Biodiversity and the EU Green Infrastructure Strategy in Europe: boundary object or ecological trap?

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Keywords: Biodiversity, conservation, planning, ecological connectivity, ecosystem services, natural capital, green economy.

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.

Keywords: Biodiversity, conservation, planning, ecological connectivity, ecosystem services, natural capital, green economy.

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 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 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 & 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 & McMahon 2002) and landscape ecology (e.g. Jongman & 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 & Davy 2002), ecological networks (Lindenmeyer & Fisher 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., 2012). 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 infrastructures* 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.

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 & 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 (Shwarts *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 & 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 & 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 59 GI strategies and plans that we could locate online (2005 – 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 assign potential GI areas (see Snäll *et al.* 2016 for the limitations of this approach); (b) only 6.7% (four) used or incorporated a systematic, scientific method for 'drawing' corridors that takes into account ecology; and (c) none of them considered trade-offs between GI and biodiversity conservation. As a general finding, we could also add that often,.

GI and Natural Capital

The connections between GI, ESs and natural capital were not explicit when the GI concept first emerged in the US. But, as the whole field of environmental – and not just biodiversity – conservation and restoration gradually moved to a more utilitarian and neoliberal framing of nature (Gómez-Baggethun *et al.* 2010), so did GI. The idea of nature as a provider of 'services' that can produce financial gains along with biodiversity conservation is also reflected in the EU GI strategy (*Green Infrastructure – Enhancing Europe's Natural Capital*, EC 2013) and the *EU Biodiversity Strategy* (EC 2011). In line with this new thinking, the EU GI strategy does not have a separate section on 'biodiversity conservation' and the concept is explicitly framed in terms of 'natural capital' (as one form of capital alongside built, financial and human capital). By analogy with hard infrastructure, this framing suggests that nature and green spaces must be actively managed and measured as economic assets (Thomas and Littlewood 2010; Wright 2011).

A key aspect of the influence of the idea of GI as natural capital is the way its value is expressed in terms of its capacity to deliver ESs that are valuable for the economy (EEA 2011). The emphasis on ESs and the parallel underestimation of an explicit reference to biodiversity conservation in the EU GI strategy implies that biodiversity and ESs are one and the same. However, although management interventions to enhance biodiversity conservation and ESs, especially in semi-natural or human dominated landscapes, can be mutually beneficial under specific circumstances (Schneiders et al., 2012), the interplay between ESs and biodiversity is complex and context dependent (Bullock *et al*. 2011), so improving one does not necessarily imply benefits for the other (Adams 2014). Moreover, while GI has the potential to enhance diverse urban ESs (Gómez-Baggethun and Barton, 2013), an economically driven focus on those 'services' that are valuable to the current economic system and profitable to investors may restrict GI projects to those that match the needs of the market and not biodiversity conservation (Vira and Adams 2009). Especially regarding large-scale GI projects that would require significant funding, available funds through the EU cohesion policy programmes or the European Investment Bank require that projects contribute not only to environmental targets but also to economic growth and job creation (Maes *et al*. 2015).

The framing of GI in terms of natural capital by the EU locates it as part of a 'green economy' agenda that belies trade-offs between environmental protection and economic growth (Gomez-Baggethun and Naredo 2015). Indeed, the EU strategy emphasizes the role of GI in enabling economic growth and investment (EC 2013). GI is expected to contribute to the 'recovery of Europe's economy by fostering innovative approaches and creating new green businesses'[1] as the Roadmap to a Resource Efficient Europe reiterates calling for proposals to 'foster investments in natural capital, to seize the full growth and innovation potential of GI and the restoration economy'[2]. Thus the role of GI in supporting biodiversity becomes secondary to the broader needs of economic growth. Many GI projects are designed to address infrastructure cost, durability, safety, or aesthetics (Foster *et al*. 2011) and biodiversity conservation features only as a mere desirable side effect or co-benefit. For instance, among the 1824 green roof projects reviewed by Williams *et al*. (2014) only 8% cited biodiversity conservation or related benefits.

Furthermore, in a green economy, the enhancement of GI becomes an economic opportunity to promote development and growth by attracting investment and actors pursuing entrepreneurialism and place competitiveness agendas (Thomas and Littlewood 2010). Such growth may have negative broader impacts on biodiversity that are not educed or offset by any GI created, for the reasons discussed above. Current initiatives to enhance GI in the EU, the US and globally (e.g. UNEP 2014) prioritize support for economic growth over the need to conserve biodiversity and natural ecosystems. In Europe, industry and the business sector are considered as increasingly important by the EC to the funding of GI (EC 2012) while in the USA, new partnerships (e.g. 'NatLab') among private companies and conservation agencies are being promoted to attract private capital in GI, e.g. through credit trading programs, offsite mitigation, private-public partnerships and transformation of vacant lands[3]. To corporations, hybrid approaches combining green and grey infrastructure are seen to provide an optimum solution to 'improve business resilience' through new investment opportunities but the precise impacts of GI on biodiversity remain largely unaddressed (Williams *et al*. 2014). GI projects still lack rigorous evaluation in terms of baseline measures or agreed indicators over time (EC 2012) despite recent efforts to bridge this gap (Bonthoux *et al*. 2014).

Enhancing GI's value for biodiversity conservation

[1] http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf
[2] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0571&from=EN
[3] http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/newsroom/nat-lab-release.xml

While in principle various forms of GI can lead to the enhancement of biodiversity and habitat restoration, planners, scientists and civil society actors need to be realistic about GI's potential and limitations in this regard. There is a risk that biodiversity loss will be legitimized under this banner, and this loss hidden behind a generic rhetoric of 'green planning'. We identify four areas that need to be explicitly addressed to ensure the contribution of GI projects to biodiversity conservation.

First, the level of uncertainty involved in assuming that 'green spaces' will necessarily support significant biodiversity needs to be recognized. The assumptions made about the ecological value of linear or visual 'corridors' in species dispersal or movement need to be addressed explicitly in project planning. Where appropriate research should be carried out to determine the relative value of different kinds of GI landscape elements, for example 'connectivity' versus habitat extent and quality as variables in explaining population persistence. Approaches that integrate information about organisms' life histories, habitat quality, and other key determinants of connectivity are available for bridging this gap and reducing the uncertainty of connectivity models (e.g. Moilanen and Hanski 1998; Ovaskainen *et al.* 2008; Rudnick *et al*., 2012). Nevertheless, further research is needed to improve our understanding of not only the structural connectivity created by GI projects (the physical characteristics of the landscape), but also the functional connectivity (how well genes, individuals, or populations would be able to move through the new landscapes).

Second, biodiversity proofing of projects appears in the Commission's agenda, see for instance action 7a, b (on not net loss) in the EU's Biodiversity Strategy (EC, 2011). However, the benefits of such strategies for biodiversity conservation need to be proved, and subject to great uncertainty and the focus of strong debate (e.g. Moreno *et al*., 2015; Apostolopoulou and Adams, 2016). Hence, the environmental impacts of GI projects need to be carefully assessed in project design, for example through improved Environmental Impact Assessments, and appropriate mechanisms need to be integrated to ensure the protection of biodiversity as projects develop. Depending on the complexity of the target landscape and the scope of the intervention, this will require the adoption of the precautionary approach as well as flexibility and anticipation in GI projects. Among other issues, to avoid irreversible damage, careful assessment will be needed , to adapt GI projects to the emerging properties of new landscapes and to ensure appropriate resources (human, economic, technological and legal) to handle the unintended consequences such as the spread of invasive species and disease through connected landscapes.

Third, measures to safeguard those ecosystems and species of critical importance for biodiversity conservation need to be made central in planning GI programmes. Lessons on biodiversity safeguards from other conservation interventions (Phelps *et al*., 2012) should be incorporated to GI projects. Safeguards should be binding and monitored against previously defined indicators for assessing biodiversity outcomes. This will require improved knowledge of species' requirements, habitat and ecosystem processes to ensure functional green infrastructures for biodiversity together with strong mechanisms to ensure the accomplishment of Target 1 of the Biodiversity Strategy (EC, 2011) in any GI project.

Fourth, attention needs to be paid to the synergies and trade-offs between biodiversity and ESs. Assumptions that conflate ESs and biodiversity in GI projects needs to be recognized and questioned, and the synergies demonstrated. While there is increasing evidence on the ways in which specific elements of biodiversity underpin the provision of ESs (Isbell *et al*., 2015; Maes *et al.* 2015), lessons from ecological restoration show that both opportunities and conflicts for biodiversity conservation emerge from interventions to enhance ESs (Bullock *et al*., 2011). Plans to enhance ESs have often failed in their attempt to achieve biodiversity conservation (Macfadyen *et al*., 2012). Important drawbacks also arise from the lack of spatial concordance between some ESs and species richness measures (Naidoo *et al*., 2008). Hence, attention needs to be paid to the trade-offs and synergies between biodiversity conservation and other objectives of GI projects like the provision of ESs. Systematic conservation planning has recently been proposed as a way to include these trade-offs and synergies at the planning stage (Snäll *et al.* 2016), although such an approach has rarely been promoted (*ibid*) or used in practice. Likewise novel spatial approaches have emerged promising to reconcile conservation targets with ES based GI approaches (Schneiders *et al*., 2012). However, due to the small scale of the majority of GI projects, the knowledge-practice gap, and the time and funding problems faced by many local and regional authorities in Europe, such approaches are unlikely to gain mass use.

Conclusion

The increasing calls for 'smart' conservation (e.g. EEA 2011) identify the need for conservationists to engage with spatial planning and the economic engine that drive it. GI works powerfully as a boundary object to enable that engagement (c.f. Abson *et al.* 2014). However, the idea of GI, as currently configured, poses challenges as well as opportunities for biodiversity conservation. To draw an analogy from ecology, there is a risk GI could act as a conceptual ‘ecological trap’ (Battin 2004, Robertson and Hutto 2006) – an idea that attracts funding and effort from specific conservation measures that could deliver better biodiversity outcomes.

In an era when the pursuit of economic growth is considered a paramount policy goal to deal with the effects of the economic crisis, calls to de-regulate and weaken state support for environmental protection have grown both in the US (McCarthy 2012) and Europe (Apostolopoulou and Adams 2015)[4]. In this policy context, it is not surprising that GI initiatives are increasingly linked to business interests. However, GI projects that are attractive for the market or cost-effective for investors will not necessarily be beneficial to biodiversity conservation.

GI has an important complementary role in the implementation of the EU biodiversity strategy, and is influential in shaping the wider policy context of biodiversity conservation in Europe. However, if the GI strategy is implemented without specific measures for biodiversity, GI could divert funding and effort from specific conservation measures, with negative net effects on biodiversity. Clarity about the goals of GI projects, and the incorporation of biodiversity conservation needs from the earliest stage of project planning through implementation and maintenance, are essential if this trap is to be avoided.

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