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Research Paper

Continental-scale homogenization of residential lawn plant communities

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ABSTRACT

Residential lawns are highly managed ecosystems that occur in urbanized landscapes across the United States. Because they are ubiquitous, lawns are good systems in which to study the potential homogenizing effects of urban land use and management together with the continental-scale effects of climate on ecosystem structure and functioning. We hypothesized that similar homeowner preferences and management in residential areas across the United States would lead to low plant species diversity in lawns and relatively homogeneous vegetation across broad geographical regions. We also hypothesized that lawn plant species richness would increase with regional temperature and precipitation due to the presence of spontaneous, weedy vegetation, but would decrease with household income and fertilizer use. To test these predictions, we compared plant species composition and richness in residential lawns in seven U.S. metropolitan regions. We also compared species composition in lawns with understory vegetation in minimally-managed reference areas in each city. As expected, the composition of cultivated turfgrasses was more similar among lawns than among reference areas, but this pattern also held among spontaneous species. Plant species richness and diversity varied more among lawns than among reference areas, and more diverse lawns occurred in metropolitan areas with higher precipitation. Native forb diversity increased with precipitation and decreased with income, driving overall lawn diversity trends with these predictors as well. Our results showed that both management and regional climate

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shaped lawn species composition, but the overall homogeneity of species regardless of regional context strongly suggested that management was a more important driver.

1. Introduction

The expansion of large areas devoted to single-family residential housing has been postulated to create ecosystems in urban and suburban areas that are much more homogeneous than regional native ecosystems (Kühn & Klotz, 2006; McKinney, 2006; Schwartz, Thorne, & Viers, 2006). This pattern occurs in part because people select a relatively uniform mixture of grass, trees, ornamental plantings, and open areas (Groffman et al., 2014), which homogenizes many plant taxa on multiple spatial scales (McKinney, 2006). Homogenization of urban and suburban plant communities likely occurs through a variety of mechanisms that are both direct and indirect results of human actions. In residential areas, many homeowners obtain plants from nationwide garden and home improvement stores in which sales are dominated by a relatively small pool of plant species (Smith, Thompson, Hodgson, Warren, & Gaston, 2006; Yue & Behe, 2008). However, homogenization is not limited to planted areas or gardens, but also occurs in non-planted urban plant communities, such as spontaneous communities around urban street trees (Del Tredici, 2010; Wittig & Becker, 2010).

Lawns, or the turfgrass-dominated and maintained areas in yards, are a widespread and characteristic element of urban and suburban landscapes. Lawns cover more land than any other irrigated crop in the United States (Milesi et al., 2005; Robbins & Birkenholtz, 2003). Lawns provide ecological services such as water filtration (Beard & Green, 1994), moderation of the urban heat island effect (Hall et al., 2016; Jenerette, Harlan, Stefanov, & Martin, 2011), stormwater management (Mueller & Thompson, 2009), floral resources for pollinators (Larson, Kesheimer, & Potter, 2014), and connectivity between populations or reservoirs of species (Dearborn & Kark, 2010; Stewart et al., 2009), as well as recreational and aesthetic benefits to people and their pets (Beard & Green, 1994; Dearborn & Kark, 2010).

Although lawns are often assumed to be relatively uniform and species-poor, they can be diverse and rich in native species (Bertoncini, Machon, Pavoine, & Muratet, 2012; Thompson, Hodgson, Smith, Warren, & Gaston, 2004) or dominated by non-native species (Stewart et al., 2009). Residential lawns are typically designed to contain a limited number of turfgrass species. They are often maintained to reduce or eliminate weeds, and are continuously shaped through management with mowing, watering, fertilizing and use of pesticides. However, it remains unclear what species are actually present in typical residential lawns across broad regions and what management or regional environmental drivers may lead to different lawn species compositions.

Lawn management varies within and among cities (Polsky et al., 2014). The ways people choose to manage their lawns varies with characteristics such as resident beliefs and norms, population density, and housing density (Martini, Nelson, Hobbie, & Baker, 2015; Zhou, Troy, Grove, & Jenkins, 2009), and these management choices in turn affect lawn species composition (Bertoncini et al., 2012). Cultural and socioeconomic factors such as family income and resident age also influence urban plant diversity (Hope et al., 2003; Kinzig, Warren, Martin, Hope, & Katti, 2005; Meléndez-Ackerman et al., 2014). The urban "luxury effect" describes the tendency of plant diversity in urban greenspace to increase with increasing socioeconomic status (Hope et al., 2003; Martin, Warren, & Kinzig, 2004). Moreover, urban environments are known to select for species that have functional attributes that allow them to disperse and persist in settings subject to higher pollution levels, heat island effects, altered wind patterns and contrasting dispersal agents (Knapp et al., 2012). At the same time, lawns are subject to the same aspects of the regional climate that affect native communities (Thompson et al., 2004). Interestingly, management practices such as irrigation and fertilization may not be linked to regional abundance of water and nitrogen (Groffman et al., 2016). While there have been a number of studies of controls on lawn species composition in individual cities (e.g., Stewart et al., 2009; Thompson et al., 2004), continental scale patterns of lawn plant species composition associated with climate or large regional variations in lawn management have not been well explored. These patterns are important because they could reveal how management and regional environmental drivers together shape lawn species composition.

In this study, we measured lawn plant species composition across different levels of housing density in seven cities and their associated Metropolitan Statistical Areas (MSAs) spanning climatic zones across the United States. We also measured plant species composition in representative natural reference areas in each MSA. These included, for example, Sonoran desert parks in Phoenix, tallgrass prairie in Minneapolis, and northern hardwood forest in Boston. We determined homeowner income and management practices with a phone survey. Because actions by residents may strongly influence plant species composition in lawns, we hypothesized that the plant species composition, richness and diversity of lawns, both including and excluding planted turfgrasses, would be similar among different MSAs and that lawns across the country would be more similar than reference areas

Table 1
Climate, native vegetation, and number of plots sampled in each MSA. Climate data are 30-year means from 1981 to 2010. Number of sites or locations/transects shows the number of residential lawns and the number of different reference areas and transects sampled, with total number of plots sampled in parentheses. The number of transects in each type of reference vegetation is shown in parentheses after the vegetation type.

Abbreviation	MSA	State	Mean Annual Precipitation (cm)	Annual Mean Daily Temperature (°C)	Number of Sites or Locations/Transects (No. of Plots)		Reference Area Vegetation (No. of Transects)
					Reference	Lawn	
BAL	Baltimore	MD	106	12.8	3/24 (68)	23 (123)	Oak and tulip poplar forest (24)
BOS	Boston	MA	111	10.8	6/21 (63)	31 (186)	Northern hardwood forest (18), pasture (3)
LA	Los Angeles	CA	33	17.0	3/21 (63)	20 (90)	Southern California coastal scrub (21)
MIA	Miami	FL	157	25.1	4/23 (70)	21 (121)	Pine rockland (4), subtropical hardwood hammock (3), coastal hammock (8), pine flatwoods (8)
MSP	Minneapolis − St. Paul	MN	78	7.9	6/24 (66)	21 (126)	Oak savannah (8), tallgrass prairie (4), bluff prairie (4), maple-basswood forest (8)
PHX	Phoenix	AZ	20	23.9	3/24 (72)	28 (130)	Sonoran desert (24)
SLC	Salt Lake City	UT	41	11.6	3/24 (71)	30 (180)	Sagebrush shrub-steppe (24)

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