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Authors
Avolio, ML
Pataki, DE
Pincetl, S
et al.

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Understanding preferences for tree attributes: the relative effects of socio-economic and local environmental factors

Meghan L. Avolio · Diane E. Pataki · Stephanie Pincetl · Thomas W. Gillespie · G. Darrel Jenerette · Heather R. McCarthy

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Abstract Urban plant biodiversity is influenced by both the physical environment and attitudes and preferences of urban residents for specific plant types. Urban residents are assumed to be disconnected from their immediate environment, and cultural and societal factors have been emphasized over environmental factors in studies of landscaping choices. However, we postulate that local climatic and environmental factors can also affect preferences for plant attributes. Therefore, spatial and temporal patterns in urban tree biodiversity may be driven not only by the direct effect of environmental variables on plant function, but also by the effect of environmental variables on attitudes toward trees and associated choices about which types of trees to plant. Here, we tested the relative effects of socio-economic and local environmental factors on preferences toward tree attributes in five counties in southern California in and surrounding Los Angeles, based on 1,029 household surveys. We found that local environmental factors have as strong an effect on preferences for tree attributes as socio-economic factors. Specifically, people located in hotter climates (average maximum temperature 25.1 °C) were more likely to value shade trees than those located in cooler regions

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M. L. Avolio (✉) · D. E. Pataki
Department of Biology, University of Utah, 257 S 1400 E, Salt Lake City, UT 84112, USA
e-mail: meghan.avolio@utah.edu

S. Pincetl
Institute of Environment and Sustainability, University of California Los Angeles, La Kretz Hall, 619 Charles E. Young Drive E., Los Angeles, CA 90095, USA

T. W. Gillespie
Department of Geography, University of California Los Angeles, 1255 Bunche Hall, Los Angeles, CA 90095, USA

G. D. Jenerette
Department of Botany and Plant Sciences, University of California Riverside, 3203 Batchelor Hall, Riverside, CA 92521, USA

H. R. McCarthy
Microbiology and Plant Biology, University of Oklahoma, 770 Van Vleet Oval, Norman, OK 73019, USA

(23.1 °C). Additionally, people located in desert areas were less likely to consider trees to be important in their city compared with people located in naturally forested areas. Overall, our research demonstrates the inherent connections between local environmental factors and perceptions of nature, even in large modern cities. Accounting for these factors can contribute to the growing interest in understanding patterns of urban biodiversity.

Keywords Cities · Climate · Demographic · Los Angeles · CA · Precipitation · Structural equation modeling · Temperature · Urban biodiversity

Introduction

People generally like having trees on their streets (Gorman 2004), in their neighborhoods (Hull 1992) and in their cities (Lohr et al. 2004; Dwyer et al. 1991). As a result, trees are a dominant characteristic of cities (Nowak et al. 2001), even in arid and semi-arid regions where trees would not naturally be found. Although continental-scale patterns of climate still affect tree diversity in local urban areas (Ramage et al. 2013), the majority of urban trees are planted and managed, and thus urban forests to some extent overcome traditional biological constraints of dispersal and environmental filters (Pataki et al. 2013). As such, urban tree diversity is highly influenced by human preferences for specific tree types, and thus it is necessary to have some understanding of what affects resident's preferences for both public and private trees in order to make predictions of urban tree diversity.

Surveys of residents' attitudes towards trees have been conducted in different types of cities and climates. These studies have shown that people generally rank shade and beauty as the most valued benefits of urban trees, and damage to sidewalks and falling debris as the most important costs (Flannigan 2005; Gorman 2004; Lohr et al. 2004; Lorenzo et al. 2000; Schroeder et al. 2006; Schroeder and Ruffolo 1996; Sommer et al. 1990). Additionally, demographic and socio-economic factors affect resident preferences; age (Lohr et al. 2004; Sommer et al. 1990; Todorova et al. 2004; Williams 2002), gender (Hitchmough and Bonugli 1997; Williams 2002) and education (Williams 2002) can affect opinions of trees and tree attributes and income can affect a resident's willingness to pay for urban trees (Lorenzo et al. 2000; Zhang et al. 2007; Kirkpatrick et al. 2012; Treiman and Gartner 2005; Lo and Jim 2010).

While many studies have examined residents' views toward urban trees, few studies have evaluated how the local environment (e.g. landscapes within 50 km) might affect residents' views. People have been commonly assumed to be disassociated from their immediate landscape, such that cultural and societal factors have been emphasized in studies of how people relate to nature (Greider and Garkovich 1994), and this is especially true for urban residents. Although this paradigm has shifted with the rise of environmental sociology (Dunlap and Catton 1994; Freudenburg 2008), there remains a paucity of research on the effects of the local environment on residents' preferences for specific types of urban vegetation. One study on urban trees noted that local climate might affect a person's view of trees; Schroeder et al. (2006) found that people in the U.S. Midwest valued trees more for shade than people from the UK, and suggested that this might be a result of different climates, in that shade may be more valued in the sunnier Midwest than in the more overcast UK. However, to our knowledge, no study has attempted to evaluate the relative effects of socio-economic factors versus local environmental factors (such as temperature and precipitation) in influencing preferences toward urban trees.

Here, we study the relative effects of socio-economic (age, income, gender, and education) as well as local biophysical (temperature, elevation, precipitation, distance from coast; hereafter termed 'environmental') factors on preferences of residents for trees in five southern California counties in and surrounding the Los Angeles Metropolitan Area. This area is a model setting for our research questions because the area spans three ecosystem types with different biophysical characteristics: desert, pine-oak forested mountains, and coastal sage scrub/chaparral, in addition to being the second largest metropolitan area in the United States.

We conducted a survey of residents in and around Los Angeles, where, in the city limits alone, there are an estimated 6 million trees, the majority of which are planted (Nowak 2010). We used structural equation modeling (SEM) software to perform regression modeling and path analysis that included both socio-economic and environmental factors to explain variability in residents' attitudes and preferences toward urban trees. We chose an SEM framework because it allows for a direct comparison of the explanatory power of correlated factors (Grace 2006; Schumacker and Lomax 2004). First, we studied whether socio-economic and environmental factors differ in their effects on residents' attitudes towards private (yard) and public (city) trees. We hypothesized that people with higher incomes would value both public and private trees because of a perceived "luxury effect" of affluence on vegetation (Hope et al. 2003). Second, we investigated whether socio-economic and environmental factors affect residents' preferences for tree attributes and types. We expected that 1) residents in warmer areas would value shade more than residents in cooler areas; 2) older people would rank the negative attributes of trees as more important than younger people because of personal experiences with tree maintenance; and 3) residents in hotter and drier areas would value trees that are more water efficient. Third, using a subset of the data we examined whether residents that live in desert had different attitudes towards trees compared with residents that live in forested areas. We hypothesized that those who live in forested areas would value trees more than those that live in the desert because of sense of place with their local environment where trees are a natural component. Finally, we addressed whether income affected attitudes towards trees by comparing residents that earned more than $150,000 a year versus those that earned less than $25,000 in the coastal sage scrub/chaparral ecosystem. In Los Angeles, residents are required to pay for damage to sidewalks caused by street trees (McPherson 2000), and trees can be costly to maintain since they need to be watered. Accordingly, we hypothesized that residents with lower incomes would be more concerned with the cost of trees than those of higher incomes. This study is the first to incorporate local environmental characteristics into understanding resident's attitude towards trees and is an important first step to having a more comprehensive understanding of determinants of planted urban tree biodiversity.

Methods

Survey

In July and August 2010, 1,051 people were surveyed using the Knowledge Networks (Burbank, C.A.) KnowledgePanel. Knowledge Networks organizes national, probability-based, online, and non-volunteer access panels described in detail at http://www.knowledgenetworks.com/knpanel/KNPanel-Design-Summary.html. Internet access is provided for households that do not have it. The panel is intended to be demographically representative of the U.S. population, but was not demographically representative of the area surrounding Los Angeles. Our online survey targeted people in Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties (Fig. 1). The survey was provided in

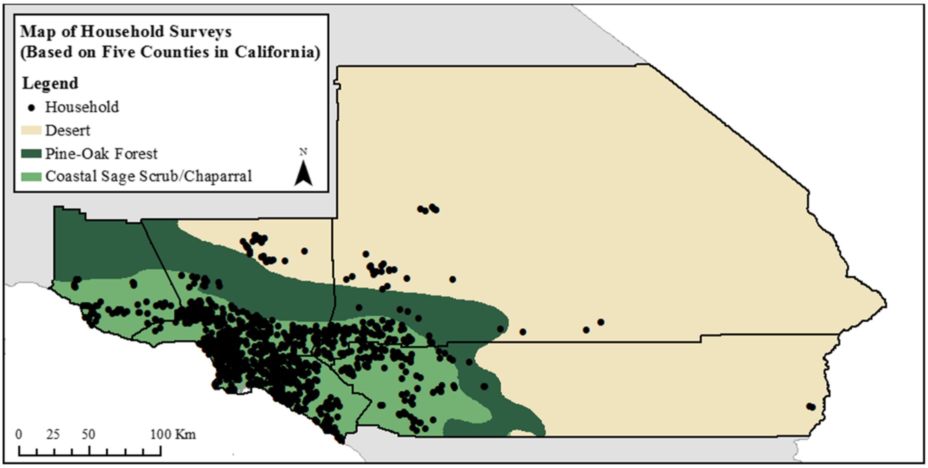


Fig. 1 Map of household surveys. The five counties where surveys were administered spanned three vegetation types. Desert areas were drier, hotter and at relatively high elevations; pine-oak forest areas were at wetter, cooler, and at relatively high elevations; Coastal Sage Scrub areas were hotter, received an intermediate amount of precipitation, and at lower elevations (Table S5). The Coastal Sage Scrub portion of the Los Angeles region is almost entirely urbanized

Spanish for Spanish speaking households. Survey questions were designed to probe how people felt about urban trees overall and their attributes. For example, one question stated: "please rank the following attributes of trees: Shading (important, somewhat important, somewhat unimportant, not important)". The survey questions analyzed in this paper can be found in the supplementary information (Text S1). Of the 1,051 surveys, 1,029 responses were suitable for analyses based on time spent answering the survey questions (more than three minutes) and geographic location (in one of the five counties in southern CA).

Socio-economic data, including age, education level, gender, and household income (Fig. S1) was provided by the survey participants. Local environmental data was collected by geocoding each household in Geographic Information System software (ArcGIS 9.2, ESRI 2006) and overlaying with environmental variables (Fig. S1). Climate data (temperature, annual maximum; precipitation, average annual) was averaged over a 30 year period (1981–2010) and acquired from the PRISM Climate Group at Oregon State University at a 1 km pixel size (Corvallis, OR; 2012). We used the National Elevation Dataset to determine elevation for each household (USGS, The National Map Viewer; 2012) with a 3 m pixel size. Distance from the coast was calculated in kilometers for each house using the Euclidean distance spatial analysis tool in ArcGIS. The Ecoregion and potential macro-vegetation types for each house was determined using the EPA Ecoregions III vegetation data set (EPA, Ecoregions of North America; 2006). Many of the variables were significantly, albeit weakly, correlated with one another (Table S1).

Statistical analyses

Statistical analyses were conducted in SAS (v9.3, SAS Institute, Cary, NC) and Structural Equation Modeling (SEM) was conducted in IBM SPSS AMOS (v.20, Amos Development Corporation, Chicago, IL). We used a 4-point Likert scale from 3 (important) to 0 (not important) and a 5-point Likert scale from 2 (strongly like/strongly agree) to −2 (strongly dislike/strongly disagree). Participants also had the option to refuse to answer a question, which was then dropped for a specific analysis. For the socio-economic data, education was binned into 7 categories: no high school degree, high school diploma or GED, some college with no degree, associate degree, bachelor's degree, master's degree, and professional or doctorate degree. Income (in United States dollars) was binned into 19 categories: less than 5,000; 5,001–7,500 7,501–10,000; 10,001–12,500; 12,501–15,000; 15,001–20,000; 20,001–25,000; 25,001–30,000; 30,001–35,000; 35,001–40,000; 40,001–50,000; 50,001–60,000; 60,001–75,000; 75,001–85,000; 85,001–100,000; 100,001–125,000; 125,001–150,000;150,001–175,000; and 175,001 or greater. Gender was coded as 0 for male and 1 for female. We log transformed both distance from coast and elevation to meet assumptions of normality.

SEM is a powerful tool that allows for the relative effect of many explanatory factors on a response variable to be determined, even if many of the explanatory factors are correlated (Grace 2006; Schumacker and Lomax 2004). Both regression models and path models are specific types of SEMs. Regression models have a single dependent variable and multiple correlated independent variables. A path analysis allows for multiple dependent (endogenous) variables that can also be independent (exogenous) to other variables. Regardless of the type of model, we first included all possible paths (arrows) between independent and explanatory exogenous (climate and socioeconomic status) and dependent endogenous (survey questions) variables (Fig. S2). For our analyses on attitudes towards public and private trees, we included only those residents who had a private yard ($n=782$) in the path analysis on private trees, while for the regression model of attitudes toward public trees, all residents were included ($n=1,018$). We were less interested in the overall explanatory power of the endogenous variables (squared multiple correlations, R^2), and more interested in the direct comparison of exogenous variables on their explanatory power of the endogenous variable (standardized effect sizes; SES). A positive SES denotes a positive relationship among variables, compared with a negative SES, and a larger number denotes a stronger relationship among the variables. We used the specification search program in AMOS, which calculates all possible model permutations and gives an associated AIC score, to determine which independent variables to include in our final model. We chose the model with the lowest AIC value and reduced the model accordingly. All of our models fit the data well according to the χ^2 statistic (Table 1) with a p-value>0.05, indicating that observed and predicted co-variance matrixes are similar (Grace 2006). Because we had a large number of samples, we also explored several other goodness of fit indexes, all of which indicated our models were a good fit to the data (Table S2). All endogenous variables have an error associated with them, ζ, which is unexplained residual variance, and all independent variables were specified to be correlated with one another. Additionally, we investigated the degree to which endogenous explanatory variables were spatially auto-correlated. We detected modest spatial auto-correlation of only four survey questions (Table S3).

Lastly, we performed t-tests of differences between residents located in the desert ($n=57$) versus forested mountain (pine-oak forest) ($n=27$) areas and high ($n=106$) versus low ($n=97$) income residents. In the Los Angeles area, desert cities are surrounded by extensive natural desert and forested cities are surrounded by extensive lands owned and managed by the U.S. Forest Service. These two habitat types are essentially integrative measures of the environmental variables and there were no statistically significant differences in the socio-economic status of residents between the two areas (Table S4). This analysis excluded the heavily urbanized Los Angeles basin in which relatively little native land cover remains. Thus, we were able to isolate environmental affects and test whether there were differences in the responses of residents where trees are not a part of the local landscape versus residents who

Table 1 Mean and standard error of respondent's attitudes towards tree attributes and tree types as well as the results of regression models. Answers ranged from 0 (not important) to 3 (important) or from −2 (strongly dislike) to 2 (strongly like). Attributes and tree types are ranked by their preference. Shown are the squared multiple correlations (R^2) for each survey question as explained by environmental and socioeconomic variables and the model χ^2, degrees freedom, and *p*-value

	Survey question	Mean (±S.E.)	R^2	χ^2	D.F.	*p*-value
Importance of tree attributes	Beauty	2.74 (0.02)	0.028	0.972	3	0.808
	Shade	2.73 (0.02)	0.022	3.351	5	0.646
	Remove air pollutants	2.62 (0.02)	0.015	3.377	6	0.760
	Bird habitat	2.50 (0.02)	0.026	3.581	7	0.827
	Privacy	2.39 (0.02)	0.016	1.545	5	0.908
	Damage to sidewalks	2.31 (0.03)	0.016	4.109	6	0.662
	Fruits and products	2.17 (0.03)	0.052	0.617	3	0.893
	Absorb storm water	2.15 (0.03)	0.022	1.649	4	0.800
	Other animal habitat	2.11 (0.03)	0.033	2.339	4	0.674
	Lots of falling debris	1.92 (0.03)	0.006	2.398	6	0.880
	Water use	1.80 (0.03)	0.029	3.596	3	0.308
	Cost of maintenance	1.55 (0.03)	0.020	3.467	4	0.483
Attitude towards tree types	Shade	1.65 (0.02)	0.012	4.020	6	0.674
	Flowering	1.29 (0.02)	0.039	2.853	5	0.723
	Fruit	1.30 (0.03)	0.015	2.080	5	0.838
	High water use	1.20 (0.03)	0.037	1.772	3	0.621
	Low water use	1.01 (0.02)	0.008	3.452	6	0.750
	CA native	0.994 (0.03)	0.009	5.453	5	0.363
	Evergreen	−0.335 (0.03)	0.023	3.616	6	0.729
	Drop a lot of debris	−0.625 (0.03)	0.048	1.978	4	0.740

live surrounded by trees (although we have no way to determine whether the presence or absence of natural trees was more important than other environmental differences such as temperature). We tested for differences in the responses to questions about the overall importance of trees and questions relating to water use. Second, we focused on residents in the coastal sage scrub/chaparral and compared residents that made over USD $150,000 to those who made under $25,000 annually (see Table S5 for comparison of socio-economic and environmental status of residents). We tested for differences in, again, overall importance of trees as well as monetary cost of planting and maintenance.

Results

Views towards private and public urban trees

For those residents who lived in a residence with a yard, it was important to have trees on their property (2.41±0.03, Likert scale, mean±S.E.). The importance of trees on one's property was most strongly related to time spent doing yard work (Fig. 2a); those who spent the most time doing yard work reported that having trees was important. Additionally, wealthier residents and those located at higher elevations thought trees were more important in their yard than residents at lower elevation and with lower income. In addition to their yards, residents also thought it was important to have

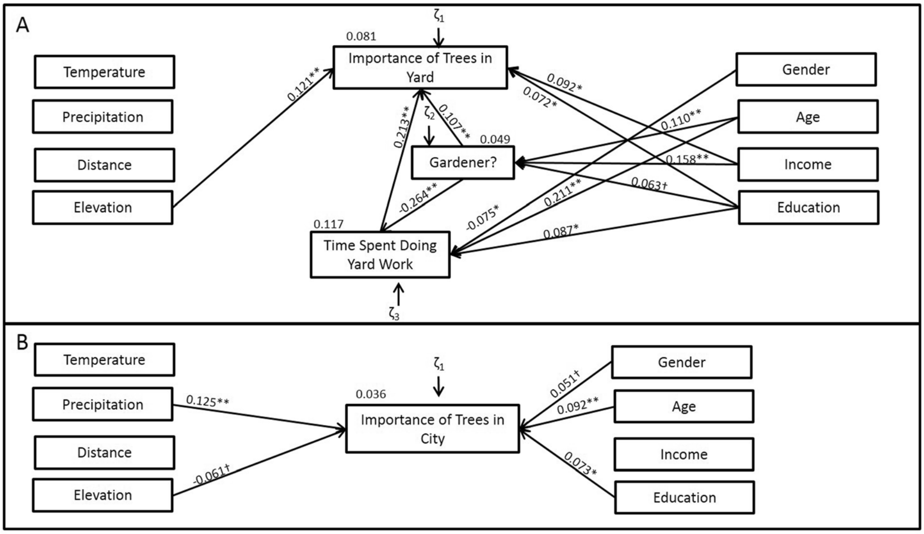
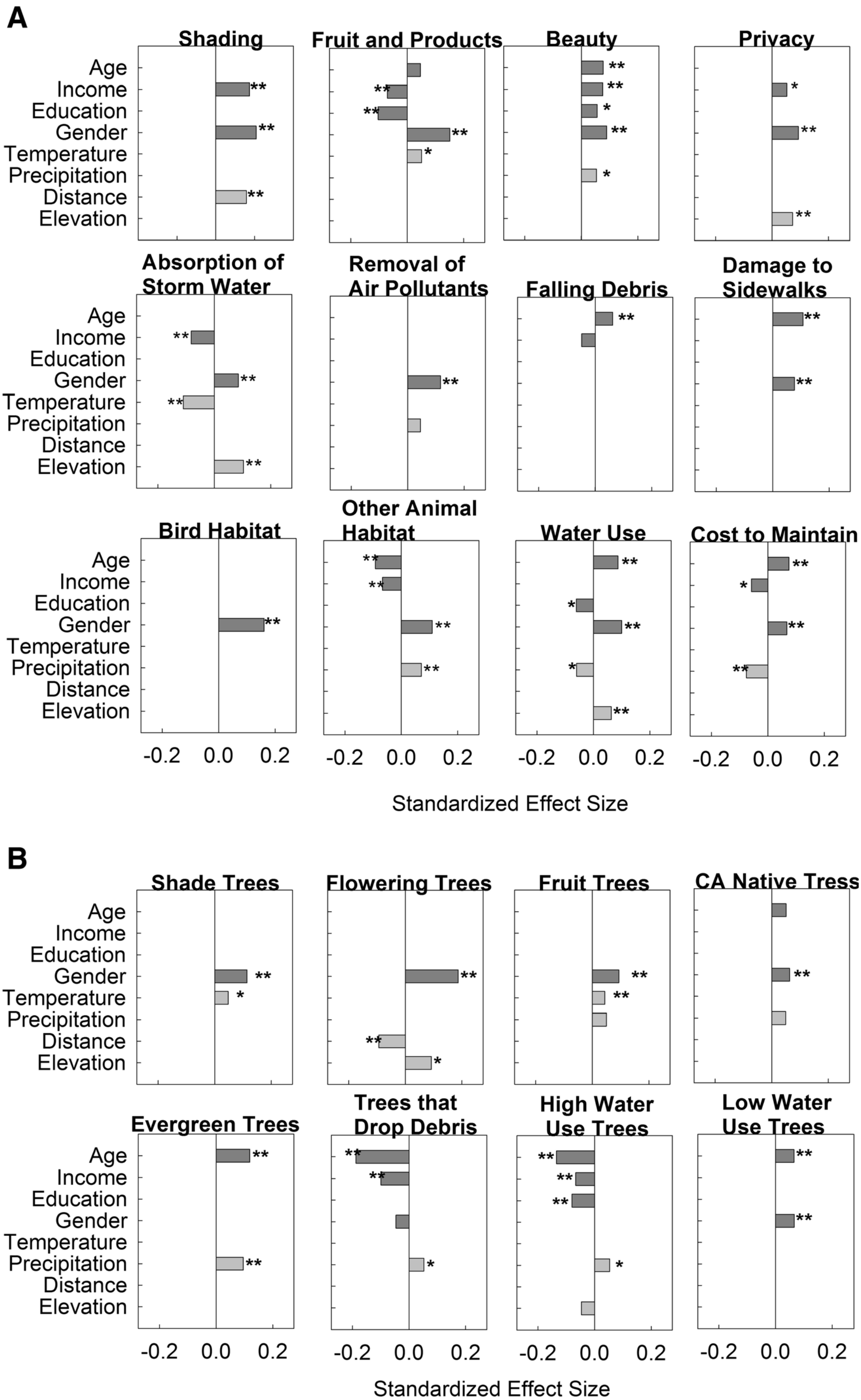


Fig. 2 Diagram of the path analysis (**a**) and regression model (**b**) used to determine how socio-economic factors and local environmental factors influence an individual's opinion about the importance of trees in A) their yard (i.e. private trees, χ^2=9.925 d.f. = 11, p=0.537) and B) their city (i.e. public trees, χ^2=1.413, d.f. = 3, p=0.703). Shown are standard regression weights above the arrows, and squared multiple correlations (R^2) for each endogenous factor above its box. Missing paths were not significant at $p<0.01$ and not included in the final model. † $p<0.1$, *$p<0.05$, **$p<0.01$. In the private tree model, having a gardener and time spent in the yard were both exogenous and endogenous variables. ζ denotes error associated with and endogenous variable. Correlations among exogenous factors are not shown (see methods). Also in model A, temperature, precipitation, and distance were correlated with the error associated with having a gardener, but there was not a direct path between these variables

trees in their city (i.e. public trees, 2.72±0.03; Fig. 2b). Precipitation explained most of the variation in the responses about the importance of public trees, as respondents in areas of higher precipitation were more likely to find public trees to be important. Level of education was similarly related to importance of both public and private trees, where residents who had more education thought trees were more important. Although overall our SEMs explained little variation in the data (greatest R^2= 0.08), the goal of our study was not to best explain variation in participant's views of trees, but to understand the relative effects of socio-economic versus local environmental factors on a participant's view of urban trees

Opinions of tree attributes and tree types

Residents were asked to separately rate the importance of 12 tree attributes (Table 1, Fig. 3). Of the 12 attributes, shade and beauty were ranked the highest; 75 % of residents thought shade and beauty were important attributes. Residents were less concerned with negative tree attributes. Damage to sidewalks was the most common concern, but only 47 % of respondents thought this was important. Each attribute was evaluated in a regression model (Table 1). Both socio-economic and environmental factors contributed to attitudes toward specific tree attributes (Fig. 3a). Three attributes – habitat for birds, falling debris and damage to sidewalks – were only explained by socio-economic variables, while all other attributes were also partially explained by environmental factors. We found that residents further from the coast were more likely to value shade, and residents located in areas of lower precipitation (precipitation ranged


A
Shading
Fruit and Products
Beauty
Privacy
Absorption of Storm Water
Removal of Air Pollutants
Falling Debris
Damage to Sidewalks
Bird Habitat
Other Animal Habitat
Water Use
Cost to Maintain
Age
Income
Education
Gender
Temperature
Precipitation
Distance
Elevation
-0.2 0.0 0.2
Standardized Effect Size
B
Shade Trees
Flowering Trees
Fruit Trees
CA Native Tress
Evergreen Trees
Trees that Drop Debris
High Water Use Trees
Low Water Use Trees
Age
Income
Education
Gender
Temperature
Precipitation
Distance
Elevation
-0.2 0.0 0.2
Standardized Effect Size

◀ **Fig. 3** Standarized effect sizes of socio-economic (*dark gray*) and environmental (*light gray*) independent variables on respondents. **a**) attitudes towards specific tree attributes (n=1,029) and **b**) preferences for specific tree types (n=930). See Table 1 for details on each model. Two asterisks denotes the factor is significant at p<0.05, a single asterisk denotes significance at p<0.1 and no asterisks denotes that the factor did not significantly affect the response variable

from 83–1,004 mm a year) were more likely to be concerned with water use and the cost to maintain trees. Residents were also asked about attitudes toward eight tree types. Here, we found preference for shade trees was affected by gender and temperature (average maximum temperature ranged from 17–31 °C; Fig. 3b). Preferences for tree water use were only affected by socio-economic factors, where high water use was more likely to be disliked by older, more educated, and wealthier residents. Trees that dropped a lot of debris were also more likely to be disliked by older residents and those with higher incomes as well as residents who lived in areas with higher precipitation.

Comparing subpopulations in the data

Desert versus forested areas

To isolate the effect of local environment we used a subset of all the data and compared those living in desert areas with those living in the natural pine-oak forest portion of the study area (the mountainous region; Fig. 1). We found significant differences between residents who lived in forested versus desert areas (Table 2). In the pine-oak forests, 77 % of residents thought trees were important in their city, compared with 61 % in desert cities. Similarly, in the pine-oak forest 93 % of residents strongly agreed that trees positively impact the environment, compared with 61 % of residents who lived in the desert. We also found that residents who lived in the desert regarded tree water use as more important than those that live in a forested area (Table 2). However, we found no differences between residents that lived in desert and forested areas in their view about the importance of trees in their yard, and attitudes towards trees of high and low water use.

Table 2 Differences in responses from residents located in desert (n=57) versus forested (n=27) areas of the study region. Shown are the mean±S.E. of each survey question. The degrees of freedom, t-value, and p-value for each comparison are also shown. Note that some residents refused to answer certain questions, resulting in varying degrees of freedom

Survey question	Likert scale	Desert	Forest	D.F.	t-value	P-value
Urban trees have positive effects on the environment	−2 to 2	1.51±0.10	1.93±0.05	82	−2.77	0.01
Importance of trees in yard	0 to 3	2.43±0.12	2.63±0.14	73	−0.98	0.33
Importance of trees in city	0 to 3	2.41±0.12	2.78±0.08	81	−1.95	0.05
Importance of water use	0 to 3	2.11±0.09	1.70±0.18	79	2.24	0.03
Attitude towards trees with high water use	−2 to 2	−0.50±0.11	0.19±0.14	79	−1.72	0.09
Dislike trees because they require a lot of water	0 and 1	0.52±0.11	0.25±0.11	37	1.72	0.09
Attitude towards trees with low water use	−2 to 2	1.14±0.11	0.96±0.16	81	0.94	0.35
Like trees because they require little water	0 and 1	0.58±0.09	0.37±0.11	48	1.46	0.15

Table 3 Differences in responses of residents that lived in coastal sage scrub who made \$25,000 or less (n=97) compared with residents who made \$150,000 or more a year (n=106). Shown are the mean±S.E. of each survey question. The degrees of freedom, t-value, and p-value for each comparison are also shown. Note that some residents refused to answer certain questions, resulting in varying degrees of freedom

Survey question	Likert scale	Low income	High income	D.F.	t-value	P-value
Would like more trees on property	−2 to 2	0.43±0.15	0.32±0.14	199	−0.55	0.581
Importance of trees in yard	0 to 3	2.18±0.14	2.97±0.06	141	3.49	<0.01
Importance of trees in city	0 to 3	2.75±0.06	2.83±0.04	200	1.20	0.23
Importance of damage to sidewalks	0 to 3	2.32±0.08	2.20±0.08	198	−1.11	0.27
Importance of monetary cost of maintenance	0 to 3	1.67±0.10	1.45±0.08	200	−1.75	0.08
Importance of monetary cost of planting	0 to 3	1.45±0.09	1.25±0.08	200	−1.72	0.09
Like or dislike trees that damage sidewalks	0 and 1	0.74±0.09	0.75±0.06	82	0.13	0.894
Like or dislike trees because that are expensive	0 and 1	0.26±0.09	0.14±0.04	82	−1.33	0.188

High versus low income

Using a subset of the dataset we compared residents in the coastal sage scrub/chaparral ecosystem who made over \$150,000 to those who made less than \$25,000 a year (Table 3). We found that 50 % of low income residents thought it was very important to have tree in their yard compared with 70 % of high income residents (Table 3). There was no difference in attitudes towards cost of maintenance between high and low income residents.

Discussion

We find, for the first time, that in southern California local climate and ecosystem types affect residents' opinions of tree attributes as much as socio-economic factors. Although previous studies have shown that features of the local environment can affect resident' opinions, our study has distinguished between local climate and socio-economic variation, which tend to be correlated (incomes tend to be higher near the coast in this region and lower in the desert). Given the limited geographic scope of this study, our findings demonstrate that residents' are influenced by subtle variations in climate and suggest that across larger geographic ranges, such as the continental scale, effects of the local environmental may be greater, though possibly more difficult to disentangle from cultural and historical factors. In our study, as in many others, socio-economic factors influenced tree preferences where we found older residents preferred trees with less maintenance and females had a higher preference for flowering trees. Comparing the average rankings of all tree attributes, it is clear that respondents showed stronger preferences for certain attributes and types (shading/shade trees) versus others (tree water use, and water use type). This information can be helpful for both understanding current biodiversity and for incorporating preferred attributes of urban trees in future planting programs.

Overall, our study showed similar trends with other resident tree preference surveys. Similar to past research, we found shade and beauty as well as damage to sidewalks and falling debris were ranked the highest benefits and concerns about trees, respectively, and the benefits of trees were rated much higher than the concerns (Flannigan 2005; Schroeder and Ruffolo 1996; Gorman 2004; Lohr et al. 2004; Lorenzo et al. 2000; Schroeder et al. 2006; Sommer et al. 1990). Older residents were more likely to be concerned with the cost of maintenance. This is also similar to other studies (Sommer et al. 1990) and shows the importance of experience with the maintenance and costs of trees. We found consistent effects of gender, where females always had stronger preferences for tree attributes or tree types compared with males. Hitchmough and Bonugli (1997) found males in Scotland had stronger preferences for trees, and attributed this to women having a greater fear of assault on streets with high tree cover. In Los Angeles, there is a similar perception that tree cover makes it easier for criminals to hide (Pincetl 2010); however, we found no evidence of females having a lower preference for trees in our survey, possibly because the data not only included the city of Los Angeles, but also a much larger area, including less urbanized regions.

We found a resident's income was positively correlated with the importance of private trees on their property, but not public trees, and these results were supported by our targeted analysis of high and low income residents. Together, this suggests that residents with higher income more strongly value trees, supporting the "luxury effect" – the positive relationship between income and plant diversity and plant cover (Hope et al. 2003; Martin et al. 2004). In the city of Los Angeles a positive relationship between neighborhood income and tree cover has been observed (Clarke et al. 2013). Surprisingly, there was no difference between high and low income residents in their opinions about the importance of damage to sidewalks, even though damage to sidewalks by street trees must be paid for by private residents rather than the city in Los Angeles. The practice of having residents pay for street tree maintenance is common in California where property owners paid 39 % of repair costs to sidewalks caused by tree damage (McPherson 2000). However again, our surveyed area was much larger than the City of Los Angeles, and if we limit our sample to residents who lived in Los Angeles there is a marginally significant difference by income in the importance of tree damage to sidewalks, where low income residents were more concerned with damage to sidewalks than high income residents (t-value $_{\text{d.f. } 46}=-1.97$, $p=0.055$). Lastly, we found that for private trees there were similar effects of education and income, but for public trees, level of education was an important predictor of tree importance while income was not. This might suggest that level of education may be as important or more important than income in understanding patterns of urban tree diversity, as has been found by Kendal et al. (2012a) and Luck et al. (2009).

We hypothesized residents' preferences for shading and water use of trees would be affected by temperature and precipitation, respectively. We found support for the first hypothesis; people located in hotter regions had stronger preferences for shade trees than those from cooler regions. The pattern for precipitation was not as straightforward. Residents located in areas of low precipitation were more likely to be concerned with water use, but precipitation did not affect preferences for trees with low or high water use. The ways in which these different aspects of climate directly affect the experience of residents may explain some of these results. Urban residents in this region always have access to water, regardless of local precipitation, but are likely to have personal experiences with outdoor temperature. This is similar to previous work in Phoenix, where a long history of promoting the city as an oasis in the desert has resulted in long-time residents expressing greater preferences for lush lawns than newcomers, and less awareness of the scarcity of local water resources (Larson et al. 2009; Yabiku et al. 2007). Increasing costs of water could shift these preferences, although this has not been fully investigated. In addition to precipitation and temperature, we found that elevation and distance from the coast also affected tree preferences. Distance from the coast was most strongly related to attitudes toward shading, and temperatures tend to be hotter further from the coast in the desert. We also found a significant effect of elevation on perceptions of the importance of absorption of storm water. It is possible that those living at higher elevation are more concerned with erosion and mudslides, a problem in southern California, but this was not directly included in the survey.

Although our study is the first to explicitly show an effect of local climate and ecosystem type on tree preferences, the importance of local biophysical features of the landscape in individual attachment to place has recently been demonstrated (Beckley et al. 2007; Clark and Stein 2003; Stedman 2003). Features of the local environment have also been found to affect support for regulation and protection. Larson and Santelmann (2007) found that people who lived closer to streams had greater support for protection of waterways than those that lived further away. Drawing upon similar notions, the connection to one's local environment might affect opinions about urban trees. Our comparison of desert versus forest residents suggests that local natural features can affect how people view urban trees. In the desert, where there is a lack of natural trees, residents were less likely to think that trees are important and were less likely to state that trees benefit the environment. Ramage et al. (2013) found that regardless of temperature, planted urban trees were similar in species composition to the surrounding native biome, although this is not true for our study site in Southern California. Ramage et al. (2013) concluded that climatic controls on vegetation exist in planted urban forests across a broad continental gradient. However, the results of our study suggest that it may be difficult to distinguish between direct effects of local climate on urban tree biophysical processes and the indirect effect of climate of residents' preferences and subsequent planting decisions. If there is an indirect effect of climate on attitudes towards trees, then planting decisions, tree performance, and environmental variables may all be closely correlated, and understanding urban tree biodiversity will require distinguishing among the drivers, mechanisms, and response variables in urban tree communities.

Ultimately the goal of this research is to contribute to our understanding of the factors that influence urban tree biodiversity. A commonality across cities is that the majority of vegetation is planted (Kendal et al. 2011) and therefore chosen by residents presumably for specific attributes. The literature is currently lacking a formal classification of preferences for specific types of vegetation, and whether plants with desired attributes have greater abundance in planted areas than those that lack these attributes. For example, we found that after shade, the respondents in our survey were most likely to prefer flowering trees. In Japan, researchers have found a strong preference for street flowers (Todorova et al. 2004) and Lindemann-Matthies et al. (2010) found the presence of flowers enhanced people's appreciation of local vegetation. This suggests planted vegetation may have been chosen simply because they flower, and showy flowering plants will have greater "fitness" in urban systems. Linking preferences to patterns of vegetation is a new and developing area of urban ecological research (Kendal et al. 2012b; Pataki et al. 2013), and is necessary to predict patterns of urban biodiversity. Our present study demonstrates that individual preferences for tree attributes can be affected by local environmental and socioeconomic factors, which is a necessary first step towards a comprehensive understanding of the drivers of urban biodiversity patterns.

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