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Collecting Data on Charismatic Mini-Fauna: Public Participation and the Dragonfly Mercury Project

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Collecting Data on Charismatic Mini-Fauna:

Public Participation and the Dragonfly Mercury Project

by Colleen Flanagan Pritz and Sarah J. Nelson

Abstract

The Dragonfly Mercury Project (DMP) engages citizen scientists in collection of dragonfly larvae for mercury analysis in national parks, allowing for national-scale assessment of this neurotoxic pollutant. DMP goals for citizen scientist engagement are to (1) provide opportunity for biodiversity discovery; (2) connect people to parks; and (3) provide a vehicle for mercury education and outreach. Over 90 parks and 3,000 citizen scientists have participated in the project. Here we summarize information about citizen groups who participated in 2014–2016. High school students (20%), interns and youth groups (24%), and local community groups (15%) comprised the majority of participants. Park liaisons reported that the project achieved internal and external communication that otherwise would not have occurred. Opportunities for improvement included further curriculum and workforce development. Ultimately, citizen scientists gained new perspectives and practiced civic skills while project scientists and resource managers gained data and insights on mercury in foodwebs.

BACKGROUND

While scouring a local stream, carefully and cautiously, in search of the great larval "toothed one" on behalf of the Dragonfly Mercury Project, a student exclaims, "I didn't know dragonflies lived underwater!" Oftentimes observations of underwater inhabitants focus only on other mini-fauna like fish and tadpoles, or perhaps distant cousins of the dragonfly like the water strider or backswimmer.

Well, larval dragonflies can live up to seven to nine years underwater, before emerging as energetic, flying adults with flashy colors. What may be even more fascinating than its underwater existence and aerial acrobatics is that these insects have been around since the dinosaurs lived on earth. That's a staggering 300 million years. And, while modern dragonflies have wingspans of two to five inches, fossil dragonflies have been found with wingspans of up to two feet—that's roughly the wingspan of the present-day American kestrel, a bird of prey. In its spiritual existence, the dragonfly often symbolizes the wisdom of transformation and adaptability in life.

Considered alongside its watery reality and copious countenances, the creature has a cult-like following. The mere mention of the word *dragonfly* gets people jazzed about citizen science. The Dragonfly Mercury Project (DMP) builds on the overall panache of the dragonfly. It is an excellent example of a scientific, educational, and experiential partnership that brings together government and academic scientists, land managers, and public participants of all ages. Goals of the project are to increase the understanding of mercury contamination in national parks across the United States and to engage citizen scientists in the collection of dragonfly larvae. Mercury is a global pollutant that is highly toxic to animals and humans, and mercury levels in dragonfly larvae serve as an indicator of wildlife health.

To achieve these goals, the scientist team at the University of Maine (UMaine), US Geological Survey (USGS), and National Park Service (NPS) enlists a liaison within each national park or partner within the community. The liaison then coordinates, trains, and leads citizen scientists in actively collecting samples of dragonfly larvae from waters within the parks and sends them to laboratories at USGS and Dartmouth College, where they are analyzed for mercury. The results provide scientists and land managers data regarding the distribution of mercury at broad spatial scales. The data are also available for citizen scientists to use in the classroom for science projects or lesson plans (Nelson, Webber, and Flanagan Pritz 2015).

Since 2013, more than 2,500 citizen scientists in over 90 US national parks from Alaska to Florida and from California to Maine have contributed beyond 10,000 hours and collected close to 7,500 dragonfly larvae for the Dragonfly Mercury Project. Maine—

where the project has its deeply entrenched roots—is just 1 of 42 states with NPS units contributing samples to the study. The broad geographic coverage of this science is possible because of the participation of citizen scientists. Public participants range from middle school– and college–aged students to families and retirees (Eagles-Smith et al. 2016).

In remote places like Maine and remote landscapes like national parks, mercury is generally delivered via atmospheric deposition (e.g., rain, snow, dust). After being emitted to the air, mercury often undergoes long-range transport. Because mercury bioaccumulates in tissues of living animals and biomagnifies up food webs, reaching concentrations that can have toxic effects, it threatens the very resources that the NPS is mandated to protect (Flanagan Pritz, Nelson, and Eagles-Smith 2014). In particular, the NPS Organic Act (54 U.S.C. 100101 et seq.) of 1916 directs the NPS to promote and regulate the use of the "national parks… which purpose is to conserve the scenery and the natural and historic objects and the wild life therein, and to provide for the enjoyment of the same… as will leave them unimpaired for the enjoyment of future generations."

Because fish occur across a wide geography and provide strong links to human and wildlife health, they are perhaps the most commonly used indicator for mercury contamination. But dragonfly larvae are easier to collect than fish and easier to identify relative to other aquatic insects. Furthermore, dragonfly larvae are ubiquitous, an important prey item, and due to their position on the food chain, more likely than other mini-fauna to bioaccumulate pollutants such as mercury at ecologically relevant concentrations. They also represent the risk from mercury in fishless ecosystems such as shallow ponds and pools—some of the most productive and ecologically important aquatic habitats. The larvae remain in the pond or stream where they hatched from eggs, giving researchers and managers a clearer picture of mercury risk within the watershed where they are caught (Nelson, Webber, and Flanagan Pritz 2015).

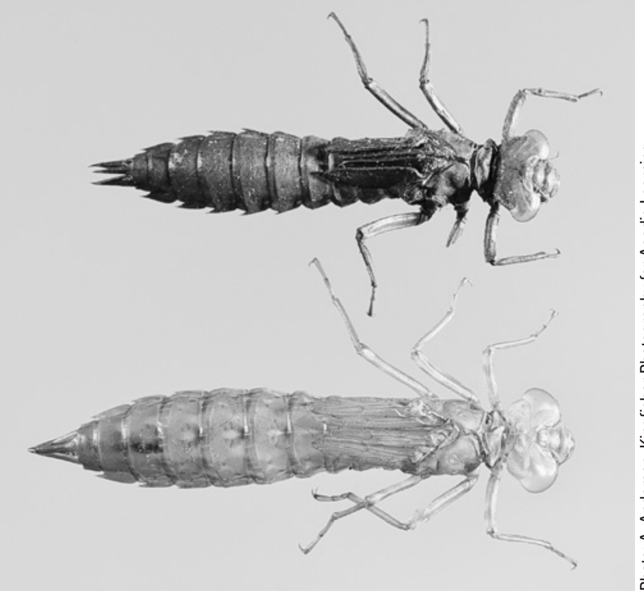


Photo: A. Anderson, Kingfisher Photography for Acadia Learning

Aeshnidae dragonfly larvae exuviae (their shed exoskeletons), which look just like the larvae.

The DMP began in 2011 with four national parks. By 2016—the centennial year of the National Park Service—it had multiplied in size to include more than 80 NPS units. The citizen science aspects of the DMP grew from UMaine efforts to develop curricula regarding mercury around local schools in Maine (Zoellick, Nelson, and Schauffler 2012; see Lindsey this issue) and builds on an extensive set of curricula, videos, and interpretive materials available on the project website (http://go.nps.gov/dragonflymercury/). The expansion of the DMP since its inception has generated considerable interest nationally and provides valuable services to the scientific community, parks, and public participants. The *train-the-trainer* approach ensures that the on-site liaison oversees sampling and provision of training materials and ensures that samples are collected by citizen scientists following strict protocols to avoid contamination.

STUDY

The DMP goals for citizen scientist engagement are to (1) provide an opportunity for biodiversity discovery; (2) connect people to parks; and (3) provide a vehicle for education and outreach regarding mercury. Entering its eighth field season in 2018, the DMP seeks to better connect with the citizen scientists who make this work possible and to improve project implementation. Therefore, we interviewed park liaisons and synthesized results, hoping to enhance the DMP's educational opportunities and increase data relevance among the public audience. From 2013 to 2016, the DMP team spoke with park and partner citizen scientist leaders, covering over 100 sampling expeditions across 77 national parks, involving more than 3,200 citizen scientists who typically contribute 4 hours each to the DMP. Questions asked included (1) What was one thing that most surprised you about the project? and (2) Do you have suggestions for improvement? (Nelson et al. 2017).

The majority of citizen scientist participants were lumped into three main categories based on the interview results: high school students (20 percent), interns and youth groups (24 percent), and local community groups (15 percent) (Figure 1). In the following paragraphs, we discuss noteworthy surprises for each group in the form of challenges, successes, and opportunities.

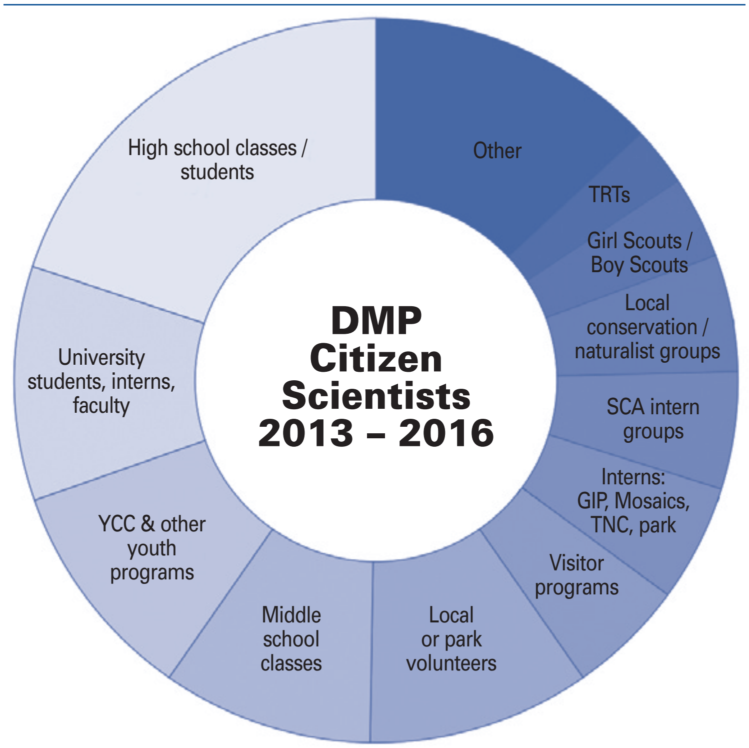
Regardless of the group type, time and effort can present challenges when establishing a relationship with a group new to the park or setting up new visitor programs. Specific challenges expressed by park liaisons who led groups of high school students included the lack of a platform or mechanism to share resources that teachers have developed, with many requesting curriculum and data analysis tools. Additionally, the time of involvement presented a challenge for the intern, youth, and local community groups because most often the interaction was brief and may be only a one-time occurrence. Ultimately, the shortened interface affects the level of engagement and can limit overall participation, accountability, and commitment.

In contrast, the level of engagement of the groups of high school students was considered a success. Park liaisons noted that the students truly enjoyed and were interested in the project. (It can be generally assumed that the total interaction time with high school groups is higher than with the other groups.) Intern groups reported viewing this field-based project as a reward and reprieve from indoor work. For other interns and youth groups, the project helped identify interests and a career path. Moreover, park liaisons who led local community groups revealed that the project achieved both internal and external communication that otherwise would not have occurred. For example, many parks linked with local experts to assist with fieldwork and identification, and park staff learned from others within the park who had specific expertise (e.g., entomology).

Lastly, the interviews showed us many areas that could be improved. We learned that the facilitation of community of practice for teachers and emphasis on existing data literacy and curriculum resources would greatly benefit the high school teacher and student group. For interns and youth groups, the DMP should create a plan for workforce development and better link career paths with these participants. We were largely unaware how many local community groups exist, and therefore we need to continue facilitating connections with such groups.

In Maine alone, expanded sampling plans at Acadia National Park allowed for multiple citizen science expeditions, with over 660 participants during 2013–2016, thereby diversifying the interview results. Due to the large number of contributors, the DMP at Acadia reached a variety of audience types (from middle school students to families to retirees), enabling sampling events to occur at several sites within one park and at different habitat types (stream, pond, lake). Highlights included the engagement of different groups such as middle school

FIGURE 1: **Wheel Representation of Citizen Scientist Groups Participating in the Dragonfly Mercury Project, 2013–2016**



Abbreviations: TRT = Teacher Ranger Teacher; SCA = Student Conservation Association; YCC = Youth Conservation Corps; GIP = Geoscientists in Parks; TNC = The Nature Conservancy.

students, who gained hands-on skills, and passing visitors at Jordan Pond, who interacted with the study in a quick but meaningful way. Scientifically, this large pool of participants generated both an increase of statistical power and evaluation of temporal variability of mercury concentrations in dragonfly larvae.

Overall findings indicate that deep engagement in biodiversity discovery was an overwhelmingly important aspect of the project, with several participants citing "getting kids outdoors" as a highlight of the program. Feedback indicated that the optimal group size varied by park and group type, but generally about 15 people per sample site per sampling event appeared to be ideal. Given earlier comments from parks, we are restructuring the DMP to streamline coordination and speed up the distribution of data to parks. Parks explicitly expressed an interest in sharing data with citizens before the teachable moment passes.


Photo: S. Nelson

A sampling trip at Acadia National Park, where Ranger Michael Marion is leading a group of middle school students in sampling for dragonfly larvae.

DISCUSSION

The Dragonfly Mercury Project is unlike any other NPS-wide study in that it combines easy-to-achieve fieldwork with sophisticated laboratory and computational analyses to shed light on the risk of mercury contamination across varied ecosystems of our national parks. The project builds on the framework described in Zoellick, Nelson, and Schauffler (2012), where teachers' objectives and outcomes are expected to be separate from scientists' objectives and outcomes, even in a cocreated project. Mercury data collection is the scientific goal, but for park staff liaisons, the goal is often somewhat different. For park liaisons, the main project goal is most often biodiversity discovery or a vehicle for discussion of pollution issues. The DMP's continued success has come not only from the allure of dragonflies, but also from the recognition of these different goals and outcomes and careful consideration about which aspects of planning, implementation, and interpretation are best suited for citizen science. The DMP has evolved from its cocreated roots in Maine schools, through a collaborative phase of development in partnership with early-adopter parks, to its current formulation as a largely contributory effort (e.g., Bonney et al. 2009). Ultimately, such collaborative research can help the NPS better manage risk and protect resources from the effects of mercury and educate park visitors about the issue and potential health impacts.

The DMP creates next generation environmental stewards and enlightens a mainly youth-based pool of citizen scientists about the connection of all living things, the influence humans have upon natural systems, and how environmentally responsible decisions can protect our parks and the planet. In high school and university settings, DMP data often allow students to hone their data literacy skills (e.g., Webber et al. 2014). Citizen scientists gain new perspectives and practice civic skills while project scientists gain additional data and insights on mercury in the food web. Participation enables the NPS to foster teachable moments on the management of air, water, and biological resources and connects people to parks using parks as outdoor classrooms and living laboratories.

Results of this work suggest there is a need to better facilitate citizen science engagement with the Dragonfly Mercury Project. In future years, we hope increase the capacity to address these challenges and opportunities. Diversified partnerships and a broadened impact with agencies such as state parks and The Nature Conservancy may foster a deepened engagement with citizen scientists and ultimately advance an appreciation of national parks and other landscapes and the diversity of resources they contain for thousands of youth across America.

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Photo: UMaine

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