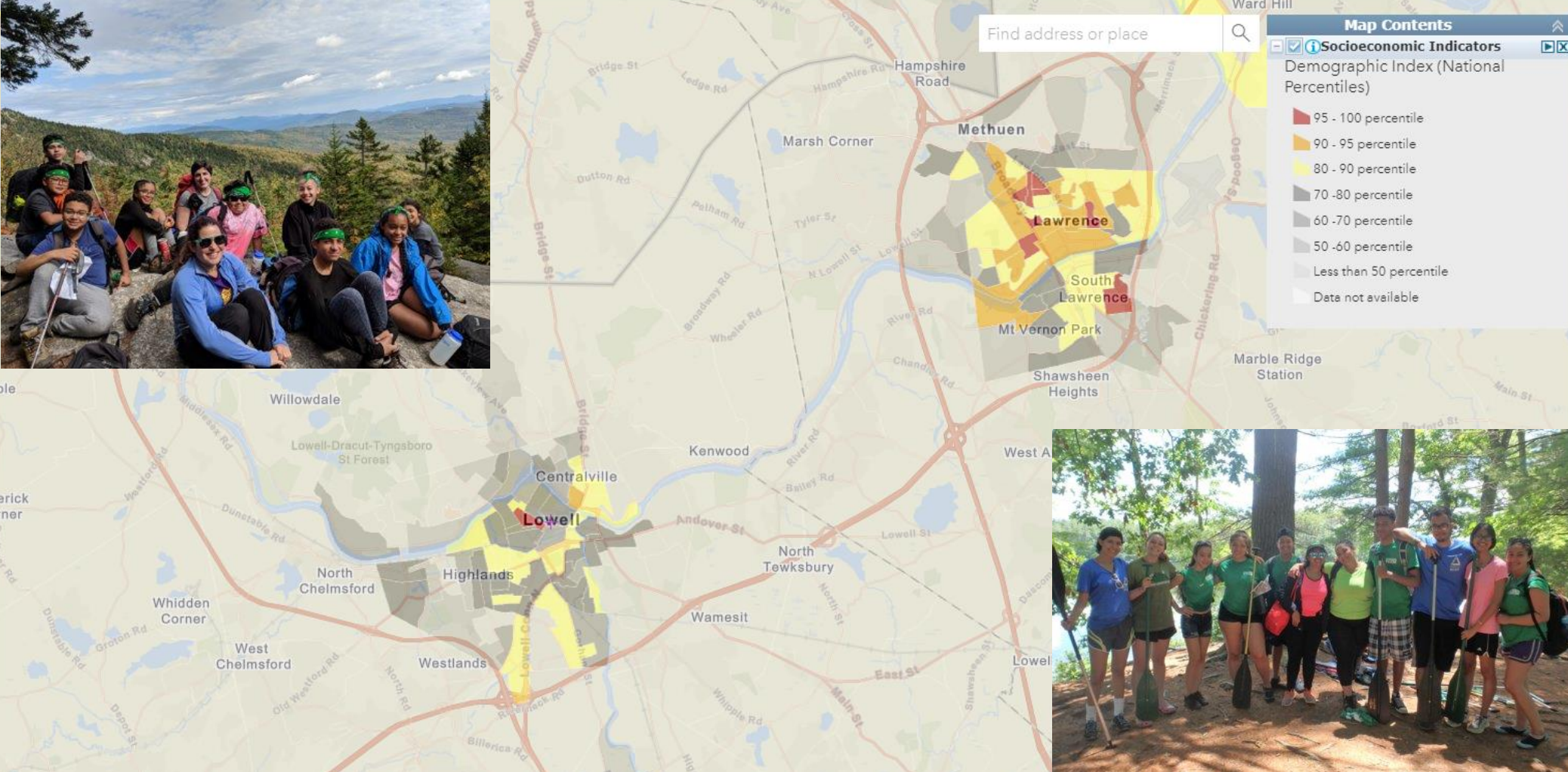

Find address or place

Map Contents

- Socioeconomic Indicators
- Demographic Index (National Percentiles)
 - 95 - 100 percentile
 - 90 - 95 percentile
 - 80 - 90 percentile
 - 70 - 80 percentile
 - 60 - 70 percentile
 - 50 - 60 percentile
 - Less than 50 percentile
 - Data not available

Socioeconomic Indicators

- Demographic Index**
 - People of Color
 - Low Income
 - Unemployment Rate
 - Linguistically Isolated
 - Less Than High School Education
 - Under Age 5
 - Over Age 64
- Health Disparities
- Climate Change Data
- Critical Service Gaps
- More Demographics



Lake Champlain Mercury Community Science Project 2023-2024



- **Collaboration with Lake Champlain Watershed Alliance; 2 education coordinators**
- **2-day training workshop at Dartmouth on June 26-27, 2023**
- **On-line and in-person support throughout the school year for in-class presentations, sample collection and student research projects**
- **Sampling supplies and shipping for mercury analysis**
- **Feedback and 1-day refresher workshop in June 2024**





Thank you!



Dartmouth

Christine Gardiner, Research Technician

Kate Buckman, Post-Doc, Research Scientist

Hannah Roebuck, Research Technician

AMC

Nate Schumacher

Collaborators

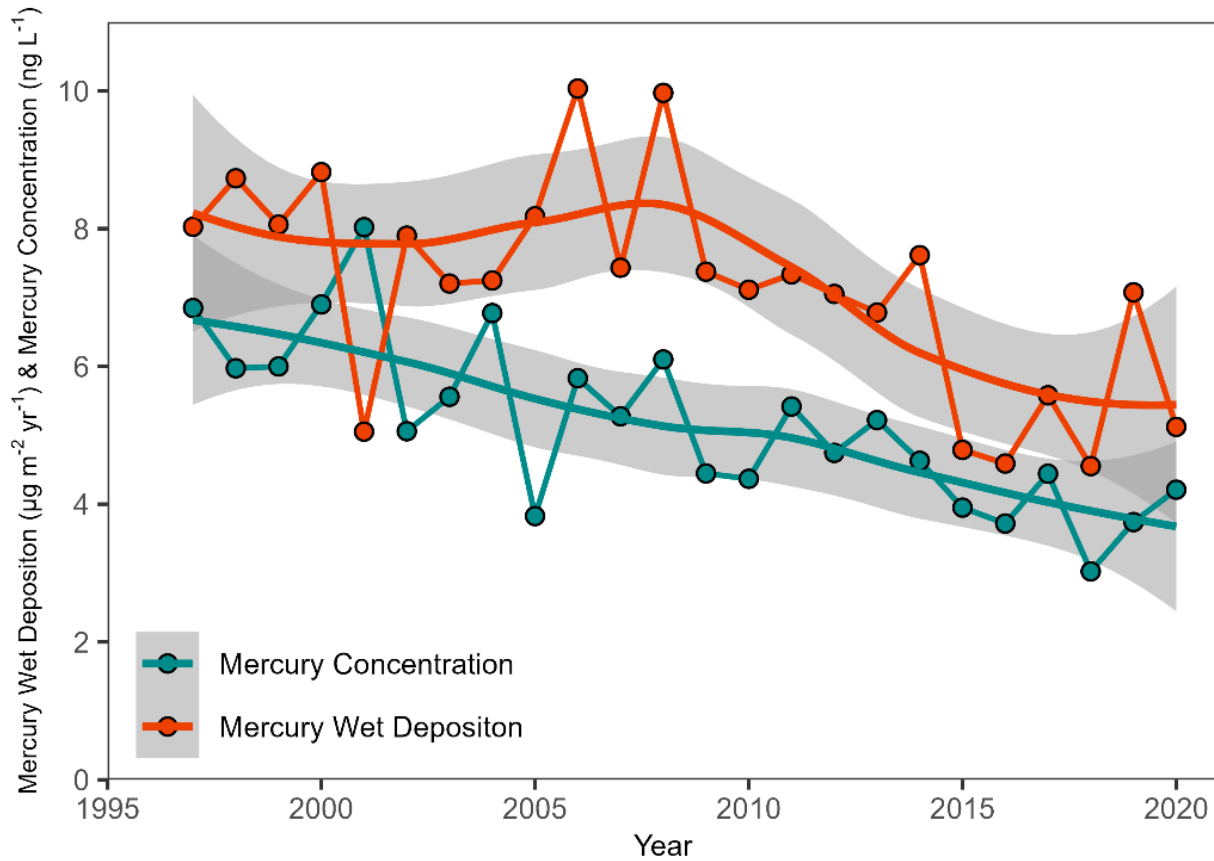
Colleen Flanagan Pritz, National Park Service

Collin Eagles-Smith, US Geological Survey

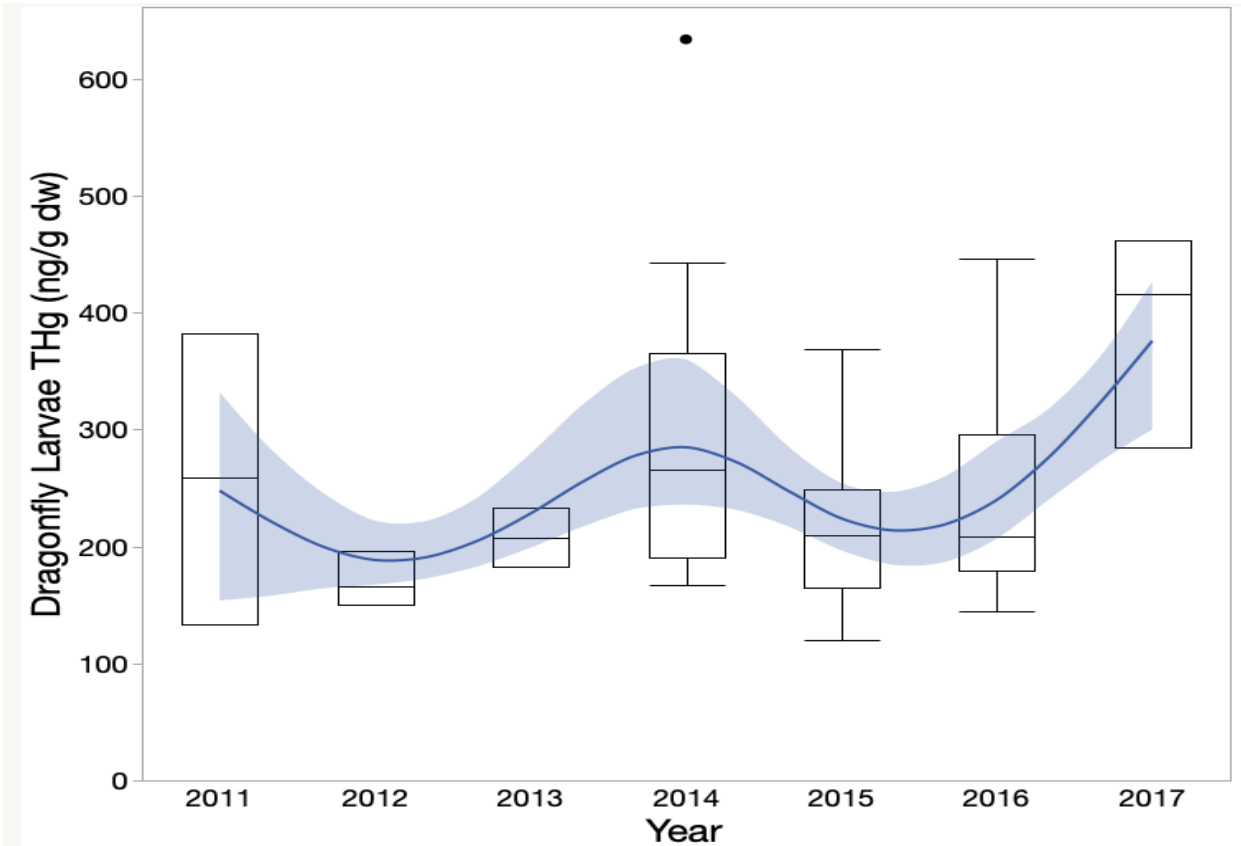
Funding Sources

- **National Institute of Environmental Health Sciences**
- **Wellborn Fund (NH Charitable Foundation)**
- **Forest Ecosystem Management Cooperative**
- **US Environmental Protection Agency**
- **Parker Foundation**
- **Lake Champlain Basin Program**
- **Lake Champlain Sea Grant**

Patterns in Dragonfly Larvae are not Declining



Annual wet-only Hg concentration and deposition for MDN site ME98, Acadia, from 1997-2020. Smoothed lines are derived using LOESS regression methodology and the shaded area represents the 95% confidence interval.



Aeshnid equivalent THg concentrations in dragonfly larvae over time. Each data point comprising the boxplots represents the geometric mean THg concentration of a site during the specific sampling years (site-year).