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Review

Optimising UK urban road verge contributions to biodiversity and ecosystem services with cost-effective management

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ABSTRACT

Urban road verges can contain significant biodiversity, contribute to structural connectivity between other urban greenspaces, and due to their proximity to road traffic are well placed to provide ecosystem services. Using the UK as a case study we review and critically evaluate a broad range of evidence to assess how this considerable potential can be enhanced despite financial, contractual and public opinion constraints. Reduced mowing frequency and other alterations would enhance biodiversity, aesthetics and pollination services, whilst delivering costs savings and potentially being publically acceptable. Retaining mature trees and planting additional ones is favourable to residents and would enhance biodiversity, pollution and climate regulation, carbon storage, and stormwater management. Optimising these services requires improved selection of tree species, and creating a more diverse tree stock. Due to establishment costs additional tree planting and maintenance could benefit from payment for ecosystem service schemes. Verges could also provide areas for cultivation of biofuels and possibly food production. Maximising the contribution of verges to urban biodiversity and ecosystem services is economical and becoming an increasingly urgent priority as the road network expands and other urban greenspace is lost, requiring enhancement of existing greenspace to facilitate sustainable urban development.

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1. Introduction

The greenspace associated with urban roads, called 'tree lawn', 'parking strips' or 'sidewalk buffer' in North America, 'nature strips' in Australia, or 'road verges' in the UK and Europe, often consists of narrow strips of mown grassy vegetation, typically 2–5 m wide, with trees sometimes being present. Road verges (the term used throughout the rest of this manuscript) cover large areas of land, e.g. 800 km^2 in the Netherlands (2% of total land area – Schaffers, 2000), 135,400 km^2 in Finland (0.4% of land area – Saarinen et al., 2005), and 4928 million km^2 in USA (Forman et al., 2003); the spatial extent of road verges will increase further due to increased urbanisation (Seto et al., 2012) and a projected increase of 60% in the global road network from 2010 to 2050 (Laurance et al., 2014).

It is thus surprising that verges are often excluded from studies assessing the value of urban greenspace, especially as they can support considerable biodiversity (Parr and Way, 1988; Hausmann et al., 2016) and provide a wide range of ecosystem services (Säumel et al., 2016). These include regulating services such as pollinator support, carbon sequestration, air quality enhancement, local climate regulation, flood risk management and noise reduction; cultural services such as aesthetic, psychological, and safety benefits; and potential for provisioning services such as food and biofuel production (reviewed in Säumel et al., 2016). Street trees are a key aspect of many road verge ecosystem services with large contributions to carbon sequestration (Rogers et al., 2011; Nowak et al., 2013a) and pollution interception (Nowak et al., 2013b), although the herbaceous layer can also contribute to these services (Bouchard et al., 2013; Weber et al., 2014a). Verge vegetation can enhance temperature regulation through evapotranspiration (Shashua-Bar et al., 2011; Armson et al., 2013), improve aesthetics (Todorova et al., 2004; Blumentrath and Tveit, 2014), reduce driver stress (Antonson et al., 2009) and contribute to reduced flood risk and erosion control (Stovin et al., 2008; Mueller and Thompson, 2009). Verges contribute markedly to maintaining structural connectivity between urban greenspaces (Davies et al., 2014), and their location along transport routes and residential areas increases their importance for regulating pollution and providing aesthetic and other cultural services (Säumel et al., 2016).

Verges experience less habitat loss and their management is determined by fewer stakeholders compared to some other forms of urban greenspace, (cf. private gardens and their multiple owners). There are thus considerable opportunities to improve the contributions of urban verges to biodiversity and ecosystem services. We focus on the UK as a case study, although our conclusions apply to regions with similar verge management such as much of temperate Europe.

Current verge management primarily focuses on safety (e.g. providing sight lines and emergency stopping locations) and aesthetics, whilst minimizing costs (Parr and Way, 1988). This typically generates regularly mown short grass verges, although trees are frequently planted to improve aesthetics, provide shade and support biodiversity (Silvera Seamans, 2013). In the UK verges are the responsibility of the highway authority or local council who have a statutory duty to consider biodiversity conservation in all their activities. There is, however, no requirement to prioritise, or even equally weight, conservation relative to other considerations. Increasingly local authorities are contracting out roadside verge management to private companies for periods of 5–25 years (AMA Research, 2015), providing an opportunity for conservation sensitive management over ecologically relevant time periods - but also a potential constraint if ecologically damaging management is locked in for such time periods. There exist substantial opportunities to alter verge management in a manner that delivers enhanced biodiversity and ecosystem services for similar, or in some cases lower, costs than current management regimes.

2. Objectives and approach

Our primary objective is to review and critically evaluate the potential for enhancing road verge management for biodiversity and ecosystem service provision, whilst considering pragmatic constraints, trade-offs, and economic viability. To facilitate this we ascertained the relative impacts of alternative management options on the costs of verge management through discussions with the private company contracted to manage road verges in Sheffield, the 5th largest city in the UK. These discussions obtained initial information on the economic implications of alternative management regimes, but it is beyond the scope of this manuscript to attempt an analysis of full economic costings. This information was supplemented with data from the literature in the few cases where such information was available. Despite much interest in road ecology (e.g. Forman et al., 2003; Coffin, 2007), there has been insufficient evaluation of alternative management options for enhancing verges' biodiversity and ecosystem services whilst recognising the constraints associated with this habitat type. Our study thus addresses a crucial gap concerning improvement of road verge management in the UK and elsewhere.

3. Management options to enhance biodiversity and ecosystem service provision

Enhancement of ecosystem services may not protect biodiversity per se, but enhanced biodiversity can strengthen the long-term resilience of ecosystem function and service provision to environmental change (Oliver et al., 2015). Road verge management that enhances both biodiversity and ecosystem services is thus preferable to management that focuses exclusively on ecosystem services.

3.1. Pollinator support and biodiversity

Urban verges in the UK are typically mown every 2–4 weeks with occasional use of glyphosate herbicide for spot-weeding. They thus rarely provide the floral and other resources needed by pollinators, although some verges can support diverse and abundant populations of bees and other pollinators (Noordijk et al., 2009; Skórka et al., 2013).

Biodiversity improvements could be delivered by reduced mowing frequencies, as demonstrated for insects on urban roundabouts (Helden and Leather, 2004). A two cut regime (early and late summer) was shown to be optimal for plant (Parr and Way, 1988) and animal (Noordijk et al., 2009) biodiversity in non-urban highway verges, but remains to be tested in an explicitly urban context. Partial cutting of verges, e.g. only mowing areas closest to