A day in the park–tracking mercury with dragonfly larvae

September 26 2016, by Dr. Sarah Nelson

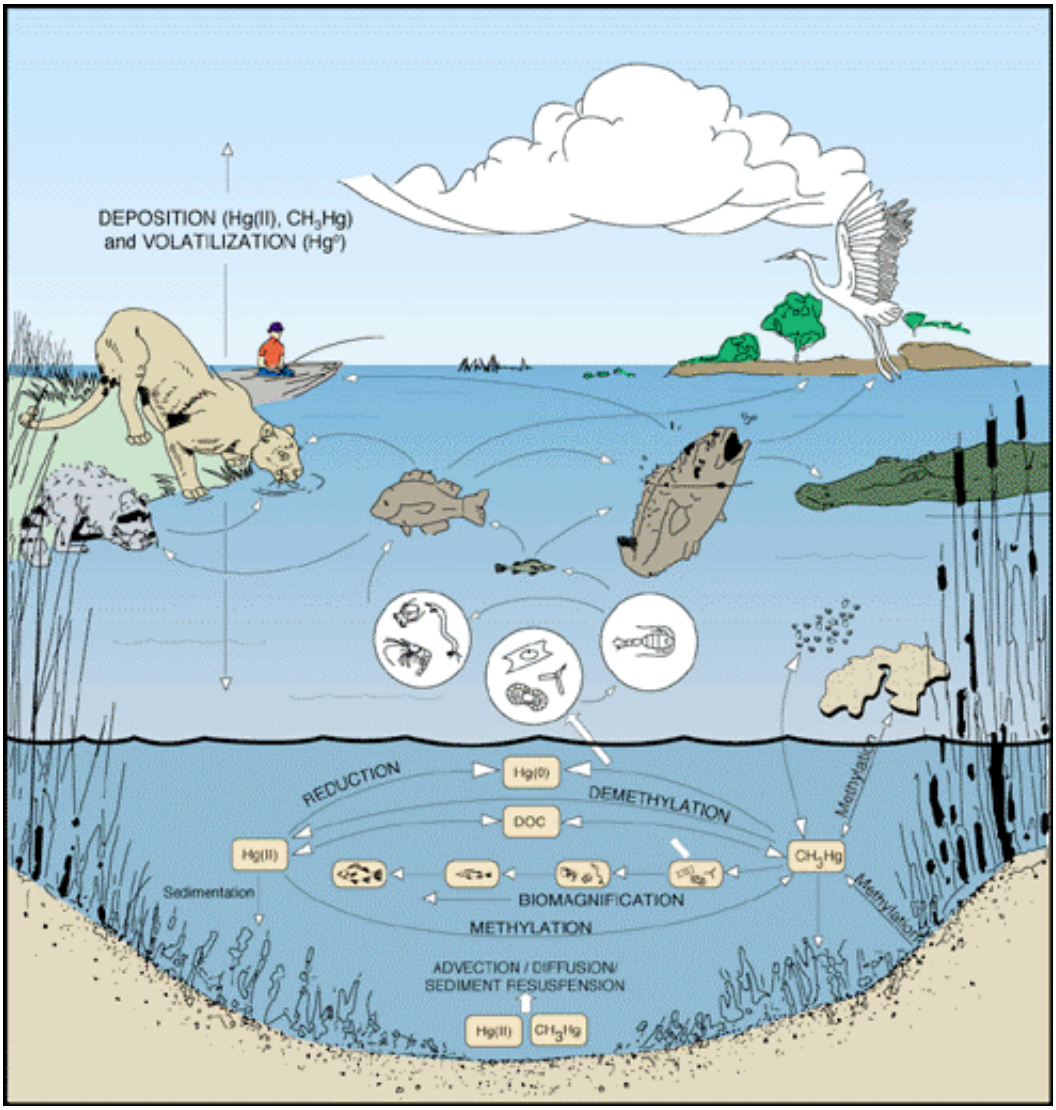
Close-up of a dragonfly larvae. Credit: Dave Huth

Mercury is a toxic element that can adversely impact human and wildlife health. And while it can be found as an introduced pollutant in the environment, it can also occur naturally. Mercury enters the environment from coal burning, mining processes and medical waste—primarily through atmospheric deposition, the majority of which is from coal-burning power plants. When atmospherically deposited mercury

undergoes methylation in the environment, it becomes the highly toxic, bioavailable methylmercury (CH3Hg). Methylation is a complex, bacterially mediated process by which a methyl group (CH3) is added to elemental mercury (Hg). This new compound, methylmercury mercury, is bioavailable and can enter the food chain. Methylation rates are greater in waters with high concentrations of dissolved organic carbon (DOC) and low pH or more acidic waters.

Scientists are keen on understanding mercury fluxes and quantifying mercury concentrations in our ecosystems in order to assess potential impacts to human and wildlife health. On the leading edge of this is the Dragonfly Mercury Project, a continental scale, citizen science project and collaboration between the University of Maine, the United States Geological Survey, Cornell University, and the National Park System that seeks to improve our understanding of the spatial variation in baseline levels of mercury in the environment.

Dragonfly larvae present a unique opportunity to track environmental mercury because they are long-lived (with nearly five years of time in the larval stage), eat many small insects and thus bioaccumulate mercury (i.e. the mercury builds up in their system), and are much easier to sample than quick moving fish. All of these factors allow the larvae to serve as a "sentinel," meaning they allow scientists to tell whether any mercury in the environment is in a detrimental form. Dr. Sarah Nelson from the University of Maine and Co-Principal Investigator on the project, highlighted the practicality of using dragonfly larvae, "There are several advantages—both scientifically and logistically—to dragonfly larvae bio-sentinels. First, they spend most of their life cycle, up to several years, in freshwater aquatic ecosystems, where methylation of mercury to its toxic form is thought to largely occur. Second, they are predators, and are also prey for many aquatic organisms, occupying a key position in many aquatic foodwebs."



Mercury in an aquatic food web.

Dragonfly larvae also have another advantage—they are almost everywhere, "we find larvae in sites from Alaska to Maine to California to Florida and even desert oases in the arid Southwest," said Dr. Nelson, "They also provide a bio-sentinel for waterbodies that are fishless, like small wetlands, ponds, or some streams. They exhibit site fidelity, meaning that a dragonfly larva represents the site conditions in the

waterbody in which it was captured; it hasn't migrated from elsewhere or spent any of its life in a different ecosystem."

Dragonfly larva are uniquely suited to citizen science also, "Logistically, the typical concentrations of Hg in larvae that we've analyzed is in a range that's straightforward for a relatively inexpensive type of laboratory analysis, which allows us to analyze samples individually and capture the range of variability within and across sites," said Dr. Nelson, "The larvae are relatively large, providing plenty of material for laboratory analysis, and they are easy to identify with minimal training, which allows for their sampling by citizen scientists."

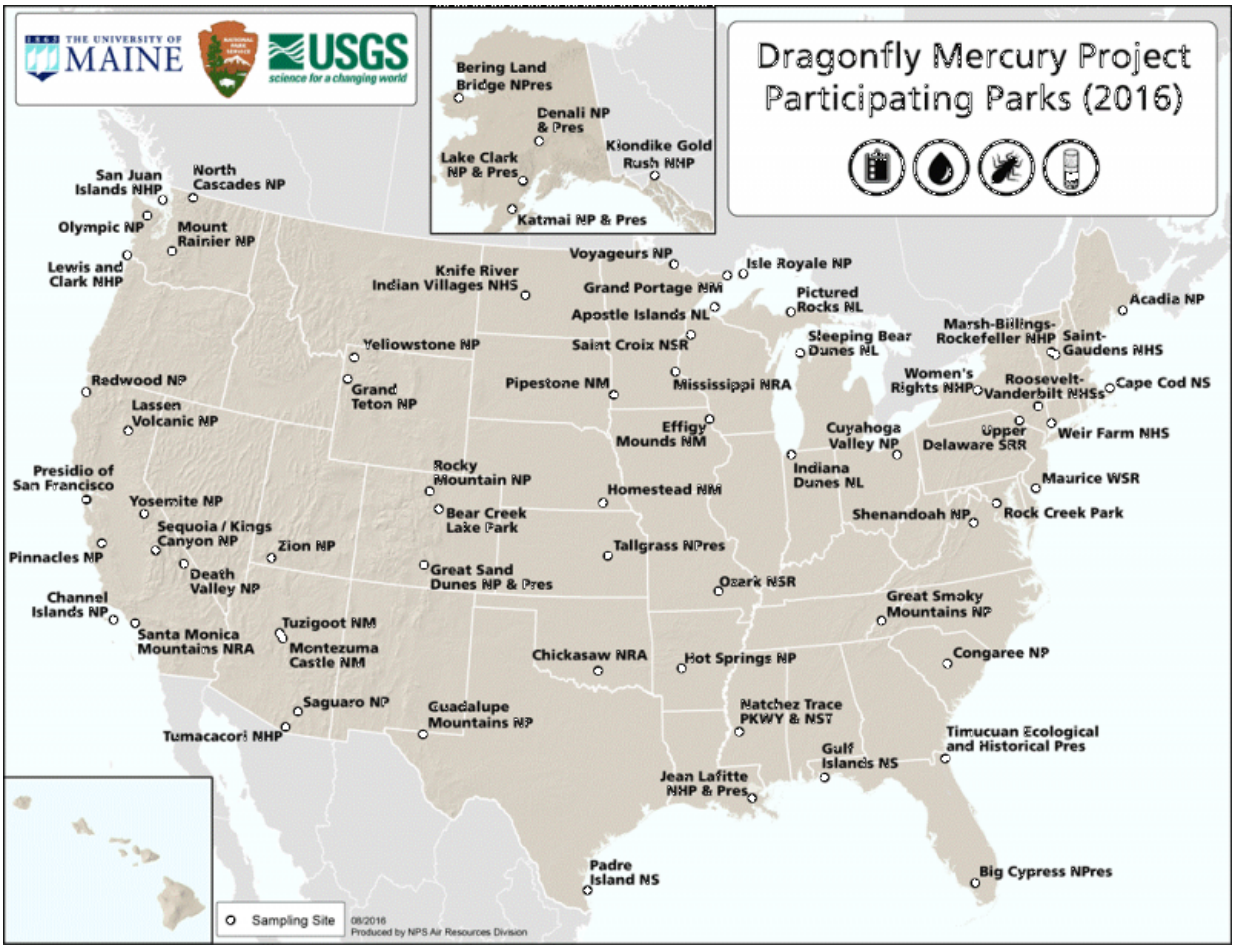
Also, there is a practical consideration as well, "they are far easier to collect than fish," said Dr. Nelson, " and can potentially serve as a surrogate for fish mercury concentrations."

Finding the larvae in the nets. It's over there to the left. Can you see it?

This summer, I had the opportunity, along with my nine-year-old, to participate in an annual dragonfly larvae sampling event at Shenandoah National Park.

Our sampling trip started on an exceedingly warm morning in July—over 90 degrees Fahrenheit by 9 AM. We met Shenandoah National Park Staff at the Graves Mill entrance to the park, on the Rapidan River. One of the best parts about the Dragonfly Mercury Project is how it engages kids. Not only did we meet park staff, but in tow were a group of middle and high school aged kids from the DC-Baltimore Metro area who were participating in a multi-week national park service program where they lived and worked in a national park during the summer.

This connection with people and the local communities is vital to this project, "The Dragonfly Mercury Project provides the ideal vehicle for connecting people with parks and using parks as outdoor laboratories," said Dr. Nelson, "The hands-on, minds-on approach can allow anyone interested to participate in a real scientific research study, and learn how to be a scientist for a day."



After a brief safety discussion and introductions, nets and buckets were distributed and we began the half mile hike to our sampling location on the Staunton River, about 500 feet from the confluence of the Rapidan and Staunton. In 1995, this area experienced nearly 30 inches of rainfall in a 1-2 day time period and experienced a tremendous flood that carved into the mountains resulting in gorgeous, exposed boulders and granite. Nearly 30 years later, vegetation has regrown along the river, resulting in a stark contrast between the upland forest and riparian habitat.

"Citizen science, in short, makes this project possible. Over 1,000 citizen scientists, from school kids to Girl Scouts to Youth Conservation Corps to visiting teachers to park visitors to VIPs (Volunteers in Parks) have participated. Together, these volunteer scientists have contributed hours that add up to over two full-time staff for a year's worth of time – and have covered the broad geography of the project. We just wouldn't be able to cover the same ground and get all of the sites sampled if only project scientists were in the field. Furthermore, the inclusion of lay scientists has generated numerous educational materials about mercury, dragonflies, and national parks. Their involvement has spread awareness of this project, and participating classrooms are also using the data and presenting the research during science fairs"—Dr. Sarah Nelson

The larvae themselves, as Dr. Nelson noted, are large and not that difficult to find once you get the hang of it. We broke into small groups and waded into the stream. The cool water was a relief from the heat. To capture a dragonfly larvae, we would overturn rocks in the stream and move around the sediment beneath, making sure to hold our nets downstream slightly to capture anything that escaped. As anyone who has spent time rifling around a streambed with a net knows, it is a much more enjoyable experience than most fieldwork.

An absolutely “huge” larvae.

Whenever we would find a larvae, we would measure it to make sure it was big enough, and then place it into a bucket of water so that it could be prepared appropriately for analysis. In total, my son and I only found three useful larvae (though I am pretty sure we found the largest one of the day!). But not only did he have a great time playing in the stream, but we also made a small contribution to a larger project. It was also great to see how well the students took the work. My son and I worked closely with a couple of young women from Baltimore for whom it was their first time in the woods, let along sampling dragonfly larvae. After they learned how to tell dragonflies from all of the other crawlies in the water and where to find them, they were off. By the time we need to leave for the day, they had six or seven between the two of them.

The Dragonfly Mercury Project started in the parks in 2011 and now spans from Florida to Washington and many stops in between. "We are concerned about mercury in parks and other seemingly 'pristine' locations across the US – and globe – because mercury is toxic and thereby challenges the National Park Service mandate to maintain resources 'unimpaired' for future generations. Additionally, like other air pollutants, mercury doesn't respect park boundaries," noted Dr. Nelson, "Air pollution is a challenging issue for just that reason—atmospheric air masses move and deposit everywhere, not just where pollution was created."

Mercury is a big problem. Similar projects to the Dragonfly Mercury Project, such as the US EPA's National Lake Fish Tissue Study and a recent USGS Stream Study, have shown a majority of lakes and a

quarter of streams have fish that exceed the US EPA advised limit of 0.3 ppm of Mercury. Beyond the human health issues this raises, there are also concerns for aquatic food webs and ecosystem effects. Citizen science projects such as this offer an excellent win-win scenario, with scientific progress stemming from the massive data gathering effort and public engagement and education about the concerns of mercury in the environment in the process.

Want to help? Find a park near you here where you can participate or contact the wonderful people at the Dragonfly Mercury Project directly to become involved.

More information: For more information:

www.schoodicinstitute.org/what … fly-mercury-project/
www.who.int/mediacentre/factsheets/fs361/en/
www2.usgs.gov/themes/factsheet/146-00/
www.nature.nps.gov/air/studies … /dragonfly/index.cfm

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