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The importance of Biodiversity in Cities and Ecosystem Services

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Abstract

In 1984 E. O. Wilson described the word “biophilia” as “the connections that human beings subconsciously seek with the rest of life”. Had Wilson written this text one year later he might have replaced the phrase “the rest of life” with a single word: Biodiversity. There is now clear evidence from various disciplines: medicine, health, sociology, physiology, and ecology, that biodiversity provides many ecosystem services (usually classified as supporting, provisioning, regulating, and cultural) that are fundamental to individual and societal health and well-being. In this talk this evidence will be reviewed briefly. Yet over time, as human society has developed from hunting and gathering to post-industrial there has been an erosion of individual and societal contact with nature; a trend which will be mapped out in this talk.

Biodiversity is, through the provision of ecosystem services, key to the resilience of cities. The dawn of the 21st century brought with it unprecedented cultural challenges: peak oil, climate change; both testing societal resilience. It is our culture: our shared ideas, attitudes, and actions, which will determine how resilient our cities are. It is our attitudes to biodiversity that will shape the cities of tomorrow, and we need the outputs from good science to shape these attitudes. There are a number of scientific and cultural challenges that lie ahead; these will be drawn out in the concluding section of this paper.

Introduction

Cities are the product of human endeavour. They are centres of industry, commerce, and human habitation. It is in the cities that over half of the world's 7 billion people live. It is here that the majority of us will have our daily contact with biodiversity. The word biodiversity was coined by W.G.Rosen in 1985. In 1988 the entomologist E. O. Wilson used the word as the title of a book. It went on to be a best seller and brought biodiversity to the attention of a wider public (National Forum on BioDiversity, 1988). Four years previous, in 1984, Wilson had published a book titled "Biophilia" (Wilson, 1984). In this book Wilson defined biophilia as "the innate tendency to focus on life and lifelike processes" (p1). Wilson went on (p2) "Modern biology has produced a genuinely new way of looking at the world that is incidentally congenial to the inner direction of biophilia. In other words, instinct is in this rare instance aligned with reason. The conclusion I draw, [he said], is optimistic: to the degree that we come to understand other organisms, we will place a greater value on them, and on ourselves". Had Wilson written his book on biophilia after that on biodiversity I postulate that he would have replaced the phrase "other organisms" with the word biodiversity. He would have been optimistic that the more we understand about biodiversity the more we will value it. This raises two fundamental questions which are particularly relevant in the context of our cities: what do we know of biodiversity in cities, and what are the implications of placing a value on biodiversity.

Biodiversity and cities

Knowledge of biodiversity in cities can be considered in terms of what is known by professional ecologists and conservationists, and what is known by the lay public. We have recently seen a number of books published on Urban Ecology: Urban Ecology: an international perspective on the interaction between humans and nature by Marzluff (2008), Urban Biodiversity and Design by Müller *et al.* (2010), Urban Ecology by Gaston (2010), The Routledge Handbook of Urban Ecology by Douglas *et al.* (2010), and Urban Ecology: Patterns, processes, and applications by Niemelä, *et al.* (2010a).

Professionally we know that plant communities in urban areas are generally characterized by species adapted to anthropogenic disturbances, an abundance of species in eutrophic habitats, and a high diversity of non-native species (Pyšek, 1998; Godefroid & Koedam 2007; Vallet *et al.* 2008; James. 2010). As urbanization increases the composition of avian communities changes; species diversity and richness decrease, and biomass and density increase (Mills *et al.*, 1989; Chace & Walsh, 2006; Clergeau, *et al.*, 2006; McKinney, 2008). Urban areas tend to favour granivores, omnivores, and cavity nesting species (Beissinger & Osborne, 1982; Blair, 1996). Amphibian populations are affected by the pondscape -- the spatial pattern of freshwater habitat in the urban matrix (Gledhill *et al.*, 2008). Studies of arthropods suggest reasonably consistent community-level responses to urbanisation. Both abundance and species richness of native species decrease along the rural-urban gradient. Urban environments are characterised by a few dominant, often invasive exotic, species. Most species of urban/suburban areas are capable of flight whereas those that cannot fly are more common in rural areas (Kotze, *et al.*, 2010).

Biodiversity encompasses all living things - plants, animals, and microbes - and all the places where they are found (NERC, 2011a), and we know that there are many places within cities where biodiversity thrives. Fifty-seven per cent of "urbanized" Greater Manchester (i.e. discounting the surrounding agricultural land within the administrative unit) is covered by vegetated surfaces (Pauleit & Breuste, 2011), that is to say by land cover dominated by biodiversity. While figures for other cities vary considerably the message is clear: biodiversity is part of the urban fabric.

We also know that habitat loss, invasive species, pollution and waste, over-exploitation of renewable resources, and climate change are the main pressures on biodiversity (NERC, 2011b). As energy prices rise and the available carbon based energy resources decreases, and the World's population grows the intensity of these pressures is set to increase.

So professionally, we know quite a bit about urban ecology. True there are still some unanswered questions. We professionals still have much to learn about urban ecosystems are structured and function, about how humans interact with their biotic and abiotic environments, and about understanding better the interaction between ecology and society (Niemelä *et al.* 2010b).

What about the non-ecologist, the non-specialist, what is their level of knowledge about urban biodiversity? According to a survey conducted for the UK's National Trust, a major environmental charity, only 29% of British children could identify a magpie (*Pica pica*), 50% could not tell the difference between a bee (*Apis* sp.) and a wasp (Vespidae). The leaf of the Oak (*Quercus*), the UK's national tree, was identified by just 53 per cent. Only 47 per cent of children correctly identified a barn owl (*Tyto alba*) and one in three failed to recognise a Red Admiral (*Vanessa atalanta*) (The National Trust, n.d.). The Daily Telegraph (2011) reported the results of a survey in which it was revealed that the distinctive blue cap and yellow breast helped only 70% of people to pick out the Blue tit (*Parus caeruleus*) from a line-up of the five most common garden birds: House sparrow (*Passer domesticus*), Blackbird (*Turdus merula*), Starling (*Sturnus vulgaris*), Blue tit, Chaffinch (*Fringilla coelebs*), and when asked to identify the Chaffinch only 56% recognised it. This lack of knowledge is put down to children spending too much time indoors and an absence of outdoor play. Only 14% of children aged 7-11 years engaged in informal outdoor play. This compared to 38% for the under 50s and 46% for the over 50s (England Marketing, 2009). What these and other figures suggest is that our children are being taught by parents and teachers who themselves have little knowledge of the natural world around them. These data indicate that, at least in certain countries, there is a culture where people spend little time in direct contact with biodiversity and know little of the plants and animals that surround them.

Human societies are understood in terms of long-term processes of development and change. To an anthropologist human societies can be organized according to their primary means of subsistence. So, we have hunter-gatherer societies, nomadic pastoral societies, horticulturalist or simple farming societies, intensive agricultural societies, industrial societies, and knowledge societies. With each step along this time line the levels of direct contact with the natural environment has decreased: knowledge decreases, skills are lost, and values are changed. This lack of knowledge about the natural world is unplanned and unintended. Now, there is a generally recognised disconnect between people and biodiversity. This disconnect has been exacerbated by the late 20th century public health literature in which the environment is couched in terms of problems and hazards to be controlled. There has been a tendency to view human society and the natural environment' as conceptually distinct with an emphasis placed on the risk to human health *from* the environment (Peterson and Lupton, 1996).

Viewing the natural world as distinct from human society is a manifestation of the frontier mentality: the cultural mindset that rich, valued biodiversity is associated only with remote areas, which reflects a model of an empty world in which human development is completely isolated from natural (wild) processes (Farina *et al.*, 2003). It is the dominant mindset in the western world; it is a dialogue of otherness (Farina *et al.*, 2003). The phrase “Urban wildscape” is used to highlight and promote particular landscape qualities, functions, and experiences. It is defined as “urban spaces where natural, as opposed to human agency, appear to be shaping the land, especially where there is spontaneous growth of vegetation through natural succession. Such wildspaces can exist at different scales, from cracks in the pavement, to much more extensive urban landscapes, including woodland, unused allotments, river corridors, and derelict or brownfield sites” (Jorgensen, 2008 p1). Whilst such sites evoke contradictory responses: both feared and valued, the concept clearly draws on this idea of separateness, of otherness.

Gilles Clement, a French landscape architect, has argued that there must be recognition of the “Tiers Paysage” or “Third Landscape” as an ecological landscape that is neither urban nor rural which “is no longer a place abandoned to rubbish and weeds, but becomes a sort of reservoir or ‘biological time capsule’ for the future” (Clement *et al.*, 2006:92). The emphasis here is to encourage a vision of these landscapes which recognises their ecological importance. Of course we do not need to look too far to see other examples where humans and biodiversity are linked but it is an example that falls outside the scope of the Urban wildscape: the garden. Owens (2010) records 2,673+ species of plants and animals in a 741m² garden in Leicester. The plus sign in the figure of 2,673+ is attributed to the unidentified Colleoptera. Owens notes that exotic as well as native species of plant are used by the animals in the garden with, for example, one moth larva feeding on 12 native and 42 exotic species.

What we see here is the emergence of questions around the way in which urban biodiversity is portrayed: is it wild, is it separate from people, or is it part of our every day journey through a city? What vocabulary do we use – is land “waste” or a dynamic example of early succession? Do we value gardens and the exotic plants they contain appropriately? These questions lead to thoughts about the value of and the values ascribed to biodiversity.

Biodiversity and Ecosystem Services

Aristotle (384-322 BC), having lost out on the top job at Plato's academy in Athens went to Lesbos where he laid the foundations for the sciences of Biology and of Ecology. Aristotle, in the same way that we all do, interpreted the world he saw about him in the light of the knowledge and social/political context of the time. He is reported as stating: Nature made nothing in vain and everything has a purpose. Plants were created for the sake of animals and animals for the sake of men (*sic*). Domestic animals are here to labour, wild ones to be hunted (Thomas, 1984). Two and a half thousand years later, in 2007, environment ministers from the governments of the G8+5 countries, meeting in Potsdam, Germany, agreed to "initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation." The Economics of Ecosystems and Biodiversity (TEEB) study emerged from that decision. TEEB was hosted by the United Nations Environment Programme and supported by the European Commission; the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety; the UK government's Department for the Environment, Food and Rural Affairs, and Department for International Development; Norway's Ministry for Foreign Affairs; Sweden's Ministry for the Environment; The Netherlands' Ministry of Housing, Spatial Planning and the Environment; and Japan's Ministry of the Environment. Interestingly, TEEB Phase II, from which the main reports emerged, was lead by Pavan Sukhdev, a career banker. The TEEB reports make the case for the systematic appraisal of the economic contribution of biodiversity and ecosystem services to human well-being, and for routine steps to prevent that contribution being lost or diminished through neglect or mismanagement (TEEB, 2010). It is an appeal to each of us, whether a citizen, policy maker, local administrator, investor, entrepreneur, or academic to reflect both on the value of nature, and on the nature of value.

Biodiversity is an important component for ecosystem service provision; hence it is at the heart of the resources and processes that are supplied by natural ecosystems. Biodiversity provides: food; raw materials; fresh water; medicinal resources; local climate and air quality regulation; carbon sequestration and storage; moderation of extreme events; waste-water treatment; erosion prevention; maintenance of soil fertility; pollination; biological control; habitat for species; maintenance of genetic diversity; recreation; mental and physical health; tourism; aesthetic appreciation and inspiration for culture, art, and design; spiritual experience and sense of place. Through these provisioning, regulating, habitat or supporting, and cultural ecosystem

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services biodiversity influences and affects human well-being and most economic activity (TEEB, 2011).

Biodiversity enhances the amenity and liveability of the urban fabric (DTLR, 2002). It contributes to people's recreational and leisure needs (Urban Parks Forum, 2001) and to the social (Kuo, 2003; Westphal, 2003), environmental (EA, 2002) and economic (Wolf, 2003) vitality of urban communities. The importance of biodiversity to physical, psychological, and social health is clear (Tzoulas *et al.* 2007; Tzoulas and Greening, 2010) and the message seems to have got through to the public. In a recent survey that I and others carried out in Wigan, UK we found that 95% of the people using a nature reserve in that town stated that their visit to the reserve was beneficial to their health: 68% reported that this was related to their physical health, 38% to their psychological health, and 6% to their social health (James *et al.*, 2011). Together these and similar studies suggest that urban green space can have positive effects as external determinants of health and well-being of the community and individuals. Thus, urban green space becomes fundamental to the liveability and health of urban settlements (Tzoulas & James, 2004).

Mapping of both ecosystem service provision and demand is fairly common (Chan *et al.*, 2006). Spatially, provision and demand may be close to each other (shade provided by a tree cooling a house and reducing the need for air-conditioning), nearby (open green-space providing recreation, leisure, and health benefits for those living within a few hundred meters), or at some distance (provision of clean water in a city's hinterland for consumption some kilometres away in the city) (MacDonald & Marcotullio, 2010). Recognising these spatial relationships is important as the links between provision and demand need to be maintained. There may also be temporal differences: while the provision of shade is instantaneous, water infiltrating the ground today might not be used for drinking water for many hundreds, or thousands of years. So, we have, as always in ecology, spatial and temporal scales to consider.

There is currently research being undertaken that is examining the evidence for thresholds, tradeoffs, and tools to measure when those thresholds have been reached. This is a direction that if successful will allow society to make judgements, based on good science, that we have enough biodiversity to maintain the ecosystem services and this implies that we can do something else with the vegetated areas that are surplus to requirements. Is this a question that we really want to answer?

In November 2011, seven of the world's leading environmental scientists published a paper in *Science* in which they report that over the past 50 years, 60 percent of all ecosystem services have declined as a direct result of the conversion of land to the production of foods, fuels, and fibres (Kinzig *et al.*, 2011). The authors point out that, while there are well developed markets for agricultural, aquaculture, and forest products, many ecosystem services are public goods that lie outside individual governmental control. Influencing market forces by subsidies has often resulted in unforeseen consequences: agricultural subsidies being one example. The danger here is in affecting markets for ecosystem services where there is no clear control and where the science is often poorly understood.

What separates the TEEB reports from Aristotle's comment is that TEEB is setting out to reframe the dialogue: moving biodiversity to the centre of business thinking, moving biodiversity so that it cannot be overlooked, moving biodiversity to a position where it is not set aside. If this is to happen there are some hard, ingrained attitudes to overcome and we, as urban ecologists will have to find ways of influencing others who manage the land. What emerges is that the key factor is not so much how much carbon we use, or how much of the natural resources we consume, but rather how we respond to the knowledge that our use of carbon is affecting the atmosphere, that the climate is changing, and that natural resources are becoming increasingly scarce. What determines how we respond is our culture: or shared beliefs, ideas, and actions.

Agenda

So, whilst we face challenges from peak oil, climate change, and increased human population size, perhaps the greatest challenge we face in terms of urban ecology is from our own culture. Within urban ecology we have many unanswered questions about ecosystem function, about the resilience of ecosystems to environmental change and all that will bring in terms of pests and diseases, and we have much to take on board from psychology and sociology about the ways in which humans interact with and live alongside biodiversity. Generally urban inhabitants are disconnected from the natural world, we have limited knowledge of that world and that knowledge is decreasing generation by generation, and we view biodiversity as a resource which we can manage as we can any other resource. In managing resources we ascribe value and values. The dialogue of the 20th Century has been of otherness, and of harm. Reframing this dialogue within society, in the 21st Century developing a language that is laden with positive values, providing evidence for the links

between ecosystem service provision and demand are, I suggest, important elements on the agenda of the Urban Ecologist.

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