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Viewpoint

Biodiversity and Green Infrastructure in Europe: Boundary object or ecological trap?

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ABSTRACT

The concept of green infrastructure is widely used in environmental planning, but so far it has no standard definition. Planners, conservationists and scientists tend to welcome the term because it can serve as a boundary object, providing links among policy makers, developers and different academic disciplines. However, the concept of green infrastructure creates risks for biodiversity conservation in its adoption. It can be used to water down biodiversity conservation aims and objectives as easily as it can be used to further them because of the different ideas associated with it and the multiple interests pursued. In this paper, we address such risks by looking, among others, at the European Union's Green Infrastructure Strategy and we suggest how planners and conservationists might deal with its growing importance in environmental policy and planning to enhance its value for biodiversity conservation.

1. Introduction

Green Infrastructure (hereafter GI) has become increasingly an important concept in environmental planning (UNEP, 2014), for example in Europe, (e.g. in France, Grenelle Environment, 2010, and the UK, DCLG, 2012), and the USA (EPA, 2014). Most recently, the European Union's (EU) Green Infrastructure Strategy has been launched, where GI is defined as 'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' (EC, 2013, p. 3). Such ecosystem services (ESs) include provision of new habitats, flood protection, cleaner air and water. Furthermore, at least four key actions of the EU Biodiversity Strategy appear to us as relevant to GI, including: (i) the provision of baselines against which nature's benefits to society can be valued and GI investments can be measured (action 5); (ii) the establishment of a restoration prioritization framework (action 6a); (iii) the mainstreaming of biodiversity in key EU funds (action 7a); and (iv) the establishment of links between GI implementation and no-net-loss policies (action 7b), through, for example compensation or offsetting schemes (EC, 2013). Hence, the way GI has been framed, interpreted and implemented in practice can significantly influence the way the wider biodiversity conservation agenda is understood and promoted in Europe.

The concept of GI can act as a 'boundary object', as does the concept of ecosystem services (Abson et al., 2014). 'Boundary objects' may be concrete or abstract (e.g. an idea), and are plastic enough to be interpreted differently among communities or interest groups, yet are robust enough to enable cross-communication (Star and Griesemer, 1989). In this case, the term 'green infrastructure' has the potential to link planners, conservationists and academics together in a common task, namely the provision of areas of habitat or undeveloped open space in human-dominated (predominantly urban) landscapes.

The idea of GI builds on the long history of the creation of public parks and open spaces in industrialized regions for amenity and ecological purposes (Walmsley, 2006). Academic interest in GI cuts across several disciplines, although it draws in particular on landscape and urban planning (Benedict and McMahon, 2002) and

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landscape ecology (e.g. Jongman and Pungetti, 2004). In ecology and biodiversity conservation, the idea of GI (particularly in the context of urban planning and regeneration projects) is framed in the context of habitat creation and restoration (Perrow and Davy, 2002), ecological networks (Lindenmayer and Fischer, 2006), urban biodiversity (Muller et al., 2010) and increasingly ESs (Schindler et al., 2014). GI projects also show a great diversity of scale, from green roofs (Williams et al., 2014) through local storm water management projects (Ahern, 2010) to large national ecological networks (Weber and Allen, 2010).

GI is considered important in biodiversity conservation for three main reasons. First, it focuses attention on the creation or maintenance of areas of wildlife-rich natural or semi-natural habitat in heavily developed, developing or urbanised landscapes. Second, it involves the creation of ecological connections between different areas of habitat, potentially allowing species movements among otherwise isolated habitat blocks. Third, it translates ideas about the importance of areas of wildlife habitat in a language that can be understood by planners and private businesses that control decisions about land development and urbanisation. In the EU, GI is seen as having an important role in conserving biodiversity (Kettunen et al., 2014). In particular, GI has been considered the main instrument for the implementation of Target 2 of the EU 2020 Biodiversity Strategy, which aims by 2020 to maintain and enhance ecosystems and their services by establishing green infrastructure and restoring at least 15% of degraded ecosystems (EC, 2011).

However, there are risks in the adoption of the GI concept. In this paper, we analyze these, focusing on its current deployment in Europe as this is illustrated in the EU Strategy for Green Infrastructure (EC, 2013). We consider first the biodiversity value of GI landscapes and second the implications of the role of GI as natural capital. Finally, we provide a series of recommendations to enhance GI's value for biodiversity conservation. These recommendations are not limited to the European case, but extend globally wherever GI is implemented in a similar manner.

2. Biodiversity value of GI landscapes

A range of factors determines the value of GI landscape features for biodiversity. Here we identify three.

First, multi-functional planning is central to the conception of GI, seeking to provide 'win–win' solutions by enhancing multiple benefits simultaneously (Benedict and McMahon, 2002). Thus the stated benefits of GI in the new EU strategy (EC, 2013) include biodiversity conservation; climate change adaptation and mitigation; disaster risk management; reduced energy use; water regulation; cooling; food provision; economic growth; recreation, health and well-being; increased land and property values; and the enhancement of territorial cohesion, among even more. Planning to meet multiple goals of this kind inevitably involves trade-offs (Maes et al., 2012), and the provision of habitat for biodiversity can easily become buried in an agenda of broadly defined 'green' projects (see also EPA, 2014; UNEP, 2014). Indeed, GI is widely considered as a means to create 'appealing places to live and work in' (EC, 2013, p. 3), a goal that can be interpreted in many different ways and which does not necessarily include biodiversity conservation as one of its objectives. The issue of potential conflicts between GI functions is not simply a technical issue (Wright, 2011). On the contrary, achieving biodiversity conservation goals in the face of competing demands on land and investment involves hard political choices where win–win outcomes may not be possible (Hirsch et al., 2011). Hence, planning for multi-functionality involves inclusions and exclusions, has winners and losers and can exacerbate environmental and socio-spatial injustices for certain social groups (Hansen and Pauleit, 2014) while also creating conflicts that can negatively impact on biodiversity (Redpath et al., 2013).

Second, the definition of GI is so broad as to include urban plazas, sports pitches, cycle-paths, landscaped gardens, road verges or landfill sites (EEA, 2011). In practice, GI often tends to be confounded with generic 'green space', meaning land that is not built upon. The value of a piece of land for biodiversity depends on a species-and-place-specific balance between habitat area, quality and connectivity. The quality of such land for biodiversity is often low and rarely corresponds to breeding habitat for most species (Hodgson et al., 2009). Indeed, despite the contribution of urban ecosystems to specific taxonomic groups (Muller et al., 2010) and diverse ESs (Gómez-Baggethun and Barton 2013), recent reviews and meta-analyses show that flagship GI elements such as corridors (Shwartz et al., 2014; Snäll et al., 2016), urban gardens (Cameron et al., 2012), green roofs (Williams et al., 2014) and brownfields (Bonthoux et al., 2014) are not as valuable for biodiversity as often portrayed. To the above, we should add the possible effects of disturbance and maladaptive habitat selection. Examples include Cooper's hawks (*Accipiter cooperii*) in urban contexts (Boal and Mannan, 1999), the desert lizard *Acanthodactylus beershebensis* and afforestation (Hawlena et al., 2010), wetland restoration and the *Lycaena xanthoides* butterfly (Severns, 2011), and road traffic disturbance and meadow birds (Reijnen et al., 1997).

Third, while the enhancement of connectivity between areas of wildlife-rich habitat is identified as an important contribution of GI to biodiversity conservation (Benedict and McMahon, 2002), the value of these connections is highly variable and often species and species-group specific (Henle et al., 2004). The EU strategy observes that GI has the potential to reduce ecosystem fragmentation and increase the connectivity between Natura 2000 sites (an EU-wide network of nature protection areas established under the 1992 Habitats Directive), connecting 'national parks, nature parks, biosphere reserves, trans-boundary protected areas and non-protected areas along or across borders' (EC, 2013, p. 10). However, understanding the multiplicity of factors that contribute to landscape connectivity remains challenging and the scientific evidence of the value of corridors is still inconclusive (Moilanen, 2011; Snäll et al., 2016). In addition, the connectivity relevant to biodiversity may not be at a spatial scale relevant to planning (Rudnick et al., 2012): ecosystem elements visible to humans, e.g. hedges or linear parks, may only be relevant to a subset of species e.g. birds. Hence, the quality of habitat in corridors is likely to be more important than their layout, and corridors developed within GI projects for other purposes than biodiversity (e.g. a footpath to link housing areas to open spaces, or the visual effect of a line of roadside trees, Jongman and Pungetti, 2004) may be of limited ecological value. Synergies between these objectives and biodiversity will depend on visual character and ecological character coinciding, and human and wildlife movements being enhanced by the same features. Moreover, in a context of increasing urban and development pressures, connectivity or wildlife corridors, can be used to legitimise habitat destruction allowing planners to 'ring-fence the best and trade-off the rest' (Selman, 2002, p. 284), permitting development of all land except a minimalist network of defined 'corridors'.

To investigate if our concerns reflect the reality of GI practice, we conducted a desk study of the GI strategies developed for England, arguably the European country where 'explicit' GI policies have been most developed. We surveyed all GI strategies and plans that we could locate online using the search term "green infrastructure UK"(59, from 2005 to 2015). Their treatment of connectivity included cycle paths, footpaths, road verges and planning-style corridors—even in some cases with connectivity of 'habitats and landscapes, businesses and communities at a range of scales' (UE Associates, 2010, p. 6). While all of them analysed maps within a GIS system: (a) 94% (56) only used map overlays within a GIS system to

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