Sustainable Cities and Society 5 (2012) 70–76

Contents lists available at SciVerse ScienceDirect

Sustainable Cities and Society

journal homepage: www.elsevier.com/locate/scs

Predicting native plant landscaping preferences in urban areas

M. Nils Peterson[a,*], Brandi Thurmond[b], Melissa Mchale[c], Shari Rodriguez[a], Howard D. Bondell[d], Merril Cook[a]

[a] Department of Forestry and Environmental Resources, Fisheries, Wildlife, and Conservation Biology Program, North Carolina State University, Raleigh, NC 27695-7646, USA
[b] Department of Mathematics, Science, and Technology Education, North Carolina State University, Raleigh, NC 27695-7646, USA
[c] Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695, USA
[d] Department of Statistics, North Carolina State University, Raleigh, NC 27695, USA

ARTICLE INFO

Keywords:
Biodiversity
Ecosystem services
Ethnicity
Landscape design
Native plant garden
Norms

ABSTRACT

The rapidly growing physical footprint of cities makes understanding residential landscaping preferences increasingly important for water quality, biodiversity conservation, and addressing climate change. In this paper we answer four interrelated questions about residential landscaping preferences with a case study in Raleigh, NC: (1) How are residents' landscaping preferences influenced by what residents believe their neighbors prefer? (2) Do residents accurately assess their neighbors' landscaping preferences? (3) How does ethnicity influence landscaping preferences? and (4) Do the socio-demographic and neighborhood norm based correlates of landscaping preferences persist when both are accounted for in multivariate models? Respondents ($n = 179$) in this study preferred a 50% native plant garden design over 100% turf grass or the 75% and 100% native plant garden designs, and inaccurately assumed that their neighbors preferred turf over the native plant garden based landscaping designs. These results suggest that correcting erroneous assumptions about neighborhood preferences may alleviate normative pressure against adopting alternatives to turf grass landscaping. Although landscaping choices were best predicted by what residents perceived their neighbors preferred, ethnicity, income, and home ownership were also related to landscape preferences. African American ethnicity and income were positively related to preference for turf grass coverage. Environmental justice concerns linked to urban vegetation should be considered in light of the finding that African Americans appeared to prefer turf grass dominated landscaping. Results from this study indicate that middle income neighborhoods with high levels of home ownership may prove most receptive to initiatives aimed at increasing the use of more sustainable landscaping.

1. Introduction

The rapidly growing physical footprint of cities makes home landscaping a growing concern with respect to water and soil quality, loss of biodiversity, and climate change. Urbanization can contribute to sustainability when cities are densely populated (Jacob & Lopez, 2009), but urbanization in the United States, and other developed nations, has recently been characterized by sprawling suburban neighborhoods (Owen, 2009). Because private residents own and make management decisions for major portions of the urban land area, their decisions will drive efforts to design more sustainable urban landscapes (Breuste, 2004; Grimm et al., 2008). Further, private landowners may influence vegetation cover on public lands near their homes, making residential preferences for landscape design a central theme in managing sustainable urban ecosystems (Zhou, Troy, Morgan, & Jenkins, 2009). Turf grasses are often a desired landscape feature (Robbins & Birkenholtz, 2003) constituting more than 16,380,000 ha in the United States, an area three times larger than that dedicated to corn (Milesi et al., 2005). Furthermore, that area is expanding annually, with 23% of new urban land area (675,000 ha per year) dedicated to turf grass lawns (Robbins & Sharp, 2008).

The production of turf grass significantly impacts urban biogeochemical cycling and the global carbon cycle (Kaye, Groffman, Grimm, Baker, & Pouyat, 2006; Milesi et al., 2005). Maintenance of this landscape design contributes to environmental degradation through use of chemicals, including fertilizers, pesticides, and herbicides, which degrade water and soil quality; increased lawn mower usage, which contributes to increased carbon dioxide emissions linked to global climate change; and irrigation, which threatens limited water supplies (Bijoor, Czimczik, Pataki, & Billings, 2008; Zhou et al., 2009). Further, turf grass dominated landscapes tend to be relatively sterile in terms of wildlife habitat as they lack vertical and horizontal structure and the native plant species required for food, cover and reproduction (Adams & Lindsey, 2010).

* Corresponding author. Tel.: +1 919 515 7588.
E-mail address: nils_peterson@ncsu.edu (M.N. Peterson).

2210-6707/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.scs.2012.05.007

Ecologically friendly alternatives to turf grass dominated landscape designs can promote a number of ecosystem functions simultaneously, including moderating urban microclimates, sequestering carbon, reducing air and water pollution, and providing habitats for birds and urban wildlife (Grove, Troy, et al., 2006; Helfand, Sik Park, Nassauer, & Kosek, 2006; Martin, Peterson, & Stabler, 2003; Troy, Grove, O'Neil-Dunne, Pickett, & Cadenasso, 2007). Native plant gardens are one example of an ecologically friendly landscape design that can provide these services. The conversion of turf grass to native plant garden may reduce the use of chemicals, energy, and water (Nassauer, Wang, & Dayrell, 2009).

Although little research has addressed how native plant labeling influences residential landscaping preferences, several studies have investigated relationships between residential landscaping preferences and socio-economic status of residents. One study has addressed the value associated with the "native plant" label, and suggests willingness to pay for landscaping plants increases when the plants are labeled native and decreases when the plants are labeled as invasive (Yue, Hurley, & Anderson, 2010). Martin, Warren, and Kinzig (2004) identified a positive correlation between vegetation richness and socio-economic status. Larsen and Harlan (2006) found lower income homeowners preferred lawn landscapes, middle income homeowners preferred native desert landscapes, and higher income homeowners preferred "oasis" landscapes. Several other studies have found education was positively related with preferences for natural landscapes (Buijs, Elands, & Langers, 2009). Kirkpatrick, Daniels, and Zagorski (2007) found individuals with higher education levels implemented more complex native plant gardens than those with lower education levels.

Landry and Chakraborty (2009) extended this research by exploring differences in tree cover in relation to ethnicity. They found a significantly lower proportion of tree cover on public rights-of-way in Tampa, FL, USA neighborhoods containing a higher proportion of African Americans and low income residents. This study raises environmental justice concerns, particularly if minorities and lower income communities do not have access to areas with vegetation cover needed to provide important ecosystem services. African Americans may, however, prefer less rural looking landscapes dominated by turf grass. Caucasians often have more favorable attitudes toward wildlife, wilderness, and natural landscapes than African Americans (Floyd, Shinew, McGuire, & Noe, 1994; Kaplan & Talbot, 1988; Sasidharan, 2002; Van Velsor & Nilon, 2006; Virden & Walker, 1999; Zube & Pitt, 1981). Although these studies have focused on parks and natural areas, it seems reasonable that preferences for open landscapes among African Americans may translate into preferences for front yard landscaping with low horizontal and vertical complexity typified by turf grass.

Another body of research suggests neighborhood level norms shape landscaping preferences, at least in part, independently from socio-demographic differences among residents (Zmyslony & Gagnon, 1998). Nassauer et al. (2009) conducted a computer aided simulation study of suburban MI, USA residents which suggested the existing landscaping in a hypothetical neighborhood predicted personal preferences for landscaping better than broad cultural norms. If a hypothetical neighborhood was dominated by landscaping that included large areas of native plant gardens, preferences for conventional turf grass landscaping were replaced by preferences for designs including 75% native plant gardens. Grove, Cadenasso, et al. (2006) and Grove, Troy, et al. (2006) added the possibility that neighborhood level lifestyle differences predicted vegetation cover on private lands and public rights-of-way better than historical trends in population density or socio-economic stratification. These findings suggest advocacy efforts intended to promote increased use of native plants in landscaping must focus to some degree on neighborhoods and not just individuals.

Current research on residential preferences for turf grass landscaping and innovative alternatives with higher vertical and horizontal complexity raises several questions: (1) How are residents' landscaping preferences influenced by what residents believe their neighbors prefer? (2) Do residents accurately assess their neighbors' landscaping preferences? (3) How does ethnicity influence landscaping preferences? and (4) Do the socio-demographic and neighborhood norm based correlates of landscaping preferences persist when both are accounted for in multivariate models? Answering the first and second questions allow us to conduct the first assessment of how personal preferences for landscaping may be swayed by assumptions, false or otherwise, about neighbors' preferences. By addressing the third question, this paper sheds light on potential environmental justice issues associated with the recently documented ethnically related inequities in distribution of urban environmental amenities (e.g., trees, wildlife, green space; Landry & Chakraborty, 2009). Finally, a multivariate approach allows us to determine if each variable predicts unique variance in preferences for landscaping.

We began answering these questions with a case study in Raleigh, NC, USA. Raleigh, serves as a good place for assessing factors influencing residents' front yard landscaping preferences because the region is the third fastest sprawling metropolitan region in the USA, following Greensboro, NC and Riverside, CA (Ewing, Pendall, & Chen, 2011). Sprawl centers are critical areas for understanding landscaping preferences because sprawl regions have rapid population growth, bring larger than average geographic areas into household landscaping per capita, and typify new development patterns. We tested four hypotheses related to residential landscaping preferences: (1) landscaping preferences are predicted by perceptions of neighbor's landscaping preferences, (2) the perceptions about neighbor's preferences are false, (3) African Americans prefer turf grass landscaping more than Caucasians, and (4) socio-economic status is negatively correlated with turf grass landscaping.

2. Methods

We used a stratified sampling approach based on PRIZM classifications to increase the odds of generating socio-economic diversity within our sample. The PRIZM classifications are marketing tools that classify census block groups using a two stage process: (1) clustering neighborhoods based on social rank (e.g., income, education), household data (e.g., life stage, size), mobility, ethnicity, urbanization, and housing (e.g., home value, ownership), and (2) associating clusters with data from market surveys and purchasing records (Grove, Troy, et al., 2006). We chose to sample from PRIZM 12 (primarily Caucasian, middle aged, and high tech online purchasing) and PRIZM 62 (mixed ethnicity, older, order items by mail) classifications because they represented the lifestyle groups in sprawling urbanized areas with both ethnic diversity and relatively high levels of home ownership, and occurred in Raleigh, NC. Accordingly, these groups allowed us to test hypotheses about homeowner's landscaping preferences and the role of socio-economic status and ethnicity, whereas other groups did not.

We used a random number generator to select four census blocks (two classified as PRIZM 12 and two classified as PRIZM 62). There were 120 blocks to sample from in the 7 PRIZM 12 block groups, and 44 blocks to sample from in the PRIZM 62 block group in Raleigh. Homes in the PRIZM 12 blocks averaged 58 years old with construction dates ranging from 1923 to 2008. Homes in the PRIZM 62 blocks averaged 30 years old with construction dates ranging from 1930 to 2007. All four blocks sampled in the study were within Raleigh's inner beltline formed by the highway US 440.

Fig. 1. Four alternative front yard designs ranging from 0% native plant garden ground cover to 100% native plant garden ground cover.

We used Hawth's Analysis Tools for ArcGIS, to generate samples of random addresses within each block group. The Census Blocks for PRIZM 12 had 491 addresses. We selected 100 of those for the sample, and 11 of the 100 were either PO boxes or not residences, leaving 89 as the sample for PRIZM 12. The Census Blocks for PRIZM 62 had 457 addresses. We selected 100 of those for the sample, and 10 of the 100 were either PO boxes or not residences, leaving 90 as the sample for PRIZM 12.

The survey was administered door-to-door from February to March 2010. Interviewers (graduate or senior level undergraduate student workers) attempted to make contact at each address three times, including evenings and weekends. After the third attempt interviewers moved to the next proximate address that was not already part of the sample frame. Of the original sample, 72 respondents (40% response rate) were contacted during the three interview attempts and the remaining 107 were from proximate addresses. Compliance rate among respondents who answered the door was 100%. The survey included questions to gather demographic information, including whether or not residents owned the property on which they lived, highest level of education completed, ethnicity, total household income in 2009 before taxes, and gender.

Residents were asked to examine four photos of front yards depicting 0%, 50%, 75%, and 100% of the landscape covered by native plant gardens (Fig. 1). The photos shown on the survey were adapted from Nassauer et al. (2009). Each photo included a caption stating the percent of the yard covered by native plant gardens (Fig. 1). This method of presenting the landscaping tested respondent preferences for both the label "native plant garden" and the differing levels of vertical and horizontal complexity in the photos. The four photos were printed in gray scale on one plain 8.5 by 11 in. piece of paper so that all four front yard designs were visible to respondents simultaneously. Since previous research suggests color influences preferences (Nassauer, 1983) black and white photos were used to avoid confounding the effects of color and percentage cover for the native plant garden.

Residential preferences for front yard designs were assessed by having residents examine the photos while answering questions about their yard preferences and the perceived opposition or support they believed they would receive from neighbors if they chose to install the landscaping in the pictures. Residents were first asked to imagine that they had the opportunity to install a new front yard and indicate on a scale of 1–7, with 1 being strongly do not prefer and 7 being strongly prefer, how much they would or would not prefer each of the four yard designs depicted in the photos. Then residents were asked how much they thought their neighbors would support or oppose their plans to install each of the four yard designs, using a scale from 1 to 7, with 1 being strongly oppose and 7 being strongly support.

To further examine the effects of the socio-economic variables on preference for native plant gardens versus turf grass, we first converted each respondent's ratings into an overall score that quantified their preference toward native plant garden coverage. We also repeated the same procedure for the perception of neighbor's support. Creating a score for each respondent was done by first ranking each of the four levels of native plant garden coverage (0%, 50%, 75%, and 100%) from favorite to least favorite based on the respondent's preference. The favorite design was given 4 points, next favorite 3 points, and so on down to 1 point for the least favorite (when ties occurred the ranks were averaged). To create the score for the preference of the respondent, the coverage (0, .5, and .75, 1) was then multiplied by the points for that design and then totaled. This resulted in a score between 4 and 7.25, where a lower score indicates the respondent tended to favor less native plant garden coverage.

We used SPSS 19.0 for all analyses. In addition to calculating descriptive statistics, we compared preferences for each landscape

Table 1
Comparison of mean resident preferences and perceptions of neighbor's support for four landscaping designs. Group comparisons made using Wilcoxon Signed Rank test where all group differences were highly significant ($p < .001$) and other comparisons had high overlap.

Percent native plant garden	Mean preference	Percent of respondents ranking each landscaping design in each category from 1 = strongly do not prefer to 7 = strongly prefer						
		1	2	3	4	5	6	7
0	**4.08 (B)**	28.1	6.7	6.1	11.7	11.7	6.1	29.2
50	5.11 (A)	4.5	5.1	6.7	15.7	21.9	19.9	27
75	3.66 (C)	18.1	15.8	16.9	13.6	13.6	10.7	11.3
100	2.82 (D)	45	11.9	11.4	5.7	7.4	4.5	13.1
Percent native plant garden	Mean perceptions of neighbor's support	Percent of respondents ranking their neighbor's support for each landscaping design in each category from 1 = strongly oppose to 7 = strongly support						
		1	2	3	4	5	6	7
0	**5.09 (A)**	5.6	5.1	4	29.4	7.3	13	35.6
50	5.24 (A)	1.1	1.7	3.9	27.5	20.2	21.9	23.6
75	3.73 (B)	9.6	9	20.3	37.9	12.4	4	6.8
100	2.94 (C)	31.5	18.5	12.4	20.8	5.1	2.8	9

Bolded text indicates significant differences between individual preferences and perceptions of neighbors' support for a given landscape design.

design using pairwise Wilcoxon Signed Rank tests. We used linear regression to model the preference score for native plant garden coverage as the response variable. Because PRIZM was correlated with ethnicity and they could not be used in the same model, we used an information theoretic approach to model selection to determine if the data provided more evidence for a model with PRIZM group or a model with ethnicity (Burnham & Anderson, 2002). Specifically, we used Akaike's information criterion corrected for small sample size (AIC_c) to compare two regression models for predicting preference for native plant garden coverage. One model included perceptions of neighbor's support, education level, income, home ownership, and ethnicity as independent variables, and the other was identical with the exception of replacing ethnicity with PRIZM group. We also calculated Akaike weights (w_i) for each model, where w_i equals the probability that the ith model is the best approximating model among those considered. Income data were transformed by taking the midpoint of residents' selected income bracket (in thousands) and then taking the natural log of that number. The transformation was required to meet normality assumptions for linear regression. Respondents who did not self-identify as African American or Caucasian (6%) were omitted from the regression models.

3. Results

In total, 179 residents participated in the study. The sample was 47% female, 56% Caucasian, and 38% African American. Residents had a median household income of $37,500 USD, with 19% having a high school diploma or GED, 4% a vocational, technical, or trade school certificate, 14% having some college work, 35% an undergraduate degree, and 24% a graduate degree. The 50% native plant garden design was the most preferred landscaping design among residents and this design was significantly preferred over all others (p-value < .0001 from each of the pairwise Wilcoxon tests, Table 1). The samples from PRIZM 12 and 62 were demographically similar in terms of home ownership rates (PRIZM 12 = 61%, PRIZM 62 = 55%), income levels (median category = $37,500), gender (PRIZM 12 = 43% female, PRIZM 62 = 53% female), but PRIZM 62 had a higher percentage of African Americans (93%) than PRIZM 12 (15%). The probability that the model including ethnicity was the best approximating model (i.e., better than the model including PRIZM group) was > 99.9% ($w_i > .999$), so the remaining results refer to the model including ethnicity and not PRIZM group (Table 2).

Our results provide support for the first three hypotheses in the study. Holding all other variables constant, perceptions of neighbor's support was positively correlated with residents' preference for native plant garden coverage (Table 2), and residents overestimated their neighbors' support for the 0% native plant garden design (p-value < .001 from the Wilcoxon test, Table 1). Respondent's assumptions about their neighbor's support for 50%, 75%, and 100% native plant garden designs more accurately reflected neighborhood preferences than assumptions about the 0% native plant garden design (Table 1). Being African American was negatively related with residents' preference for native plant garden coverage (Table 2).

Analysis of how respondents ranked the different landscape designs, suggests the 100% native plant garden design did not elicit distinctions between ethnic groups or between homeowners and renters (Table 3). African Americans ranked the 0% native plant garden first more than twice as often as the 50% native plant garden design, and ranked it first more than 5 times as often as the 75% and 100% native plant garden designs. Caucasian preferences were less distinct, but the 50% native plant garden design was ranked first most often and the 0% native plant garden design was ranked first least often. Ranking distinctions among home owners and renters primarily occurred for the 0% native plant garden design which renters tended to rank higher than home owners (Table 3). Finally, our results may counter hypothesis 4 because we did not detect an effect associated with education level, and income was negatively related with residents' preference for native plant coverage in the landscape designs (Table 2).

4. Discussion

The findings from this study support the hypothesis that resident's landscaping preferences are influenced by assumptions about neighborhood norms, and suggest residents erroneously assume their neighbors prefer turf grass dominated landscaping over designs with more vertical and horizontal complexity. These findings are consistent with previous research suggesting residents' preferences are swayed toward landscaping designs prevalent in their neighborhoods (Nassauer et al., 2009), and add to it by suggesting residents assume prevalent landscaping designs are preferred landscaping designs even when that is not the case. Our respondents' preference for a 50% native plant garden design over a 0% native plant garden design persisted despite residents mistakenly believing their neighbors liked the 0% native plant garden design equally well. Further, adding the native plant label (this study) to the same landscaping designs depicted in previous research without the label (Nassauer et al., 2009) appeared to have positive impacts on homeowner preference for the landscaping. Although limited research on how residents view the native plant

Table 2
Linear regression results for predicting residents' preference for native plant garden landscaping.

B (standardized B)						Intercept	R^2 (adjusted R^2)	AIC_c	w_i
Neighbor's support[a]	Income[b]	Ownership[c]	Education[d]	Ethnicity[e]	PRIZM[f]				
.51(.40)***	−.27(−.18)*	.40(.16)*	−.003(−.005)	−.947(−.384)***	NA	3.95***	.39(.37)	.488	.999
.52(.41)***	−.29(−.19)*	.46(.19)*	.04(.08)	NA	−.61(−.25)***	3.66***	.34(.32)	14.205	.001

[a] Perceived neighbor's support (4 = lowest preference for native plant garden landscaping, 7.25 = highest preference for native plant garden landscaping).
[b] Income (in thousands) after taking midpoint, and transformation by natural log.
[c] Ownership (0 = non-owner, 1 = owner).
[d] Education (1 = high school/GED, 2 = vocational/technical/trade school certificate, 3 = some college course work, 4 = undergraduate degree, and 5 = graduate degree).
[e] Ethnicity (0 = Caucasian, 1 = African American).
[f] PRIZM group (0 = 12, 1 = 62).
* $p < .05$.
** $p < .01$.
*** $p < .001$

Table 3
Native plant garden design ranking comparisons based on ethnicity and home ownership.

Ranking of landscape designs	Ethnicity		Home ownership	
	African American ($n = 65$)	Caucasian ($n = 99$)	Owner ($n = 102$)	Renter ($n = 75$)
0% native plant garden	$\chi^2 = 54.98$***		$\chi^2 = 9.83$*	
1st	45	13	28	37
2nd	8	30	27	14
3rd	6	18	14	10
4th	6	38	33	14
50% native plant garden	$\chi^2 = 30.28$***		$\chi^2 = 1.48$	
1st	21	51	48	30
2nd	42	24	37	34
3rd	2	24	17	11
4th	0	0	0	0
75% native plant garden	$\chi^2 = 29.83$***		$\chi^2 = 3.85$	
1st	6	28	22	14
2nd	10	39	34	18
3rd	48	32	46	42
4th	1	0	0	1
100% native plant garden	$\chi^2 = 7.17$		$\chi^2 = 5.71$	
1st	8	19	19	11
2nd	4	17	14	9
3rd	22	29	37	18
4th	31	33	32	36

* $p < .05$
** $p < .01$
*** $p < .001$

label suggests it may have positive connotations (this study; Yue et al., 2010), future research should address the extent native plant labeling carries negative connotations such as messiness.

Incorrect assumptions about neighborhood landscaping preferences among residents may be explained by norm theory. Because turf grass was a dominant part of the landscape in our study area, descriptive norms, indicated by what people do (Cialdini, Kallgren, & Reno, 1991), strongly suggested neighborhood preferences for turf grass. Descriptive norms become stronger as a greater number or proportion of people engage in the behavior (Cialdini et al., 1991), so descriptive norms supporting turf grass landscaping should be strong in many urban areas. Strong descriptive norms supported by dominance of turf grass landscaping may contribute to unfounded subjective norms, perceived social pressures to behave in certain ways (Cialdini & Trost, 1998; Fishbein & Ajzen, 1975). In this study descriptive norms generated by prevalence of turf grass may have created unfounded subjective norms suggesting neighbors prefer turf grass over the more vertically and horizontally complex landscaping depicted in the native plant gardens.

The preference for at least 50% turf grass highlights the critical importance of broad descriptive norms supporting turf lawns. Cues to care are landscaping elements that demonstrate a home owner is controlling a landscape. They are typified by an element of mown turf, colorful flowers, borders, or canopy trees, and improve perceptions of landscaping by suggesting social order, influence of labor, and respect for nature (Jorgensen, Hitchmough, & Dunnett, 2007; Kaplan & Austin, 2004; Nassauer et al., 2009; Todorova, Asakawa, & Aikoh, 2004). Despite the apparent multicultural value placed on mown turf, as a cue to care, we found that losing the turf entirely (i.e., moving from 75% to 100% native plant garden landscaping) had a small impact on residents' preferences relative to losing turf as a dominant component of the landscaping (i.e., moving from 50% to 75% native plant garden landscaping). Differences in mean preference between the 50% and 75% native plant garden designs were nearly double the difference in mean preference for the 75% and 100% native plant garden designs despite the 100% native plant garden design lacking a mown strip of turf. These findings suggest cues to care shaped preference less than simply having a dominant component ($\geq$50%) of turf grass.

African Americans preferred turf grass more than Caucasians even after controlling for neighborhood norms, education, income, and home ownership. Because this study was the first to identify the relationship, no published research has attempted to explain the causal mechanisms involved. Research in other contexts does provide potential explanations that could be tested in future research. Landry and Chakraborty (2009) found neighborhoods containing a higher proportion of African Americans had fewer street trees in public rights-of-way. These findings may suggest turf grass is seen as an alternative to total neglect. Such a relationship may explain why African Americans showed distinct

preferences for the 100% turf grass landscape design. Differences between African American and Caucasian preferences for turf grass landscaping may also be explained by different childhood experiences. Van Velsor and Nilon (2006) suggested urban backgrounds, threatening experiences with wildlife, and shared messages of anxiety in association with wildlife may explain ethnic differences in connections with wildlife. Similar formative experiences may shape African American perspectives toward landscaping with high vertical and horizontal complexity typified by the native plant garden designs presented in this study. Although our respondents lived in urban neighborhoods, Caucasians may have had more rural backgrounds or had more family members living in rural environments where landscapes are less controlled, less ordered, and less dominated by turf grass. This explanation seems reasonable given African Americans constitute over 20% of the population in primary cities within the USA, but less than 10% in exurbs where Caucasians make up more than 80% of the population (Frey, 2010). Another suite of hypotheses for explaining ethnic differences in preferences for the landscape designs could be derived from historical perspectives suggesting an aversion to wilderness associated with segregation (Chen, 2009), or negative memories of ancestors' experiences in wilderness or natural areas (Starkey, 2005).

Our findings suggest ethnicity will play a major role in any efforts to improve urban sustainability through introduction of native plant landscaping with more vertical and horizontal structure such as native plant gardens. Despite the uncertainty regarding causal mechanisms, adding trees to public rights-of-way in minority neighborhoods would be a logical first step for addressing environmental justice concerns about landscaping (Landry & Chakraborty, 2009), even if it does not create more favorable dispositions toward the use of non-turf grass landscape designs in personal landscaping. Further, the variability in landscaping created by changing right-of-way landscaping may create enough variability in neighborhoods to constitute "mixed" landscaping where individual innovation is considered more acceptable (Nassauer et al., 2009). Future research should attempt to assess the relationship between ethnicity and preference for trees in landscaping since trees provide many key urban ecosystem services, and previous research has documented ethnic disparities in distribution of street trees (Landry & Chakraborty, 2009). Research focusing on how cultural legacies influence landscaping choices (Larson, Casagrande, Harlan, & Yabiku, 2009) should address legacies related to ethnicity (Boone, Buckley, Grove, & Sister, 2009).

Surprisingly, socio-economic status was not positively related to support for replacing turf grass with native plant gardens. We detected no effect for education and a negative relationship for income after controlling for neighborhood norms and ethnicity. These findings may be explained in part by the way native plant gardens were integrated into landscaping designs in this study. Although Kirkpatrick et al. (2007) found individuals having a higher education implemented more complex native plant gardens than those with lower education levels, the native plant gardens in this study differed largely based on percent cover. Similarly, research finding a positive correlation between vegetation richness and socio-economic status (Martin et al., 2004) may reflect total species more than total coverage of plants. This distinction is critical because percent ground cover of native plants may influence ecosystem services (e.g., preventing erosion and contaminated runoff) more than the number of species.

The potential positive relationship between income and preference for turf grass landscaping identified in this study suggests efforts to enhance ecosystem services through native plant based landscaping innovations may be more difficult in affluent neighborhoods than in middle income neighborhoods. This suggestion is supported to some degree by Larsen and Harlan (2006) who found lower income homeowners preferred traditional landscapes, middle income homeowners preferred native desert landscapes, and higher income homeowners preferred "oasis" landscapes. Although the findings are non-linear in terms of landscaping impacts on ecosystem services, they may support the contention that middle income neighborhoods provide the most promise for introduction of more sustainable alternatives to turf grass.

5. Conclusions

Because socio-economic status was relatively unimportant relative to ethnicity and neighborhood norms, future research attempting to link landscaping preferences with socio-economic status should account for both ethnicity and neighborhood norms to avoid identifying spurious relationships. Our findings also suggest efforts to promote just distribution of ecosystem services should recognize African Americans appear to prefer turf grass dominated landscaping over landscaping dominated by native plant gardens with higher vertical and horizontal complexity. Although income was weakly related to landscaping preferences, our findings suggest middle income neighborhoods with high levels of home ownership may prove most receptive to initiatives aimed at increasing the use of native plant landscaping. Efforts to promote native plant landscaping must address neighborhood norms, because landscaping preferences were best predicted by what residents perceived their neighbors' preferences were. Our findings support the contention that environmentally beneficial innovations in residential landscape design should target neighborhoods (Nassauer et al., 2009) in addition to individuals, but also suggest an individual focus will work adequately as long as innovations are not perceived as too extreme. Further, our results suggest simply correcting erroneous subjective neighborhood norms may alleviate pressure against adopting native plant based landscaping.

Acknowledgements

We thank Morgan Grove for advice on project design and comments on earlier versions of this manuscript. Support was provided by North Carolina State University and an Urban Long-Term Research Area Exploratory (ULTRA-Ex) award jointly supported by the National Science Foundation and the U.S. Department of Agriculture Forest Service.

References

Adams, C. E., & Lindsey, K. J. (2010). *Urban wildlife management*. New York: CRC Press.

Bijoor, N. S., Czimczik, C. I., Pataki, D. E., & Billings, S. A. (2008). Effects of temperature and fertilization on nitrogen cycling and community composition of an urban lawn. *Global Change Biology*, *14*(9), 2119–2131.

Boone, C. G., Buckley, G. L., Grove, J. M., & Sister, C. (2009). Parks and people: An environmental justice inquiry in Baltimore, Maryland. *Annals of the Association of American Geographers*, *99*(4), 767–787.

Breuste, J. H. (2004). Decision making, planning and design for the conservation of indigenous vegetation within urban development. *Landscape and Urban Planning*, *68*(4), 439–452.

Buijs, A. E., Elands, B. H. M., & Langers, F. (2009). No wilderness for immigrants: Cultural differences in images of nature and landscape preferences. *Landscape and Urban Planning*, *91*(3), 113–123.

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: A practical information-theoretic approach* (2nd ed.). New York: Springer-Verlag.

Chen, X. (2009). African Americans and wildlands: A case study in Alabama, USA. *Journal of Human Ecology*, *26*(1), 19–24.

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, *24*, 201–234.

Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity, and compliance. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (4th ed., pp. 151–192). Boston: McGraw-Hill.

Ewing, R., Pendall, R., & Chen, D. (2011). *Measuring sprawl and its impact*. Retrieved June 10, 2011 from: http://www.smartgrowthamerica.org/sprawlindex/MeasuringSprawl.PDF

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Floyd, M. R., Shinew, K. J., McGuire, F. A., & Noe, F. P. (1994). Race, class and leisure activity preferences: Marginality and ethnicity revisited. *Journal of Leisure Research*, *26*, 158.

Frey, W. (2010). Race and ethnicity. In Metropolitan Policy Program (Ed.), *State of metropolitan America* (pp. 50–63). The Brookings Institution.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., et al. (2008). Global change and the ecology of cities. *Science*, *319*(5864), 756.

Grove, J. M., Cadenasso, M. L., Burch, W. R., Pickett, S. T. A., Schwarz, K., O Neil-Dunne, J., et al. (2006). Data and methods comparing social structure and vegetation structure of urban neighborhoods in Baltimore, Maryland. *Society & Natural Resources*, *19*(2), 117–136.

Grove, J. M., Troy, A., O'Neil-Dunne, J. P. M., Burch, W., Cadenasso, M., & Pickett, S. (2006). Characterization of households and its implications for the vegetation of urban ecosystems. *Ecosystems*, *9*(4), 578–597.

Helfand, G. E., Sik Park, J., Nassauer, J. I., & Kosek, S. (2006). The economics of native plants in residential landscape designs. *Landscape and Urban Planning*, *78*(3), 229–240.

Jacob, J. S., & Lopez, R. (2009). Is denser greener? An evaluation of higher density development as an urban stormwater quality best management practice. *Journal of the American Water Resources Association*, *45*(3), 687–701.

Jorgensen, A., Hitchmough, J., & Dunnett, N. (2007). Woodland as a setting for housing-appreciation and fear and the contribution to residential satisfaction and place identity in Warrington New Town, UK. *Landscape and Urban Planning*, *79*, 273–287.

Kaplan, R., & Austin, M. E. (2004). Out in the country: Sprawl and the quest for nature nearby. *Landscape and Urban Planning*, *69*, 235–243.

Kaplan, R., & Talbot, J. F. (1988). Ethnicity and preference for natural settings: A review and recent findings. *Landscape and Urban Planning*, *15*, 107–117.

Kaye, J. P., Groffman, P. M., Grimm, N. B., Baker, L. A., & Pouyat, R. V. (2006). A distinct urban biogeochemistry? *Trends in Ecology & Evolution*, *21*(4), 192–199.

Kirkpatrick, J., Daniels, G., & Zagorski, T. (2007). Explaining variation in front gardens between suburbs of Hobart, Tasmania, Australia. *Landscape and Urban Planning*, *79*, 314–322.

Landry, S. M., & Chakraborty, J. (2009). Street trees and equity: Evaluating the spatial distribution of an urban amenity. *Environment and Planning*, *41*(11), 2651–2670.

Larsen, L., & Harlan, S. L. (2006). Desert dreamscapes: Residential landscape preference and behavior. *Landscape and Urban Planning*, *78*, 85–100.

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.

Martin, C. A., Peterson, K. A., & Stabler, L. B. (2003). Residential landscaping in Phoenix, Arizona, US: Practices and preferences relative to covenants, codes, and restrictions. *Journal of Arboriculture*, *29*(1), 9–17.

Martin, C. A., Warren, P. S., & Kinzig, A. P. (2004). Neighborhood socioeconomic status is a useful predictor of perennial landscape vegetation in residential neighborhoods and embedded small parks of Phoenix, AZ. *Landscape and Urban Planning*, *69*(4), 355–368.

Milesi, C., Running, S. W., Elvidge, C. D., Dietz, J. B., Tuttle, B. T., & Nemani, R. R. (2005). Mapping and modeling the biogeochemical cycling of turf grasses in the United States. *Environmental Management*, *36*(3), 426–438.

Nassauer, J. I. (1983). Framing the landscape in photographic simulation. *Journal of Environmental Management*, *17*(1), 1–16.

Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design. *Landscape and Urban Planning*, *92*, 282–292.

Owen, D. (2009). *Green metropolis: Why living smaller, living closer, and driving less are keys to sustainability*. New York: Penguin.

Robbins, P., & Birkenholtz, T. (2003). Turfgrass revolution: Measuring the expansion of the American lawn. *Land Use Policy*, *20*(2), 181–194.

Robbins, P., & Sharp, J. T. (2008). Producing and consuming chemicals: The moral economy of the American lawn. In J. M. <ET AL> Marzluff (Ed.), *Urban ecology: An international perspective on the interactions between humans and nature* (pp. 180–206). New York: Springer.

Sasidharan, V. (2002). Special issue introduction: Understanding recreation and the environment within the context of culture (Editorial Material). *Leisure Sciences*, *24*(1), 1–11.

Starkey, M. (2005). *Wilderness, race, and African Americans: An environmental history from slavery to Jim Crow*. Unpublished Thesis. University of California Berkeley.

Todorova, A., Asakawa, S., & Aikoh, T. (2004). Preferences for and attitudes towards street flowers and trees in Sapporo, Japan. *Landscape and Urban Planning*, *69*(4), 403–416.

Troy, A. R., Grove, J. M., O'Neil-Dunne, J. P. M., Pickett, S. T. A., & Cadenasso, M. L. (2007). Predicting opportunities for greening and patterns of vegetation on private urban lands. *Environmental Management*, *40*(3), 394–412.

Van Velsor, S. W., & Nilon, C. H. (2006). A qualitative investigation of the urban African-American and Latino adolescent experience with wildlife. *Human Dimensions of Wildlife*, *11*(5), 359–370.

Virden, R. J., & Walker, G. J. (1999). Ethnic/racial and gender variations among meanings given to, and preferences for, the natural environment. *Leisure Sciences*, *21*(3), 219–239.

Yue, C., Hurley, T. M., & Anderson, N. (2010). Do native and invasive labels affect consumer willingness to pay for plants? Evidence from experimental auctions. *Agricultural Economics*, *42*(2), 195–205.

Zhou, W., Troy, A., Morgan, G. J., & Jenkins, J. C. (2009). Can money buy green? Demographic and socioeconomic predictors of lawn-care expenditures and lawn greenness in urban residential areas. *Society & Natural Resources*, *22*(8), 744–760.

Zmyslony, J., & Gagnon, D. (1998). Residential management of urban front-yard landscape: A random process? *Landscape and Urban Planning*, *40*(4), 295–307.

Zube, E., & Pitt, D. (1981). Cross-cultural perceptions of scenic and heritage landscapes. *Landscape Planning*, *8*(1), 69–87.