Opportunities for Cities to Cultivate Biodiversity

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Abstract

Cities pose a major threat to global biodiversity in every sense of the word. Municipal leaders have opportunities to promote biodiversity efforts in their cities. Several studies have shown that managing resources with biodiversity in mind within cities is effective and benefits both human and non-human residents and visitors. Two major opportunities for biodiversity investment in urban areas include the use of urban green spaces, such as parks and other public lands, and using nature-based solutions for existing municipal challenges.

Keywords: Biodiversity, local government, urban green spaces, nature-based solutions

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The shift from agrarian to industrial societies over the past 200 years has led to the growth of large urban areas and the decline of rural living. With this change humans have benefited from efficiencies and economies of scale from shared resources. At the same time, however, we have devastated our natural environment. Indeed, Barnosky et al. (2011) demonstrated that the percentage of species we have lost due to industrialization has exceeded those of the five prior mass extinction events. Haddad et al. (2015) explained how habitat fragmentation, caused by cutting through forests to lay roads, for example, can render otherwise pristine areas unsuitable for their longtime inhabitants, drastically reducing biodiversity in one fell swoop. Can cities and biodiversity coexist?

When we think of nature preserves and conservation areas, we typically think of large tracts of undeveloped land far away from major cities. Perhaps we need to expand our approach to wildlife preservation, though, and include urban settings. Ives et al. (2016) analyzed the occurrence rate of endangered land species, including plants and animals, across the entire continent of Australia. They found that threatened species occur more frequently per area unit in urban environments, which they defined as cities with more than 10,000 residents, than in others. They suggested that, while we tend to build preserves in remote, wild areas, threatened species need recognition and protection in highly (human) populated areas, as well. Their findings showed that proximity to coasts did not significantly impact the number of threatened species living in urban areas, as had been previously suggested, making their findings applicable to inland cities, as well.

As Mayer (2011) noted, the term “biodiversity” has been used to mean different things to different stakeholders. While the scientific community measures specific factors of biodiversity, such as species richness or distribution, in assessing the health of ecosystems, environmentalists tend to use the term in a more general sense as a call to arms to protect what species remain from the dangers of human development and resource consumption. Much of the research in urban green space planning and nature-based solutions has been interdisciplinary, so biodiversity has not always been clearly defined. For the purposes of this paper, we can assume that the authors intended it to be synonymous with species richness unless explicitly stated otherwise.

In this paper, we will examine two major opportunities for city government leaders to promote biodiversity. The first is in their urban green spaces, a natural choice for installing diverse plant species to support diverse fauna. The second is the use of nature-based solutions to meet existing municipal challenges. This is a new area that needs to be further explored and proven to gain wide acceptance. We finish with a collection of steps that leaders can take to implement these findings in their own cities.

The Role of Urban Green Space

Cities probably conjure images of skyscrapers and freeways for many of us, but hopefully they contain some room for nature, as well. This can be in the form of parks, school playgrounds, grassy strips on the edge of highways, or even the right-of-ways under utility poles. Wherever there is room for a flower bed or a few trees, there is a potential urban green space. Managing those green spaces for biodiversity benefits both humans and the rest of the natural world.

Human Benefits

Shanahan et al. (2016) investigated human health benefits derived from exposure to urban green spaces, including reduced blood pressure, reduced depression, increased feelings of social cohesion, and increased time spent exercising. They also sought to determine whether a subject's urban green space exposure frequency, duration, or intensity altered the degree of benefits observed. The trials followed a dosing framework posed in prior work by one of the authors. They found that duration of exposure led to positive health results in all areas, while frequency and intensity showed mixed results. Intensity, in this case, could mean feeling separated from the urban environment due to the overwhelming amount of green space or that a green space exhibited particular heterogeneity, or biodiversity. The authors concluded that spending at least 30 minutes per week in urban green space provided health benefits for urban dwellers.

A more recent study might explain the seemingly weak link between biodiversity in urban green spaces and human psychological benefits. Meyer-Grandbastien et al. (2020) tackled the assumption that humans who were not ecologists did not seem particularly capable of identifying species of plants and therefore should not receive higher degrees of psychological

restoration from urban green spaces with higher levels of biodiversity. They found that while non-ecologist humans might not excel at differentiating among plants within the same category (grasses, for example), they did tend to notice when there were many different categories of plants present. An urban landscape exhibiting grasses, shrubs, trees, vines, and many colors of flowers, therefore, was considered more diverse than a well-manicured collection of different conifers. Accordingly, subjects gained greater degrees of psychological restoration in areas with greater plant structure diversity than in more homogenous settings (Meyer-Grandbastien et al., 2020).

Biodiversity Benefits

Oliver et al. (2011) examined several large urban parks in the St. Louis, Missouri, region to determine what factors contribute to species richness in birds. They cited MacArthur and Wilson's theory of island biogeography to predict how habitat fragmentation due to urbanization would impact avian biodiversity in the region (MacArthur & Wilson in Oliver et al., 2011). The authors pointed out that St. Louis has been named the second most threatened city by urban sprawl, further illustrating the extreme fragmentation of the study area. Their findings suggested positive relationships among species richness for both contiguous urban greenspace areas and plant biodiversity within the area. Biodiversity in one kingdom (plants), therefore, seemed to positively impact biodiversity in others (animals). Also, just as humans were shown to benefit more (in terms of psychological restoration, at least) above from diverse plant structures, parks with more diverse habitat types (structures) resulted in greater species richness in migratory birds in the Oliver et al. (2011) study.

Managing Urban Green Space for Biodiversity

We typically think of urbanization as a threat to biodiversity due to its destruction of natural habitat. This is largely the case, but Aronson et al. (2017) showed how urbanization can present some opportunities to benefit city biodiversity goals through the management of urban green space, including parks, lawns on government-owned properties, and right-of-ways along transportation and utility corridors. These urban green spaces can range in their composition from remnant patches of native ecosystems to highly manicured lawns to brownfields to overtly engineered bioswales. Consideration must be given to their economic, social, and environmental

purposes within the community when cities make decisions on how to use their green spaces, but, in consultation with the local scientific community, cities can leverage their existing green spaces to increase regional biodiversity.

Attracting a diversity of fauna requires providing a diversity of food sources. Hicks et al. (2016) studied the nutritional benefit of commercially available wildflower mixes used in urban green spaces throughout Europe. Their controls included spaces with manicured lawn or turf as well as unmanaged spaces with "weeds." The researchers found that while the flowers from the two seed mixes provided much more pollen and nectar than the lawns (which provided almost no nourishment), the weeds in the unmanaged spaces provided the most overall. Further analysis suggested that the nutritional quality of the nectar and pollen was not as high as that provided by the wildflower mixes. The takeaway is that urban green spaces with managed lawns, while considered attractive and safe by some, provide no biodiversity benefits and require more upkeep than unmanaged lots. Using wildflower seed mixes seems to be a good compromise.

Research from Haddad et al. (2015) has shown us that fragmentation of habitats is a major cause of extinction. When a habitat becomes split in half by a road or similar development, the resulting fragments tend to support far fewer species and individuals than the original area due to the exposure of the interior area. In effect, there is a higher edge to interior ratio, opening up the area to invasive species that were previously unable to penetrate into the inner regions of the habitat area.

An interesting thing happens when applying this logic in urban green spaces, however. Ibáñez-Álamo et al. (2020) looked at the effects of land-sharing versus land-sparing on bird diversity in urban green spaces throughout Europe. Land-sparing is the practice of maximizing the continuity of green spaces to provide the largest contiguous habitat area possible. Land-sharing is the result of casually mixing in green space among developed areas in a more patchwork fashion. The researchers predicted that land-sparing would result in higher diversity due to the reduced fragmentation of habitats. They found, however, that there was no noticeable difference in taxonomic (species) or functional (niche) diversity among the birds in either setting during breeding season and a slightly higher diversity among over-wintering birds in land-sharing settings. Their results suggested that as long as land-sharing areas minimized their

impervious surfaces and provided sufficient tree or water cover (as required per species) they could support as many or more species as land-sparing areas.

Nature-Based Solutions in Urban Municipalities

Another area for cities to get involved in promoting biodiversity is the implementation of nature-based solutions. Raymond et al. point to an European Commission report that defines nature-based solutions as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience" (European Commission in Raymond, et al., 2017). Kabish et al. (2016) gave the example of green roofs and green walls that solved multiple problems at once, such as noise absorption and heat reduction. While nature-based solutions do not inherently increase biodiversity, they do provide more opportunities to increase biotic components within the urban landscape; with proper planning, the use of diverse plants in green roofs, for example, can bring the same benefits to nature-based solutions that they do in urban green spaces.

Potential Benefits

Raymond et al. (2017) focused on ten areas in which sustainable and cost efficient nature-based solutions could benefit urban municipalities. These included water management, urban biodiversity and biodiversity conservation, public health and well-being, air quality, coastal resilience, green space management, green jobs and other economic opportunities, urban regeneration, social justice and social cohesion, and participatory planning and governance. The authors pointed out that many nature-based solutions provided co-benefits; that is, they addressed more than one problem. For example, planting urban trees to help with carbon sequestration can also increase air quality, prevent erosion, manage stormwater, provide habitat, increase biodiversity, beautify the area, and more.

Kabisch et al. (2016) suggested using indicators to quantify the benefits of nature-based solutions. Their expert panel identified many indicators, including decreased air pollution, reduced temperature and carbon dioxide emissions, tons of carbon sequestered, percentage of flood risk reduced, increased number of species, increased vegetation cover, and reduction in brownfield area. At the same time, they recognized that there would be some "disservices" created when employing nature to solve problems, and they suggested quantifying those as well.

These could include increases in mosquito prevalence and increases in allergic reactions due to pollen. Measuring and reporting both of these facets helps bring attention and transparency to the process, which increases social cohesion and stakeholder buy-in.

Challenges

Raymond et al. (2017) also pointed out that nature-based solutions could present negative impacts for humans that need to be weighed with their benefits. For example, the trees planted in the above scenario for carbon sequestration and other myriad benefits could also produce pollen, which induces allergic reactions in some people. The trees might also need to be maintained to reduce interference with utility lines and have their debris removed after strong weather, both of which would require funding but also create jobs. Particularly nefarious side effects of urban beautification projects involving the creation of urban green spaces are gentrification and reduced social cohesion as community members become priced out of their neighborhoods by rising property values and, therefore, increased property taxes.

Besides post-implementation challenges, Kabisch et al. (2016) listed several procedural challenges to implementing nature-based solutions. Sectional silos within local governments make communication and planning difficult. The neverending onslaught of unexpected short-term needs interrupt achieving long-term goals. Many people fear new, untested ideas, and nature-based solutions certainly seem cutting edge. There is also a significant knowledge gap to overcome; urban ecology and nature-based solutioning are new concepts not traditionally encountered in city planning and administration.

Actions for Local Governments

Raymond et al. (2017) provided a framework to help local governments develop and evaluate the performance of nature-based solutions when addressing these and other challenges. Their seven steps included identifying potential nature-based solutions to address municipal challenges, listing potential co-benefits as well as possible negative side effects, communicating and working with diverse groups of stakeholders and experts, and measuring outcomes. They stated that city officials must take the leadership role and make sure that proposed nature-based solutions complement urban planning strategies and follow proper governance.

Kabisch et al. (2016) suggested many opportunities to make implementing nature-based solutions and biodiversity initiatives positive experiences for communities. They advocated knowledge valorization, or assigning value to new ideas and concepts. The mere shift from talking about barriers to increasing biodiversity to thinking in terms of solving problems using nature promotes positivity and teamwork. They emphasized that knowledge and experience gained from implementing nature-based solutions must be shared to build expertise and promote acceptance of the practice.

Oliver et al. (2011) found that within large urban areas, local governments must provide large urban greenspaces high in plant biodiversity to mitigate disruptions to fauna biodiversity due to urbanization. This was especially important to support diverse migratory species, such as birds along flyways. As Meyer-Grandbastien et al. showed, increasing heterogeneity in plant structure, while increasing biodiversity by definition, increased the psychological restoration of human visitors, as well. This is also an opportunity to provide for endangered species, as Ives et al. (2016) demonstrated. They called for local governments to discover what endangered species called their city home and look for opportunities to provide protections and habitat accordingly. A local example is the City of St. Louis' "Milkweeds for Monarchs" project (2015), in which the city government sponsored the creation of hundreds of pollinator gardens throughout the city to support the endangered monarch butterfly; St. Louis, Missouri, sits directly in the flyway of the monarch's annual migration.

Conclusion

Urban growth has severely threatened global biodiversity. City leaders have the opportunity to aid biodiversity initiatives through proper planning, though. Urban green spaces provide a straightforward means to increase biodiversity for the benefit of both human and non-human residents and visitors. Nature-based solutions, though a new concept, provide many exciting opportunities to cut costs, solve problems, and build relationships in urban environments.

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