



Conserving urban biodiversity? Creating green infrastructure is only the first step

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ABSTRACT

Urban planning efforts to conserve urban biodiversity have often concentrated on establishing protected natural areas and corridors. While green infrastructure is important, it is critical that surrounding neighborhoods and commercial areas have minimal impacts on conserved areas. Everything from invasive exotics to stormwater runoff can degrade the biological integrity of green infrastructure. In this essay, we discuss future research and strategic directions to achieve a systems approach that includes the design and management of nearby built areas to be compatible with green infrastructure. Planners, developers, researchers, and residents all play a role in shifting conventional development inertia to something more compatible with green infrastructure. We outline a range of processes, research, policy tools and educational strategies that could be used to engage key stakeholder groups more closely with urban biodiversity conservation.

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1. Introduction

Conserving biodiversity in cities is an important global issue as urban environments play a role in the conservation of local/regional species and provide a platform for urban citizens to understand the natural processes that ultimately govern global and human sustainability. To conserve urban biodiversity, a common focus of planning and growth management efforts is to establish green infrastructure, which we define here as protected natural open space and corridors (adjoining residential yards or sections). For example, in conservation subdivisions, the focus is on conserving natural areas by setting aside some percentage of open space (e.g., 40%). The proper engagement, design, and management of nearby neighborhoods and business districts, however, are often overlooked. As a result, green urban infrastructure is often heavily impacted by surrounding residential and commercial areas. In this essay, we discuss the challenges and future directions for maintaining the functionality of green infrastructure in urban settings.

2. Why worry about surrounding landscapes?

In a matrix of green and built infrastructure, the range of impacts varies from the design and management of nearby built lots to

human behaviors and uses that degrade natural areas (Hostetler and Drake, 2009). For example, built lots and neighborhoods that are dominated by exotic plants, turf grass, and impervious surfaces can adversely impact native plants and animals found in the conserved areas. Stormwater runoff in these areas can contain an excessive amount of nutrients (e.g., phosphates and nitrates), causing algal blooms in water bodies, fish kills, and the growth of invasive exotic plants. Developers and homeowners may choose to install invasive exotic plants into their landscapes which can escape and become established in the conserved areas, affecting native plant and animal communities. Additionally, impacts of construction can compromise the biological integrity of green infrastructure (e.g., silt runoff not properly contained and heavy earthwork machines compacting soil in conserved areas). Even roaming pets can impact wildlife in conserved areas as they prey on mammal, amphibian/reptile, and bird species.

In particular, how people view and use nearby conserved areas can lead to impacts on biodiversity. Studies suggest that homeowners, even those residing in conservation subdivisions, do not understand how important individual actions are towards the functionality of conserved natural areas and waterways (Hostetler and Noiseux, 2010; Meurk and McMurtrie, 2006). Just the frequent presence of humans has been shown to reduce the number of breeding bird territories and nests (Miller and Hobbs, 2000). In a study on the conservation value of clustered subdivisions, researchers found that the plant community within the open space was dominated by exotics; they speculated these subdivisions did not have proper land stewardship to maintain native plant communities (Lenth et al., 2006). Even trees in established natural areas and

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buffers may be cut down by adjoining residents facing conflicted values such as the trees interfering with their “view.” Addressing these conflicts is an important part of maximizing urban biodiversity conservation.

Both developers and the public, therefore, 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 nearby green infrastructure, but need to give more thought to ensuring that city-wide efforts reinforce each other and that stakeholders are engaged. Below we offer some thoughts and examples on how policy and future research can foster the compatibility of built and green infrastructure to maximize urban biodiversity conservation.

3. Future directions for planners and governments

Integrating green and built infrastructure requires governments to play a facilitating role in education and empowering change and innovation among developers/builders and residents. In particular, planners can help shape policies to impact the design and management of proposed and existing developments that are situated near green infrastructure. While there is no best policy that will achieve this in all situations, we can point to a number of key interventions that can collectively have a major impact on maintaining the biodiversity and functionality of urban natural areas and corridors.

3.1. Implement systems thinking

Historically, many attempts to increase biodiversity in urban areas are characterized by a relatively narrow focus. They concentrate on managing a particular green space or conserving and restoring particular habitats. In so doing managers often focus on the immediate issues and ignore the wider ecological and social patterns and processes that surround them. This can result in planners and resource managers continually treating the symptoms rather than the underlying causes of land management problems. Recent literature suggests the need for new ways of thinking to manage complex problem situations that lie at the intersection of social and place-based systems. While there are a wide range of such approaches, many of these build on systems thinking. Systems thinking encourages us not to focus on discrete elements in the system, but rather to see the world as elements and processes that connect and interact in dynamic ways to form a whole.

As Miller (1996) argues in *Balancing the Scales*, planners and researchers must first expand the geographic scales of conservation efforts to move beyond individual species and individual places to embrace whole ecosystems. These activities include the need to develop an underpinning city philosophy and understanding of biodiversity, and to ensure that attention is paid to the use of inclusive and collaborative social processes that involve a wider range of stakeholders in planning and management. These efforts also need to include a “monitor to manage” approach, which is used to create the feedback and reflection necessary for constant improvement by stakeholders at all levels.

3.2. Remove current regulatory barriers

Created in an earlier era, many current policies, strategies, and regulations are barriers to “green” design and management practices. These should be removed or updated to encourage creativity and the implementation of sustainable practices. Agencies often do not update plans and policies to protect biodiversity in tandem with policies to support city growth and development. For example, in Florida and in Nelson, New Zealand, stormwater policies are based around traditional management policies. This means

developers cannot get credit for implementing Low Impact Development (LID) stormwater designs, such as installing rain gardens and bioswales. Such LID features reduce impacts on nearby natural areas and associated flora and fauna by improving water quality. Currently, discussions are underway to change such policies in these and other urban areas.

3.3. Engage built environment professionals and residents

Most green infrastructure policies do not address possible impacts of nearby built areas or the importance of design and management of nearby developments (Wald and Hostetler, 2010). Policies should be crafted to influence the design and construction of developments situated near conserved natural areas. First, policies should require or provide incentives for developers to use native plants and LID techniques. A more natural built environment designed to minimally impact surrounding landscapes can foster improved homeowner engagement and land stewardship. Second, with the goal of minimizing impacts on nearby green infrastructure, policies should require or encourage the use of trained built environment professionals during the construction phase. Sustainable construction techniques should be used on site and construction site managers and contractors should be trained and certified through continuing education courses and programs sponsored or recommended by local governments.

To engage residents, policies should require or provide incentives for developers to fund the creation of environmental education programs. These could include educational kiosks, Web pages, and brochures that target environmental and resources issues for a neighborhood (Hostetler et al., 2008). Such a program would inform residents about proper biodiversity management practices for both built and conserved areas. Learning about environmental and conservation language, concepts, and management can help shape how landscapes are maintained. What is important is that such programs are carried out over time so they are available to new residents. To help pay for the educational program, innovative approaches could derive funds from a number of sources including a portion of individual lot sales and re-sales, homeowner association dues, development impact fees (collected at the municipal level), and even monies derived from “gifting” land to local land trusts. In addition, policies should require environmental Codes, Covenants, and Restrictions (CCRs). CCRs are deed restrictions that go along with the sale of a house. Environmental landscape language in a CCR, such as native plant requirements, limitations on turf, and proper use of fertilizers and irrigation, can help shape how landscapes are maintained.

4. Future directions for researchers

Researchers can help to determine what policies, educational programs, and growth management strategies are successful in creating functional green infrastructure. They can also act as facilitators, collaborating with planners and governments to help tailor policies and programs to local conditions (Allen et al., 2002). Below, we highlight a few important research paths.

4.1. Regulatory and incentive-based policies

Researchers can help determine which regulatory or incentive-based policies work to engage built environment professionals and residents. As Young et al. (1996) point out, prospects for changing behavior will always be greater “if direct regulatory approaches are overlain with a web of mechanisms that create a financially attractive and voluntary atmosphere that encourages cooperation and the sharing of information.” Although voluntary policies are easier to pass, such policies could evolve into regulations as people

become familiar with and recognize their rationality or necessity. The impacts of policies, however, are often not monitored. In a review of incentive-based policies tried in Florida and other states, it was found that very few were actually adopted by developers (Romero and Hostetler, 2007). The most successful policies had these three ingredients: (1) governments explicitly involved stakeholders to help create the incentive-based policies; (2) a marketing and education campaign was implemented that successfully increased awareness among built environment professionals, landowners, and the public; and (3) municipalities had clear communication with and cooperation between regulators and planners. Step 3 was critical because delays or rejections often occurred in the permitting of new practices (e.g., LID features) if regulators were not engaged. This frustrated builders and increased production costs (in terms of delays), discouraging the initial uptake of unique practices.

Researchers can also help in determining whether policies have the desired impacts on the behaviors of residents. For example, do environmental CCRs have an impact on landscape maintenance? A study in Phoenix, AZ found that yards in neighborhoods with CCRs had less turf coverage than neighborhoods without CCRs, despite homeowner preferences for turf (Martin et al., 2003). This example suggests that CCRs have some influence, but more work is needed.

Another issue is to develop studies that help us look across the range of environmental education programs to see what elements most effectively support improved environmental knowledge, attitudes, and behaviors in different settings. Urban environmental education programs can be effective; a comparative study in Florida showed improved environmental knowledge, attitudes, and behaviors among homeowners exposed to such a program (Hostetler et al., 2008).

4.2. Green infrastructure and biological integrity

Currently, there is a lack of temporal studies to help understand the range of elements that support green infrastructure areas and retain their biological integrity over time. An important question here is the long-term outlook of green infrastructure adjacent to green designed subdivisions compared with that located near conventional developments. In terms of new subdivision construction, very few studies compare and contrast the environmental impacts on conserved areas as a result of different construction techniques. In particular, it is important to determine whether construction sites with trained contractors are managed in a more appropriate way and have fewer impacts on nearby conserved areas. This will help to evaluate various training and educational programs that emphasize sustainable construction techniques.

5. Conclusion

The conservation of urban biodiversity and the functionality of green infrastructure are contingent upon how well nearby residential and commercial areas are designed and managed. Policies that target both new and established neighborhoods can help inform and engage an urban populace to recognize the connection between

built and green infrastructure. Using a systems approach, planners, governments, and researchers should move beyond the establishment of green infrastructure and include strategies that engage communities and help create built areas that are compatible with conserved areas.

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