

It's Raining Nitrogen

Collaboration establishes testing site for atmospheric pollution at Weld Hill

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Nitrogen is an essential element for all living organisms. Human activities, such as fossil fuel consumption and use of synthetic fertilizers, have significantly increased atmospheric deposition of nitrogen to our terrestrial and aquatic ecosystems. Much like the fertilizers used by gardeners and farmers, these inputs of nitrogen from the atmosphere can stimulate growth of natural vegetation. However, at high rates, nitrogen deposition can saturate plants' need for this nutrient, leading to a cascade of negative effects including soil acidification, reductions in biodiversity, fish mortality in waterways, and nitrate pollution of groundwater and coastal waters. Total rates of atmospheric nitrogen deposition in rain and snow have decreased in recent decades due to the Clean Air Act, yet they remain almost ten times greater than pre-industrial levels in the Northeast. Moreover, our research has shown that nitrogen deposition is even greater here in Boston than in nearby rural areas such as Petersham and Fitchburg, MA.

Since increased rates of nitrogen deposition can lead to ecosystem degradation, we are working to discern the drivers of high rates of atmospheric inputs here in Boston, assess potential variation in deposition across the city, and to investigate potential "hotspots" of deposition. During the summer of 2014, with support from an Arnold Arboretum Deland Award for Student Research, we established 15 study sites throughout the greater Boston area. We found that nitrogen deposition in the city is not only elevated relative to nearby rural sites, but also highly variable, and that some of this variability can be explained by traffic patterns, and possibly even the seasonal application of fertilizer. We expanded our network in 2015 to include nine new sites throughout the greater Boston area to continue this work, but also began to measure deposition of phosphorus, another nutrient that causes damage in large amounts, particularly to aquatic ecosystems. This year we collected rain water and outflows in soil water at our study sites, and analyzed these samples for inorganic nitrogen and phosphorus.

Across the United States, atmospheric deposition is measured by two national networks. The National Atmospheric Deposition Program (NADP) measures



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Boston University Professors Pamela Templer and Lucy Hutyra stand at the foot of Weld Hill at the Arboretum, within sight of the equipment used to measure atmospheric pollutants for the National Atmospheric Deposition Program.

nitrogen deposition in precipitation and the Clean Air Status and Trends Network (CASTNET) of the EPA measures dry particulate deposition. These two national networks provide a robust analysis of national trends, but they purposefully place their sites in rural areas to avoid local hotspots of deposition. In 2015, we established two new NADP sites in Boston to add critical urban measurements to the NADP network, which are leading the way to create a national subnetwork of urban sampling sites. One site (NADP MA98) is located adjacent to the Weld Hill Research Building at the Arnold Arboretum and was established with the support of the DaRin Butz Foundation, and the other (NADP MA22) is located on the roof of the College of Arts and Sciences at Boston University. Each site has a bucket [*Continued on page 9*]

connectivity of the natural world. Mary remembers observing enormous snapping turtles at the edge of Dawson Pond with a group of Head Start children. “At one point, there were two large males, poking their noses out of the water, curiously looking back at equally curious children. They could see the turtles open and shut their jaws in the water, and when one turned around in a circle, the children could see its long, spikey tail. They looked so reptilian and so unlike the turtles they’d seen in picture books that one boy adamantly exclaimed his disbelief they could be turtles at all. No amount of convincing could change his mind.”

Simply put, there would be no Field Studies Experiences for schoolchildren at the Arnold Arboretum without the extraordinary commitment and support of the Field Study Guides. Through ongoing training, volunteers learn many skills to effectively share nature with young children in our “outdoor classroom.” Continuous investigation of life science and learning best practices for engaging children are built into the program for guides, ensuring our volunteers provide focused, exciting, and enriching experiences for kids. In fact, Mary recommends getting involved not only for the positive effect it has on kids, but also for the remarkable camaraderie and fellowship offered by her fellow guides. “I became part of a terrific and diverse community of guides who enjoy working together—with all the support I needed and where my input really matters.” Peter promotes the experience to friends more directly: “My recruitment pitch is a simple one: be outdoors in a diverse and beautiful setting, work alongside committed and talented volunteers, and open children’s eyes to the natural world.”

Every time a child achieves success in the landscape—whether defined academically, socially, personally, or physically—it rewards the patience and dedication of the volunteers who shepherd their experiences here. “I love when nature surprises me,” says Betsy. “I delight in sharing the



Nancy Sableski

New guides are recruited for the Field Study Experiences at the Arboretum each spring and fall, and receive extensive training from Arboretum educators, staff, and veteran participants in the program. Additional enrichment programming is offered throughout the year, such as this winter walk in the Conifer Collection.

Arboretum’s treasures with children, and am happy when I feel I’ve met the challenge of helping kids understand the natural processes occurring around them.” Nick Kerpan adds, “Getting to work with students in the landscape is so beneficial for everyone. It gets students interested in nature, nurtures fascination, and excites and energizes guides to learn new things and interact with young learners in new ways.” For Peter, success happens when a second grader looks at you and says, “Mr. Peter, can you come back to school and have lunch with us?” Indeed, success of this sort also makes a great impression on teachers who often remark on how terrific the experience was for students and teachers alike.

Perhaps it is the small ratio of adults to children, or the programs’ content linked to current science standards, or the hands-on nature of exploration that sets the FSE apart from other nature-based programming. However, the guides know that when a child’s eyes and heart are opened to the natural world, wonderful things happen. ♪

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protected from potential conaminants that opens during storms, and we sample collected water on a weekly basis. These two sites are the first official urban sites in the NADP program and will shed light not only on urban deposition of nitrogen, but of many other pollutants as well, including phosphate and sulfate.

Together, the data from our study sites around Boston, as well as from the two NADP sites, will provide a more complete understanding of the biogeochemical cycling of nitrogen around the greater Boston area. Ultimately, our work will help illuminate how atmospheric deposition affects the loading of nitrogen to the Charles River, providing policy-relevant data with implications for both ecosystem and human health. ♪