

Monitoring bee diversity and abundance in Boston Harbor Islands National Recreation Area: A pilot study

By Jessica Rykken

BOSTON HARBOR ISLANDS received NPS Challenge Cost Share Funding in 2010 to pilot a native bee monitoring project.

This extended the first phase of an All-Taxa Biodiversity Inventory (focused on terrestrial arthropods) the park had been conducting for the previous five years in collaboration with Harvard University's Museum of Comparative Zoology. Globally, bees have been of conservation concern because of their critical role as pollinators in natural and agricultural ecosystems, but populations of many species are declining and there is evidence to suggest that their ranges are shifting in response to changing climates. Native bees are an ideal group to monitor on the Boston Harbor Islands because they

are diverse and abundant, easy to sample with a standardized, repeatable protocol, and have a taxonomy that is relatively well known.

The two main objectives of the project were (1) to develop and pilot a monitoring program with adequate power to detect relatively small changes in bee abundance and diversity over five-year intervals, and (2) to assess the feasibility of involving citizen scientists in all phases of the project, including field collecting and lab processing. We used "bee bowls" (small painted cups filled with soapy water) to sample bees. Each sampling transect comprised 30 bee bowls spaced 5 m (16 ft) apart. Sixteen transects were set up on nine islands and sampled at intervals during the bloom-

ing season (April to October). This work yielded an impressive 3,938 identified bees, comprising 104 species (approximately 60% of the total bee diversity known from the islands) and including 23 new park records. Among the bees were 26 "cleptoparasitic" species, also called "cuckoo bees." As their name suggests, cuckoo bees lay their eggs in the nests of other host bees, and their developing larvae kill the host progeny and eat their pollen and nectar provisions. Cuckoo bees are thought to be good indicators of the health of the entire bee community, as they are dependent on robust host bee populations for their survival. Three nonnative bees, *Apis mellifera* (honey bee, introduced by European colonists in the 1600s), *Andrena wilkella*, and *Lasioglossum leucozonium*,

Family: Apidae

Small carpenter bees - *Ceratina*



Ceratina dupla ♂ *Ceratina sp.* ♀

(3 species) **Appearance:** Small. Stout. Metallic dark blue/green in color, most with ivory marks on face and/or legs. **Pollen transport:** Hind legs. **Nests:** Solitary, excavate nests in the pithy dead stems of shrubs like sumac and blackberry. Within the stem, the female makes a series of brood cells divided by chewed pith. Adults emerge at the end of summer and usually overwinter in their original nest. **Foraging:** Generalists.

Large carpenter bees - *Xylocopa*



Xylocopa virginica ♀

(1 species) **Appearance:** Large. Similar in size and shape to bumble bees but abdomen is dark, smooth, and shiny. Males have a yellow face patch. **Pollen transport:** Hind legs. **Nests:** Females excavate solitary nests in wood such as house eaves, picnic tables, and standing dead trees (look for the tell-tale sawdust). They chew tunnels into the wood and lay eggs in a series of sealed brood cells. Males are often seen patrolling near nests and will dash at suspected enemies. **Foraging:** Many food crops including blackberry and pepper.

Digger bees - *Anthophora*



Anthophora terminalis ♂

(1 species) **Appearance:** Small to medium. Stout, hairy. Dark body with gray/white hair in our species. Males have a large yellow face patch. **Pollen transport:** Hind legs. **Nests:** Most species dig solitary nests in the ground or in soil banks, and line them with an oily waterproof layer. The mining bee we find on the islands, however, nests in hollow stems. **Foraging:** Generalists.

Honey bees - *Apis*



Apis mellifera ♀ (worker)

(1 species) One species introduced from Europe. **Appearance:** Medium. Amber-colored, banding on the abdomen. **Pollen transport:** Moistened pollen balls in baskets on hind legs. **Nests:** Social, live in permanent colonies. One egg-laying queen and tens of thousands of sterile female workers perform different tasks essential to maintaining the colony. Wild colonies nest in large cavities like hollow trees. Wax combs hang from the nest roof for storing honey and developing bees. **Foraging:** Very effective pollinators of many crops and other plants; they can be raised and transported in managed hives.

Bumble bees - *Bombus*



Bombus impatiens ♀

(7 species) **Appearance:** Large. Robust, fuzzy. Black background with various patterns of yellow and brown hair on the body. Queens are much larger. **Pollen transport:** Moistened pollen balls in baskets on hind legs. **Nests:** Social annual nests. Mated queen bees establish new nests in the spring in cavities in or near the ground (e.g., old rodent burrows). After producing the first brood of female workers, the queen stays in the nest to lay eggs. Later in the season she produces reproductive males and females, and after mating, future queens will overwinter while the rest of the colony dies. **Foraging:** Generalists, many are important crop pollinators for plants such as tomatoes and blueberries. Bumble bees can fly in cooler temperatures, and are active from early spring through late autumn.

Long-horned bees - *Melissodes*



Melissodes drucivella ♂ *Melissodes drucivella* ♀

(6 species) **Appearance:** Medium. Robust. Mainly brown with more or less yellow hair, and a fuzzy thorax. Males have long antennae, and yellow on their lower face. **Pollen transport:** Very hairy hind legs, resembling yellow legwear when loaded with pollen. **Nests:** In most species, females make solitary nests in burrows in the ground and line them with waxy secretions. Some species are communal with more than one female using the same nest but each provisioning her own brood cells. **Foraging:** Sunflowers and other aster species; active from midsummer into autumn.

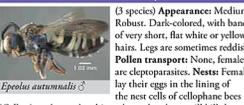
Cuckoo bees - *Nomada*



Nomada imbricaria ♂

(18 species) **Appearance:** Small to medium. Slender-bodied, wasp-like. The thorax and abdomen are dark or red, and the abdomen is often brightly marked or striped with yellow. **Pollen transport:** None, females are cleptoparasites. **Nests:** Females can often be seen flying low to the ground looking for nests to enter, and once in the nest, females of some species lay 2 or more eggs next to the single host bee egg. The first cuckoo bee larva to emerge kills its siblings and the host egg, then eats the pollen provisions. **Nomada** cuckoo bees are most common in spring because that's when their hosts (usually mining bees, *Andrena*) are most abundant.

Cuckoo bees - *Epeolus*



Epeolus autumnalis ♂

(3 species) **Appearance:** Medium. Robust. Dark-colored, with bands of very short, flat white or yellow hairs. Legs are sometimes reddish. **Pollen transport:** None, females are cleptoparasites. **Nests:** Females lay their eggs in the lining of the nest cells of cellophane bees (*Colletes*), and upon hatching, the cuckoo larva will kill the *Colletes* egg and eat the pollen provisioned for it.

Cuckoo bees are diverse and are found in most bee families. Along with cleptoparasitism they share several characteristics: they have no pollen-carrying structures on their bodies; they usually have a thick exoskeleton to protect them from their hosts; and they are often brightly colored like wasps.

Family: Colletidae

Cellophane bees - *Colletes*



Colletes solidaginis ♀

(6 species) **Appearance:** Small to medium. Fuzzy head and thorax (usually yellow or orange hair), and a dark abdomen, often patterned with pale hair bands. **Pollen transport:** Hind legs. **Nests:** Excavate solitary tubular nests in the ground and line them with a waterproof cellophane-like secretion. This prevents water from getting into the nest, and also prevents the liquid nectar and pollen provision in each brood cell from leaking out. Some species nest in dense aggregations. **Foraging:** Many species are specialists.

Masked bees - *Hylaeus*

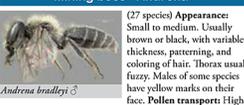


Hylaeus affinis ♂

(7 species) **Appearance:** Tiny to small. Slender, smooth. Mostly black in color, with bright yellow or white marks on the face, front "shoulders," and legs. These bees resemble tiny wasps. **Pollen transport:** Females swallow pollen and carry it internally in a "crop." They later regurgitate a mix of nectar and pollen for each egg in the nest. **Nests:** Made in pre-existing tunnels such as hollow stems or in twigs, and are lined with a cellophane-like secretion. **Foraging:** Presumed to be generalists.

Family: Andrenidae

Mining bees - *Andrena*



Andrena bradleyi ♂

(27 species) **Appearance:** Small to medium. Usually brown or black, with variable thickness, patterning, and coloring of hair. Thorax usually fuzzy. Males of some species have yellow marks on their face. **Pollen transport:** High up on hind legs. **Nests:** Solitary ground-nesters, many species nest in large aggregations. A few species are "communal" meaning several females share the same nest, but build their own brood cells within it. The cells are lined with a waxy secretion. **Foraging:** Specialists or generalists, varies among species. Common in early spring.

Calliopsis



Calliopsis andreniformis ♀

(1 species) Only one species in New England. **Appearance:** Small. Brown body with light hair bands on the abdomen. Females have white marks on the face, and males have a bright yellow face, antennae, and legs. **Pollen transport:** Hind legs. **Nests:** Make solitary burrows in sandy ground, pilling the excavated soil on top of the burrows in a mound. Eggs are laid in waxed cells in lateral burrows off the main tunnel. **Foraging:** Favored plants are legumes such as clover.

...discover the microwilderness of Boston Harbor Islands national park area

The project involved developing a foldout field guide to bee genera found at Boston Harbor Islands NRA.



A volunteer records data while setting out bee bowls on a warm, sunny day—just right for pollinators.

were collected in small numbers; none are of management concern for the park.

In addition to one full-time entomologist from the Museum of Comparative Zoology (me) and one dedicated paid intern, 24 students, volunteers, NPS staff, and other professionals logged more than 450 hours with the project, including 57 field hours and 394 hours in the lab sorting, pinning, labeling, and databasing specimens. I identified the majority of the bees with assistance from Sam Droege at the USGS Patuxent Wildlife Research Center, Beltsville, Maryland, who also helped with developing the statistical design for the monitoring program, and John Ascher at the American Museum of Natural History. This project successfully integrated scientific and community involvement goals. All sampling and processing protocols were developed and documented with citizen scientists in mind, so that they will be easily replicable in future monitoring efforts. We also produced a field guide to the bees of the Boston Harbor Islands, which includes photos and descriptions of 24 bee



Signs were set out at both ends of each bee bowl transect to inform passersby about the bee monitoring project and to ensure that the cups were not mistaken for trash.

genera found in the park and provides easily accessible information about important park pollinators to park staff, volunteers, and visitors alike.

About the author

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