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To mow or to mow less: Lawn mowing frequency affects bee abundance and diversity in suburban yards

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ABSTRACT

Green spaces embedded within the urban matrix, particularly residential yards, could mitigate negative aspects of urban development and provide pollinator habitat. Lawns represent a dominant green space, and their management consists of frequent mowing to inhibit the growth of ostensibly "weedy" species (e.g., dandelions and clover). Since widespread population declines of bees and other pollinators from habitat loss are a growing concern, these spontaneous flowers could provide pollen and nectar sources throughout the growing season. We experimentally tested whether different lawn mowing frequencies (1, 2 or 3 weeks) influenced bee abundance and diversity in 16 suburban western Massachusetts yards by increasing lawn floral resources. Lawns mowed every three weeks had as much as 2.5 times more lawn flowers than the other frequencies. Interestingly, lawns mowed every two weeks supported the highest bee abundance yet the lowest bee richness and evenness. We suggest these patterns were driven by a combination of more abundant floral resources (compared with 1-week yards), easier access to lawn flowers due to shorter grass and a more drastic impact on grass biomass and floral resources (compared with 3-week yards), and the dominance of a few generalist bees overwhelming our samples, thus driving richness and evenness. Our results highlight a "lazy lawnmower" approach to providing bee habitat. Mowing less frequently is practical, economical, and a timesaving alternative to lawn replacement or even planting pollinator gardens. Given the pervasiveness of lawns coupled with habitat loss, our findings provide immediate solutions for individual households to contribute to urban conservation.

1. Introduction

Bees and other pollinators provide essential ecosystem services in agricultural and pristine landscapes (Gallai et al., 2009; Ollerton et al., 2011), and are experiencing severe declines on a global scale (Vanbergen et al., 2013). Loss and alteration of habitat primarily due to urban development together with the intensification of agricultural practices (e.g., increased applications of pesticides, tilling, monocultures, reduced season-long floral resources) largely contribute to these declines (Goulson, 2013; Harrison and Winfree, 2015; Vanbergen et al., 2013; Winfree et al., 2009). However, recent urban research has documented cities supporting a surprising level of bee richness and abundance (e.g., Fischer et al., 2016; Frankie et al., 2005; Harrison and Winfree, 2015; Matteson et al., 2008; Pardee and Philpott, 2014; Threlfall et al., 2015), suggesting that public parks, ruderal grasslands, meadows, community gardens and flower gardens in private yards have the capacity to serve as bee refugia (Hall et al., 2017). Some cities may even harbor more diverse and abundant populations of native bees compared with nearby forest preserves and other natural systems (Baldock et al., 2015; Fetridge et al., 2008; Winfree et al., 2007). Consequently, green spaces embedded within the urban matrix could mitigate negative aspects of urban development, by providing pollinator and other wildlife habitat (Goddard et al., 2010). However, it is unclear how bees respond to one of the most pervasive urban green spaces, lawns.

Lawns cover $>163{,}000\ km^2$ in the US and include golf courses, athletic fields, commercial and industrial parks and urban and suburban yards (Milesi et al., 2005). High proportions of lawns are located in yards, and serve both social and environmental functions. From a historical and social perspective, the lawn represented a status symbol of upward mobility and more recently, a platform for self-expression of, or projecting adherence to social norms (Nassauer et al., 2009; Robbins, 2007; Robbins and Sharp, 2003).

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Fig. 1. Example of a lawn-dominated yard participating in the study. Note the minimal landscaping and bare patches in the lawns, which were common throughout the sites. Also note the yard sign in the lawn explaining the objectives of the study. Not only did this demonstrate a 'cue to care' (Nassauer et al., 2009) but also informed neighbors about their role in improving the sustainability of their neighborhoods.

Lawns also provide important ecosystem services. Depending on soil texture, storm water can infiltrate pervious lawns and can serve as a reservoir for some of the run-off (Mueller and Thompson, 2009). Lawns might also mitigate the urban heat island by regulating humidity, particularly when irrigated (Hall et al., 2016). A suburban lawn's capacity for storing carbon (C) and nitrogen (N) can exceed that of non-urban grasslands (Pouyat et al., 2006; Raciti et al., 2008).

In addition to ecological benefits, the intensive management that lawns require can negatively impact urban and suburban ecosystems. Typical lawn management consists of irrigating, applying chemicals and mowing, and is carried out by millions of individual households and neighborhood associations whose actions have ecological and social consequences (Cook et al., 2012). For example, Americans use up to 48 gal of water per day for irrigating lawns and gardens (Environmental Protection Agency; www.epa.gov/waterwise). In arid regions, this kind of water use diminishes scarce natural resources. In addition, fertilizers and other chemical applications can degrade water quality and contaminate groundwater (Law et al., 2004), while gas-powered lawn mower exhaust fumes elevate CO_2 emissions (Zirkle et al., 2011). Although not every household irrigates or fertilizes (Polsky et al., 2014), most households mow to conform to societal expectations, city ordinances, and the personal satisfaction of a neat and tidy yard (Robbins, 2007). Many municipalities even enforce 'weed laws' to ensure conformity of the lawn ideal by restricting grass height (e.g., a Chicago ordinance prohibits lawn vegetation from exceeding 24.4 cm; Municipal Code of Chicago: §7–28-120). Intensive lawn management requires time and financial commitments, and are often driven by aesthetics and social norms to adhere to ideals of orderly, weed-free, lush carpets of green grass (Jenkins, 1994; Nassauer, 1995; Nassauer et al., 2009; Robbins, 2007).

One of the outcomes of frequent lawn mowing is a simplistic vegetation configuration. Consequently, many ecologists and wildlife organizations have dismissed the habitat potential of lawns, referring to these lawn-dominated yards as 'sterile environments for biodiversity' (Gaston et al., 2005: 3342). However, even with it's simplicity, lawns can support rich and diverse plant communities. A survey of 52 residential lawns in Sheffield, UK recorded 159 species of vascular plants (Thompson et al., 2004). However, floral richness and abundance in these lawns might depend on lawn management behaviors and disturbance (Bertoncini et al., 2012; Grime, 1974; Wastian et al., 2016). Research on bees in New York residential yards that had extensive flower gardens showed that frequent lawn mowing (and herbicide application) depleted lawns of floral resources for bees (Fetridge et al., 2008), suggesting that less frequent mowing and avoiding herbicides could have the opposite effect.

Lawns lacking applications of herbicides and other chemicals generally support spontaneous flowers, such as common dandelion *Taraxacum officinale* (Asteraceae) and white clover *Trifolium repens* (Fabaceae) (Bertoncini et al., 2012). This has potential habitat implications for bees (Larson et al., 2014) given their dependence on pollen and nectar resources from flowering plants (Frankie et al., 2005). However, frequent (e.g., weekly) lawn mowing generally prohibits plants from flowering (Fetridge et al., 2008). Because declines in native bees and other pollinators are largely caused by habitat loss (Vanbergen et al., 2013), nectar and pollen from these and other 'weedy' species have the potential to support bee conservation in urban areas. In this study, we manipulated lawn mowing behaviors in suburban yards to test the hypothesis that decreasing mowing frequency may result in increased lawn floral resources, and in turn, increased bee abundance, bee richness and bee diversity. Testing the effects of alternative lawn care management practices on floral resources may have important implications for bee and other pollinator populations given the cumulative area of lawns in urban and suburban areas in the U.S. and the millions of people that manage these systems.

2. Material and methods

2.1. Study sites

We conducted the study in 16 single-family, owner-occupied suburban yards (sites) in Springfield, Massachusetts, USA. Because we were working with private households, we relied on volunteers that we recruited via a local tree planting organization. Parcels ranged in size between 0.03 and 0.18 ha (typical of medium-density housing stock within Springfield), and houses were built between 1921 and 1957. We