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Research Paper

Examining the potential to expand wildlife-supporting residential yards and gardens

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HIGHLIGHTS

- Residentials yards and gardens can expand wildlife habitat in cities.
- Gardening as a hobby is associated with the adoption of wildlife-supporting yards.
- The desire for low-maintenance yards is a barrier to wildlife yard features.
- Homeowner and neighborhood associations predict wildlife-supporting yards.
- Efforts to expand yard habitat will benefit from tailored, community-engaged approaches.

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ABSTRACT

Research has demonstrated that residential yards can provide important habitat for urban birds, pollinators, and other wildlife. In addition, the motivations and constraints underlying decisions to manage traditional lawns, water-conserving yards, native plants, and other landscape types are well understood. Yet relatively little research has addressed people's decisions to adopt wildlife-supporting yards. Analyzing survey data from six U.S. cities, we address three related questions: 1) to what extent do residents choose yard features that support wildlife habitat?; 2) how do yard priorities and neighborhood governance, along with socio-demographic factors, explain the adoption of wildlife-supporting features?; and 3) how do residents who have already adopted wildlife-supporting yard features differ in their motivations from those who plan to adopt such features and those who do not? We found significant potential for adding vegetation (specifically shrubs and native plants) and other wildlife-supporting features to increase yard complexity and vegetation diversity. While gardening as a hobby was a significant motivator for people who have adopted wildlife yard features, the desire for low-maintenance yards is a constraint among non-adopters. We therefore recommend promoting the planting of low-maintenance plant species or varieties that provide wildlife habitat but require little upkeep, especially among residents who would like to attract wildlife to their yards into the future. We also found that neighbourhood and homeowner associations increase the local adoption of wildlife-supporting yards. Coupled with other findings, our results underscore the importance of tailoring residential landscape features to diverse lifestyles while leveraging social institutions to expand wildlife habitat across urban and suburban neighborhoods.

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1. Introduction

Residential yards and gardens (hereafter yards) pervade urban ecosystems as a dominant land use in cities and suburbs (Goddard, Ikin, & Lerman, 2017; van Heezik, Dickinson, & Freeman, 2012). Research around the globe—from North America and Europe to South Africa and Australia—examines the social and ecological dynamics of yards, which offer opportunities for people to connect with the natural world where they live (DeStefano & DeGraaf, 2003; Jones, Teel, Solomon, & Weiss, 2021; Mumaw, 2017; Shackleton et al., 2018). Yet the traditional characteristics of yards—specifically intensively managed, monoculture lawns—raise concerns about how residential land systems negatively affect biodiversity, water resources, and environmental quality (Bormann, Balmori, Geballe, & Geballe, 2001; Robbins, 2007). While urbanization is a major contributor to declines in native biodiversity worldwide, ecological research across the Global North and South has demonstrated that yards can provide crucial habitats for birds, pollinators, and other wildlife within urban regions (Akinnifesi et al., 2010; Belaire, Whelan, & Minor, 2014; Coetzee, Barnard, & Pauw, 2018; Collins, Magle, & Gallo, 2021; Fetridge, Ascher, & Langellotto, 2008; Jaganmohan, Vailshery, & Nagendra, 2013; Lerman et al., 2021; Threlfall et al., 2015). As a result, conservationists advocate for more biodiverse urban landscapes that produce various benefits, including habitat for wildlife (Larson et al., 2020; Nilon et al., 2017).

The vegetation composition of yards substantially influences their value as wildlife habitat. Native vegetation, in particular, has been linked to increases in birds, bees, and other wildlife (Berthon, Thomas, & Bekessy, 2021; Coetzee et al., 2018; Lerman & Warren, 2011; Narango, Tallamy, & Marra, 2017). Vegetation complexity—in the form of plants, trees, and shrubs of varying heights—also delivers habitat, as do bird feeders and baths, nesting boxes, and natural features (e.g., log or leaf piles) that provide places to hide or shelter (Goddard, Dougill, & Benton, 2013; Widows & Drake, 2014). Given the significant habitat yards provide for birds and other urban wildlife, efforts are underway in countries such as the United Kingdom, Australia, and the United States to promote wildlife gardening in residential areas (Gaston et al., 2007; Jones et al., 2021; Mumaw, 2017; Shaw, Miller, & Wescott, 2013). Some programs, such as the National Wildlife Federation's Wildlife-Yard Certification program in the United States, certify yards that provide habitat (Widows & Drake, 2014), higher native plant diversity (Padullés Cubino et al., 2020), and diverse bird communities (Lerman et al., 2021). Other programs, such as Gardens for Wildlife in Australia, involve partnerships between government and community organizations that provide landscape assessments, resources, and social events that seek to expand wildlife gardening (Mumaw, 2017).

Previous research on residential landscaping practices has examined the motivations and constraints for residents' adoptions of low water-use yards (e.g., Head & Muir, 2007; Fernández-Cañero, Ordovás, & Machuca, 2011; Stacy, Ryan, Roy, & Milman, 2021) and native plants (e.g., Helfand, Park, Nassauer, & Kosek, 2006; Kendal, Williams, & Williams, 2012; Shaw et al., 2013; Anderson, Messer, & Langellotto, 2021). In recent years, attention to biodiversity outcomes and wildlife conservation has increased (e.g., Goddard et al., 2013; Hobbs & White, 2016; Mumaw, 2017; Jones & Niemiec, 2020; Jones et al., 2021). This research has found that engaging in wildlife gardening creates a positive feedback loop wherein residents express pride, gratification, and validation as they experience positive results such as wildlife visiting their yards (Goddard et al., 2013; Mumaw, 2017). As a result of such rewarding experiences, wildlife yards are reinforced and residents continually seek to steward nature. Social experiences and programs that offer information and other resources also fortify wildlife yards, in addition to establishing the norms for planting native vegetation and landscaping to support wildlife (Jones et al., 2021; Mumaw, 2017). While recent research has focused on the diffusion of wildlife gardening through urban conservation programs (Hobbs & White, 2016; Jones & Niemiec, 2020; Mumaw, 2017), our study closely examines how various yard priorities and institutional forces influence the adoption—and potential future adoption—of yard features that support wildlife.

Research has identified aesthetics, recreation, and maintenance as top priorities for residents when they choose among various types of landscapes (Larson et al. 2009, 2016; Wheeler, Larson, & Andrade, 2020). However, different aesthetic preferences and social lifestyles can create varied landscape preferences and practices within these overarching priorities (Larson, Casagrande, Harlan, & Yabiku, 2009). For example, while many people prefer the appearance of neat and manicured landscapes, some people prefer natural-looking yards that may appear messy to others (Larson & Brumand, 2014; Nassauer, Wang, & Dayrell, 2009). Similarly, leisure pursuits may lead to the desire for low-maintenance landscapes among some people, especially those who view gardening as a chore (Larson et al., 2009; Mumaw, 2017). Overall, varied yard priorities affect landscape choices and associated outcomes. As one study demonstrated, for instance, the desire for neat yards has been linked to lower plant species diversity (Padullés Cubino et al., 2020).

Other major drivers of yard management are social institutions, including both formal (codified) and informal (uncodified) rules that govern human behavior across multiple scales (Cook, Hall, & Larson, 2012; Larson & Brumand, 2014). Informal institutions comprise normative expectations and neighborly pressures, which can fortify the management of traditional lawns or other types of landscapes (Grove et al., 2006; Robbins, 2007; Sisser et al., 2016; van Heezik et al., 2012). Research has specifically shown that not all neighborhoods emphasize lawns, and broadly, landscape expectations can vary across relatively local residential environments (Nassauer et al., 2009). For example, in a study of the arid southwestern U.S., residents do not expect neighbors to maintain a lawn or another specific type of landscape, but they do overwhelmingly expect their neighbors to maintain neat, orderly yards (Larson & Brumand, 2014). As a whole, social norms are important drivers of residents' landscape choices, and although social expectations and traditions can vary across people and places, establishing norms for wildlife gardening can spread throughout neighborhoods (van Heezik et al., 2012).

In addition to informal institutions, legally enforceable (formal) institutions influence yard management at various scales (Cook et al., 2012; Larson & Brumand, 2014). Formal institutions include municipal and state regulations, as well as neighborhood-scale institutions such as Homeowners Associations (HOAs), all of which have significant potential to permit or constrain landscaping choices (Fraser, Bazuin, Band, & Grove, 2013; Larson et al., 2020; Turner & Stiller, 2020). HOAs, in particular, are semi-private institutions that govern planned subdivisions through legal documents often known as covenants, codes, and restrictions, which are intended to protect property values by upholding community expectations for housing, yards, or other features of neighborhoods (Turner & Stiller, 2020). While HOAs have been shown to affect landscaping decisions, the outcomes are varied. For example, in some cases in the U.S., HOAs reinforce industrial lawn management through fertilization (Fraser et al., 2013), whereas in other cases HOA-governed neighborhoods support biodiverse yards (Lerman, Turner, & Bang, 2012; Turner & Stiller, 2020).

Relying on survey data from six metropolitan regions of the U.S., this study examines how yard priorities and social institutions affect the adoption of wildlife yard features. Specifically, we sought to address three research questions: 1) to what extent do, or might, residents undertake landscaping practices to support wildlife?; 2) how do yard priorities and social institutions, especially neighborhood governance, explain the likelihood of maintaining or adopting wildlife-supporting yards (controlling for socio-demographic factors)?; and 3) how do residents who have already adopted wildlife-supporting yard features differ from those who plan to adopt such features and those who are unlikely to adopt them? While we expected most residents to maintain at least some grass, we expected varying amounts of other vegetation in yards. We also anticipated that adopters and non-adopters would have

different yard priorities and different neighborhood governance types. For example, since more vegetation can lead to more maintenance, we anticipated that low-maintenance priorities might constrain wildlife yard management. Altogether, our results identify the potential for increasing wildlife habitat in residential landscapes, along with the primary motivations and constraints for doing so. These results inform how conservationists can more effectively promote a shift toward wildlife yards and gardens.

2. Methods

The survey data in this study originate from a 2018 household survey, which was part of an extensive interdisciplinary study to evaluate the homogenization of urban ecosystems in six Metropolitan Statistical Areas (MSAs, as defined by the U.S. Census) of the U.S.: Boston, MA, Baltimore, MD, Miami, FL, Minneapolis–Saint Paul, MN, Phoenix, AZ, and Los Angeles, CA. These regions were chosen based on long-term research experience in each area by our research team. The regions also cover diverse regions considering both hydro-climatic and socio-political factors. Each MSA includes urban, suburban, and exurban areas surrounding a core city. In 2011, phone surveys were conducted with 9480 owners of detached, single-family homes who answered questions about their yard management practices (see Polsky et al., 2014, for more details). Of these households, 58%–68% (4417) agreed to a follow-up contact in the future.

In 2018, we surveyed these 4417 households aiming for roughly equal numbers in each MSA. From February to March 2017, we sent two postcards to each household: the first reminded them about their participation in the earlier study and informed them of the upcoming survey, and the second encouraged them to complete the new survey online and also stated that we would follow up with a phone call (Dillman, Smyth, & Christian, 2014).

Households that did not respond to the online survey (4223) became the sub-sample for the phone survey. A total of 363 people responded: 194 online and 169 via the phone. Considering all eligible participants, this number of survey completions amounts to 8.5% of the sample from the previous phone survey.

Of the 363 survey respondents, four were removed since they were outside the study regions, and an additional four cases were removed due to the lack of responses for the data included in our analyses. Thus, the valid sample size was 355, with the following sample sizes by region: 105 for Minneapolis–St. Paul, 56 for Boston, 57 for Baltimore, 37 for Miami, 53 for Phoenix, and 47 for Los Angeles. The higher sample size in Minneapolis–St. Paul is likely due, at least partly, to the University of Minnesota and Saint Cloud State University administering the survey.

Regarding demographics, our sample is relatively old (average age was 64 years), male (54%), and predominately white (92%). Moreover, respondents' average household income level was around $75,000, and the average level of education was some college experience (Table 1). While we recognize that our sample is not generalizable and may include highly engaged residents who participated in our surveys, the inclusion of homeowners from diverse regions of the U.S. is a strength relative to single-site studies that tend to dominate the literature (Cook et al., 2012; Larson et al., 2020). Nevertheless, given that our homeowner sample is not representative of the U.S., we exercise caution in generalizing our results to other populations.

2.1. Data for question 1: Yard types and possible changes

To document the type of yards people managed at the time of the survey, we first asked survey participants about their existing yard features, specifically: whether their yard consisted of a lawn and no other plants, mainly lawn and some plants, some lawn with mixed plants, or some lawn with hardscape (Table 2). To capture past and future changes to yards, we asked respondents whether they had made certain changes to their yards since owning their home and whether they plan to make these changes over the next 5–10 years: adding and removing grass, trees, shrubs, plants, and native plants, as well as "wildlife features" generally (Fig. 1). Lastly, we asked homeowners about their likelihood of adopting four types of wildlife-supporting features:.

1) "more locally native plants";.
2) "yards designed to attract/support wildlife (especially birds)";.
3) "yards designed to attract/support pollinators (bees, butterflies, etc.)"; and.
4) "increased use of natural elements including wood, mulch or stone.".

The response scales include the following options: "I would never want to do that" (never = 1) and "I already have this and want to keep it"

Table 1
Socio-Demographic Variables and Sample Characteristics.

Demographic Variables	Mean / Percent	Std. Dev.	Minimum	Maximum	Valid N
Age	64.1	12.16	17 years^	97 years	322
Household income	5.2	1.83	1 (<$25 K)	9 (>$250 K)	258
Education level	3.6	0.94	1 (less than high school)	5 (post-grad)	340
Household size	2.4	1.21	1 person	8 people	343
Years in neighborhood	25.9	13.4	0 years	97 years	345
Neighborhood governance*	1.7	1.28	0 (no association)	3 (both NBH-A & HOA)	346
Race: White	92.20%	n.a.	0 (person of color)	1 (white)	335
Gender: Female	46.10%	n.a.	0 (male)	1 (female)	336
Unemployed/retired	46.70%	n.a.	0 (employed)	1 (unemployed)	338

^Age was calculated based on year of birth, not age reported at the time of the survey. All respondents were asked if they were 18 or older, so we assume this person was barely 18 based on the month of the survey and their birthday.
*30.1% neither / 10.2% NBH-A / 17.8% HOA / 41.3% Both HOA & NBH-A.

Table 2
Reported Yard Types: Frequencies (n = 352) and Descriptive Statistics for Likelihood of Adopting Wildlife-Supporting Yards (see Fig. 2).

Yard Type	Percent (N)	Mean Likelihood of Adopting Wildlife-Supporting Yards ± Standard Deviation
Lawn, no other plants	2.3% (8)	2.38 ± 0.46
Mostly lawn, some other plants	64.2% (226)	2.97 ± 0.61
Little grass, mixed plants	27.6% (97)	3.20 ± 0.52
Little grass, hardscape	6% (21)	2.60 ± 0.73

Note: The scale for mean likelihood of adopting wildlife yards ranged from a low of 1 (not likely) to a high of 4 (have already adopted).

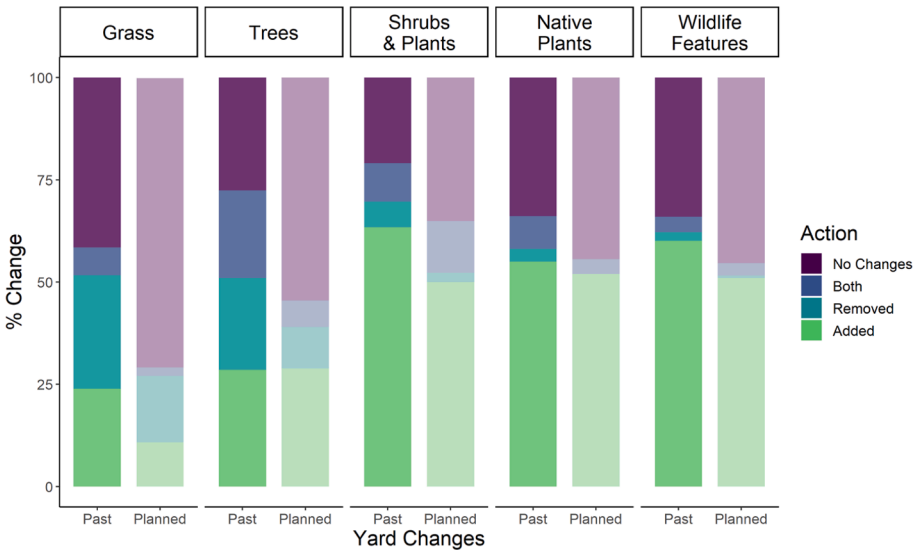

Fig. 1. Yard Changes since Residency and Planned Changes over the next 5–10 years: Valid Percentages of Survey Respondents (n = 355).

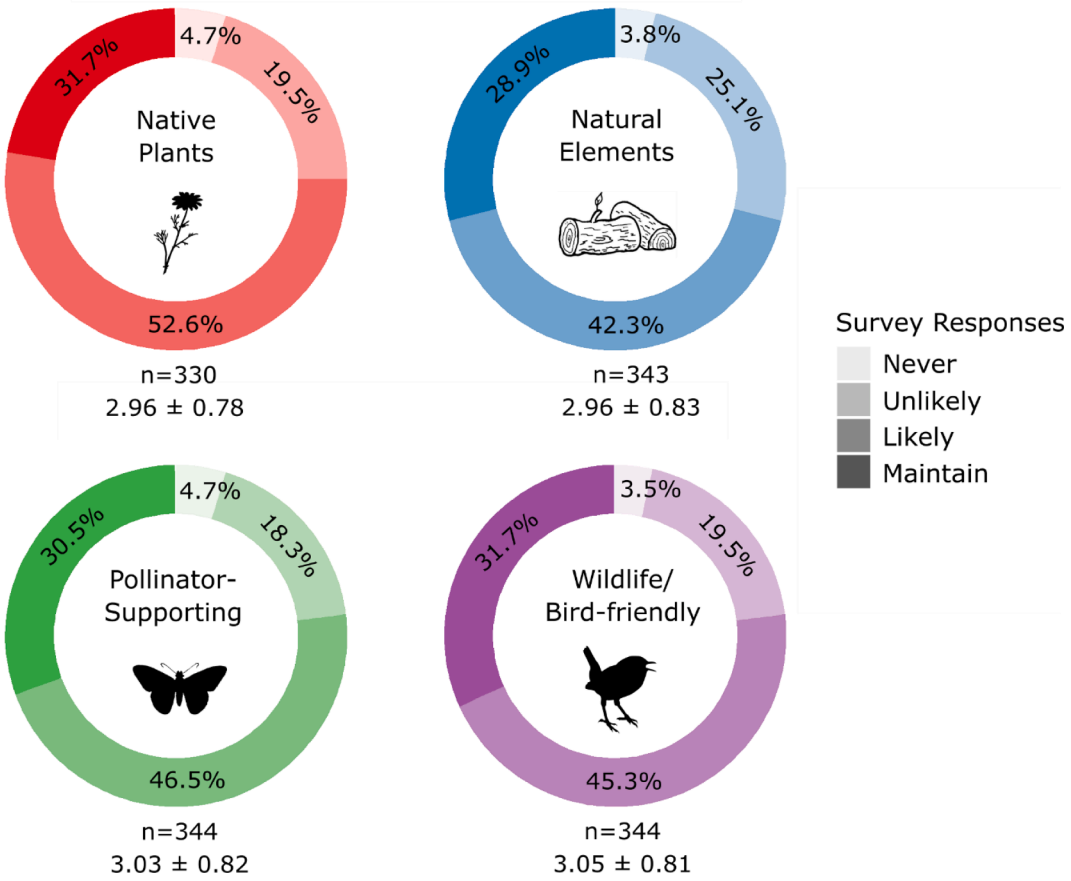

Fig. 2. Frequency of Responses: Likelihood of Adopting Wildlife-Supporting Yards. The response scales for the individual variables comprising the dependent variable in this study included: never (lightest shade), unlikely, likely, and already maintain (darkest shade). These four variables were averaged to create the composite scale that serves as the dependent variable for the regression models (Table 5). The overall mean was 2.99 ± 0.62. Picture of the wren by Anthony Caravaggi via Phylopic.org. The three other images were available for reuse without copyright under the public domain.

(maintain = 4), as well as "not likely" (2) and "likely" (3) to adopt (Fig. 2). Across the regions, the adoption of wildlife-supporting yard practices was fairly similar; specifically, the mean rate of adoption for the above practices ranged from an average of 2.9 in Los Angeles and Phoenix to a high of 3.2 in Minneapolis. Given the lack of regional distinctions as well as the small sample sizes for each region, our subsequent analyses do not differentiate by region.

2.2. Data for question 2: Factors influencing the likelihood of adopting Wildlife-supporting yards

To capture yard priorities, we followed Larson et al. (2016; see also Padullés Cubino et al., 2020) by considering personal priorities and social norms and activities, as well as environmental benefits and impacts that are known motivations in vegetation choices and landscaping practices. Across three sets of survey questions, we included a range of motivations for landscaping choices in the past and into the near future, as well as those pertaining to the social context of neighborhoods: 1) *reasons* for yard management decisions made in the past, 2) *ideal* yard attributes and potential reasons for future changes, and 3) yard priorities given the social *norms* of neighborhoods. All responses were measured on four-point ordinal scales, including not important, slightly important, important, and very important. As seen in Table 3, we intentionally repeated specific reasons across the three sets of questions to examine the internal consistency of individual's responses using standard methods (Carmines & Zeller, 1979; Spector, 1992).

As described below, we reduced these yard priority variables into a smaller set of reliable measures for our analysis (Tables 3 and 4). In addition to the above landscaping priorities, socio-demographic factors were gathered via the survey to capture residents' life stage and lifestyle factors (as covariates), as well as the applicable neighborhood governance where they live. The latter included a variable that captured the extent of community governance, wherein residents' properties include both a neighborhood association (NBH-A) and a homeowners' association (HOA), either an NBH-A or HOA, or neither. We also asked about the length of residence at their current home, household size, and individuals' age, gender, and race. Finally, we asked if respondents were retired or unemployed (relative to at least part-time employment), in addition to measuring income and education on ordinal response scales (see Table 1 for details and summary statics).

2.3. Data for question 3: Adopters compared to likely and unlikely adopters

To distinguish motivations among adopters of wildlife-supporting yard features relative to likely and unlikely adopters, we focused on the two dependent variables that most strongly represent intentions to attract and support 1) birds and other wildlife, and 2) pollinators such as bees and butterflies. We compared these variables across three groups: people who have adopted wildlife-supporting practices and plan to maintain them, people who are likely to adopt such practices into the near future, and lastly, people who reported they would 'never' adopt or were unlikely to adopt practices to attract and support wildlife. The last group combines the 'never' and 'unlikely' adopters, given the relatively low sample sizes for the former response (Fig. 2).

3. Analysis

We ran ordinary least squares regression to examine the relative influence of residents' yard priorities and socio-demographic attributes,

Table 3
Component Matrix from Factor Analysis with Principle Components Extraction and Varimax Rotation.

Variables	1	2	3	4	5	6	7	8
Ideal: Less Pollution	**0.755**	0.165	0.096	0.215	0.069	0.106	−0.058	−0.057
Norm: Water Conservation	**0.740**	0.118	0.145	0.180	0.066	−0.103	0.185	−0.061
Norm: Water Quality	**0.730**	0.174	0.060	0.317	0.032	−0.080	0.116	−0.236
Reason: Low Pollution	**0.690**	0.091	−0.027	0.267	0.104	0.269	0.019	0.004
Ideal: Low Water Use	**0.670**	0.107	0.338	−0.015	0.008	−0.019	−0.080	0.206
Ideal: Climate Adapted	**0.626**	0.248	0.201	0.123	0.007	0.047	−0.070	0.310
Reason: Less Irrigation	**0.588**	−0.034	0.163	0.068	0.006	0.417	−0.005	0.029
Reason: Beauty	0.177	**0.742**	0.069	0.047	0.027	0.178	−0.176	0.037
Ideal: Beautiful	0.192	**0.710**	0.151	0.094	0.078	0.083	−0.114	0.250
Norm: Pride	0.106	**0.703**	−0.140	0.194	0.148	0.113	0.154	−0.119
Norm: Property Values	0.097	**0.547**	0.186	−0.064	0.478	−0.067	0.170	−0.100
Ideal: Home Value	0.154	**0.542**	0.415	0.046	0.329	0.041	0.031	0.168
Norm: Individuality	0.159	**0.502**	−0.086	0.453	0.080	0.113	0.238	−0.080
Reason: Landscape Hobby*	0.174	*0.454*	−0.235	0.251	0.022	0.352	−0.269	−0.122
Ideal: Little Work	0.013	−0.085	**0.797**	−0.091	0.044	−0.025	−0.018	0.063
Ideal: Little Time	0.201	0.055	**0.755**	0.042	0.058	0.054	−0.118	0.121
Ideal: Low Costs	0.141	0.157	**0.662**	0.088	0.084	0.002	0.090	−0.025
Norm: Easy Maintenance	0.149	0.034	**0.644**	0.054	−0.008	−0.044	0.201	−0.460
Reason: Low Maintenance	0.323	−0.105	**0.542**	0.064	0.121	0.409	−0.002	−0.144
Norm: Natural/Wild	0.149	−0.010	0.066	**0.824**	0.058	−0.062	0.023	−0.001
Reason: Natural-Looking	0.337	0.102	0.163	**0.669**	0.052	0.081	0.055	0.083
Reason: Wildlife Habitat	0.262	0.279	−0.128	**0.593**	−0.083	0.304	−0.190	−0.021
Reason: Nature Interactions	0.310	0.183	−0.072	**0.578**	0.005	0.458	−0.097	0.106
Ideal: Wildlife Habitat	0.515	0.244	0.083	**0.539**	−0.003	0.032	−0.223	0.077
Ideal: Fits Neighborhood	0.102	0.115	0.138	0.035	**0.793**	−0.019	0.026	0.227
Norm: Match Neighbors	0.014	0.039	−0.003	−0.104	**0.751**	0.079	0.093	0.010
Reason: Neighbors Happy	0.067	0.033	0.034	0.175	**0.664**	0.315	0.027	−0.028
Norm: No Bother	−0.050	0.287	0.103	0.082	**0.593**	−0.004	−0.139	−0.435
Reason: Pests Avoidance*	0.178	0.152	0.310	0.176	0.066	*0.333*	0.131	0.244
Reason: Socializing*	0.045	0.390	0.076	0.184	−0.036	**0.586**	0.230	−0.048
Reason: Kids Playscape*	−0.005	0.114	0.004	−0.020	0.231	**0.584**	−0.032	0.036
Norm: No Wildlife*	0.023	−0.024	0.033	−0.047	0.109	0.056	**0.828**	0.048
Ideal: Trends*	0.068	0.179	0.067	0.298	0.375	0.006	0.250	**0.479**

Notes: We labeled the factors as: 11) low environmental impact; 2) aesthetic pride; 3) low cost/maintenance; 4) nature/wildlife benefits; 5) neighborly norms; 6) recreation and leisure; 7) wildlife deterrence; and 8) latest trends. For all factors except 6, we created composite scales representing landscaping priorities by averaging individuals' responses to the variables that loaded (>0.5) on each factor. *Asterisks indicate single variables not included in composite scales. Variables that loaded on the recreation and leisure (6) factor were analyzed individually since children's recreation might uniquely impact the decision to draw wildlife to yards.

Table 4
Descriptive Statistics for Yard Priorities (Cronbach's alpha for composite survey scales) The response scales for all variables ranged from 1 (not important) to 4 (very important). See the supplementary material for the verbatim wording of survey questions for each variable herein.

Explanatory Factors: Composite Scales and Individual Variables	Mean	Standard Deviation	Valid N
Low Cost/Maintenance (alpha = 0.776)	**2.78**	**0.71**	**349**
Easy to Maintain	3.06	0.83	345
Low Cost	2.80	0.95	345
Little Work	2.76	0.99	346
Maintenance Reduced	2.71	1.03	345
Little Time	2.56	1.05	345
Aesthetic Pride (alpha = 0.789)	**2.78**	**0.65**	**349**
Beauty/Looks	3.03	0.93	347
Property Values	2.91	0.86	346
Beautiful	2.85	0.90	346
Yard Pride	2.84	0.88	344
Home Value	2.76	0.97	346
Unique/Individuality	2.29	1.08	343
Environmental Impacts (alpha = 0.862)	**2.71**	**0.72**	**349**
Pollution Reduced	2.89	0.97	346
Water Quality	2.83	0.89	344
Water Conservation	2.80	0.90	343
Pollution Reduced	2.75	1.03	346
Climate Adaptation	2.60	1.03	344
Water Decreased	2.56	0.97	344
Water Reduced	2.53	1.05	347
Nature/Wildlife Benefits (alpha = 0.830)	**2.44**	**0.79**	**349**
Wildlife Effects	2.76	1.03	344
Nature Interaction	2.61	1.01	346
Wildlife Benefits	2.49	1.12	346
Natural Looking	2.47	1.02	347
Wild/Natural	1.92	0.95	344
Neighborly Norms (alpha = 0.714)	**2.04**	**0.67**	**349**
Doesn't Bother Neighbors	2.56	0.94	343
Neighbors Happy	1.95	0.93	347
Match Neighbors	1.85	0.92	344
Neighborhood Fit	1.80	0.88	345
Individual Variables	N.A.	N.A.	N.A.
Entertain Guests	2.60	0.99	347
Yard Hobby	2.36	1.14	348
Pest Avoidance	2.14	1.12	347
Kids Play	2.10	1.10	347
Wildlife Deterrence	1.65	0.92	341
Latest Trends	1.53	0.84	346

on wildlife-supporting yard choices. Our dependent variable captures the likelihood of adopting wildlife-supporting yards, which we measured as the average of individuals' responses to the likelihood of adopting the four features: native plants, wildlife/bird-friendly, pollinator-supporting, and natural elements. This composite scale offers a reliable measure (Cronbach alpha = 0.76) of individuals' likelihood to continue to maintain or to adopt wildlife-supporting features overall. The scale ranges from 1 (will not adopt) to 4 (will continue maintaining features), with 2 as unlikely and 3 likely to adopt. Although some explanatory variables were correlated, the VIF statistics (all < 3.0, below the criterion of 10) and tolerance values (all > 0.3; above the 0.2 criterion) indicated no multicollinearity problems (Mansfield & Helms, 1982).

For the explanatory variables, we conducted preliminary analyses—factor analysis and reliability analyses—of the thirty-three individual variables representing yard priorities to create robust multivariable composite scales (following Kim, Ahtola, Spector, & Mueller, 1978; Carmines & Zeller, 1979; Spector, 1992). Specifically, we ran principal components factor analysis with varimax rotation across the three sets of questions about yard management priorities. Eight factors emerged, six of which produced composite scales with two to seven variables each (Table 3). We labeled these factors based on the variables loading highly (>0.5) onto each motivation: 1) low maintenance/costs, 2) aesthetic pride, 3) environmental impacts, 4) nature/wildlife benefits, 5) neighborly norms, and 6) recreation and leisure. Each of these

Table 5
Regression Results for Factors that Explain Adoption of Wildlife-Supporting Yards: Yard Priorities and Socio-Demographics (F = 8.98, p < 0.01; adjusted $R^2 = 0.41$; n = 232). Significant variables at p < 0.05 are italicized for emphasis.

Explanatory Variables	Beta Coefficients		t	Sig.
	Standardized	Unstandardized (Std. Error)		
(Constant)		2.61 (0.38)	6.806	0.000
Residents' Yard Priorities				
Nature/wildlife benefits	*0.43*	*0.33 (0.06)*	*5.731*	*0.000*
Yard hobby	*0.15*	*0.07 (0.03)*	*2.225*	*0.027*
Low environmental impacts	0.05	0.04 (0.06)	0.679	0.498
Aesthetic pride	0.04	0.04 (0.06)	0.560	0.576
Entertaining guests	0.03	0.02 (0.04)	0.535	0.593
Low cost/ maintenance	*−0.22*	*−0.19 (0.05)*	*−3.540*	*0.000*
Wildlife deterrence	*−0.12*	*−0.08 (0.04)*	*−2.156*	*0.032*
Latest trends	−0.03	−0.02 (0.05)	−0.407	0.685
Neighborly norms	−0.02	−0.02 (0.05)	−0.306	0.760
Pest avoidance	−0.02	−0.01 (0.03)	−0.332	0.741
Kids play space	−0.01	−0.01 (0.03)	−0.218	0.828
Socio-Demographic Factors				
Age	*−0.20*	*−0.01 (0.00)*	*−2.255*	*0.025*
Education	*0.19*	*0.12 (0.04)*	*3.406*	*0.001*
Income	−0.04	−0.01 (0.02)	−0.568	0.571
Race: White	−0.02	−0.04 (0.12)	−0.317	0.751
Household size	−0.04	−0.02 (0.03)	−0.631	0.529
Gender: Female	0.06	0.07 (0.07)	1.046	0.297
Retired/unemployed	0.11	0.13 (0.09)	1.548	0.123
Years in neighborhood	0.05	0.00 (0.00)	0.712	0.477
Neighborhood governance	*0.19*	*0.09 (0.02)*	*3.085*	*0.002*

labels is self-evident, though it is worth noting that price was statically related to both aesthetics and property values (Tables 3 and 4). The variables that loaded (>0.5) onto each of these six factors were internally consistent based on Cronbach's alphas higher than 0.7 (see descritiptive statistics for the composite survey scales in Table 4). Our regression model included six additional, distinct individual variables for: entertaining guests, landscaping as a hobby, avoiding pests, having a place for children to play, deterring wildlife, and keeping up with the latest trends. In addition to these motivations for landscaping practices, we also included the neighborhood governance variable as well as demographic attributes in the model (Tables 1 and 5).

Lastly, we conducted Analysis of Variance (ANOVA) with Tukey's post-hoc, pair-wise tests to compare the landscaping practices to support birds and wildlife (Fig. 3a), as well as pollinators such as bees and butterflies (Fig. 3b), across adopters, likely adopters, and non-adopters.

4. Results

4.1. Question 1: Residential landscape changes that support wildlife

About two-thirds of survey respondents reported having mostly grass with some additional plants in their yards, and over a quarter reported having little grass and a variety of plants (Table 2). Relatively few had a lawn with no plants (<3%) or a hardscape with little grass (6%). The group who reported little grass with a variety of plants was the most likely to adopt wildlife-supporting landscaping practices (the mean likelihood for the composite variable was 3.2 ± 0.52 standard deviation), followed by those with mostly lawns and some plants (3.0 ± 0.61). Although the sample sizes are small for the other two yard types, those with hardscapes reported an average likelihood of 2.6 ± 0.73 and those with lawns and no plants 2.4 ± 0.46. Overall, homeowners reported that they are likely to adopt features that support birds or other wildlife

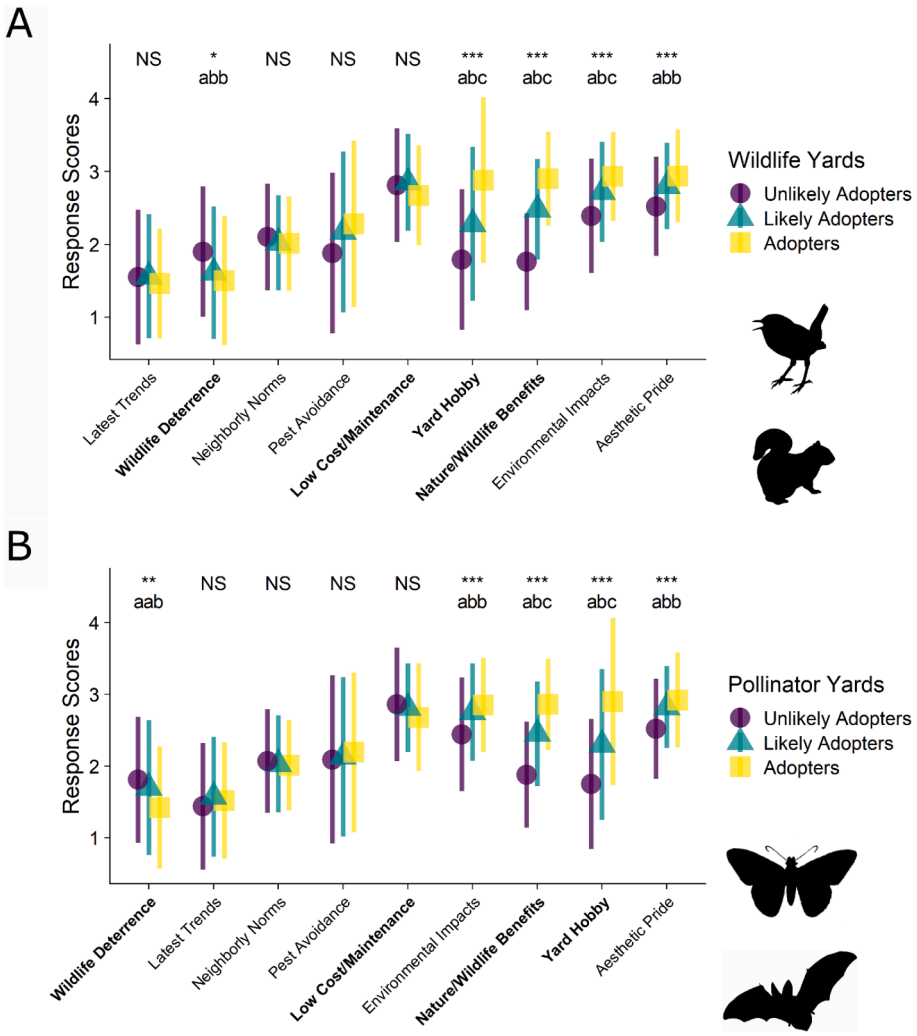

Fig. 3. Differences in Means for Yard Priorities across Adopters, Likely Adopters, and Unlikely Adopters for Landscaping Practices that Support a) Birds and other Wildlife and b) Pollinators such as Butterflies and Bats (n = 343). **Bolded** yard motivations were significant in our regression models (see Table 5). Results above are based on ANOVA tests with Tukey's pair-wise comparisons, wherein asterisks indicate differences across adopters vs. likely and unlikely adopter at $p < 0.001$***, $p < 0.01$**, $p < 0.05$* and NS indicates non-significance. The different letters for each motivation represent differences based on Tukey's tests at the $p < 0.01$ level, except for two pairs (in figure A) where $p < 0.05$ for environmental impacts* (0.043) and wildlife deterrence** ($p = 0.011$). The groups that share letters within a yard motivation are not significantly different. The picture of the wren and squirrel was created by Anthony Caravaggi (Phylopic.org). The other images were available for reuse without copyright under the public domain.

(composite scale mean = 2.99 ± 0.62 standard deviation; see Table 2).

Many surveyed residents have undertaken, or plan to undertake, changes to their yards to increase their value for wildlife (Fig. 1). More specifically, 60% of survey respondents indicated that they have added "plants or other features that attract wildlife and pollinators" to their yards. About half also indicated plans to make changes over the next five to ten years. Meanwhile, 2% or fewer have removed or plan to remove such features from their yards. Adding native plants was common for past yard changes (55% of respondents) and planned changes (51%), while removing native plants was rare (3.1%). A similar trend occurred for residents who added shrubs and plants, wherein at least half of respondents had undertaken these changes or plan to do so in the near future (Fig. 1). In contrast, relatively few have removed or plan to remove shrubs or other plants. Adding and removing trees was less common but still prevalent, and interestingly, 21% of respondents have both added and removed trees in their yards. More people (29%) plan to add trees than remove them (10%), which signals a potential net gain in trees into the near future. While approximately two-thirds have lawns, 28% reported removing grass, and 16% plan to remove grass. Changes to lawns, however, were the least common planned landscape change in our survey (Fig. 1).

About 30% of survey respondents (Fig. 2) said they would continue to maintain yards that attract wildlife such as birds as well as support pollinators. An additional 45–46% said they are likely to adopt certain wildlife-supporting features in the near future. Planting native vegetation was less common for residents in the past but is likely to increase into the future; 22% of respondents indicated they currently maintain natives, while 53% said they are likely to plant natives in the next five to ten years. Adding natural elements such as rocks and wood was also less common (22%) but likely among more than half of respondents into the future. As a whole, many homeowners expressed a high likelihood of adding wildlife-supporting features to their yards, and roughly 20–30% will continue to maintain such features in their home landscapes.

4.2. *Question 2: Factors influencing the adoption of wildlife-supporting yards*

The regression model estimating the likelihood of homeowners adopting wildlife-supporting yard features revealed the influence of certain yard priorities, socio-demographic factors, and neighborhood governance ($F = 8.98$, $p < 0.01$; see Table 5 for details). Specifically, seven independent variables significantly explained 41% of the variation in the dependent variable.

Regarding yard priorities, the motivation to maintain natural yards that attract wildlife and facilitate interactions with nature (i.e., nature/wildlife benefits) is the most significant factor for wildlife-supporting landscaping overall. People who enjoy yard care as a hobby are also significantly more likely to adopt wildlife-supporting yards. Meanwhile, people who prioritize low-maintenance, low-cost yards are less likely to adopt wildlife-supporting yards, as are people who intentionally deter wildlife from their yards and the broader neighborhood. Seven additional yard priority variables were insignificant in the model, including

aesthetic pride, neighborhood norms, following the latest trends, income, and tenure of residency in the neighborhood (Table 5).

Regarding socio-demographic factors, respondents' age significantly explained wildlife-supporting landscaping, with older people less likely to adopt wildlife-supporting yard features (controlling for other factors, including retirement/unemployment; Table 5). Two other social factors had a significant, positive relationship with the adoption of wildlife-supporting yards. The first was education level, and the second was the level of neighborhood governance. For the latter, the presence of one or more local governance mechanisms (i.e., neighborhood and homeowner associations) led to more wildlife-supporting landscaping choices.

4.3. Question 3: Yard priorities among yard adopters, likely adopters, and non-adopters

The strongest priorities for wildlife-supporting yard practices—i.e., gardening as a hobby and explicitly managing yards for nature and wildlife benefits—differed significantly ($p < 0.05$) between the three groups of adopters, likely adopters, and unlikely adopters. This held true for intentional yard practices aimed at providing habitat for both birds and pollinators (Fig. 3a-b, respectively). Although low-maintenance yard priorities were associated with the lack of wildlife-supporting yard features in the regression analyses, the three groups did not significantly differ in the ANOVA tests for supporting birds or pollinators. The intent to deter wildlife from the neighborhood did vary between groups; specifically, for yard features that support birds and pollinators, the unlikely adopters reported this motivation as more important to them relative to adopters, and for features that support pollinators, the unlikely adopters also upheld this motivation as more important than likely adopters.

Although the overall similarities and differences in the landscaping priorities across the three groups were consistent for supporting birds and pollinators (Fig. 3a-b), the pair-wise tests for overall group differences only varied for wildlife deterrence as well as reducing environmental impacts. For the latter, minimizing environmental impacts of yard management differed significantly between all groups for features that support birds and other wildlife. However, for features that support pollinators, the priority of environmental impacts did not differ between the adopters and likely adopters. In addition to environmental impacts, aesthetic pride was the only other motivational factor that differed significantly between groups but was insignificant in the regression model; particularly, both likely and actual adopters of landscaping features that support both birds and pollinators upheld aesthetic pride as more of a priority compared to unlikely adopters.

As a whole, three yard priorities—connecting with nature and wildlife, enjoying landscaping as a hobby, and lowering environmental impacts—were significantly stronger for adopters than non-adopters of wildlife-supporting yard features. Meanwhile, unlikely adopters were distinguished by two social factors—a lack of pride regarding their management and the intention to deter wildlife from the neighborhood.

5. Discussion

We found significant potential for expanding the adoption of wildlife-supporting landscapes in residential settings of the U.S. Specifically, while a majority of residents in our study have already added native plants, shrubs, and other vegetation to their yards, about half plan to add more in the near future. Since shrubs and other plants tend to be added more than removed, planting more vegetation will help diversify yards and provide habitat for birds, pollinators, and other wildlife (Goddard et al., 2013; Lerman & Warren, 2011). Moreover, although residents are more likely to plant trees than remove them, tree removal is reportedly more common than other vegetation removal, likely due to concerns about tree maintenance and poor tree health (Conway, 2016). Consequently, in addition to promoting tree planting, we recommend special attention to native plants, shrubs, and other vegetation, especially species known to provide wildlife habitat.

Since many residents still maintain lawns and most do not plan to remove grass, increasing the use of low-input native plants and diverse vegetation has the potential to increase habitat complexity while reducing the negative impacts of high-input traditional lawns (Braun et al., 2020; Lane, Watkins, & Spivak, 2019). For example, bee lawns—seeded with native grasses, clover, or wildflowers—offer habitat for bees and other pollinators (Ramer et al. 2019). Similar wildlife benefits can result from less frequent lawn mowing (Lerman, Contosta, Milam, & Bang, 2018). As a whole, yards that redesign lawns or reduce maintenance intensity, rather than eliminating grass entirely, may be the most successful since lawns with other plants—in addition to yards with relatively little grass and a mix of plants—were the most dominant yard types in our study. Moreover, the residents who had these common yard types were the most likely to adopt landscape features to attract and support wildlife.

Given that our survey sample is not representative of the U.S., or other populations, we exercise caution in generalizing our results. We also encourage further research with diverse populations and other locations to validate our findings. With these considerations in mind, we focus our discussion on related literature and theory, in addition to emphasizing what our results imply for expanding wildlife-supporting yards in the U.S. and beyond.

5.1. Behavioral intentions, norms, and landscaping priorities

We found that the intention to deter wildlife from neighborhoods prevents wildlife gardening, whereas intentionally managing yards as habitat explains the adoption of wildlife-friendly practices. This finding resonates with the theory of planned behavior (Ajzen, 1991) and other research that demonstrates the importance of behavioral intentions as antecedents to action (e.g., McKenzie-Mohr, 2011; Lauren, Smith, Louis, & Dean, 2019; Gillis & Swim, 2020). Since social norms strongly influence yard management (Cook et al., 2012; Gillis & Swim, 2020; Larson & Brumand, 2014; Nassauer et al., 2009), local programs that promote wildlife gardening can help actualize intentions by normalizing and facilitating the adoption of wildlife yard features (Jones & Niemiec, 2020; van Heezik et al., 2012). Furthermore, by engaging residents as land stewards, community programs can validate and reinforce intentions and actions through social activities including yard assessments and nursery visits, which have been shown to foster a sense of purpose and confidence in managing yards for wildlife (Jones & Niemiec, 2020; Mumaw, Maller, & Bekessy, 2019; Mumaw, 2017; van Heezik et al., 2012).

Our study also identified extra time and effort as possibly barriers to the adoption of wildlife gardening, as seen in the opposite relationships we identified between gardening as a hobby (positive) and maintaining low-maintenance yards (negative). Given the widespread desire for low-maintenance and aesthetically desirable yards (Conway, 2016; Larson et al., 2016), promoting specific plants and practices that support wildlife but are easy to maintain and aesthetically pleasing has the potential to increase wildlife gardening. For example, mowing lawns less frequently does not require additional skill or effort and can support more floral resources and a higher abundance of bees (Lerman et al., 2018). Likewise, leaving leaf litter reduces workload while providing important overwintering habitat for pollinators and other arthropods (Schmitt & Burghardt, 2021). Additional efforts might include government or non-profit programs (e.g., plant giveaways) that promote locally appropriate vegetation that is easy to grow and maintain. Locally-native cultivars can also be been bred to express certain traits that facilitate ease of care and aesthetic attributes while still supporting local pollinator communities (Baisden, Tallamy, Narango, & Boyle, 2018). In general, targeted information and resources—including procedural knowledge on how to manage landscapes for wildlife—is more likely to be effective than general calls to plant native vegetation or garden for

wildlife (Frisk & Larson, 2011; McKenzie-Mohr, 2011).

5.2. Social context and local governance

Given that organized neighborhood associations were connected to the adoption of wildlife yard features in our study, local social institutions might be central to their expansion. Specifically, residents living in areas with neighborhood organizations—whether Homeowners Associations or voluntary forms—were more likely to adopt wildlife-friendly landscaping practices. This finding is in contrast to research that has found neighborhood norms and rules result in the management of high-input lawns (Fraser et al., 2013; Robbins, 2007). Our findings, instead, are more consistent with research that found higher vegetation and bird diversity in neighborhoods with HOAs compared to those without HOAs (Lerman et al., 2012). Although the mechanisms underlying the findings in our study remain unclear, it is clear that neighborhood governance matters and likely depends on the social context and specific local goals (e.g., aesthetic-focused lawns vs. nature-friendly landscaping). A recent study of HOA rules in metropolitan Phoenix found, for example, that neighborhood institutions often encourage native plants or other environmental features to conserve water (Turner & Stiller, 2020). Additionally, HOAs often require a minimum number of plants. Whether required or encouraged, specific rules promoting vegetation diversity and complexity could explain why neighborhood institutions were associated with more wildlife-supporting yard features than those without such collective governance structures.

As emphasized earlier, previous research points to the influential role of public programs in promoting wildlife gardens (Hobbs & White, 2016; Jones et al., 2021; Mumaw et al., 2019). As a result, partnerships among municipal agencies, non-profit organizations, and neighborhood associations appear to be an effective avenue for promoting wildlife gardening through the provisioning of knowledge and resources that are reinforced and spread through social interactions (Jones & Niemiec, 2020; Mumaw, 2017). These conservation efforts build community capacity for wildlife gardening while also expanding norms that will expand habitat in residential and urban areas (Mumaw et al., 2019; van Heezik et al., 2012).

5.3. Socio-demographics and heterogenous people

Lastly, we found that education and age were significantly associated with the adoption of wildlife yards. While we found younger residents were more likely to adopt wildlife yard features than older residents, we recommend research to more deeply explore how age—coupled with retirement and other lifestyle factors—combine to influence heterogeneous landscaping priorities and practices (Troy, Grove, O'Neil-Dunne, Pickett, & Cadenasso, 2007). For instance, people in their 30–40 s without children, or people in their 60–70 s who are comfortably retired, may be more likely to undertake landscaping as a hobby than others in different life circumstances. Since non-linear and complex relationships have been found between landscape choices and income levels, as well as other lifestyle factors (such as having children or not), understanding heterogeneous priorities and practices is important for promoting wildlife yards among diverse populations (Larsen & Harlan, 2006; Larson et al., 2009; Yabiku, Casagrande, & Farley-Metzger, 2008).

Given the differences we identified in yard priorities among residents who have already adopted wildlife-supporting yard features compared to likely adopters and unlikely/non-adopters, a couple of additional points are noteworthy. In particular, the most likely adopters in our study may be persuaded by appealing to their environmental values since these residents often espoused intentions to minimize environmental impacts and to support wildlife. However, since these residents often do not view landscaping as a hobby compared to adopters, information and resources on designing and managing yards for wildlife habitat through low-maintenance practices will likely be crucial. Appealing to the sense of pride among likely adopters, along with their desire for beautiful, natural-looking landscapes, may also be an effective marketing approach given that these are strong motivations for landscaping practices (Goddard et al., 2013; Mumaw, 2017).

5.4. Limitations and future research

As with all survey research, our study is subject to response bias, particularly among individuals who are active gardeners. As a result, our results may overestimate the extent to which residents plan to add yard features that provide wildlife habitat. Follow-up research that monitors whether such shifts occur in the study regions and elsewhere can validate yard changes, as can additional research with diverse populations.

Since our non-random sample consists of predominantly white homeowners, caution must be used in generalizing our results to other populations. We recommend future research that further tests and validates the patterns and relationships found in our study across other settings, specifically with consideration of behavioral and normative theories (e.g., Ajzen, 1991; Gillis & Swim, 2020; Jones & Niemiec, 2020), as well as those about collective governance, capacity building, and behavior change (e.g., Fraser, Bazuin, & Hornberger, 2016; Mumaw et al., 2019; Turner & Stiller, 2020). While our sample size did not allow robust regional comparisons, cross-regional research can facilitate generalizations by validating social-ecological dynamics across diverse places (Cook et al., 2012; Polsky et al., 2014). Additionally, research with more diverse communities could highlight how yard management might provide more equitable access to nature in urban environments.

Lastly, in-depth research on how diverse life stages, lifestyles, and socio-cultural factors—including race and ethnicity—influence landscaping practices could advance understanding of residential yard management and attendant outcomes across households, neighborhoods, and regions. Though several studies, including ours, have quantitively examined the relationships between demographic attributes and yard management (e.g., Grove et al., 2006; Larson et al., 2016; Larson et al., 2020), qualitative research and in-depth, participatory research could advance knowledge about how different amalgamations of social characteristics interact to affect land management and outcomes.

6. Conclusion

Based on a survey across six metropolitan regions of the U.S., we found that many residents plan to change their yards to provide habitat for birds, pollinators, and other wildlife. These individuals tend to view gardening as a hobby and specifically manage their yards to attract and support wildlife. In contrast, their counterparts—people who are unlikely to adopt wildlife-supporting yard features—emphasize low-maintenance yards as a significant landscape priority and aim to deter wildlife from their neighborhood. Additionally, since the presence of local institutions increased the likelihood of managing yards for wildlife in our study, local organizations such as homeowner or neighborhood associations may be effective avenues for programs aimed at expanding wildlife habitat in residential settings.

Furthermore, we suggest that conservation efforts to enhance habitat in residential areas promote low-maintenance, native vegetation, including but not limited to trees. Promoting vegetation that provides habitat for native birds, pollinators, and other wildlife while also being visually appealing to residents is critically important as well, since the aesthetic appeal of landscapes is a primary motivation for yard management. Yet since heterogenous populations have different priorities, we recommend strategic approaches tailored to heterogenous people and places. Lastly, leveraging the power of social institutions—especially through community partnerships that empower residents and reinforce norms—will likely be effective in expanding wildlife gardening in residential neighborhoods and beyond.

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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.2022.104396.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.
Akinnifesi, F. K., Sileshi, G. W., Ajayi, O. C., Akinnifesi, A. I., de Moura, E. G., Linhares, J. F. P., & Rodrigues, I. (2010). Biodiversity of the urban home gardens of São Luís city, Northeastern Brazil. *Urban Ecosystems, 13*, 129–146.
Anderson, A. G., Messer, I., & Langellotto, G. A. (2021). Gardeners' perceptions of northwestern US native plants are influenced by ecological information and garden group affiliation. *HortTechnology, 1*(aop), 1–14.
Baisden, E. C., Tallamy, D. W., Narango, D. L., & Boyle, E. (2018). Do cultivars of native plants support insect herbivores? *HortTechnology, 28*(5), 596–606.
Belaire, J. A., Whelan, C. J., & Minor, E. S. (2014). Having our yards and sharing them too: The collective effects of yards on native bird species in an urban landscape. *Ecological Applications, 24*(8), 2132–2143.
Berthon, K., Thomas, F., & Bekessy, S. (2021). The role of 'nativeness' in urban greening to support animal biodiversity. *Landscape and Urban Planning, 205*, Article 103959.
Bormann, F. H., Balmori, D., Geballe, G. T., & Geballe, G. T. (2001). *Redesigning the American lawn: A search for environmental harmony*. Yale University Press.
Braun, R. C., Patton, A. J., Watkins, E., Koch, P., Anderson, N. P., Bonos, S. A., & Brilman, L. A. (2020). Fine fescues: A review of the species, their improvement, production, establishment, and management. *Crop Science, 60*, 1142–1187.
Carmines, E. G., & Zeller, R. A. (1979). *Reliability and Validity Assessment*. Sage Publications.
Coetzee, A., Barnard, P., & Pauw, A. (2018). Urban nectarivorous bird communities in Cape Town, South Africa, are structured by ecological generalisation and resource distribution. *Journal of Avian Biology, 49*, jav-01526.
Collins, M. K., Magle, S. B., & Gallo, T. (2021). Global trends in urban wildlife ecology and conservation. *Biological Conservation, 261*, Article 109236.
Conway, T. M. (2016). Tending their urban forest: Residents' motivations for tree planting and removal. *Urban Forestry and Urban Greening, 17*, 23–32.
Cook, E. M., Hall, S. J., & Larson, K. L. (2012). Residential landscapes as social-ecological systems: A synthesis of multi-scalar interactions between people and their home environment. *Urban Ecosystems, 15*(1), 19–52.
DeStefano, S., & DeGraaf, R. M. (2003). Exploring the ecology of suburban wildlife. *Frontiers in Ecology and the Environment, 1*(2), 95–101.
Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. John Wiley & Sons.
Fernández-Cañero, R., Ordovás, J., & Machuca, M.Á. H. (2011). Domestic gardens as water-wise landscapes: A case study in southwestern Europe. *HortTechnology, 21*(5), 616–623.
Fetridge, E. D., Ascher, J. S., & Langellotto, G. A. (2008). The bee fauna of residential gardens in a suburb of New York City (Hymenoptera: Apoidea). *Annals of the Entomological Society of America, 101*(6), 1067–1077.
Fraser, J. C., Bazuin, J. T., Band, L. E., & Grove, J. M. (2013). Covenants, cohesion, and community: The effects of neighborhood governance on lawn fertilization. *Landscape and Urban Planning, 115*, 30–38.
Fraser, J., Bazuin, J. T., & Hornberger, G. (2016). The privatization of neighborhood governance and the production of urban space. *Environment and Planning A, 48*(5), 844–870.
Frisk, E., & Larson, K. L. (2011). Educating for sustainability: Competencies & practices for transformative action. *Journal of Sustainability Education, 2*(1), 1–20.
Gaston, K. J., Fuller, R. A., Loram, A., MacDonald, C., Power, S., & Dempsey, N. (2007). Urban domestic gardens (XI): Variation in urban wildlife gardening in the United Kingdom. *Biodiversity and Conservation, 16*(11), 3227–3238.
Gillis, A. J., & Swim, J. K. (2020). Adding native plants to home landscapes: The roles of attitudes, social norms, and situational strength. *Journal of Environmental Psychology, 72*, Article 101519.
Goddard, M. A., Dougill, A. J., & Benton, T. G. (2013). Why garden for wildlife? Social and ecological drivers, motivations and barriers for biodiversity management in residential landscapes. *Ecological Economics, 86*, 258–273.
Goddard, M. A., Ikin, K., & Lerman, S. B. (2017). Ecological and social factors determining the diversity of birds in residential yards and gardens. In *Ecology and Conservation of Birds in Urban Environments* (pp. 371–397). Springer.
Grove, J. M., Troy, A. R., O'Neil-Dunne, J. P. M., Burch, W. R., Cadenasso, M. L., & Pickett, S. T. A. (2006). Characterization of households and its implications for the vegetation of urban ecosystems. *Ecosystems, 9*, 578–597.
Head, L., & Muir, P. (2007). Changing cultures of water in eastern Australian backyard gardens. *Social and Cultural Geography, 8*(6), 889–905.
Helfand, G. E., Park, J. S., Nassauer, J. I., & Kosek, S. (2006). The economics of native plants in residential landscape designs. *Landscape and Urban Planning, 78*(3), 229–240.
Hobbs, S. J., & White, P. C. (2016). Achieving positive social outcomes through participatory urban wildlife conservation projects. *Wildlife Research, 42*(7), 607–617.
Jaganmohan, M., Vailshery, L., & Nagendra, H. (2013). Patterns of insect abundance and distribution in urban domestic gardens in Bangalore, India. *Diversity, 5*, 767–778.
Jones, M. S., & Niemiec, R. M. (2020). Social-psychological correlates of personal-sphere and diffusion behavior for wildscape gardening. *Journal of Environmental Management, 276*, Article 111271.
Jones, M. S., Teel, T. L., Solomon, J., & Weiss, J. (2021). Evolving systems of pro-environmental behavior among wildscape gardeners. *Landscape and Urban Planning, 207*, Article 104018.
Kendal, D., Williams, K. J., & Williams, N. S. (2012). Plant traits link people's plant preferences to the composition of their gardens. *Landscape and Urban Planning, 105*(1–2), 34–42.
Kim, J.-O., Ahtola, O., Spector, P. E., & Mueller, C. W. (1978). *Introduction to Factor Analysis: What it is and how to do it*. Sage Publications.
Lane, I., Watkins, E., & Spivak, M. (2019). Turfgrass species affect the establishment and bloom of Kura clover (*Trifolium ambiguum)* in lawns. *Hortscience, 54*(5), 824–828.
Larsen, L., & Harlan, S. L. (2006). Desert dreamscapes: Residential landscape preference and behavior. *Landscape and Urban Planning, 78*(1–2), 85–100.
Larson, K. L., Andrade, R., Nelson, K. C., Wheeler, M. M., Engebreston, J. M., Hall, S. J., … Heffernan, J. B. (2020). Municipal regulation of residential landscapes across US cities: Patterns and implications for landscape sustainability. *Journal of Environmental Management, 275*, Article 111132.
Larson, K. L., & Brumand, J. (2014). Paradoxes in landscape management and water conservation: Examining neighborhood norms and institutional forces. *Cities and the Environment, 7*(1), 6.
Larson, K. L., Casagrande, D., Harlan, S. L., & Yabiku, S. T. (2009). Residents' yard choices and rationales in a desert city: Social priorities, ecological impacts, and decision tradeoffs. *Environmental Management, 44*(5), 921–937.
Larson, K. L., Nelson, K. C., Samples, S. R., Hall, S. J., Bettez, N., Cavender-Bares, J., … Hobbie, S. E. (2016). Ecosystem services in managing residential landscapes: Priorities, value dimensions, and cross-regional patterns. *Urban Ecosystems, 19*(1), 95–113.
Lauren, N., Smith, L. D., Louis, W. R., & Dean, A. J. (2019). Promoting spillover: How past behaviors increase environmental intentions by cueing self-perceptions. *Environment and Behavior, 51*(3), 235–258.
Lerman, S. B., Contosta, A. R., Milam, J., & Bang, C. (2018). To mow or to mow less: Lawn mowing frequency affects bee abundance and diversity in suburban yards. *Biological Conservation, 221*, 160–174.
Lerman, S. B., Narango, D. L., Avolio, M. L., Bratt, A. R., Engebreston, J. M., Groffman, P. M., … Trammell, T. L. E. (2021). Residential yard management and landscape cover affect urban bird community diversity across the continental US. *Ecological Applications, 31*(8), Article e01455.
Lerman, S. B., Turner, V. K., & Bang, C. (2012). Homeowner associations as a vehicle for promoting native urban biodiversity. *Ecology and Society, 17*(4).
Lerman, S. B., & Warren, P. S. (2011). The conservation value of residential yards: Linking birds and people. *Ecological Applications, 21*(4), 1327–1339.
Mansfield, E. R., & Helms, B. P. (1982). Detecting multicollinearity. *The American Statistician, 36*(3a), 158–160.
McKenzie-Mohr, D. (2011). *Fostering Sustainable Behavior: An Introduction to Community-based Social Marketing*. New Society Publishers.
Mumaw, L. (2017). Transforming urban gardeners into land stewards. *Journal of Environmental Psychology, 52*, 92–103.
Mumaw, L. M., Maller, C., & Bekessy, S. (2019). Assessing and strengthening community capacity building in urban biodiversity conservation programs. *Cities and the Environment (CATE), 12*(2), 4.
Narango, D. L., Tallamy, D. W., & Marra, P. P. (2017). Native plants improve breeding and foraging habitat for an insectivorous bird. *Biological Conservation, 213*, 42–50.
Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design. *Landscape and Urban Planning, 92*(3–4), 282–292.
Nilon, C. H., Aronson, M. F., Cilliers, S. S., Dobbs, C., Frazee, L. J., Goddard, M. A., … Werner, P. (2017). Planning for the future of urban biodiversity: A global review of city-scale initiatives. *BioScience, 67*(4), 332–342.
Padullés Cubino, J. P., Avolio, M. L., Wheeler, M. M., Larson, K. L., Hobbie, S. E., Cavender-Bares, J., … Neill, C. (2020). Linking yard plant diversity to homeowners' landscaping priorities across the US. *Landscape and Urban Planning, 196*, Article 103730.
Polsky, C., Grove, J. M., Knudson, C., Groffman, P. M., Bettez, N., Cavender-Bares, J., … Larson, K. L. (2014). Assessing the homogenization of urban land management with an application to US residential lawn care. *Proceedings of the National Academy of Sciences, 111*(12), 4432–4437.
Robbins, P. (2007). *Lawn People: How Grasses, Weeds, and Chemicals Make Us Who We Are*. Temple University Press.
Schmitt, L., & Burghardt, K. T. (2021). Urbanization as a disrupter and facilitator of insect herbivore behaviors and life cycles. *Current Opinion in Insect Science*. https://doi.org/10.1016/j.cois.2021.02.016
Shackleton, C. M., Blair, A., De Lacy, P., Kaoma, H., Mugwagwa, N., Dalu, M. T., & Walton, W. (2018). How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. *Landscape and Urban Planning, 180*, 273–281.

Shaw, A., Miller, K., & Wescott, G. (2013). Wildlife gardening and connectedness to nature: Engaging the unengaged. *Environmental Values, 22*(4), 483–502.
Sisser, J., Nelson, K. C., Larson, K. L., Ogden, L. A., Polsky, C., & Chowdhury, R. R. (2016). Lawn enforcement: How municipal policies and neighborhood norms influence homeowner residential landscape management. *Landscape and Urban Planning, 150*, 16–25.
Spector, P. E. (1992). *Summated Rating Scale Construction: An Introduction*. Sage Publications.
Stacy, J., Ryan, R.L., Roy, A.H., & Milman, A. (n.d.). Homeowners' willingness to adopt environmentally beneficial landscape practices in an urbanizing watershed. *Cities and the Environment*, 14(1), 2.
Threlfall, C. G., Walker, K., Williams, N. S., Hahs, A. K., Mata, L., Stork, N., & Livesley, S. J. (2015). The conservation value of urban green space habitats for Australian native bee communities. *Biological Conservation, 187*, 240–248.
Troy, A. R., Grove, J. M., O'Neil-Dunne, J. P., Pickett, S. T., & Cadenasso, M. L. (2007). Predicting opportunities for greening and patterns of vegetation on private urban lands. *Environmental Management, 40*(3), 394–412.
Turner, V. K., & Stiller, M. (2020). How do Homeowners Associations regulate residential landscapes? An analysis of rule structure and content in Maricopa County (AZ). *Journal of the American Planning Association, 86*(1), 25–38.
van Heezik, Y. M., Dickinson, K. J., & Freeman, C. (2012). Closing the gap: Communicating to change gardening practices in support of native biodiversity in urban private gardens. *Ecology and Society, 17*(1).
Wheeler, M. M., Larson, K. L., & Andrade, R. (2020). Attitudinal and structural drivers of preferred versus actual residential landscapes in a desert city. *Urban Ecosystems, 23*(3), 659–673.
Widows, S. A., & Drake, D. (2014). Evaluating the National Wildlife Federation's Certified Wildlife Habitat™ program. *Landscape and Urban Planning, 129*, 32–43.
Yabiku, S. T., Casagrande, D. G., & Farley-Metzger, E. (2008). Preferences for landscape choice in a Southwestern desert city. *Environment and Behavior, 40*(3), 382–400.