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REVIEW PAPER

Urban expansion as a driver of biodiversity loss: Integrating biodiversity in urban planning in African context

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ABSTRACT

Africa has high biodiversity and is rapidly urbanizing. However, there is limited understanding of how urban expansion in Africa is likely to affect its habitats and biodiversity. Little urban ecological research has been done in Africa. This study needs to think ahead as Africa move into the "urban age" it is critical to inform the public on the importance of urban environment and to justify the need to preserve these areas. The conservation value of urban environments stems should not be overlooked. Cities represent considerable opportunities for forwarding global biodiversity and sustainability goals. However, recent scientific evidence shows that these assumptions do not always hold. Although it is generally true that increasing the size, quality, and connectivity of habitat patches will improve the probability that a species can persist, the inverse is not that small, degraded, or fragmented habitats found in urban environments are worthless. In this study an updated messages that guide and inspire researchers, practitioners, and decision makers to undertake conservation action of African urban environments is proposed: considering small spaces, recognize the value of integrating biodiversity in African cities, test creative solutions, and use ecological knowledge to minimize the impacts of future urban development in African biodiversity.

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INTRODUCTION

Urban biodiversity management is at a peripheral stage in most African countries. Urban planning in Africa assigns very low priority on aspects related to biodiversity conservation. Been accorded with this is a common situation in developing countries where urban planning systems accord low priority to biodiversity. Biodiversity are important for the urban population as they contribute to economic stability as well as physical security (SIDA, 2016). However, recent global analyses indicates that urban areas are expanding and are the major causes of biodiversity loss (Seto *et al*. 2012; Aronson *et al*., 2014). Urban areas encompass a wide range of ecosystems, include regions of high native biodiversity, and are inhabited by rare, endangered and threatened species (Schwartz *et al*., 2002; Rebelo *et al*., 2011; Kantsa *et al*., 2013; Ives *et al*., 2016). Urban areas are expanding and these areas contains important native species, it follows that protecting and promoting biodiversity in such areas should be critical. Currently, the continent has seven megacities, that is cities with populations

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over 10 million. In 15 years time, Luanda and Dar es Salaam will be added to the list (Guneralp *et al.,* 2017). It should be noted that how African cities grow and develop can have negative implications when it comes to protection of biodiversity and climate change mitigation and adaptation. While rapid urban growth will occur over the next several decades, there is a unique urgency to act now. Decisions taken by governments in the next few years could significantly change and help shape how cities grow and develop. This review aimed at investigating the currently under-utilized opportunity of biodiversity conservation within cites. Yet in practice, progress is slow and uneven, despite repeated calls to action in the scientific literature (Miller and Hobbs 2002; Rosenzweig 2003; Dunn *et al.,* 2006).

The regions are based on United Nations (UN) regional categorization; mid-latitudinal Africa is the Western, Middle, and Eastern Africa regions. Grayed-out areas represent the projection interval (UN, 2014). The total population in the continent is projected to reach almost 2.5 billion people by 2050 with about 55% living in urban areas (Fig. 1). This is a significant increase given that less than 10% of Africa's population resided in urban areas in 1950. Most of the increase in urban population is taking place in small- and medium-sized cities in mid latitudinal Africa. The growth of existing villages and towns is also transforming rural landscapes into urban Areas (Laswa *et al*., 2014).

Probabilistic forecasts of urban expansion by 2030 in Africa. Estimates the probability for each location by calculating the percentage of 1000 spatially explicit simulations of urban growth, in which that location becomes urban. Probabilities vary from 1% to 100% from yellow to red on the maps (Fig. 2). High rates of urban expansion are expected along the Nigerian coast and within the Lake Victoria Basin (Bren d'Amour *et al.,* 2017). Even in relatively lower-fertility countries such as South Africa, major urban centers are expected to grow well beyond their current municipal boundaries. The increase in urban population in Africa will be accompanied with an expansion in urban land (Guneralp *et al*., 2017). Between 2000 and 2030, urban land in Africa is forecasted to increase by nearly 600% (Seto *et al*., 2012) (Fig. 2) The forecasted urban expansion in the continent is concentrated in five regions: the Nile River in Egypt, the coast of West Africa along the Gulf of Guinea, the northern shores of Lake Victoria in Kenya and Uganda and extending into Rwanda and Burundi, the Kano region in northern (Guneralp *et al*., 2017). Urban expansion as driver of

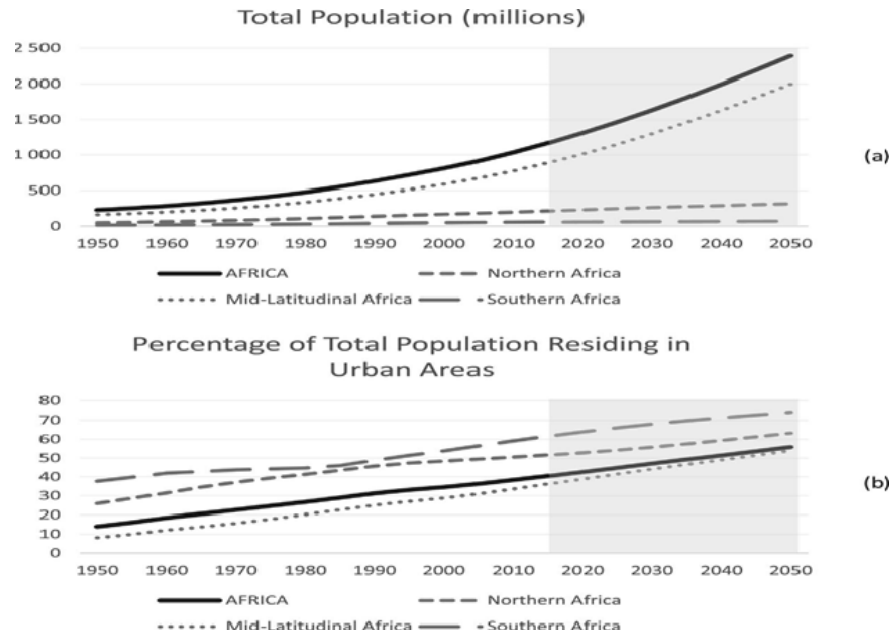

Fig. 1. Historical trends and future projections for total population (*a*) Percentage of total population living in urban areas (*b*) in Africa and its three regions (Guneralp *et al.,* 2017).

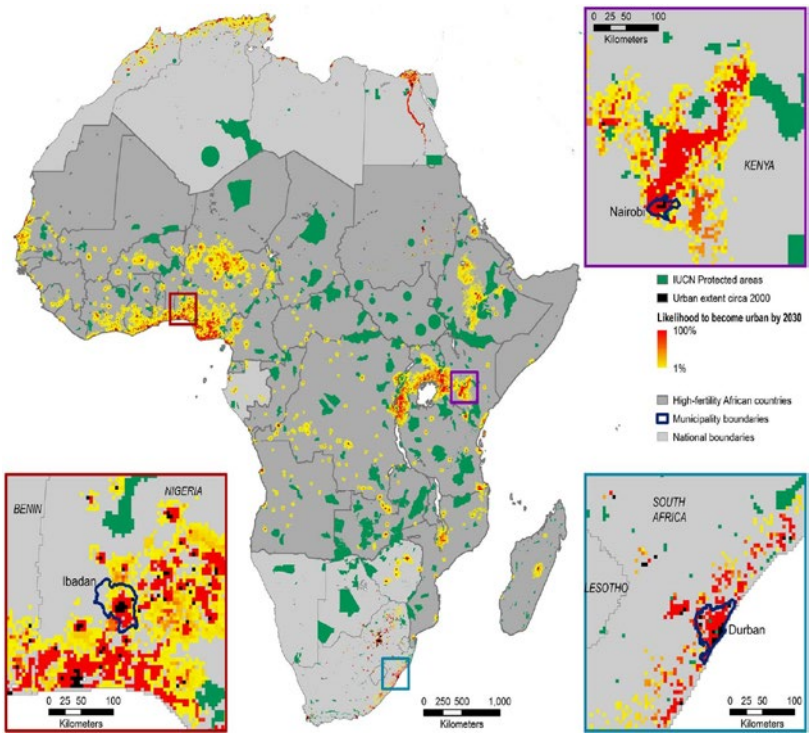

Fig. 2. Geographic location of the study area in Africa (Guneralp *et al.*, 2017)

biodiversity loss: Linking biodiversity of city planning in Africa. Africa has several regions with exceptional biodiversity (SADC, 2012), however, urban areas are expanding towards natural habitats and increasing demands of growing urban populations on natural resources pose direct and indirect pressures on biodiversity, e.g. Human settlements and social facilities such as road construction network, water systems are main drivers of urban development (UN, 2015). Still, as urban expansion is higher in Africa caution must be taken in reducing predicted impacts on biodiversity (Fig. 1). There is a serious need to integrate biodiversity in city planning (public parks, open space, constructed wetlands), however suggestions for urban biodiversity conservation are still met with surprise, doubt, or skepticism (Semlitsch and Bodie 1998; Sanderson and Huron 2011; Salomon Cavin 2013). Linking biodiversity in city planning can be achieved through involving both developers and the public. The government and its cross sectoral ministries must be engaged in order to facilitate the conservation of urban biodiversity. Planners and researchers can play a role in encouraging proper design/management of built areas and monitoring the functionality of urban habitats, although there is a large and increasing body research on ecosystem services in cities, the findings are not often used by city planners (Ahern *et al*., 2014; Haase *et al*., 2014).

Negative views of researchers and practitioners towards urban conservation

Africa conservation strategies and policies place a premium on large, high-quality, well-connected patches of remnant vegetation with a low prevalence of threats. However, such patches are rare in the urban realm and this invites the view that urban environments are inherently worse for conservation. In other cases, urban areas are overlooked altogether (Soanes, *et al.,* 2018). For example, In Tanzania it is not unusual for large-scale conservation prioritization or planning exercises to exclude urban areas from consideration or assign them a low conservation value a priority (Moilanen *et al.,* 2005). Policy makers, land managers, and conservation practitioners are, thus, reluctant to invest their limited conservation funds and effort in an area deemed to be of high risk, low

value, and with a low probability of success (Miller and Hobbs 2002; Sanderson and Huron 2011; Olive 2014). Although it is generally true that increasing the size, quality, and connectivity of habitat patches will improve the probability that a species can persist, the inverse is not that small, degraded, or fragmented habitats are worthless. (Prugh *et al*., 2008) meta-analytic study of >1,000 bird, mammal, reptile, amphibian, and invertebrate population networks on 6 continents demonstrated that patch area and isolation are surprisingly poor predictors of occupancy for most species. Further, a recent review found little evidence to support the notion that habitat fragmentation per se has a negative impact on biodiversity (Fahrig, 2017). The role of the intervening matrix in providing resources and facilitating movement is now well recognized, to the point that it can no longer simply be referred to as non-habitat (Franklin and Lindenmayer, 2009; Driscoll *et al.,* 2013). Turning to organisms themselves, it is noted that the life-history traits of a species, such as reproductive requirements, generation time, and mobility, can play a large role in determining the likelihood of persistence in urban environments. For example, large patches of habitat may not be required to support the persistence of small plants with limited dispersal ability (McCarthy *et al.,* 2006). Other factors such as adaptive potential (i.e., phenotypic or behavioral plasticity) also influence the capacity of organisms to exploit and survive in urban environments (McDonnell and Hahs 2015). These research insights do not support the lost cause narrative so frequently applied to urban environments. The mismatch between common understanding (among researchers and practitioners) and recent scientific evidence (Norton *et al*., 2016) suggests the need for revised messages to guide conservation action in cities. Identified examples from the growing body of research on urban biodiversity, and considered how policy and practice could be updated to make these actions more effective. In short, urban conservation must consider small spaces, creating and recognizing urban habitats, test creative solutions, and use science to minimize the impacts of future urban development.

Valuing small urban spaces

The nature of urban landscapes are fragmented (Phillips, *et. al.,* 2017), resulting into small urban spaces. These small urban spaces can support and sustain populations of native species. Even very small landscape elements, such as solitary trees (Stagoll *et al.,* 2012) or ponds (Calhoun *et al*., 2014; Hill and Wood 2014), provide critical habitat resources. Many species can inhabit small patches in altered landscapes by adjusting their home range and behaviors or by taking advantage of resources that lie beyond the patch within the urban matrix (Shochat 2004; Wright *et al*., 2012). In some cases, small urban habitats support comparable populations and species diversity to nonurban areas, are critical to the persistence of local populations, and enhance regional diversity. For example, a comprehensive analysis of 80 ponds in Switzerland not only found little evidence for taxon-specific species area relationships, but the number of species in a set of small ponds was greater than a single large pond of comparable total area (Oertli *et al*., 2002). Similarly, an assessment of a network of urban grasslands in Australia showed that small grasslands contained unique species not found in larger reserves and thus contributed to the overall biodiversity of the landscape (Kendalet *et al., 2017*). The potential for cumulative biodiversity gains to be made through the management of multiple small urban spaces may also better attract conservation initiatives led by local government or community groups with limited resources. Protecting and enhancing small landscape elements in urban environments through appropriate policy and decision making is therefore critical to maintain native biodiversity in cities and town.

Recognizing urban habitats

Areas originally created for human use that can provide important habitat or resources for native biodiversity. The potential for unconventional habitats is wonderfully diverse, ranging from large spaces such as brownfields, golf courses, and cemeteries (Colding and Folke, 2009; Threlfall *et al.,* 2015; Gilchrist *et al.,* 2016; Gallo *et al.,* 2017*)* to smaller pockets such as roadsides or cavities within buildings and infrastructure (Ray and George, 2009*;* Iqbal *et al.,* 2015; Maclagan *et al.,* 2018). For example, wetlands constructed to trap sediments and treat storm water before it enters creeks and rivers are readily inhabited by a variety of native species (Hassall and Anderson 2015).

Developing creative actions

There is a growing need to intentionally create conditions for nature to thrive in urban environments

(Rosenzweig 2003; Sanderson and Huron, 2011). This includes actions to minimize human–wildlife conflict, reduce mortality rates, or provide resources that might otherwise be lacking in urban areas (e.g., feeding or nesting sites). Changing the type of street lighting, for example, can reduce the impact of artificial light on nocturnal species (Lewanzik *and* Voigt, 2017), novel collars can reduce predation of urban wildlife by domestic cats (Calver *et al.,* 2007), and artificial cavities can provide suitable nesting sites for wildlife (Bender *et al.,* 2016; Griffiths *et al.,* 2018). Artificial structures, such as wildlife bridges and tunnels, can also be used to overcome barriers to movement created by urban infrastructure Rope bridges installed as part of the Urban Monkeys Program in southern Brazil provided safe passage for brown howler monkeys (*Alouattaguariba clamitans*), porcupine (*Spiggurus villosus*), and white-eared opossum (*Didelphis albiventris*) across urban roads (Teixeira *et al.,* 2013). More recently, conservation scientists have advocated for bolder initiatives in urban environments, such as creating habitats on built infrastructure (Williams *et al. 2014*), recognizing the value of novel ecosystems (Hobbs *et al.,* 2009; Kowarik 2011), and restoring species through reintroduction and translocation (Watson and Watson, 2015). If creative actions are to become routine management practice, they must be accompanied by a thorough and coordinated evaluation of their effectiveness. Studies that take an experimental approach to evaluating new methods (Lewanzik *and* Voigt, 2017; Griffiths *et al.,* 2018; Soanes *et al.,* 2018) will help build an evidence base for urban conservation that can guide managers and practitioners to apply creative practices that promote biodiversity in cities and towns.

Minimizing future impacts

In rethinking urban conservation, one must also have future urban development squarely in sight. Urbanization is accelerating through expansion (Jim, 2004; Seto *et al.,* 2011) and densification (Haaland and van den Bosch, 2015; Hedblom *et al.,* 2017); the majority of urban growth is predicted to occur in biodiversity hotspots in Asia and Africa (Seto *et al.,* 2012; Schneider *et al.,* 2015; UN DESA, 2018). This will place increasing pressure on natural environments, including direct impacts in situ such as habitat loss, fragmentation, and degradation, as well as indirect impacts that can propagate a city's ecological footprint far beyond the immediate area of development (Rees and Wackernagel 1996). Although minimizing the ecological footprint of cities requires sustainability innovations beyond the scope of this paper, we point to existing scientific evidence and tools that can be used to build urban environments with improved outcomes for biodiversity. At the landscape scale, systematic conservation planning can be used to plan new cities or suburbs that maximize development objectives while avoiding areas critical for biodiversity. This approach explicitly quantifies and maps the relative biodiversity value of different areas across the landscape (e.g., based on modeled habitat quality for target species or expert opinion) to help stakeholders visualize, understand, and deliberate the merits of multiple urban development options. (Bekessy *et al.,* 2012) showed how systematic planning methods can aid the community and decision makers in making informed and intelligent trade-offs, such as designating development zones in areas of lower biodiversity value in western Melbourne (Australia), while (Ground *et al.,* 2016) illustrated the value of urban and peri-urban conservation planning for the conservation of grassland ecosystems in the rapidly urbanizing eThekwini Municipal Area of South Africa. Analyses that take approaches that address the entirety of a landscape will be particularly useful for comparing often debated development alternatives, such as sharing versus sparing (Lin and Fuller, 2013) or sprawl versus densification (Rebelo *et al.,* 2011), as well as the likely outcomes of sustainable development initiatives (Guneralp *et al.,* 2017). Considering the site-level scale (i.e., 10s to 1000s of m2), evidence-based urban design principles can help develop neighborhoods that are more sensitive to biodiversity (Milder 2007; Hostetler and Drake 2009; Marshall 2013; Ikin *et al.,* 2015; Garrard *et al.,* 2017). These synthesize the growing body of urban ecological research to show how protecting and increasing habitat, facilitating dispersal and ecological processes, minimizing threats, and promoting positive human–nature interactions can all be achieved in urban developments. (Garrard *et al.,* 2017) proposed the framework of "biodiversity sensitive urban design" to guide the implementation of these principles during the design, construction, and post construction phases of development. A key advantage of this approach is the emphasis on ensuring the persistence of biodiversity within urban settings, in contrast to

offsetting (Chee, 2015), which is unlikely to provide fair and adequate compensation for urbanization impacts (Coker *et al.,* 2018). Regardless of scale, achieving better biodiversity outcomes in future urban developments will depend on forward planning and collaborative partnerships among the community, government, ecologists, planners, engineers, and architects to develop co-created solutions.

Urban conservation as an opportunity waiting For Africa

The problems of urban conservation are not insurmountable, but success requires a careful start" (Dearborn and Kark, 2010). Conserving native biodiversity is both important and achievable in cities and towns. There is mounting evidence that the public support the conservation of urban biodiversity (Chen and Jim, 2010; Olive, 2014), including the importance of interactions with charismatic species (Savard *et al.,* 2000; Stokes *et al.* 2010) and the cultural significance of urban nature (Cocks and Dold, 2006; MSDI, 2015). The presence of biodiversity in cities also benefits people, improving human health and well-being through connection to nature (Fuller *et al.* 2007; Shanahan *et al.,* 2015). Community engagement can also boost biodiversity conservation: the urban community was instrumental in documenting the return of smooth-coated otters to Singapore (Theng and Sivasothi, 2016) and the installation and monitoring of rope bridges for arboreal mammals in southern Brazil (Teixeira *et al.,* 2013). However, long-held perceptions that undervalue urban environments undermine opportunities for conservation. The messages which have highlighted here update the narrative of urban biodiversity conservation, enabling researchers, policy makers, planners, and practitioners to act based on scientific evidence and tools. Although the list is not exhaustive, tackling current misconceptions represents a critical step in moving toward effective conservation action in urban environments. Recognizing the value of urban habitats for native species, and the potential for creative conservation opportunities, opens up new avenues for managers in urban environments and will lead to better conservation outcomes. For example, researchers in Germany reintroduced grassland species to urban wasteland lots, taking advantage of these small, unconventional spaces to create novel ecosystems that met conservation goals (Fischer *et al.,* 2013). Also a Researcher in Tanzania explained how urban dumpsite and sewage stabilization support birds diversity in urban areas (Massawe, *2017*). Further, the experimental approach allowed the researchers to identify the most successful and cost-effective methods and provide guidance to land managers. Re-imagining urban habitats proposed developments as opportunities for conservation gains rather than as derelict, modified habitats helps empower communities and local managers to take positive actions for biodiversity on a local scale. In this way, inspiring biodiversity in urban environments will ultimately benefit both urban biodiversity and the humans that live in cities. A major concern to be understood is how African cities grow and develop can have negative implications for protecting biodiversity and for climate change mitigation and adaptation. While rapid urban growth will occur over the next several decades, there is a unique urgency to act now. Decisions taken by governments in the next few years could significantly change and help shape how cities grow and develop.

A way forward for managing and integrating biodiversity in city planning.

African Governments need to plan for a positive natural future, one where urban growth and development occurs while biodiversity is protected. Some actions are crucial are to be taken as advantage of this unique moment. *Integrate local governments in national planning from the start*: Countries use National Biodiversity Strategies and Action Plans (NBSAPs) to delineate how they will achieve progress towards Convention of Biological Diversity goals. There is an urgent need to better consider urban growth in the next iteration of NBSAPs, as well as in sub-national and local Biodiversity Strategies and Action Plans. National governments should integrate local governments into the planning process and set aside appropriate resources, supporting local governments as they implement these plans. The financial and resource commitments that countries make to urban conservation should match the scale of the challenge that poorly planned urban growth poses to the goals of the Convention of biological diversity. *Empower African cities to plan for a positive natural future:* Urban growth plans need to incorporate information on biodiversity and ecosystem service value. Create "green prints" of urban growth. These green prints plan for how to protect and restore existing habitat that is important for biodiversity and ecosystem

services, as well as create new natural features (e.g., parks, street trees) that achieve the same goals. Participatory methods can be used to identify positive futures based on the local preferences of different city stakeholders. Governments at all levels should empower cities and metropolitan areas to plan effectively for protecting biodiversity. *Leverage international institutions*: International institutions will play a key role in influencing the design and funding of cities of the future. More extensive consideration of urban growth impacts on biodiversity and ecosystem services in the funding decisions of major institutions, both multilateral and bilateral. Major international funding sources, such as the Global Environmental Facility and the Green Climate Fund, should seek to directly appropriate funding to mitigate the impact of urban growth on biodiversity and ecosystem services, focusing especially on key priority areas where the impact is likely to be largest. Similarly, bilateral donors should aim to fund projects that minimize urban growth impacts on key protected areas. *Creation of Convention of Biological Diversity in urban phase:* Parties needs view the time between now and 2020 as a period to plan what urban conservation investments are needed to meet the challenge urban growth poses to the goals of the Convention of biological diversity. In the next meeting of the CBD in 2020 will be a moment for Parties to the CBD to make significant commitments to protect biodiversity and human wellbeing in the urban century.

CONCLUSION

Encroachment of urban areas towards natural habitats and increasing demands of growing urban populations on natural resources put direct and indirect pressures on ecosystem (Guneralp *et al.*, 2017). Biodiversity and ecosystem services are a crucial part of sustainable urban development. They contribute to resilience against disasters, regulate temperature, improve food and water security, absorb pollution, contribute to livelihoods and addressing poverty. The strong linkages between urban quality of life and how cities use and manage natural resources becomes essential in having integrated approaches to sustainable urban planning. Many challenges lie ahead for the successful integration of biodiversity into local planning processes. Biodiversity is still a foreign concept to many planning scholars and professionals. Managing protected areas near cities will be a common challenge in urban century, and close to half of all protected areas will require special management if they are to retain their ecological functions. There is very little coverage of biodiversity in planning schools. The typical physical planning tools are limited in their ability to address biodiversity, a concept which is sometimes confused for 'green areas'. However, students of planning will be the practitioners of tomorrow, and will influence the way African cities are planned and developed. While with the predictions that rapid urban growth will occur over the next several decades especially in African cities, there is a unique urgency to act soon. In this review we urge prompt decisions to be taken by governments in the next few years that could significantly change and help shape how cities grow and develop. As urban expansion is growing higher in Africa, if is well managed through proper establishment of good policy on urban management at this time, predicted impacts on loss of biodiversity can be reduced. Biodiversity conservation in the urban areas should be integrated with the city planning that is setting aside (public parks, open space, constructed wetlands) etc, however suggestions for urban biodiversity conservation are still met with surprise, doubt, or skepticism. Linking biodiversity in city planning can be achieved by involving both developers and the public, and this can be coordinated by the African Governments through its cross sectorial ministries i.e. ministry of Natural Resources and Tourism, Ministry of Prime Minister (Environment), Ministry of Agriculture etc. Planners and researchers under these ministries can play a role in encouraging proper design/management of built areas and monitoring the functionality of urban habitats, for the wellbeing of biodiversity at large.

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CONFLICT OF INTREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. In addition, the ethical issues; including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy have been completely observed by the authors.

REFERENCES

Ahern, J.; Cilliers, S.S.; Niemela, J., (2014). The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation. Landscape Urban Plan. 125: 254–259 (**6 pages**).

Aronson M.F.; La Sorte, F.A.; Nilon, C.H.; Katti, M.; Goddard, M.A.; Lepczyk, C.A.; Warren, P.S.; Williams, N.S.; Cilliers, S.; Clarkson, B., (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. Proceedings of the Royal Society B 281**:** 20133330 (**8 pages**).

Bekessy, S.A.; White, M.; Gordon, A.; Moilanen, A.; McCarthy, M.A.; Wintle, B.A., (2012). Transparent planning for biodiversity and development in the urban fringe. Landscape Urban Plann., 108: 140–149. (**10 pages**).

Bender, J.; Fidino, M.; Limbrick, K.; Magle, S., (2016). Assessing nest success of black-capped chickadees (Poecile atricapillus) in an urban landscape using artificial cavities. Wilson J. Ornith., 128: 425–429 (**5 pages**).

Bren d'Amour, C.; Reitsma, F.; Baiocchi, G.; Barthel, S.; Güneralp, B.; Erb, K.H.; Haberl, H.; Creutzig, F.; Seto, K.C., (2017). Future urban land expansion and implications for global croplands. Proceedings of the National Academy of Sciences, 114(34): 8939-8944 (**6 pages**).

Calhoun, A.J.; Jansujwicz, J.S.; Bell, K.P.; Hunter, M.L., (2014). Improving management of small natural features on private lands by negotiating the science-policy boundary for Maine vernal pools. P. Nat. Acad. Sci. USA, 111: 11002–11006 (**5 pages**).

Calver, M.; Thomas, S.; Bradley, S.; McCutcheon, H., (2007). Reducing the rate of predation on wildlife by pet cats: the efficacy and practicability of collar-mounted pounce protectors. Biol. Conserv., 137(3)**:** 341–348 (**8 pages**).

Chalker, Scott, L., (2015). Nonnative, noninvasive woody species can enhance urban landscape biodiversity. Arboric. Urban For., 41(4):173–186 (**14 pages**).

Chee, Y.E., (2015). Principles underpinning biodiversity offsets and guidance on their use. Pages 51–59 in van der Ree R, Smith DJ, Grilo C, editors. Handbook of road ecology. Wiley and Blackwell publication, London. 51-59 (**9 pages**).

Chen, W.Y.; Jim, C., (2010). Resident motivations and willingness-to-pay for urban biodiversity conservation in Guangzhou (China). Environ. Manage., 45: 1052–1064 **(13 pages).**

Cocks, M.; Dold, A., (2006). Cultural significance of biodiversity: The role of medicinal plants in urban African cultural practices in the Eastern Cape, S. Afr. J. Ethnobiol., 26(1): 60–81 (**22 pages**).

Coker, Me.; Bond, N.R.; Chee, YE.; Walsh, CJ., (2018). Alternatives to biodiversity offsets for mitigating the effects of urbanization on stream ecosystems. Conserve. Biol., 32(4): 789–797. (**12 pages**).

Colding, J.; Folke, C., (2009). The role of golf courses in biodiversity conservation and ecosystem management. Ecosyst. 12(2):191–206. (**16 pages**).

Davies, Z.G.; Fuller, R.A.; Loram, A.; Irvine, K.N.; Sims, V.; Gaston, K.J., (2009). A national scale inventory of resource provision for biodiversity within domestic gardens. Biol. Conserv. 142(4):761–771 (**11 pages**).

Dearborn, D.C.; Kark, S., (2010). Motivations for conserving urban biodiversity. Conserv. Biol. 24(2):432–440. (**9 pages**).

Driscoll, D.A.; Banks, S.C.; Barton, P.S., Lindenmayer, D.B.; Smith, A.L., (2013). Conceptual domain of the matrix in fragmented landscapes. Trends Ecol. Evol., 28(10): 605–613 (**9 pages**).

Dunn, R.R.; Gavin, M.; Sanchez, M.C.; Solomon, J.N., (2006). The pigeon paradox: Dependence of global conservation on urban nature. Conserv. Biol., 20(6): 1814–1816 (**2 pages**).

Fahrig, L., (2017). Ecological responses to habitat fragmentation per se. Annu. Rev. Ecol. Evol. Syst., 48:1–23 (**23 pages**).

Fischer, L.K.; Lippe, M.V.D.; Rillig, M.C.; Kowarik, I., (2013). Creating novel urban grasslands by reintroducing native species in wasteland vegetation. Biol. Conserv., 159: 119–126 (**8 pages**).

Franklin, J.F.; Lindenmayer, D.B., (2009). Importance of matrix habitats in maintaining biological diversity. P. Natl. Acad. Sci. USA., 106(2): 349–350 (**2 pages**).

Fuller, R.A.; Irvine, K.N.; Devine-Wright, P.; Warren, P.H.; Gaston, K.J.; (2007). Psychological benefits of greenspace increase with biodiversity. Biol. Lett. 3:390–394 (**5 pages**).

Gallo, T.; Fidino, M.; Lehrer, E.W.; Magle, S.B., (2017). Mammal diversity and Meta community dynamics in urban green spaces: implications for urban wildlife conservation. Ecol. Appl., 27(8): 2330–2341 (**12 pages**).

Garrard, G.E.; Williams, N.S.; Mata, L.; Thomas, J.; Bekessy, S.A., (2017). Biodiversity sensitive urban design. Conserv. Lett., 11(2) (**10 pages**).

Gilchrist, A.; Barker, A.; Handley, J.F., (2016). Pathways through the landscape in a changing climate: the role of landscape structure in facilitating species range expansion through an urbanized region. Landscape. Res., 41(1):26–44 (**19 pages**).

Griffiths, S.R.; Lentini, P.E.; Semmens, K.; Watson, S.J.; Lumsden, LF.; Robert, K.A., (2018). Chainsaw-carved cavities better mimic the thermal properties of natural tree hollows than nest boxes and log hollows. Forests 9(5): 235 (**14 pages**).

Ground, L.E.; Slotow, R.; Ray-Mukherjee, J., (2016). The value of urban and peri-urban conservation efforts within a global biodiversity hotspot. Bothalia Afr. Biodivers. Conserv. 46: 1–10 **(10 pages).**

Guneralp, B.; Lwasa, S., Masundire, H.; Parnell, S.; Seto, K.C., (2017). Urbanization in Africa: challenges and opportunities for conservation. Environ. Res. Lett. 13(1): 015002 (**9 pages**).

Haaland, C.; van den Bosch, C.K., (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. Urban For. Urban Green., 14(4):760–771 (**12 pages**).

Haase, D.; Haase, A.; Rink, D., (2014). Conceptualizing the nexus between urban shrinkage and ecosystem services. Landscape Urban Plann., 132: 159–169 **(11 pages).**

Hassall, C.; Anderson, S., (2015). Storm water ponds can contain comparable biodiversity to unmanaged wetlands in urban areas. Hydrobiologia 745**:** 137–149 **(12 pages).**

Hedblom, M.; Andersson, E.; Borgstrom, S., (2017). Flexible land-use and undefined governance: From threats to potentials in peri-urban landscape planning. Land Use Policy 63: 523–527 **(5 pages).**

Hill, M.J.; Wood, P.J., (2014). The macro invertebrate biodiversity and conservation value of garden and field ponds along a rural-urban gradient. Fundam. Appl. Limnol., 185:107–119. **(13 pages).**

Hobbs, R.J.; Higgs, E.; Harris J.A., (2009). Novel ecosystems: Implications for conservation and restoration. Trends Ecol. Evol., 24: 599–605 **(7 pages).**

Hostetler, M.; Drake, D., (2009). Conservation subdivisions: A wildlife perspective. Landscape Urban Plann., 90: 95-101 **(7 pages).**

Ikin, K.; Le Roux, D.S.; Rayner, L.; Villase-nor, N.R.; Eyles, K.; Gibbons,

P.; Manning, A.D.; Lindenmayer, D.B., (2015). Key lessons for achieving biodiversity-sensitive cities and towns. Ecological Management and Restoration 16: 206–214 **(8 pages).**

Iqbal, M.; Shafiq, M.; Zaidi, S.; Athar, M., (2015). Effect of automobile pollution on chlorophyll content of roadside urban trees. Global J. Environ. Sci. Manage., 1(4): 283-296 **(14 pages).**

Ives, C.D., (2016). Cities are hotspots for threatened species. Global Ecol. Biogeogr., 25: 117–126 **(8 pages).**

Jim, C.Y., (2004). Green-space preservation and allocation for sustainable greening of compact cities. Cities, 21: 311–320. (**10 pages).**

Kantsa, A.; Tscheulin, T.; Junker, R.R.; Petanidou, T.; Kokkini, S.; (2013). Urban biodiversity hotspots wait to get discovered: the example of the city of Ioannina, NW Greece. Landscape Urban Plann., 120: 129–137 **(9 pages).**

Kendal, D.; Zeeman, B.J.; Ikin, K.; Lunt, ID.; McDonnell, M.J.; Farrar, A.; Pearce, L.M.; Morgan, J.W., (2017). The importance of small urban reserves for plant conservation. Biological Conservation 213: 146–153. **(8 pages).**

Kowarik, I., (2011). Novel urban ecosystems, biodiversity, and conservation. Environmental Pollution 159: 1974–1983. **(10 pages).**

Lwasa, S., (2014). Managing African urbanization in the context of environmental changes. *Inter disciplina* 263–280 **(18 pages).**

Lewanzikm, D.; Voigt, C.C., (2017). Transition from conventional to light emitting diode street lighting changes activity of urban bats. J. Appl. Ecol., 54: 264–271. **(8 pages).**

Lin, B.B.; Fuller, R.A., (2013). Sharing or sparing? How should we grow the world's cities? J. Appl. Ecol., 50: 1161–1168 **(8 pages).**

Maclagan, S.J.; Coates, T.; Ritchie, E.G., (2018). Don't judge habitat on its novelty: Assessing the value of novel habitats for an endangered mammal in a peri-urban landscape. Biol.l Conserv., 223: 11–18 (**8 pages).**

Marshall, A., (2013). Start with the grasslands: design guidelines to support native grasslands in urban areas. Victorian National Parks Association, Melbourne **(103 pages).**

Massawe, G., (2017). Diversity of bird's communities on dumpsite and sewage stabilization ponds of Moshi Municipal, Kilimanjaro, Tanzania. Int. J. Hum. Capital Urban Manage., 2(4): 309-318 **(10 pages).**

McCarthy, M.A.; Thompson, C.J.; Williams, N.S.G., (2006). Logic for designing nature reserves for multiple species. The American Naturalist 167:717–727 **(11 pages).**

McDonnell, M.J.; Hahs, A.K., (2015). Adaptation and adaptedness of organisms to urban environments. Ann. Rev. Ecol. Evol. Systematics 46: 261–280 **(19 pages).**

Milder, J.C., (2007). A framework for understanding conservation development and its ecological implications. AIBS Bulletin 57:757–768 **(10 pages).**

Miller, J.R.; Hobbs, R.J., (2002). Conservation where people live and work. Conserv. Biol., 16: 330–337 **(8 pages).**

Moilanen, A.; Franco, A.M.; Early, R.I.; Fox, R.; Wintle, B.; Thomas, C.D., (2005). Prioritizing multiple-use landscapes for conservation: methods for large multi-species planning problems. Proceedings of the Royal Society of London B: Biol. Sci., 272:1885– 1891 **(6 pages).**

MSDI, (2015). Caring for country: an urban application. MSDI, Melbourne. Norton BA, Evans KL, Warren PH. 2016. Urban biodiversity and landscape ecology: patterns, processes and planning. Monash Sustainable Development Institute. Current Landscape Ecol., Reports 1: 178–192 **(15 pages).**

Oertli, B.; Joye, D.A.; Castella, E.; Juge, R.; Cambin, D.; Lachavanne, J.B., (2002). Does size matter? The relationship between pond area and biodiversity. Biol. Conserv., 104: 59–70 **(12 pages).**

Olive, A., (2014). Urban awareness and attitudes toward conservation: A first look at Canada's cities. Appl. Geogr., 54: 160–168 **(9 pages).**

Phillips, H.R.P.; Knapp, S.; Purvis, A., (2017). Estimating the potential biodiversity impact of redeveloping small urban spaces: the Natural History Museum's grounds. PeerJ., 5: e3914 (**29 pages**).

Prugh, L.R.; Hodges, K.E.; Sinclair, A.R.E.; Brashares, J.S., (2008). Effect of habitat area and isolation on fragmented animal populations. Proceedings of the National Academy of Sciences of the USA. 105: 20770– 20775 **(6 Pages).**

Ramırez-Restrepo, L.; Koi, S.; MacGregor-Fors, I., (2017). Tales of urban conservation: Eumaeus butterflies and their threatened cycad hostplants. Urban Ecosystems 20: 375–378 (**4 pages).**

Ray, J.G.; George, J., (2009). Phytosociology of roadside communities to identify ecological potentials of tolerant species. J. Ecol. Nat. Environ., 1**:** 184–190 **(7 pages).**

Rebelo, A.; Holmes, P.; Dorse, C.; Wood, J., (2011). Impacts of urbanization in a biodiversity hotspot: conservation challenges in metropolitan Cape Town. South Afr. J. Botany 77**:** 20–35 **(15 pages).**

Rees, W.; Wackernagel, M., (1996). Urban ecological footprints: why cities cannot be sustainable—and why they are a key to sustainability. Environ. Impact Assess. Rev., 16:223–248 **(25 pages).**

Rosenzweig, M.L., (2003). Reconciliation ecology and the future of species diversity. Oryx 37: 194–205 **(11 pages).**

SADC, (2012). Sustainable use of biodiversity in SADC: Shifting paradigms in biodiversity conservation **(78 pages**).

Salomon Cavin, J., (2013). Beyond prejudice: Conservation in the city. A case study from Switzerland. Biol. Conserv., 166**:** 84– 89 **(6 pages)**.

Sanderson, E.W.; Huron, A., (2011). Conservation in the city. Conserv. Biol., 25: 421–423 **(3 pages).**

Savard, J-P.L.; Clergeau, P.; Mennechez, G., (2000). Biodiversity concepts and urban ecosystems. Landscape Urban Plann., 48: 131–142. **(12 pages**).

Schlaepfer, M.A.; Runge, M.C.; Sherman, P.W., (2002). Ecological and evolutionary traps. Trends Ecol. Evol., 17**:** 474-480. **(6 pages).**

Schlaepfer, M.A.; Sax, D.F.; Olden, J.D., (2011). The potential conservation value of non-native species. Conserv. Biol., 25**:** 428–437 **(14 pages).**

Schneider, A.; Mertes, C.; Tatem, A.; Tan, B.; Sulla-Menashe, D.; Graves, S.; Patel, N.; Horton, J; Gaughan, A.; Rollo, J., (2015). A new urban landscape in East–Southeast Asia, 2000–2010. Environmental Research Letters 10**:** 034002. **(15 pages**).

Schwartz, M.W.; Jurjavcic, N.L.; O'Brien, J.M., (2002). Conservation's disenfranchised urban poor. BioScience 52: 601–606. **(6 pages).**

Semlitsch, R.D.; Bodie, J.R., (1998). Are small, isolated wetlands expendable? Conservation Biology 12**:**1129–1133. **(4 pages).**

Seto, K.C.; Fragkias. M.; Guneralp, B.; Reilly, M.K., (2011). A meta-analysis of global urban land expansion. PLoS ONE **6** (e23777). **(9 pages).**

Seto K.C.; Guneralp, B.; Hutyra, L.R., (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and

carbon pools. Proceedings of the National Academy of Sciences of the USA 109:16083–16088. **(5 pages).**

Shanahan, D.F.; Lin, B.B.; Bush, R.; Gaston, K.J.; Dean, J.H.; Barber, E.; Fuller, R.A., (2015). Toward improved public health outcomes from urban nature. American Journal of Public Health 105:470–477. **(7 pages).**

Shochat, E., (2004). Credit or debit? Resource input changes population dynamics of city-slicker birds. Oikos 106**:**622–626 **(5 pages).**

SIDA, (2016). Urban Development, Biodiversity and Ecosystems Art. No.: sida62003en, urn: nbn: se:Sida-62003en Print: Edita **(2 pages).**

Soanes, K.; Taylor, A.C.; Sunnucks, P.; Vesk, P.A.; Cesarini, S.; der Ree, R., (2018). Evaluating the success of wildlife crossing structures using Genetic approaches and an experimental design: Lessons from a gliding mammal **(9 pages).**

Soanes, K.; Sievers, M.; Chee, Y.; Wiliams, N.S.G.; Bhardwaj.; M.; Marshall, A.; Parris, K., (2018). Correcting common misconceptions to inspire conservation action in urban environment. Conserv. Biol., (**7 pages**).

Stagoll, K.; Lindenmayer, D.B.; Knight, E.; Fischer, J.; Manning, AD., (2012). Large trees are keystone structures in urban parks. Conserv. Lett., 5: 115–122 (**8 pages**).

Stokes, D.L.; Hanson, M.F.; Oaks, D.D.; Straub, J.E.; Ponio, A.V., (2010). Local land-use planning to conserve biodiversity: planners' perspectives on what works. Conserv. Biol., 24**:** 450-460 (**11 pages).**

Teixeira, F.Z.; Printes, R.C.; Fagundes, J.C.G.; Alonso, A.C.; Kindel, A., (2013). Canopy bridges as road overpasses for wildlife in urban fragmented landscapes. Biota Neotropica 13**:** 117–123 **(7 pages).**

Theng, M.; Sivasothi, N., (2016). The smooth-coated otter Lutrogale perspicillata (Mammalia: Mustelidae) in Singapore: Establishment and expansion in natural and semi-urban environments. IUCN Otter Spec. Group Bull., 33**:** 37–49. **(12 pages).**

Threlfall, C.G.; Walker, K.; Williams, N.S.; Hahs, A.K.; Mata, L.; Stork, N.; Livesley, S.J., (2015). The conservation value of urban green space habitats for Australian native bee communities. Biol. Conserv., 187**:** 240–248 **(9 pages).**

Tulloch, A.I.T.; Barnes, M.D, Ringma, J; Fuller, RA.; Watson, J.E.M., (2016). Understanding the importance of small patches of habitat for conservation. J. Appl. Ecol., 53**:** 418–429 **(12 pages).**

UN DESA, (Department of Economic and Social Affairs).,(2018). Revision of world urbanization prospects. UN, New York. **(32 pages).**

UN, (2015). Population 2030: Demographic challenges and opportunities for sustainable development planning. United Nations **(58 pages).**

Watson, D.M.; Watson, M.J., (2015). Wildlife restoration: Mainstreaming translocations to keep common species common. Biol. Conserv., 191**:** 830–838 **(9 pages).**

Williams, N.S.; Lundholm, J.; Scott MacIvor, J., (2014). Do green roofs help urban biodiversity conservation? J. Appl. Ecol. 51**:** 1643–1649 **(7 pages).**

Williams, N.S.G.; McDonnell, M.J.; Phelan, G.K.; Keim, L, van der Ree, R., (2006). Range expansion due to urbanization: increased food resources attract grey-headed flying-foxes (Pteropus poliocephalus) to Melbourne. Austral Ecol., 31**:** 190–198 **(9 pages).**

Wright, J.D.; Burt, M.S.; Jackson, V.L., (2012). Influences of an urban environment on home range and body mass of Virginia opossums (Didelphis Virginian). Northeastern Naturalist 19: 77–86 **(10 pages).**

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