Boston Harbor Islands All Taxa Biodiversity Inventory

Integrating science, education, and management in an urban island park

By Jessica Rykken and Marc Albert

FROM 2005 TO 2011, HARVARD University collaborated with the National Park Service and others in the Boston Harbor Islands Partnership to conduct an All Taxa Biodiversity Inventory (ATBI) at Boston Harbor Islands National Recreation Area, Massachusetts. This first phase of the ATBI has focused on the vast diversity of insects and their arthropod relatives that comprise what renowned entomologist and Harvard professor emeritus Dr. E. O. Wilson has affectionately termed the "microwilderness."

An urban island park may seem like an unlikely place to conduct an ATBI. After all, the 34 islands and peninsulas that make up this park have been heavily influenced by humans over the past few centuries, serving as sites for military forts, farms, schools, hospitals, sewage treatment plants, and, until quite recently, a landfill. This is no hot spot of biodiversity. However, the park's location in the heart of New England's most densely populated metropolis couldn't be better for engaging a large and diverse audience. Like most ATBIs, our inventory has three complementary objectives: (1) to catalog insect biodiversity in the park (fig. 1), (2) to educate and excite the public about local biodiversity, and (3) to use biodiversity data to inform park management.

Biodiversity does exist in an urban park. In our pitfall and malaise traps, bee bowls, nets, beating sheets, and at UV lights, we have collected an impressive array of taxa, including more than 170 species of native bees, 15 species of millipedes, and 52 species of ants (more than twice as many as predicted by Dr. Wilson himself!). In total, more than 65,000 specimens representing approximately 1,800 species populate the ATBI database—and that doesn't include the vast majority of superabundant and hyperdiverse flies and parasitic wasps still sitting on the shelf (see sidebar). Among the identified species, we have documented many new state and regional records, and even a few new introductions to the United States, including *Laemostenus terricola terricola* (Herbst), a ground beetle from Europe; *Myrmica scabrinodis Nylander*, the common elbowed red ant, also from Europe; and *Hishimonus sellatus* Uhler, a mulberry-feeding leafhopper from Asia.

Discovering patterns: Nonnative species and island biogeography

Boston is one of the nation's oldest active ports, and presumably has long been a point of entry for introduced species. Although comparable data sets for most taxa are not available for the mainland, where they do exist the ATBI allows us to assess whether the number of introduced species as a proportion of all species on the islands is high relative to that of the mainland. A recent catalog for Rhode Island (Sikes 2004) allows comparison for beetle families. Among the four most diverse families on the islands, the percentage of introduced species in the park is markedly higher than in Rhode Island. For example, 14% of all ground beetle (Carabidae) species found in the park are introduced,

Figure 1. A robber fly from the Boston Harbor Islands, *Albibarbefferia albibarbis*.

compared with 6% in Rhode Island. The same pattern holds for weevils and bark beetles (Curculionidae; 39% vs. 21%), rove beetles (Staphylinidae; 24% vs. 9%), and leaf beetles (Chrysomelidae; 22% vs. 8%). Among other taxa in the park, percentages of introduced species range from 95% for millipedes to just 4% for bees. We hypothesize that these proportions relate to taxon mobility, functional group (i.e., herbivore vs. predator), and other life history traits. For example, the high proportion of introduced millipedes may also hold true for other sedentary, soil-dwelling decomposers.

In an island park it is also interesting to consider patterns of species richness in relation to island size and isolation as a test of the theory of island biogeography, which predicts that smaller and more isolated islands will have relatively fewer species (MacArthur and Wilson 1967). At Boston Harbor Islands, there is a strong positive relationship between island size and species richness (i.e., bigger islands have more species), but an island's distance from the mainland does not appear to be a strong predictor of species richness, regardless of mobility. With the most isolated island being only 3.2 km (2.0 mi) from shore, distances to islands appear to be short enough that even sedentary species, such as millipedes, can colonize near and far islands via drift or human transport. As the islands (most of which are deposits of glacial till) were connected to the mainland approximately 9,000 years ago, some native species may have arrived before isolation and persisted. Habitat diversity appears to have a very strong influence on species diversity, especially the presence of freshwater, which is a scarce resource on the islands. Small islands with even a small freshwater seep have many more species than their size alone would predict.

Public education and engagement

Outreach and education have been integral components of the ATBI since its inception. We want to instill an awareness that "biodiversity" is not restricted to the tropics or defined only by colorful birds and large mammals in wild, remote parks, but rather that everyone can "explore the microwilderness," even in a small urban park. You can't expect people to appreciate what they can't see, and therefore we have worked to bring insects up to a scale where their bizarre forms, beautiful colors, and fascinating bits and pieces can be seen clearly using high-resolution images generated from state-of-the-art imaging software at Harvard. Aside from each species having a full gallery of images in the ATBI's online database, we have produced eye-catching posters of the ants, leafhoppers, bees, weevils, and other denizens of the park (fig. 2) as well as an award-winning PredatOR-Prey playing card game and foldout field guides to commonly encountered "Creatures of the Microwilderness."

The ATBI has also stimulated the development of insect-themed, curriculum-based school programs for fifth through eighth graders. The field and classroom activities were developed through collaboration among project scientists, NPS education rangers, and Thompson Island Outward Bound Education Center staff, and have thus far reached more than 4,000 students in the Boston area. The curricula and materials, including almost 200 specimens embedded in clear resin, and several wheeled suitcases full of insect-collecting and -observing gear, are intended to long outlast the ATBI itself.

In addition to educating people about insect diversity, the ATBI has been a catalyst for getting people involved in the process of biodiversity discovery (fig. 3, next page). The project has relied on a small army of high school and college students, interns, volunteers, youth groups, retirees, skilled amateurs, and citizen scientists to do much

Figure 2. A poster featuring predators and their prey found in the microwilderness.

of the day-to-day work. This includes tending traps on the islands and, even more importantly, sorting, pinning, labeling, and databasing tens of thousands of specimens in the lab. We have gotten new park records from the nets of fifth graders, and we have had almost every staff person at the park spend a day in the lab marveling at bee diversity through the microscope. An added benefit of the project is that their new appreciation and enthusiasm for insects make students, citizens, and park staff alike ideal ambassadors and advocates for the microwilderness.

Practical applications

Managers might wonder, aside from getting baseline knowledge of biodiversity in the park and looking out for potential pest or rare species, how we can make use of distribution information for 1,800 invertebrate species. Documenting "hot spots" of biodiversity within the park is one way, including habitats that we already know to be important for other wildlife and plants (e.g., freshwater) and microhabitats that might otherwise be overlooked (e.g., sandy south-facing banks that provide nesting

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Figure 3. Families out on Spectacle Island collecting insects for the ATBI during a Family Fun Days program.

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habitat for solitary bees). Another opportunity is to select appropriate taxa to serve as indicators of ecosystem integrity for long-term monitoring, especially in the face of large-scale disturbances such as climate change. To this end, Boston Harbor Islands has piloted a bee monitoring project with a robust sampling design that will allow detection of relatively small changes in bee abundance and richness over five-year intervals. The sampling itself is very simple and replicable, and volunteers can easily be trained to collect bees in the field and process them in the lab, leaving only the task of species identification for the scientists.

A fruitful partnership

As more parks across the country become interested in conducting various kinds of biodiversity discovery activities, it will be useful to have different models from which to draw. Available resources, location, and other factors all figure into designing a successful project. In the Boston Harbor Islands model, a close collaboration between one university and the Boston Harbor Islands Partnership, including the capacity to leverage NPS funding with private donations, has resulted in a remarkably successful ATBI. Total project funding over six years will include approximately $225,000 from NPS sources and $213,000 from private donations. Harvard University benefits directly from this collaboration by adding more than 100,000 local specimens to its invertebrate collections, and the ATBI has provided opportunities for more than 15 Harvard students to learn field, lab, and taxonomy skills, and for some to pursue honors thesis projects. The park, in turn, has benefited from having university scientists coordinate the entire scientific endeavor, which has provided access to other scientists (for specimen identification), lab space and equipment, library resources, imaging and printing equipment, collection facilities, and personnel support for Web site and database maintenance, imaging, and design of outreach products. This model has worked especially well for a small urban park to which scientists are not easily enticed to come and collect for themselves, given the relatively low overall biodiversity and the lack of park facilities such as lab space and accommodations.

References

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