Title

Editorial: Global urban biodiversity and the importance of scale

Permalink

Authors

Blumstein, Daniel T
Alberti, Marina
Beninde, Joscha
et al.

Publication Date

2023

DOI

10.3389/fcosc.2023.1149088

TYPE Editorial
PUBLISHED 08 February 2023
DOI 10.3389/fcosc.2023.1149088

OPEN ACCESS

EDITED AND REVIEWED BY
Christos Mammides,
Frederick University, Cyprus

*CORRESPONDENCE
Daniel T. Blumstein
marmots@ucla.edu

SPECIALTY SECTION
This article was submitted to Global Biodiversity Threats, a section of the journal Frontiers in Conservation Science

RECEIVED 21 January 2023
ACCEPTED 31 January 2023
PUBLISHED 08 February 2023

CITATION
Blumstein DT, Alberti M, Beninde J, Blakey RV, Burger JR, Cooper DS, Niesner CA, Schell CJ, Soga M and Uchida K (2023) Editorial: Global urban biodiversity and the importance of scale. *Front. Conserv. Sci.* 4:1149088.
doi: 10.3389/fcosc.2023.1149088

Editorial: Global urban biodiversity and the importance of scale

Daniel T. Blumstein[1,2]*, Marina Alberti[3], Joscha Beninde[4], Rachel V. Blakey[4,5], Joseph R. Burger[6], Daniel S. Cooper[7,8], Chase A. Niesner[2], Christopher J. Schell[9], Masashi Soga[10] and Kenta Uchida[10]

[1]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, Los Angeles, CA, United States, [2]Institute of the Environment and Sustainability, University of California, Los Angeles, Los Angeles, CA, United States, [3]Department of Urban Design and Planning, University of Washington, Seattle, WA, United States, [4]The LaKretz Center for California Conservation Science, Institute of the Environment and Sustainability, University of California, Los Angeles, Los Angeles, CA, United States, [5]Biology Sciences Department, California Polytechnic University, Pomona, CA, United States, [6]Department of Biology, University of Kentucky, Lexington, KY, United States, [7]Department of Ornithology, Natural History Museum of Los Angeles County, Los Angeles, CA, United States, [8]Resource Conservation District – Santa Monica Mountains, Topanga, CA, United States, [9]Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, United States, [10]Graduate School of Agricultural and Life Sciences, The University of Tokyo, Tokyo, Japan

KEYWORDS

urban biodiversity, scaling, city size, resilience, green space

Editorial on the Research Topic
Global urban biodiversity and the importance of scale

Despite the fast pace of urbanization and city growth worldwide, we lack a general framework to study urban biodiversity across scales. In light of this gap a few attempts have emerged to develop a comprehensive theory using the general perspective of metacommunity ecology (Swan et al., 2021). Many ecological and evolutionary processes are affected by urbanization, but cities vary by orders of magnitude in both their size and degree of development. Scaling has been recognized as an important topic in urban ecology (e.g., Cottineau et al., 2017; Dong et al., 2020) and social and physical characteristics of cities have been shown to scale in a variety of ways including linearly, superlinearly and sublinearly (Bettencourt, 2013). City size is quantified differently across the globe, e.g., by human population size or impervious surface area, and the precise relationships between city size, biodiversity, and drivers that influence biodiversity are key knowledge gaps in the field of urban evolutionary ecology. Understanding scaling relationships and their deviations between cities and biodiversity is necessary to inform urban biodiversity management globally (Uchida et al., 2021). Achieving this requires a truly global and interdisciplinary approach, extending across the regional biases that persist in urban ecology (e.g., an overrepresentation of wealthy temperate nations), and integrating the historical and ongoing social inequities that continue to influence urban biodiversity. In this Research Topic, contributors have explored some key knowledge gaps in the field of scaling and global urban biodiversity. We summarize them below.

Burger et al. tested an assumption of urban scaling theory that human population density increases as the area a city occupies increases. Urban Scaling Theory (UST) predicts this based on increasing efficiency of infrastructural and communication networks as cities grow, resulting in *economies of scale* (Bettencourt et al., 2007; Bettencourt, 2013). In a global analysis based on 933 cities from 38 countries, Burger et al. found that while 18/38 cities supported the prediction that population density would increase with city size, for 17/38 cities, there was no support for population growth beyond a constant (linear) rate, with city size. Given that both city area and human population density are known to influence urban biodiversity, Burger et al. suggest that regional scaling relationships can be used to plan biodiversity management at regional scales. For example, different strategies and incentives can be used to promote connectivity in urban greenspace in larger denser cities. They encourage further research on the relationships between species-area relationships and city size across biomes, as well as the scaling of extra-urban impacts of cities on biodiversity (e.g. relative contribution of greenhouse gases to global climate change).

Dunn et al. explored the potential of developing a general theory for the future evolution of species in cities based on insights from island biogeography, metapopulation theory and macroecology. They asked what evolutionary pressures on biodiversity in cities of the future would look like under different scenarios. The results, as one might expect, varied by scenario: If people become what they referred to as locophilous—meaning that there was extremely little physical movement of humans—we might expect local adaptation and extreme isolation by distance in all species experiencing strong human-mediated dispersal. If people became extremely mobile, then divergence will be restricted to those species that cannot hitch rides on future transportation (e.g., they suggest that rats will become more isolated while smaller species—including pathogens—will travel freely). Other scenarios explored the source of food in cities—is it human associated waste (which they referred to as a 'grey world scenario') or is it green vegetation (a 'green world scenario')? And the amount of waste in cities—is all waste used or does it have to be shipped to landfills. Each option can select for different traits and hence will influence the specific nature of biodiversity. Since these scenarios are under our control, city management decisions and policies will have evolutionary effects on urban biodiversity.

Cooper et al. focused on cities in three California metropolitan areas—Los Angeles, San Diego, and San Jose. Richer cities, those with more pervious cover, and larger cities tended to have more native biodiversity, but average biodiversity levels wanes with city size. Economic variation and past development patterns of the largest cities have led to considerable variation in local biodiversity levels, with vast, biodiversity-poor expanses. However, active management could reverse this trend, as many cities are attempting to do through conservation planning. As cities are human constructs, our policies and decisions will affect their biodiversity and consequently, the evolutionary trajectory of their associated species.

Underpinning the relationships between biodiversity and city size are the resilience dynamics of ecological communities. McCloy et al. reviewed the literature on resilience of avian communities to the dual pressures of urbanization and climate change, including interactions of the two disturbances. By synthesizing studies of avian resilience in the context of ecological theory and key concepts in community assembly, McCoy et al. proposed potential mechanisms to explain substantial variation in bird community response to urbanization and climate change in the literature. In closing, McCloy et al. proposed that resilience (incorporating both functional diversity and adaptive capacity) will be a vital indicator for tracking biodiversity response to urbanization and climate change across scales, and provide actions to overcome current hindrances in resilience science.

Urban green spaces form essential habitat for much urban biodiversity and Rogers looked at how the structure of urban green spaces, measured using LiDAR data, was associated with avian biodiversity in Los Angeles. As is widely believed, area, not habitat structure, was a better predictor of biodiversity for most avian foraging guilds. This is consistent with a species-area relationship and suggest that cities that wish to support avian biodiversity should develop and/or protect urban green space. This, however, is not to say that improving their the quality of habitats is not useful for protecting biodiversity in urban areas. Indeed, there was substantial interspecific variation in how bird species responded to habitat structure which suggests that not all species will respond similarly. Therefore, achieving specific biodiversity goals may require species-specific management.

It is not just green space that provides habitat for urban animals. Niesner et al. explored the idea that the built environment creates novel structures, but that some species may essentially be pre-adapted to thriving in these urban infrastructural habitats. Focusing on how animals perceive the world around them they described how the anthropogenic landscape is filled with 'affordances' for wildlife. By focusing more on a species' umwelt—its perceptual world— we can gain new insights into the forms and forces impacting urban biodiversity. Importantly, they also called for a better understanding of how "infrastructural signatures", the conforming of wildlife movement to human infrastructural spaces, grow as cities grow because this will create opportunities for what they refer to as an 'emergent hybridity' whereby anthropogenic features are used by both humans and wildlife.

Given that not all species respond the same way to urbanization, Thaker et al. focused on how landscape heterogeneity varied across a large urban area in India and how this influenced the presence of a single lizard species at multiple scales. Using remote sensing and community science data they found substantial variation in a variety of landscape features as one moves away from a city center. Not all features changed predictably, nor did they vary linearly; lizard presence was best explained by land surface temperature at the landscape scale, while the proportion of rocks best explained lizard presence at the microhabitat scale. The study emphasized the importance of focusing on the species' relevant environmental factor to better understand the scale dependency. Findings like these have important implications for how we can expect urban environments to sustain species.

Pro-conservation strategies and actions implemented in urban areas contribute to the conservation of global biodiversity both directly *via* the enhancement of local biodiversity and indirectly through improving people's positive perceptions, attitudes and behaviour towards nature. Given this, Pierce et al. focused on how cities can meet global biodiversity targets. Specifically, they compared the Aichi Biodiversity Targets with 44 local biodiversity plans from cities of multiple sizes from around the world. They identified actions at the local scale to achieve global biodiversity targets, which include increasing awareness, integrating biodiversity values, reforming incentives, protecting habitat to manage endangered species, managing invasive species, protecting ecosystem services, habitat restoration, creating biodiversity action plans, and sharing knowledge with others.

These papers have illustrated some of the issues that arise when thinking about urban scaling and biodiversity. Clearly, there is much more to do.

Most exciting to us are the many philosophical, ethical and political issues that arise from trying to manage biodiversity in cities. Cities require that we think of biodiversity conservation in an explicitly socio-ecological framework. Thus, future studies must answer questions such as:

1. *How can scaling of cities inform equitable access to biodiversity across regions?* For example, as cities grow, people of low socioeconomic status may have more access to biodiversity within the Global South (e.g., informal settlements), or less access to biodiversity in the Global North (e.g., high density living). Importantly, access to biodiversity can bring both ecosystem services and disservices (Kendal et al., 2020).
2. *How does the effectiveness of biodiversity management scale with city size?* For example, are different biodiversity management approaches required for smaller and larger cities, and for denser or sparser cities?
3. *How do multiple entities either coordinate or cause interference in biodiversity management at multiple scales?* For example, how can we ensure that nested management of large resources that are important for biodiversity, like rivers, are effective, inform each other and representative of local and indigenous knowledge?
4. How does city scale influence the relationship between systemic racism and biodiversity (current and historical)? For example, how have historical legacies of racism perpetuated current inequities in our cities (both social and ecological) across the Global South and Global North?
5. How does human diversity and/or inequality scale with city size, and do these attributes have an effect on biodiversity? For example, can intentional policies by city planners to diversity neighborhoods increase connectivity of greenspace and equitable access to nature while avoiding the social harm of gentrification?
6. How do we reconcile the conservation strategies of land sparing and land sharing with urban scaling and questions of environmental justice? For example, as cities grow, what type and configuration of natural areas will balance access to biodiversity and its ecosystem services, with connectivity to ensure biodiversity persists?
7. How does the history of city growth influence patterns of biodiversity in cities? For example, do cities that grow faster have less stable ecosystems than cities that grow more slowly?
8. And, can we predict biodiversity responses to urban shrinking by developing an understanding of scaling? For instance, as cities contract or expand, can we predict the expected change in species richness.
9. What is the role of chance and contingency in novel urban ecosystems, and how should we plan accordingly in our management practices? In other words, how strong are the scaling patterns and how do we understand the variation unexplained by scaling? Is it deterministic or is it random?
10. How might eliciting the perspectives of diverse informers on urban biodiversity (e.g., pest control professionals, sanitation workers, infrastructure repair persons) afford conservationists a better understanding of "cross-scale functional arrangements," whereby differently-scaling, natural-cultural processes overlap to form novel and somewhat unpredictable urban ecosystems? For example, how does the weekly waste collection schedule influence behavior of opportunistic urban scavengers (e.g., coyotes), and consequently human behavior and political views?
11. How can we begin to frame the ways nature within cities consists of novel ecosystems/novel biodiversity, as opposed to the disappearance or homogenization of existing biodiversity, and might this depend on city size? For example, can our cities provide "arks" for threatened taxa as our world changes (Shaffer, 2018)?

We hope that the papers in this Research Topic stimulate interdisciplinary scholars to address these and other questions about urban biodiversity scaling. Doing so will put us in a better position to manage urban biodiversity within our dynamic cities in the Anthropocene.

Author contributions

DB wrote the first draft; all authors edited and approved it for publication.

Acknowledgments

We thank Christopher Kelty for helping conceive this Research Topic.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Bettencourt, L. M. A. (2013). The origins of scaling in cities. *Science* 340, 1438–1441. doi: 10.1126/science.1235823

Bettencourt, L. M. A., Lobo, J., Helbing, D., and West, G. B. (2007). Growth, innovation, scaling and the pace of life in cities. *Proc. Nat. Acad. Sci. U.S.A.* 105, 7301–7306. doi: 10.1073/pnas.0610172104

Cottineau, C., Hatna, E., Arcaute, E., and Batty, M. (2017). Diverse cities or the systematic paradox of urban scaling laws. *Comp. Environ. Urban Sys* 63, 80–94. doi: 10.1016/j.compenvurbsys.2016.04.006

Dong, L., Huang, Z., Zhang, J., and Liu, Y. (2020). Understanding the mesoscopic scaling patterns within cities. *Sci. Rep.* 10, 21201. doi: 10.1038/s41598-020-78135-2

Kendal, D., Egerer, M., Byrne, J. A., Jones, P. J., Marsh, P., Threlfall, C. G., et al. (2020). City-size bias in knowledge on the effects of urban nature on people and biodiversity. *Environ. Res. Lett.* 15, 124035. doi: 10.1088/1748-9326/abc5e4

Shaffer, H. B. (2018). Urban biodiversity arks. *Nat. Sust* 1, 725–727. doi: 10.1038/s41893-018-0193-y

Swan, C. M., Brown, B., Borowy, D., Cavender-Bares, J., Jeliazkov, A., Knapp, S., et al. (2021). A framework for understanding how biodiversity patterns unfold across multiple spatial scales in urban ecosystems. *Ecosphere* 12, e03650. doi: 10.1002/ecs2.3650

Uchida, K., Blakey, R. V., Burger, J. R., Cooper, D. S., Niesner, C. A., and Blumstein, D. T. (2021). Urban biodiversity and the importance of scale. *Trends Ecol. Evol.* 36, 123–131. doi: 10.1016/j.tree.2020.10.011