# WHAT IS LANDSCAPE-SCALE CONSERVATION AND HOW DOES IT APPLY TO URBAN REGENERATION?

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**ABSTRACT:** Landscape-scale conservation is a recently derived concept which brings together principles of landscape ecology and biological conservation. The concept has significance in urban regeneration activities where the importance of green open space and green infrastructure are increasingly recognised within the contexts of global climate change, flood management, and the health of those who live and work in urban centres.

The authors have conducted a systematic, critical literature review based on library databases, the ISI web of knowledge database and Elsevier Science Direct database using selected key words and phrases to find relevant books and journal articles.

The results of the review show how complex the concept of landscape-scale conservation can be. From this critical literature review the authors define the concept of landscape-scale conservation in an understandable format, examine the key principles, and illustrate how the concept can be applied to urban regeneration with regards to social, economic and environmental factors.

**Keywords -** Green infrastructure, landscape-scale conversation, Urban regenerisation.

## 1. INTRODUCTION

In the UK, 80% of the population now live in urban areas (Office for National Statistics, 2005). As the population continues to grow the need for good quality housing and pleasant communities is also increasing. Barker (2004) suggested that between 70,000 and 120,000 new homes will have to be built each year in England to keep up with demand and maintain house prices at a low scale. The Government's Housing Policy for England (Office of the Deputy Prime Minister, 2005) states that 60% of this new housing should be on brownfield land, and in fact 67% of new development in England in 2003 was on brownfield land, up 56% from 1997 (Office of the Deputy Prime Minister, 2005). Urban regeneration is therefore being strongly driven by governmental policies on housing.

As ongoing development starts to sprawl out of the cities and into more rural settings, one can wonder; where are the spaces left for nature? There are many environmental, social and economic benefits in providing space for nature, and nature for people. Urban nature and urban parks not only help to provide sustainability, but according to Chiesura (2004) they also fulfil many social and non-consumptive human needs. Grahn and Stigsdotter (2003) carried out a study on stress-related illnesses in Sweden. A significant positive relationship was found between health and the use of urban open green spaces; people who visited green spaces frequently reported less stress than those who visited such spaces less often. Trees and vegetation can trap and absorb many pollution particles that can exacerbate asthma and other conditions (Beckett, Freer-Smith *et al.*, 1998), as well as reduce levels of carbon based gases which contribute to global climate change (Nowak, Crane *et al.*, 2006).

There are wildlife reserves, parks and other areas set aside for nature conservation. However, many green spaces are threaded through urban and suburban areas where we live and work, and thinking on a single site level, such as a single wildlife reserve is not always appropriate. There are a number of benefits to using a wider landscape-scale approach for conservation. Landscape-scale conservation provides a holistic approach, and forces

practitioners to take note of ecological functions, processes and species that may be affected within and beyond a specific site. Li (2000) illustrated with mathematical formulation why an ecological system cannot be understood by reducing it to its parts; a holistic landscape-scale approach is more appropriate.

As landscape-scale conservation is an emerging discipline there are many issues that still surround it. Such issues have so far limited use within urban regeneration projects. One of the key concerns is how landscape-scale conservation is defined: it has developed from landscape ecology and biological conservation, and therefore different practitioners view it differently. This lack of a single definition is also associated with a difference in understanding and interpretation of terms and phrases. The use of landscape-scale conservation could be facilitated by a clear and understandable definition from which practitioners and conservationists can work. A further concern is the way in which landscape-scale conservation is incorporated into planning and development. Problems with definition and interpretation send confused messages to practitioners, and this is exacerbated by a lack of communication between disciplines. These issues hinder the use of a concept which could have wide ranging beneficial results for the environment, society, and economy.

The aims of this paper are to examine and discuss what landscape-scale conservation means; to evaluate the literature surrounding the use of this principle; and to assess its potential use within urban regeneration projects.

## 2. METHODS

The first step in carrying out the critical literature review was to find papers relevant to the topic. This was done using the online journal search engines Elsevier's 'science direct' and ISI's 'web of knowledge'. Key words and phrases were searched for in the 'title', 'abstract' and 'key words' sections of the journals and the results are shown in table 1.

The second step was to use these journals as sources for other journals, books and articles on a similar topic. This was a more subjective approach, done through reading articles and citied references, and highlighting key pieces of work. All relevant references were kept track of using the programme 'Endnote©'.

The University of Salford library catalogue was also used as a reference source, and was searched using key search terms. Other Northwest libraries were accessed to supplement the texts available from the University of Salford library. The internet was an important source of information, giving access to governmental or organisational papers and information.

A simple content analysis was carried out by noting down the main themes of each paper to give an overview of the key issues. Further analysis of papers with the key words 'landscape scale' and 'conservation' was carried out by using the analysis tools on ISI's web of knowledge to determine when papers where published and what key subjects they describe. The texts collected were then reviewed to appraise different definitions of landscape-scale conservation and critically evaluate the relevance of this emerging discipline for urban regeneration activities.

*Table 1. Search terms used and number of results found from Elsevier's science direct and ISI's web of knowledge on 16/12/06*

| First term | Second term | Third term | Number of results from 'science direct' | Number of results from 'web of knowledge' |
|---|---|---|---|---|
| Conservation | Regeneration | | 245 | 1000 |
| "Landscape-scale" | conservation | | 80 | 308 |
| Landscape | Conservation | Urban | 109 | 289 |
| Landscape | Urban | Environment | 181 | 196 |
| Urban | "Green space" | | 62 | 51 |
| "Landscape-scale" | Urban | | 15 | 42 |
| "Urban environment" | Conservation | | 20 | 27 |
| Urban | Conservation | England | 8 | 26 |
| Landscape | Regeneration | Urban | 6 | 26 |
| "Urban nature" | | | 19 | 24 |
| "Urban conservation" | | | 15 | 12 |
| Conservation | "Green space" | | 10 | 14 |
| "Landscape-scale" | Conservation | Regeneration | 4 | 10 |
| "Green infrastructure" | | | 3 | 10 |
| "Landscape-scale conservation" | | | 5 | 5 |
| Regeneration | "Green space" | | 0 | 1 |
| "Green infrastructure" | Regeneration | | 0 | 0 |

## 3. RESULTS AND DISCUSSION

### 3.1 Evaluation of Literature Surrounding Landscape-scale Conservation

With the use of the analysis tools on ISI's web of knowledge it is possible to see how the discussion of landscape-scale conservation has changed over time. Figure 1 shows how the terms 'landscape scale' and 'conservation' appear more frequently in journal articles over time. The terms do not appear together until after 1990, and increase from only three journal articles in 1990 to 196 journal articles in 2006. The frequency of use of these terms and therefore their importance has increased substantially in the past 17 years.

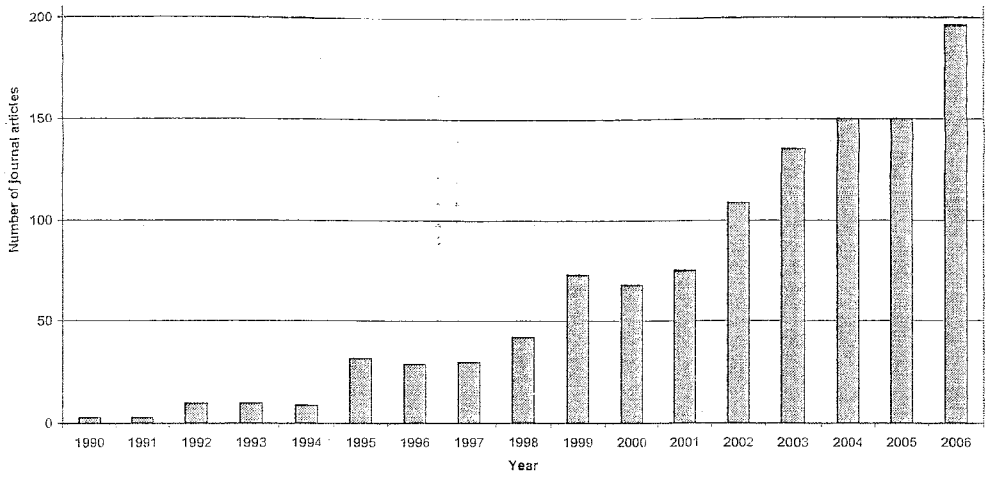


*Fig. 1. The number of journals with the key terms 'landscape scale' and 'conservation' published each year by ISI's web of knowledge.*

A similar analysis was carried out to identify the main categories in which journals carrying the phrases 'landscape scale' and 'conservation' were classified. Figure 2 shows the top categories that the journals were classified under; ecology, environmental science, and biodiversity conservation are the top categories, illustrating some of the main sources of the landscape-scale conservation concept. Urban studies are at number thirteen, highlighting the relatively low use of this concept within that discipline area.

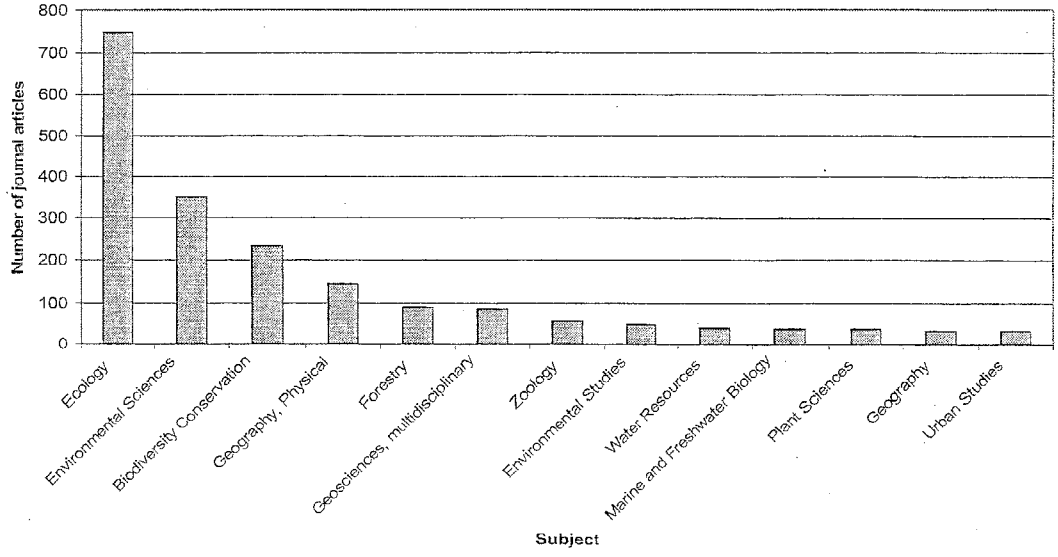


*Fig.2. The key subjects that journal articles containing the phrases 'landscape scale' and 'conservation' are published under.*

A separate content analysis was carried out of journal articles read as part of the critical literature review of landscape-scale conservation. The key themes of each paper were picked out and are listed alphabetically in Table 2. The themes primarily come from landscape-scale conservation, but the table shows how they can also be related to urban regeneration. Some themes such as 'flagship species' would not be directly related to urban regeneration unless a site had a particularly rare species associated with it, in which case development would probably be restricted anyway. Specific ecological theories such as 'island biogeography'

cannot be directly related to urban regeneration because they contain ideas rather than practical implications. However, there are many themes that could simply and directly crossover into planning and development projects. Some of the key themes that will most easily crossover include; 'access to green space', 'wildlife corridors and greenways', 'landscape function', 'multifunctional landscapes', 'street trees', and 'sustainable development'. Interestingly, the themes that crossover between landscape-scale conservation and urban regeneration are those that fulfil social or economic needs as well as environmental ones. If planners and developers were to include some of these conservation themes into regeneration projects they would also be complying with sustainable development requirements by providing a multidisciplinary approach.

*Table 2. The key issues picked out through content analysis in journal articles on the subject of landscape-scale conservation.*

| Theme | Landscape-scale conservation | Urban regeneration |
|---|---|---|
| Access to green space | ✓ | ✓ |
| Communication between conservationists and planners | ✓ | ✓ |
| Connecting habitats on landscape level | ✓ | ✓ |
| Environmental quality in spatial planning | ✓ | ✓ |
| Flagship species | ✓ | |
| Fragmentation | ✓ | ✓ |
| Green infrastructure | ✓ | ✓ |
| Habitat loss | ✓ | |
| Habitat mapping | ✓ | ✓ |
| Holistic approach | ✓ | ✓ |
| Hydrology | ✓ | ✓ |
| Individual gardens/sites | ✓ | ✓ |
| Influence of scale | ✓ | ✓ |
| Island biogeography | ✓ | |
| Landscape entropy | ✓ | |
| Landscape function | ✓ | ✓ |
| Landscape pattern | ✓ | ✓ |
| Metapopulation | ✓ | |
| Multifunctional landscapes | ✓ | ✓ |
| Open space systems | ✓ | ✓ |
| Physical and mental health | ✓ | ✓ |
| Social needs | ✓ | ✓ |
| Species composition | ✓ | ✓ |
| Street trees | ✓ | ✓ |
| Sustainable development | ✓ | ✓ |
| Urbanisation | ✓ | ✓ |
| Urban planning | ✓ | ✓ |
| Wildlife corridors and greenways | ✓ | ✓ |

### 3.2 What is Landscape-scale Conservation?

Landscape-scale conservation is derived from landscape ecology and biological conservation, and as such there is no single recognised definition of what it is. Biological conservation is the study of biodiversity and how it can be protected; it encompasses the fields of biology, planning, management and the politics of biodiversity protection

(Gutzwiller, 2002). Biological conservation emphasises some of the anthropological effects that influence biodiversity and the structure of the landscape. Landscape ecology is defined by The International Association for Landscape Ecology (2006) as 'the study of spatial variation in landscapes at a variety of scales' that effectively 'links natural sciences with related human disciplines'. Gutzwiller (2002, p9) stated that 'the overarching principle of landscape ecology is that the spatial configuration of landscapes can have important effects on a wide variety of landscape processes'.

A landscape itself can be defined in various ways. For example Forman (1995, p20) described a landscape as 'a mosaic where the mix of local ecosystems or land uses is repeated in similar form over a kilometres-wide area'. Gutzwiller (2002, p4) similarly stated that 'Landscapes are composed of multiple elements (or patches), and the variety of these elements creates heterogeneity within an area. From an ecosystem perspective, a landscape contains multiple habitats, vegetation types, or land uses'. He went on to suggest that 'It is the spatial relationships among landscape elements as much as their variety that make landscapes important , for these relationships can affect interactions among the elements in a mosaic as well as what goes on within individual patches'. The structure and configuration of patches, corridors and matrices within the landscape have a profound influence on the flow and function of the landscape.

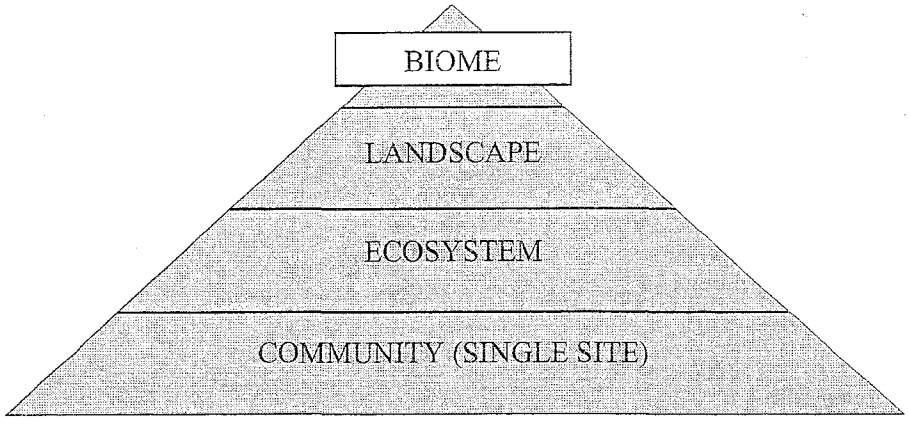


*Fig. 3. Showing the levels at which conservation can be carried out.*

The 'level' or 'scale' of a landscape is difficult to define, but can be described within an ecological hierarchy (Gutzwiller, 2002). The levels that conservation is carried out runs from a community (single site) level, to an ecosystem level, a landscape level and a whole biome level (see Figure 3). A biome is a major global biotic community characterised by a distinct habitat and species. A community is a group of interacting populations, often living within the same habitat or ecosystem, whereas 'an ecosystem is a community of living organisms together with the physical processes that occur within the environment' (Pullin, 2002, p19). The convention of an ecosystem is that it is large enough to be considered a closed system. A landscape is not considered in this same way, and can therefore include any ecological functions or elements of the landscape that affect the conservation area. It can include rivers and streams that run into the area, and geological attributes that run way beyond any administrative boundaries. Landscape-scale conservation can be applicable at all levels because even if a project is only focused on one site, all of the external landscape factors can be considered regardless of boundaries.

In summary landscape-scale conservation is environmental conservation that is carried out over an area of landscape where the mix of local ecosystems or land uses is repeated in

similar form over a kilometre-wide area. Landscape-scale conservation is based on the premise that the spatial configuration of a landscape has a profound effect on the ecology and biodiversity found within it. The functions and processes of a landscape are as important as the species living there.

### 3.3 How can Landscape-scale Conservation be used in Urban Regeneration Projects?

There are complex reasons why conservation, planning and development have not become integrated. Quite often planners and conservationists have different points of view, and this is compounded by the way in which different professions use different technical languages. Antrop (2001) discussed the different language that landscape ecologists and planners use, thus illustrating that within the international journal 'Landscape Ecology' the two groups used concepts differently. The goals, concepts and theories of the two disciplines are quite different. Niemela (1999) describes four important steps for understanding how the ecology of urban environments affects planning. The first is to know what kind of nature exists in cities. The second is to understand the ecological processes important in urban nature. The third is to design management schemes based on ecological knowledge that will maintain the diversity of urban nature, and the forth is to promote interdisciplinary research involving natural and social sciences.

In the UK the perspectives of urban nature conservation practitioners in London were surveyed by Harrison and Davies (2002). They reported that problems facing practitioners promoting environmentally sensitive development included inconsistent scientific knowledge, and a lack of co-operation between disciplines. Planners in particular were thought to compartmentalise conservation rather than allow it to become integrated into urban development.

There are some common features of exemplar projects found within the literature that can lead to successful integration of landscape-scale conservation with urban regeneration projects. Habitat and landscape mapping are primary methods used in landscape-scale conservation. The type of map depends on the scale and type of project. For example, habitat mapping (Johnson, 1995) is beneficial at all scales, but is more often used in projects that are rooted in conservation. Function mapping (Hope and Nolan, 2005; de Groot, 2006) and land use mapping (Ferguson, 2005) however, are more widely used because they illustrate where important conservation sites are, show how land is being used socially and economically, and can refocus conservation efforts where they are most needed. The primary way of analysing landscape maps is to use a Geographical Information System (GIS); from this system other models and analysis tools can be used. Models such as percolation theory can be applied to various habitat maps, quantitatively analysing connectivity and flow within the landscape (McIntyre and Wiens, 1999). Mapping is required early on in the planning phases if any kind of landscape-scale conservation is to be employed.

Modelling is another important feature of landscape-scale conservation, and this is particularly true in urban environments. Models can be used to analyse the functions of the landscape, and examine how these overlap and interact (Hope and Nolan, 2005; de Groot, 2006). Models can be used to examine how environmental systems currently work; they can also be used to illustrate how developments or land use changes might affect the existing environmental systems. De Ridder *et al.* (2004) described a model known as 'Benefits of Urban Green Space' (BUGS), which focuses on environmental issues, and the potential for green space enhancement within a city. Most examples found in the literature used some kind of modelling to determine the best way to carry out conservation. Modelling is a valuable tool

for analysing large amounts of data and studying the possible effects of different scenarios (Leibowitz *et al.*, 2000; Young and Jarvis, 2001; Pauleit *et al.*, 2005).

Maintaining landscape and ecological functions is an important principle that should be adhered to when designing development or regeneration projects. The environment provides us with many services that we rely on, such as clean air and water, food, natural materials, and recreation spaces. To sustain these services the function and integrity of the landscape and its processes has to be maintained. An ecological system with ecological integrity 'has the capacity to support and maintain a balanced, integrative, adaptive community of organisms' (Gutzwiller, 2002, p46). Maintaining integrity and function is especially difficult in urban areas where many changes have already been made: whole forests have been chopped down, pollutants riddle the soils, water courses are diverted and culverted, and flood plains have been built upon. Urban redevelopment projects could provide an opportunity to correct some of these problems. McGuckin and Brown (1995) used spatial distribution models to examine the functionality of an ecological system in a developing area of Guelph, Canada. They showed how landscape integrity, ecological integrity, and wildlife habitat could be increased by incorporating blue-green (water and vegetation) open spaces during planning. Master planning was a method employed by Urbonas and Doerfer (2005) to mitigate the effects of urban development on the functioning of watersheds and waterways. This method is also being used in Cheshire in the Mouth of the Weaver Project where a land use map and development plan has been created with the aim of improving the function of the river and providing new access to green spaces. Integrity and function of a landscape should be maintained in every possible way if conservation efforts are to be successful. Maintaining landscape integrity and function also provide benefits for the human population by safeguarding environmental services that we rely upon and improving access to green and blue spaces.

Connectivity is very important for the maintenance of functional landscapes; it can be described by mapping, and analysed by modelling. Connectivity is a measure of 'how connected or spatially continuous a corridor, network or matrix' (Gutzwiller, 2002, p46). Connecting one habitat with another allows species to flow between patches, interbreed, genetically mix, and access food and other resources. Connecting habitats makes populations more resilient to disease, starvation, inbreeding and freak weather events. Populations that are able to move freely within the landscape are able to fulfil their natural behaviours and functions. Connectivity can also include patches which are not physically connected, but are connected by the movement of species. Metapopulations often live within patches that are not physically connected; examples of species that can live in this way are birds, insects and seed bearing plants. Current practical conservation methods for connecting habitats include green infrastructure, greenways and wildlife corridors. Wildlife corridors are defined by Gutzwiller (2002, p46) as 'landscape structures that enhance the dispersal of organisms between suitable habitat patches in fragmented landscapes where isolates of suitable habitat patches are surrounded by a matrix of inhospitable habitat types'. Wildlife corridors or greenways can be used to connect up patches so long as the use is clearly defined, and target species are properly understood during planning (Hess and Fischer, 2001). An integrated system of greenways or habitat corridors could be used on many spatial scales, aiding the movement of species and nutrients, and maintaining functional ecological systems

A further way to improve the connectivity of the landscape is to incorporate green infrastructure. Green infrastructure is about increasing the number of green spaces throughout urban, urban fringe and rural areas and providing a network of interconnected habitats. Green infrastructure helps to maintain many of the landscape and ecological functions discussed above. It also fulfils many social and economic functions, by providing space for recreation, relaxation and exercise, and encouraging businesses to a pleasant area. Opdam *et al.* (2006)

discussed why a coherent large-scale spatial structure of ecosystems is needed to preserve a biologically diverse landscape. Ecological networks allow development within the landscape because the structure of the network is flexible, yet it helps to focus attention onto an effective scale.

A solution to the problems associated with distinct patches and large edges can be remedied by zoning conservation areas. That is, designating areas based on their conservation regime. Core conservation areas have the most protection, and surrounding these core areas there are buffer zones and/or environmentally sensitive areas. Pullin (2002) described the concept of biosphere reserves with this kind of zoning in place. If zoning of entire conservation areas is not possible, then buffer zones can provide protection for core habitats and mitigate the harsh edge effects.

In the past there have been many barriers to the integration of conservation with planning and development projects. These barriers include communication and varying interpretations between disciplines. However, there are many practical solutions and examples from the literature that can be used to integrate landscape-scale conservation into urban regeneration projects. Most examples involve mapping and modelling; many solutions are simple, such as increasing the amount of green spaces, connecting habitats and creating buffer zones. The benefits include environmental, social, economic and sustainability goals.

## 4. CONCLUSION

Landscape-scale conservation is environmental conservation that is carried over an area of landscape where the mix of local ecosystems or land uses is repeated in similar form over a kilometres-wide area. Landscape-scale conservation is based on the premise that the spatial configuration of a landscape has a profound effect on the ecology and biodiversity found within it. The functions and processes of a landscape are as important as the species living there.

The issues surrounding landscape-scale conservation are complex, and occasionally contradictory. Such a large body of evidence coming from separate disciplines means that inconsistencies can be common. This fuels the development of research and provides interesting debate, but it sends confusing messages to practitioners from other disciplines. If true integration between landscape-scale conservation, planning and development of urban regeneration is to occur then clear, practical and uniform information needs to be easily available.

As the discussion above shows, there are many ways in which landscape-scale conservation could be applied during the development of regeneration projects. The benefits of such integration would be felt over environmental, social and economic scales. Regeneration projects may be able to provide opportunities for restoration and remediation of the environment that will provide connections within the landscape. Increased connectivity or better configuration of habitats within the urban landscape could improve biodiversity, as well as provide recreational opportunities, increase house prices and encourage economic development. Landscape-scale elements such as habitat corridors, greenways, and green infrastructure can be simply and effectively incorporated so long as landscape-scale conservation is considered during the planning and design phases.

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