Urbanization leads to more pathogens and inbreeding of wild bees, study finds

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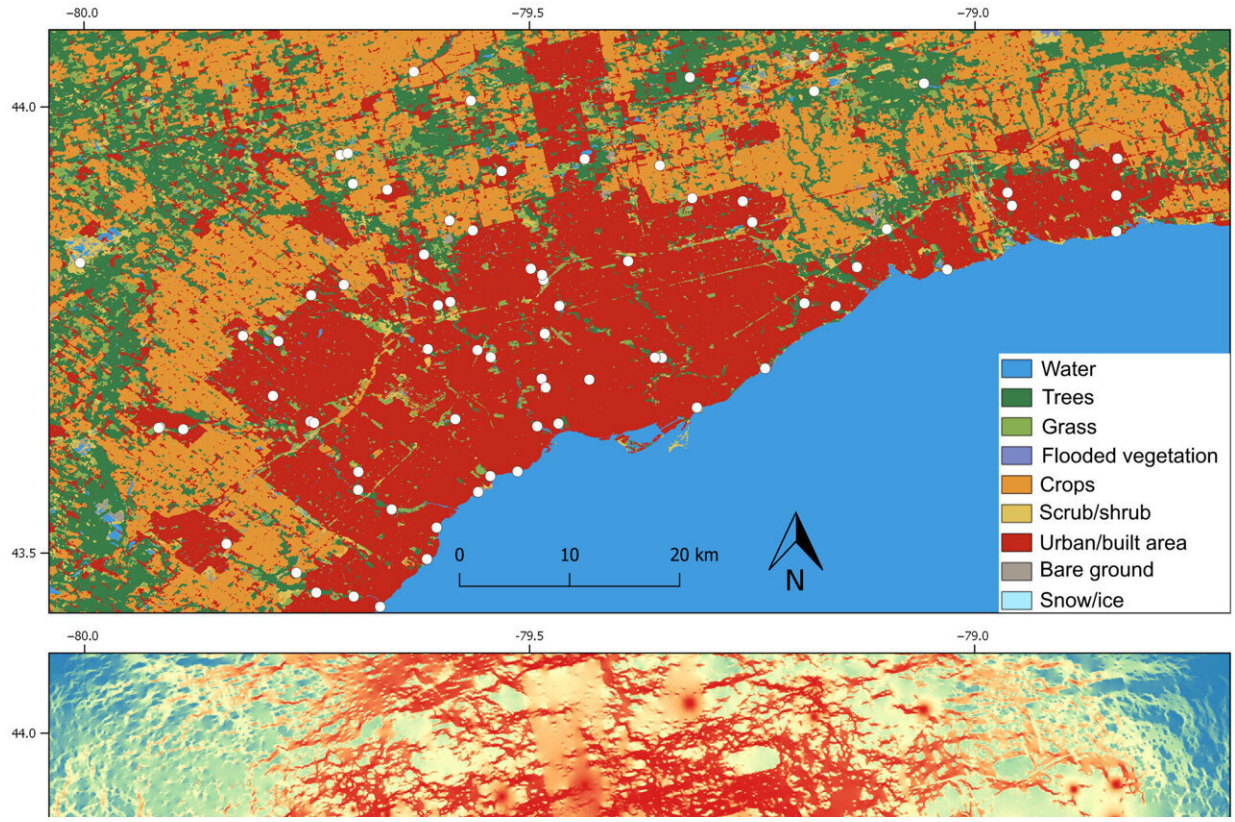

Land use across the study area with white circles indicating collection sites (top). Data source: Esri 2020 Land Cover. Karra et al. (2021). Global land use/land cover with Sentinel-2 and deep learning, IEEE, 2021. The following land use classes were present within the examined area: water (32.03%), trees (14.86%), grass (3.44%), flooded vegetation (0.05%), crops (20.38%), scrub/shrub (1.84%), urban/built area (27.11%), and bare ground/ no vegetation (0.29%). Map generated in Circuitscape using resistance values from hypothesis 4 (IBR 4) (bottom). Warmer colors in the bottom map show higher cumulative current

flow and correspond to green spaces, including, grasses, crops, and shrub/scrub land based on the top map. Maps produced using QGIS Geographic Information System, Open Source Geospatial Foundation Project (http://qgis.org). Credit: *Global Change Biology* (2023). DOI: 10.1111/gcb.16757

Wild bees living in cities like Toronto are facing increased environmental stressors compared to those in rural and even suburban areas, such as more pathogens and parasites, found researchers at York University.

They also found changes in the microbiomes of wild bees living in densely urban areas and fragmented habitats, which makes it more difficult for the bees to access food sources, ideal nesting areas and mates.

These environmental stressors will likely increase in the future as cities expand and landscapes are reshaped, posing one of the largest threats to the natural ecosystems of wild bees and their biodiversity. Two-thirds of the world's population are expected to live in cities by 2050.

"Having less connected habitats in dense urban areas not only leads to more inbreeding, so less genetic diversity, but it also creates higher pathogen diversity leaving city bees exposed to more pathogens," says Corresponding author and Associate Professor Sandra Rehan of the Faculty of Science, York University.

The researchers used whole genome sequencing of 180 common carpenter bees—Ceratina calcarata—to look at their population genetics, metagenome and microbiome, as well the impact of environmental stressors across the Greater Toronto Area. These small carpenter bees are wild and native bees, not managed and non-native bees, such as a

honeybees.

They also found significant environmental variation in bee microbiomes and nutritional resources even in the absence of genetic differentiation.

"Parasite and pathogen infections in bees are a major driver in global bee population declines and this is further exacerbated by urbanization and a loss of habitat and degraded habitat. There are things, though, that cities could do to help wild bees," says lead author York Ph.D. student Katherine D. Chau.

"We found the best way to connect bee habitats and create conditions for more genetic diversity is through green spaces, shrubs and scrub. Conservation efforts focused on retaining and creating these habitat connectors could go a long way toward helping wild bee health."

Although bees are the most prominent pollinators, cities could impact all insect pollinators, which pollinate more than 87 percent of flowering plants and 75 percent of food crops globally. Cities, unlike rural areas, also create an urban heat island effect—higher temperatures in the city than those in the surrounding areas—and this affects flowering times and growing season length. This could lead to flowers, for example, blooming before or after bees are out and foraging.

The higher number of pathogen and parasite infections in urban areas can also be attributed to disease spill over. Because the bees are concentrated in certain areas, infected bees are more likely to contaminate the flowers they visit, which then spreads the infection to the next bee that visits that flower, even across bee species, say the researchers.

"Our research is the first known whole genome sequencing, population genomic and metagenomic study of a wild, solitary bee in an urban

context, which looks at the complex relationship between bees, metagenomic interactions and dense urban landscapes," says Rehan. "This approach provides a tool to assess not only the overall health of wild bees in urban settings but could also be applied across a broad range of wildlife and landscapes."

Now that several known bee and plant pathogens have been identified in dense urban areas, the researchers say it paves the way for early detection and monitoring of threats to wildlife in cities.

"Future studies should explore the link between reduced genetic diversity and the fitness of wild bees in cities," says Chau.

The work is published in the journal *Global Change Biology*.

More information: Katherine D. Chau et al, Integrative population genetics and metagenomics reveals urbanization increases pathogen loads and decreases connectivity in a wild bee, *Global Change Biology* (2023). DOI: 10.1111/gcb.16757

Provided by York University