Environ Manage (2007) 40:394–412
DOI 10.1007/s00267-006-0112-2

Predicting Opportunities for Greening and Patterns of Vegetation on Private Urban Lands

Austin R. Troy · J. Morgan Grove · Jarlath P. M. O'Neil-Dunne · Steward T. A. Pickett · Mary L. Cadenasso

Received: 31 March 2006 / Accepted: 21 March 2007

Abstract This paper examines predictors of vegetative cover on private lands in Baltimore, Maryland. Using high-resolution spatial data, we generated two measures: ''possible stewardship,'' which is the proportion of private land that does not have built structures on it and hence has the possibility of supporting vegetation, and ''realized stewardship,'' which is the proportion of possible stewardship land upon which vegetation is growing. These measures were calculated at the parcel level and averaged by US Census block group. Realized stewardship was further defined by proportion of tree canopy and grass. Expenditures on yard supplies and services, available by block group, were used to help understand where vegetation condition appears to be the result of current activity, past legacies, or abandonment. PRIZM™ market segmentation data were tested as categorical predictors of possible and realized stewardship and yard expenditures. PRIZM™ segmentations are hierarchically clustered into 5, 15, and 62 categories, which correspond to population density, social stratification (income and education), and lifestyle clusters, respectively. We found that PRIZM 15 best predicted variation in possible stewardship and PRIZM 62 best predicted variation in realized stewardship. These results were further analyzed by regressing each dependent variable against a set of continuous variables reflective of each of the three PRIZM groupings. Housing age, vacancy, and population density were found to be critical determinants of both stewardship metrics. A number of lifestyle factors, such as average family size, marriage rates, and percentage of single-family detached homes, were strongly related to realized stewardship. The percentage of African Americans by block group was positively related to realized stewardship but negatively related to yard expenditures.

A. R. Troy (✉)
Rubenstein School of Environment and Natural Resources, Aiken Center, University of Vermont, Burlington, VT 05405, USA
e-mail: atroy@uvm.edu

J. M. Grove
Northern Research Station, USDA Forest Service, 705 Spear Street, South Burlington, VT 05403, USA

J. P. M. O'Neil-Dunne
Rubenstein School of Environment and Natural Resources, Aiken Center, University of Vermont, Burlington, VT 05405, USA

S. T. A. Pickett
Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, USA

M. L. Cadenasso
Department of Plant Sciences, University of California, Davis, One Shields Avenue, CA 95616, USA

Keywords Urban ecology · Private land · Neighborhood segmentation · Urban forestry · Baltimore LTER · Urban greening

Introduction

Urban green space provides a variety of important benefits (Lohr and others 2004, Grove and others 2005). Examples include aesthetic amenities (Acharya and Bennett 2001, Morancho 2003, Tajima 2003, Lohr and others 2004, Grove and others 2005), reducing energy use for cooling (Shashua-Bar and Hoffman 2000, Akbari 2002), carbon sequestration (Jo and Mcpherson 1995, Nowak and Crane 2002), filtering and attenuating stormwater runoff (Whitford and others 2001), and promoting neighborhood social capital (Sullivan and others 2004, Vemuri 2004).

Significant variation exists in the average amount of canopy cover of American cities, from 0.4% in Lancaster, CA, to 55% in Baton Rouge, LA (Nowak and others 1996). Although surrounding natural vegetation, which reflects local environmental conditions, may be a critical factor, it explains only part of the variation (Nowak and others 1996).

Although variation in average vegetation cover at the scale of the metropolitan area has been fairly well addressed, less understood is the heterogeneity in vegetation cover within cities. With a 34% increase in the amount of urbanized land in the United States between 1982 and 1997 (USDA 1999) and the percentage of developed land in the nation projected to increase from 5.2% to 9.2% by 2025 (Alig and others 2004), indicators for measuring and predicting intra-urban vegetation patterns will become increasingly important. In this paper we present two such indicators. The first, ''possible stewardship,'' is a measure of plantable area, defined as the proportion of privately owned properties not occupied by buildings. The second indicator is ''realized stewardship'' or the proportion of a parcel's possible stewardship land on which vegetation is growing. Figure 1 offers a visualization of both metrics.

Theories Related to Possible Stewardship

Possible stewardship, or plantable area, has been well studied, though unintentionally. This is because it is essentially the inverse of lot coverage (building footprint area divided by lot size), a measure of urban density. The determinants and dynamics of urban density are, in turn, the subject of a significant body of literature in the fields of urban economics and planning (e.g., Alonso 1964, Muth 1969, Mills 1970, Harr and others 1975, Kau and Lee 1976, Craig and Haskey 1978, Mills 1979, Alperovich 1982, Cho 2001). Among the determinants examined by this literature are ''pull'' factors that attract new residential development, such as employment and retail clustering, infrastructural investments, amenities, cheap land, and services, and, conversely, ''push'' factors, such as crime, fiscal problems, taxes, expensive land, and pollution. Existing building densities are a result of these processes operating over multiple time scales. Much of the built environment in the center of many Eastern U.S. cities is a result of the clustering of industries and placement of transportation infrastructure that occurred in the late 19th and early 20th centuries. Because of this, much of the dense housing we see in postindustrial cities is a lagged indicator of past demand that often no longer exists. Construction has increasingly shifted towards the suburbs as automobiles, trucks, air traffic, and interstates have brought down transportation costs while communication technologies have released businesses from their dependency on city centers. These factors have amplified the preexisting decentralization of population (Mieszkowski and Mills 1993).

Another theory salient to predicting plantable area is the housing filtering model (Muth 1969, Sweeney 1974a, 1974b), which suggests that as housing ages and depreciates, residents gain less utility from it and it ''filters down'' to lower income residents. Wealthier residents can pay to move to suburban locations where housing is newer, land is cheaper, lots are larger, and public service levels are greater (Fischel 1985). A variant of this model is offered by Bond and Coulson (1989), whose findings suggest that housing filters to lower income residents based on size, rather than age, although age and size are strongly related (according to our data, there is a statistically significant inverse correlation between the two in Baltimore). In other

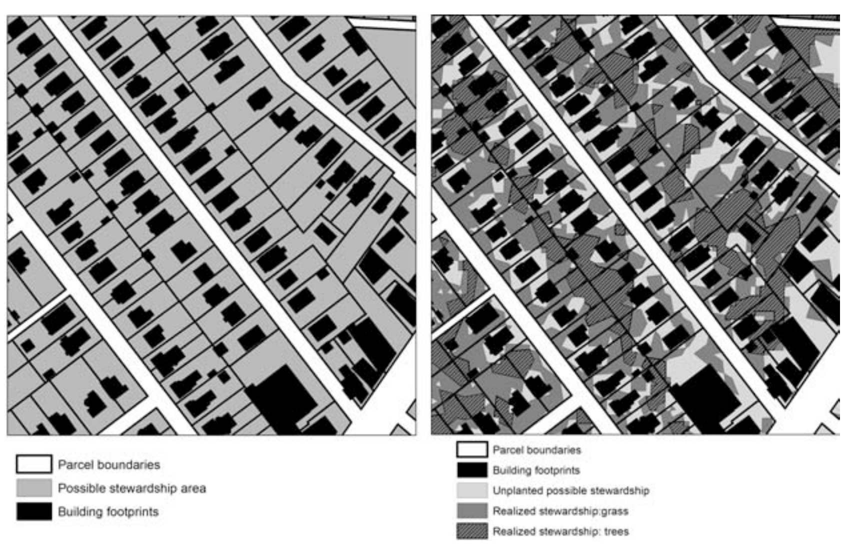

Fig. 1 Possible and realized stewardship

words, the filtering model suggests that lower income residents are likely to live in older neighborhoods characterized by smaller houses, and hence higher densities. This in turn suggests that low-income residents will tend to live in areas with lower possible stewardship.

Theories Related to Realized Stewardship

Among the few studies that have examined predictors of vegetative coverage on private urban lands, three social theories have been proposed: population density, social stratification, and lifestyle behavior (Grove and others 2006). Population density is presumed to drive vegetative change through development. Social stratification theory has been used to predict vegetative patterns based on relative power and income differences among neighborhoods that result in different levels of public and private investment in green infrastructure. This relates not only to the ability of different socio-economic groups to invest or attract investment in greening initiatives, but also their ability to move to neighborhoods with conditions more to their preferences (Logan and Molotch 1987). A number of studies have used income and education to examine the relationship between social stratification and vegetation (Whitney and Adams 1980, Palmer 1984, Grove 1996, Grove and Burch 1997, Dow 2000, Vogt and others 2002, Martin and others 2004).

The so-called luxury effect relates to the third social theory: lifestyle behaviors. The term ''ecology of prestige'' refers to the phenomenon in which household patterns of consumption and expenditure on environmentally relevant goods and services are motivated by group identity and perceptions of social status associated with different lifestyles (Grove and others 2004, Law and others 2004, Grove and others 2006a). This theory suggests that a household's land management decisions are influenced by its desire to uphold the prestige of its community and outwardly express its membership in a given lifestyle group.

Conceptions of luxury and prestige, however, are highly variable, even within the same income or demographic group. Weiss (2000) notes this when he quotes F. Scott Fitzgerald's famous comment: ''America's rich … aren't just different from you and me but different from each other'' (p. 95). Analyzing Weiss' book, Holbrook (2001:76) notes that there is substantial variety even within lifestyle types in the ''affluent market.'' Lifestyle variables that may only be weakly correlated with socio-economic status, such as family size, marriage status, and life stage, can play a critical role in determining not only where households choose to locate (Timms 1971, Knox 1994, Short 1996, Gottdiener and Hutchison 2000, Kaplan and others 2004), but potentially in how they manage their properties.

In Baltimore, Maryland, Grove and others (2006) conducted one of the only studies that compared how population density, socio-economic status, and lifestyle behavior theories predict the distribution of vegetation cover within and among riparian zones, public rights of way, and private land. To operationalize these three theories for analysis, they used the PRIZM^{TM} (Potential Rating Index for Zipcode Markets, hereafter referred to as ''PRIZM'') sociodemographic segmentation system from Claritas, Inc. This system, used for targeting direct marketing and advertising efforts, categorizes neighborhoods based on residents' characteristics and has three nested levels of aggregation—5, 15, or 62 categories. These segmentation levels correspond approximately with population density, social stratification, and lifestyle theories, respectively. Table 1 gives the defining dimensions of each PRIZM segmentation. Grove and others (2006) found that variations in vegetation cover in riparian areas were not adequately explained by any of the three segmentations, whereas the lifestyle behavior segmentation best predicted differences in vegetation cover on private lands and on public rights of way. Vegetation cover on private lands was also found to relate quadratically to median housing age.

Research Questions

In this paper, four questions are addressed based upon gaps in the research. First, does population density, social stratification, or lifestyle theory best predict variations in possible and realized stewardship on urban private lands? Second, which component variables of PRIZM segmentations are most significant to predicting variations in possible and realized stewardship? Third, are there additional variables that are not components of PRIZM segmentations but that predict variations in possible and realized stewardship? And, fourth, what are the predictors of yard supply expenditures, and how do differences between these and the predictors of realized stewardship shed light on the process of how vegetation was established?

To address the first question, we followed Grove and others (2006) to test whether the PRIZM 5, 15, or 62 segmentation best describes differences in both realized and possible stewardship. To address the second question, each PRIZM segmentation was ''unpacked'' into a number of continuous variables expected to be reflective of the three theories. These sets of variables were regressed against possible and realized stewardship. Because the theories are cumulative, variable sets for a given theory include variables from the ''lower'' or constituent theories. That is, lifestyle regressions also include social stratification and population density variables, and the social stratification regressions also include the population density variable.

Table 1 Constituent variables of PRIZM segmentations; shaded boxes indicate that variables are included

Variable	PRIZM classification		
	Urbanization (PRIZM 5)	Socioeconomic status (PRIZM 15)	Lifestyle (PRIZM 62)
Urbanization			
Population density	■	■	■
Housing			
Housing density	■	■	■
Home value		■	■
Social rank			
Education		■	■
Occupation		■	■
Household income		■	■
Ethnicity			
Race/ancestry		■	■
Household composition			
Age of population			■
Family type			■
Mobility			
Owner/renter			■
Tenure duration			■

To address the third question, three additional variables were included that are hypothesized to be important in predicting urban vegetation distribution but are not considered as defining dimensions of PRIZM 5, 15, or 62 classes. These are housing age, crime level, and green space. The age of housing stock has been found to be significantly associated with plant species composition (Whitney and Adams 1980), diversity (Hope and others 2003), abundance (Martin and others 2004), and vegetation cover (Grove and others 2006a, 2006b). Moreover, age of housing has been found to be correlated positively with lawn fertilizer application levels (Law and others 2004). Based on the housing filtering model, discussed above, housing age is hypothesized to be strongly related to socioeconomic status and, hence, considered as a component of social stratification theory. The second variable, crime level, is expected to impact the way that residents perceive of, use, and manage surrounding green spaces. Greener surroundings, especially when dominated by canopy trees, have been found to reduce crime (Kuo and others 1998), in part because of increased pedestrian traffic (Coley and others 1997, Kuo and others 1998, Sullivan and others 2004). Therefore, in areas with a crime problem, residents may use planting and landscaping as ways to create safer neighborhoods. Because our data set indicates that in Baltimore there is a statistically significant inverse relationship between certain measures of crime and median household income, crime is included as a social stratification variable.

The third variable is percent of area that is protected green space at the block group level. It is included as a lifestyle component variable for several reasons. First, protected urban green space has a positive impact on property values (see Fausold and Lilieholm 1999 for a review), suggesting that residents with certain preferences self-select locations based partly on proximity of open space. Second, the amount that homebuyers are willing to pay to live near public green spaces can vary based on lifestyle factors such as retirement status (Des Rosiers and others 2002).

Finally, the fourth question addresses the issue that although realized stewardship measures vegetation quantity, it does not necessarily measure the level of management of that vegetation. Comparing the predictors of yard expenditures and realized stewardship may provide insight into the likely conditions under which a high level of vegetation cover can be interpreted as an indicator of current management versus abandonment, succession, or historic legacies.

Methods

Site Description

Baltimore, Maryland houses approximately 614,000 people in 276 neighborhoods. In 2000, the City of Baltimore had 258,518 households and 300,477 household building units, with an average of 2.5 persons per household. The City has experienced extensive demographic and economic changes over the past 50 years, with its population declining from nearly 950,000 in the 1950s to its current level (Burch and Grove 1993). Baltimore City displays the classic pre-World War II urban spatial configuration with a monocentric form and high-density, affluent neighborhoods at the center (urban uptown), surrounded by high-density, low-income neighborhoods (urban core), and then mid-income, less dense neighborhoods (urban midscale). Figure 2 shows the distribution of PRIZM 15 segments, reflecting population density and socio-economic status. The characteristics of each of these clusters are outlined in Appendix 1. Recent urban redevelopment and revitalization is manifest in 2nd City Center neighborhoods.

Data

The PRIZM system, which was developed for market research (Claritas 1999, Weiss 2000), has two primary goals. The first is to segment the population into socio-economically meaningful clusters. The second is to associate these clusters with consumer spending patterns, household tastes, and attitudes using additional data such as market research surveys, public opinion polls, and point-of-purchase receipts. Segmentations are in three levels of aggregation: 5, 15, and 62 classes, and are mapped to the U.S. Census block group. PRIZM aggregation levels are nested and cumulative, each building on and inclusive of the previous one. The 5 group categorization is arrayed along an axis of urbanization. The 15 group categorization adds a second dimension: socioeconomic status. The 62 class disaggregation further expands density and socio-economic status with a lifestyle dimension (Claritas 1999). The variables upon which social stratification and lifestyle dimensions are built are listed in Table 1 and the characteristics of specific classes are described in Appendix 1.

PRIZM is useful for a number of reasons. In addition to having three levels of aggregation representative of population density, social stratification, and lifestyle theories, it is designed to predict variations in expenditures on different types of consumer goods and services, of which yard care products and services are an example. In this sense, PRIZM is expected to be well suited for understanding variations in household land-management preferences and behavior.

A GIS data layer of Census block groups coded by PRIZM category was created for Baltimore City by joining Tele Atlas' Dynamap® Census data with a PRIZM classification for each block group from the Claritas 2003 database (http://www.claritas.com). Because PRIZM is a nationwide system, not all PRIZM classes are present in a given metropolitan area. In this data set, PRIZM 5, 15, and 62 classifications, have 4, 10, and 29 classes represented, respectively. Table 2 gives the population share of each PRIZM 5 and 15 group for

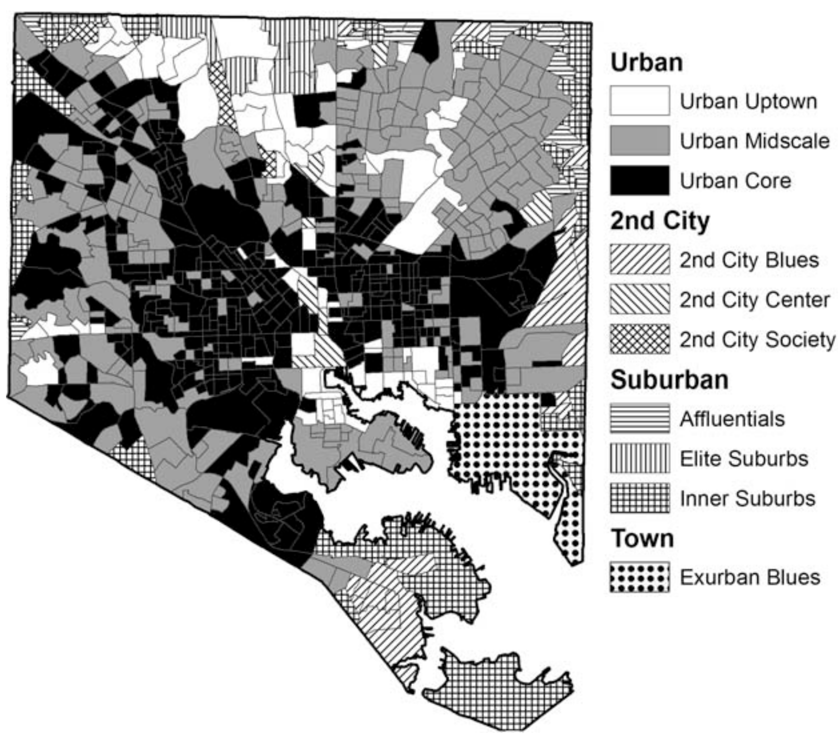

Fig. 2 PRIZM 15 market segments mapped by block group for Baltimore, MD

Table 2 PRIZM 5 and 15 group population breakdown for Baltimore, MD with classes in gray dropped from the analyses of variance because of their small population sizes

PRIZM Category	Population	Percent of total
Urban	578,086	88.8%
Urban core	277,007	42.5%
Urban midscale	238,656	36.7%
Urban uptown	62,423	9.6%
Suburban	42,428	6.5%
Affluentials	11,228	1.7%
Elite suburbs	5,112	0.8%
Inner suburbs	26,088	4.0%
2nd City	29,538	4.5%
2nd City blues	17,136	2.6%
2nd City center	8,877	1.4%
2nd City society	3,525	0.5%
Town	1,102	0.2%
Exurban Blues	1,102	0.2%

the study region. Median house age for each block group was obtained from Maryland Property View® data at the individual property level and the mean was derived by block group.

Property parcel boundaries were obtained in digital format from the City of Baltimore. These parcel boundaries, converted to digital format from the City's cadastral maps, were current as of July 2001. The vegetation data used in this study came from the Strategic Urban Forests Assessment (SUFA) for Baltimore City (Irani and Galvin 2003). Four land cover classes were derived from IKONOS satellite imagery (GeoEye Corporation) acquired in October 2001: grass, forest, water, and other (developed). After fusing the 1-m panchromatic imagery with the 4-m imagery to create a pan-sharpened 1-m multispectral image, Irani and Galvin (2003) applied a series of algorithms to extract land cover.

Building footprints were obtained in digital format from Baltimore City's planimetric database, which includes all permanent structures greater than or equal to 100 ft^2 (9.3 m^2). Buildings were originally mapped at a scale of 1:480 from imagery acquired during 2000–2001, and then updated using 2001–2003 1:4080 scale imagery. More than 1500 ha (~7% of Baltimore City) of building footprints were examined to check for errors. Only eight errors of omission were found.

Average 2003 household yard care expenditure data by Census block group, obtained from Claritas, Inc., included expenditures for lawn/garden services and supplies and yard machinery. The ''yard expenditures'' variable used in this analysis refers to the sum of these three expenditure types.

Geoprocessing

Possible and realized stewardship were calculated at the parcel level and then summarized at the Census block group level. In the first step, the parcel boundary layer was combined with the building footprints layer using the ArcGIS™ union geoprocessing function, yielding a combined parcel-building layer in which each polygon was attributed with a code indicating whether or not a structure resides on that land. Next, the SUFA vegetation layer was unioned with the combined parcel-buildings layer. Each polygon had a series of attributes indicating whether or not the polygon fell within a parcel, was a structure, or was vegetated. Some polygons were attributed as both vegetation and building due to overhanging tree canopy. Realized stewardship polygons were identified by selecting polygons that met the following criteria: (1) vegetation; (2) fell within a parcel; and (3) not overhanging a structure. Similarly, possible stewardship was calculated from the union of the SUFA vegetation layer and the layer of building footprints subtracted from parcels. This was done by selecting polygons with the following criteria: (1) fell within a parcel, (2) not buildings, (3) not vegetation, and (4) not water. Percent possible stewardship was summarized at the block group level by dividing possible stewardship area by private land parcel area for each block group. Percent realized stewardship was calculated by dividing the vegetated area on possible stewardship land by the total possible stewardship area. This measure was also broken down by grass and trees.

Statistical Analyses

Statistical analysis was conducted in two parts. First analysis of variance (ANOVA) was combined with a multimodel comparison approach to determine which PRIZM segmentation most effectively and parsimoniously described differences in the following variables, all averaged by block group: 1) percent possible stewardship; 2) percent realized total stewardship; 3) percent realized stewardship accounted for by trees; 4) percent realized stewardship accounted for by grass; and 5) yard care expenditures. For each dependent variable, three ANOVA models were compared (PRIZM 5, PRIZM 15, and PRIZM 62) yielding 15 models (Table 3). For the second group of analyses, regressions were run for each dependent variable using continuous predictor variables representing the three demographic theories plus housing age, crime, and open space.

Multimodel comparisons were conducted using the information theoretic approach of Burnham and Anderson (2002) to compare whether ANOVA models using PRIZM 5, 15, or 62 classifications best explained the variation in

Table 3 ANOVA model descriptions and results

Model name	Response variables	Explanatory variables	F stat (p val)
P1	Possible stewardship	PRIZM5	44.06 ($p < 0.0001$)
P2	Possible stewardship	PRIZM15	23.21 ($p < 0.0001$)
P3	Possible stewardship	PRIZM62	10.88 ($p < 0.0001$)
R1	Total reazlied stewardship	PRIZM5	24.33 ($p < 0.0001$)
R2	Total reazlied stewardship	PRIZM15	15.20 ($p < 0.0001$)
R3	Total reazlied stewardship	PRIZM62	12.44 ($p < 0.0001$)
T1	Realized stewardship: trees only	PRIZM5	22.97 ($p < 0.0001$)
T2	Realized stewardship: trees only	PRIZM15	16.28 ($p < 0.0001$)
T3	Realized stewardship: trees only	PRIZM62	10.53 ($p < 0.0001$)
G1	Realized stewardship: grass only	PRIZM5	11.75 ($p < 0.0001$)
G2	Realized stewardship: grass only	PRIZM15	11.60 ($p < 0.0001$)
G3	Realized stewardship: grass only	PRIZM62	11.05 ($p < 0.0001$)
Y1	Yard expenditures	PRIZM5	27.16 ($p < 0.0001$)
Y2	Yard expenditures	PRIZM15	85.15 ($p < 0.0001$)
Y3	Yard expenditures	PRIZM62	36.04 ($p < 0.0001$)

each of the response variables. In this approach, the best model is selected from a set based on minimization of the Akaike Information Criterion (Akaike 1973, 1978), which is described further in Appendix 2. Three models were compared for each dependent variable, yielding five three-way comparisons and five ''best'' models. PRIZM categories with three or fewer block groups were dropped from each ANOVA because these categories represented too small a proportion of the population to be considered as valid predictors (the mean number of observations per PRIZM class is 177 for PRIZM 5, 71 for PRIZM 15, and 25 for PRIZM 62). Therefore, of the 708 block groups used as observations for the ANOVA, 707 were used for the PRIZM5 model, 704 for PRIZM15, and 684 for PRIZM62.

For the second set of analyses, each dependent variable was regressed against sets of continuous predictors that are reflective of each of the three social theories (Table 4). Since the three PRIZM segmentations sequentially build upon each other (i.e., social stratification includes population density, and lifestyle includes social stratification and population density), so do the regressions. Therefore, population density models have only one continuous predictor, while social stratification models include population density in addition to variables for income, race, education, crime level, vacancy level, and housing age. Lifestyle models include all aforementioned variables in addition to variables for household size, owner occupancy rates, percent single-family detached homes and townhomes, marriage rates, and amount of park or protected land in the block group. For dependent variables best explained by PRIZM 15, only social stratification variables are included in continuous regressions, whereas for those best explained by PRIZM 62, lifestyle variables are also included. Regressions were first run with all variables expected to be significant and then rerun with insignificant terms dropped (Table 5).

Results

Categorical Models

For the ANOVA of possible stewardship, PRIZM15 (social stratification) has the lowest AIC score, meaning it strikes the best balance of model fit and parsimony (i.e., fewest number of categories) among the three candidate models. PRIZM62 (lifestyle) has the lowest AIC score for realized total stewardship (trees plus grass), realized tree stewardship, and realized grass stewardship, as well as for yard care expenditures. Based on these results, we ran regressions of possible stewardship against continuous measures representing social stratification theory (which is inclusive of population density) and regressions of realized stewardship and yard expenditures against measures representing lifestyle theory (which is inclusive of population density and social stratification). ANOVA model descriptions and results are given in Table 3 and multimodel comparisons of ANOVAs using AIC scores are given in Table 6. Box and whisker plots comparing possible and realized stewardship by PRIZM class for each segmentation level are given in Figures 3a–c and 4a–c. Pairwise comparisons among the PRIZM groups (using the Tukey method) are given in Table 7 for possible stewardship and in Tables 8 and 9 for realized total stewardship. Only pairs with significant differences are

Table 4 Description of predictor variables grouped by theory

Variable	Description	Mean	StDev	Median	Variable set
POPD	Population density	15213	9566	13541	Population density theory
MED.HH.INC	Median household income	31508	16717	29821	Social stratification theory (includes population density variable)
MED.VAL	Median home value	69433	46822	63200	
P.VAC	Percent of housing vacant	0.147	0.125	0.113	
P.HS	Percent high school graduates	0.656	0.170	0.663	
YRSOLD	Average house age, based on assessor's data	55.45	9.67	58.00	
P.AFAM	Percent of population that is African American	0.659	0.368	0.852	
CRIMEIND	Crime index based on composite of all crime types, where 100 equals the national average	356.09	123.75	357	
P.SFDH	Percent of housing that is single family detached homes	0.149	0.213	0.053	Lifestyle theory (includes social stratification and population density variables)
P.TH	Percent of housing that is townhomes	0.556	0.309	0.607	
AVE.HH.S	Average household size	2.55	0.49	2.58	
P.OWNOCC	Percent of owner-occupied housing	0.523	0.247	0.542	
P.PROT	Percent of land that is public parks or other protected open space	0.074	0.144	0.005	
P.MARRIED	Percent of population that is married	0.281	0.146	0.277	

Table 5 Continuous model predictors excluding insignificant terms

Model name	Response variables	Explanatory variables included from variable sets
PSS	Possible stewardship	Population density, median household income, percent building vacancy, normalized national crime index, house age, (housing age squared)
RLS	Realized total stewardship (grass plus trees)	Population density, median home value, percent building vacancy, percent African American, percent high school graduate, house age, (house age)^2, average household size, percent single family detached homes, percent townhomes, percent married, percent protected land in block group
YLS	Yard expenditures	Median household income, median age, population density, median home value, percent African American, average household size, percent owner occupied, percent single family detached homes, house age, (house age)^2
TLS	Realized tree stewardship	Population density, median home value, percent building vacancy, percent African American, percent high school graduate, house age, (house age)^2, average household size, percent single family detached homes, percent townhomes, percent married
GLS	Realized grass stewardship	Percent owner occupied housing, population density, percent vacancy, house age, (house age)^2, percent African American, percent high school graduates, percent single family detached homes

Models are named with three letters based on their dependent variables and predictor variable set (e.g. RLS = realized stewardship as a function of lifestyle variables); all variables recorded by block group

listed. Quantitative descriptions of the PRIZM classes are given in Appendix 1.

Continuous Models

The regression of possible stewardship against all social stratification/population density variables revealed that several variables of expected importance, such as race and home value, were insignificant. Removing insignificant terms resulted in the model PSS, in which possible stewardship was found to relate negatively to population density, percent vacancy, and crime index and positively to median income (Table 10). It related quadratically to housing age (Figure 5). R-squared for this model was .69.

The regression of realized total stewardship against lifestyle variables also revealed several insignificant terms among the expected set, including income. Dropping these terms resulted in model RLS, in which realized stewardship related positively to mean home value, percent African American (note that this was the only racial variable used because whites and African Americans together make up 96% of the city's population and no other race has more

Table 6 Categorical model comparisons

Model	Residual df	K	AIC	rank	Akaike weight
P1	701	4	–461.42	3	0%
P2	693	9	–515.01	1	100%
P3	664	18	–505.99	2	0%
R1	701	4	–46.68	3	0.0%
R2	693	9	–88.82	2	0.0%
R3	664	18	–165.63	1	100%
Y1	701	4	8735.60	3	0.0%
Y2	693	9	8317.64	2	0.0%
Y3	664	18	7919.25	1	100%
T1	701	4	–684.46	3	0.0%
T2	693	9	–735.72	2	0.0%
T3	664	18	–791.61	1	100%
G1	701	4	–885.48	3	0.0%
G2	693	9	–923.70	2	0.0%
G3	664	18	–958.06	1	100%

K, number of parameters

than 1.7% population share), percent high school graduation rate, mean household size, percent single-family detached homes, percent married, and percent protected land in the block group, and negatively to population density, percent vacancy, and percent townhouses (Table 11). It related quadratically to housing age (Fig. 6). R-squared was .61.

The model predicting realized stewardship for trees only (TLS) indicated a similar set of significant relationships (Table 12). Realized tree stewardship was positively related to home value, percent African American, high school graduation rate, percent single-family detached homes, mean household size, percent married, and percent protected land. It related negatively to population density, percent vacancy, and percent town houses and again was quadratically related to housing age, but with a different maximum. The R-squared was .58.

In the model GLS, grass stewardship related positively with high school graduation rate, percent African American, percent owner-occupied housing, population density, and percent single-family detached homes, and negatively with percent vacancy, and it had a quadratic relationship with housing age (Table 13). The R-squared was .41.

In the model YLS, yard expenditures related positively to income, home value, median age, mean household size, percent owner occupancy, and percent single-family detached homes, and negatively to population density and percent African American (Table 14). It also related quadratically to housing age, but the signs were flipped from earlier models, yielding a U-shaped curve. The R-squared was considerably higher at .79.

Lifestyle models for realized stewardship and yard expenditures (i.e., RLS, TLS, GLS, YLS) were compared to models with only social stratification variables and population density as predictors, using AIC scores for comparison. In all cases, Akaike weights near 100% and much higher R-squared values indicated the superiority of the lifestyle models. Results of the other models are not given in the interests of space.

Discussion

Possible Stewardship

Multimodel comparisons of categorical predictors indicated that PRIZM 15, which describes social stratification and is inclusive of population density (PRIZM 5), best described differences in possible stewardship. One might expect that parsing PRIZM 15 into the nearly threefold number of categories that constitute PRIZM 62 would make at least a small improvement in predicting possible stewardship. However, AIC scores indicated that any improvement was outweighed by the penalty from increased model complexity. This result is consistent with theory because possible stewardship is a proxy measure of lot coverage and building density. Areas of high lot coverage and density, and hence low possible stewardship, tend to be located in older and more centrally located neighborhoods. These neighborhoods are characterized by higher population density and often by lower incomes and high proportions of minority households, as the housing filtering theory predicts.

Disaggregating this result using regressions of continuous predictor variables provided elaboration. The negative

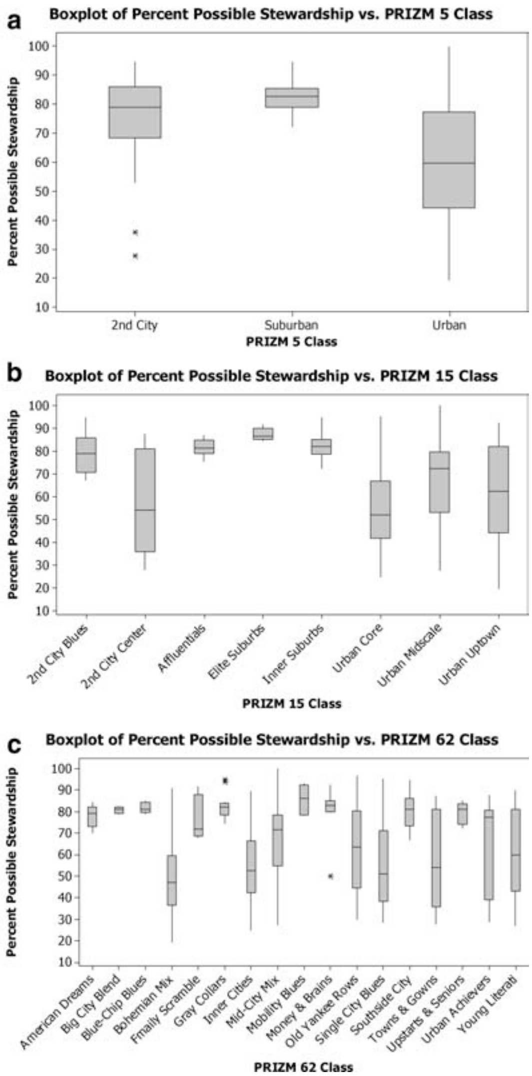

Fig. 3 a–c Box plots of possible stewardship against PRIZM classes

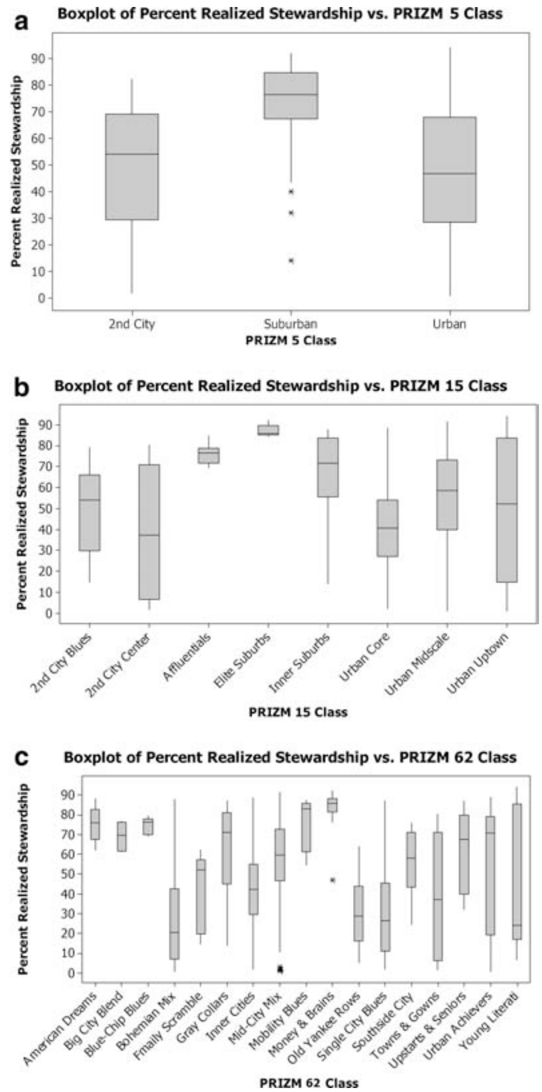

Fig. 4 a–c Box plots of realized total stewardship against PRIZM class

relationship between possible stewardship and population density confirms that higher density means higher lot coverage and less space to plant. The positive relationship with income and negative relationship with percent vacancy and crime levels indicate the importance of social stratification; wealthier, lower crime neighborhoods have more plantable area. Race was not a significant variable, which was likely due to the strong correlation between race and housing age (when that quadratic term is dropped, percent African American becomes significant). The nonlinear relationship between possible stewardship and housing age was expected. Holding all else constant, a block group had a mean possible stewardship value of approximately 40% for new housing, increased to 70% at around 38 years of age, and declined thereafter until reaching 0% at near 95 years. In other words, possible stewardship in the city was at its highest and lot coverage was lowest for neighborhoods built in the late 1960s. This means that possible stewardship for new homes is high compared to prewar housing and suggests that many—but certainly not all—prewar neighborhoods are characterized by high lot coverage and lower possible stewardship. Prewar neighborhoods are particularly likely to have very low possible stewardship when also characterized by low incomes and high vacancy rates. This lends support to Bond and Coulson's (1989) findings that housing filters to lower income groups based on both age and size.

Pairwise comparisons from the ANOVA of possible stewardship provided further insight into these differences. In the interests of space, only a few are discussed. For instance, Elite Suburbs had 32% more land available for possible stewardship than Urban Cores. Consistent with our hypotheses and results, Claritas (1999) describes significant differences in education and affluence among these

Table 7 Significant pairwise comparisons from ANOVAs for possible stewardship

Possible stewardship by PRIZM 5			Diff. in means	Simultaneous 95% confidence limits	
Suburban	—	Urban	0.228	0.165	0.290
2nd City	—	Urban	0.141	0.063	0.290
Possible stewardship by PRIZM 15					
2nd city blues	—	Urban core	0.233	0.114	0.353
2nd city blues	—	Urban midscale	0.122	0.001	0.242
2nd city blues	—	Urban uptown	0.160	0.029	0.291
2nd city center	—	Inner suburbs	–0.229	–0.443	–0.015
Affluentials	—	Urban core	0.264	0.115	0.413
Affluentials	—	Urban midscale	0.153	0.003	0.303
Affluentials	—	Urban uptown	0.191	0.033	0.349
Elite suburbs	—	Urban core	0.322	0.114	0.531
Elite suburbs	—	Urban midscale	0.211	0.002	0.420
Elite Suburbs	—	Urban uptown	0.249	0.034	0.464
Inner suburbs	—	Urban core	0.276	0.177	0.376
Inner suburbs	—	Urban midscale	0.165	0.064	0.266
Inner suburbs	—	Urban uptown	0.203	0.090	0.316
Urban core	—	Urban midscale	–0.111	–0.154	–0.068
Urban core	—	Urban uptown	–0.073	–0.141	–0.006

Table 8 Significant pairwise comparisons from ANOVAs for realized total stewardship by PRIZM 5 and 15

Realized Total stewardship by PRIZM 5			Diff. in means	Simultaneous 95% confidence limits	
2nd City	—	Suburban	–0.221	–0.35	–0.091
Suburban	—	Urban	0.249	0.165	0.332
Realized stewardship by PRIZM 15					
2nd City blues	—	Elite suburbs	–0.354	–0.675	–0.0334
2nd City center	—	Affluentials	–0.358	–0.684	–0.0325
2nd City center	—	Elite suburbs	–0.471	–0.852	–0.0896
Affluentials	—	Urban core	0.348	0.146	0.549
Affluentials	—	Urban midscale	0.217	0.0142	0.419
Affluentials	—	Urban uptown	0.263	0.049	0.477
Elite suburbs	—	Urban Core	0.46	0.178	0.742
Elite suburbs	—	Urban midscale	0.329	0.0461	0.612
Elite suburbs	—	Urban uptown	0.376	0.0841	0.667
Inner suburbs		Urban core	0.26	0.125	0.395
Inner suburbs		Urban uptown	0.175	0.022	0.329
Urban core		Urban Midscale	–0.131	–0.189	–0.0731

two PRIZM 15 groups. The Elite Suburbs group is dominated by households with college and graduate education, median household income of $81,900 per year, median home value of $225,000, and most are owner-occupied. In contrast, Urban Cores is dominated by households with, on average, less than an 8th grade or high school education, median household income of $18,800, and median home value of $56,700, and most are renter-occupied. Six other PRIZM15 categories, including Affluentials, 2nd city blues, inner suburbs, urban uptown, elite suburbs, and urban midscale, had higher possible stewardship than the urban cores.

Realized Stewardship

Differences in realized total stewardship were best predicted by PRIZM 62, or lifestyle clusters. In other words, parsing the PRIZM 15 categories more finely yielded better explanatory power, unlike with possible stewardship. Again, this result was hypothesized because planting and

Table 9 Significant pairwise comparisons from analyses of variance for realized total stewardship by PRIZM 62

Realized stewardship by PRIZM 62			Diff. in means	Simultaneous 95% confidence limits	
2nd city blues	—	Elite suburbs	–0.354	–0.675	–0.033
2nd city center	—	Affluentials	–0.358	–0.684	–0.032
2nd city center	—	Elite suburbs	–0.471	–0.852	–0.089
Affluentials	—	Urban core	0.348	0.147	0.550
Affluentials	—	Urban midscale	0.215	0.013	0.418
Affluentials	—	Urban uptown	0.263	0.049	0.478
Elite suburbs	—	Urban core	0.461	0.178	0.743
Elite suburbs	—	Urban midscale	0.328	0.045	0.611
Elite suburbs	—	Urban uptown	0.376	0.084	0.667
Inner suburbs	—	Urban core	0.260	0.125	0.396
Inner suburbs	—	Urban uptown	0.175	0.022	0.329
Urban core	—	Urban midscale	–0.133	–0.191	–0.074
American dreams	—	Bohemian mix	0.445	0.177	0.713
American dreams	—	Inner cities	0.321	0.084	0.557
American dreams	—	Old Yankee rows	0.441	0.167	0.716
American dreams	—	Single city blues	0.447	0.193	0.701
Big city blend	—	Single city blues	0.389	0.008	0.771
Blue chip blues	—	Bohemian mix	0.440	0.085	0.794
Blue chip blues	—	Old Yankee rows	0.436	0.076	0.795
Blue chip blues	—	Single city blues	0.441	0.097	0.785
Bohemian mix	—	Gray collars	–0.331	–0.575	–0.088
Bohemian mix	—	Mid city Mix	–0.263	–0.408	–0.118
Bohemian mix	—	Mobility blues	–0.449	–0.804	–0.095
Bohemian mix	—	Money & brains	–0.516	–0.784	–0.248
Bohemian mix	—	Upstarts & seniors	–0.322	–0.630	–0.014
Bohemian mix	—	Urban achievers	–0.258	–0.435	–0.082
Family scramble	—	Money & brains	–0.390	–0.769	–0.012
Gray collars	—	Old Yankee rows	0.327	0.076	0.578
Gray collars	—	Single city blues	0.333	0.104	0.561
Inner cities	—	Mid city mix	–0.138	–0.209	–0.066
Inner cities	—	Money & brains	–0.391	–0.627	–0.154
Inner cities	—	Single city blues	0.126	0.013	0.240
Inner cities	—	Urban achievers	–0.134	–0.257	–0.010
Mid city mix	—	Money & brains	–0.253	–0.492	–0.015
Mid city mix	—	Old Yankee rows	0.259	0.102	0.416
Mid city mix	—	Single city blues	0.264	0.147	0.382
Mobility blues	—	Old Yankee rows	0.445	0.086	0.805
Mobility blues	—	Single city blues	0.451	0.106	0.795
Money & brains	—	Old Yankee rows	0.512	0.237	0.786
Money & brains	—	Single city blues	0.517	0.263	0.771
Money & brains	—	Towns & gowns	0.421	0.059	0.783
Money & brains	—	Young literati	0.356	0.067	0.646
Old Yankee rows	—	Upstarts & seniors	–0.318	–0.632	–0.005
Old Yankee rows	—	Urban achievers	–0.254	–0.441	–0.068
Single city blues	—	Upstarts & seniors	–0.324	–0.620	–0.028
Single city blues	—	Urban achievers	–0.260	–0.415	–0.105

Table 10 Possible stewardship model results (PSS)

Term	Value	t value	Sig
(Intercept)	0.656772	11.183	**
POPD	–0.000011	–24.293	**
MED.HH.INC	0.000001	4.329	**
P.VAC	–0.336543	–9.836	**
CRIMEIND	–0.000154	–4.641	**
YRSOLD	0.014977	6.268	**
YRSOLD^2	–0.000200	–8.125	**
R-squared: .688			

* Significant at the 95% confidence level

** Significant at the 99% confidence level

Table 11 Total realized stewardship (RLS) model results

Term	Value	t value	Sig
(Intercept)	–0.33470	–3.583	**
POPD	–0.00001	–7.124	**
MED.VAL	0.0000004	2.485	*
P.AFAM	0.16839	7.636	**
P.HS	0.21609	4.747	**
P.VAC	–0.17986	–3.284	**
YRSOLD	0.02523	7.018	**
YRSOLD^2	–0.00029	–7.759	**
AVE.HH.SZ	0.05923	3.097	**
P.SFDH	0.29523	5.666	**
P.TH	–0.16325	–4.979	**
P.MARRIED	0.18101	2.903	**
P.PROT	0.12336	2.995	**

R-squared: .614

maintenance behavior were expected to vary based on many lifestyle factors in addition to the socio-economic status of the neighborhood.

Disaggregating the PRIZM 62 segmentations into a series of continuous variables provided additional insight. Population density as well and vacancy were negatively associated with realized stewardship, just as they were with possible stewardship. However, other social stratification variables were different. Median income and crime were not significant, but median home value, percent African American, and percent high school graduation rate were significant and had positive relationships with realized stewardship. Although the relationship between housing age and realized stewardship had the same functional form as with possible stewardship, the response was somewhat different. Realized stewardship started out slightly above zero for new homes, increased to 55.5% at roughly 46 years of age and then declined again, reaching zero at about 89 years. This suggests that some vegetation present today is a function of past planting efforts and that the amount of vegetation present today is a function of the time since construction and preferences during the era of construction.

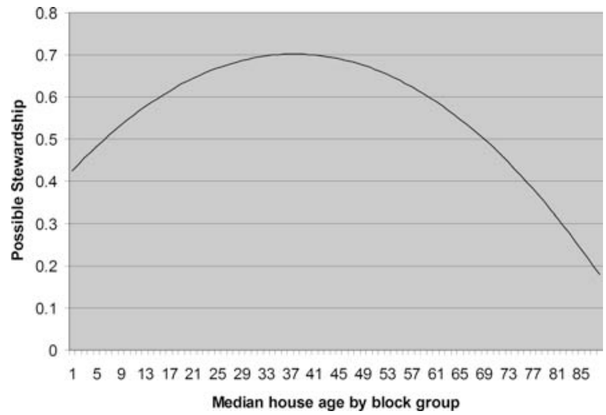

Fig. 5 Housing age versus percent possible stewardship

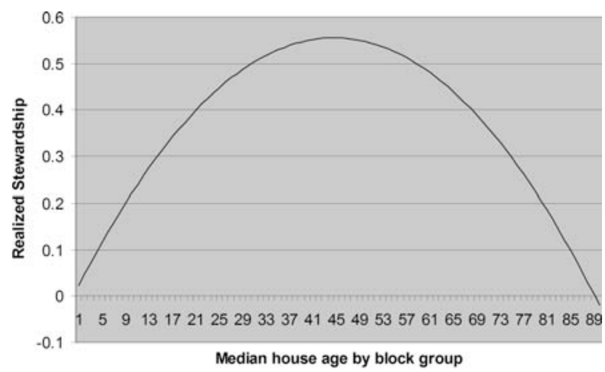

Fig. 6 Housing age versus percent realized stewardship

Table 12 Realized tree stewardship (TLS) model results

Term	Value	t value	Sig
(Intercept)	–0.12512	–2.018	
POPD	–0.000004	–7.893	**
MED.VAL	0.0000006	4.985	**
P.AFAM	0.05283	3.610	**
P.HS	0.08620	2.853	**
P.VAC	–0.08299	–2.284	*
YRSOLD	0.00845	3.542	**
YRSOLD^2	–0.00010	–3.989	**
AVE.HH.SZ	0.03838	3.024	**
P.SFDH	0.15236	4.406	**
P.MARRIED	0.08229	1.989	*
P.TH	–0.13263	–6.096	**
P.Protland	0.09222	3.373	**

R-squared: .577

Table 13 Grass Stewardship Models

Term	Value	t value	Sig
(Intercept)	–0.16111	–2.748	**
POPD	–0.0000014	–2.965	**
P.OWNOCC	0.06780	3.543	**
P.AFAM	0.12360	10.682	**
P.VAC	–0.07069	–1.995	*
P.HS	0.09634	3.672	**
YRSOLD	0.01654	6.934	**
YRSOLD^2	–0.00019	–7.825	**
P.SFDH	0.17969	7.937	**

R-squared: .410

Table 14 Yard expenditure models

Term	Value	t value	Sig
(Intercept)	17.43238	0.440	
POPD	–0.00059	–2.186	*
MED.VAL	0.00070	9.860	**
MED.HH.INC	0.00295	12.608	**
P.AFAM	–43.70979	–5.539	**
P.OWNOCC	104.46216	7.962	**
MED.AGE	2.25572	5.687	**
AVE.HH.SZ	46.45852	7.651	**
P.SFDH	36.45075	2.718	**
YRSOLD	–2.89700	–2.136	*
YRSOLD^2	0.02650	1.904	*

R-squared: .790

Lifestyle factors added further insight. As expected, average household size, percent married, and percent single-family detached homes were positively related to realized total stewardship. All of these factors are more generally associated with more suburban or lower density neighborhoods, where yards tend to be larger and better maintained. Similarly, the percent townhouse variable, which most of Baltimore's dense urban row houses are classified as, was negatively associated with realized stewardship. One of the most interesting results was that percent protected open space was positively related to realized total stewardship. In other words, homes in neighborhoods with considerable public green space were more likely to maintain private green space. Whether this is causal (i.e., seeing green space causes people to want to plant), associative (i.e., the underlying cause may be good site conditions), or due to self-selection (i.e., homeowners with a taste for private greening move to neighborhoods with public green space), is a tantalizing question, but cannot be answered with our data.

When realized stewardship was broken down by the amount of trees and grass, the similarities and differences were telling. Percent single-family detached homes, high school graduates, and African American population were positive and significant predictors of both grass and trees; population density and vacancy rate were negative and significant for grass and trees; and housing age was quadratically related for grass and trees. However, some magnitudes were considerably different. For instance, the effect of population density on trees was nearly three times greater than it was on grass, and the effect of African American population share on trees was nearly half of what it was for grass. Also, housing age had a greater impact on grass than on trees, with a maximum realized grass stewardship of 38% (at year 45) and a maximum realized tree realized stewardship of 19% (at year 43). The fact that the percent owner-occupied variable was significant for grass and not for trees suggests that there may be a legacy effect associated with trees. Specifically, if we assume that home ownership is associated with better stewardship and that grass requires constant maintenance (except for volunteer vegetation in vacant lots), whereas trees require less maintenance, then it follows that current home ownership rates are more likely to be associated with grass than with trees, because trees may have been planted long ago. Home value was positively associated with tree stewardship but not with grass. This may suggest that trees attract higher income residents to neighborhoods in a way that grass does not. Finally, that average household size and marriage rates are positively associated with trees but not with grass suggests the importance of family characteristics in predicting tree cover; that is, married households with more children tend either to plant and maintain more trees or to self-select by moving to neighborhoods with more trees.

The pairwise comparisons from the ANOVA of realized stewardship are generally consistent with the findings of the regressions. For instance, the Bohemian Mix category has 51.6% less realized stewardship than the category Money and Brains. Claritas (1999) describes similar levels of population density and education but significant differences in income, family composition, and housing between these two classes. Both groups can be found in relatively dense settlements, dominated by households with college and graduate education. However, the median household income for ''Money and Brains'' is $67,500 per year, far more than the $38,500 per year for households in the ''Bohemian Mix'' lifestyle group. The other major differences are apparent in family composition and housing. Households associated with the ''Money and Brains'' lifestyle group are dominated by married couples who are 45 years or older, living in their own single-family detached homes. In contrast, households associated with the ''Bohemian Mix'' lifestyle group are dominated by singles who are between 25 and 44 years old, living in a rental unit in multi-unit buildings.

Yard Expenditures

Realized stewardship indicates how much vegetation is present. It says nothing about the quality or type of vegetation, how much work went into its planting and management, or whether it was intentionally planted or established through lot abandonment. Assessing the discrepancies between yard expenditures and realized stewardship contributes to a better understanding of where realized stewardship may be the result of current planting and maintenance, past legacies, or natural succession processes.

Among the categorical models, differences in yard expenditures were best explained by PRIZM 62. For continuous models, there was no surprise that yard expenditures varied positively with income, home value, median age of resident, average household size, percent owner occupancy, and percent single-family detached homes. If yard expenditure is considered a normal good, then it is expected to increase with income and with home value, which is an additional indicator of wealth. It is also expected to increase with household size, because children are often the main users of yards, and with owner occupancy and single-family homes, because both are traditionally associated with lower density neighborhoods where yards are commonly a critical component. Yard expenditures also related quadratically to housing age, but with the opposite sign of all the other regressions, yielding a ''U'' shaped curve. Holding all else constant, yard expenditures averaged around $350/year for new houses, reached a minimum of $279 at 55 years and then continuously increased for older houses. This is consistent with the finding by Law and others (2004) that fertilizer application rates are significantly higher for homes in new housing developments in the Baltimore area.

An even more interesting discrepancy was that although the percent African American variable related positively to realized stewardship, it related negatively (and with a high magnitude) to yard expenditures. That is, residents of neighborhoods with high proportions of African Americans are less likely to spend money on planting and yard maintenance, but live in neighborhoods with higher than average private vegetation. This result may be due to a combination of three factors. First, this may reflect that African American neighborhoods are disproportionately characterized by vegetation that is predominantly the result of historical legacies (e.g., past tree plantings). Second, it may reflect that residents in such neighborhoods use resources other than those measured by spending surveys to conduct planting and maintenance; for instance, they may benefit more from municipal or nonprofit community greening efforts whose expenditures are not reflected in these surveys, or they may substitute their labor for these purchased inputs. Third, it may be partially due to the large number of vacant lots found in predominantly African American neighborhoods. According to the Parks and People Foundation, many such lots in Baltimore are characterized by unmanaged vegetation (Parks and People Foundation 2002), and thus would appear to have high realized stewardship levels. This suggests that in some neighborhoods (e.g., wealthier, predominantly white), realized stewardship is better at measuring intentional, current yard greening activities, whereas in predominantly African American neighborhoods, it may be measuring a combination of intentional current greening, past planting, and unmanaged vegetation in abandoned lots. The relative importance of each component has yet to be understood.

Management Implications

Our results suggest that built form alone does not predetermine the distribution of urban vegetation. This has significant implications for urban natural resource policy and planning. For example, urban tree canopy goals are being developed for urban areas in the Chesapeake Bay Watershed. Private lands are a critical component to achieving these goals; in Baltimore, total canopy cover is 20%, with 90% of that cover located on private lands. Likewise, about 85% of the unplanted land area where potential future planting could occur is on private land, as compared to less than 15% for public rights of way. With Baltimore considering a goal of increasing canopy cover to 46.3% over the next 30 years, it is clear that increasing canopy cover on private lands is essential to this goal (Galvin and others 2006).

The results from this research can be used to begin to develop strategies for increasing canopy cover on private lands. The association of lifestyle indicators with vegetation levels suggests the potential for environmental marketing strategies where planners and managers ''sell'' greener neighborhoods to different neighborhood-based consumer markets, building upon different groups' needs, sense of social status, and group identity. Indeed, Robbins and Sharp (2003:427) describe recent trends in how and to whom the lawncare-chemical industry markets its products by associating ''community, family, and environmental health with intensive turf-grass aesthetics.'' In the case of urban foresters and environmental planners, an environmental marketing strategy could be done systematically using tools of geodemography and cluster-based market segmentation, measuring different lifestyle groups' preferences and motivations for various environmental behaviors, and developing communication strategies to address those preferences and motivations in a spatially explicit context.

The results from this research also indicate that realized stewardship does not vary in constant proportion to possible stewardship. For instance, modelers cannot assume that vegetation will always be 20% of plantable space on a parcel. Modelers will need to know the household sociodemographic characteristics of areas they would like to model. Our research suggests that realized vegetation, as a percentage of possible stewardship, can be predicted based upon lifestyle behavior characteristics.

Acknowledgments We thank the U.S. Forest Service's Northern Research Station and Northeastern Area State & Private Forestry Program (USDA 03-CA-11244225-531), and the National Science Foundation for their support of the Baltimore Ecosystem Study, Long-Term Ecological Research project (NSF DEB-0423476), which this research was a part of. We also thank the Maryland Department of Natural Resources' Forest Service, The City of Baltimore, Space Imaging, LLC. The Parks & People Foundation for their generous contribution of data and expertise to this project, and Dr. Jennifer Jenkins. We also thank the anonymous reviewers of this manuscript for their helpful comments. This paper has benefited from insights gained through interactions with generous collaborators, students, and community partners from Baltimore since 1989. Finally, Dr. William Burch has been an enduring visionary and motivator for this research.

Appendices

Table A1 Description of PRIZM 15 and 62 classes

PRIZM 15 Nickname	PRIZM 62 Nickname	SER	HH Median Income	Family Type	Adult Age	Education	Occupation	Housing	Race/Ethnicity				
									W	B	A	H	I
Elite Suburbs	Blue Blood Estates	1	$135,900	Fam/Cpl	45–64	CG	Exec	Single	[]		•		
	Winner's Circle	2	$90,700	Fam/Cpl	45–64	CG	Exec	Single	[]		•		
	Pools & Patios	9	$67,100	Cpl	45+	CG	Exec	Single	[]		•		
	Kids & Cul-de-Sacs	10	$68,900	Fam/Cpl	35–54	SC/CG	WC/Exec	Single	[]		•		
Urban Uptown	Urban Gold Coast	3	$73,500	Sgl	25+	CG	Exec	Hi-Rise	[]		•		
	Money & Brains	5	$67,500	Cpl	45+	CG	WC/Exec	Single	[]		•		
	Young Literati	6	$63,400	Sgl	25–44	CG	Exec	Hi-Rise			•		
	American Dreams	14	$59,000	Fam/Cpl	Mixed	SC/CG	WC	Single		•	•	•	
	Bohemian Mix	17	$38,500	Sgl	25–44	CG	Exec	Hi-Rise		•	•	•	
2nd City Society	Gray Power	16	$41,800	Sgl/Cpl	55+	SC/CG	WC/Exec	Single	[]				
The Affluentials	Young Influentials	12	$51,700	Sgl/Cpl	25–44	CG	Exec	Multi	•		•		
	New Empty Nests	15	$51,400	Fam/Cpl	45+	SC/CG	WC/Exec	Single	[]				
	Suburban Sprawl	24	$46,400	Mixed	25–44	SC	WC	Mixed		•	•	•	
	Blue-Chip Blues	30	$47,500	Fam/Cpl	35–64	HS/SC	WC/BC	Single	[]				
Inner Suburbs	Upstarts & Seniors	28	$35,600	Cpl/Sgl	Mixed	HS/SC	WC	Multi	[]				
	New Beginnings	29	$35,600	Sgl	18–44	SC/CG	WC	Multi		•	•	•	
	Mobility Blues	41	$33,600	Fam	25–44	HS/SC	BC/Serv	Multi		•	•	[]	
	Gray Collars	42	$34,600	Fam/Cpl	65+	HS	BC/Serv	Single		•			
Urban Midscale	Urban Achievers	22	$40,000	Sgl	Mixed	SC/CG	WC/Exec	Hi-Rise	[]		•	•	
	Big City Blend	32	$39,700	Fam	25–44	HS/SC	WC/BC	Single			•	[]	
	Old Yankee Rows	37	$34,600	Sgl/Fam	Mixed	GS/HS	C/BC/Serv	Multi		•	•	•	
	Mid-City Mix	46	$35,000	Sgl/Fam	25–34	S/HS/SC	WC/Serv	Multi		[]	•		
2nd City Centers	Towns & Gowns	31	$19,700	Sgl	18–34	SC/CG	WC/Serv	Multi	•		•		
Exurban Blues	Military Quarters	40	$32,600	Fam	18–34	HS/SC	WC/Serv	Multi		•			
Urban Cores	Single City Blues	51	$21,200	Sgl	Mixed	GS/HS	WC/Serv	Hi-Rise		•	•	•	
	Inner Cities	61	$16,500	Sgl/Fam	18–34	GS/HS	BC/Serv	Multi		[]		•	
2nd City Blues	Smalltown Downtown	49	$22,800	Sgl/Fam	18–44	HS/SC	WC/BC/Serv	Multi	•	•	•	•	•
	Hometown Retired	52	$20,000	Sgl/Cpl	65+	GS/HS	BC/Serv	Mixed	[]				
	Family Scramble	59	$20,600	Sgl/Fam	25–34	GS/HS	BC/Serv	Multi				[]	•
	Southside City	62	$17,000	Sgl/Fam	18–34	GS/HS	BC/Serv	Multi		[]			

Table A1 Continued

Key
SER (socio-economic ranking): 1 highest, 62 lowest
Family Type:
    Fam Married Couples with Children or Single Parents with Children
    Cpl Married Couples (few children)
    Sgl Singles / Unmarried Couples
GS Grade School
HS High School / Technical School
SC Some College
CG College Graduates
Occupation
    Exec Executive, managerial & professionals (teachers, doctors, etc.)
    WC Other White-Collar (technical, sales, admin/clerical support)
    BC Blue-Collar (assembly, trades & repair, operators, laborers, etc.)
    Serv Service (hospitality, food prep, protective & health services, etc.)
    Farm Farming
Race/Ethnicity
    W White
    B Black
    H Hispanic
    A Asian or Pacific Islander
    I Native American, Eskimo, Aleut
    [] Prevalent
    • Above Average
Housing
    Single Mostly SFDUs, some townhomes or duplexes
    Multi Townhomes, Low-rise Condos/apts., some SFDU
    Hi-Rise Mid/Hi-rise, 10+ unit condos/apts., duplexes
Table Adapted from Claritas (1999)

Appendix 2: multi-model selection

Burnham and Anderson's inferential modeling approach relies on the information theoretic method pioneered by Akaike (1973, 1978), which contends that minimization of the Akaike Information Criterion (AIC) can help select the ''order'' of likelihood of a set of nested or non-nested models. Complexity comes at the tradeoff of parsimony, and therefore it is commonly accepted that a better model is one that achieves a balance between fit and number of parameters (Myung and others 2000, Wagenmakers and Farrell 2004). AIC penalizes model complexity and indicates which model best compromises complexity and fit. The formula for AIC is given by:

$$AIC = -2\log L\ (M) + 2k \tag{1}$$

where k is the number of parameters plus one and log$L(M)$ is the maximized log likelihood for the model.

AIC scores can be compared for models with the same dependent variable. The model with the lowest AIC score out of a set of models is considered to be most likely to be correct. Although the order of AIC scores gives model rankings, this does not reveal how likely it is that a model with the lowest AIC score is the best model. Small differences in AIC scores can lead to a false sense of confidence that one model is superior to another (Wagenmakers and Farrell 2004). Akaike weights (Burnham and Anderson 2002) show the probability of a given model being the correct one out of a set of potential models and are given by the equation:

$$w_i\,(AIC) = \frac{e^{-.5(\Delta_i(AIC))}}{\sum_{k=1}^{K} e^{-.5(\Delta_k AIC)}} \tag{2}$$

where k = the number of models.

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