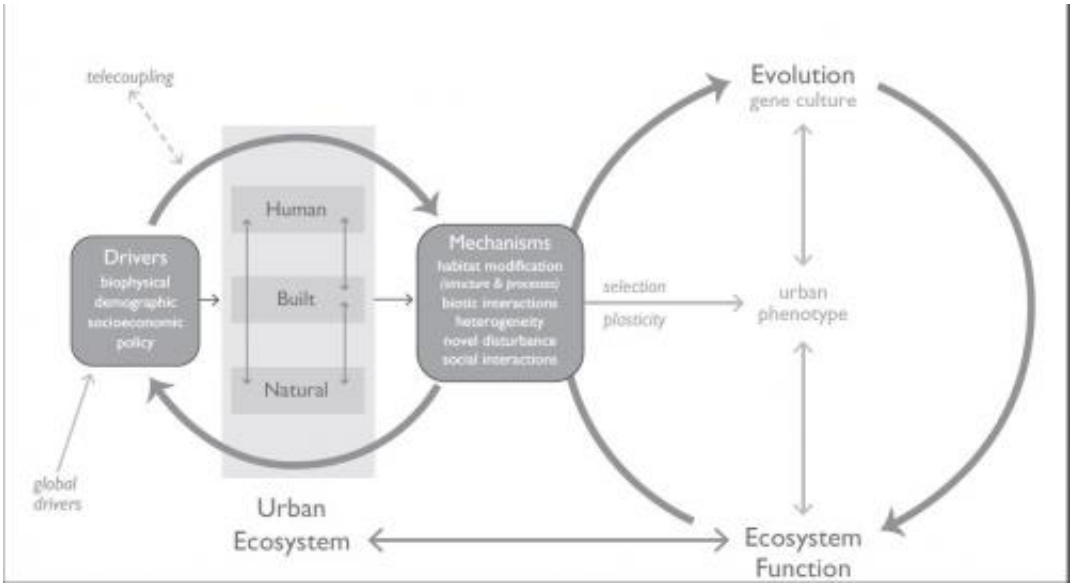
Is urbanization pushing Earth's evolution to a tipping point?

February 19 2015, by Peter Kelley



The work of Marina Alberti of the UW College of Built Environments shows that key urban drivers of change influence eco-evolutionary dynamics through interactions among the human, natural, and built system components of the urban ecosystem. This happens through a series of subtle mechanisms including changes in habitat, biotic interactions, novel disturbance and social dynamics. Credit: Trends in Ecology & Evolution

That humans and the cities we build affect the ecosystem and even drive some evolutionary change in species' traits is already known. The signs are small but striking: Spiders in cities are getting bigger and salmon in rivers are getting smaller; birds in urban areas are growing tamer and

bolder, outcompeting their country cousins.

What's new is that these evolutionary changes are happening much more quickly than previously thought, and have potential impacts on ecosystem function on a contemporary scale. Not in the distant future, that is—but now.

A new paper by Marina Alberti of the University of Washington College of Built Environments' Urban Ecology Research Lab published this month in the journal *Trends in Ecology & Evolution* suggests that if human-driven evolutionary change affects the functioning of ecosystems—as evidence is showing—it "may have significant implications for ecological and human well-being."

Alberti, a professor of urban design and planning, said that until recently it was assumed that evolutionary change would take too long to affect ecological processes quite so immediately. Such thinking has prevented evidence from coming together "in a way that can only emerge through a cross-disciplinary lens," she said, observing the interactions between humans and natural processes.

"We now have evidence that there is rapid evolution. These changes may affect the state of the environment now. This is what's called eco-evolutionary feedback.

"Cities are not simply affecting biodiversity by reducing the number and variety of species that live in urban habitats," Alberti said. Humans in cities are causing organisms to undergo accelerated evolutionary changes "that have effects on ecosystem functions such as biodiversity, nutrient cycling, seed dispersal, detoxification, food production and ultimately on human health and well-being."

These are examples of documented human-driven evolutionary change in selected species. Upper-left: Reproduction in the Daphnia, a zooplankton which plays a key role in the food webs. Center: Body size of the Pacific salmon. Upper-right: New traits in urban white-footed mice compared with those in rural areas. Lower-left: Migratory behavior of European blackbirds. Center: Dispersal of urban Crepis sancta's seeds. Lower-right: Earthworms' tolerance to metals in the soil. Credit: Reproduced with permission from Paul Heber, Michael Jefferies, J.N. Stuart, Lip Kee, Bernard Dupont and Belteguese.

In the paper, Alberti systematically reviews evidence of "human signatures," or documented examples of human-caused trait changes in fish, birds, mammals and plants, and their effects on ecosystem function.

In addition to the shrinking salmon, she cites earthworms with increased tolerance to metals, seeds of some plants dispersing less effectively and a type of urban mouse that is a "critical host" for the ticks that carry Lyme disease, leading to spikes in human exposure to the illness.

Songbirds are becoming tamer and bolder and also are changing their tunes to ensure their acoustic signals are not lost in the noisy urban background. European blackbirds are becoming sedentary and have changed their migratory behavior in response to urbanization.

Humans in cities cause these changes through a variety of ways, Alberti said. Our urbanization alters and breaks up natural vegetation patterns, introduces toxic pollutants and novel disturbances such as noise and light and increases the temperature. Human presence also changes the availability of resources such as food and water, altering the life cycle of many species.

Alberti said the emerging evidence prompts serious questions with implications for the focus and design of future studies:

- Can global rapid urbanization indeed affect the course of Earth's evolution?
- Is urbanization moving the planet closer to an environmental tipping point on the scale of the Great Oxidation Event that introduced oxygen into the atmosphere more than 2 billion years ago?
- Might different patterns of urbanization alter the effect of human action on eco-evolution?

Still, Alberti said hers is not a "catastrophic" perspective, but one that highlights both the challenges and the unique opportunity that humans have in shaping the evolution of planet Earth.

Ecosystems in urban environments are a sort of hybrid, she said: "It is their hybrid nature that makes them unstable, but also capable of innovating." She explores the theme further in a book to be published in spring 2016, titled "Cities as Hybrid Ecosystems."

"We can drive urbanizing ecosystems to collapse—or we can consciously steer them toward a resilient and sustainable future," Alberti said. "The question is whether we become aware of the role we are playing."

More information: "Eco-evolutionary dynamics in an urbanizing

planet." DOI: dx.doi.org/10.1016/j.tree.2014.11.007

Provided by University of Washington