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Research paper

Biodiverse perennial meadows have aesthetic value and increase residents' perceptions of site quality in urban green-space

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HIGHLIGHTS

- Perennial meadows increased perceived quality and appreciation of urban green-space.
- Meadows were preferred to herbaceous borders, bedding planting & mown amenity grass.
- Meadows that contained more plant species had the highest preference scores.
- Structurally diverse meadows were preferred to short meadows.
- Giving information about meadows ecosystem service benefits promotes acceptance.

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ABSTRACT

We used photo-elicitation studies and a controlled perennial meadow creation experiment at ten urban green-spaces in southern England (five experimental sites and five control sites) to assess green-space visitors' responses to urban meadows. Multiple meadows, which varied in their structural diversity (height) and plant species richness, were created at each experimental site. Photo elicitation demonstrated that meadows were generally preferred to herbaceous borders and formal bedding planting. Moreover, our experimental meadows had higher preference scores than a treatment that replicated mown amenity grassland, and meadow creation improved site quality and appreciation across a wide range of people. Meadows that contained more plant species and some structural diversity (i.e. were tall or of medium height) were most preferred. The magnitude of these preferences was lower amongst people that used the sites the most, probably due to a strong attachment to the site, i.e. sense of place. People with greater eco-centricity (i.e. those who used the countryside more frequently, had greater ability to identify plant species and exhibited more support for conservation) responded more positively to meadow vegetation. Crucially a wide range of respondents was willing to tolerate the appearance of meadows outside the flowering season, especially when provided with information on their biodiversity and aesthetic benefits and potential cost savings (from reduced cutting frequencies). Re-designing urban green-spaces and parks through the creation of species rich meadows can provide a win–win strategy for biodiversity and people, and potentially improve connections between the two.

1. Introduction

The benefits of urban green-space for biodiversity and the provision of ecosystem services are well established (e.g. Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Kong, Yin, Nakagoshi, & Zong, 2010). Urban green-space is important for human health and well-being (Andersson, Tengo, McPherson, & Kremer, 2014; Dias, Fargione, Chapin, & Tilman, 2006), not least because over half of the world's human population now reside in cities, and this proportion is increasing rapidly (United Nations Development Program, 2011). Despite recognition of its importance, urban green-space is being lost across much of the globe (Haas, Furberg, & Ban, 2015; McDonald, Foreman, & Kareiva, 2010; Sheng & Thuzar, 2012). The drivers of this loss vary spatially and temporally, but include planning policies that restrict urban sprawl and thus promote densification of urban areas (Dallimer et al., 2011; Haaland & van den

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Bosch, 2015), reductions in size of public green-spaces as a result of land sales (Chen & Hu, 2015), the redevelopment of derelict land (Pauleit, Ennos, & Golding, 2005), and householders' decisions to replace gardens with impervious surfaces for alternative uses, such as house extensions and car-parking (RHS, 2015). The pressures driving the loss of urban green-space are likely to increase, with global urban land-cover projected to triple between 2000 and 2030 (Seto, Guneralp, & Hutyra, 2012).

Mown grassland, i.e. amenity grassland or lawn, is one of the commonest forms of urban green-space, especially in temperate regions (Irvine et al., 2009; Kazmierczak, Armitage, & James, 2010). Whilst providing space for recreation, urban mown grassland supports relatively little biodiversity. Lawns do contribute to overall native plant richness in urban gardens (Thompson, Hodgson, Smith, Warren, & Gaston, 2004), but are typically very homogenous and are characterised by a few highly dominant grass species (Dover, 2015). This lack of heterogeneity typically supports lower diversity of other taxonomic groups, such as wild bees, spiders and soil macrofauna (Hostetler & McIntyre, 2001; Shochat, Stefanov, Whitehouse, & Faeth, 2004; Smith, Chapman, & Eggleton, 2006), and reduced provision of many ecosystem services compared to less intensively managed alternatives (Garbuzov, Fensome, & Ratnieks, 2015; Meurk, Blaschke, & Simcock, 2013). Mown amenity grassland also requires regular cutting, typically 15 times a year in the UK (Woodland Trust, 2011), and climate change has already increased growing season length and duration of mowing period by about 25% between 1984 and 2004 (Sparks, Croxton, Collinson, & Grisenthwaite, 2005). High and increasing mowing frequencies are incompatible with the decreasing financial resources available for managing urban green-space in many parts of the world (Heritage Lottery Fund, 2014; Walls, 2009). This has led to increasing interest in the adoption of vegetation types requiring less intensive management (and hence cost) whilst providing improved biodiversity and ecosystem services (Briffett, 2001; Klaus, 2013).

Urban meadows (i.e. naturalistic, unmown grassland with or without flowering forbs) provide an alternative landcover type to mown amenity grassland, and whilst meadows are increasingly being established in some urban areas, they still comprise a tiny fraction of urban green-space (Hitchmough & De la Fleur, 2006: Loder, 2014). Claims are frequently made regarding the ecological, educational, aesthetic and sustainability benefits of meadows in urban areas (Ahern & Boughton, 1994; Standish, Hobbs, & Miller, 2013) but are based on limited, and largely observational, evidence (Klaus, 2013). This reflects the more general need for studies that quantify the relationships between urban biodiversity and cultural ecosystem services (Shwartz, Turbé, Simon, & Julliard, 2014). Initial work on urban meadows suggests that whilst people are theoretically supportive of the enhanced biodiversity value of urban meadows their presence does not increase peoples' enjoyment of a site (Garbuzov et al., 2015), perhaps because many people do not perceive a change in biodiversity (Shwartz et al., 2014). These results are surprising, as much research conducted on vegetation preference and the factors that influence its attractiveness suggests that the latter include characteristics frequently found in meadow vegetation, including colour, and structural and floristic diversity (Hands & Brown 2002; Lindemann-Matthies & Bose, 2007; Lindemann-Matthies, Junge, & Matthies, 2010). More work is thus needed to understand how people respond to the creation of meadow vegetation in urban environments before it can be advocated as a management tool to enhance biodiversity and ecosystem service provision in urban green-spaces currently dominated by mown amenity grassland.

We established urban meadows in a replicated design across five public green spaces in southern England; at each site meadows were created that varied in their structure (height) and number of plant species (grasses and forbs). Sites where we created meadows were paired with similar nearby public green spaces without meadows. Users of these green spaces were interviewed to address three broad questions: (i) How do people value urban meadows relative to alternative planting styles commonly used in parks? (ii) Does the presence of the urban meadows alter users' perceptions of green-space quality? (iii) How do structural diversity and plant species richness influence people's preferences for alternative meadow types. In all these analyses we assessed how respondents' characteristics influence their responses to meadows, focusing on their usage of the site, measures of their connection to the countryside and wildlife, and socio-demographic traits. Finally, as all previous work on the aesthetic value of urban meadows has focused on their appearance during the flowering season we assess (iv) whether people are willing to tolerate the appearance of the meadows during other seasons, and how tolerance changes when information is provided on their biodiversity and other benefits.

2. Methods

2.1. Site selection

Meadow plots were established in five areas of mown grassland situated in urban green spaces in Bedford and Luton, Southern England (Bedford sites: Chiltern Avenue, Goldington Green, Brickhill Heights, Jubilee Park; Luton site: Bramingham Road; Fig. S1). All sites are surrounded by residential areas and visited frequently by local people. An indicator of the socio-economic profile is provided by the Multiple Index of Deprivation (National Office for Statistics, 2015) of the lower super output area surrounding each site. This is the smallest spatial unit used in the National Census, and is typically slightly larger than the area represented by a full post-code. This deprivation index varies from 1 to 100, with higher numbers indicating greater deprivation. The deprivation indices of our sites range from 5 (Chiltern Avenue, placing it in the 10% least deprived neighbourhoods in England) to 39 (Goldington Green, placing it in the 20% most deprived neighbourhoods). Each experimental site was paired with a nearby control site that was as similar as possible in its size, vegetation features, type of surrounding residential development and deprivation index.

2.2. Experimental design

There were nine meadow treatments spanning two axes of variation: plant species richness (low, medium and high) and structural diversity (short, medium and tall; Fig. 1). Plant species richness was manipulated by sowing seed mixes that varied in their total species richness. The low plant species richness seed mixes only contained grasses and the short plots containing this mix replicated mown amenity grassland (Table S1). When seed mixes contained forbs, variation in flower colour between the mixes was minimized through species selection. Seed mixes were randomly allocated to standardised rectangular plots (250 m^2) within each site. There were 5 m gaps (of original short mown turf) between plots. All species were perennial, as annual meadows typically need re-sowing at regular intervals, thus increasing costs. All species were native to southern England. Structure was partly determined through plant selection but primarily controlled with different cutting regimes; short plots were cut every 4 weeks (average height c. 5 cm); medium height plots were cut twice a year (April and September, average height c. 50 cm) and the tall plots were cut once a year (February, average height 100 cm).

Plots were first sown in April 2013 and hand weeded during July 2013 to remove non-sown species. Some supplementary sowing was carried out in autumn 2013 where necessary to aid full establishment. One plot (Jubilee Park) was fully reseeded in April 2014