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Research Paper

Exploring park visitor perceptions of 'flowering bee lawns' in neighborhood parks in Minneapolis, MN, US

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A B S T R A C T

Flowering bee lawns integrate low-growing flowers into mowed turfgrass to increase the availability of bee forage. They also maintain many of the aesthetic and recreational functions of the lawns in urban green spaces. Common cultural preferences for uniform, green, grass-monoculture lawns may pose a barrier to widespread adoption of flowering lawns. However, a growing body of literature suggests that there may be a higher degree of acceptance of lawn alternatives, such as grass-free lawns or urban meadows, than previously thought. We examined park visitors' perceptions of flowering lawns at four parks in Minneapolis, U.S. through an on-site questionnaire survey using photos. When first asked, 97.2% of respondents supported implementing flowering lawns in public parks. Informing participants that flowering lawns are designed to provide bee forage had a polarizing effect where strong support increased yet overall support declined slightly. Positive perceptions of bees and of flowering lawn appearance were the only two significant factors associated with support for flowering lawns in both pre- and post-informational intervention logistic regression models. Similarly, aesthetics and benefits to bees were the most frequently stated perceived benefits. When asked about concerns, the most frequent responses were 'no concerns' and 'reduced recreational use of lawns'. For public land managers who wish to add flowering lawns to their suite of green infrastructure options to increase forage availability for bees, our findings suggest there is widespread public support. Public engagement should be carefully crafted to address concerns about flowering lawns and reinforce existing positive perceptions.

1. Introduction

Urban parks and other green spaces are complex socio-ecological systems (Hunter & Luck, 2015; Jorgensen & Gobster, 2010) that can play an important role in supporting human health and well-being (Chiesura, 2004; van den Bosch & Sang, 2017) as well as increasing biodiversity (Shwartz, Muratet, Simon, & Julliard, 2013), sequestering carbon, reducing air pollution, and providing other important ecological benefits (Derkzen, Teeffelen, & Verburg, 2015; Mexia et al., 2018). Flowering lawns are a mix of turfgrasses and low-growing flowers designed with dual goals: to increase the availability of high-quality nectar and pollen for bees, and to maintain the recreational uses and aesthetic preferences of traditional mown lawns. Recognizing that park visitors' values, preferences, and uses of parklands are central to the design and management of urban parks (Hunter & Luck, 2015), this paper examines visitor perceptions of flowering bee lawns and explores how these may affect adoption in urban landscapes. We begin with a brief discussion of recent insights about the cultural importance of lawns and their ecological impacts.

1.1. Lawns as socio-ecological systems

Turfgrass lawns are a dominant feature of urban green spaces, particularly in temperate climates (Hedblom, Lindberg, Vogel, Wissman, & Ahrne, 2017; Irvine et al., 2009; Stewart et al., 2009; Wheeler et al., 2017). In the U.S. alone, lawns cover an estimated 1.9% of the total land area, compared to the estimated 3.5–4.9% covered by urban development (Milesi, Running, Dietz, & Tuttle, 2005). Rooted in centuries-old European landscape design traditions, grass lawns have a long history as material manifestations of orderliness, mastery over nature, and social status (Byrne, 2005). The cultural importance of lawns persists today and well-kept lawns have been associated with good moral character, neighborliness, and higher property values (Blaine, Clayton, Robbins, & Grewal, 2012; Ignatieva et al., 2015; Nassauer, Wang, & Dayrell, 2009; Robbins & Sharp, 2003). The appearance of lawns is often listed as their most important feature (Blaine

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et al., 2012), with preferences for dense coverage, light green color, a limited number of grass species, and the absence of weeds (Yue et al., 2017).

The potential for lawns to affect ecosystems, either positively or negatively, is largely determined by the management practices used. These can vary substantially between regions, neighborhoods, and even within individual parcels (Harris et al., 2012; Martini, Nelson, Hobbie, & Baker, 2015). Compared to hard surfaces or bare ground, lawns can provide multiple ecological benefits such as carbon sequestration, erosion control, mitigation of the urban heat island effect, and reduction in air pollution (Beard & Green, 1994; Blaine et al., 2012; Milesi et al., 2005). While low-input turfgrass species have the potential to reduce fertilizer and mowing requirements (Hugie & Watkins, 2016), the most common turfgrasses require intensive management and substantial use of fertilizer, pesticides, and irrigation to maintain a uniformly thick, green monoculture (Barnes et al., 2018; Blaine et al., 2012). This may lead to ecosystem disservices such as carbon emissions from frequent mowing, water quality degradation from over-fertilization (Fissore et al., 2012), increased water consumption, and potential non-target effects of herbicides and insecticides (Robbins & Sharp, 2003). Furthermore, lawns support lower plant and vertebrate diversity compared to other types of green infrastructure, such as urban meadows (Shwartz, Turbé, Simon, & Julliard, 2014) or 'reference natural areas' (Wheeler et al., 2017).

1.2. Bee diversity

Steep losses of managed honeybee colonies have been reported in Europe and the U.S. (Goulson, Nicholls, Botías, & Rotheray, 2015), and declines in wild bee diversity have been observed in Europe (Nieto et al., 2014), the U.S. (Burkle, Marlin, & Knight, 2013; Cameron et al., 2011), China, and Japan (Goulson et al., 2015). These declines are likely driven by multiple, interacting threats including nutritional deficiencies resulting from habitat loss, diseases and parasites, and pesticide exposure (Goulson et al., 2015; Spivak, Mader, Vaughan, & Euliss, 2011). In the U.S. and the U.K., agricultural conversion has dramatically reduced floral resources (Goulson et al., 2015), so increasing bee forage availability is a key strategy for bee conservation (Lane, 2016; Nieto et al., 2014). Samuelson, Gill, Brown, & Leadbeater (2018) found that even very dense urban areas act as a refugia for bumblebees (*Bombus terrestris*), likely because cities tend to have more abundant floral resources relative to agricultural zones. It is common for lawns to contain spontaneous forbs (Muratet et al., 2008; Thompson, Hodgson, Smith, Warren, & Gaston, 2004), some of which, such as dandelion (*Taraxacum officionale*) and white clover (*Trifolium repens*), provide forage for pollinators (Larson, Kesheimer, & Potter, 2014; Lerman & Milam, 2016). However, lawn cover is dominated by turfgrasses (Thompson et al., 2004) which do not provide forage (Tonietto, Fant, Ascher, Ellis, & Larkin, 2011). Ecological modeling in Chicago suggests that replacing turf lawns with "a more florally-rich land cover" would support greater bee abundance and richness in urban areas (Davis et al., 2017, p. 157).

1.3. What is a flowering bee lawn?

Flowering bee lawns are composed of a mix of low-input turfgrasses and low-growing flowers selected to provide high-quality bee forage while still maintaining recreational uses. As a concept, flowering lawns are closely related to other types of green infrastructure but are distinct in important ways (Table 1). Relative to traditional lawns, flowering lawns are mown to similar heights, preserving recreational uses that involve walking or running across them and requiring only minimal changes in lawn maintenance regimes. Lawns that contain spontaneously-occurring forbs can support a surprisingly diverse assemblage of bees and other pollinators (Larson et al., 2014; Lerman & Milam, 2016). However, our parallel research on bee diversity and flowering

Table 1
Comparison of key characteristics of lawns, flowering lawns, and common types of lawn alternatives. Note: (a) Table entries are brief summaries rather than comprehensive definitions. There can be variation in each category. (b) Flowering lawns, urban meadows, grass-free lawns, and native grasslands tend to be substantially better sources of bee forage relative to traditional lawns. (c) "Suitability as a surface for foot traffic" was inferred by authors based on McCormack, Rock, Toohey, & Hignell (2010) and Sherratt (2014) and the reported vegetation height and evenness of each type.

	Brief description	Key criteria for species inclusion	Mowing frequency	Typical vegetation height	Suitability as surface for foot traffic
Traditional lawn (multi-use)	Area planted to and managed for turfgrasses, though "it may have spontaneously occurring herbaceous species."[1] (p.213)	• Appearance (e.g. color, texture)[2] • Maintenance requirements & tolerance of foot traffic[2,3]	1–2/week[2,3] to 1–2/month[2]	Short (5–11 cm)[3]	Moderate to High
Flowering lawn	A mix of turfgrasses and low-growing forbs intentionally selected to provide high-quality bee forage. Mowed regularly to maintain recreational uses similar to lawns.[4]	• Provision of pollinator forage (& other ecological benefits)[4] • Ability to compete with turfgrasses & withstand regular mowing[4]	1–3/month[4]	Short (5–11 cm)[4]	Moderate
Urban meadow	"Naturalistic, unmown grassland with or without flowering forbs."[5] (p.106)	• Biodiversity & other ecological benefits[5,6] • Appearance/Color diversity[5]	1/month to 1/season[5]	Short (5 cm) to Tall (100 cm) [5]	Low to None
Grass-free lawn	Mixed planting of "mowing tolerant clonal perennial forbs"[7] (p. 491) without grasses.	• Ability to withstand mowing[7] • Similar growth rates relative to other species included[8]	1–2/month[7]	Short (2–9 cm)[7]	Low
Native grassland (remnant or restored)	Area dominated by grasses and grass-like species, often with a diverse assemblage of forbs and other plant species.[9]	• Native biodiversity & other ecological benefits[9,10,11]	0–2/season May also be maintained by prescribed burns[10]	Short (15 cm) to Tall (300 cm)[9,11]	None

References for table: [1]Ignatieva, Eriksson, Eriksson, Berg, & Hedblom, 2017; [2]Yue et al., 2017; [3]Cornell University, 2018; [4]Lane, 2016; [5]Southon et al., 2017a,b; [6]Hoyle et al., 2018; [7]Smith & Fellowes, 2015; [8]Smith & Fellowes, 2014; [9]Blair, Nippert, & Briggs, 2014; [10]Minnesota Dept of Natural Resources, 2004; [11]Oregon State University, 2018.

lawns suggests that by intentionally selecting forb species with favorable forage characteristics, flowering lawns can support higher bee diversity than lawns with spontaneously-occurring forbs (*unpublished data*, *manuscript in preparation*).

1.4. Prospects for adoption of flowering lawns

Conceptually, flowering lawns combine key features and uses of traditional lawns and lawn alternatives, particularly urban meadows. Based on the existing literature, we hypothesize that this hybridity provides both potential opportunities for public acceptance as well as barriers to adoption.

1.4.1. Integrating flowers into lawns: aesthetic preferences and perceived biodiversity

Uniform greenness and the control of non-turfgrass species are important lawn design principles in Western landscape architecture traditions influential in Europe, Australia, New Zealand (Ignatieva et al., 2015; Ignatieva, Eriksson, Eriksson, Berg, & Hedblom, 2017), as well as the U.S. and Canada (Yue et al., 2017). Particularly in these cultural contexts, the presence of forbs in flowering lawns may elicit a negative response. Conversely, humans have a psychological predisposition in favor of cultivated flowers (Haviland-Jones, Rosario, Wilson, & McGuire, 2005). Preferences for diverse and brightly colored flowers have been reported for street plantings in Japan (Todorova, Asakawa, & Aikoh, 2004) and urban meadows in the U.K. (Hoyle et al., 2018). This suggests that park visitors may view the presence of brightly colored forbs positively, however, these studies examined flower species with blooms that are larger and taller than would be typically included in flowering lawns, so it is unclear if these findings are transferable to a lawn context. It is also possible that urban residents will not notice the addition of flowering species, as was the case with the addition of flower meadows in urban gardens in Paris (Shwartz et al., 2014).

More broadly, a growing body of research suggests that urban residents highly value perceived biodiversity in green space (Belaire, Westphal, Whelan, & Minor, 2015; Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Lindemann-Matthies & Bose, 2007; Lindemann-Matthies, Junge, & Matthies, 2010). Some studies have found a gap between perceived and actual species richness (Belaire, Westphal, Whelan, & Minor, 2015; Dallimer, Irvine, Skinner, Davies, Rouquette, Maltby, Warren, Armsworth, & Gaston, 2012) while others found that perceived and actual richness was correlated (Hoyle et al., 2018; Southon, Jorgensen, Dunnett, Hoyle, & Evans, 2017a, 2017b). Color diversity, in terms of both vegetation color and flower color, is an important factor in public perception of biodiversity (Hoyle et al., 2018; Lindemann-Matthies et al., 2010; Southon et al., 2017b), perhaps even more important than actual species richness (Hoyle et al., 2018). These findings suggest flowering lawns that incorporate forbs with multiple flower colors could be perceived as more biodiverse and more attractive.

1.4.2. Perceptions of bees

Perceptions of bees are also likely to impact support for flowering lawns if park visitors are aware that flowering lawns are intended to attract bees. A fear of insects is common among many children and adults, particularly towards wasps and bees that have the ability to sting (Schoenfelder & Bogner, 2017). Beyond from the discomfort caused by stings, they may represent a serious health concern for some. In the U.S., it is estimated that 1% of children and 3% of adults have systemic allergic reactions to insect stings and an additional 5% of people experience unusually large localized inflammation (Golden, 2013). We anticipate that negative perceptions of bees would reduce support for flowering lawns.

In contrast to the fear sometimes attached to stinging insects, insects that provide direct benefits to people are often viewed more positively (Schoenfelder & Bogner, 2017). This may be the case with honeybees, which provide honey as well as pollination services for many cultivated crops and wild plants (Schoenfelder & Bogner, 2017). Wilson, Forister, and Carril (2017) found that 99% of survey respondents in the U.S. said that bees were 'somewhat important' or 'critical'. While their convenience sample may have led to an overestimate of positive perceptions of bees, the results suggest that bees are highly valued, at least among some social networks. Furthermore, in the U.S., threats to honeybee colony health (e.g. Baral, 2017; Barrionuevo, 2007; Klein & Barron, 2017; Spivak, 2013) and declining native bee diversity (Winfree, Bartomeus, & Cariveau, 2011) have both received growing media attention. We expect that positive perceptions of bees will correspond to a higher level of public support for flowering lawns, though respondents may still object to locating flowering lawns in park areas used for recreation.

1.5. Research questions

Against the backdrop of this complex web of values attached to lawns, lawn alternatives, and bees, we explore visitors' perceptions of flowering lawns at four urban parks in Minneapolis, U.S., and how these might influence adoption in urban landscapes.

- To what extent do park visitors support the introduction of flowering lawns in urban parks?
- Is visitor response related to flowering lawn aesthetics, perceptions of bees and stings, frequency of park use, and/or sociodemographic characteristics?
- What are the key benefits of and concerns about flowering lawns as perceived by park visitors?

2. Research design and methods

The study described here is part of a broader research partnership between the Minneapolis Park and Recreation Board (MPRB) and an interdisciplinary group of researchers at the University of Minnesota to examine park visitor perceptions of flowering lawns as well as bee pollinator response to experimental flowering lawns sown in four urban parks. To assess public perceptions of flowering lawns prior to establishment, the present study incorporated on-site photo elicitation techniques, using three photographs including four forb species which had been sown in the pilot flowering lawns. At the time of the surveys, the sown plots were not fully established and visitors did not view flowering lawns on site.

2.1. Site selection

Minneapolis is a mid-sized city in the upper Midwest of the U.S. (population 422,000, U.S. Census Bureau, 2018). The MPRB park system has been ranked as the best in the country according to Trust for Public Lands' ParkScore®, an index based on metrics such as park access, park size, and per capita investments (Trust for Public Land, 2018). The park system includes 37 regional parks and 100 smaller neighborhood parks, with median park size of 2.3 ha. Parklands cover a total of 2052 ha, which accounts for 14.9% of the city's area (Trust for Public Land, 2018).

In 2016, the MPRB partnered with researchers at the University of Minnesota to pilot test flowering lawns in four neighborhood parks, one in each of MPRB's four geographic management divisions: Audubon Park, Kenwood Park, Matthews Park, and Willard Park (Fig. 1; details on seeding and establishment in A1). The parks were purposively selected to capture variation in terms of overall park size, the kinds of amenities at each park, and the sociodemographic characteristics of the surrounding neighborhoods (Tables A2 & A3). By doing so, we hoped to invite a wide diversity of park visitors to participate in the survey.

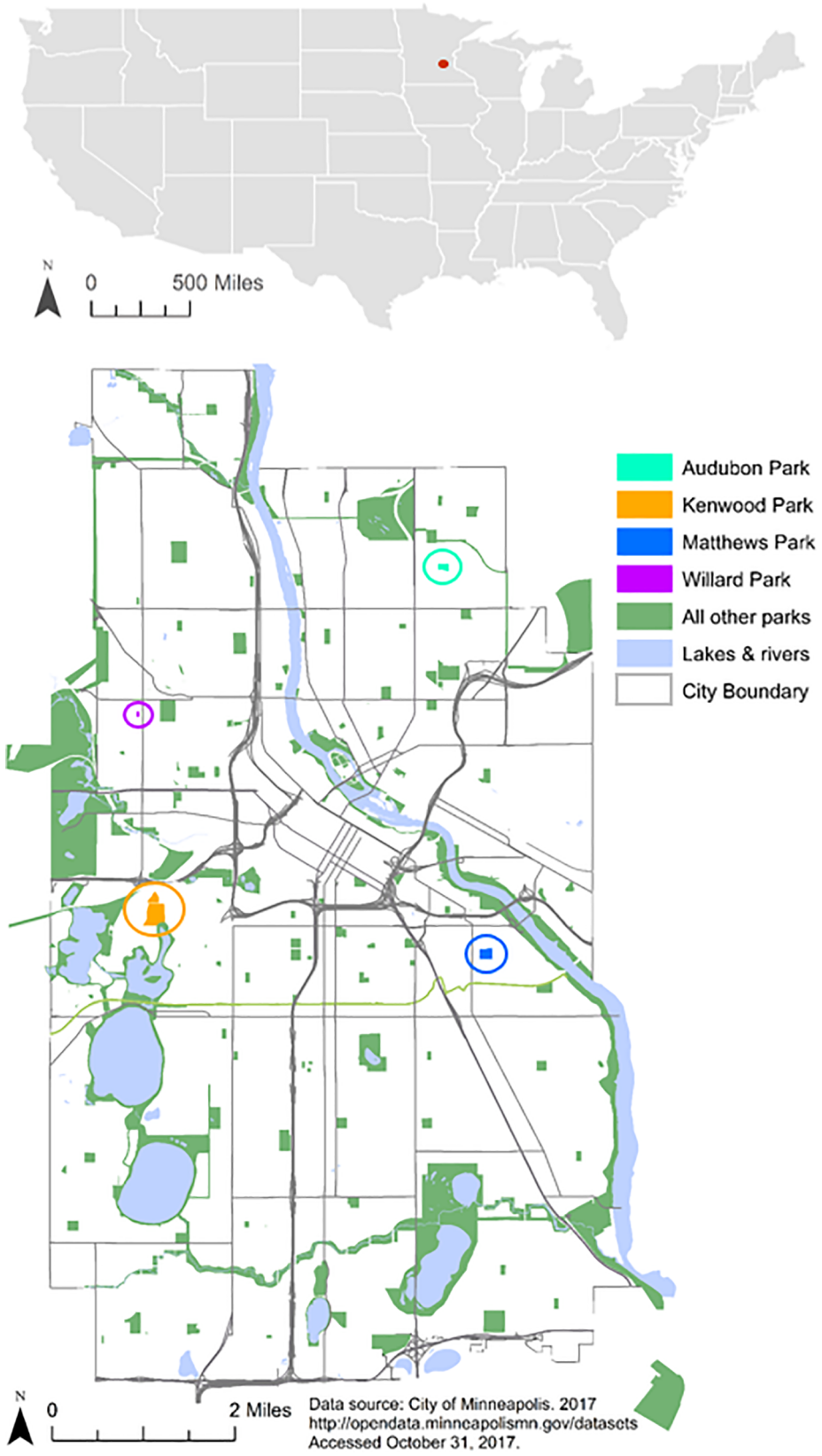

Fig. 1. Map of four parks where park visitors were surveyed in Minneapolis, MN, US.

2.2. Survey design

The questionnaire was designed collaboratively with an interdisciplinary research team of entomologists, environmental sociologists, a turfgrass scientist, and a MPRB staff member. It was composed of 19 multiple-choice and eight open-ended questions that asked participants about their perceptions of flowering lawns, perceptions of bees and bee stings, park use characteristics, and

Table 2
Summary of on-site questionnaire, including research topics, survey items, and answer options.

Theme	Survey item	Response options
Park use	Frequency of visits to sample park	Daily, Weekly, Monthly, Annually, Never
	Frequency of visits to other parks	Daily, Weekly, Monthly, Annually, Never
	Use of grassy areas	Walk, Sit, Picnic, Informal sports, Organized sports, Other
Perceptions of flowering lawns	"I like the way flowering lawns look"	4-point scale: Strongly agree to Strongly disagree
	"I would avoid an area with a flowering lawn"	4-point scale: Strongly agree to Strongly disagree
	Benefits of flowering lawns	Open-ended
	Concerns about flowering lawns	Open-ended
	Support for flowering lawns in parks (pre- & post-information)	4-point scale: Strongly support to Strongly oppose
Perceptions of bees and bee stings	Like, tolerate, or dislike bees (pre- & post-information)	3-point scale: Like, Tolerate, or Dislike
	Benefits of bees	Open-ended
	Concerns about bees	Open-ended
	Allergy to insect stings, personal or someone in household	Yes, No, Don't know
	Level of concern about stings while at park	4-point scale: Not at all to Very concerned
	Change in concern about stings at a park with flowering lawn	5-point scale: Significantly more concerned to Significantly less concerned
Socio-demographic characteristics	Year of Birth	Open ended
	Race/Ethnicity	Amer. Indian/Alaska Native, Asian, Black or African Amer., Hispanic/Latino, White, Multiple, Other
	Highest level of education	7 categories: did not complete high school to graduate degree
	Postal code includes or borders park	Yes/No
	Live in Minneapolis	Yes/No

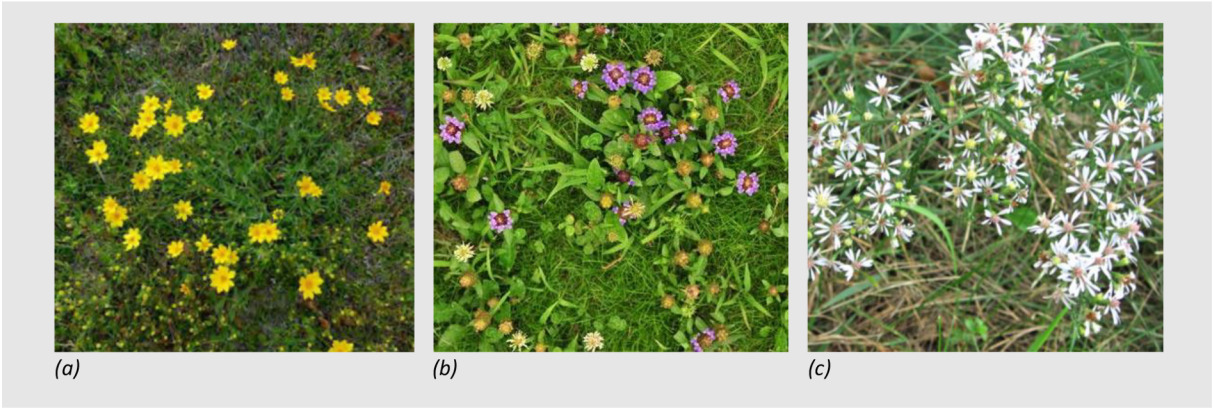

Fig. 2. Photos included on the survey: (a) lanceleaf coreopsis (*C. lanceolata*), (b) self-heal (*Prunella vulgaris*), white clover (*T. repens*) with mixed grasses, and (c) calico aster (*S. lateriflorum*). Photo credits to: (a and b) - Ian Lane; (c) - Barry Van Dusen.

sociodemographic characteristics (Table 2). Photographs of four forbs (*Coreopsis lanceolata*, *Prunella vulgaris*, *Symphyotrichum lateriflorum*, and *Trifolium repens*), all candidates for use in flowering lawns in the region, were included on the questionnaire (Fig. 2). Because flowering lawns are still experimental, there was a limited selection of photos depicting the selected forb species in combination with grasses. Two photos contained a single forb species and one photo contained two forb species. Conducting the survey on-site ensured that each participant had direct experience with the park context where they were sampled. The survey questionnaire did not explicitly ask participants to compare the photographs of forbs with existing lawn vegetation. The questionnaire included two pairs of pre/post questions, where participants encountered the same question twice: once before an informational intervention and then again after. For example, respondents were initially asked about their level of support or opposition after receiving a description that did not mention bees ("Flowering lawns have a mix of grasses and low-growing flowers") and viewing photos of the forbs seeded in pilot flowering lawns. This was intended to gauge baseline perceptions of park visitors who might encounter flowering lawns in a park without prior knowledge of them. Later in the survey, participants were informed that white clover (*Trifolium repens*) present in existing lawn vegetation supported a high diversity of bees and that new flowering lawns were designed to enhance bee forage (e.g. "The seeds in the new enhanced flowering lawns were chosen to improve the quantity and quality of food for honey bee and native bee pollinators by including different kinds of flowers." See A4 for full text). Respondents were then asked to indicate their level of support in light of this new information. This pre/post design was repeated with a pair of questions about perceptions of bees before and after receiving information about differences between honey bees and wasps (e.g. "Wasps and honey bees are quite different: A yellowjacket wasp can sting repeatedly, but if a honey bee stings, it loses its stinger and dies afterwards. You can recognize honey bees by the presence of hair on their bodies, whereas wasps are hairless." See A4 for full text.)

2.3. On-site procedure

Surveys were collected from May 31-August 28, 2017 on both weekdays and weekends between 8am and 8pm. In an effort to obtain similar numbers of completed surveys from each park, surveyors spent more hours sampling at Willard Park, due to both lower overall park visitation, especially by adults, and lower response rates.

All park visitors who were 18 years or older and who self-identified as proficient in English were considered eligible to participate in the

survey. Each of the parks has multiple entry points and several differentiated recreation zones, so surveyors circulated throughout each park to maximize the number and variety of potential participants. Researchers avoided interrupting park visitors who were engaged in active sports, play, or work, though visitors were often approached before or after such activities. If park visitors were in a group, only one adult park visitor was recruited to participate per group. Four park visitors asked the surveyors to administer the questionnaire verbally, but participants typically completed the questionnaires on their own.

2.4. Data analysis

2.4.1. Assessing public support for flowering lawns

Descriptive statistics were used to compare the proportion of park visitors who supported flowering lawns across parks. We used McNemar's paired-proportions test ('caret' package in RStudio, version 1.1.419) to compare support for flowering lawns before and after the informational intervention that explained flowering lawns were designed to support bees. Thirty-five case were excluded because of missing responses to the pre/post questions for a total sample size of 502.

2.4.2. Identifying predictors of support

We used logistic regression models to examine associations between park use variables (frequency and type), perceptions of flowering lawns (appearance and avoidance), perceptions of bees (pre- and post-informational intervention) and bee stings (level of concern, change in concern with presence of flowering lawns, allergy of household member to bee stings), as well as individual characteristics (age, race and ethnicity, education, postal code that includes or borders park, Minneapolis resident) with the dependent variables of interest (support for flowering lawns pre- and post-informational intervention). The outcome variable was condensed from four-levels to two-levels (support and oppose), and levels of several predictor variables were condensed for analysis (Table 6). Two variables, sample park and use of lawns for organized sports, were excluded from both models to avoid problems with complete separation, which occurs when the values of the predictor are associated with only one outcome value. Responses with missing data were excluded, resulting in a total sample size of 383. We confirmed an absence of multicollinearity among predictor variables (VIF < 10). For all cases, Cook's D < 3.0. Cases with the highest Cook's D were influential because of unbalanced data and were not excluded. Potential predictors were assessed for significance ($p < 0.05$) within full models. Model fit was assessed by calculating classification rate, sensitivity, and specificity, as well as Nagelkerke's pseudo R^2 and Hosmer-Lemeshow test.

2.4.3. Perceived benefits and concerns

The responses to open-ended survey questions about benefits and concerns regarding flowering lawns were transcribed and then coded in Excel. Codes were developed using an iterative, open coding strategy that allowed themes to emerge from the words and phrases used by respondents (Rubin & Rubin, 2012). The emergent themes were analyzed using descriptive statistics.

3. Results

3.1. Socio-demographic and park use characteristics

A total of 537 park visitors completed all or part of the survey questionnaire (response rate 66.4%). Compared to the population of Minneapolis, a higher proportion of survey respondents were white, had completed a bachelor's degree or more, were 25–44 years old, and lived in a household with children (Table 3). These differences may reflect response bias, different rates of park use between demographic groups, or both.

Table 3
Sociodemographic characteristics among survey respondents. Valid percentages shown due to missing data.

	Study Parks	Minneapolis
Race/Ethnicity (n)	(503)	(399,950)
American Indian/Alaska Native	3.0%	1.2%
Asian or Pacific Islander	3.4%	6.0%
Black or African American	15.5%	18.0%
Hispanic/Latinx	4.4%	10.0%
Other Race/Ethnicity	3.6%	0.1%
Two or More Races	6.2%	4.4%
White Alone	64.0%	60.3%
Educational Attainment, ages 25+ (n)	(443)	(267,800)
Less than high school	2.3%	11.4%
High school diploma or GED	9.0%	16.6%
Some college/assoc. degree	25.7%	24.6%
Bachelor's degree	35.2%	28.9%
Graduate or professional degree	27.8%	18.5%
High school or higher	97.7%	89.0%
Bachelor's or higher	63.0%	47.7%
Age, only 18+ (n)	(496)	(319,960)
18–24 years	13.7%	17.3%
25–34 years	33.9%	27.7%
35–44 years	23.6%	16.8%
45–54 years	13.5%	14.6%
55–64 years	8.5%	12.6%
65–74 years	5.8%	6.7%
75 years and older	1.0%	4.3%
Children in household? (n)	(521)	(169,803 households)
Yes	55.9%	23.9%
Postal code includes or borders park (n)	(505)	–
Yes	59.4%	–
Live in Minneapolis (n)	(499)	–
Yes	85.4%	–

Table 4
Park use frequency and type.

Survey item	%
Visit frequency at sample park (n)	(528)
Daily	23%
Weekly	43%
Monthly	20%
Annually	15%
Visit frequency at other parks (n)	(537)
Daily	24%
Weekly	51%
Monthly	18%
Annually	5%
Daily	2%
Uses of lawn areas (n)	(530)
Walking	77%
Sitting	48%
Sports, informal	38%
Picnic	37%
Sports, organized	11%
Dog	2%
Running	2%
n/a	6%

In terms of park use characteristics (Table 4), a majority of survey respondents reported visiting the park where they were surveyed or other local parks once a week or more often. Across all parks, walking across grassy areas was the most common use of lawns, followed by sitting.

3.2. Level of support

A substantial majority of respondents at all four parks supported

Table 5
Comparison of (1) support for flowering lawns and (2) perceptions of bees, pre- & post-informational interventions. McNemar's paired proportions test was used to test for significant differences (*p < 0.5, *** < 0.001).

Survey item		Pre	Post
Support for or opposition to flowering lawns in parks (n = 502)	Strongly support	55.2%	68.1%***
	Moderately support	42.0%	27.3%***
	Moderately oppose	2.4%	3.2%
	Strongly oppose	0.4%	1.4%
	Support	97.2%	95.4%***
	Oppose	2.8%	4.6%***
Perceptions of bees (n = 478)	Like	54.8%	55.4%
	Tolerate	31.0%	32.4%
	Dislike	14.2%	12.1%*

creating flowering lawns in parks, both before and after receiving information that flowering lawns were intended to provide forage for bees (Table 5, Fig. 3). Following the informational intervention, opposition to flowering lawns rose by 1.8 percentage points to 4.6% (McNemar's chi-sq = 3.3684, df = 1, p < 0.05). At the same time, strong support increased by 12.9 percentage points (McNemar's chi-sq = 31.325, df = 1, p < 0.001), indicating that the informational intervention had a polarizing effect on participants who initially expressed moderate support. The pattern of polarizing support was observed at all parks.

3.3. Variables associated with support

Prior to the informational intervention, participants with positive perceptions of the appearance of flowering lawns and of bees were more likely to support flowering lawns (Table 6). Conversely, likelihood of support decreased with age. Post-informational intervention, liking the look of flowering lawns and liking bees remained statistically significant. In addition, participants who visited the sample park weekly or more were more likely to support flowering lawns. Participants who reported that the presence of flowering lawns would increase their level of concern about bee stings were less likely to support them. While these results are suggestive, they should be interpreted carefully. The unbalanced data led to high odds ratios, large confidence intervals, and low specificity for the pre-information model. The post-support model achieved higher specificity and classification rate because of a higher number of oppose cases.

3.4. Perceived benefits and concerns

3.4.1. Aesthetics

Aesthetics was the most frequently mentioned benefit across all parks (Table 7). Participants said that flowering lawns were "aesthetically pleasing" (Participant M477), "are beautiful!" (K318) or "make it look more attractive" (W325). Moreover, 96.5% of participants strongly or moderately agreed with the statement *I like the way flowering lawns look* (Table 8). Some participants explicitly connected the appearance of flowering lawns to individual and community well-being (e.g. "increase the beauty, make people happy" K166). At Willard Park in particular, several respondents believed that aesthetic benefits would reach beyond the park and would demonstrate care (e.g. "make our neighborhood look nice" W325 and show "interest in caring for our neighborhood" W171).

Aesthetics were also mentioned as a concern by 5% of respondents. Some of these were personal concerns that flowering lawns may grow

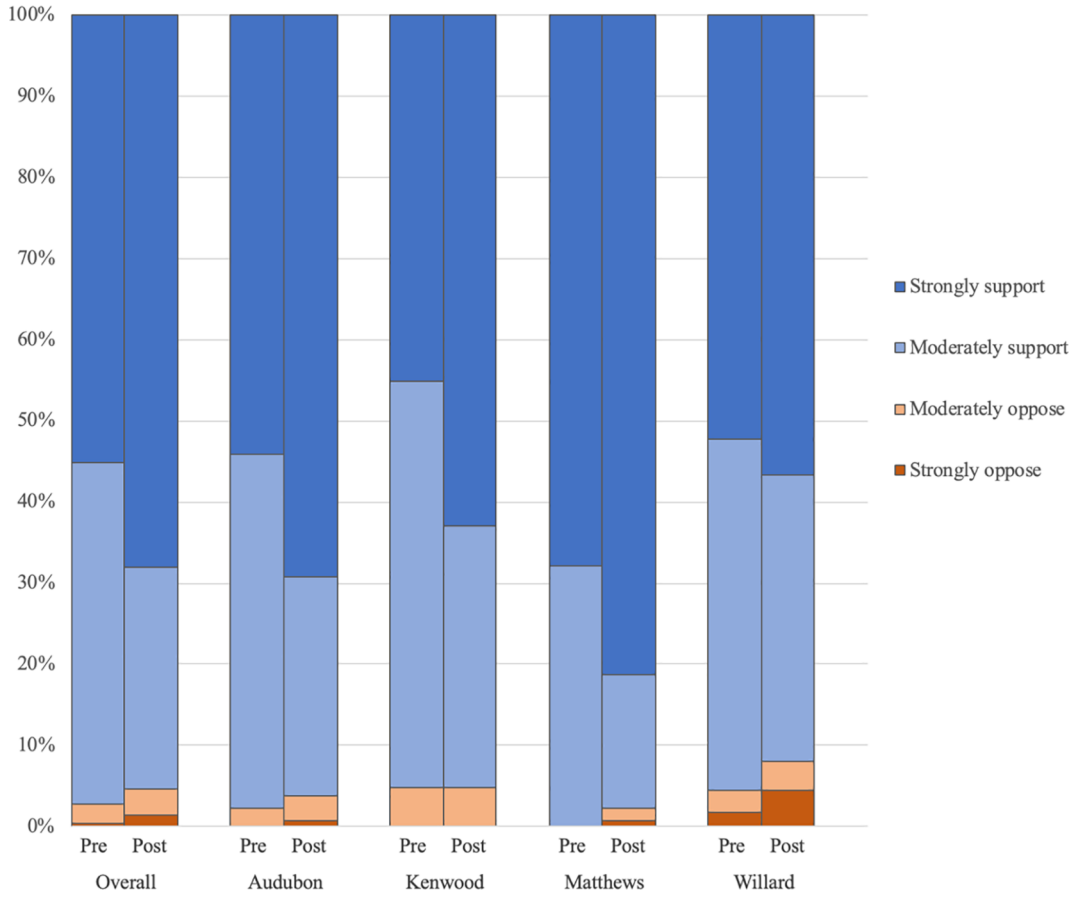

Fig. 3. Support for flowering lawns pre- and post-informational intervention explaining that flowering lawns were designed to support bees.

Table 6
Factors associated with support for flowering lawns in parks in logistic regression models, before and after the informational intervention explaining that flowering lawns were designed to support bees.

	Support (pre-information)			Support (post-information)		
N = 387	CI 2.5%	OR	CI 97.25%	CI 2.5%	OR	CI 97.25%
Park Use Variables						
Visit sample park – daily or weekly	0.41	2.28	13.32	1.69	9.44*	77.89
Visit other parks – daily or weekly	0.38	2.38	13.91	0.85	5.05	34.45
Lawn use						
Walk	0.07	2.01	32.61	0.01	0.27	4.69
Sit	0.02	0.46	4.20	0.26	3.11	33.57
Picnic	0.09	0.98	12.87	0.05	0.67	7.46
Sports, informal	0.06	0.68	7.57	0.09	1.01	10.99
Other	0.09	1.35	48.19	0.02	0.35	13.39
No Use	0.02	1.37	54.03	0.01	0.53	18.36
Perceptions of flowering lawns (FL)						
Like the way FL look	7.34	76.82**	1279.92	8.16	85.85**	1705.80
Would not avoid area with FL	0.43	2.57	14.42	0.05	0.38	2.07
Perception of bees & bee stings						
Like, tolerate, or dislike bees						
Like bees (pre)	1.95	14.72*	136.07	–	–	–
Tolerate bees (pre)	0.99	6.86	61.08	–	–	–
Like bees (post)	–	–	–	12.24	209.31**	9878.48
Tolerate bees (post)	–	–	–	0.93	5.43	40.38
Allergy to bee stings	0.12	0.63	4.05	0.09	0.40	1.76
Somewhat to very concerned about stings while at park	0.47	5.70	254.99	0.57	3.21	23.52
Concern about stings at park with FL						
More concerned with FL	–	–	–	0.01	0.08*	0.48
Less concerned with FL	–	–	–	0.02	0.29	9.27
Individual characteristics						
Age	0.85	0.91**	0.97	0.86	0.94	1.00
Race						
Black or African American	0.48	5.55	104.17	0.30	3.00	41.37
Other	0.25	2.14	53.97	0.08	0.60	4.89
Education – highest level completed						
High school or equivalent	0.54	31.26	2817.30	0.56	26.25	1220.72
College or assoc. degree	0.63	23.26	591.64	0.50	20.72	774.32
More than college	0.75	38.86	1715.83	0.57	39.74	3932.98
Child in household	0.19	1.19	7.61	0.10	0.59	3.03
Postal code includes or borders park	0.04	0.44	3.40	0.22	1.29	7.26
Minneapolis resident	0.02	0.57	10.58	0.01	0.13	1.67
Classification rate		96.5%			98.7%	
Sensitivity (true positive)		97.9%			99.5%	
Specificity (true negative)		72.7%			80.0%	
Pseudo R^2 – Nagelkerke		0.37			0.50	

Reference categories: Visit sample park = Monthly or less; Visit sample other = Monthly or less; Like look of FL = Disagree; Perceptions of bees (pre/post) = Dislike; Concern about stings while at park = Somewhat to Very concerned; Concern about stings at park with FL = No more or less concerned; Race = White; Education = Did not complete high school.
*$p < 0.05$; **$p < 0.01$.

Table 7
Five most commonly mentioned perceived benefits of and concerns about flowering lawns.

Benefits (n = 393)		Concerns (n = 383)	
Theme	%	Theme	%
Aesthetics	53%	No concern	56%
Bees	24%	Reduced use	10%
Pollinators/pollination	12%	Bees	9%
Biodiversity	9%	Unsure	9%
Good for environment	7%	Fragility of flowering lawns	6%

unevenly, “might appear like weeds” (K133), or that “if it's not well maintained, [it] could look trashy” (A345). In other cases, respondents expressed concern that *other* park visitors might object to the way flowering lawns look. For example, one participant wrote “people may think they are unkempt” (M47) and another said, “I wouldn't have any [concerns]; some people might think its weeds, if they didn't know” (A080).

3.4.2. Bees and pollinators

Even before the informational intervention, participants frequently connected flowering lawns with bees, expressing both positive and negative perceptions. Bees were the second most common benefit listed by participants (Table 7). Examples of responses include “helping bees” (W163), “flowering lawns can add a food source for bees” (M056), and “potential to increase declining bee populations” (A077). Furthermore, roughly half of respondents indicated that they like bees, and an additional third said they tolerate bees (Table 8). The informational intervention about the differences between bees and wasps led to a small, but statistically significant decline in the proportion of people who disliked bees.

Bees were also mentioned as a concern, though less frequently (Table 7). Some participants stated a general concern about “bees and other insects” (K284), while others specifically mentioned the risk of bee stings. It was common for participants to qualify their concern

Table 8
Descriptive statistics for key survey items.

Survey item		%
"I like the way they look" (n = 523)	Strong agree	59.8%
	Moderately agree	36.7%
	Moderately disagree	2.9%
	Strongly disagree	0.6%
"I would avoid an area with a flowering lawn" (n = 522)	Strong agree	10.2%
	Moderately agree	15.9%
	Moderately disagree	27.8%
	Strongly disagree	46.2%
Allergy to bee sting, personal or someone in household (n = 519)	Yes	17.1%
	Not sure	12.3%
	No	70.5%
Level of concern about stinging insects while at a park (n = 513)	None	43.9%
	A little	39.6%
	Somewhat	11.1%
	Very	5.5%
Change in level of concern about stinging insects at a park with flowering lawn (n = 510)	Significantly less	3.9%
	Slightly less	3.1%
	No more or less	65.9%
	Slightly more	22.2%
	Significantly more	4.9%

about stings by expressing uncertainty (e.g. "maybe bee stings?" K117) or by saying that they believed stings were not common (e.g. "stings from stepping/sitting on a bee…though it is probably unlikely" M177). The question about potential concerns occurred before the informational intervention that explained flowering lawns were designed to support bees, and more participants may have mentioned bees as a concern if the order had been reversed. Post-informational intervention, nearly three-fourths of participants said that flowering lawns would not increase their level of concern about stinging insects (Table 8).

Pollinators/pollination was the third most frequently mentioned benefit (Table 7). While this theme sometimes overlapped with the *bee* theme, respondents often mentioned pollinators in a general way, without mentioning bees specifically (e.g. "food for pollinators, increase in pollinator populations" A346).

3.4.3. Other emergent themes

Biodiversity was the fourth most commonly mentioned benefit (Table 7). Responses included "increased biodiversity allowing for a wider range of insects/small animals to live in the park" (M206) and "maybe more native or more diverse grass culture" (M070). A similar, but more generalized category of *good for the environment* also emerged. For example, one participant stated that flowering lawns were "eco-friendly" (K416) and another responded that flowering lawns would provide "ecosystem services!" (M376).

When asked about concerns, over half of participants gave responses such as "none!" (M019), "nothing" (W153) or other replies that indicated that they did not have any concerns about flowering lawns. Among respondents who articulated a specific concern, a possible reduction in recreational use of park lawns was the most frequently mentioned. One respondent said, "perhaps people think they look nice and thus avoid using them" (A438). Other concerns were specifically related to sports uses: one participant said flowering lawns were "not as friendly for sports" (K039) and another was concerned that there may be "less room for frisbee…?" (K269). Participants also expressed concern that even if flowering lawns could be used the same as traditional lawns, park visitors might not know this and could choose to avoid those areas. On a related point, several participants expressed concern about the fragility of the flowering lawns themselves and that they could be damaged by regular park uses. For example, one participant was concerned about "crushing the flowers when walking on them" (M364) and another wrote that "if flowers get picked + they die + no more pollen for bees" (K394).

Lastly, participants' responses frequently reflected uncertainty, ranging from a low degree (e.g. "attracts bees?" W543) to a high degree of uncertainty (e.g. "No clue" K312), suggesting that many participants were unfamiliar with flowering lawns as a concept.

4. Discussion

Given that aesthetic preferences play a dominant role in shaping urban landscapes (e.g. Blaine et al., 2012; Nassauer, 1995; Nassauer et al., 2009; Robbins, Polderman, & Birkenholtz, 2001), it was not surprising that liking the appearance of flowering lawns was associated with increased likelihood of support. However, because flowering lawns do not share many of the valued features of traditional lawns, namely, uniformity, greenness, or exclusion of non-turfgrass species (Alumai et al., 2010; Byrne, 2005; Cheng et al., 2008; Robbins and Sharp, 2003; Yue et al., 2017), nor the tall vegetation and structural diversity valued in urban meadows (Lindemann-Matthies & Bose, 2007; Southon et al., 2017a), we were surprised that nearly all respondents reported liking the way flowering lawns look.

Several scholars have described a dominant cultural preference for uniformity in lawns in Western landscape traditions (e.g. Byrne, 2005; Ignatieva et al., 2015; Robbins & Sharp, 2003). However, there is growing evidence from Europe and North America suggesting that both public preferences as well as extant lawn flora may be more heterogeneous than previously thought. For example, in the U.K., Southon et al. (2017a) found increasing public acceptance of urban meadows, which are less uniform and more colorful than traditional lawns. Choice experiments in Switzerland revealed preferences for meadows that were highly diverse in terms species, vegetation height, and leaf forms (Lindemann-Matthies & Bose, 2007). In the U.S., Graves, Pearson, & Turner (2017) found public preferences that favored floral abundance and color diversity in forest understory vegetation. In addition to heterogenous preferences, several studies have documented substantial species diversity in existing lawn flora in the U.S. (Lerman & Milam, 2016; Wheeler et al., 2017), the U.K. (Thompson et al., 2004), and France (Bertoncini, Machon, Pavoine, & Muratet, 2012).

While the questionnaire did not ask specifically about color, several responses to open-ended questions mentioned color as a benefit of flowering lawns. This is consistent with previous findings that urban residents value vegetation with bright colors (Hoyle et al., 2018; Lindemann-Matthies & Bose, 2007), though there may be 'threshold effect', whereby plantings are considered attractive only once they reach a certain minimum proportion of flower cover (Hoyle, Hitchmough, & Jorgensen, 2017). Furthermore, three of the most frequently mentioned benefits of flowering lawns were related to species diversity (*bees*, *pollinators*, and *biodiversity*) and previous research has found links between aesthetic appreciation and preferences for biodiversity (Lindemann-Matthies et al., 2010). In particular, there is growing evidence that laypeople use color diversity as a cue for estimating biodiversity (Hoyle et al., 2018; Lindemann-Matthies et al., 2010; Southon et al., 2017a,b). Examining the possible connections between aesthetic appeal and flowering lawns with varying levels of color and forb diversity is an exciting avenue for future research.

While concerns about the potential for flowering lawns to look 'weedy' or 'unkempt' were less frequent than positive perceptions, these concerns pose an important potential barrier to adoption. Defining which plant species qualify as a 'weed' is difficult because the boundaries of the category are socially constructed and shift over time (Falck, 2010). Following Falck (2010) we use the general definition that weeds are plant species considered to be undesirable by a social group in particular time and place. The presence of weeds often carries symbolic weight, conveying messages about care, neighborliness, and moral character (Blaine et al., 2012; Robbins & Sharp, 2003).

Research on turf management and lawn preferences frequently frames *any* non-turfgrass plant species as undesirable in lawns (e.g. Alumai et al., 2010 or Yue et al., 2017). Yet, inventories of the floral

diversity in lawns suggests that spontaneously occurring forbs (or 'weeds') are quite common (Lerman & Milam, 2016; Thompson et al., 2004). This may suggest a gap between the idealized vision of a perfect lawn and the resources required to achieve it, perhaps resulting in a certain level of tolerance or even acceptance of 'weedy' lawns among some (Dahmus & Nelson, 2013) or growing acceptance of a 'messier' aesthetic (Hoyle, Jorgensen, Warren, Dunnett, & Evans, 2017). Alternatively, people may simply not notice floral diversity. In one example, diverse flower meadows were added to small public gardens in Paris, France, but unless the meadows were advertised or there was organized public involvement, most garden visitors did not notice a change in species diversity (Shwartz et al., 2014). Based on these findings, we propose that signage and educational programming could address potential pitfalls and increase perceived benefits of flowering lawns. Such public engagement efforts could help make flowering lawns more legible as intentional design choices rather than the result of neglect or lack of care. The legibility of alternative landscapes as designed and intentional plays a key role in social acceptance (Nassauer, 1995; Nassauer et al., 2009). Additionally, publicizing flowering lawns is likely to increase perceived biodiversity and the attendant social benefits.

However, polarization of support following the informational intervention suggests that the public engagement and messaging about flowering lawns must be framed carefully. A substantial minority of participants dislike bees, which held true following an informational intervention that emphasized differences between bees and wasps. Similarly, a majority expressed concerned about stinging insects when visiting parks. So, it is unsurprising that the informational interventions that focused on bees resulted in a slight increase in overall opposition. Alternative messaging might focus on the wider invertebrate diversity value of flowering lawns or perceived benefits that are less controversial, such as aesthetic benefits. Designing informational interventions around existing positive attitudes is likely to be more effective than interventions aimed at prompting substantial attitude changes (Heberlein, 2012). Future research could also test outreach efforts that are more in-depth or multimodal. Nevertheless, even the most effective messaging is unlikely to convince all skeptical park visitors. Selecting park areas with lower foot traffic for the creation of flowering lawns may be one way to ease persistent concerns about potential negative interactions with bees.

Prioritizing park areas with lower foot traffic for flowering lawn placement may also help address participants' fears that trampling could damage the vegetation. While trampling should be restricted during the month following initial seeding, flowering lawns can withstand walking and running once established. However, park visitors who are unfamiliar with flowering lawns may not be aware of this and could avoid flowering lawns out of well-intentioned, but ultimately overly cautious, concern. Locating flowering lawns in areas with lower foot traffic, at least to begin with, may minimize the potential for unintentionally changing park use patterns.

Older age decreased the likelihood of pre-information support for flowering lawns in parks. One possible explanation may be that older park visitors are more committed to the ideal of uniform, green turfgrass (Byrne, 2005). This would be consistent with findings that age was correlated with use of chemical fertilizers in private lawns (Carrico, Fraser, & Bazuin, 2013; Robbins et al., 2001), though a study of homeowners in the Minneapolis-St. Paul metropolitan area did not find that age was not related to fertilizer use (Martini et al., 2015). Furthermore, Southon et al. (2017a) found that in the U.K. older people showed stronger preferences for urban meadows with greater plant species diversity. The significance of age in the present study may also be related to our relatively young sample. Future research could target older adults to explore the role of age in perceptions of flowering lawns in more depth.

Based on our findings, we suggest several directions for future research. First, targeted sampling of populations likely to oppose flowering lawns could help elucidate variables associated with opposition. Second, as flowering lawns become fully established in park settings, future research can incorporate photos or direct observations of flowering lawns in the context of a park landscape and at different periods during the growing season. Third, future research should examine the role of additional variables that previous research suggests may influence landscape preferences, such as ecological knowledge and gender (Lindemann-Matthies & Bose, 2007; Southon et al., 2017a). Furthermore, the present study had a limited geographic scope and additional research should examine perceptions of flowering lawns in other cities and countries.

5. Conclusion

Urban green spaces are tasked with fulfilling multiple ecological and social goals ranging from stormwater infiltration and supporting biodiversity to offering opportunities for urban residents to exercise, socialize, and connect with nature (Hunter & Luck, 2015). The design of public green spaces must also be responsive to diverse stakeholder groups, who may perceive, experience, and value landscapes quite differently. The overwhelming degree of support for flowering lawns that we found among survey participants suggests flowering lawns can provide multiple benefits, including enhancing aesthetic appeal, increasing perceived biodiversity, and maintaining recreational use. Public land managers who wish to adopt flowering lawns to provide forage for bees can use our findings to craft public engagement messages that address concerns about flowering lawns and reinforce existing positive perceptions.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2019.04.015.

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