Assessing Preferences for and Attitudes towards Urban Forests

Assessing Preferences for and Attitudes towards Urban Forests

(Final Report to the National Urban and Community Forestry Advisory Committee)

by

Yaoqi Zhang, Bin Zheng, Dvaid Laband
School of Forestry and Wildlife Sciences, Auburn University, AL 36849
Email: zhangy3@auburn.edu

Jeff L. Sibley
Department of Horticulture, Auburn University, AL 36849

December, 2010

Acknowledgements

This research report was made possible primarily by a grant from USDA-Forest Service, *National Urban and Community Forestry Advisory Committee,* along with financial support from School of Forestry and Wildlife Sciences, Auburn University.

Table of Contents

Executive Summary

Urban trees and greening play a special role in building a livable community. How to use urban trees to promote community development is an important issue to city planners, policy makers, academicians and the general public. This project examines the preferences for and attitudes towards urban trees regarding both biophysical presence of trees (e.g., the amount, size, species and spatial configuration of trees) and forest management and governance (e.g., tree ordinances and tree program financing).

To understand public preferences and attitudes toward urban trees, visual preference survey (VPS) was conducted (see **Appendix 1.1**). The results indicate that trees are important in residential landscaping, and people usually prefer to live in houses with more trees. Large trees with wide round canopy seem also favored. Although most of our respondents claimed that they love nature and wild-look residential landscape, our survey findings suggest that they prefer to live in a clean and well maintained environment. It is also found college students majoring in wildlife science prefer more trees than students majoring in forestry.

Special attention has been paid to college students and attempt to examine how education matter in the preferences to wildness versus neatness landscape to understand the trade-off between ecologically friendly vs aesthetically appealing community. It seems students majoring in agriculture economics, horticulture, and social sciences are more inclined to choose a neat, well-kept environment. Students who come from large cities and college students in their 3rd & 4th years also prefer well-maintained and artificial landscapes. However, wildlife science students prefer naturalized landscapes. It is also found that environmental group membership would matter as well. It seems education and information people received plays an important role in shaping their preferences and attitudes (see **Appendix 2)**.

To understand public preferences and attitudes toward urban trees management, another mail survey was conducted (See **Appendix 1.2**). It is found that people prefer to have trees on their property and in their community regardless of their gender, age, race, income, or family background. The most desirable amenity of trees is the improved appearance provided by trees. Individuals with higher education tend to like more trees in their property. Individual

characteristics such as race, gender, and residence were not statistically significant factors in explaining attitudes toward urban forestry programs. Regarding attitudes toward supporting tree programs, we find that the willingness to donate is significantly less than the amount he or she think should contribute, based on the respondents' statements. Private donation is widely agreed as an important source of support, and using alcohol and tobacco tax revenue to finance urban tree programs has more support than using corporate income tax and property tax. A similar separate study using earlier data sources was conducted to understand public preference and attitudes to forest management (see **Appendix 5)**.

Using canopy cover data from USDA-Forest Service and other data sources, the demand for urban trees at a city level was conducted firstly only in the southern states, then for all cities in the USA. The results show that urban forest percentage across cities exhibits characteristics of the Environmental Kuznets Curve. We estimate that household annual income around $39,000 is a threshold that changes the relationship between income and urban forest coverage from negative to positive. It was also found that the impact of population density on urban forests is just the opposite, from positive to negative when population density is around 180 persons per square kilometer. Secondly, an empirical economic model was used to examine and estimate the demand for urban forests in all cities with population over 100,000 in the United States. Our empirical findings suggest that the demand for urban forests is elastic with respect to price and highly responsive to changes in income. Urban forest area increases as total populations grows but at a lower rate than population growth (see **Appendixes 3 and 4)**.

An important aspect of urban tree governing is to use tree ordinances, which are developed to provide authority, offer guidance to residents, and specify the rights, responsibilities and minimum standards to regulate human relationships regarding trees. Tree ordinances are also an effective tool to engage public participation and awareness of urban trees in the process of formulating, implementing, and amending of the tree ordinances. Development of tree ordinances requires government support, citizen participation and consideration of local resources (see **Appendix 6)**

The results from this study would be useful for policy makers to develop sustainable urban landscape planning. While, urban forests are economic goods, so socio-economic development is an important factor with respect to promoting urban tree programs, institutional arrangements such as tree ordinances are important to urban tree program development.

Education on ecology and environmental awareness, and public engagement in volunteering activities would be helpful to promote environmental friendly communities that are aesthetically as well as culturally and socially appealing.

Part I: Preferences and Attitudes: Urban Forests and Greening

1. 1 Introduction

In Europe, landscaping tree and green space were historically used to be the privilege of rich people. The poor could only enjoy the trees and open spaces provided by the rich. Since the uses of land were highly competitive, landowners tried to maximum the use of the land by closely packing their house together and thus there was no space for trees (Bradshaw et al. 1995). In America, it was not until the late 18th century that trees and lawns were intentionally established in colonial villages. The emerging middle and upper classes promoted the need of park-like residential landscape and home buyers started to place high premiums on wooded parcels (Miller 1989). At the beginning of the 20th century, people realize that trees should be an integral part of the cities. Most large cities and many medium sized communities initiated city forestry programs to plant and care for urban forestry. Nowadays, tree has been well known as an elemental design factor and has been widely used in residential landscape. Advertisements for a new house usually have a carefully drawn tree somewhere in the picture. However, when making change in the physical landscape it is important to realize that each person has different preference and needs. To make the best use of land, city planners need the information of public preference of trees in their residential area. This information may help to promote the ecological and sustainable use of green space.

Trees in urban areas provide a lot of socio-economic and ecological benefits, such as improvement of air quality (Nowak 1993; Nowak and McPherson 1993; Akbari 2002; Rowntree and Nowak 1991), groundwater recharge (Sanders 1986), modification of microclimate (Heisler 1986; McPherson 1990; Meier 1991;), reduction of noise levels (Cook 1978), and provision of wildlife habitat (Johnson 1988) such as birds (Emlen 1974; DeGraaf 2002). The shade from trees for residential house can also save summertime electricity use (Donovan and Butry 2009). The mental and physical benefits from a visual pleasure environment were widely discussed (e.g. Ulrich 1984; Kaplan et al. 1998; Kaplan and Kaplan 1989; Ode and Fry 2002; Price 2003). More recently, a number of studies have established a direct relationship between human health or well being and the long term exposure to natural landscape (e.g. Lafortezza et al. 2009; O'Brien and Murray 2007; Hartig and Cooper-Marcus 2006).

Urban trees make neighborhoods aesthetically appealing. First, trees in community humanize the residential landscape. Houses without trees are hard and even relentless. When confronted by hard surfaces, the eye is restless. Trees break up these lines and planes and related people to their environment. In other words, trees add a nature element to the physical landscape (Nadel et al. 1977). More importantly, this aesthetically appealing usually reflects the emotional resonance. Trees also add beauty, health and comfort to the home and trees in housing landscape usually are meaningful to the owner. For example, to a child, they represent adventure; to a grandmother they represent a memory. Young couples roam around their new home and one remarks "dear, we should buy a new tree to plant right over there." (cited from Willeke 1989, p.61). In this way, trees add a feeling of home to the house and bring harmony to the community. On the other side, house owners show their taste of art and their personality through housing landscape design. A well-maintained front yard usually suggests a good family and a good citizen. As Garrett Eckbo (1950) said," Trees, rather than building, are the best measures of a civilized landscape. A community in which many mature trees survive and more are planted regularly demonstrates a sense of time, history, and continuity on the land" (cited from Walhein 1977, p.7).

The visual contribution of trees is largely a function of design. The line, size, form, texture and color of trees are important design elements. A right size tree can provide a framework for the entire landscape and make the scene spark. A large tree helps create a sense of establishment and permanence. Trees, especially round trees planted at the corners of houses can help to soften the entire picture and define the space (Streich and Rodie 2007). Tree rows in regimented configurations may create outdoor rooms by their sense of enclosure (Anlian 1989).Trees can also be used as accents by various forms. For example, tall and narrow trees add height and drama to the landscape. The evergreen trees usually make the house outstanding on the white snow background in winter.

The condition, posture, and form of trees in a design will influence the mood of observers. Many researchers have been tried to reveal people's preference towards some specific tree figures. Willeke (1989) pointed out that trees provide a sense of security, and most Americans prefer homes that are surrounded by "the umbrella of trees". Sommer and Summit (1996)'s findings also indicated a preference across nationality for spreading and globular trees, and conical and columnar forms were less favored. Summit and Sommer (1999) did further studies on tree shapes and show that people prefer acacia-like characteristics with large canopies and short trunks. Lohr and Pearson-mins (2006) suggested that scenes with trees were more attractive than scenes with inanimate objects, and spreading trees were more attractive than rounded or columnar trees. This finding was consistent with savanna hypothesis.

Li and Strahler (1992) developed a model to measure the crown vegetation canopy. Nelson et al. (2001) tested the preference to tree canopy and found that the visual attractiveness of a tree reflects the completeness of its canopy: trees with the most complete canopies are the most attractive and trees in bare branch are less attractive than trees in leaf. Wolf (2005) conducted a survey to explore the trees in business district preferences. The presence of a full-canopy forest was found to be associated with higher visual quality ratings of the retail district. Todorova et al. (2004) also focused on the preferences of street vegetation, especially the compositions of flowers and trees, and they found that flowers were the most preferred element beneath street trees. Behe et al. (2005) conducted a survey to explore which attributes in a "good" landscape consumer valued most. Participants viewed 16 photographs that depicted the front of a landscape residence. Results showed that the relative importance increased from plant material type to plant size to design sophistication.

Public preference to the tree also produces economic value. Early experience has shown that in the sale of homes in a new residence district, trees are as essential as sidewalks and paving, and second only to sewer, water, gas and electric connections (Pack 1922). Recently, urban trees add to the value of property have also been widely discussed (Mansfield et al. 2005; Schroeder 1989; Laverne and Winson-Geideman 2003). Previous hedonic price analyses showed clearly that trees increase the value of residential properties and that people are willing to pay more for housing with trees (Anderson and Cordell 1985, 1988; Tyrväinen 1997; Morales 1980; Payne and Strom 1975). Crompton (2001) concluded that a quality forest or green space has a positive economic ripple effect on nearby properties. Appraised property values of homes that are adjacent to parks and open spaces are typically about 8 to 20 percent higher than those of comparable properties elsewhere. Rental rates of commercial office properties are about 7 percent higher on sites having a quality landscape, which included trees.

Beginning in the 1960s, researchers addressed the question of individual's preferences for landscapes. The collective evidence from environmental psychology and landscape research has shown that individual preference is an influential factor in shaping land use change (Schroeder 1989; Luzar and Diagne 1999; Erickson et al. 2002; Zhang et al. 2007). It is also a powerful tool in determining human response to policies and planning decisions (Kaiser et al. 1999). However, preference is formed and influenced by a complex of socio-economic, cultural and biophysical interactions which cannot be directly observed (Balram and Dragićević 2005; Bourdieu 1984; Fraser and Kenney 2000; Grusky and Wheedon 2001).

Preferences usually are based on how people perceive the surrounding world. Human beings perceive the surrounding through all senses (seeing, hearing, smelling, tasting, touching) simultaneously, and through the information processing system, those sensed data that can be further organized to help to understand and structure the world (Simon 1979). Dialectical materialism argues that perceptions are simply a reflection of the independent material world that surrounds us. Tuan (1990) also believes that the images of topophilia are derived from the surrounding reality. Even if the environment does not "determine" them, it provides the sensory stimuli to our joys and ideals. The development of individual perception of environment plays an important role in shaping individual preferences and attitudes to the landscape.

As a conceptualization of people's mind, preference of landscape is an important part of assessment of landscape quality, and much work has been done with landscape appreciation (Lothian 1999). Danial et al. (1978) focused on the scenic beauty estimation method. Kaplan and Kaplan (1989) studied the information processing model of landscape aesthetics, and Urlich (1983) worked on the development of affective theory. Furthermore, Carlson (1999) argued that appropriate appreciation of human environments also depends on their functions and their roles in our lives. In a word, both beauty and function are important factors for landscape appreciation.

There is little systematic information about the public's preferences towards urban trees. However, this information would be very useful to managers, planners and developers. Characterizing the complexity of individual attitudes can better support the integration of all interest groups, maximize local benefits, and increase success in community tree programs. Respectively, public preferences attitudes are often not same as the planners'. Community planning still rarely involves the public directly nor is it typically based on systematic data about the public needs and interests (Porteous 1977). A better understanding of public preference to urban trees will help policy maker and developer make right decision on urban forest management and also help residents manage their residential area.

We focus on single family residential areas and in new communities in the Southeastern United States. However, we anticipate that the observations and findings will be transitive nationwide. The final results provide important information that can be used to compare with other regions. Therefore, our expected results have nationwide applicability. Our findings from this study provide an important source of inspiration and ideas for planners, developers, civic leaders, urban forestry practitioners, the general public, academic researchers and residents seeking better ways for their communities to expand with green-based growth and urban forestry.

1. 2. Research Methodology

1. 2.1 Literature Review

There are two ways to reveal individual attitudes and preferences. One is from actual choices or actions, such as voting or buying. This is called revealed preference. Another one is to directly ask for responses in attitudes or preferences. This is called stated preference. In resource and environmental economics, a growing number of studies combine these revealed data and stated data (e.g., Adamowicz et al. 2004).

In the context of urban trees, hedonic analysis is the most widely used method for revealed preference study (Morales 1980, Adderson and Cordell 1985,1988, Luttik 2000, Thorsnes 2002, Irwin 2002, Tyrvainen and miettinen 2000, Shultz and King 2001, Powe et al. 1995, Thompson et al 1999). Examining tree contribution to transacted housing prices can reveal public attitudes to and preferences for urban trees and environmental amenities. NUCFAC has already supported several projects, such as "The Influence of Trees on the Appraised Value of Urban Land" in 1996. This method is acceptable, but has some limitations: First, the observed housing or land prices depend on such a large number of factors that missing variables and incomplete specification are often unavoidable; secondly, home buyers' preferences are subject to the market availability within their resident cities and communities. Housing prices may reveal some information about public attitudes and preferences, but in general homebuyers usually cannot choose freely across cities and communities since home and land are fixed commodities; third, attitudes and preferences for many other aspects of urban forests cannot be revealed from hedonic analysis, for example, public policies.

Implicitly or explicitly asking individual attitudes and preferences are more generally applicable and flexible. Surveys and interviews have been extensively used in the field of landscape architecture and environmental psychology. The overview of research findings concerning human responses to natural and urban landscapes provided by Ulrich (1986) shows that most of the reviewed works concern issues related to preferences for natural landscapes, urban versus natural scenes, and the importance of vegetation in urban landscapes. After literature review we find a number of studies, such as Hitchmough et al. (1997), Jorgensen et al. (2002), Schroeder (1983, 1986), Schroeder et al. (1983), Sommer et al. (1990, 1992), Wolf (2003), Talbot and Kaplan (1984), Lorenzo et al. (2000), Todorova et al. (2004), have touched some aspects of attitudes and preference. But generally they only addressed very specific aspects. Following are some of the studies that we think are relevant to our proposed study.

Sullivan (1994) investigated citizens' perception of and preferences for natural and developed settings in the rural-urban fringe in Washtenaw County, Michigan. In this study, farmers, township planning commissioners and other citizens were asked to rank 32 pictures taken at the rural-urban fringe. The results indicated that settings including farm and forest were preferred, and housing developments with mature trees were preferred over development with few trees, and single family housing was preferred over those with multiple family housing.

Tahvanainen et al. (2001) evaluated the public attitudes towards and perceptions of the impacts on scenic beauty and recreational value of forest practices near cities. Five different management practices, clear cutting, thinning, removal of undergrowth, natural state, and traditionally managed cultural landscape, and two evaluation methods, visual presentation (pictures produced by image-capture technology) and verbal questions, were used. Scenic beauty and recreational value were assessed from slides in which management measures were presented by the pairwise comparison technique. The results indicate that scenic beauty and recreational preferences differ considerably from each other.

Lohr et al. (2004) conducted a survey on how urban residents rate and rank the benefits and problems associated with trees in the largest metropolitan area in the continental United States. These studies examined attitudes and preferences from some perspectives of urban trees, but still have not specially addressed the suburban communities, particularly in the Southern U.S.

Austin (2004) investigated resident perspectives of the open space conservation subdivision in Hamburg Township, Michigan. The purpose of this study was to investigate how the process of such planning is implemented and how homebuyers respond to lot size and group management of natural areas. Questions asked included the satisfactions and problems associated with life in these communities, as well as understanding of the open space concept. Interviews revealed that residents were pleased with the access to nearby nature as well as the social aspects of living in their neighborhoods. However, understanding of the open space conservation concept varied considerably among the residents and carries little recognition of the unique features offered by such subdivisions. The results provide useful feedback from residents to those seeking to implement this planning philosophy.

Balram and Dragicevic (2005) used some valid instruments to measure the dimensions of citizen attitudes toward urban green spaces. Geographic information system (GIS) techniques are collaboratively with informal interviews to generate complementary insights about the spatial and non-spatial factors influencing attitude towards urban green spaces. Affinity analysis aggregated the issues into three homogeneous categories that guided the construction of questionnaire items. Factor analysis and reliability analysis were applied to the items set to create a valid attitude measurement scale. The analysis shows that households are characterized by a two-factor attitude structure towards urban green spaces: behavior and usefulness. It was concluded that urban green spaces attitude is a multi-dimensional construct.

Ozguner and Kendle (2005) examined the public attitudes towards urban naturalistic landscapes in contrast to more formal designs of urban green spaces. Attitudes of the general public were investigated using a site-based questionnaire survey in contrasting two public green spaces of Sheffield, UK. The results show that the general public perceived ‘nature’ or ‘natural’ in two ways in different contexts: as the opposite of formal in a park context and as the opposite of the built-up environment in a town/city-wide context. The public prefers both types of natural areas in an urban setting for different reasons and design styles seem to have an influence on preferences.

Therefore, accounting for public preferences to the greening in community is complicated. The aesthetic quality and environmental services of a community-such as water, fresh air, sense of neighborhood identity-are not bought and sold in the market. For policy making, the main problem is how to differentiate the different preference since it is always not directly observable.

Previous studies have employed strategies such as inferred cues and interrogation using surveys to account for attitude measurements (Dawes 1972). The common questionnaire approach to study landscape-related attitude includes a range of semantic-differential (with good/bad options) and Likert items (with agree/disagree options) (Kerlinger 1992). Both of these methods help to construct the attitude structure.

Stamps and Nasar's (1997) experiments revealed different public preferences to different architectural styles. They used five sets of photo stimuli: a sample of houses which were exempt from review, a sample of houses which passed review, a sample of high style houses to compare with exempt and design review houses, a sample of popular houses, and a second sample of high style houses to contrast with the popular houses. Demographic factors such as city, politics and ethnic origin were examined in this study. Results indicate that architectural components of style or individual buildings make a difference in public preference.

Purcell et al. (2001) investigated two different types of outdoor scenes based on the Perceived Restorative Scale (PRS). Two example scenes were chosen from one of the five scene types including industrial zone, houses, city streets, hills, and lakes. Responses were recorded based on a familiarity scale and two preference scales: the extent of liking the place and preference relative to all other places where the individual had been. An analysis of variance was carried out to examine the relationship between preference, familiarity, and the PRS and scene type. The results indicated that the correlation of preference and the perceived restorative scale score was 0.81; familiarity and the restorative scale at 0.31, and preference and familiarity at 0.32.

Todorova et al. (2004) focused on the preferences of street vegetation, especially the compositions of flowers and trees. He used color photos as stimulations. Those photos have the same background with only the planting models differing. The base photo represented a typical residential district of Sapporo, and on the right side was an apartment building and on the left side were the various street-planting models. The questionnaire consisted of structured items in the form of a rank list, all of which were related to perceptions of street flowers. Respondents were asked to rank each item on a five-step rating scale from "strongly agree" to "strongly disagree". Factor analysis was applied to estimate the relationship. The results indicated that flowers were the most preferred element beneath street trees.

Wolf (2005) investigated how consumers respond to the urban forest in central business districts of cities of various sizes. He conducted three four-concept framework guided surveys which started with a preference ratings exercise, using up to 30 images that depicted streetscapes with varying urban forest character. Respondents were asked to rate their level of agreement with statements using a Likert scale, and a pricing assessment was done using a contingent valuation method to understand the impact of streetscape trees on local economics. The study revealed that trees had a positive effect on visual quality. Also trees can significantly influence individual's consumer behavior.

Lohr and Pearsonmins' (2006) study tried to prove savanna hypothesis. Slide images of spreading, rounded, or columnar trees, or inanimate objects in two urban scenes were created, and preferences and emotional responses to those images of 206 participants were measured. A shortened version of the self-report Zuckerman Inventory of Personal Reactions-State Test II was used to monitor general emotional or psychological states. More specifically, the skin temperate and blood pressure were recorded as an indicator of stress variation. Results suggested that scenes with trees were more attractive than scenes with inanimate objects, and spreading trees were more attractive than rounded or columnar trees. This finding was consistent with savanna hypothesis.

In sum, the available literature indicates that people usually apply similar methodologies for the measurement of attitude and preference. However, since attitude may also be influenced by the spatial surrounding environment (Downs and Stea 1977), the challenging part is how to select representative variables for our survey in a simple but effective way.

1.2.2 Survey design

Landscape configurations of trees, green space and house are very much in the broader discipline or landscape architecture. For example, the open space conservation subdivision (Arendt 1996) or "cluster" buildings (Sullivan 1996) has been presented as an alternative to conventional large lot residential development. A form of clustering emphasizes the quality as well as the quantity of land preserved. The format offers a means for local planning officials to accommodate residential growth while preserving natural areas, rural features, and wildlife habitat that is typically altered as sprawl spreads outward from urban centers. It is generally believed that open space conservation subdivision is more environmental friendly and more livable. But this has not been tested and we have even less information on the relationship between the demographic characteristics and their attitudes.

A creative and innovative approach to assessment of preferences for and attitudes towards (sub)urban tree cover, green space and patterns and livability is by evaluation of different virtual patterns of green infrastructure, woodlots, and/or tree composition for single-family residential areas when all other variables are carefully controlled. With computer-alteration we simulated alternative tree compositions on an otherwise identical residential lot, which permitted us to hold constant all other factors that might influence the relative desirability of a property. Then we conducted a series of choice experiments with prospective homeowners to infer public perceptions of the relative desirability of each forest composition. This permitted us to derive a set of homeowner preferences for different types and configurations of trees. So far as we know, this type of tightly-controlled experimental methodology has not been used heretofore to analyze homeowner preferences for trees in a (sub)urban context. But this method has been used to test many other issues in economics, psychology and other disciplines. Because the design is hypothetical, we have the freedom to design different configurations of expansion of the green space and woodlots. We can jointly use internet, personal interviews and mail for the survey.

The common questionnaire approaches to studying landscape-related attitude include a range of semantic-differential (with good/bad options) and Likert items (with agree/disagree options) (Kerlinger 1992). Both of these methods help to construct the attitude structure. In this study, we use a combination of a visual preference survey (VPS) and a questionnaire to obtain a full scope of individual preferences for trees in residential landscape.

VPS methods have been widely used as a research tool by forest managers, environmental psychologists, and landscape architects. Typical uses of VPS include helping the community define preferences for architectural style, signs, building setbacks, landscaping, parking areas, size/scope of transportation facilities, surfaces finishes, and other design elements (see Ulrich 1983; Schroeder 1988; Kaplan and Kaplan 1989; Shaffer and Anderson 1983; Ewing 2001).

In this study, to explore the influence of different combination of trees in housing landscape, the scenes are designed on purpose and to generate following attributes: (1) the amount of trees; (2) wildness/ naturalistic (e.g., different species) versus managed (e.g., the neatness, even aged, planted and well trimmed); (3) the shape of the trees; (4) the size of the trees; (5) the location of trees.

To begin with, we selected 200 different housing landscape photographs from thousands of color photographs. These slides were taken around Alabama, Georgia and Florida without any specific aesthetic considerations or constraints. The selection of the photographs was based on the following criteria: the presence of natural landscapes and a common housing style; good photographic quality with little distortion; and horizontal photographic shots taken at approximately eye level without looking up or down. All the photographs were taken from August to September, 2007.

Then we designed specific scenes based on these 200 slides. The scenes were designed to generate the five tree attributes in Table 1.1. In order to exclude other visual factors such as house style, lawn and sky, we modified the pictures with Adobe Photoshop 7.0 software to obtain a consistent house style, sky, lawn, and path way. To create the alternative scenes, we first created the full factorial design, i.e., all of the possible combinations of attribute levels. This gave a total of 14 alternative scenes for single house community landscape, 6 designs for streetscapes and woodlots respectively (See Appendix 1.1).

Table 1.1 Variables of attributes of urban trees in suburban community

Variable	Description
At single home level	
Amount of trees	By the amount of trees canopy (%)
Tree shape	1=Round 2=Conoid 3=Columnar
The location of trees (front)	0=close to the home 1=far away from home
Size of the trees	0= small 1=medium 2=big
Wilderness vs. well maintained	0=wilderness 1=neatness
At streetscape level	
Amount of trees	By the amount of trees canopy (%)
Tree species	0=Single specie 1=Mixed species
The location of trees	0=close to the home 1=far away from home
Wilderness vs. well maintained	0=wilderness 1=neatness
At woodlot level	
Amount of trees	By the amount of trees canopy (%)
Tree species	0=Single specie 1=Mixed species
The location of trees	0=close to each other 1=far away from each other
Wilderness vs. well maintained space	0=wilderness 1=neatness

There are different ways to display the scenes to participants. Some visual preference studies use ordinal ranking method and forced choice between scenes in paired comparisons. However, ranking is not often used because the common medium alternative precludes side-by-side comparisons of more than a few scenes. Similarly, although paired comparisons are more commonly used and considered more reliable than rating methods, a large number of comparisons might be required when there are many pictures. Therefore, a rating/scaling method was used in this study, and the study design also emphasized the comparisons among different landscape designs. Instead of paired comparison, we group 6-scene per slide and ask for assigned rating on a Likert scale from 1 to 5 (**1 =** least preferred; **5**= most preferred). Such a procedure allowed us to provide various combinations of scenes. In a total, 10 slides were developed based on different combination of the 14 housing landscape scenes.

The survey was conducted in two groups: university students with different majors and local community residents. Students survey was conducted in a classroom equipped with a projection machine and Office PowerPoint 2007. Prior to starting, instructions were given based on a slide of example pictures. Each slide was shown for a limited time, and then it was replaced by a new slide automatically. A short beeping sound was set up to remind the switch of slides. After some pretest, timing was set up based on the following rules: the first 5 slides for individual home were shown for 30 seconds, and the other 5 slides were shown for 25 seconds each. We shortened the showing time based on the experience that individual get familiar with the designs after the first 5 slides. We make sure that students have enough time to make a choice. Speed up a bit made people more comfortable after people got used to the procedure and scenes. Participants took the questionnaire after they finished the visual survey. It usually took 5 minutes to complete this part. In total, survey was completed within 10-15 minutes. Outdoor residents' survey was conducted in rest areas of highways in Alabama and Georgia. Considering the restriction of outdoor environment, we did not use PowerPoint display. A poster for landscape designs were shown and people were asked to rate them in a 1-5 scale. Participants also need to finish a paper questionnaire.

To better investigate the attributes of urban trees in a suburban community and get more information on some specific questions, questionnaire was also used. The questionnaire was designed to elicit information on the size, species, numbers of trees, and the level of open space and wilderness/nature. The viewers were asked to rate the importance of some characteristics of trees (e.g., seasonal color, shape of trees and growing rate). We also collected socio-demographic information including respondent's education background and household characteristics.

1.3. Results

1. 3.1 Participants' descriptions

There were 365 responses for the in-class student survey, 137 responses for the resident survey and 54 responses for on-line survey. In a total, the sample size is 556. The descriptive statistics were reported in Table 1.2. The average annual household income of the total sample was 64,780 dollars. Most of them have 2-3 children in their family. 30% of the families have a child less than 18 years old. In the sample, 64% of them were male. 87% of the responses were white. Also, 25% of the responses were a member of an environmental group.

Table 1.2 Descriptive statistics of respondents

Variable	Total (N = 556)	Student (N =365)	Resident (N = 191)
Family income $ (Std.dev)	64,780 (29,140)	63,160 (30,420)	67,880 (24,360)
# Siblings	2.71 (1.37)	2.73 (1.37)	2.69 (1.32)
Presence of child < 18 yrs	30.04%	29.04%	31.94%
White	87.20%	87.88%	85.40%
Male	63.67%	72.60%	46.60%
Environment Group	25.54%	23.84%	28.80%

For students, most students were more than 20 years old (83%), and 65% of them were higher than senior level. Students had different academic disciplines (see Figure1.1), and they were grouped into 5 majors: wildlife science, forestry, agriculture economics (including business and accounting), horticulture (including building science, architecture and recreation management) and social science (including history, psychology and education). About 26% of the students came from rural area (population <2000) and 46% of them came from small city (population <50,000). Almost 90% of the students' parents held a bachelor degree or higher and 75% of them were professionals. For residents, most of them had a job (69%) and 18% of them were retired. 38% of residents held a house worth more than 200,000 dollars, suggesting a relative wealthy family background.

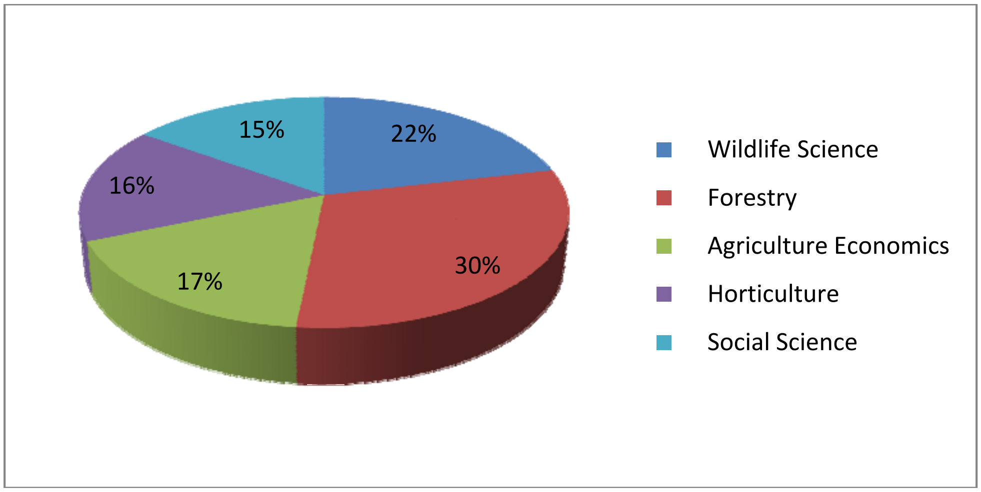

Figure 1.1 Students' academic disciplines structure (N=365)

1.3.2 Landscape design rating

The mean value of Likert scale of each single housing landscape design for student survey and resident survey was shown in Table 1.3. Our results suggested that H3, H13 and H11 were the top 3 favorite residential landscape designs. S4 was the most favorite design in streetscapes. W3 received the highest score in woodlot designs. H1, S3 and W2 were the least preferred designs respectively. A t-test was conducted to compare the rating score from students and residents. Results indicated that the ranking of the designs from students are almost the same as residents, suggesting a similar preference of students and residents toward those landscape designs.
To explore the question of whether there is a difference between forestry majors and those in other natural resource fields (NRES) or outside of natural resources and environmental studies (non-NRES), the sample was aggregated into three groups: 1) Forestry, 2) majors in a natural resource field other than forestry, including wildlife science, agricultural economics and recreation management, 3) majors in non-natural resource disciplines. Moreover, we also wanted to explore the difference between rural and urban residences. The results of this analysis were listed in Table 1.4 and suggested that there was a relationship between academic major and housing landscape visual preferences.

Table 1. 3 Mean value of Likert score of landscape designs of students and residents

Variables	Student rating (Std.dev) N=369	Resident rating (Std.dev) N=191	Overall rating (Std.dev) N=556
Single house			
H1	1.89 (1.23)	1.64 (1.02)	1.80 (1.17)
H2	3.29 (1.22)	3.24 (1.26)	3.28 (1.23)
H3	3.84 (0.90)	4.05 (0.93)	3.91 (0.92)
H4	2.33 (0.86)	2.05 (0.84)	2.23 (0.86)
H5	2.25 (1.13)	2.16 (1.14)	2.21 (1.13)
H6	3.25 (0.79)	3.21 (0.92)	3.23 (0.84)
H7	3.19 (0.88)	3.17 (1.09)	3.18 (0.95)
H8	3.33 (0.91)	3.36 (1.11)	3.34 (0.98)
H9	2.51 (1.03)	2.32 (1.08)	2.44 (1.05)
H10	2.58 (0.90)	2.53 (1.13)	2.57 (0.99)
H11	3.57 (0.93)	3.89 (1.05)	3.68 (0.98)
H12	2.34 (1.10)	2.20 (1.20)	2.29 (1.13)
H13	3.62 (1.40)	3.95 (1.33)	3.73 (1.38)
H14	2.89 (0.85)	2.94 (1.18)	2.91 (0.97)
Streetscape			
S1	2.77 (1.05)	2.92 (1.15)	2.82 (1.09)
S2	2.80 (1.13)	2.96 (1.18)	2.86 (1.15)
S3	1.86 (1.26)	2.04 (1.25)	1.92 (1.26)
S4	3.91 (1.20)	4.01 (1.15)	3.94 (1.18)
S5	3.64 (1.15)	3.60 (1.17)	3.63 (1.15)
S6	3.70 (1.17)	3.79 (1.19)	3.73 (1.18)
Woodlot			
W1	3.51 (1.24)	3.56 (1.32)	3.53 (1.27)
W2	2.01 (1.32)	2.07 (1.20)	2.03 (1.28)
W3	3.63 (1.22)	3.89 (1.08)	3.72 (1.18)
W4	3.09 (1.08)	3.21 (1.19)	3.13 (1.12)
W5	3.15 (1.53)	3.00 (1.28)	3.10 (1.45)
W6	3.54 (1.06)	3.29 (1.04)	3.45 (1.06)
t-value (df = 26)	t = -0.12		
p-value	P = 0.9087		

Three groups' comparison results indicated that the preferences for H1, H2, H3, H9, H10, H12, H13, S2, S4, S5, S6, W5 and W6 were significantly different among Forestry, NRES, and non-NRES students groups. More specifically, differences were noticed between Forestry and non-NRES, and between NRES and non-NRES. There was no significant difference in preferences between students from urban and rural area.

Table 1.4 Forestry, NRES and non-NRES Comparisons; Location comparison

Item mean	Group (a) Forestry N=106	(b) NRES N=135	(c) Non-NRES N=124	F-value	Location Rural N=93	Urban N=272	F-value
H1	1.71 c	1.82 c	2.14 a,b	3.56**	1.82	1.91	0.35
H2	3.41 c	3.47 c	2.90 a,b	7.83***	3.25	3.30	0.09
H3	3.82	3.93 c	3.68 b	2.51*	3.81	3.83	0.01
H4	2.28	2.27	2.48	2.07	2.31	2.34	0.11
H5	2.09	2.25	2.32	1.16	2.22	2.24	0.02
H6	3.25	3.26	3.19	0.32	3.22	3.24	0.03
H7	3.14	3.22	3.13	0.51	3.19	3.17	0.05
H8	3.19	3.40	3.29	1.80	3.22	3.34	1.06
H9	2.24c	2.49 c	2.79 a,b	7.62***	2.49	2.52	0.06
H10	2.41 b	2.65 a	2.64	2.50*	2.61	2.57	0.17
H11	3.56	3.60	3.47	0.68	3.59	3.54	0.18
H12	2.08 b,c	2.40 a	2.55 a	5.02***	2.36	2.36	0.00
H13	3.77 c	3.76 c	3.29 a,b	4.43**	3.46	3.67	1.47
H14	2.80	2.89	2.97	1.06	2.89	2.89	0.00
S1	2.71	2.75	2.79	0.17	2.60	2.80	2.41
S2	2.57 c	2.81	2.94 a	3.00**	2.73	2.80	0.27
S3	1.76	1.82	1.96	0.72	1.79	1.86	0.24
S4	4.18 b,c	3.86 a	3.69 a	4.43***	3.95	3.88	0.22
S5	3.63	3.78 c	3.41 b	3.31**	3.58	3.64	0.23
S6	3.92 b,c	3.61 a	3.60 a	2.64*	3.58	3.73	1.10
W1	3.46	3.58	3.45	0.42	3.53	3.50	0.04
W2	2.04	1.89	2.10	0.86	1.93	2.02	0.29
W3	3.58	3.63	3.64	0.08	3.71	3.59	0.55
W4	3.13	3.04	3.12	0.28	3.09	3.09	0.00
W5	3.17	3.36 c	2.91 b	2.61*	3.16	3.18	0.00
W6	3.82 c	3.52 c	3.21 a,b	8.83***	3.52	3.53	0.02

Note: Values are based on a scale of 1 to 5, with 1=least preferred, and 5=most preferred. Values in the same row with differing letters are significantly different from each other at a 0.05 level.

1. 3.3 Preference to tree and landscape attributes

In the questionnaire, responses were asked to indicate their preference toward some specific tree attributes (see Figure 1.2). Results indicated that most of the responds preferred to live in a house surrounded by big trees and a lot of trees. Compared with exotic species, they prefer to plant trees with native species.

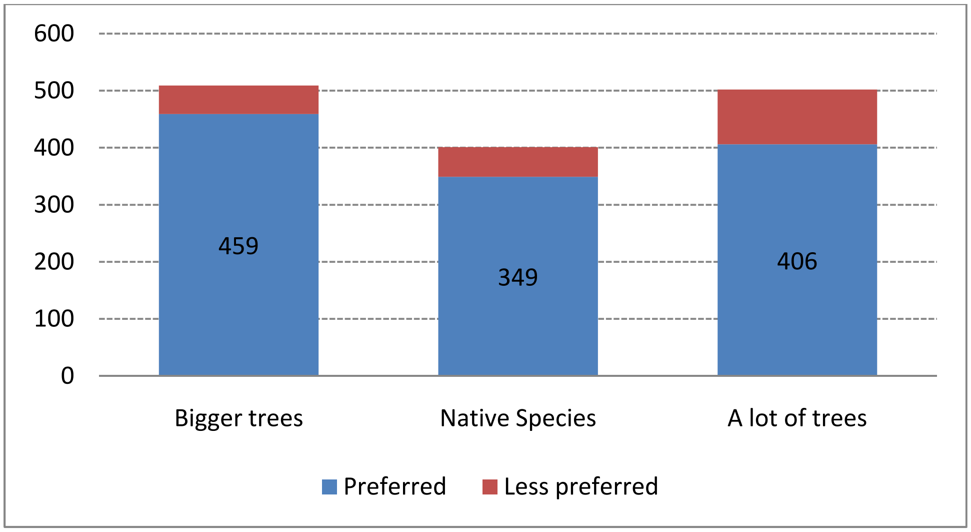

Figure 1.2 Tree factor preference: tree size, species and amount of tree

Among three attributes of tree: seasonal color, tree shape and growing rate, most of people considered seasonal color as the most important factor in landscaping design. Growing rate is relatively less important.

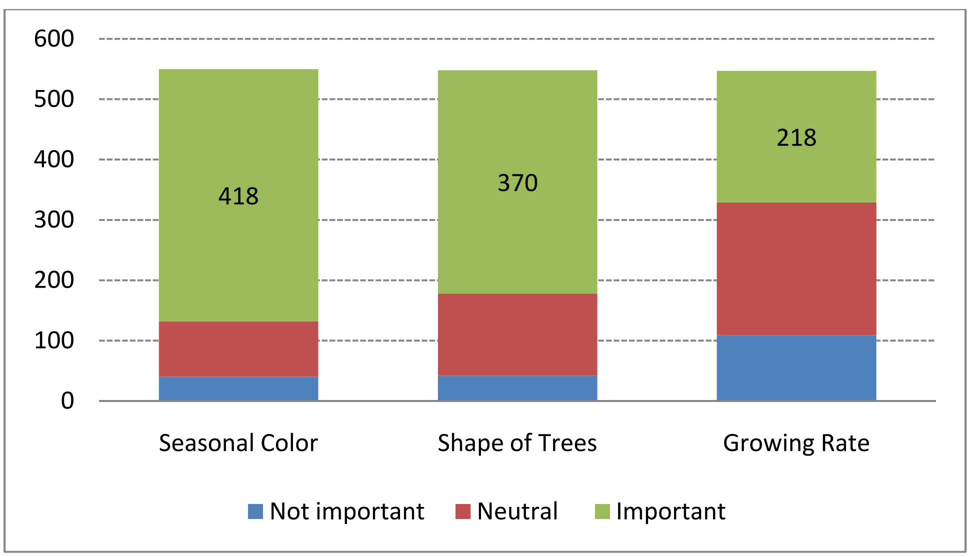

Figure 1.3 Preference to tree features: season color, tree shape and growing rate

Participants were also asked to indicate the importance level of the following six urban tree and landscaping alternatives indicated in Figure 1.4. Results suggested that 401 out of 556 responds chose “To keep more naturalized landscape” as the most important influencing factor. On the other side, “To use more created and artificial landscape” was the least preferred landscaping factor. In addition, “To have a good mix of conifers and deciduous trees” and “To increase tree canopy by planting more trees” received a high importance level.

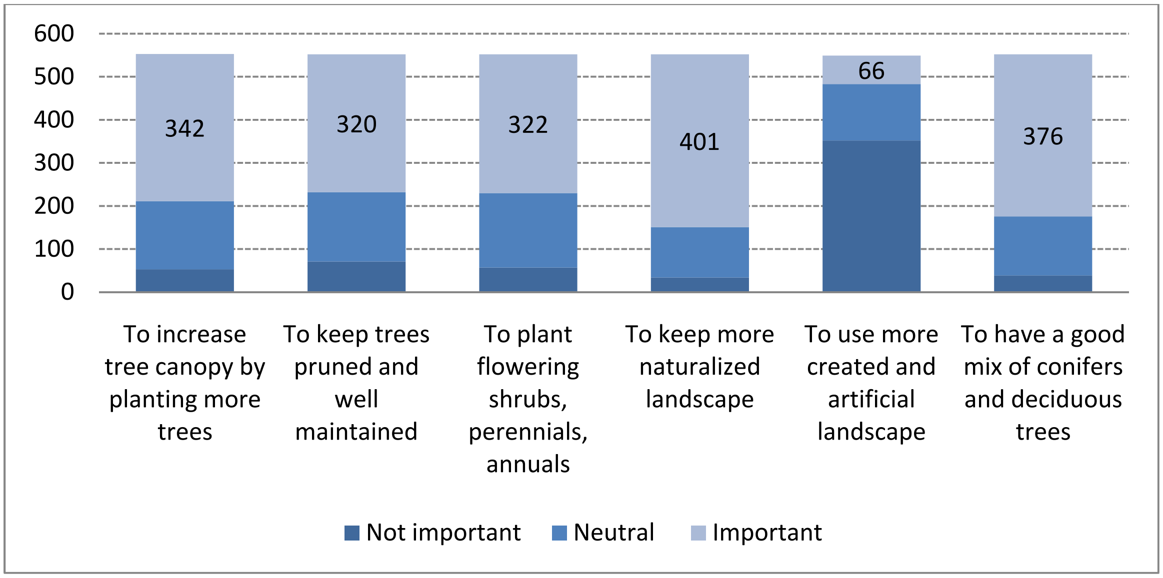

Figure 1.4 Preference to urban trees and landscaping factors

The ranking of these six alternatives were shown in Figure 1.5. And the results were consistent with the importance level in Figure 1.4. We found the top three factors were “To keep more naturalized landscape”, “To have a good mix of conifers and deciduous trees” and “To increase tree canopy by planting more trees”

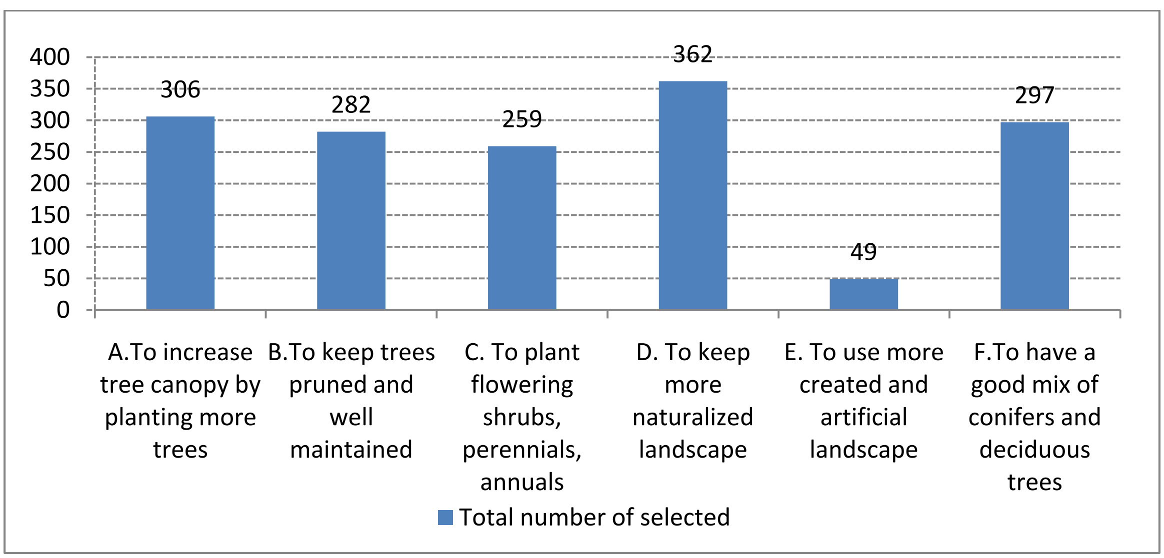

Figure 1.5 Top rating of landscaping factors

Our questionnaire also explored individual's preference to community subdivision. Within same size of subdivision and same construction area and number of single house, most respondents preferred a dispersed development. However, most of them do not like a lot of open space. That may ascribe to the concern of exposure of privacy. As a result, most of them indicated that they prefer a landscape with trees close to home because trees provide shadows and cover. Also, 300 of the responses liked natural and wild-look landscape while 237 of them liked a clean and well-maintained one. See Figure 1.6.

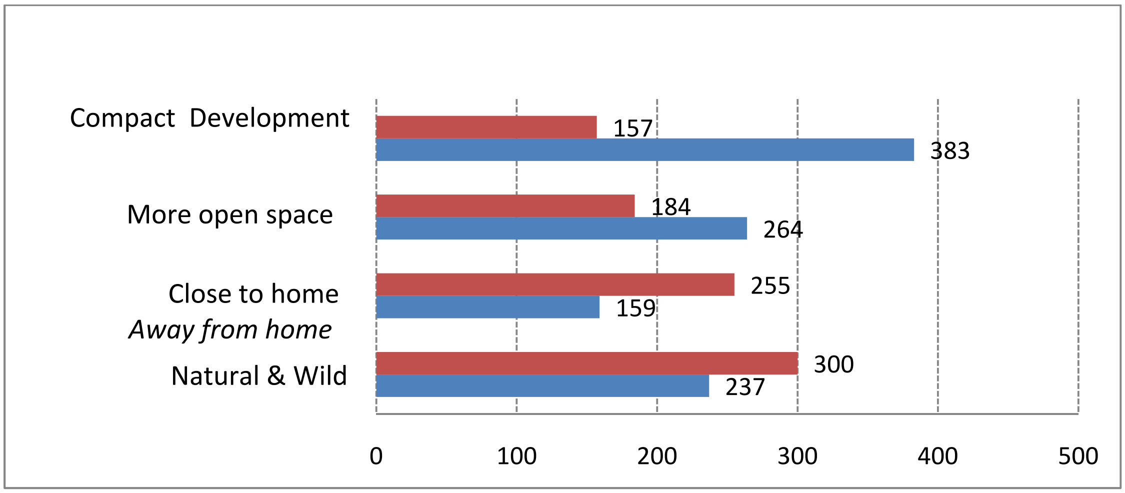

Figure 1.6 Preference to the landscape of community subdivision

1.3.4 Accounting for variation of the preferences

If we ordered the fourteen designs of single housing landscape from higher value to lower value, we noticed that most popular landscapes having a lot of green trees surround the house. Also, in the questionnaire, responses were asked to indicate their preference toward some specific tree attributes. Results indicated that most of the responds preferred to live in a house surrounded by big trees and a lot of trees.

However, sometimes, what people say might not truly reflect what they really think. By using a multiple regression model, we try to reveal the relationship between tree attributes and landscape preferences under the different scenes. Four models were included in this study. The first model used the pooled data for both student and residences' survey. There were 7784 observations in the full dataset, including 556 responses for 14 single house designs. The second model and third model had 5110 observations from student survey, including 365 responses for

14 single house designs. In the fourth model, only 181 students majoring in forestry and wildlife science were included, that is, 2534 observations in total. The regression results were shown in Table 1.5.

Table 1.5 Tree characteristics regression results

Variables	**Model (1)** N=7784 **Coefficient (Robust Std. err)**	**Model (2)** N=5110 **Coefficient (Robust Std. err)**	**Model (3)** N=5110 **Coefficient (Robust Std. err)**	**Model (4)** N=2534 **Coefficient (Robust Std. err)**
Intercept	0.964***	1.139***	1.316***	0.959***
	(0.064)	(0.079)	(0.099)	(0.122)
Amount	0.055***	0.050***	0.046***	0.058***
	(0.003)	(0.003)	(0.003)	(0.005)
$Amount^2$	-0.000343***	-0.000316***	-0.000316***	-0.00033***
	(0.00003)	(0.00003)	(0.00003)	(0.00004)
Round	0.230***	0.191***	0.191***	0.158***
	(0.033)	(0.039)	(0.039)	(0.053)
Conoid	-0.212***	-0.207**	-0.207***	-0.247***
	(0.047)	(0.055)	(0.055)	(0.076)
Big	0.206***	0.219***	0.219***	0.253***
	(0.045)	(0.053)	(0.053)	(0.073)
Medium	0.461***	0.457***	0.457***	0.392***
	(0.053)	(0.063)	(0.063)	(0.086)
Faraway	-0.043	-0.036	-0.036	-0.043
	(0.030)	(0.036)	(0.036)	(0.049)
Neatness	0.397***	0.352***	0.352***	0.302**
	(0.035)	(0.041)	(0.061)	(0.075)
Forestry				-0.029
				(0.109)
Forestry*Amount				-0.003**
				(0.002)
Forestry*Neatness				0.090
				(0.086)
Senior			-0.271***	
			(0.087)	
Senior*Amount			0.007***	
			(0.001)	
Senior*Neatness			0.0002	
			(0.067)	
F-Value	330.92***	194.11***	145.16***	118.14***
$Adj\text{-}R^2$	0. 253	0.232	0.237	0.337

The regression result for the first model suggested that the five tree attributes had significant influence on preferences toward single house landscape, and they explained 25% of the rating score variation. The results from the second model with students' data shared similar findings. This is reasonable because the finding of the t-test in Table 1.3 suggested that the student and local residents shared a similar preference toward housing landscape. The adjust R-square from the third model was 0.2369, which was 0.0047 higher than the R2 from the second model. That is to say, tree characteristics explained most of the variation in this model. Personal characteristics are relatively less influential to home landscape preference.

From model 1, the amount of trees had a significant quadratic relationship with the preference value. By mathematic calculation, the turning point was 80 percent. It suggested that people prefer house landscapes with more trees in general, but that does not necessarily mean the more the better. When the amount of trees was more than 80% in the whole picture, the amount of trees had a negative impact on preference rating.

As for the shape of tree, this study found that people loved round trees which were usually accompanied with a large amount of shade. The average rating increased 0.23 compared to those pictures with columnar tree shape. This result adds support to functional and evolutionary theories of landscape preference. Conoid shape was the least preferred style. When considering the size of trees, the results indicated that people preferred medium and large sized trees. Basically, the pictures with bigger trees got a 0.21 increase in the average rating, and the pictures with medium size of trees got a 0.46 increase in the rating over the picture with small trees. These results are consistent with respondents' answer in the questionnaire. Apparently, amenity value is subjective, but most functional benefits of trees are objective. Decades of preference research suggests otherwise. Kaplan and Kaplan (1989) pointed out that the consistency of response in their study with other studies suggest that amenity value is NOT subjective, in that there are clear patterns of how people respond to trees. Rather, there is a broader, now predictable pattern, with a secondary level of personal variability within the general tendencies.

The openness of the house landscape had no significant impact on preference rating. This is the same conclusion according to the answer to the question regarding openness. Some respondents indicated that they liked more openness for a better view, but they also liked some trees in front of the house to get some kind of 'cover'. However, we should avoid placing trees too close to the home, as they can cause damage to the roof and fill gutters with plant debris. Large trees close the house may even dangerous when tornado comes. From an aesthetic perspective, the distance of the tree to the house is very important. Trees can create a variable sense of scale for a house. Large trees planted near a home may make the home appear very small. Trees can screen undesirable views, and help to develop the sense of shelter and security. Therefore, the balance of openness and privacy, the good-looking and safety is more depended on other factors such as house style, neighborhood structure or local climate. Further studies are needed.

The regression results also suggested that in general, people significantly preferred a neat environment. The pictures which were messy, wild-looking received a 0.39 lower rating on average. This finding is conflict with respondents' selection in the questionnaire in which 300 of the respondents indicated that they like a natural and wild-look landscape. Nassauer (1988) proposes that neatness is one of the most important factors for an attractive landscape, but usually clean-cut bush is not good for biological diversity (Nassauer 1995). Thus, this confliction might reflect an inconsistence between individual's talk and behavior. A messy environment may be more ecological health. It provides habitat for animals. But a messy environment might be not comfortable for human being. For example, bush attracts snakes or bugs. On the one hand, people are willing to express their concern about the natural environment. To have an environmental friendly home might be a symbol of a good citizen. On the other hand, people are not willing to sacrifice their convenience. It is a critical issue to balance the ecological environmental health and the visual amenity.

The difference between senior students and first year students was compared in model 3. The finding indicated that the overall rating from senior students were 0.27 lower on average than the rating from fresh students. This finding revealed the bias between senior and first year students in the overall rating. Usually the senior students were more critical of the man-made changes in the landscapes which they observed. Also, senior student preferred the landscape with more trees and clean environment comparing with first year students.

In model 4, we compared the difference in rating between forestry students and wildlife science students. While other tree attributes still had similar effects as that on model 1, the interaction term of forestry major and tree amount had a significant positive effect on single house landscape preferences at a 0.05 significance level. The result suggested that forestry students were more inclined to give a lower score (-0.003) to the pictures with more trees compared with students majoring in wildlife science. Thus, even though people preferred housing landscape with more trees, the preferences might be different within different majors.

1.4. Conclusions and Discussions

Urban forest plays a special role in building a livable community for American's new suburbs, which should be not only environmental friendly, esthetically as well as cultural and socially appealing. Findings of this study indicated that greening was important in residential landscapes, and people prefer to live in houses with more trees. Large trees with wide round canopy were also favored. This finding supported the savanna landscape assumption in some previous studies (Summit and Sommer 1999; Sommer and Summit 1996). Although our study did not find a significant relationship between the location of trees and individual preference to housing landscape, "where to place the trees" is still a realistic issue in housing development. Our study indicated that people are more inclined to rate the clean and neat environment higher although most of them claim that they love nature and wild-look residential landscape.

The results from our survey suggest that most people have similar preferences regarding residential landscapes aesthetic. There was no difference in preferences to residential landscapes between students and the general public. College students are future buyers. Studies of students' perception provide helpful information in the planning of future housing developments. Compared with forestry students, students majoring in wildlife science prefer the landscapes with more trees. The education background shed some light on shaping individual preference.

Trees are among the most appreciated plants around the home. Lack of adequate information has led to the use of trees that are poorly suited Southern landscapes, resulting in poor performance and high maintenance, or high removal costs (Williams et al. 1993). Building new homes often go to great lengths to maintain landscape trees. It usually takes a minimum of ten years to grow a tree to useful landscape size. So it is wise to take advantage of existing trees by maintaining them in a state of good health. Moreover, people usually like large trees but large trees are hard to transplant. We need to be more careful about the removal of those trees. These old trees have heritage value and should be preserved before landscape construction. How city can grow without complete destruction of the natural environment is a critical issue.

Trees are constantly competing for space in the city. When landscape planners try to integrate new places into established communities, using trees as design elements can help gain public acceptance of the new place. Thus, in areas that are already developed, questions are how to identify the space available for trees and choose the best trees to fit the site. Our findings provided valuable information to city, community policy makers and planners, developers, nonprofit organization, general public and academic researchers to enhance their ability for appropriate tree selection and management in the establishment phase of future urban forests.

While we might be able to assess the preferences, but more studies need to investigate how the preferences to specific landscapes have been developed as well. Goodchild (2006) defines landscape as a concept, a real or imaginary environment in which the land, natural and semi-natural elements are prominent. However, residential landscape is not only a physical part of environment; it is also the results of interaction between human and nature. Earlier, Darwin (1995) proposed the "habitat theory" which asserted that the humans maintain the same kind of relationship with the environment as other organisms. Building on this theory, Appleton (1975) presented the "prospect-refuge" theory of human aesthetics, which suggested that human by their biological nature, are attracted to arts and aesthetics. Apparently amenity value is subjective, but most functional benefits of trees are objective. Are they linked together? More investigation could be interesting.

Part II: Preferences and Attitudes: Urban Forests Management

2.1. Introduction

Amenities have been driving urban growth and becoming magnets of the cities (Clark et al. 2002). For example, a lot of beautiful cities are chosen as technological innovation centers as they are more capable to attract more talented people nationally and internationally. In any specific city, America's growing population is increasingly spreading into the countryside and the rural-urban interface in search of green areas and associated amenities. Trees and green space play a special role in enhancing livability of communities. Urban and community trees, an important part of a city's green infrastructure, provide valuable services just like other forms of municipal infrastructure. The services provided by trees and green space to communities include energy savings, improved air quality, aesthetics, health benefits, habitats for birds and other wildlife, and recreation opportunities. These values are reflected in higher real estate prices, lower electric bills, and an influx of tourists, as well as talented people and businesses (Bradley 1995; Dwyer et al. 1992; Orland et al. 1992).

Community involvement is critical for the continued vitality of urban forests (Dwyer et al. 2002). The number of local urban and community tree programs and related activities has been increasing over the past years. Hauer and Johnson (2008) found a significant increase in local urban forestry activity which had increased on average by 2.1% annually from 1997 to 2002 through reported Performance Measures and Accountability System (PMAS) data to the federal Urban & Community forestry program. There are more than 3,400 communities that are currently a Tree City USA. The number of Alabama's towns and cities that are certified in Tree City USA has grown from one in 1979 to more than eighty in the 2000s.

Financial assistance has been suggested as the most effective means to promote urban forestry programs (Wray and Prestemon 1983; Studer 2003; Straka et al. 2005). Different kinds of activities in urban and community forestry programs are provided from a variety of funding. The most important activities include tree planting, public awareness and volunteer training. Now, many other activities are also occasionally supported, for example, carbon dioxide emission reduction credits, and shade-tree programs for energy conservation, storm water management, and air pollution mitigation. Financial assistance provides money for activities to increase tree inventories and natural resources, develop management plans, and conduct workshops to train community members.

Individuals and business sectors are also an important source, providing an assured source of income for many nonprofit organizations once a solicitation program is in place. An organization supported by its community will also find it easier to secure funding source and corporate support. Corporate entities provide funding to signal the greenness (Majumdar and Zhang 2009). Traditionally, individuals make gifts of either money or time. Members are volunteers who provide the man-power necessary for membership drives, fundraising events, and lobbying. Volunteers can serve as a link between a nonprofit and a potential donor, especially a corporate donor. For example, Trees Atlanta, founded in 1985, has been a prime force in addressing Atlanta residents' loss, creating increased green space. Nearly 25 years after its inception, Trees Atlanta has inspired thousands of Atlanta citizens to advocate for better tree ordinances to protect the city's urban landscape. The activities have been largely supported by thousands of volunteers, as well as private donations (Tree Atlanta: http://www.treesatlanta.org/).

Although volunteers, individual and corporate donors provide much needed assistance, financial support for urban forestry is still short and often inconsistent (Center for Urban Forest Research 2003). Securing financial resources, as well as developing diverse and adaptable long term fund-raising strategies and funding mechanisms is, thus, very important. Current information about the financial sources for community tree programs is lacking, partly due to the diverse sources (a mix of public funding; cost avoidance, reduction and recovery; trust/private funds) and changing organizations involved (Zhang et al. 2009).

In order to facilitate the development of urban and community forestry programs from a financial perspective, and to formulate a workable strategy, we need to explore, assemble, and share information regarding public attitudes toward urban trees and the public's willingness to support urban forestry programs financially. Public attitudes have a significant influence on many aspects, such as budgeting, public involvement and participation, integration of tree programs into social infrastructure, and community identity (see Austin 2002; Sommer et al. 1994; Barro et al. 1997). Therefore, it is important to consult the public and better understand their attitudes in developing a diverse and adaptable strategy. Obtaining information regarding public preferences to support urban tree programs is, therefore, important.

While many studies on urban forestry have analyzed public attitudes on the benefits of urban trees (e.g., Dwyer and Miller 1999; Gorman 2004; Lohr et al. 2004; McPherson et al. 1999; Thompson et al. 1999; Tyrvainen 2001), a more critical issue is developing a sustainable and adequate community forestry support program (e.g., Lorenzo et al. 2000). The purpose of this paper is twofold. First, we examine public attitudes to urban trees including both amenities and negative impacts from trees, from the demand side. Secondly, we explore the public's willingness and preferences to financially support urban forestry programs from a supply side. In the next section, we present the data collection and methodology of analysis, followed by results and conclusions.

2.2. Data Collection and Methodology

To know public attitudes toward urban trees and to formulate a financial strategy for urban forest programs acceptable to the public, we conducted a household survey with a mail-in questionnaire (see Appendix 1.2). Questions related to the following aspects were asked:

- Perceived importance of urban trees on personal and community property;
- Perceived benefits and negative features of urban trees and forests;
- Attitudes to public funding of urban forests and the variety of sources of funding;
- Participation in urban forestry activities;
- Willingness to donate money or volunteer time to urban tree activities
- Socio-demographic information such as age, education, employment status, income, race, gender and number of children.

The survey was conducted from late 2004 to early 2005. We asked Survey Sampling International (One Post Road, Fairfield, CT 06824 USA) to get 3,500 random home addresses (including phone number, addresses and names) from major cities in Alabama (Greenville, Cullman, Mobile, Fairhope, Dothan, Montgomery, Demopolis, Auburn, Hoover, Birmingham, Huntsville, Florence).

We mailed our questionnaires to the 3,500 participants. We received about 280 completed responses and about 350 bad addresses (due to relocating homes or too old database used by Survey Sampling International). After 3-4 weeks we mailed our questionnaires again to those who did not respond. We received about 220 completed responses and 50 bad addresses. After one month, we randomly selected 250 addresses who never responded. We enclosed the value of 3.7 dollars of stamps as economic incentive. It did work to some degree, since we received about 80 responses out of the 250. In total, we received 582 responses, of which there were 102 incomplete responses. Overall we received a roughly 20% response rate from the 3,100 valid addresses. The response rate was a little lower than we expected considering this kind of survey.

In the data analysis, some simple statistical methods are used to describe the attitudes and preferences to urban trees and financing strategies. OLS regression and ordered logistic model are further applied to investigate what factors might influence the preferences. For example, we are particularly interested in the amount of monetary value that the respondents consider "should" be donated (e.g., using tax to impose the changes to all households) and "would" be donated (voluntary contribution) as a function of family background, personal characteristics, and their attitude indicators. The difference between public choice (should donate) and individual choice (willingness to donate or would donate) has been investigated for a long time (see, e.g., Arrow, 1951). People have one set of preferences that govern their private choices, and another set that governs social actions and choices (Kelman, 1981; Sagoff, 1988; Sen, 1995). For example, individual choice of grazing under open access institutional arrangement would cause the tragedy of the commons due to free rider problem. However open access would not be chosen if public choice arrangement is made.

The purpose we ask "should donate" versus "would donate" is to see the individual behaviors under current institution of voluntary contribution versus public choice of forced payment on public support to urban tree program. For example, many people would say they would not donate, but they might support to collect additional property tax to support the urban forest program. For this purpose, a question in the questionnaires was intended to ask the amounts of an average family support urban tree program annually through state sales tax, local property tax, estate tax alcohol, tobacco tax, state income tax, corporate income tax and private donations to know the how much the respondents think is appropriate (or should) to support urban tree programs. The second question to ask the amount the respondent would like to donate their money to support urban tree activities in your area annually (See the survey instrument in the appendix).

Following research by others (see, for instance, Yen et al., 1997; Saz-Salazar & Garcia-Menendez, 2001), it is hypothesized that an individual's response to support urban tree programs depends on his/her income, education, race, gender, experience, and residential location. The OLS regression models are presented below:

$$\textit{Should donate} = \beta_0 + \beta_i x_i + \varepsilon \tag{1}$$

$$\textit{Would donate} = \beta_0 + \beta_i x_i + \varepsilon \tag{2}$$

where *should dona*te is the response to the answer of Question 1 and *would donate* is the response to the answer of Question 2. The dependent variable equals the mean value of each choice. For example, choice C is corresponding to \$115. The dependent variables x_i represent the socio-economic characteristics, such as "family size", "child < 18 years old", education level, race, gender, age and income. The variable of "awareness of tree service" is defined as the total number of forestry agencies he/she knows, including the USDA Forest Service, the National Arbor Day Foundation, the International Society of Arboriculture, the Alabama Cooperative Extension System, the Alabama Forestry Commission and the Auburn University School of Forestry and Wildlife Sciences.

For specific preferences, such as choosing the presence of trees at their home and communities, as well as special financial channels to support urban forestry, the ordered logistic model is applied instead of ordinary linear regression (OLS). Following the work of Zavoina and McElvey (1975) as discussed by Greene (1993), the ordered logistic model is set up in the following way:

$$y^j = \beta' x + \varepsilon \tag{3}$$

where y^j is the level of choice to measure the preference to the dependent variables: "Having tree on property" (y^1), "Having tree in community"(y^2), and the support for "Alcohol & tobacco tax" (y^3), respectively. The dependent variables are of three choices: low level of importance (scale = 6 or 7); median level of importance (scale = 3 to 5); high level of importance (scale = 1or 2). x is a vector of explanatory variables, β an unknown parameter vector, and ε is the error term. ε is assumed to have a standard logistic distribution with mean 0 and variance $\pi^{2/3}$.

The marginal effects are nonlinear functions of the parameter estimates and levels of the explanatory variables. Hence, they generally cannot be inferred directly from parameter estimates. Marginal effects for distributions can be derived as follows:

$$\frac{\partial[p(y_i=0)]}{\partial(x_{ji})}=-\lambda(u_1-x_i^{'}\beta)\beta_j$$

$$\frac{\partial[p(y_i=1)]}{\partial(x_{ji})}=-[\lambda(u_2-x_i^{'}\beta)-\lambda(u_1-x_i^{'}\beta)]\beta_j$$

$$\cdots\cdots$$

$$\frac{\partial[p(y_i=J)]}{\partial(x_{ji})}=-\lambda(u_J-x_i^{'}\beta)\beta_j \tag{4}$$

Based on the equation (4), we can see one variable's marginal effect is related not only to its own coefficient, but also to the values of all other coefficients. Moreover, each observation and each level carry a distinct set of marginal effect values. In practice, marginal effects are generally calculated using the parameter final point estimates and average variable values. In this study, the marginal effects are calculated separately for every observation at three levels, respectively. The results are then averaged to provide a single, average response estimate for every variable, recognizing cumulative effects across the region. Results obtained in this way anticipate more global changes for the population of points and respect the multivariate distribution of parameter values (Wang and Kockelman, 2009).

2.3. Results

Table 2.1 lists the descriptive statistics of the data in our study. Half of our respondents are employed full time and one-third of them are retired. The education level is relatively high: 61% with a bachelor's degree or higher. The average income of respondent household income is $66,280 which is relatively high compared to Alabama's average level of $42,000 in 2007. About 85% of them are white and 13% are African-American; about 60% of respondents are male.

Table 2.1 Statistical summary of the participants

Variables	Mean (Std. dev)
Should donate $	48 (50)
Would donate $	34 (36)
Annual income (in $ 1,000)	66 (33)
Age	51 (13)
Family size	2 (1)
# of Children <18 years old	0.49 (0.93)
	Frequency (%) N=476
Employee status	
Employed	60
Retired and unemployed	39
Education level	
<= high school	13
Some college	25
Bachelor's or higher	61
Race	
African-American or others	14
White/Caucasian	85
Male	60

The results indicate that people like trees in general (see Table 2.2). "Improve the appearance of the community" and "Improvement in air quality" are considered the most important benefits of trees by the largest percentage of people. Attitudes toward the negative impacts are quite mixed: the potential cause for property damage is the most concerned factor. More importantly, the magnitude of the beneficial responses is never above 3, yet all of the negative impacts are above 3, suggesting the public's preference for the benefits of trees outweigh the negative sides or costs of maintaining trees.

Table 2.2 Ranking importance of urban forestry and management (N=470)

	Frequency (%)							Mean(Std.dev)
	1 Very	2 important	3 ---------	4 ---------	5 --------→	6 not important	7	
	Urban tree benefits and negative impact							
Benefits								
Appearance of the community	48.73	28.18	14.19	7.42	0.42	0.42	0.42	*1.86 (1.08)*
Improvement in air quality	47.97	22.81	17.70	8.53	1.49	0.85	0.64	*1.98 (1.20)*
Control runoff, soil erosion	44.68	22.77	21.06	8.09	2.13	0.64	0.64	*2.05 (1.20)*
Creation of buffer zones	43.10	24.84	19.32	8.49	2.76	1.06	0.42	*2.08 (1.22)*
Increase in property values	37.00	28.75	20.51	10.15	1.48	0.21	1.90	*2.19 (1.26)*
Reduction of noise levels	40.89	24.58	18.86	7.63	4.87	2.12	1.06	*2.22 (1.38)*
Decrease in energy costs	36.40	28.69	18.63	11.35	2.36	0.86	1.71	*2.24 (1.31)*
Increase in community pride	33.90	27.51	22.39	11.09	2.99	1.28	0.85	*2.29 (1.27)*
Creation of wildlife habitat	41.19	18.05	18.90	13.38	5.73	1.06	1.70	*2.34 (1.46)*
Improvement in health	34.70	25.86	20.47	13.36	2.16	2.16	1.29	*2.34 (1.36)*
Recreational opportunities	24.52	22.17	24.95	19.40	5.33	1.71	1.92	*2.72 (1.41)*
Negative impacts								
Property damage	21.15	13.68	18.38	20.94	11.54	8.97	5.34	3.36 (1.79)
Safety problem	19.57	12.34	17.66	21.49	13.62	9.57	5.74	3.49(1.79)
Costs planting & maint.	12.31	10.83	20.17	25.05	14.23	9.13	8.28	3.79(1.72)
	Importance of applying tree ordinances							
New construction site	50.00	21.70	9.57	10.64	2.34	1.91	3.83	2.15(1.57)
Public property	55.25	21.84	10.49	7.49	2.14	0.43	2.36	1.90(1.34)
Individually-owned yard	17.45	13.19	17.23	18.72	8.30	8.09	17.02	3.80(2.04)
Having tree on property	47.61	23.08	14.55	8.52	3.53	1.04	1.66	2.07 (1.36)
Having tree on community	54.47	25.16	10.60	6.44	2.08	0.42	0.83	1.81 (1.16)

The results indicate that about 80-90% of respondents strongly agree that tree ordinances should be required on public property and new construction sites, but only 30% strongly agree that tree ordinances should be applied to individual-owned yards. Apparently, households prefer more flexibility to manage their own property.

In the survey, respondents were asked to indicate their attitudes toward “having trees on property” and “having trees in a community.” The results show that about 85% of respondents who are looking for a residence such as a house or apartment indicate that having trees on the property is important, and more than 90% of respondents rate “having trees in the community” as important.

An interesting question is whether the preference is associated with socio-economic and demographic characteristics of the individuals. The ordered logistic model is applied in the investigation. The regression results and the corresponding marginal effects are given in Table 2.3. Ordered logistic regression assumes that the coefficients that describe the relationship between the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories. This is called the proportional odds assumption. The test of the proportional odds assumption is not significant, suggesting that the assumption satisfied.

Table 2.3 Ordered logistic results and marginal effect for having tree on property & community

Variables	Have tree on property) (Y^1)				Have tree on community (Y^2)			
	Ordered logit	Marginal Effect %			Ordered logit	Marginal Effect %		
		Y^1= low	Y^1= median	Y^1= high		Y^2= low	Y^2= median	Y^2= high
Intercept 1	1.75*** (0.13)				2.01*** (0.15)			
Intercept 2	-0.44 (0.93)				-0.37 (0.95)			
Benefit of tree	-0.001 (0.01)	0. 03	-0. 01	-0. 02	-0.0004 (0.011)	0. 01	-0. 006	-0. 004
Negative impact	-0.04 (0.03)	1.01	-0. 42	-0. 58	-0.07** (0.03)	1.78	-1.03	-0. 74
Awareness of tree service	0.004 (0.07)	-0.10	0.04	0.06	-0.03 (0.07)	0.63	-0.37	-0. 27
Family size	0.21 (0.16)	-5.07	2.14	2.93	0.25 (0.16)	-6.06	3.51	2.54
Child < 18 yrs	-0.15 (0.20)	3.72	-1.57	-2.15	-0.20 (0.21)	4.72	-2.74	-1.98
College	0.63* (0.33)	-15.39	6.49	8.89	0.70** (0.34)	-17.00	9.86	7.13
Bachelor	0.16 (0.31)	-3.78	1.57	2.18	0.27 (0.32)	-6.55	3.80	2.74
White	0.34 (0.29)	-8.26	3.49	4.77	0.43 (0.29)	-10.27	5.96	4.31
Male	-0.09 (0.21)	2.10	-0. 89	-1.22	-0.21 (0.21)	5.15	-2.99	-2.16
Age	-0.003 (0.008)	-0. 08	0. 03	-0. 04	0.002 (0.008)	-0. 05	0.03	0.02
Income (in thousand $)	0.001 (0.003)	-0. 03	0. 01	0. 02	0.001 (0.003)	-0. 04	0.02	0. 02
Employed	-0.41* (0.23)	9.92	-4.18	-5.73	-0.32 (0.23)	7.56	-4.38	-3.17
Chi-square	15.22				15.94			
Likelihood Ratio	13.00				14.46			

Note: “Awareness of trees service” is defined as the total number of forestry agency he/she known

The results suggest that education level is positively associated with the tendency to prefer having trees on a property and within the community. For every one level increase in education (e.g., from high school to some college), we expect a 0.63 increase in the expected log odds of moving to the next higher level of preference to having trees on a property. When the respondent holds a college degree, the probability to choose a high level of importance of having trees on their property is increased by 8.89%. That is to say, people with a high level of educational attainment are more likely to consider having trees on their property as an important characteristic. Similarly, people with high levels of education also have tendencies to rate having trees within the community as an important characteristic.

In contrast with retired respondents, employed individuals are less likely to consider having trees on their property, holding other variables constant. A one unit increase in the rating of negative impact of trees would reduce the probability to support having trees within the community by 0.74%, suggesting that respondents who rate highly the negative impact of trees are less likely to support having trees in a community. However, most of the explanatory variables are not significant, such as income, family size, race, age, presence of young child, and gender, suggesting that people in general enjoy trees regardless of their personal characteristics.

In regards to the source of public funding supporting a community's planting and maintenance of trees, the local government is considered by 60% of respondents to be important, while only 50% and 25% for state government and federal government, respectively. "Private donations" is also widely considered being an important source, but using taxes as a financial source is not largely supported with the exception of the "alcohol and tobacco tax" and corporate income tax. The "state sales tax," "local property tax," and "estate tax" each received low support (see Table 2.4).

Table 2.4 The attitudes and preference to finance community trees programs

	Frequency (%)							Mean(Std.dev)
	1 Very	2 important	3 ---------------	4 ---------------	5 →	6 not important	7	
State sales tax	7.40	10.76	11.43	18.16	11.21	8.07	32.96	4.71 (2.03)
Local property tax	14.32	14.54	14.99	15.88	8.50	7.38	24.38	4.09 (2.14)
Estate tax	7.34	5.73	8.49	19.04	9.63	10.09	39.68	5.07 (1.98)
Alcohol and tobacco tax	30.46	10.82	11.26	15.67	5.74	4.19	21.85	3.55 (2.30)
State income tax	8.50	9.40	14.77	18.34	9.84	8.28	30.87	4.60 (2.04)
Corporate income tax	23.45	12.83	14.82	15.49	5.53	6.19	21.68	3.72 (2.23)
Private donations	42.64	22.86	13.85	11.87	2.86	1.10	4.84	2.32 (1.61)
Others	38.37	10.47	6.98	9.30	2.33	3.49	29.07	3.35 (2.57)

Since most people indicate that "private donations" is an important source for financing urban tree programs, their willingness to donate became an important question. In the survey, people were asked to rate their willingness to donate money and the willingness to volunteer time to support urban tree activities. We found only 20% of the respondents indicate they are very likely to donate time or money toward a community tree program. This finding suggests that although people notice private donation is important for the establishment of community trees, they do not have a strong willingness to donate either time or money themselves, simply hoping other people will do that.

Furthermore, when comparing the question of "how much should an average family support urban tree programs annually?" versus "how much would you like to donate annually", we found that, on average, donations for an urban tree program would be $14 less than the money respondents think should be used to support such a program (see Table 2.1). Without specifying the source of funding, most people are inclined to say they like trees in residential areas and strongly support the urban forestry program. However, when they were asked to bear the costs either by all the community members or voluntary manner, the amount of donation is more in question. To investigate what factors affect the amount of donations to urban trees programs, a multiple regression is conducted, and the results are presented in Table 2.5.

Table 2. 5 Regression results for donation willingness

Variables	Should donate $ per family	Would donate $ per family
Intercept	22.20 (16.32)	-19.71 (12.04)
Awareness of tree service	1.89 (1.71)	2.29** (1.19)
Family size	0.55 (3.82)	-3.91 (3.00)
Child < 18 yrs	-4.74 (4.99)	-0.50 (3.61)
College	6.10 (8.19)	6.06 (5.97)
Bachelor	9.42 (7.86)	-0.54 (5.73)
White	18.08*** (6.78)	2.07 (4.96)
Male	-14.01*** (5.17)	-6.58* (3.76)
Age	0.07 (0.21)	-0.01 (0.17)
Income (in thousand $)	0.17** (0.08)	0.27*** (0.06)
Employed	-2.26 (5.76)	5.30 (4.28)
R-square	0.10	0.13
F-value (Chi-square)	2.80	3.52

The results suggest that both models are significant at a 0.01 level. Factors that significantly influence the money that respondents believe **should** be donated to support community trees are race, gender, income. Factors significantly influencing a respondent's willingness to donate money (or **would** be donated) include gender, income and the awareness of tree service. High income families will donate more for urban tree programs in both “should” and “would” models. However, the magnitude of money is 0.1 dollars higher for “would donate” than “should donate” for each one thousand dollar increase in annual household income. That is to say, an individual’s donation decision is more sensitive to their income level. The public’s knowledge of tree services significantly influences the amount of donation in the “would donate” model. A better knowing of the forestry service agencies such as USDA forest service will increase the support of public for urban tree program.

Individual characteristics also matter in this case. White respondents, on average, believe that a family should donate $18 more on tree programs than do African-American respondents. Males, on average believe a family should donate $14 less than do female respondents. Family background such as family size, presence of child less than 18 years old, working status, education level and age have no significant influence on the donation amount.

Table 2.6 Ordered logistic results and marginal effect for alcohol & tobacco tax

Variables	Alcohol & tobacco tax (Y^3)			
	Ordered Logistic Estimate	Marginal effect %		
		Y^3=low	Y^3=median	Y^3=high
Intercept 1	0.99*(0.09)			
Intercept 2	-1.31*** (0.92)			
Awareness of tree service	-0.06 (0.06)	1.36	-0.32	-1.04
Family size	0.05(0.16)	-1.13	0.27	0.86
Child < 18 yrs	-0.05 (0.20)	1.09	-0.26	-0.83
College	0.73*** (0.34)	-17.61	4.16	13.44
Bachelor	0.56* (0.33)	-13.58	3.21	10.36
White	0.18 (0.28)	-4.45	1.05	3.40
Male	0.29(0.21)	-7.02	1.66	5.36
Age	0.01 (0.008)	-0.26	0.06	0.20
Income (in thousand $)	0.002(0.003)	-0.05	0.01	0.04
Employed	-0.002 (0.23)	0.06	-0.01	-0.04
Chi-square	31.04			
Likelihood Ratio	14.92			

To explore the level of obtaining financing from the alcohol and tobacco tax, a logistic model is applied. The results of ordered logistic regression are shown in Table 2.6. Our results suggest that education level and being male are positively associated with the tendency to support alcohol and tobacco tax. For every one level increase in education (from high school to some college, from some college to bachelor degree), we expect a 0.5-0.7 increase in the expected log odds as move to the next higher level of support. The probability of having a high level of support increases by 13.44 % and 10.36% for college education and bachelor degree, respectively. That is to say, people with high education prefer the government to add tax to alcohol and tobacco users and the money can be a source of finance for community tree programs. Similarly, males are more inclined to support the finance from alcohol and tobacco tax compared to women based on our findings. Other variables such as race, age, income, working status, family size and children have no significant impact on the support level probability.

2.4. Conclusions and Discussions

The findings from this study provide further support for the evidence found in previous studies that humans like trees (e.g., Lohr et al. 2004; Clark et al. 2002; Strata et al. 2005; Zhang et al 2007). People like to have trees on their property and in the community rather than based on their gender, age, race, income, and family background. The most favored amenity of trees is that trees improve the appearance of the community. Individuals with higher education have a higher tendency to have trees on their property. People with a high concern of the negative impacts of trees, such as the potential damaged caused by trees, would be less likely to prefer trees in their community.

Our further analysis on the characteristics contributing to an individual's willingness to donate money shed light on the policy implications, as people who have more information about urban tree programs and forestry services are more likely to donate money. Managers and planners should take more action to help public access to urban tree program and encourage the public to participate in urban tree activities. Tree agencies also play a role in distributing information and providing technical support. To educate the public on the functions of urban tree programs is an important means of gaining their support, especially for small communities (Thompson and Ahern 2000). For example, providing public education and more accessible media information can increase public awareness of urban tree programs. Females and whites have a high tendency to donate money to a fundraiser. Family income is a significantly positive influence in the amount of donation. A good economic environment helps in fund raising.

While evidence shows that there is significant demand for urban trees, financial support for urban trees does not match the growing demand. This is not surprising since demand would be high if the cost issue is not addressed. In contrast with many studies that primarily focused on the demand side or the attitudes toward urban trees, this study not only investigate public attitudes to trees but also the preferences to financing urban tree programs. While this study has its limitations in sampling size, response rate, and the questions formulated, the results shed some light on our perception of financing urban trees programs, and provide some results for further investigation. Our survey was targeted to citizens, a further investigation to mayors and city managers would be useful. Another limitation in our study is that the sample could be potentially biased due to the relatively low response rate. Our sample population is from relatively high income, high education level families as compared to the average level in Alabama.

Acknowledgements

We gratefully acknowledge the financial support of the National Urban and Community Forestry Advisory Council Challenge Cost-Share Program (#05-DG-11083150-160). We also thank the students who participated in the survey. The survey instrument was approved by the Auburn University Institutional Review Board. We would also like to thank valuable comments and tremendous supports provided by Dr. Brenda Allen, Dr. Becky Barlow, Dr. Conner Bailey, Dr. Jiquan Chen, Mr. Neil Letson , Dr. Zhifang Wang, Mr. Pengyu Zhu in the progress of this project implementation.

References

Akbari, H. 2002. Shade trees reduce building energy use and Co2 emissions from power plants. Environmental pollution 116: S119-S126.

Anderson, L.M., and H.K Cordell. 1985. Residential property values improved by landscaping with trees. Southern Journal of Applied Forestry 9(3): 162-166.

Anderson, L.M., and H.K.,Cordell. 1988. Influence of trees on residential property values in Athens, Georgia (U.S.A.): A Survey based on actual sales prices. Landscape and Urban Planning 15: 153-164.

Anderson, L.M., and H.W. Schroeder. 1983. Application of wildland scenic assessment methods to the urban landscape. Landscape Planning 10: 219-237.

Anlian, S.J. 1989. Building a sense of place. In: Moll G, Ebenreck S (Eds) Shading our cities—a resource guide for urban and community forests, Island Press, Washington, D.C, pp 106-111.

Appleton, J. 1975. The experience of landscape. John Wiley and Sons. Chichester, UK.

Arrow, K.J. 1951. Social choice and individual value. Yale University Press, New Haven.

Austin, M.E. 2002. Partnership opportunities in neighborhood tree planting initiatives: Building from local knowledge. Journal of Arboriculture 28: 178-186.

Barro, S.C., P.H. Gobster, H.W. Schroeder, and S.M. Bartram. 1997. What makes a big tree special? Insight from the Chicagoland Treemendous Trees program. Joournal of Arboriculture 23: 239-249.

Balram, S., and S., Dragićević (2005) Attitude toward urban green spaces: integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. Landscape and Urban Planning 71: 147-162.

Behe, B., J,,Hardy, and S. Barton. 2005. Landscape plant material, size, and design sophistication increase perceived home value. Journal of Environmental Horticulture 23(3): 127-133.

Bourdieu, P. 1984. Distinction: A social critique of the judgement of taste. Harvard University Press, Cambridge, MA.

Briggs, D.J., and J. France. 1980. Landscape evaluation: a comparative study. Journal of Environmental Management 10: 263–275.

Bradshaw, A., B,, Hunt, and T. Walmsley. 1995. Trees in the urban landscape—principles and practice. E&FN Spon, London, UK.

Bradley, G. 1995. Urban Forest Landscapes: Integrating Multidisciplinary Perspectives. Seattle: University of Washington Press.

Campbell, L., C.S. Gulas, and T.S. Gruca. 1999. Corporate giving behavior and decision-maker social consciousness. Journal of Business Ethics 19: 375-383.

Carlson, A.1999. Aesthetics and the environment: The appreciation of nature, art and architecture. Routledge, New York.

Carter, S.M., and J.M. Dukerich. 1998. Corporate responses to changes in reputation. Corporate Reputation Review 1(3): 250-270.

Center for Urban Forest Research. 2003. Urban Forest Research Newsletter. Pacific Southwest Research Station, USDA Forest Service, spring, 2003.
Clark, T.N., R. Iloyd, K.Wong, and P. Jain. 2002. Amenities drive urban growth. Journal of Urban Affairs 24(5): 493-515.
Cook, D.I. 1978. Trees, solid barriers, and combinations: alternatives for noise control. In: Hopkins G (ed) Proceedings of the National Urban Forestry Conference. USDA Forest Service, SUNY College of Environmental Science and Forestry, New York, pp 330–339.
Crompton, J.L. 2001. Parks and economic development. American Planning Association, Chicago, IL.
Crompton, J.L. 1997. Partnering with business: What's in it for them? Journal of Park and Recreation Administration 15(4): 38-60.
Daniel,T.C., L.M., Anderson, H.W., Schroeder, and IIIL. Wheeler. 1978. Mapping the scenic beauty of forest landscapes. Leisure science 1(1): 35-52.
Danovan, G.H., and D.T. Butry. 2009 The value of shade: Estimating the effect of urban trees on summertime electricity use. Energy and Buildings 41: 662-668.
Darwin C (1995) The origin of species. Random House Value Publishing, Inc, NY,
DeGraaf, R.M. 2002. Trees, shrubs, and vines for attracting birds. University Press of New England, Hanover, New Hampshire.
Dwyer, J.E., D.J. Nowak, and G.W. Watson. 2002. Furture directions for urban forestry research in the Unitied States. Journal of Arboriculture 28:231-236.
Dwyer, J.F., E.G. McPherson, H.W. Schroeder, and R.A. Rowntree. 1992. Assessing the benefits and costs of the urban forest. Journal of Arboriculture 18(5): 227-234.
Dwyer, M.C., and R.W. Miller. 1999. Using GIS to assess urban tree canopy benefits and surrounding greenspace distributions. Journal of Arboriculture 30 (1): 102-106.
Eckbo, G. 1950. Landscape for living. Architectural Record with Duell, Sloan, & Pearce, New York.
Emlen, J.T. 1974. An urban bird community in Tucson, Arizona: derivation, structure, regulation. The Condor 76: 184–197.
Erickson, D.L., R.L., Ryan, and R. De Young. 2002. Woodlots in the rural landscape; landowner motivations and management attitudes in a Michigan (USA) case study. Landscape Urban Plan 58: 101-112.
Ewing, R. 2001. Using a visual preference survey in transit design. Public Works Management and Policy 5(4): 270-280.
Fombrun, C., and M. Shanley. 1990. What's in a name? Reputation building and corporate strategy. Academy of Management Journal 33(2): 233-258.
Fraser, E.D.G., and W.A. Kenney. 2000. Cultural background and landscape history as factors affecting perceptions of the urban forest. Journal of Arboriculture 26(2): 106-112.
Gorman, J., 2004. Residents' opinions on the value of street trees depending on tree allocation. Journal of Arboriculture 30 (1): 36-43.
Goodchild, P.H. 2006. A suggested primary definition of landscape. http://www.icomos.fi/HUL_US_Goodchild2.pdf. Accessed September 11 2008.
Grusky, D.B., and K.A. Wheedon. 2001. Decomposition without death: A research agenda for a new class analysis. Acta Sociologica 44(3): 203-218.
Greene, W.H. 1993. Econometric Analysis, 2nd edn, Macmillan, New York.

Hauer, R.J., and G.R. Johnson. 2008. State urban and community forestry program funding, technical assistance, and financial assistance within the 50 United States. Arboriculture & Urban Forestry 34:280-289.

Hauer, R.J., C.J. Casey, and R.W. Miller. 2008. Advancement in state government involvement in urban and community forestry in the 50 United States: Changes in program status from 1986 to 2002. Arboriculture & Urban Forestry 34 (1): 5-12.

Hartig, T., and C. Cooper-Marcus. 2006. Healing gardens—places for nature in health care. The Lancet 368: 36-37.

Heisler, G.M. 1986. Effects of individual trees on the solar radiation climate of small buildings. Urban Ecology 9: 337–359.

Herzog, T.R., S., Kaplan, and R. Kaplan. 1982. The prediction of preferences for unfamiliar urban places. Population and Environment 5(1): 43-59.

Herzog, T.R., S., Kaplan, and R. Kaplan. 1986. The prediction of preferences for familiar urban places. Environment and Behavior 8: 627-645.

Johnson, C.W. 1988. Planning for avian wildlife in urbanizing areas in America desert/mountain valley environments. Landscape and Urban Planning 16: 245–252.

Kaiser, F.G., S., Wolfing, and U. Fuhrer. 1999. Environmental attitude and ecological behavior. Journal of environmental psychology 19: 1-19.

Kaplan ,R., and S. Kaplan. 1989. The experience of nature: A psychological perspective. Cambridge University Press, Cambridge, UK.

Kaplan, R., S., Kaplan, and R.L. Ryan. 1998. With people in mind. Island Press, Washington D.C.

Kelman, S. 1981. Cost-benefit analysis: an ethical critique. Regulation 5:74-82.

Kerlinger, F.N. 1992. Foundations of behavioral research. Harcourt Brace, Orlando, FL.

Lafortezza, R., G., Carrus, G., Sanesi, and C. Davis. 2009. Benefits and well-being perceived by people visiting green spaces in periods of heat stress. Urban Forestry & Urban Greening 8: 97-108.

Laverne, R.J., and K. Winson-Geideman. 2003. The Influence of Trees and Landscaping on Rental Rates at Office Buildings. Journal of Arboriculture 29(5): 281-290.

Liao, F.T. 1994. Interpreting probability models. Thousand Oaks, CA: Sage.

Li, X., and A.H. Strahler. 1992. Geometric – optical bidirectional reflectance modeling of the discrete crown vegetation canopy: effect of crown shape and mutual shadowing. IEEE Transactions on Geoscience and Remote Sensing 30(2): 276– 292.

Lohr, V.I., and C.H. Pearson-Mims. 2006. Response to scenes with spreading, rounded, and conical tree forms. Environment and Behavior 38(5): 667-688.

Lothian, A. 1999. Landscape and the philosophy of aesthetics: is landscape quality inherent in the landscape or in the eye of the beholder. Landscape and Urban Planning 44: 177-198.

Luzar, E.J., and A. Diagne. 1999. Participation in the next generation of agriculture conservation programs: the role of environmental attitudes. Journal of Social Economics 28: 335-349.

Lohr, V.I., C.H. Pearson-Mims, J. Tarnai, and D.A. Dillman. 2004. How urban resident rate and rank the benefits and problems associated with trees in cities. Journal of Arboricultural 30 (1): 28-35.

Lorenzo, A.B., C.A. Blanche, Y. Qi, and M.M. Guidry. 2000. Assessing residents' willingness to pay to preserve the community urban forest: A small-city case study. Journal of Arboriculture 26(6): 319-324.

Majumdar, S., and Y. Zhang, Y. 2009. Market for green signaling. The Business Review, Cambridge 13 (2): 87-92.
Mansfield, C., S.K., Pattanayak, W., McDow , R., McDonald, and P. Halpin. 2005. Shade of green: Measuring the value of urban forests in the housing market. Journal of Forest Economics 11(3): 177-199.
McPherson, E.G. 1990. Modeling residential landscape water and energy use to evaluate water conservation policies. Landscape Journal 9: 122–134.
McPherson, E.G., J.R. Simpson, P.J. Peper, and Q. Xiao. 1999. Benefit-cost analysis of modesto's municipal urban forest. Journal of Arboriculture 25 (5): 235-248.
Meier, A.K. 1991. Measured cooling savings from vegetative landscapes. In: Vine E, Crawley D, Centolella P (Eds) Energy Efficiency and the Environment: Forging the Link. American Council for an Energy-Efficient Economy, Washington, DC, pp 321–334.
Morales, D.J. 1980. The contribution of trees to residential property value. Journal of Arboriculture 1: 109–112.
Nassauer, J.I. 1988. The aesthetics of horticulture: Neatness as a form of care. HortScience 23(6): 973-977.
Nassauer, J.I. 1995. Messy ecosystems, orderly frames. Landscape Journal 14(2): 161-170.
Nasar, J.L. 1981-1982. A model relating visual attributes in the residential environment to fear of crime. Journal of Environmental Systems 11: 247-255.
Nadel, B,, C.H., Oberlander, and L.R. Bohm. 1977. Trees in the city. Pergamon Press, New York.
Nelson, T., T., Johnson, M., Strong, and G.Rudakewich. 2001. Perception of tree canopy. Journal of Environmental Psychology 21: 315-324.
Nowak, D.J. 1993. Atmospheric carbon-reduction by urban trees. Journal of Environmental Management 37 (3): 207–217.
Nowak, D.J., and E.G. McPherson. 1993. Quantifying the impact of trees: the Chicago Urban Forest Climate Project. Unasylva 173 (44): 39–44.
Ode Åsa, K., and G.L.A. Fry. 2002. Visual aspects in urban woodland management. Urban Forestry & Urban Greening 1: 15-24.
O'Brien, L., and R. Murray. 2007. Forest school and its impacts on young children: Case studies in Britain. Urban forestry & Urban Greening 6: 249-265.
Orland, B., J. Vining, and A. Ebreo. 1992. The effect of street trees on perceived values of residential property. Environment and Behavior 24(3): 298-325.
Pack, C.L. 1922. Trees as good citizens. The American tree association, Washington, DC.
Price, C. 2003. Quantifying the aesthetic benefits of urban forestry. Urban forestry & Urban Greening 1: 123-133.
Payne, B.R., Strom, S. 1975. The contribution of trees to the appraised value of unimproved residential land. Valuation 22(2): 36–45.
Porteous, J.D. 1977. Environment and behavior: Planning and everyday urban life. Addison-Wesley, MA.
Rowntree, R.A., and D.J. Nowak. 1991. Quantifying the role of urban forests in removing atmospheric carbon dioxide. Journal of Arboriculture 17: 269-275.
Sagoff, M. 1988.The economy of the earth. Cambridge University Press, Cambridge, UK.
Sanders, R.A. 1986. Urban vegetation impacts on the hydrology of Dayton, Ohio. Urban Ecology 9: 361–76.
Saz-Salazar, S., and L. Garcia-Menendez. 2001. Willingness to pay for environmental improvements in a large city. Environmental and Resource Economics 20: 103-112.

Schroeder, H.W., and L.M. Anderson. 1984. Perception of personal safety in urban recreation sites. Journal of Leisure Research 16: 178-194.

Schroeder, H.W. 1988. Environment, behavior, and design research on urban forests. In Zube EH, Moore GT (eds) Advances in environment, behavior, and design, 2nd edn. Plenum Press, New York, pp 87-117.

Schroeder, H.W. 1989. Psychological and cultural effects of forests on people. In Healthy forests, healthy world. Proceedings of the 1988 Society of American Foresters National Convention. Society of American Foresters, Bethesda, Mayland, USA, pp 10-14.

Sen, A. 1995. Environmental evaluation and social choice: contingent valuation and the market analogy. Japanese Economic Review 46: 23-37.

Shaffer, G.S., and L.M. Anderson. 1983. Perceptions of the security and attractiveness of urban parking lots. Journal of Environmental Psychology 5: 311-323.

Simon, H.A. 1979. Information processing models of cognition. Annual Review of Psychology 30: 363-396.

Sjovall, A.M., and A.C. Talk. 2004. From actions to impressions: cognitive attribution theory and the formation of corporate reputation. Corporate Reputation Review 7(3) 269-281.

Sommer, R., F. Learey, J. Summit, and M. Tirrell. 1994. The social benefits of resident involvement in tree planting. Journal of Arboriculture 20: 170-175.

Sommer, R., and J. Summit. 1996. Cross-National rankings of tree shape. Ecological Psychology 8(4): 327-342.

Streich, A., and S. Rodie, 2007. Trees in the Home Landscape. University of Nebraska Cooperative Extension Nebguide G-1747, pp 4.

Straka, T.J., A.P. Marsinko, and C.J. Childers. 2005. Individual characteristics affecting participation in urban and community forestry programs in South Carolina, U.S. Journal of Arboriculture 31: 131-137.

Stroup, M.A., and R.L. Neubert. 1987. The evolution of social responsibility. Business Horizons 30: 22-24.

Studer, N. 2003. Urban forest program development in Washington State municipalities. In: Kollin, C. (editor), 2003 National Urban Forest Conference Proceedings, September 17-20, 2003, San Antonio, Texas. Washington, DC: American Forests, pp. 21-23.

Summit, J., and R. Sommer. 1999. Further studies of preferred tree shapes. Environment and Behavior 31(4): 550-576.

Thompson, R., R. Hanna, J, Noel, and D. Piirto. 1999. Valuation of tree aesthetics on small urban-interface properties. Journal of Arboriculture 25 (5): 225-233.

Thompson, R.P., and J.J. Ahern. 2000. The state of urban and community forestry in California: status in 1997 and trends since 1988. California Department of Forestry and Fire Protection.

Todorova, A., S., Asakawa, and T. Aikoh. 2004. Preferences for and attitudes towards street flowers and trees in Sapporo, Japan. Landscape and Urban Planning 69: 403-416.

Tree Atlanta: http://www.treesatlanta.org/. Last accessed May 1, 2010.

Tuan, Yifu. 1990. Topophilia: A study of environmental perception, attitudes and values. Columbia University Press, New York.

Tyrväinen, L. 1997. The amenity value of the urban forest: an application of the hedonic pricing method. Landscape and Urban Planning 37: 211-222.

Tyrvainen, L. 2001. Economic valuation of urban forest benefits in Finland. Journal of Environmental Management 62: 75-92

Urlich, R.S. 1983. Aesthetic and affective response to natural environment. In: Altman I, Wohlwill JF, (eds) Human Behavior and the Environment, vol. 6. Plenum Press, New York, pp 85-125.
Urlich, R.S. 1984. View through a window may influence recovery from survey. Science 224: 420-421.
Urlich, R.S. 1986. Human responses to vegetation and landscapes. Landscape and Urban Planning 13: 29-44.
Wang, X., and K.M. Kockelman. 2009. Application of the dynamic spatial ordered probit model: Patterns of land development change in Austin, Texas. Papers in Regional Science 88: 345-365.
Walhein,L. 1977. The world of Trees: Selecting and caring for trees in your yard and neighborhood. Chevron Chemical Company, San Francisco, CA.
Wolf, K.L. 2005. Business district streetscapes, trees, and consumer response. Journal of Forestry 103(8): 396-400.
Wray, P.H., and D.R. Prestemon. 1983. Assessment of street trees in Iowa's communities. Iowa State Journal of Research 58: 261-268.
Willeke, D.C. 1989. The imperative Forest. In: Moll G, Ebenreck S (eds) Shading our cities—a resource guide for urban and community forests, Island Press, Washington, D.C, pp58-63.
Williams, J.D., D.C., Fare, and C.H. Gilliam. 1993. Shade trees for the southeastern united states: An auburn university evaluation. Brown Printing Co., Montgomery, AL.
Yen, S.T., P.C. Boxall, and W.L. Adamowicz. 1997. An econometric analysis of donations for environmental conservation in Canada. Journal of Agricultural and Resource Economics 22(2)::246-263.
Zavoina, R., and W. McElvey. 1975. A statistical model for the analysis of ordinal level dependent variables. Journal of Mathematical Sociology 103-120.
Zhang, Y., A. Hussain, J. Deng, and N. Letson. 2007. Public attitudes toward urban trees and supporting urban tree programs. Environment and Behavior 39:797-814.
Zhang, Y., B., Zheng, B., Allen, N., Letson, and J. Sibley. 2009. Tree ordinances as public policy and participation tools: Development in Alabama. Arboriculture & Urban Forestry 35 (3): 166-172.
Zhang, Y., A., Hussain, J.Y., Deng, and N. Letson. 2007. Public attitudes toward urban trees and supporting urban tree programs. Environment and Behavior 39(6): 797-814.

Appendix 1.2

Urban Forestry Citizen Survey in Alabama 2005

Instruction: Use any pen or pencil to mark one answer to each item. Simply complete the form and return it to us with the stamped envelope.

1. General Attitude to the importance of urban trees

	Very important … Not important 1	2	3	4	5	6	7
1. If you were looking for a residence in which to live (such as a house or apartment), how important would you rate having trees on the property?	O	O	O	O	O	O	O
2. If you were choosing a neighborhood, town, or city in which to live, how important would you rate having trees in the community?	O	O	O	O	O	O	O
3. Ranking Importance of urban forestry benefits:							
• Increase in property values	O	O	O	O	O	O	O
• Decrease in energy costs	O	O	O	O	O	O	O
• Improvement in air quality	O	O	O	O	O	O	O
• Reduction in storm water runoff, soil erosion, water quality	O	O	O	O	O	O	O
• Creation of wildlife habitat	O	O	O	O	O	O	O
• Increase in community pride	O	O	O	O	O	O	O
• Appearance of the community (beauty, aesthetics)	O	O	O	O	O	O	O
• Increase in recreational opportunities	O	O	O	O	O	O	O
• Improvement in health and well-being	O	O	O	O	O	O	O
• Reduction of noise levels	O	O	O	O	O	O	O
• Creation of buffer zones	O	O	O	O	O	O	O
• None of above	O	O	O	O	O	O	O
4. Ranking the negative impacts of urban forestry							
• Safety (e.g., by branch falling down, hurricane)	O	O	O	O	O	O	O
• Property damage (e.g., by hurricane)	O	O	O	O	O	O	O
• Costs of planting and maintenance (topping, clearing leaves)	O	O	O	O	O	O	O
5. Below is a list of forms of promoting and educating urban forestry, how useful do you think?							
• TV programs	O	O	O	O	O	O	O
• Newspapers	O	O	O	O	O	O	O
• Internet	O	O	O	O	O	O	O
• City activities and festivals	O	O	O	O	O	O	O
• Forestry extension professional and urban foresters	O	O	O	O	O	O	O
• Private consultants	O	O	O	O	O	O	O
• Distributing brochure and other materials	O	O	O	O	O	O	O

Appendix 1.2

2. General Attitudes to Governing and Financing Community Trees Program

	Strongly agree ……………Not agree 1 2 3 4 5 6 7
6. To what extent do you agree that **governments** should adopt tree ordinances requiring builders and developers to follow guidelines to preserve and protect trees?	
• New construction site	O O O O O O O
• Public property	O O O O O O O
• Individually-owned yard	O O O O O O O
7. How important is it for following governments to provide funds to help **individual communities plant and maintain trees**?	
	Strongly important ….Not important 1 2 3 4 5 6 7
• Federal government	O O O O O O O
• Alabama state government	O O O O O O O
• local government	O O O O O O O
8. How important to you are the following ways to finance community trees programs?	
• State sales tax	O O O O O O O
• Local property tax	O O O O O O O
• Estate tax	O O O O O O O
• Alcohol and tobacco tax	O O O O O O O
• State income tax	O O O O O O O
• Corporate income tax	O O O O O O O
• Private donations	O O O O O O O
• Others (please specify:)	O O O O O O O
9. How much should an average family support urban tree program annually by the above ways? 0 ☐ less than $ 30 ☐ $31-80 ☐ $81-150 ☐ $151--$250 ☐ more than $250 ☐	
10. In the future, how likely would you donate your money to support urban tree activities in your area?	Very likely ……………..…Not likely 1 2 3 4 5 6 7 O O O O O O O
How much would you like to donate annually? 0 ☐ less than $ 30 ☐ $31-80 ☐ $81-150 ☐ $151--$250 ☐ more than $250 ☐	
11. In the future, how likely would you volunteer your time to support urban tree activities in your area?	Very likely ……………..…Not likely 1 2 3 4 5 6 7 O O O O O O O
12. An urban tree activity in which you would be willing to become involved, if requested:	Very likely ……………..…Not likely 1 2 3 4 5 6 7
• Help plant trees on public property	O O O O O O O
• Help with local public education activities	O O O O O O O
• Help recruit and mobilize other citizens to plant and care for urban trees	O O O O O O O
• Serve on your community's Tree Board/Commission	O O O O O O O

Appendix 1.2

3. Other Information

13. Have you personally performed any of the following urban tree activities in the past 10 years		
• Planted a tree	☐ Yes	☐ No
• Mulched around a tree	☐ Yes	☐ No
• Staked a tree	☐ Yes	☐ No
• Pruned a tree	☐ Yes	☐ No
• Removed a tree	☐ Yes	☐ No
• Others	☐ Yes	☐ No
14. Are you aware of following forestry programs		
• USDA Forest Service	☐ Yes	☐ No
• the National Arbor Day Foundation	☐ Yes	☐ No
• the International Society of Arboriculture	☐ Yes	☐ No
• the Alabama Cooperative Extension System	☐ Yes	☐ No
• the Alabama Forestry Commission	☐ Yes	☐ No
• Aware of the Auburn University School of Forestry & Wildlife Sciences	☐ Yes	☐ No

15. Including yourself and your children, how many people live in your household?	**16. How many children under 18 years of age currently live in your household?**
---------------------	--------------------

17. Current Employment Status:
☐ Full-time ☐ Part-time Homemaker ☐Retired ☐Unemployed ☐ Other (e.g. student, disabled, etc.)

18. What is your highest level of education?
☐ Less than high school ☐ High school diploma/GED ☐ Some college ☐Bachelor's or higher

19. Which category best describes your annual household income?
☐ Less than $20,000 ☐ $20,000-$39,999 ☐ $40,000-$74,999 ☐ $75,000-$99,0999 ☐ $100,000+

20. What race do you identify with?
☐ African-American ☐White/Caucasian ☐ Hispanic ☐Other (e.g., Asian)

21. Gender
☐Male ☐Female

22. In which age group would you include yourself?
☐18-30 ☐31-45 ☐46-60 ☐60 +

23. How would you classify the house in which you live?
☐ Apartment
☐House (less than $100,000)* ☐ House ($100,000 –150,000)
☐House (150,000-200,000) ☐ House (more than $200, 000)
* Estimated current market value

Other Comments and Information (particularly on how to support community tree programs):

Thank you for participating in this Survey!
Please put it back into the stamped envelope and drop it in the mail box.

#:

Appendix 2

Landscape and Urban Planning 99 (2011) 1–8

Contents lists available at ScienceDirect

Landscape and Urban Planning

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

Preference to home landscape: wildness or neatness?

Bin Zheng[a], Yaoqi Zhang[a,*], Jiquan Chen[b]

[a] School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL 36949, United States
[b] Landscape Ecology & Ecosystem Science, Department of Environmental Sciences, University of Toledo, Toledo, OH 43606-3390, United States

ARTICLE INFO

Article history:
Received 5 October 2009
Received in revised form 17 August 2010
Accepted 20 August 2010
Available online 17 September 2010

Keywords:
Landscape design
Multinomial logit model
Student
Visual preference survey
Urban forestry

ABSTRACT

This study explores students' preferences toward natural and wild versus clean and neat residential landscapes using preference survey data. Based on the rating scores of four housing landscape designs, multinomial logit models were used to explore the potential influential factors on people's preferences, especially the wildness or neatness of the home landscape. The results suggest that students in agricultural economics, horticulture, and social sciences are more inclined to choose a neat, well-kept environment around their homes. In contrast, wildlife science students prefer more natural landscapes. This study also found that senior students and students from large cities also prefer well-maintained and artificial landscapes. Also, students who are members of an environmental group, and those whose parents have a better education, are more likely to choose a more natural landscape. The results would provide additional information for planners, developers, engineers, architects and foresters in building more livable communities which are aesthetically appealing but also ecologically sound.

1. Introduction

Landscape, which includes topography, vegetation and associated plants and soil, water bodies, and their spatial configuration, is one of the most visual needs by people. Human–nature interactions lead human beings to have contrasting preference on the surrounding landscape and environment because a pleasing landscape can bring mental and physical benefits to people (e.g., Kaplan et al., 1998; Kaplan and Kaplan, 1989; Ode and Fry, 2002). Consequently, a landscape is constantly modified due to people's preferences (Erickson et al., 2002; Luzar and Diagne, 1999; Schroeder, 1988), causing further complex feedbacks with policy making and planning processes (Kaiser et al., 1999). Clearly, understanding people's preferences for their surrounding landscapes and how the preferences shaped the environment is not only an academic challenge but also critical for policy making and implementation. For example, knowledge of the preferred landscape would enable planners and developers to construct more appealing neighborhoods while enhancing ecological services.

Scientific investigation of the preference to landscape is challenging due to the complexity of land mosaics, its design and change over time. There are many attributes (e.g., vegetation and associated plants, spatial configuration of landscape elements, the topography, bodies of water, etc.) that determine the quality of a visual landscape. Additionally, the role of each attribute is dependent of the context and its interaction with the other attributes (Chen et al., 2006; Lindenmayer and Franklin, 2002). Another challenge arises from the heterogeneous and dynamics nature of people's preferences for the landscape (i.e., preference is temporally, spatially and personally specific), suggesting that cultural background needs to be included in sound analysis of people–landscape interactions (Nassauer, 1995). In urban landscapes, for example, landscape architects often struggle with the balance between wildness and neatness in designing a neighborhood in the context of broader urban landscape. In general, neatness seems more appealing, but often has lowered ecological services (Gobster et al., 2007; Martin, 2001; McPherson et al., 1989). This suggests that pleasing alone might not be a good design from an ecological perspective (Gobster et al., 2007). Incorporating urban forestry and greenness into the planning, designing and implementing of public policy pertaining to suburbs (or edge cities) is increasingly challenged to promote not only aesthetically appealing but also ecologically sound communities.

Investigation of people's preferences on landscape has been broadly conducted in recent years (Carlson, 1999, 2006; Wessels, 1997), including studies of individual preference. Individuals' tastes on environmental appreciation are often shown to be linked to a person's training, their previous experiences and personal characteristics such as age, personal emotional experience, social status and education (Buttel, 1987; Brunson and Reiter, 1996; Lindhagen, 1996; Ma and Bateson, 1999; Silvennoinen et al., 2002; Van den Berg and Koole, 2006). More than two decades ago, Dearden (1984) found that familiarity with general landscape types appeared to have a positive correlation with landscape preferences, but none

* Corresponding author. Tel.: +1 334 844 1041; fax: +1 334 844 1084.
E-mail address: yaoqi.zhang@auburn.edu (Y. Zhang).

0169-2046/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2010.08.006

Appendix 2

of the socio-economic variables – gender, age, income, education and occupation – were significant. Rauwald and Moore (2002) reported that country and gender differences existed in environmental attitudes, while Brody et al. (2004) further indicated that environmental perceptions differed by location because of the information gaps between any two sites. From people's preferences perspective, Abello and Bernaldez (1986) found that certain aspects of personality had significant correlation with landscape preference. Recently, Nassauer et al. (2009) concluded that cultural norms for landscape appearance may affect preferences for and adoption of ecological design of residential landscape.

Education has been shown to be the most consistent predictor for environmental concern (Wall, 1995). Much of the work indicates that individuals with high levels of education tend to care more about the environment (Ewert and Baker, 2001). Most of the differences in perception with various academic disciplines are also ascribed to the "lack of information." Each academic major is corresponding to some specific "knowledge" and this "knowledge" may act as a mediating variable (Baron and Kenny, 1986) in the preference-shaping process, suggesting that schooling in different majors may serve as a mechanism to "transmit" the beliefs or attitudes of that cultural domain. Assessment of the effect of academic disciplines can be found in a wide array of literature. For example, Smith (1995) found that students majoring in business or economics were less likely to take action to protect the environment. Brown and Harris (1998) also found that professional foresters had a different environmental concept from their colleagues in ecology, wildlife, fishery, geology or recreation. Finally, it seems that different educational backgrounds refer to not only the level of education but also the type of education.

One of important features of landscape in the context the residential landscape is wildness versus neatness. Previous studies support a general conclusion that people in general prefer a neat environment. Nassauer (1988) claimed that neatness is one of the most important factors for an attractive landscape although trimmed bushes are not usually good for biological diversity (Nassauer, 1995). An over-emphasis of the "garden" aspect of the garden city has resulted in the excessive planting of trees (Tuan, 1990). Perfect green lawns may not be ecologically healthy (Steinberg, 2006). Additionally, it is argued that people have different perceptions about wilderness: "One man's wilderness may be another's roadside picnic ground" (Nash, 2001). Clearly, the bias in preference of our surrounding world might be ascribed to many factors. While the ability to know the world is limited by our knowledge and experience, public preferences are deeply embedded in class position and the relative economic, cultural and social capital (Bourdieu, 1984; Fraser and Kenney, 2000; Grusky and Wheedon, 2001).

To resolve the conflict needs for aesthetically appealing and ecological services, we studied people's preferences to natural/wild mosaics and the clean and well-maintained landscapes using both approaches. To explore the potential influential factors, hypothetical landscapes with different green space, designs and policy were generated using multinomial logit models based on our preference survey. We hypothesized that individuals with different educational backgrounds and level have different preferences to their housing landscapes.

2. Methods

2.1. Preference survey

Two approaches are broadly used to investigate individual preference. Surveys using a questionnaire are the conventional method (e.g., Getz et al., 1982; Zhang et al., 2007). The visualization method has also been widely applied to landscape design and investigations of attributes influencing people's landscape preferences. For example, Tyrväinen et al. (2006) used computer-based visualization and landscape laboratory methods to help the public better perceive the surrounding environment. Ode et al. (2008) established links between landscape aesthetic theory and visual indicators. A computer-generated visualization survey was further conducted and the perceived indicators of naturalness were found to be the more important drivers of preference than demographic factors (Ode et al., 2009). The two methods have their own weaknesses and strengths. Using verbal questions may not effectively illustrate the real landscape preference, while using a visual survey might lead to misinterpretation of the information of the visual appearance.

In this study, the primary data was obtained from both visual and verbal preference surveys, which include preference rating on visually designed landscapes (i.e., pictures) and providing verbal answers regarding their preferences to the landscapes and their socio-demographic characteristics. We created fourteen designs for single-housed landscapes. The photographic materials used for the designs were taken from Alabama and Georgia, indicating that the house style and surrounding environment in these designs is representative of the residential landscape common to the Southern U.S. We modified the picture with Adobe Photoshop 7.0 software to obtain a consistent house style, sky, front lawn and pathway. The landscape designs were shown slide by slide using Powerpoint 2007 in a time controlled manor (30 s/slide). For comparison purposes, six designs were presented in the same slide at one time. Three designs in the previous slide were replaced by three new designs in the following slide, creating various combinations of scenes. Altogether, we had ten slides, ensuring that each design was compared with other at least four times. The survey was conducted in various classrooms where students were asked to rate the different landscape designs according to a Likert scale from 1 to 5 (1 = least preferred; 5 = most preferred).

Four out of the fourteen designs were selected to present the variety of tree presence, with a particular focus on cleanliness of the environment and, such as wild vs. natural-looking landscape (Fig. 1). H1 demonstrated no tree; H2 for a clean, neat and well-maintained landscape; H3 for a natural, ecological, wild-looking; and H4 for a messy, wild-looking landscape. The four landscapes were assumed to be independent in our analysis. Based on the average rating of these four designs, we ranked them to create a variable (Y^1) to identify the most favorable design. For example, if the first design received the highest average rating, Y^1 was given a value of 1. If the third design received the highest average rating, Y^1 was given a value of to 3.

Respondents were also asked to answer verbal questions to elicit information on people's preferences to tree size, species, amount and the level of open space, and wildness/nature. Additionally, participants were asked to rate the importance of some characteristics of trees such as seasonal color, shape, and growth. Each individual's demographic information was also collected to examine the variation due to people's background. The following question was asked:

In your opinion, which is the most important factor in the following kinds of urban trees and landscaping?

(1) To increase tree canopy by planting more trees.
(2) To keep trees pruned and well-maintained.
(3) To plant flowering shrubs, perennials and annuals using more artificial landscape.
(4) To keep a more natural and wild-looking landscape.

The dependent variable Y^2 is equal to the most favored alternatives, coding from 1 to 4. For example, if the fourth alternative was chosen, Y^2 was set as 4.

Appendix 2

Fig. 1. Landscape design. (a) Landscape design H1, mean value = 1.84 and std. dev = 1.20 (N = 333); (b) landscape design H2, mean value = 3.19 and std. dev = 0.86 (N = 333); (c) Landscape design H3, mean value = 3.65 and std. dev = 1.40 (N = 333); (d) Landscape design H4, mean value = 3.33 and std. dev = 1.20 (N = 333).

2.2. The models

Two multinomial logit models were separately applied to the four landscape designs (Y^1) and the four verbally stated alternatives (Y^2). The multinomial probit model is not often used due primarily to the practical difficulties in estimating model coefficients (Park, 2005). Both Y^1 and Y^2 are functions of the characteristics of the individual making the choice. Our purpose was to compare the relative importance among the landscape characteristics (i.e., natural/wild and cleanness). Because the four categories are unordered, multinomial logistic regression was used to answer the central question: "What is a person's preference as compared to the other three alternatives?" In the multinomial logit model, one of the four alternatives was chosen as the reference. The probability of membership in other categories was compared to the probability of membership in the reference category. Our multinomial logit model (Greene, 1993) was

$$\Pr(Y_i^j = m) = \frac{\exp(Z_{mi})}{1 + \sum_{h=2}^{M} \exp(Z_{mi})} \tag{1}$$

where m refers to the other categories except for the reference category (equal to 1, 2, 3), i refers to observations (varies from 1, 2, ..., n), and j refers to the two separate multinomial logit models for landscape design and four alternatives in the questionnaire, respectively (set as 1, 2). For the reference category:

$$\Pr(Y^j = 4) = \frac{1}{1 + \sum_{h=2}^{M} \exp(Z_{hi})} \tag{2}$$

where Y^j represents the dependent variables in the two models, Y^1 is the corresponding favorite choice of the four landscape designs with the fourth design (coded as 4) set as the reference category. Y^2 is the corresponding favorite selection of the four alternatives and the fourth choice (i.e., to keep a more naturalized landscape) is designated as the reference and coded as 4. The independent variables X_{ik} represent respondents' personal characteristics and family background, such as age, major, grade, race, gender, family income, city of residence, parents' education and if they were a member of an environmental group. The terms β_{mk} are the empirical coefficients to be estimated for the respective variables.

In estimating each model, the coefficients of the reference group are normalized to zero (Maddala, 1990; Greene, 1993). This is because the probabilities for all the choices must sum up to unity (Greene, 1993). Consequently, only three distinct sets of parameters can be identified and estimated for the four choices.

The natural logarithms of the odd ratio of Eqs. (1) and (2) give the estimation as

$$\mathrm{Ln}\frac{P(Y^j = m)}{P(Y^j = 4)} = \alpha_m + \sum_{k=1}^{K} \beta_{mk} X_{ik} = Z_{mi} \tag{3}$$

Appendix 2

Table 1
Descriptive statistics of choice alternatives and demographic characteristics.

Variable	Frequency (%) (N = 333)
$Y^1 = 1$	46 (13.81%)
$Y^1 = 2$	49 (14.71%)
$Y^1 = 3$	196 (58.86%)
$Y^1 = 4$	42 (12.61%)
$Y^2 = 1$	77 (23.12%)
$Y^2 = 2$	71 (21.32%)
$Y^2 = 3$	61 (18.32%)
$Y^2 = 4$	124 (37.24%)
Major	
Wildlife science (base)	72 (21.62%)
Forestry	98 (29.43%)
Horticulture	54 (16.22%)
Social science	109 (32.74%)
Age (<20 years old)	54 (16%)
Family income (in thousand dollars)[a]	64.05 (30.27)
3rd and 4th year student	219 (66%)
Male	246 (74%)
White	299 (90%)
City of residence	
Rural area (base) (population <2000)	95 (28.52%)
Small city (2000–50,000)	150 (45.05%)
Large city (>50,000) (base)	88 (26.43%)
Environment group member	76 (23%)
Parents' education	
<=High school (base)	33 (9.91%)
College/bachelor's degree	190 (57.06%)
Graduate degree	110 (33.03%)

[a] In mean and standard deviation.

This denotes the relative probability of each of group 1, 2 and 3 to the probability of the reference group. The estimated coefficients for each choice therefore reflect the effects of "X_i"s on the likelihood of the respondents choosing that alternative relative to the reference group.

SAS 9.1.3 was used to estimate the multinomial logit model. The marginal effects were estimated by differentiating Eqs. (1) and (2) (Greene, 1993).

$$\frac{dP_{ih}}{dX_{imk}} = b_k P_{ih}(1 - P_{ih}) \tag{4}$$

3. Results

3.1. Data description

A total of 360 students of University in Alabama from different departments participated in the survey (Table 1). Five of them did not complete the survey because of their early departure. Prior to our analysis, the observations with missing values were deleted, reducing the final sample size to 333. Students were grouped into four programs: wildlife science, forestry, horticulture (including landscape design, building science, recreation management and architecture), and social science (including history, agriculture economics, psychology, education). Among the students, 84% were older than 20 and 66% were third- and fourth-year students. Twenty-three percent of the students were members of environmental groups.

In the 2008 U.S. Census, whites accounted for 71% of Alabama's population with 48% as male. In this study, the sampled population was 90% white and 74% male. Approximately half of the students were from small cities with populations ranging from 2000 to 50,000. The family background information indicated that the students were from relatively wealthy families with an average income of $64,050 (the median household income is $42,586 in Alabama). Most of the students' parents had a college degree.

H1 contained no tree and received low mean score of 1.84. H2 was well-maintained and neat compared to H4, receiving a mean score of 3.19. H4 presented wildness, with 80% of the picture being covered by trees, or houses hidden behind large trees although they looked messy because of the defoliation, straggly stems, bushes and dead wood. Nevertheless, H4 received the second highest mean score of 3.33.

H3 received the highest score among the four designs. In H3, more than 80% of the slide was covered by trees. The use of white stone edging seemed appealing, likely because the landscape was maintained. While both H3 and H4 had the understory dominated by shrubs and small trees, the white stone fence in H3 served as a good "cue to care" for the students. It seems supported by the argument made by Nassauer (1988, 1995) that perceived care of the landscape is a primary determinant of landscape attractiveness and "cues to care" can improve the appearance of some "messy" landscapes.

3.2. Multinomial logit model: landscape design

Our modeling based on the multinomial logit regression showed significant influence of four landscape designs ($p = 0.05$, Likelihood ratio = 52.80), with Y^1 as the respondents' choices for the four landscape designs (Table 2). H4 was selected as the referenced category. Among the four majors in this study, wildlife science was chosen to be the base category. For the model output, a positive significant coefficient on a variable for a particular equation indicates that the variable is associated with a higher probability of being in the group choice relative to the reference group. Preference differences were found in the students with different academic backgrounds. Horticulture students preferred H3 more than H4. H3 had good edging (i.e., an indication of some maintaining by the owners) and fit the training of horticulture students. Students majoring in social science preferred the well-maintained and clean designs in H1 and H2. Students majoring in social science appeared to believe clean residential areas were good enough for human beings. Residential landscape is the closest environment surrounding us and it should "work" for humans. A wild, forested look may represent danger and appear uncivilized.

Marginal effects of each variable for the four landscape designs were presented in Table 3. The marginal value interprets the difference in the predicted probabilities, or the effect of one unit change in X on the probability of each design outcome when all other variables are held constant at sample mean values. For example, the probability that students majoring in social science choose design H1 was 0.18 higher than the wildlife science students. The probability of choosing design H3 is 0.06 higher for wildlife science students than the social science students. Again, wildlife science students seemed preferring natural and wild-looking environments where maintained white stone edging was in the picture.

Preference of an individual differed by academic background (Table 3). However, family background and personal characteristics appeared no effect on individuals' perceptions regarding the landscape designs. Interestingly, we found that students from families with higher household income did not prefer H1 (i.e., no trees).

3.3. Multinomial logit model for alternatives

The multinomial logit model for the four alternative landscapes showed significant at P value of 0.01, with a likelihood ratio of 94.18 (Table 4). The dependent variable Y^2 represent respondents' choices for the alternatives where "To keep a more naturalized landscape" was set as the referenced category. Among the four student groups,

Appendix 2

Table 2
Maximum likelihood estimation of multinomial logit regression for four landscape designs.

Parameter (std. error)	Multinomial logit model ($N = 333$)		
	1 $\text{Ln}\,\frac{P(Y_i^1=1)}{P(Y_i^1=4)}$	2 $\text{Ln}\,\frac{P(Y_i^1=2)}{P(Y_i^1=4)}$	3 $\text{Ln}\,\frac{P(Y_i^1=3)}{P(Y_i^1=4)}$
Intercept	0.7829 (1.8208)	2.2202 (1.7293)	1.2072 (1.4223)
Log(income)	−0.2598** (0.4097)	−0.6368 (0.3803)	−0.1185 (0.3091)
Forestry	0.7156 (0.7246)	0.6600 (0.5803)	0.7710 (0.4915)
Horticulture	1.0389 (0.8428)	1.1065 (0.7421)	1.0910* (0.5948)
Social Science	1.8382*** (0.7007)	1.3189** (0.6526)	0.9670* (0.5273)
3rd and 4th year student	−0.1957 (0.5433)	−0.5423 (0.5167)	0.0211 (0.4299)
Environmental group	−0.1561 (0.5800)	−1.6153 (0.5903)	0.0561 (0.4268)
Male	−0.4283 (0.5495)	−0.1991 (0.5508)	−0.2803 (0.4515)
AgeLe20	1.2452 (0.7732)	0.3042 (0.8336)	0.9397 (0.6818)
White	−0.9010 (0.7693)	0.2940 (0.8643)	0.1989 (0.7007)
Bachelor degree	−0.2388 (0.8137)	−0.0416 (0.7813)	−0.2564 (0.6326)
Graduate degree	0.9472 (0.8696)	1.0542 (0.8385)	0.3893 (0.6973)
Small city	0.3707 (0.5689)	−0.3589 (0.5285)	0.2813 (0.4231)
Large city	0.3374 (0.6243)	−0.1270 (0.5893)	−0.0359 (0.4917)
Likelihood ratio	52.80**		

*** Significant at 0.01 level.
** Significant at 0.05 level.
* Significant at 0.10 level.

students of wildlife science were chosen as the base category, which was compared to the other three majors.

Log (income) is a significant factor for Y^1 ($p < 0.05$). The log of the ratio of the two probabilities, $P(Y^2 = 1)/P(Y^2 = 4)$ was 0.7784, suggesting that higher-income families preferred landscapes with more trees and vegetation. This was consistent with the results of the multinomial logit regression in visual landscape design. The marginal effects (Table 5) further suggested that, while Log (income) increased by only one unit (i.e., 10,000 dollars) the probability to choose "planting more trees" increased by 0.13 and the probability to choose a natural and wild landscape increased by 0.12.

Although there was no difference between the wildlife science and forestry students, our models indicated significant differences in preference among students of the four majors. It seemed that horticulture students favored significantly more toward well-maintained landscapes than wildlife science students, as the probability to choose a well-maintained landscape for horticulture students (i.e., marginal effect) was 0.19 higher than wildlife science students (Table 5). In another word, horticulture students were less likely to choose "keep a more naturalized landscape" and prefer "to keep trees pruned and well-maintained." This result was consistent with the surveys in visual designs. Similarly, students of social science preferred clean and well-maintained landscapes (marginal value = 0.25).

Seniority of the student (i.e., education level in our hypothesis) was expected to have some influence on students' attitudes because the junior/senior students would have more advanced knowledge than freshman/sophomore students. This hypothesis was accepted as the "third- and fourth-year student" was significant at $p = 0.05$ for both models (Eqs. (1) and (2); Table 4). Both logs of the ratio were, suggesting that senior students preferred "to keep trees pruned and well-maintained" or "to plant flowering shrubs perennials and annuals, using more artificial landscape". This was further supported by the marginal value of 0.06, which was higher than that of freshman/sophomore students whose marginal value was 0.02.

Participation of environmental group was a significant factor in Eqs. (2) and (3). More importantly, the sign of the log of ratio was negative, suggesting that these students would be more likely to choose a natural landscape than other students. The probability to choose a natural and wild landscape increased as high as 0.26 for those without an environmental group membership (Table 5). However, to increase tree canopy seemed more important for male students. The odds (ratio of the probability) of choosing "plant more trees" over a naturalized landscape increased by exp (0.7547) = 2.13 in Eq. (1). The marginal value for the first alternative was 0.07. Males also liked well-maintained landscape. The odds of the second alternative over the fourth were 0.8886, and the marginal value was 0.09 for the second alternative.

Variable "AgeLe20" was also significant in Eq. (1) and had a positive sign, suggesting younger students were more likely to choose a landscape with more trees. The probability to choose more trees increased by 0.23 for students younger than 20. Race was also a significant factor as both logs of the ratio are negative in Eqs. (1) and

Table 3
Marginal effect estimation for four landscape designs.

	$Y_i^1 = 1$ (Design H1)	$Y_i^1 = 2$ (Design H2)	$Y_i^1 = 3$ (Design H3)	$Y_i^1 = 4$ Reference group (Design H4)
Log(income)	−0.0139	−0.0545	0.0258	0.2680
Forestry	0.0180	0.0070	0.0785	0.1220
Horticulture	0.0208	0.0298	0.0850	0.0897
Social science	0.1790	0.0340	−0.0617	0.0742
3rd and 4th year student	−0.0176	−0.0539	0.0515	0.2454
Environmental group	−0.0055	−0.1138	0.0899	0.2548
Male	−0.0315	0.0031	−0.0270	0.2808
AgeLe20	0.0988	−0.0557	0.0791	0.1032
White	−0.1027	0.0404	0.0735	0.2142
Bachelor degree	−0.0131	0.0180	−0.0434	0.2638
Graduate degree	0.0781	0.0929	−0.0738	0.1282
Small city	0.0381	−0.0599	0.0563	0.1910
Large city	0.0596	−0.0217	−0.0306	0.2181

Appendix 2

Table 4
Maximum likelihood estimation of multinomial logit regression for four alternatives.

Parameter (std. error)	Multinomial logit model, $N = 333$		
	1	2	3
	$\text{Ln}\,\frac{P(Y_i^2=1)}{P(Y_i^2=4)}$	$\text{Ln}\,\frac{P(Y_i^2=2)}{P(Y_i^2=4)}$	$\text{Ln}\,\frac{P(Y_i^2=3)}{P(Y_i^2=4)}$
Intercept	−2.6844* (1.6223)	−1.5941 (1.6458)	−0.2523 (1.6742)
Log(income)	0.7784** (0.3713)	0.4422 (0.3686)	0.1211 (0.3756)
Forestry	−0.3475 (0.4770)	0.4684 (0.5803)	0.8044 (0.5352)
Horticulture	0.0206 (0.5226)	1.1763** (0.5946)	0.6612 (0.5688)
Social Science	0.3501 (0.4611)	1.3290** (0.5530)	0.0876 (0.5605)
3rd & 4th year student	0.8650** (0.4186)	0.9478** (0.4487)	0.6287 (0.4364)
Environmental Group	−0.2003 (0.3704)	−1.4455*** (0.5003)	−1.1763*** (0.4709)
Male	0.7547** (0.3848)	0.8886** (0.4309)	0.0342 (0.4264)
AgeLe20	1.0371** (0.4662)	0.1542 (0.5617)	0.0370 (0.5634)
White	−2.0969** (0.8793)	−2.9219*** (0.8766)	−1.3223 (0.9729)
Bachelor degree	−0.7051 (0.5527)	−0.4125 (0.5765)	−0.9651 (0.5580)
Graduate degree	−0.9748 (0.6110)	−1.2297* (0.6666)	−1.7116*** (0.6558)
Small city	0.3923 (0.3867)	0.7232* (0.4170)	0.7522* (0.4307)
Large city	0.5755 (0.4400)	0.8236* (0.4842)	1.0542** (0.5043)
Likelihood ratio	94.18***		

*** Significant at 0.01 level.
** Significant at 0.05 level.
* Significant at 0.10 level.

(2). Compared with black students, white students preferred the artificial landscape less often. The probability to choose the natural and wild landscape was 0.61 higher for white students than the black students (Table 5).

There were significant differences between students from rural and urban settings. Compared to students from a rural area, those from urban area were more inclined to choose "to keep trees pruned and well-maintained," and "to plant flowering shrubs, perennials and annuals using more artificial landscape". The magnitude of the log of ratio became larger as the population increases. Finally, there was an increase in the probability to choose alternative 2 and 3 for students from urban areas against students from rural areas (Table 5).

Parents' backgrounds (i.e., education level) were expected to have some influence on students' preferences. We found that parents' education was statistically significant in Eqs. (2) and (3) with the logs of the ratio of parents' education as negative, suggesting that the students with well education parents were more inclined to choose a natural landscape. For example, students' parents who had graduate degrees were less likely to choose pruned trees (marginal value = −0.07) and artificial landscape (marginal value = −0.13).

4. Discussion

This study explored students' preferences in urban landscapes with wild or clean characteristics surrounding the houses. To some extent, college students' preferences represent the general public's opinion (Zheng, 2009) and political attitudes (Ceci and Kain, 1982; Kaplowitz et al., 1983; Mutz, 1992). In addition, college students are future home buyers and their preferences will influence the landscape design of the future. Therefore, to understand and interpret their preference has profound implications. Our attention was also given to how preference might be affected by educational background, including students in different grades (first- and second-year students/third- and fourth-year students), affiliation with environmental groups, academic major, as well as family backgrounds such as family income, parents' education and place of residence.

Overall, we found that students preferred more trees and neat landscapes. Neatness, a feature of aesthetic appreciation, also appeared important. For example, a manicured lawn, clipped shrubs and colorful flowers indicate the owner's care for the community. This is consistent with earlier studies that residents prefer natural-looking but managed landscapes (e.g., Axelsson-Lindgren, 1995; Ribe, 1989). Woodlands with logging residues, dead snags and decayed wood were not appreciated by the students.

Students with wildlife science major were more inclined to choose wildness/natural environments surrounding the houses. Our conclusion was further supported by verbal answers of the wildlife science students. In contrast, horticulture students were less likely to choose a wild landscape. This difference may come from the education through which wildlife science students are more knowledgeable or more appreciating of ecological systems, or

Table 5
Marginal effect estimation for four alternatives.

	$Y_i^2 = 1$ (planting more tree)	$Y_i^2 = 2$ (well-maintained)	$Y_i^2 = 3$ (artificial landscape)	$Y_i^2 = 4$ Reference group (nature and wild landscape)
Log(income)	0.1324	0.0007	−0.0661	0.1215
Forestry	−0.1560	0.0448	0.1598	0.1400
Horticulture	−0.1393	0.1993	0.0222	0.1063
Social science	−0.0735	0.2567	−0.0978	0.1031
3rd and 4th year student	0.0531	0.0632	0.0200	−0.0922
Environmental group	0.2279	−0.1622	−0.1387	0.2616
Male	0.0769	0.0991	0.0969	−0.1094
AgeLe20	0.2339	−0.0702	−0.0897	0.1145
White	−0.1965	−0.1987	−0.0316	0.6153
Bachelor degree	−0.0590	0.0238	−0.0892	0.3129
Graduate degree	−0.0379	−0.0758	−0.1398	0.4420
Small city	−0.0399	0.0537	0.0628	0.1119
Large city	−0.0388	0.0313	0.1026	0.0935

Appendix 2

more concerned with wildlife. They were probably better-informed about the notion that "messy is good."

The affiliation with environmental groups and having better parents' education played important roles for student to choose a preferred landscape. Logically, students with a greater knowledge of nature should prefer more ecologically sustainable landscape (Daniel, 2001). Recent developments in information theory (Bandura, 1986, 2001; Klapper, 1960; Watt and van den Berg, 1978) also suggest that preferences can be influenced by media and education—a potential way to change public preference through awareness and ecological education. In our study, we found that male students with a higher level of education showed more preference for neatness; and the students from larger cities also favored a clean and artificial landscape.

The results from this study suggested that there exists tradeoffs between aesthetic values and ecological services. Considering residential landscape as the closest environment around us, the culture and preference over-emphasis of the neatness may be sinister. For example, the obsessive quest for the perfect green lawn in the U.S. has caused environmental problems, such as groundwater pollution (Robbins and Birkenholtz, 2003). Moreover, the pursuit of neatness is costly (e.g., time and maintenance fees). It is suggested that Americans spend $40 billion a year on lawn care (Steinberg, 2006). Meanwhile, landscape design and management might be not acceptable if one ignores the social and cultural requirements. To incorporate people's preferences (e.g., the neatness-look) with ecological function is consequently needed. Nassauer (1997)'s design strategies, i.e. "vivid care" is a good choice in this regard. Vivid care draws attention to the human presence in healthy landscapes in order to sustain ecological health over time. These strategies bring aesthetic expectation in a way that benefits landscape ecology. Given people perceived attractiveness related with neatness (e.g., white stone edging, pathway and horticultural plants), a landscape designer might explore a way to make "wildness" look "neat."

A more proactive way to coordinate aesthetical landscapes and ecological landscapes is to use education and information to shape people's preferences toward designing ecologically sound landscape. Werner (1999) proposed five critical factors for improving sustainability: awareness of the problem, knowledge about behavioral solutions and motivations engaged, forces that make the motivation salient, opportunities to engage in the behavior and skill and perceived competence to engage in the behavior correctly. Based on our study, education is also needed to achieve our long-term goal. One challenge is that future educational material should include both beauty and landscape sustainability. An improved understanding of the consequences of residential landscaping behavior should affect our preference. As Nassauer (1997) stated, "appreciation based on knowledge is the only way to avoid aesthetic omissions and deceptions" (p. 89). Clearly, encouraging the public's participation in ecological activities (i.e., education) would increase the participant's ecological knowledge and thus would change their preferences toward management of urban landscapes.

America's growing population is increasingly spreading into the countryside and expanding to the rural–urban interface. City planners, policy makers, academics and the general public are calling for "smart growth"—in which growth is managed and directed in a sustainable way that minimizes damage to the environment and builds livable towns and cities. Understanding of public preferences will help to avoid the influences of misleading preferences and the information should be helpful for the balance of landscape planning and conservation biology (Nassauer, 2006). The information derived from this study would be useful for policy makers to design health, sustainable landscapes. Regardless of our efforts in visual preference survey with verbal questionnaires, future research are needed to validated our results in other urban setting with controlled design and extend the sampling to a variety of citizens.

Acknowledgements

We gratefully acknowledge the financial support of the National Urban and Community Forestry Advisory Council Challenge Cost-Share Program (#05-DG-11083150-160). This study was partially supported by the NASA's LCLUC Program (NNX09AM55G). We also thank the students who participated in the survey. The survey instrument was approved by the Auburn University Institutional Review Board. We would like to thank comments on our visual preference survey design by Dr. Zhifang Wang. The comments from Dr. Jeff Sibley, Dr. David Laband, Dr. Becky Barlow and Dr. Conner Bailey on our earlier version and three reviewers are greatly appreciated.

References

Abello, R.P., Bernaldez, F.G., 1986. Landscape preference and personality. Landscape and Urban Planning 13, 19–28.
Axelsson-Lindgren, C., 1995. Forest aesthetics. In: Hytönen, M. (Ed.), Multiple-use Forestry in the Nordic Countries. The Finnish Forest Research Institute, Helsinki, pp. 270–289.
Bandura, A., 1986. Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice Hall, Upper Saddle River, NJ.
Bandura, A., 2001. Social cognitive theory: an agentic perspective. Annual Review of Psychology, vol. 52. Annual Reviews, Inc., Palo Alto, pp. 1–26.
Baron, R.M., Kenny, D., 1986. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology 51, 1173–1182.
Bourdieu, P, 1984. Distinction: A Social Critique of the Judgment of Taste. Harvard Univ. Press, Cambridge, MA.
Brody, S.D., Highfield, W., Alston, L., 2004. Does location matter? Measuring environmental perceptions of creeks in two San Antonio watersheds. Environment and Behavior 36 (2), 339–350.
Brown, G., Harris, C., 1998. Professional foresters and the land ethic. Journal of Forestry 96, 4–12.
Brunson, M.W., Reiter, D.K., 1996. Effects of ecological information on judgments about scenic impacts of timber harvest. Journal of Environmental Management 46, 31–41.
Buttel, F., 1987. New directions in environment sociology. Annual Review of Sociology 13, 465–488.
Carlson, A., 1999. Aesthetics and the Environment: The Appreciation of Nature, Art and Architecture. Routledge, New York.
Carlson, A., 2006. The aesthetic appreciation of environmental architecture under different conceptions of environment. The Journal of Aesthetic Education 40 (4), 77–88.
Ceci, S.J., Kain, E.L., 1982. Jumping on the bandwagon with the underdog: the impact of attitude polls on polling behavior. Public Opinion Quarterly 46, 228–242.
Chen, J., Saunders, S.C., Brosofske, K.D., Crow, T.R. (Eds.), 2006. Ecology of Hierarchical Landscapes: From Theory to Application. Nova Science Publisher, New York.
Daniel, T.C., 2001. Aesthetic preferences and ecological sustainability. In: Sheppard, S., Harshaw, H. (Eds.), Forests and Landscape: Linking Ecology, Sustainability and Aesthetics. CABI Publishing, Wallingford, pp. 15–29 (IUFRO research series 6).
Dearden, P., 1984. Factors influencing landscape preferences: an empirical investigation. Landscape Planning 11, 293–306.
Erickson, D.L., Ryan, R.L., De Young, R., 2002. Woodlots in the rural landscape; landowner motivations and management attitudes in a Michigan (USA) case study. Landscape Urban Planning 58, 101–112.
Ewert, A., Baker, D., 2001. Standing for where you sit: an exploratory analysis of the relationship between academic major and environment beliefs. Environment and Behavior 33 (5), 687–707.
Fraser, E.D.G., Kenney, W.A., 2000. Cultural background and landscape history as factors affecting perceptions of the urban forest. Journal of Arboriculture 26 (2), 106–112.
Getz, D.A., Karow, A., Kielbaso, J.J., 1982. Inner city preferences for trees and urban forest programs. Journal of Arboriculture 8 (10), 258–263.
Gobster, P., Nassauer, J.I., Daniel, T.C., Fry, G., 2007. The shared landscape: what does aesthetics have to do with ecology? Landscape Ecology 22 (7), 959–972.
Greene, W.H., 1993. Econometric Analysis. Macmillan Publishing Company, New York.
Grusky, D.B., Wheedon, K.A., 2001. Decomposition without death: a research agenda for a new class analysis. Acta Sociol 44, 203–218.
Kaiser, F.G., Wolfing, S., Fuhrer, U., 1999. Environmental attitude and ecological behavior. Journal of Environmental Psychology 19, 1–19.
Kaplan, R., Kaplan, S., 1989. The Experience of Nature. Cambridge University Press, Cambridge.
Kaplan, R., Kaplan, S., Ryan, R.L., 1998. With People in Mind. Island Press, Washington, DC.
Kaplowitz, S.A., Fink, E.L., D'Alessio, D., Armstrong, G.B., 1983. Anonymity, strength of attitude, and the influence of public opinion polls. Human Communication Research 10, 5–25.
Klapper, J.T., 1960. The Effects of Mass Communication. Free Press, New York.

Appendix 2

Lindhagen, A., 1996. Forest recreation in Sweden: four case studies using quantitative and qualitative methods. Dissertation, Swedish University of Agricultural Sciences. Report 64. Swedish University of Agricultural Sciences, Uppsala.
Lindenmayer, D.B., Franklin, J.F., 2002. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach. Island Press, Washington, DC.
Luzar, E.J., Diagne, A., 1999. Participation in the next generation of agriculture conservation programs: the role of environmental attitudes. Journal of Social Economics 28, 335–349.
Ma, X., Bateson, D.J., 1999. A multiple analysis of the relationship between attitude toward science and attitude toward the environment. Journal of Environmental Education 31, 27–32.
Maddala, G.S., 1990. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge.
Martin, C.A., 2001. Landscape water use in phoenix. Desert Plants 17, 26–31.
McPherson, E.G., Simpson, J.R., Livingston, M., 1989. Effects of three landscape treatments on residential energy and water use in Tucson, Arizona. Energy and Buildings 13, 127–138.
Mutz, D.C., 1992. Impersonal influence: effects of representations of public opinion on political attitudes. Political Behavior 14 (2), 89–122.
Nassauer, J.I., 1988. The aesthetics of horticulture: neatness as a form of care. HortScience 23 (6), 973–977.
Nassauer, J.I., 1995. Messy ecosystems, orderly frames. Landscape Journal 14 (2), 161–170.
Nassauer, J.I., 1997. Cultural sustainability: aligning aesthetics and ecology. In: Nassauer, J.I. (Ed.), Placing Nature: Culture and Landscape Ecology. Island Press, Washington, DC, pp. 65–83.
Nassauer, J.I., 2006. Landscape planning and conservation biology: systems thinking revisited. Conservation Biology 20 (3), 677–678.
Nassauer, J.I., Wang, Z., Dayrell, E., 2009. What will the neighbors think? Cultural norms and ecological design. Landscape and Urban Planning 92 (3/4), 282–292.
Nash, R., 2001. Wilderness and the American Mind. Yale Univ. Press, USA.
Ode, Å., Fry, G.L.A., 2002. Visual aspects in urban woodland management. Urban Forestry & Urban Greening 1, 15–24.
Ode, Å., Tveit, M.S., Fry, G., 2008. Capturing landscape visual character using indicators: touching base with landscape aesthetic theory. Landscape Research 33 (1), 89–117.
Ode, Å., Fry, G., Tveit, M.S., Messager, P., Miller, D., 2009. Indicators of perceived naturalness as drivers of landscape preference. Journal of Environmental Management 90, 375–383.
Park, H.M., 2005. Categorical dependent variable models using SAS, LIMDEP, and SPSS. http://www.indiana.edu/~statmath (accessed December, 2008).
Rauwald, K.S., Moore, C.F., 2002. Environmental attitudes as predictors of policy support across three countries. Environment and Behavior 34 (6), 709–739.
Ribe, R.G., 1989. The aesthetics of forestry: what has empirical preference research taught us? Environmental Management 13, 55–74.
Robbins, P., Birkenholtz, T., 2003. Turfgrass revolution: measuring the expansion of the American lawn. Land Use Policy 20 (2), 181–194.
Schroeder, H.W., 1988. Environment, behavior, and design research on urban forests. In: Zube, E.H., Moore, G.T. (Eds.), Advances in Environment, Behavior, and Design, vol. 2. Plenum Press, New York, pp. 87–117.
Silvennoinen, H., Pukkala, T., Tahvanainen, L., 2002. Effect of cuttings on the scenic beauty of a tree stand. Scandinavian Journal of Forest Research 17, 263–273.
Smith, V.K., 1995. Does education induce people to improve the environment? Journal of Public Policy Analysis and Management 14, 15–29.
Steinberg, T., 2006. American Green—The Obsessive Quest for the Perfect Lawn. W.W. Norton & Company, New York.
Tuan, Y., 1990. Topophilia: A Study of Environmental Perception, Attitudes and Values. Columbia University Press, New York.
Tyrväinen, L., Gustavsson, R., Konijnendijk, C., Ode, Å, 2006. Visualization and landscape laboratories in planning, design and management of urban woodlands. Forest Policy and Economics 8, 811–823.
Van den Berg, A.E., Koole, S.L., 2006. New wilderness in the Netherlands: an investigation of visual preferences for nature development landscapes. Landscape and Urban Planning 78, 362–372.
Watt Jr., J.G., van den Berg, S.A., 1978. Time series analysis of alternative media effects theories. In: Ruben, R.D. (Ed.), Communication Yearbook, vol. 2. Transaction Books, New Brunswick, NJ, pp. 215–224.
Wall, G., 1995. General versus specific environmental concern: a Western Canadian case. Environment and Behavior 27, 294–316.
Werner, C.M., 1999. Psychological perspectives on sustainability. In: Becker, E., John, T. (Eds.), Sustainability and the Social Sciences. Zed Books, New York, pp. 223–242.
Wessels, T., 1997. Reading the Forested Landscape: A Natural History of New England. The Countryman Press, Woodstock, Vermont.
Zhang, Y., Hussain, A., Deng, J.Y., Letson, N., 2007. Public attitudes toward urban trees and supporting urban tree programs. Environment and Behavior 39 (6), 797–814.
Zheng, B., 2009. Accounting for preferences and attitudes to urban trees and residential landscapes. MS thesis. Auburn University, Auburn, AL.

Bin Zheng, MS, is a Ph.D. student in the School of Forestry and Wildlife Sciences at Auburn University. Having earned graduate degrees in forestry, her master thesis was focused on individual's preference and attitude to urban trees and residential landscapes. Her research interests lie in natural resource economics, family forestry, recreation and tourism.

Yaoqi Zhang, Ph.D., is a Associate Professor in the School of Forestry and Wildlife Sciences, Auburn University. He received his Ph.D. from University of Helsinki. His interests include forest economics, ecological economics, environmental history, and economics and policy issues of urban ecosystem.

Jiquan Chen, Ph.D., is a Distinguished University Professor in the Department of Environmental Sciences, University of Toledo, Ohio, USA. He received his Ph.D. from University of Washington in 1991. His interests include landscape analysis, global change, carbon and water fluxes, resource management, and coupled human and natural systems at landscape and regional scales.

Appendix 3

Journal of Agricultural and Applied Economics, 38,2(August 2006):279–285

Demand for Urban Forests and Economic Welfare: Evidence from the Southeastern U.S. Cities

Pengyu Zhu and Yaoqi Zhang[1]

This study examines the relationship between urban forests and household income and population density in the 149 cities with populations over 40,000 in nine southeastern states. Our empirical results show that urban forest percentage across the cities has characteristics of the environmental Kuznets curve. We find that household income around $39,000 is a threshold that changes the relationship between income and urban forest coverage from negative to positive, whereas the impact of population density on urban forests is just the opposite, from positive to negative when population density is around 180 persons per square kilometer.

Key Words: environmental Kuznets curve, environmental quality, income, land use, population density, tree canopy

JEL Classifications: C31, Q23, Q56, Q57, R14

Economics is the study of how individuals, as well as societies, allocate scarce resources to satisfy their various needs. Economic decisions are reflected not only in individual choices, but also in public decisions such as public budgets, policies, and regulation. An important aspect of economic choices is associated with enjoyment of environmental amenities versus traditional economic goods. The term environmental Kuznets curve (EKC) was coined to describe the relationship between environmental quality, such as air quality, and income by analogy to the relationship between income inequality and national income first observed by Simon Kuznets. EKC has been tested in many studies (e.g., De Groot, Withagen, and Minliang; Lindmark; Rupasingha et al.; Stern, Common, and Barbier).

Studies of forests in this empirical framework have focused on the relationship between forest coverage and income at the national level and regional level. The results were mixed. Shafik and Bandyopadhyay found that net change in forest cover did not significantly relate to income in 149 countries between 1961 and 1986. Panayotou used strictly cross-sectional international data and found a turning point in deforestation at $1,275 (in 1985 prices) of household income. Cropper and Griffiths created pooled time series cross-section data for three separate regions of the

---

Yaoqi Zhang is assistant professor, School of Forestry and Wildlife Sciences, Auburn University, AL; and Pengyu Zhu is graduate research assistant, School of Forestry and Wildlife Sciences, Auburn University, AL.

The authors appreciate financial support provided by the Center for Forest Sustainability of Auburn University, the Challenge Cost-Share Grant Program of the National Urban and Community Forestry Advisory Council of the USDA Forest Service, and Alabama Urban and Community Forestry Assistance Program. The authors also thank Dr. David Laband and Dr. Brenda Allen for helpful comments.

Appendix 3

world and found that per capita national income was a significant factor in both Africa and Latin America but not in Asia.

So far we have not found any similar studies on urban forests. In fact, one of the best indicators of the urban environment and amenities is the status of trees present in a city. Trees have been recognized as an important component of urban landscapes throughout the history of urbanization. Sociologists and economists found that urban trees, in addition to providing environmental and aesthetic benefits, also brought a broad range of economic, social, and even psychological benefits. Trees in urban landscapes moderate temperature and microclimates, thereby reducing the needs for air conditioning and thus saving energy (Heisler; McPherson; Meier; Oke).

Urban trees help improve air quality and sequester carbon (Nowak; Nowak and McPherson; Rowntree and Nowak; Smith), help stabilize soils, reduce erosion, improve groundwater recharge, control rainfall runoff and flooding (Sanders), reduce urban noise levels (Cook), and provide habitat that increases biodiversity (Johnson). Urban trees also make neighborhoods aesthetically more appealing and add to the value of property (Schroeder). Evidence has also been shown that urban forests may reduce human stress levels (Ulrich), promote social integration of older adults with their neighbors (Kweon, Sullivan, and Wiley), and provide local residents with opportunities for emotional and spiritual fulfillment that help them cultivate a greater attachment to their residential areas (Chenoweth and Gobster).

Trees in cities are beneficial but are not free. They require space that is usually very costly in a city, as well as planting and maintenance. Any community has to face the difficulties in allocation of its limited budget for planting trees and other purposes and in allocation of the urban land for planting trees and other alternative uses. Individuals have to make the decision of what size lot to purchase for their homes and in which kinds of urban settings. So lot size and tree presence reflect, to some extent, the market forces determined by the welfare of the city citizens and their preferences. This study tests the relationship between the economic welfare and the tree presence in urban areas.

At the city level, which factors contribute to the variation in status of urban forests is interesting and may have some policy implications. Although researchers have noticed that urban forest canopy cover correlates with ecological and geographic factors as well as with urban form, they have not shown how canopy cover varies with socioeconomic conditions across all regions. Is there an EKC for urban forests? In the following sections, we first introduce econometric models and data, and then the results are presented and conclusions are made.

Econometric Model

Urban forests are either public goods, private goods, or a combination of both. They are determined by demand and supply. Unfortunately, it is impossible to get the prices and costs. Neither shadow prices nor instrumental prices or indicators, such as the residential land values, are available for each city. Only two variables, population density and income, which should be strongly related to the presence of urban forests, are obtainable for all cities. Since other variables (such as residential land value) might be fundamentally determined by these two variables, we simply use the reduced form of urban forests (*FOR*) as a function of population density and income:

$$(1) \qquad FOR = F(POD, INC) + e$$

$$\ln FOR = a_0 + a_1 \ln INC + a_2 \ln POD + a_{11}(\ln INC)^2 + a_{22}(\ln POD)^2 + a_{12}(\ln INC{*}\ln POD) + e_i,$$

where *FOR* represents the percentage of urban forest canopy coverage; *INC* is the median household income in 2000; *POD* represents the population density in the city; a_1, a_2, a_{11}, a_{22}, and a_{12} are the coefficients of the variables, respectively; e_i is the error term. It should be noted that a_{11} and a_{22} measure the second-order effect of income and population density on the urban forest canopy cover percentage, respectively, and a_{12} measures the cross effect.

There are no studies on urban forests, but some studies on other issues may be relevant. For example, most studies have concluded that public parks or recreation services, a substitute for urban forests, are a normal good with a positive income elasticity, either less than one or greater than one (Bergstrom and Goodman; Borcherding and Deacon; Perkins; Santerre). Basically, all these conclusions agree that higher income will result in more demand for environmental amenity. The difference among them is only whether environmental amenity represents a luxury good with an income elasticity greater than one.

EKC suggests that urban forest would decrease first with economic development since people choose to sacrifice environment in order to get other uses, but later it would increase with economic development because wealthy people prefer to have more environmental amenities. In fact, this subsequent positive effect of income on the demand for environmental amenity might be specified from two aspects. First, with higher income, the city gets richer and has more money in the budget for urban environmental programs. Second, rich people will also have more money in their budgets for landscaping in the construction of their houses, thereby causing more trees to be planted or maintained.

Our economic model can test whether there is a threshold that can change the impacts of income on urban forests. To get the turning point, we simply derive the function by income:

$$(2) \quad \frac{\partial \ln FOR}{\partial \ln INC} = a_1 + 2a_{11}\ln INC + a_{12}\ln POD = 0$$

$$INC^* = \exp\left(\frac{-a_1 - a_{12}\ln POD}{2a_{11}}\right).$$

We suppose that a similar relationship may exist between urban forests and population density. The biggest difference between urban areas and rural areas is that there exist various urban management programs in cities. With people first clustered in cities, urban services and programs, including urban forest programs, start to provide citizens abundant urban civilizations. At the beginning of urbanization, the clustering of people doesn't actually reduce the urban forest volume. Inversely, various urban forest programs that are not often available for small communities will have an overwhelming influence on the volume and health of our urban forests. But when population density further increases, the opportunity land value for alternative uses will convert some urban trees and green space to other uses, particularly industrial, residential, and commercial uses.

To get the turning point, we derive the function by population density:

$$(3) \quad \frac{\partial \ln FOR}{\partial \ln POD} = a_2 + 2a_{22}\ln POD + a_{12}\ln INC = 0$$

$$POD^* = \exp\left(\frac{-a_2 - a_{12}\ln INC}{2a_{22}}\right).$$

Data

Considering that the natural environment will have a great impact on the urban tree situation, we sought a region with a relatively more homogenous climate and environment. Thus we decided to select nine southeastern U.S. states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia). Cities with populations below 40,000 are considered rural communities, and their surrounding areas become strong substitutes to urban forests; therefore, these cities are excluded from our analysis. We selected a total of 149 cities for this study. Demographic and economic data, such as population, land area, and median household income, are obtained from the U.S. Census Bureau.

The U.S. Department of Agriculture (USDA) Forest Service collected and published forest canopy cover data (Dwyer et al.) in accordance with the Forest and Rangeland Renewable Resources Planning Act, which re-

Appendix 3

Table 1. Data Description of Variables

	Mean	S.D.	Min.	Max.	Sample Number
Urban forest canopy cover percentage (%)[a]	27.4	19.7	0.2	74.4	149
Urban forest area per capita (m^2/person)	422.56	776.002	0.85	8,559.47	149
Population 2000[b]	112,118	112,989	40,214	735,617	149
Land area (km^2)[b]	146.24	235.655	12.9	1,965	149
Population density in 2000 (persons/km^2)	1,208.56	796.47	61.45	4,831.48	149
Median household income ($)[b]	39,786.5	12,924.4	17,206	93,561	149

[a] Dwyer et al. (2000).
[b] U.S. Census Bureau (2000).

quires the Forest Service to assess "the current and expected future conditions of all renewable resources in the Nation" (Forest and Rangeland Renewable Resources Planning Act). The Forest Service has summarized results at state, county, metropolitan statistical area (MSA), urban area, and Census Designated Place (CDP) levels for the entire contiguous United States. These estimates of canopy cover are based on the USDA's national resources inventory and advanced very high-resolution radiometer (AVHRR) data. Urban forest canopy cover, on a 0–100 percentage scale, was calculated for every 1 km^2 in the United States using statistical models for particular physiographic regions.

These statistical models predict forest canopy per square kilometer based on the proportion of individual AVHRR pixels or cells within particular land cover. After the complete coverage for the United States was generated, selected jurisdictional boundaries (e.g., state, county, urban area) were added to the data set to extract the urban forest canopy cover percentage within these boundaries. Table 1 presents the data description of all the variables in our empirical analysis.

Results

Standard ordinary least square estimates are used for the regressions. The results are presented in Table 2. Moreover, we compare two models in our estimation to infer the significance of the cross effect of income and population density on the demand for urban forest,

Table 2. Regression Results

	Coefficient (t value)			
Independent Variables	Model A (with cross effect) (Sample = 149)		Model B (without cross effect) (Sample = 149)	
Constant	322.093	(3.53)	328.696	(3.64)
Log of income	−66.1883	(3.85)	−64.5134	(3.82)
Log of population density	8.86332	(1.12)	4.3839	(2.69)
Square of log of income	3.26349	(3.74)	3.05329	(3.85)
Square of log of population density	−0.444164	(3.53)	−0.422496	(3.53)
log(income) × log(population density)	−0.398351	(0.58)		
Adjusted R^2	0.405		0.408	

The dependent variable is the log of urban forest canopy cover percentage.
Cross effect is represented by the last term in Model A: $a_{12}(\ln INC \times \ln PD)$.

Appendix 3

one with the interaction part (model A), another one without the interaction part (model B).

We find that including the cross effect term in the empirical model decreases the adjusted R^2 value (from 0.408 to 0.405), indicating that the cross effect term doesn't contribute to the explanation power of the model. Moreover, the t ratio of the cross effect term is as low as 0.58, suggesting that its value is not statistically significant at all. Therefore, we will use model B to interpret our results.

The regression results in model B show that all of the estimated coefficients are statistically significant at the 1% level. As expected, the positive coefficient on the second-order effect of income suggests a first negative and then positive impact of income on the demand for urban forests. Inversely, the negative coefficient on the second-order effect of population density suggests a first positive and then negative influence of population density on the demand for urban forest. Based on model B, the equations used to calculate the threshold income value and population density influence in Equations (2) and (3) will be transformed as below:

$$(4) \qquad INC^* = e^{-a_1/(2a_{11})}$$

$$(5) \qquad POD^* = e^{-a_2/(2a_{22})}.$$

Substituting the coefficients estimated for model B into the above equations, we get that the income threshold value is $38,739 per household and the population density threshold value is 179 persons per square kilometer.

The existence of income threshold value provides more powerful evidence in support of the EKC. When the household income is less than $38,739, the percentage of urban forest cover decreases as income increases, indicating a negative income elasticity. As the income approaches the critical point, the income elasticity also approaches 0. After the income surpasses the threshold value, the income elasticity becomes positive and the demand for urban forest increases with the increasing income.

Similarly, there also exists a population density threshold value: 179 persons per square kilometers. When population density is less than 179 persons per square kilometer, the percentage of urban forest increases as population density increases. This is because the urbanized areas use land more efficiently than rural areas and save more land for urban forest development. After the population density surpasses the critical value, the demand for urban forest decreases with the increasing population density because of the increasing stress on providing sufficient accommodation.

The income elasticities of the demand for urban forests for all the sample cities are calculated using the following equation:

$$(6) \qquad \varepsilon_{\text{Income}} = \frac{\partial \ln FOR}{\partial \ln INC} = a_1 + 2a_{11} \ln INC.$$

Results are presented in Figure 1. The income elasticities vary from −2.86 to +4.92. The critical value of the income influence is located on the point where income elasticity equals 0. As the income gets farther away from this critical value on both sides, the absolute value of income elasticity also increases. The highest (+4.92) and lowest (−2.86) income elasticities are reached where the highest ($93,561) and lowest ($23,483) income stand. The income elasticity for the mean household income ($39,787) in our sample cities is 0.11, indicating urban forest coverage is inelastic to income. However, we must point out that this mean income elasticity doesn't have much applicable significance compared to the income threshold value found in our analysis.

Conclusions

This paper analyzes the relationships between urban forest presence and income and population density. Our results indicate a similar trend of EKC in urban forests. With continuous economic development and urbanization, its impacts on urban forests are mixed. In general, population growth will cause urban forests to be replaced by other land uses. As a result, although urban forest programs still endeavor to protect urban forests, many urban forests and green spaces are inevitably converted for construction purposes to accom-

Appendix 3

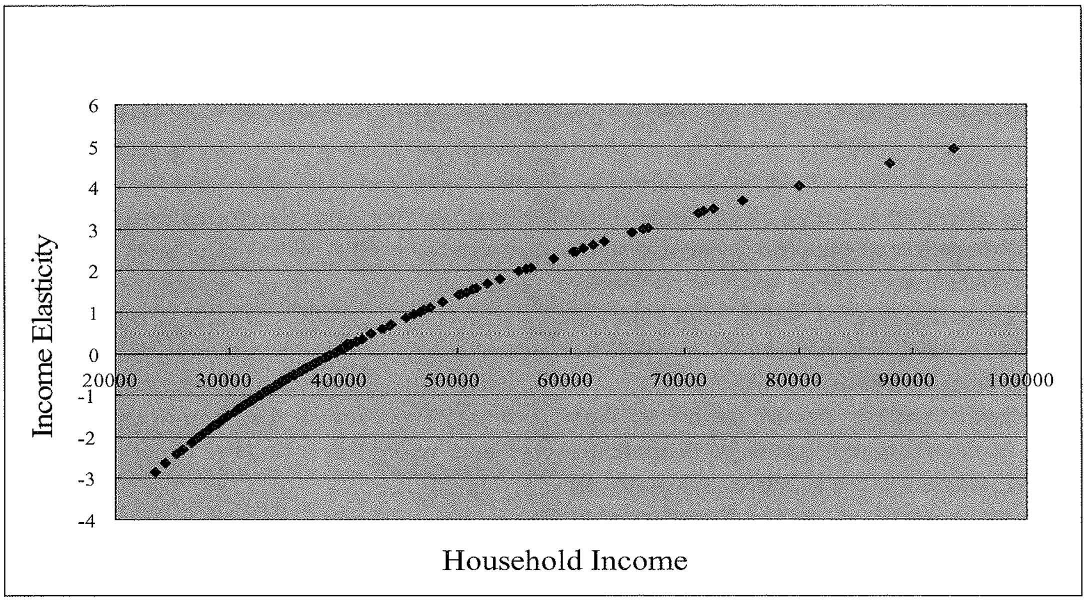

Figure 1. Income Elasticity in Sample Cities

modate the increasing population. In this period, the demand for urban forests will continuously decrease due to the increasing population density, which places more and more pressure on the urban land use.

Economic welfare will finally play a positive role in urban forest after reaching a certain level. Better economic welfare will help people afford to have more urban forests and other green spaces. Higher income will lead to higher environmental quality at the expense of alternative land use and the planting and maintaining of urban trees. Therefore, although economic development may convert more land, including open and green spaces, for construction purposes, societal wealth is significant in affording a higher quality environment.

We must point out some weaknesses of this study. Even though we limit our sample cities to the southeastern United States, the climate and natural conditions, such as landscape and soil, still vary significantly from city to city. However, from the relatively good R^2, we can say that income and population density are good indicators of the variation in urban forests.

References

Bergstrom, T.C., and R.P. Goodman. "Private Demands for Public Goods." *American Economic Review* 63(1973):280–96.

Borcherding, T.E., and R.T. Deacon. "The Demands for the Services of Nonfederal Governments." *American Economic Review* 62(1972): 891–901.

Chenoweth, R.E., and P.H. Gobster. "The Nature and Ecology of Aesthetic Experiences in the Landscape." *Journal of Landscape* 9(1990):1–18.

Cook, D.I. "Trees, Solid Barriers, and Combinations: Alternatives for Noise Control." *Proceedings of the National Urban Forestry Conference.* G. Hopkins, ed., pp. 330–39. New York: USDA Forest Service, 1978.

Cropper, M., and C. Griffiths. "The Interaction of Population Growth and Environmental Quality." *The American Economic Review* 84(1994): 1358–93.

De Groot, H.L.F., C.A. Withagen, and Z. Minliang. "Dynamics of China's Regional Development and Pollution: An Investigation into the Environmental Kuznets Curve." *Environment and Development Economics* 9(September 2004): 507–37.

Dwyer, J.F., D.J. Nowak, M.H. Noble, and S.M. Sisinni. *Connecting People with Ecosystems in* *the 21st Century: An Assessment of Our Nation's Urban Forests.* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-490, 2000.

Forest and Rangeland Renewable Resources Planning Act of August 17, 1974 (Public Law 93-378, 88 Stat. 476, as amended); 16 U.S. Code 1600–1614.

Heisler, G.M. "Effects of Individual Trees on the Solar Radiation Climate of Small Buildings." *Urban Ecology* 9(1996):337–59.

Johnson, C.W. "Planning for Avian Wildlife in Urbanizing Areas in America Desert/Mountain Valley Environments." *Landscape and Urban Planning* 16(1988):245–52.

Kuznets, S. "Economic Growth and Income Inequality." *The American Economic Review* 45(1955):1–28.

Kweon, B.S., W.C. Sullivan, and A.R. Wiley. "Green Common Spaces and the Social Integration of Inner-City Older Adults." *Environment and Behavior* 30(6)(1998):832–58.

Lindmark, M. "Patterns of Historical CO_2 Intensity Transitions among High and Low-Income Countries." *Explorations in Economic History* 41(4)(2004):426–47.

McPherson, E.G. "Modeling Residential Landscape Water and Energy Use to Evaluate Water Conservation Policies." *Journal of Landscape* 9(1990):122–34.

Meier, A.K. "Measured Cooling Savings from Vegetative Landscapes." *Energy Efficiency and the Environment: Forging the Link.* E. Vine, D. Crawley, and P. Centolella, eds. Washington, DC: American Council for an Energy-Efficient Economy, 1991.

Nowak, D.J. "Atmospheric Carbon-Reduction by Urban Trees." *Journal of Environmental Management* 37(3)(1993):207–17.

Nowak, D.J., and E.G. McPherson. "Quantifying the Impact of Trees: The Chicago Urban Forest Climate Project." *Unasylva* 173(44)(1993):39–44.

Oke, T.R. "The Micrometeorology of the Urban Forest." *Philosophical Transactions of the Royal Society of London* 324(Series B)(1989):335–49.

Panayotou, T. *Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development.* Geneva: International Labor Office, Technology and Employment Programme Working Paper WP238, 1993.

Perkins, G.M. "The Demand for Local Public Goods: Elasticities of Demand for Own Price, Cross Prices, and Income." *National Tax Journal* 30(1977):411–422.

Rowntree, R.A., and D.J. Nowak. "Quantifying the Role of Urban Forests in Removing Atmospheric Carbon Dioxide." *Journal of Arboriculture* 17(10)(1991):269–75.

Rupasingha, A., S.J. Goetz, D.L. Debertin, and A. Pagoulatos. "The Environmental Kuznets Curve for US Counties: A Spatial Econometric Analysis with Extensions." *Papers in Regional Science* 83(2)(2004):407–24.

Sanders, R.A. "Urban Vegetation Impacts on the Hydrology of Dayton, Ohio." *Urban Ecology* 9(1986):361–76.

Santerre, R.E. "Spatial Differences in the Demands for Local Public Goods." *Land Economics* 61(1985):119–28.

Schroeder, H.W. "Environment, Behavior and Design Research on Urban Forests." *Advances in Environment, Behavior and Design,* E.H. Zube and G.T. Moore, eds. New York: Plenum, 1989.

Shafik, N., and S. Bandyopadhyay. "Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence." *Background Paper for the World Development Report.* Washington D.C.: The World Bank, 1992.

Smith, W.H. *Air Pollution and Forests.* New York: Springer, 1981.

Stern, D.I., M.S. Common, and E.B. Barbier. 1996. "Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development." *World Development* 24(7):1151–60.

Ulrich, R.S. "View through a Window May Influence Recovery from Surgery." *Science* 224(1984):420–21.

Appendix 4

Available online at www.sciencedirect.com

ScienceDirect

Landscape and Urban Planning 84 (2008) 293–300

LANDSCAPE AND URBAN PLANNING

www.elsevier.com/locate/landurbplan

Demand for urban forests in United States cities☆

Pengyu Zhu[a,b,1], Yaoqi Zhang[a,*]

[a] School of Forestry & Wildlife Sciences, Auburn University, AL 36849-5418, USA

[b] School of Policy, Planning and Development, University of Southern California, CA 90007, USA

Received 24 June 2006; received in revised form 22 August 2007; accepted 10 September 2007
Available online 29 October 2007

Abstract

Extensive economic investigations have shown a variety of benefits derived from urban forests, but study on demand for urban forests remains limited. This study investigates the impact of selected potential factors on the demand for urban forests at the city level. An empirical economic model is used to examine and estimate the demand for urban forests in all cities with population over 100,000 in the United States. The empirical findings suggest that the demand for urban forests is elastic with respect to price and highly responsive to changes in income. Urban forest area increases as total population grows but at a lower rate than population growth.

Keywords: Population growth; Economic development; Urban land value; Urban forests; United States

1. Introduction

Trees have been recognized as an important component of urban landscapes. Like other forms of municipal infrastructure, urban trees provide a variety of values and services, including energy savings, improved air quality, aesthetics, health benefits, habitat for birds and other wildlife, and recreation enhancement. These factors are reflected in higher real estate prices, lower energy bills, and greater attraction to tourists and talented people and businesses (Bradley, 1995; Dwyer et al., 1992; Orland et al., 1992). Indeed, recent evidence shows that amenities function as new drivers for urban growth and communities dynamics (Clark et al., 2002).

While many studies on urban forestry have analyzed the benefits of urban trees (e.g., Gorman, 2004; McPherson et al., 1999; Dwyer and Miller, 1999; Thompson et al., 1999; Tyrvainen, 2001), very few studies have been conducted to investigate the demand for urban trees including the factors that influence this demand. Although it is obvious that urban forest canopy cover correlates with ecological and geographic factors as well as urban patterns, it is less known how socioeconomic conditions affect the urban forest demand. This issue is not only interesting from academic perspectives, but also has important policy implications.

Essentially, economics is the study of choice. An important aspect of economic choice is associated with the enjoyment of environmental amenities versus the enjoyment of traditional economic goods. Trees in cities can provide a variety of benefits, but they are not free. To have trees in cities, people not only need to bear the huge opportunity costs of the contributed land within urban areas, but also need to allocate a large amount of public funds to planting and maintenance. Therefore, any community has to face the tradeoff in allocation of its limited fiscal budget between planting trees and other purposes, and the tradeoff in allocation of its limited land between planting trees and other alternative uses. Individuals have to make the decisions of what lot size they should purchase for their homes and in which kind of urban settings they would like to live. So lot size and tree presence reflect, to some extent, the market forces determined by the welfare of the citizens and their preferences. Developers choose to build homes and develop landscape that they feel will attract buyers. Homeowners may modify their landscape to some degree based on their taste and affordability even after their purchase. Therefore, the presence of city trees also reflects individual choices. However, developers and individuals have to follow zoning, landscape and tree ordinances that are usually determined at city level.

☆ This work was completed when Pengyu Zhu was an research assistant in the School of Forestry and Wildlife Sciences, Auburn University.

* Corresponding author. Tel.: +1 334 844 1041; fax: +1 334 844 1084.
E-mail addresses: zhupeng@auburn.edu (P. Zhu), yaoqi.zhang@auburn.edu (Y. Zhang).

[1] Tel.: +1 334 844 8043; fax: +1 334 844 1084.

0169-2046/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2007.09.005

Appendix 4

The purpose of this study is to investigate the impact of economic behavior on the demand for urban forests. We first discuss the major benefits of urban trees, then we formulate demand for urban trees. Cross-sectional data of all cities with population over 100,000 in the United States are used to estimate the demand for urban forests. Conclusions and discussions are presented at the end.

2. Urban forests as economic goods

Urban forests are economic goods that provide a variety of benefits. Trees in urban landscapes moderate temperature and microclimates, thereby reducing the need for air conditioning and thus saving energy (Heisler, 1986; McPherson, 1990; Meier, 1991; Oke, 1989). Urban trees help improve air quality and sequester carbon (Nowak, 1993; Nowak and McPherson, 1993; Rowntree and Nowak, 1991; Smith, 1981), help stabilize soils, reduce erosion, improve groundwater recharge, control rainfall runoff and flooding (Sanders, 1986), reduce urban noise levels (Cook, 1978), and provide habitat that increases biodiversity (Johnson, 1988). Based on modeling of air pollution, storm water mitigation and energy impacts, the Urban Ecosystem Analysis of the Washington, DC Metropolitan Area concluded that tree cover reduced storm water storage costs by $4.7 billion and generated annual air quality benefits of $49.8 million (American Forests, 2002).

Urban trees also make neighborhoods aesthetically more appealing and add to the value of property (Schroeder, 1989). Previous hedonic price analyses showed clearly that trees increase the value of residential properties and that people are willing to pay more for housing with trees (Anderson and Cordell, 1985, 1988; Morales, 1980; Payne and Strom, 1975). More recently, Crompton (2001) concluded that a quality forest or green space has a positive economic ripple effect on nearby properties. Appraised property values of homes that are adjacent to parks and open spaces are typically about 8–20% higher than those of comparable properties elsewhere. Rental rates of commercial office properties were about 7% higher on sites having a quality landscape, which included trees (Crompton, 2001).

Studies on how trees affect shoppers' behavior in retail business districts have been addressed as well. These studies generally employed the contingent valuation method. Consumers claim they are willing to pay more for products in downtown shopping areas with trees, versus in comparable districts without trees (Wolf, 2005). Customer service, merchant helpfulness, and product quality are all judged to be better by shoppers in places with trees (Crompton, 2001).

Evidence also shows that urban forests may reduce human stress levels (Ulrich, 1984), promote social integration of older adults with their neighbors (Kweon et al., 1998), and provide local residents with opportunities for emotional and spiritual fulfillment that help them cultivate a greater attachment to their residential areas (Chenoweth and Gobster, 1990). Furthermore, the presence of trees and "nearby nature" in human communities generates numerous psychosocial benefits. Kuo (2003) found that having trees within high density neighborhoods lowers levels of fear, contributes to less violent and aggressive behavior, encourages better neighbor relationships and better coping skills. Other studies have shown that hospital patients recover more quickly and require fewer painkilling medications when they have a view of nature (Ulrich, 1984). Finally, office workers with a view of nature are more productive, report fewer illnesses, and have higher job satisfaction (Kaplan, 1993).

3. Economic model of the demand for urban forests

In a city, trees can broadly be divided into two categories by ownership. The first category includes the trees on public lands, e.g., trees in city parks and along city streets. All city citizens share and bear the costs of public trees together. Determining the presence of these public urban forests is a public choice on the public-owned land and streets. The second category of trees in the city refers to private trees, e.g., trees in individual yards and private lots. Individuals choose their subdivision/neighborhoods and the lot size based on their own preference and income. Someone may argue that urban forests are not subject to individual choice. For example, people who like trees will not move from Phoenix to Boston simply because Boston has more trees. However, these tree enthusiasts are able to move from a treeless part of Phoenix to a tree rich part. Hence, from a dynamic perspective, developers and city planners consider the expectations of their citizens in regard to trees, landscape and lot sizes. The owners also have some capacity to modify landscape after they purchase their houses. Therefore, the situation of urban trees and landscape could eventually satisfy each individual's preferences and affordability. In some situations, public trees and private trees might substitute for each other. Based on Escobedo et al. (2006), public urban forest structure is related to the socioeconomic strata of Santiago's different municipalities. The total public urban forest budgets were greater in the high socioeconomic strata. Regardless of this, when we look at the sum of private and public trees across a city, this summation reflects the average or aggregated demand for urban forests in that city, no matter how the share between public and private trees might differ from another city.

It could be very interesting to see how the share between these two affects the demand for urban forests, and how they substitute for each other. Unfortunately, no data currently exist on the different shares between public and private trees among cities. Hence, we aggregate the public and private trees at the city level, or alternatively at the level of per capita average amount. But we do think this is acceptable as an empirical study. Either public demand or private demand are mixed by individual choice as well as public choice. The share of public forests to some degree is individual choice since the budget, the land use are subject to the citizen approval. The share of private forests to some degree are subject to public choice since each individual (or developers) are subject to zoning, lot size regulation, landscape and tree ordinance that are determined by public choice. In terms of price of urban forests, it is not uncommon of trading between public land and private land. The costs of planning and maintaining trees should not vary very much between public domain and private sector.

Appendix 4

Since urban forests provide a lot of public goods, free rider issue needs to be considered. However, as an aggregated study at city level, we think it is fine. Homeowners cannot do totally what they like on their private lots, some tree presence is often mandatory. Landscape and tree ordinances, zoning and other municipal codes play an important role in maintaining good environments and providing amenities for neighborhoods. In addition, what we find of interest is the fact that most households typically contribute much more than the regulations require. If homeowners free-ride on the positive benefits conferred by their neighbors, then no one in a given neighborhood has incentive to spend more time and money on the landscaping than required. The question is, does a homeowner really enjoy the good appearance of his own yard (especially the front yard) independent of how others view his yard or are his landscaping decisions influenced by his desire to have trees that pleases his neighbors? We know that free-rider problems exist in many contexts. However, not only do free rider problems not appear to plague residential neighborhoods, at least with respect to landscaping, in many cases we observe homeowners spending considerable time and money to produce landscaping that yields benefits for the neighborhood. That is, they are free providers rather than free riders. We suggest that the externalities generated by a homeowner's good landscaping (e.g., trees) constitute a form of social 'goodness' signaling. Individuals who engage in this type of behavior use the implicit and explicit investments that produce socially beneficial landscaping to convince other members of the community that they conform to the group's norms and, as such, are viable and valuable members of the community. The community embraces these individuals and rather more than individuals who do not engage in such signaling. Because the good landscaping signal is highly visible in neighborhoods, individuals have both an incentive to produce the signal and a disincentive to free ride.

Given the above justifications and considering the paucity of data about the share between private and public forests, our empirical model classifies the urban forests within a city into two components: (1) the average aggregated level of public and private forests (Q) or per urban forest per capita (Q/N) across cities that are determined by average welfare and natural environment, and (2) the variation across individuals from the average level (Q_i) within each city that is subject to individual taste and welfare.

The amount of Q is jointly the result of decisions made by local officials together with local citizens in allocating public funds and land, as well as in defining average requirements for trees on private land. However, each individual varies in his/her quantity demanded at his/her expense and by individual decision. The utility created by Q and Q_i could be different due to spacial reasons, as well as cost difference. After choosing aggregated quantity Q at city level and Q_i at individual variation of urban forests, individuals choose other composite good, y, to maximize the utility U in Eq. (1) subject to his or her income constraint in Eq. (2),

$$U_i = U(Q,\ \ Q_i,\ \ y_i) \tag{1}$$

$$I_i = \left(\frac{P_\mathrm{f}}{N}\right) Q + P_\mathrm{f} Q_i + P_y\, y_i \tag{2}$$

where I_i is individual income; P_f is the unit price of urban forest; P_y is the unit price of the composite good y. The cost of Q is shared equally by the total population N. The cost of Q_i is totally borne by private individuals. In this study, the focus is not on investigating how each individual's choice influences the demand for urban forests. Instead, we investigate the average or total level of demand, as our objective is to examine the variation across cities rather than across individuals. Hence, we delete the individual component and get following equations:

$$U = U(Q,\ \ y) \tag{1$'$}$$

$$I = \left(\frac{P_\mathrm{f}}{N}\right) Q + P_y y \tag{2$'$}$$

The typical household's demand for units of urban forest enjoyment, Q, can be derived from the utility maximization process, which is given in a general form as:

$$Q = Q\left[\left(\frac{P_\mathrm{f}}{N}\right)\ ,\ P_y,\ I\right] \tag{3}$$

Assuming that the demand function in Eq. (3) can be written in constant elasticity form and that $P_y = \$1$, the demand function could be written as:

$$Q = k\left(\frac{P_\mathrm{f}}{N}\right)^a I^b \tag{4}$$

Taking the natural logarithmic transformation gives the final estimation equation for econometric analysis,

$$\ln(Q) = b_0 + b_1\ \ln(P_\mathrm{f}) + b_2\ \ln(I) + b_3\ \ln(N) \tag{5}$$

If we change the demand for total urban forests into demand per capita, Eq. (5) can be rewritten as

$$\ln\left(\frac{Q}{N}\right) = b'_0 + b'_1\ \ln(P_\mathrm{f}) + b'_2\ \ln(I) + b'_3\ \ln(N) \tag{5$'$}$$

where Q/N is the urban forest per capita. This is a double log econometric specification, which implies that the elasticity is constant and equal to the coefficients regardless of the level when change is occurring. Such an assumption has some limitations, but it is simple since we do not need to calculate the elasticity at different level of dependent variables.

Based on the law of demand, quantity demanded for total urban forest should respond negatively to its price ($b_1 < 0$), and positively to per capita income ($b_2 > 0$). With higher per capita income, the city has more budget for urban tree programs. In addition, wealthy citizens are more able to afford larger lots for their homes and are able to spend more money on landscaping during the construction of their homes, leading to a higher number of trees planted or maintained.

As discussed later, many researchers have found empirically that parks and recreation services, the complements to urban forests, resemble a luxury good. If urban forest represents a luxury good, its income elasticity b_2 should be greater than 1.

The estimated coefficient on population gives us an indication for the effect of population growth on urban forest demand. If all other inputs are assumed to be constant, the impact of population growth on demand for urban forests is not clear at this time.

Appendix 4

This is due to the fact that population increase would reduce the share of the cost per capita, but at the same time increase the congestion since urban forests are not purely public goods. For example, urban trees can promote city pride and improve air quality (public goods), while also provide protection of privateness and private woodlots for personal recreation (private goods). Both the marginal value and marginal costs of urban forests decreases when population grow: the optimum amount of urban forests that the average individual wishes to have (both the public as well as private for average individual) could be at the level where the marginal value for average individual is equal to the his or her cost share.

Another necessary control variable that must be considered in our model is the natural environmental factor. It is well known that natural vegetation in undisturbed environments is primarily a function of temperature and precipitation, or geographic factors such as ecoregion or altitude that correlate with them. A large area that includes generally similar ecosystems and that has similar types, qualities, and quantities of environmental resources is known as an ecoregion. Nowak et al. (1996) and Dwyer et al. (2000) show that urban tree canopy cover is highest in forested ecoregions, followed by grasslands and deserts, thus confirming ecoregion as an indispensable contributor to urban canopy variation at a national scale.

Following this line of reasoning, in a dynamic context, we see that the ecoregion condition may influence the changing amount of urban forest land during different stages of city growth. In forested ecoregions, cities are surrounded by forestland. As the city expands outward, more forestland will be delimited within city limits. Although part of the forestland will be converted into other uses such as residential or commercial use, the newly added area that has not been developed will greatly contribute to the increase of urban forest. However, in grassland or desert ecoregions, the situation will be different. Most regions outside the city limit will have a lower forest coverage than those inside the urban area. Of course, once the area has been converted into urban use, tree canopy coverage is expected to increase, due to the impact of human demand. In conclusion, the ecoregion factor will have a significant contribution to our model. For simplicity as well as data limitation, we add a dummy of ecoregion, D_{eco}, and change Eqs. (5) and (5′) into:

$$\ln(Q) = b_0 + D_{\text{eco}} + b_1 \ln(P_{\text{f}}) + b_2 \ln(I) + b_3 \ln(N) \qquad (6)$$

$$\ln\left(\frac{Q}{N}\right) = b_0' + D_{\text{eco}}' + b_1' \ln(P_{\text{f}}) + b_2' \ln(I) + b_3' \ln(N) \qquad (6')$$

4. Data

Our research will address all the big cities with population greater than 100,000 in the United States. After deleting some

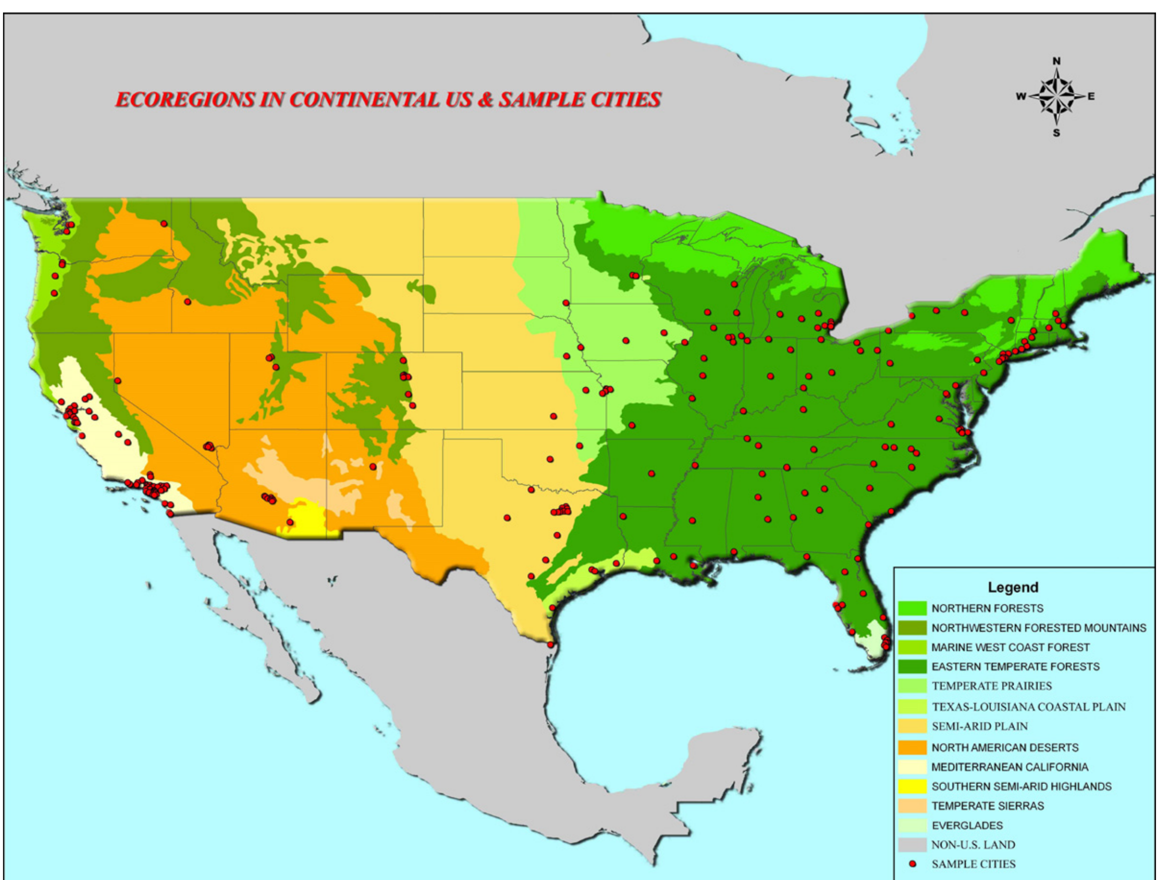

Fig. 1. Ecoregions of selected cities in Continental US.

Appendix 4

cities with missing data or incorrect data. The urban tree coverage in some cities is less than 0.05%. In these cases, the coverage percentage is regarded as 0 in the National Urban Forest Report (Dwyer et al., 2000). We obtained data for 242 cities. The locations of these sample cities are exhibited in Fig. 1.

4.1. Urban forest canopy cover

The United States Department of Agriculture (USDA) Forest Service collected and published canopy cover data (Dwyer et al., 2000) in accordance with the Forest and Rangeland Renewable Resources Planning Act of 1974, which requires the Forest Service to assess "the current and expected future conditions of all renewable resources in the Nation"(USDA Forest Service, 1989). As such, the Forest Service has summarized results at state, county, metropolitan statistical area (MSA), urban area, and Census Designated Places levels for the contiguous United States. These estimates of canopy cover are based on the USDA's national resources inventory (NRI) and advanced very high-resolution radiometer (AVHRR) data. Urban forest canopy cover, on a 0–100 percentage scale, was calculated for every 1 km^2 in the United States using statistical models for particular physiographic regions and 1991 AVHRR data.

These statistical models predict forest density per square kilometer based on the proportion of individual AVHRR pixels, or cells within it, with particular land cover. Selected jurisdictional boundaries (e.g., state, county, urban area) were added to the data set after the complete coverage for the United States was generated. The accuracy of the estimates of canopy cover was determined through comparisons with canopy inventories of selected urban areas around the United States, based on aerial photography (Nowak et al., 1996). However, the urban forest canopy cover data are statistical estimates and are most suitable for large areas (Dwyer et al., 2000). Despite this limitation, the data are well suited for our analysis since the minimum land area of the sample cities is 27.1 km^2. Based on the urban forest canopy cover data, land area data, and population data, we can calculate the dependent variable, per capita urban forest amount, for each sample city.

4.2. Ecoregion classification data

In the mid-1990s, the National Interagency Technical Team (NITT) was formed to develop a common framework of ecological regions for the nation. The intention was that this framework will foster an ecological understanding of the landscape, rather than an understanding based on a single resource, single discipline, or single agency perspective. Currently, there are two broadly recognized ecoregion division systems: Omernik's ecoregion system and Bailey's ecoregion system. After comparing their different classification criteria, we find Omernik's ecoregions are more suitable for our analysis.

The Omernik ecoregion system is hierarchical and considers the spatial patterns of both the living and non-living components of the region, such as geology, physiography, vegetation, climate, soils, land use, wildlife, water quality, and hydrology. There are four levels in the Omernik ecosystem hierarchy. Level I ecoregions were mapped and described by the North American Commission for Environmental Cooperation (CEC) in 1997. A combined data set in Arc/INFO Export format, with Level I, Level II, and Level III ecoregions for all of North America, is available from the EPA Ecoregions of North America download page (http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads).

In this study, a mixed use of Level I and Level II ecoregions was proposed. In southern Florida, the Level I ecoregion system classifies this region as "Tropical Wet Forests." But in Level II, this region is defined as "Everglades", which is not well suited for tree growth. The tree canopy coverage data collected from Dwyer et al. (2000) also attests to the low canopy percentage in this region. All the sample cities in this region have their tree canopy coverage below 5%, with some even falling below 1%. Moreover, in the central US, Level I generally classifies this region as "Great Plains". But as stated in the Level II ecoregion system, "Great Plains" includes temperate prairies, west-central semi-arid prairies, south central semi-arid prairies, Texas–Louisiana coastal plain, Tamaulipas–Texas semi-arid plain. Urban forest coverage varies greatly among these regions, with normally over 10% in temperate prairies or Texas–Louisiana coastal plain and less than 5% in others. In these cases, the Level I classification of ecoregion is neither sufficient nor accurate for our study. Based on Omernik's Level I and Level II ecoregion divisions, a revised ecoregion classification for our specific study is presented in Fig. 1.

As soon as the ecoregion division is ascertained, it is then left to ArcMap to match each sample city with the ecoregion map and extract the information of which ecoregion each city belongs to. This information is then used to build an ecoregion index with values shown in Table 2.

4.3. Economic and demographic data

Demographic and socio-economic data such as population, land area, and per capita income, can be obtained from the U.S. Census Bureau. We used the 2000 data. Since the price of urban forest is unavailable, we will use the opportunity cost of urban forest as its price. Urban forest, as one category of land use within city limits, competes with other land use types such as commercial and residential uses. After purchasing one lot of residential land, the owner can decide what percent of this lot will be developed and what percent will be used to plant trees or lawns. In this case, the price or opportunity cost of urban forest is best exhibited by the residential land price.

Table 1
Results for the regression of residential land value

	Coefficient	*t*-Ratio
Constant	−10.8479	−9.89513
LN (population)	0.309519	3.95187
LN (land area)	−0.39496	−5.50185
LN (house value)	1.16041	12.6048
Adjusted R^2	0.867	

Appendix 4

Table 2
Data description of variables

	Mean	S.D.	Min.	Max.	Sample number
Urban forest canopy cover percentage (%)[a]	17.6475	14.9355	0.1	69	242
Urban forest area per capita (m^2/person)	193.211	305.548	0.21	2126.44	242
Population 2000[b]	303565	620720	82026	8.01E+06	242
Land Area (km^2)[b]	214.506	263.089	19.5	1965	242
Population density 2000 (persons/km^2)	1716.33	1244.51	225.73	10007.8	242
Per capita Income ($)[b]	21009.8	6055.96	9762	68365	242
Residential land value (an average owner-occupied single-family lot in 44 big cities (thousands of current dollars)[c]	119.636	121.592	19	602	44
Single-family owner-occupied house value ($)[b]	138766	76388.3	40900	495200	242
Estimated residential land price (thousands of current dollars)	125.17	103.52	24.81	615.44	242
Ecoregion index[d]	1 = forest, temperate prairie, coastal plain 0 = desert, semi-arid plain, everglade, and others				

[a] Dwyer et al. (2000).
[b] U.S. Census Bureau (2000).
[c] Davis and Palumbo (2005).
[d] Omernik's ecoregion system.

Unfortunately, the residential land price for these sample cities is also unavailable. At the national level, researchers have concluded that the logarithms of the nominal price index for residential land, disposable income, and interest rates are cointegrated (Davis and Heathcote, 2004). However, this research addresses the aggregate residential land price across the whole nation. At the city level, very few studies have been conducted. Davis and Palumbo (2005) conducted a research on land values of an average owner-occupied single-family lot in 46 large cities by Metropolitan Statistical Area. This is the only available data of the residential land price in specific cities. We will use this available residential land price in 44 cities (Within the 46 cities, Washington, DC and Providence, RI are not included in our sample cities. Therefore we only use the other 44 cities for this estimation.), and single-family owner-occupied house value which is available in the US Census, to estimate the residential land price for each sample city in our study.

Previous studies have shown that residential land price is mainly correlated to house value, population, and city land area. Based on the existent residential land price of the 44 cities noted above, we regress the residential land price on house value, population and land area to determine the coefficients of every independent variable. Logarithm data are used in estimation of the model to correct for nonnormality of the distributions.

The results of this regression including the values of each coefficients and *t*-ratio are listed in Table 1. The R^2 of 0.87 indicates the strong explanation power of our model and the high reliability of our forthcoming estimation for residential land price in other cities which is based on this model.

Based on the coefficients of the independent variables: population (Pop), land area (LA), and single house value (HV), we estimate the residential land price (LV_{resi}) for each sample city in our study using following equation: $\ln(LV_{resi}) = -10.848 + 0.31\ln(Pop) - 0.395\ln(LA) + 1.160\ln(HV)$. The estimated residential land value is described in Table 2.

In our model, it is not important for the residential land value to very accurately measure the opportunity costs of urban forests. This methodology is appropriate when the residential land value is able to indicate the trend or index of the opportunity costs of urban forests. Since land value is the most costly component of the urban forests, residential land value could be the best indicator of the urban forest price across cities.

5. Results

Table 2 presents the data description of all variables in our empirical analysis. The ecoregion index, as a control variable capturing the natural environmental effect, is inappropriate to be expressed in logarithmic form. After reviewing the data, we found that some cities' data about urban trees have obvious errors or outliners. Therefore, we keep 210 cities in our final regressions. The values of other variables are transformed by natural logarithm prior to estimation, according to the analysis of our theoretical model. Standard ordinary least square estimates are obtained for the demand equation and presented in Table 3.

The regression results show that all of the estimated coefficients have their expected signs and are statistically significant at the 1% level. Ecoregion index in our model exhibits a very significant influence on the demand for urban forest. The positive sign before ecoregion index attests to the conclusions made by Nowak et al. (1996) and Dwyer et al. (2000). These prior studies claimed that urban tree canopy cover is also highest in forested

Table 3
Regression results of the demand for urban forests

	Eq. (6) (total urban forests)	Eq. (6') (urban forest areas per capita)
Independent variables	Coefficient (*t*-value)	Coefficient (*t*-value)
Constant	−18.580 (5.91)	−4.808 (1.53)
LN (income)	1.762 (5.34)	1.768 (5.36)
Estimated LN (urban forest price)	−1.260 (9.93)	−1.260 (9.94)
LN (population)	.799 (9.69)	−.202 (2.45)
Ecoregion index (dummy)	.348 (4.31)	.348 (4.31)
Adjusted R^2	0.591	0.490

Appendix 4

ecoregions, followed by other ecoregions such as grasslands and deserts.

As hypothesized, the demand for urban forest varies positively with income. The income elasticity of the demand for urban forest is 1.76, indicating urban forest is highly responsive to changes in income and may exhibit some characteristics of a luxury good. This income elasticity estimate means that a 1% increase in per capita income would cause a 1.76% increase in the demand for urban forest.

Similarly, the demand for urban forest varies inversely with its price as we expected. According to the regression results, the price elasticity of the demand for urban forest is approximately −1.26, indicating urban forest is relatively sensitive to the changes in its price. This price elasticity estimate means that with a 1% increase in the price of urban forest, the demand for urban forest will decrease 1.26%.

Our results show that the coefficient is positive between population growth and total urban forest, but negative between population growth and the per capita demand for urban forest. This means that total urban forest area increases at a lower rate than the total population growth. Such changes are likely caused by two forces: changes within the initial city limit and expansion of the city limits as the population grow.

6. Discussions and conclusions

One empirical finding we make from this study is that higher income populations or residents will have more demand for urban forests. Urban forests are economic goods. When income increases the demand will rise as well. Rich communities have larger budget on public forests, and have larger private house lots where private trees mostly are grown. Demand for urban forest is elastic with respect to price and highly responsive to changes in income. As the status of urban forest is a good indicator of urban environmental quality, higher income populations afford the expense of alternative land use, planting and maintaining of urban trees. This conclusion is also consistent with a recent study in the Southeastern United States (see Zhu and Zhang, 2006). Therefore, although economic development consumes more land for construction purposes, including residential and industrial development, the overall impact on environment is positive at least from the indicator of urban trees.

Our finding on the impact of price on the demand for urban forest is consistent with other empirical studies concerning the demand for public parks, recreation services, and environmental quality. Borcherding and Deacon (1972) found the own price elasticity for Park-Recreation to be −.50 and −.41. Bergstrom and Goodman (1973) reported an average price elasticity estimate of −.19 for parks and recreation services. Perkins (1977) found a price-elastic demand for park and recreation with an average elasticity estimate of −2.12, while Santerre (1985) uncovered price elasticity estimates of −.35 on average. Other research concerning environmental quality also concluded similar own price elasticity. Palmquist (1982) found that air quality price elasticity ranges from −1.2 to −1.4, while Bender et al. (1980) reported a range from −0.262 to −0.503. Zabel and Kiel (2000) found a price elasticity of −0.479 for ozone and −0.128 for particulates. More recently, Brasington and Hite (2005) concluded their price elasticity of demand for environmental quality to be −0.12. The estimated price elasticity in this study is −1.26 that is comparable to the results of other studies.

As far as income elasticity is concerned, Borcherding and Deacon (1972) reported estimates ranging from 1.29 to 2.74 for parks and recreation services whereas Bergstrom and Goodman (1973) estimated an income elasticity of 1.32. Other findings about income elasticity estimates for parks and recreation services were relatively lower, with an average of 0.65 for Perkins (1977), and 0.71 for Santerre (1985). Our income elasticity estimate of 1.76 for urban forest is slightly higher than most of the other estimates for parks and recreation services. This is reasonable because urban forest has a larger private component compared to other public goods such as parks and recreation services. Privately owned urban forest, such as trees in the backyard, can be seen everywhere and will greatly contribute to the whole urban forest system. However, this is not the case for parks or other recreation services.

In wrapping up this paper, it is appropriate to point out some weaknesses of this study. The first and most critical weakness is using one dummy (ecoregion) to cover geological and natural variation such as landscape, soil, climate, etc. Secondly, different specifications that might change the size of coefficients have not been investigated, partly because the data do not permit the development of more complicated models to conduct more complex estimates and testing. Thirdly, the variation of demand has only been investigated across cities, while the variation across individuals within each city (e.g., different subdivision) may also contribute to better understanding of demand for urban forests. Finally, the substitution effect by considering the landscape and environment around city and region has not been adequately addressed. All these issues are important to understand the demand for urban forests and could serve as focal points for future study. Therefore, on the one hand, we need to be cautious when we interpret elasticity of income, price and population; on the other hand, further investigation is needed to find how natural variables, individual income as well as the share between public and private urban forests affect the demand for urban forests. One potential approach that might overcome the above limitations is to explore the historical change in each city using time series analysis. This study and findings could be useful to continuous investigation for some policy implication for urban planning and decision makers.

Acknowledgements

We appreciate financial support provided by the Center for Forest Sustainability of Auburn University and the Challenge Cost-Share Grant Program of The National Urban & Community Forestry Advisory Council of USDA Forest Service. We appreciate Dr. David Laband, Dr. Brenda Allen and three anonymous reviewers' comments and suggestions. All opinions and errors are the responsibility of the authors.

Appendix 4

References

American Forests, 2002. Urban Ecosystem Analysis for the Washington, DC Metropolitan Area: An Assessment of Existing Conditions and a Resource for Local Actions. Retrieved 10/05/2005, from: http://www.americanforests.org/downloads/rea/AF_WashingtonDC2.pdf.

Anderson, L.M., Cordell, H.K., 1985. Residential property values improve by landscaping with trees. South. J. Appl. Forest. 9, 162–166.

Anderson, L.M., Cordell, H.K., 1988. Influence of trees on residential property values in Athens, Georgia (U.S.A.): a survey based on actual sales prices. Landsc. Urban Plann. 15, 153–164.

Bender, B., Gronberg, T.J., Hwang, H.-S., 1980. Choice of functional form and the demand for air quality. Rev. Econ. Stat. 62 (4), 638–643.

Bergstrom, T.C., Goodman, R.P., 1973. Private demands for public goods. Am. Econ. Rev. 63, 280–296.

Borcherding, T.E., Deacon, R.T., 1972. The demands for the services of non-federal governments. Am. Econ. Rev. 62, 891–901.

Bradley, G., 1995. Urban Forest Landscapes: Integrating Multidisciplinary Perspectives. University of Washington Press, Seattle.

Brasington, D.M., Hite, D., 2005. Demand for environmental quality: a spatial hedonic analysis. Region. Sci. Urban Econ. 35 (1), 57–82.

Chenoweth, R.E., Gobster, P.H., 1990. The nature and ecology of aesthetic experiences in the landscape. Landsc. J. 9, 1–18.

Clark, T.N., Iloyd, R., Wong, K., Jain, P., 2002. Amenities drive urban growth. J. Urban Affairs 24 (5), 493–515.

Cook, D.I., 1978. Trees, solid barriers, and combinations: alternatives for noise control. In: Hopkins, G. (Ed.), Proceedings of the National Urban Forestry Conference. USDA Forest Service, SUNY College of Environmental Science and Forestry, New York, pp. 330–339.

Crompton, J.L., 2001. Parks and Economic Development. American Planning Association, Chicago, IL.

Davis, M.A., Palumbo, M., 2005. The Price of Land in 46 U.S. Cities. Federal Reserve Board, unpublished.

Davis, M.A., Heathcote, J., 2004. The Price and Quantity of Residential Land in the United States. Federal Reserve Board of Governors and Georgetown University.

Dwyer, J.F., McPherson, E.G., Schroeder, H.W., Rowntree, R.A., 1992. Assessing the benefits and costs of the urban forest. J. Arboricult. 18 (5), 227–234.

Dwyer, J.F., Nowak, D.J., Noble, M.H., Sisinni, S.M., 2000. Connecting People with Ecosystems in the 21st Century and Assessment of Our Nation's Urban Forests. Gen. Tech. Rep. PNW-GTR-490. U.S. Department of Agriculture, Forest Service, PNRS, Portland, OR.

Dwyer, M.C., Miller, R.W., 1999. Using GIS to assess urban tree canopy benefits and surrounding greenspace distributions. J. Arboricult. 30 (1), 102–106.

Escobedo, F.J., Nowak, D.J., Wagner, J.E., De la Maza, C.L., Rodrıguez, M., Crane, D.E., Hernandez, J., 2006. The socioeconomics and management of Santiago de Chile's public urban forests. Urban Forest. Urban Green. 4, 105–114.

Forest and Rangeland Renewable Resources Planning Act. Act of Aug. 17, 1974. 88 Stat. 476, as amended; 16 U.S.C. 1600–1614.

Gorman, J., 2004. Residents' opinions on the value of street trees depending on tree allocation. J. Arboricult. 30 (1), 36–43.

Heisler, G.M., 1986. Effects of individual trees on the solar radiation climate of small buildings. Urban Ecol. 9, 337–359.

Johnson, C.W., 1988. Planning for avian wildlife in urbanizing areas in America desert/mountain valley environments. Landsc. Urban Plann. 16, 245–252.

Kaplan, R., 1993. The role of nature in the context of the workplace. Landsc. Urban Plann. 26 (1–4), 193–201.

Kuo, F.E., 2003. The role of arboriculture in a healthy social ecology. J. Arboricult. 29 (3), 148–155.

Kweon, B.S., Sullivan, W.C., Wiley, A.R., 1998. Green common spaces and the social integration of inner-city older adults. Environ. Behav. 30 (6), 832–858.

McPherson, E.G., 1990. Modeling residential landscape water and energy use to evaluate water conservation policies. Landsc. J. 9, 122–134.

McPherson, E.G., Simpson, J.R., Peper, P.J., Xiao, Q., 1999. Benefit–cost analysis of modesto's municipal urban forest. J. Arboricult. 25 (5), 235–248.

Meier, A.K., 1991. Measured cooling savings from vegetative landscapes. In: Vine, E., Crawley, D., Centolella, P. (Eds.), Energy Efficiency and the Environment: Forging the Link. American Council for an Energy-Efficient Economy, Washington, DC, pp. 321–334.

Morales, D.J., 1980. The contribution of trees to residential property value. J. Arboricult. 1, 109–112.

Nowak, D.J., 1993. Atmospheric carbon-reduction by urban trees. J. Environ. Manage. 37 (3), 207–217.

Nowak, D.J., McPherson, E.G., 1993. Quantifying the impact of trees: the Chicago Urban Forest Climate Project. Unasylva 173 (44), 39–44.

Nowak, D.J., Rowntree, R.A., McPherson, E.G., et al., 1996. Measuring and analyzing urban tree cover. Landsc. Urban Plann. 36, 49–57.

Oke, T.R., 1989. The micrometeorology of the urban forest. Philos. Trans. R. Soc. Lond. 324 (Series B), 335–349.

Orland, B., Vining, J., Ebreo, A., 1992. The effect of street trees on perceived values of residential property. Environ. Behav. 24 (3), 298–325.

Palmquist, R.B., 1982. Estimating the Demand for Air Quality from Property Value Studies. Department of Economics, North Carolina State University, Mimeo.

Payne, B.R., Strom, S., 1975. The contribution of trees to the appraised value of unimproved residential land. Valuation 22 (2), 36–45.

Perkins, G.M., 1977. The demand for local public goods: elasticities of demand for own price, cross prices, and income. Natl. Tax J. 30, 411–422.

Rowntree, R.A., Nowak, D.J., 1991. Quantifying the role of urban forests in removing atmospheric carbon dioxide. J. Arboricult. 17 (10), 269–275.

Sanders, R.A., 1986. Urban vegetation impacts on the hydrology of Dayton, Ohio. Urban Ecol. 9, 361–376.

Santerre, R.E., 1985. Spatial differences in the demands for local public goods. Land Econ. 61, 119–128.

Schroeder, H.W., 1989. Environment, behavior and design research on urban forests. In: Zube, E.H., Moore, G.T. (Eds.), Advances in Environment, Behavior and Design. Plenum, New York, pp. 87–117.

Smith, W.H., 1981. Air Pollution and Forests. Springer, New York.

Thompson, R., Hanna, R., Noel, J., Piirto, D., 1999. Valuation of tree aesthetics on small urban-interface properties. J. Arboricult. 25 (5), 225–233.

Tyrvainen, L., 2001. Economic valuation of urban forest benefits in Finland. J. Environ. Manage. 62, 75–92.

Ulrich, R.S., 1984. View through a window may influence recovery from surgery. Science 224, 420–421.

USDA Forest Service, 1989. Draft 1990 RPA Program. Washington, DC, 186 pp.

Wolf, K.L., 2005. Business district streetscapes, trees and consumer response. J. Forest. 103 (8), 396–400.

Zabel, J.A., Kiel, K.A., 2000. Estimating the demand for air quality in four US cities. Land Econ. 76 (2), 174–194.

Zhu, P., Zhang, Y., 2006. Demand for urban forests and economic welfare: evidence from the Southeastern U.S. cities. J. Agric. Appl. Econ. 38 (2), 279–285.

Appendix 5

Environment and Behavior
Volume 39 Number 6
November 2007 797-814

10.1177/0013916506292326
http://eab.sagepub.com
hosted at
http://online.sagepub.com

Public Attitudes Toward Urban Trees and Supporting Urban Tree Programs

Yaoqi Zhang
Auburn University, Alabama
Anwar Hussain
Mississippi State University, Starkville
Jinyang Deng
West Virginia University, Morgantown
Neil Letson
Alabama Cooperative Extension System, Montgomery

In this article, we analyze survey responses regarding Alabama urban residents' attitudes toward urban trees and the provision and maintenance of urban forest by federal, state, and local governments, as well as personal willingness to volunteer and donate money in support of urban tree programs and activities. Using ordered probit analysis, our results showed that individuals who are aware of forestry-related programs, hold a full-time job, belong in the age group of younger than 56 years, and earn an annual income greater than U.S. $75,000, have a positive relationship with willingness of donating money and voluntarily contributing time toward urban forestry programs and activities. Individual characteristics such as race, gender, and residence were not statistically significant factors in explaining attitudes toward urban forestry programs. In addition, with few exceptions, attitudes toward government financing of urban forestry programs and activities were influenced by similar factors.

Keywords: *community participation; urban forestry; willingness to pay*

Authors' Note: We appreciate financial support provided by the Urban and Community Financial Assistance program and the Challenge Cost-Share Grant Program of The National Urban & Community Forestry Advisory Council of U.S. Department of Agriculture Forest Service and Center for Forest Sustainability of Auburn University. All opinions and errors are the responsibility of the authors.

Appendix 5

Urban and community trees provide value and services like other forms of municipal infrastructure. Markets have already developed for environmental services from trees, such as credits for carbon sequestration and ecotourism. Other services provided by trees and green space to communities include energy savings, improved air quality, aesthetics, health benefits, habitat for birds and other wildlife, and recreation opportunities. These values are reflected in higher real estate prices, lower water bills, and an influx of tourists, as well as well-talented people and businesses (Bradley, 1995; Dwyer, McPherson, Schroeder, & Rowntree, 1992; Orland, Vining, & Ebreo, 1992). Indeed, recent evidence increasingly shows that amenities drive urban growth and dynamics (Clark, Iloyd, Wong, & Jain, 2002). These trends in economic activity, in turn, are indicative of changing public values. America's growing population is increasingly spreading into the countryside and the rural–urban interface, in search of green areas and associated amenities. Therefore, trees and green space play a special role in the livability of communities.

Urban tree programs are, however, still a new concept as compared with programs for other public infrastructure. Many people are not aware of its importance and are unaware of the need for reliable budgetary support. Municipal responsibility for urban tree programs is not well established. Depending on individual communities, responsibility for the urban trees can fall under public works, engineering, planning, parks, urban forestry, or a combination of these entities. In some cases, responsibility for urban trees is characterized by a situation where no department is responsible. In addition, the "public good" nature of these services is a source of market failure; that is, individuals lack incentive to invest in activities that benefit everyone regardless of their financial contribution. Consequently, urban tree programs often struggle for consistent and sustainable financial support, not only from governmental entities but also from individuals, businesspeople, and nonprofit organizations. In many cases, voluntary activists and business people provide significant in-kind contributions in terms of services and goods.

Public attitudes have a significant influence on many aspects including the public budgetary process and subsequent fund allocation, public involvement and participation, the integration of tree programs into social infrastructure, and community identity. Therefore, it is important to consult the public and better understand their attitudes in developing a diverse and adaptable strategy. Obtaining information regarding public attitudes to support urban tree programs is, therefore, important. Although many studies on urban forestry have analyzed public attitudes about the benefits of urban trees (e.g., Dwyer & Miller, 1999; Gorman, 2004; McPherson, Simpson, Peper, & Xiao, 1999; Thompson, Hanna, Noel, & Piirto, 1999; Tyrvainen, 2001), a more critical issue is developing a sustainable and adequate community forestry support program (e.g., Lorenzo, Blanche, Qi, & Guidry, 2000). The purpose of this article is to examine public attitudes from the perspective of funding urban forestry programs. Following a brief literature review, we present the methodology used and describe the sources of data, followed by results and conclusions.

Literature Review

A review of earlier research on urban forestry reveals that most studies have examined mainly public attitudes toward urban forestry from an aesthetic perspective and people's perception of the associated benefits. To develop sustainable programs for urban forestry, studies focusing on how to fund and finance urban forestry activities are needed. Questions regarding people's willingness to pay for urban forestry activities or if they consider them as the government's (local, state, or federal) responsibility still remain unanswered. For instance, Gooch (1995), Kellert (1979, 1980), Rauwald and Moore (2002), and Scott and Willits (1994) advanced our understanding of public attitudes toward the environment. Manzo and Weinstein (1987), Martinez and McMullin (2004), Pearce (1993), and Yen, Boxall, and Adamowicz (1997) provided insights about individual behavior to volunteer for environmental improvement activities. Sanders (1984) examined vegetation configurations and how people might react to planning changes in 12 of Dayton's 79 neighborhoods (Ohio). Sullivan (1994) investigated citizens' perception of and preferences for natural and developed settings in the rural–urban fringe in Washtenaw County, Michigan, where farmers, township planning commissioners, and other citizens were asked to rank 32 pictures taken at the rural–urban fringe. The results indicated that settings including farm and forest were preferred, and housing developments with mature trees were preferred over development with few trees. Likewise, Tahvanainen, Tyrväinen, Ihalainen, Vuorela, and Kolehmainen (2001) evaluated the public attitudes toward and perceptions of the impacts on scenic beauty and recreational value of forest practices near cities. Five different management practices—clear cutting, thinning, removal of undergrowth, natural state, and traditionally managed cultural landscape—and two evaluation methods—visual presentation (pictures produced by image-capture technology) and verbal questions—were used. Scenic beauty and recreational value were assessed from slides in which management measures were presented by the

Appendix 5

pair-wise comparison technique. The results indicated that scenic beauty and recreational preferences differ considerably from each other.

Balram and Dragicevic (2005) measured the dimensions of citizen attitudes toward urban green spaces. Geographic information systems (GIS) techniques and informal interviews were used to generate complementary insights about the spatial and nonspatial factors influencing attitudes toward urban green spaces. Affinity analysis was used to aggregate the issues into three homogeneous categories that in turn guided the construction of questionnaire items. Factor analysis and reliability analysis were applied to the items set to create a valid attitude measurement scale. The analysis showed that households were characterized by a two-factor attitude structure toward urban green spaces: behavior and usefulness. It was concluded that urban green spaces attitude is a multidimensional construct.

Ozguner and Kendle (2005) examined the public attitudes toward urban naturalistic landscapes in contrast to more formal designs of urban green spaces. Attitudes of the general public were investigated using a site-based questionnaire survey in contrasting two public green spaces of Sheffield, United Kingdom. The results showed that the general public perceived *nature* or *natural* in two ways in different contexts as the opposite of *formal* in a park context and as the opposite of the *built-up environment* in a town- and/or city-wide context. Results indicated that the public preferred both types of natural areas in an urban setting for different reasons; in addition, design styles seemed to have an influence on preferences. Summit and McPherson (1998) found that shade and appearance played more of a role in the decision to plant trees than did concerns about energy savings and environmental benefits. Lohr, Pearson-Mims, Tarnai, and Dillman (2004), who surveyed residents of the largest metropolitan areas in the United States about the benefits and problems of trees in urban areas, found that the ability of trees to shade and cool surroundings was the highest ranked benefit. Their potential to help people feel calmer was ranked second highest. Potential problems such as causing allergies were bigger concerns than were financial issues. People who strongly agreed that trees were important to their quality of life rated the benefits of trees more highly than people who did not strongly agree. Responses varied slightly based on demographic factors. The general public, not just the people who volunteer for tree programs, were strongly positive toward trees in cities. Fraser and Kenney (2000), who conducted a similar study for Canadian cities, found how public attitudes varied across cultures. Their results indicated that the British community reacted in most positive terms and expressed the greatest willingness to pay to plant shade trees and had the most shade trees per square meter on their properties. In contrast, the

Chinese community showed the least yard maintenance compared to other communities and indicated that they did not want to add trees to their property. Italian and Portuguese communities emphasized fruit trees and vegetable gardens. Gorman (2004) found that there was a statistically significant difference in residents' opinions depending on whether there was a street tree planted in front of their house. Thompson et al. (1999) developed a model to predict the value added by forest conditions on small urban wild-land interface properties and found that contributions varied from 5% to 20%.

Lorenzo's et al. (2000) work could probably be the only one that looked into factors explaining public support for urban forestry programs. This study assessed residents' willingness to pay for community urban forest preservation in Mandeville, Louisiana, and suggested that (a) residents' willingness to pay for urban forest preservation was positively associated with their perceptions of the benefits of trees but negatively associated with their perceptions of the annoying features of trees, (b) the willingness to pay a premium for tree preservation and protection was directly related to income levels, (c) more female than male respondents were willing to pay for tree preservation, and (d) age, level of education, and type of residential ownership were not significantly associated with willingness to pay.

An important limitation of earlier studies on urban forestry relates to the appropriateness of methods used. Public opinions and attitudes are usually measured on an ordinal scale, and it would make sense to use methods that account for this aspect of the data, yet researchers have so far ignored it. In this article, we use a method, outlined below, that improves on existing analyses of urban forestry.

Method

Consistent with research by others (see, for instance, Saz-Salazar & Garcia-Menendez, 2001; Yen et al., 1997), we hypothesize that an individual's response to support urban tree programs depends on his or her income, education, race, gender, experience, and residential location. Furthermore, given the ordinal nature of individuals' responses[1] (the dependent variables in the current study), we used the ordered probit model as described below:

$$y_i^* = \beta' x_i + \varepsilon_i$$

where y_i^* is related to a continuous latent variable, ranging from $-\infty$ to $+\infty$, indicating an individual's intensity of concern about the potential implications of participation in or attitudes toward urban forests; x_i are the factors that influence the attitudes y_i; ε_i are errors that are not accounted for by x_i.

Given the relationship between y_i and y_i* and the distribution of error term ε_i, the probabilities of observing an individual who is unlikely (= 0), likely (= 1), or most likely (= 2) to donate money or time to urban forestry activities is written as:

$$\text{Prob}\ (y_i = 0|\ x_i) = 1 - \Phi\ (\beta' x_i)$$
$$\text{Prob}\ (y_i = 1|\ x_i) = \Phi\ (\mu - \beta' x_i) - \Phi\ (-\beta' x_i)$$
$$\text{Prob}\ (y_i = 2|\ x_i) = 1 - \Phi\ (\mu - \beta' x_i)$$

The μ is threshold level. Of the three threshold levels, only one threshold level can be estimated. The corresponding marginal effects as:

$$\partial\ \text{Prob}\ (y_i = 0|\ x_i)/\ \partial\ x_i = 1 - (\mathit{\Phi}' x_i)\ \beta$$
$$\partial\ \text{Prob}\ (y_i = 1|\ x_i)/\ \partial\ x_i = \mathit{\Phi}\ (\mu - \beta' x_i)\ - (-\beta' x_i)\ \beta$$
$$\partial\ \text{Prob}\ (y_i = 2|\ x_i)\ \partial\ x_i = \mathit{\Phi}\ (\mu - \beta' x_i)\ \beta$$

Where Φ (.) and $\mathit{\Phi}$ (.) are respectively the cumulative normal distribution function and standard normal density function. *Marginal effect* refers to change in the probability of response outcome given a unit change in a given explanatory variable. Estimates of marginal effects are especially helpful to find answers to questions such as: will a person be more willing to donate time or money regardless of his or her income rises? Will a person be more willing to donate money and time if he or she becomes more aware of the role of urban forestry in improving air quality or its role in protecting water quality by reducing water runoff?

To be able to properly interpret marginal effects, it is important to note the following: (a) in the case of continuous explanatory variables such as annual household income, marginal effect is the change in the probability of outcome response given a unit change in a given explanatory variable. In the case of a dichotomous variable, it is the change in the outcome response, given a change in the classification of an explanatory variable such as gender or race. For instance, are men (Whites) more likely to donate money to urban forestry causes than women (Hispanics); (b) The expressions for marginal effects only partially suggest the signs of the estimated marginal effects. Although the sign of the marginal effect for J = 0 is opposite to that of β, the sign of the marginal effect for j = 2 is the same as that of β because the density, $\mathit{\Phi}$ (.), is nonnegative. The sign of the marginal effect for the category j = 1 will depend on the densities for j and j – 1 (j = 2,…, J – 1) and cannot be determined from the

Appendix 5

estimates alone. For this reason, interpreting the marginal effects of changes in the explanatory variables can be difficult without additional computations (Greene, 2003, p. 739).

Data

Requisite data for the current study were generated using a statewide telephone survey from July 14 to July 24, 2003. Prior to the survey, each interviewer received training on proper interviewing and data entry techniques. To participate in the survey, a respondent needed to be at least age 18 years and to reside in an incorporated Alabama municipality. Excluding various reasons (such as busy line, phone technical problems, no answer, and business phone number, not eligible), we had a total of 1,379 participants. We had 405 households (29%) who refused to answer, 62 participants (5%) who only partially answered our questions, and about 29% (406) asked for callback. In the end, we got 506 valid respondents with a 36% response rate for this survey. For this kind of telephone survey, a high response rate cannot be expected. We believe the data are qualified to derive some general information.

Questions related to the following aspects were asked: (a) the perception of the added value by mature trees to personal property, (b) perceived importance of urban trees on personal and community property, (c) support for public funding of urban forests, (d) perceived benefits and negative features of urban trees and forests, (e) participation in urban forestry activities, (f) acceptance of common urban forest practices and tree ordinances, and (g) willingness to donate money or volunteer time to urban tree activities (please refer to Tables 1 and 2 for more exact wording in the questionnaires).

The survey also asked about sociodemographic information such as age, education, employment status, income, gender, number of children, and size of the city where a respondent lived. About 10% of the respondents did not release their annual income. Because income is so strongly related to education, missing information on income was generated, given information on the level of education. Thus, those with a high school education were assigned to the income class "less than $20,000," those with some college, associate and/or technical, and bachelor's degree education were assigned to the income class "$20,000-$39,000" whereas respondents having master's or a higher degree were assigned to the income class "$40,000-$74,000."

Respondents were also asked about their awareness of forestry services and programs. These included: (a) U.S. Department of Agriculture (USDA) Forest Service, (b) National Arbor Day Foundation, (c) American Forest, (d) International Society of Arboriculture, (e) Alabama Forestry Commission,

Appendix 5

Table 1
Summary of General Attitude Toward Urban Trees and Urban Tree Programs (percentages are in parentheses; *N* = 506)

	Very Important	Somewhat Important	Somewhat Unimportant	Not at All Important	Don't Know
Importance of trees on property when selecting a residence	377 (75)	104 (21)	5 (1)	19 (4)	1 (0)
Importance of trees in a community when selecting a residence	389 (77)	100 (20)	5 (1)	10 (2)	2 (0)
Practice of tree topping	210 (42)	184 (36)	43 (8)	45 (9)	24 (5)
Utility companies should prune trees on private property to clear a zone for utility wires	167 (33)	184 (36)	51 (10)	90 (18)	14 (3)
Support for tree ordinances applicable to builders and developers	338 (67)	106 (21)	21 (4)	16 (3)	25 (5)
Support for local ordinances to govern the planting, maintenance, and removal of urban trees on public property	217 (43)	167 (33)	41 (8)	36 (7)	45 (9)
Support for local ordinances to govern the planting, maintenance, and removal of urban trees on private property	82 (16)	100 (20)	101 (20)	196 (39)	27 (5)

(f) Auburn University School of Forestry and Wildlife Sciences, and (g) Alabama Urban Forestry Association. Although individual responses were invoked on a Likert-type scale of 1 to 5, observations on the dependent variable were recoded to obtain only three categories. The purpose of recoding five categories to three categories for the dependent variables was to increase the sharpness of the comparison. The use of three categories is more common in similar types of studies. This was necessary given the relatively low frequencies for certain values of the scale. Variable descriptions and descriptive statistics are presented in Table 3.

Empirical Results

Overall, most Alabama residents have a strong appreciation for the state's urban forests based on survey responses (Table 1). For example,

Appendix 5

Table 2
Summary of Attitude Toward Financing Urban and Community Forestry (percentages are in parentheses; *N* = 506)

	Very Important (Very Likely)	Somewhat Important (Likely)	Somewhat Unimportant (Unlikely)	Not at All Important (Unlikely)	Don't Know
How likely would you be to volunteer your time to support urban trees activities (y_1)	94 (19)	201 (40)	95 (19)	89 (18)	27 (5)
How likely would you donate money to support urban trees activities (y_2)	64 (13)	219 (43)	112 (22)	76 (15)	35 (7)
Importance of local government funding the planting and maintenance of trees on public property (y_3)	349 (69)	121 (24)	11 (2)	10 (2)	15 (3)
Importance of Alabama state government funding to help communities to plant and maintenance of trees (y_4)	311 (61)	140 (28)	17 (3)	21 (4)	17 (3)
Importance of the Federal government funding to help individual communities to plant and maintenance of trees (y_5)	263 (52)	150 (30)	29 (6)	47 (9)	17 (3)

Appendix 5

Table 3
Descriptive Statistics of Variables Included in the Analysis

Variables	Variable Descriptions	Definition	*M*	*SD*
y_1, y_2, y_3, y_4, y_5	Respectively willingness to donate time, money, and attitudes to the roles of local, state, and federal government	2 = if very important (very likely); 1 = if somewhat important (likely); 0 = otherwise.		
X1	Be aware of the forestry services and programs	= number of programs	4.621	1.838
X2	The resident place	1 = for living in city, 0 otherwise	.543	.499
X3	Full-time job individuals	= 1 if yes, 0 otherwise	.492	.500
X4	Part-time job individuals	= 1 if yes, 0 otherwise	.085	.279
X5	Retired individuals	= 1 if yes, 0 otherwise	.227	.419
X6	Family with children	= 1 if yes, 0 otherwise	.356	.479
X7	Age younger than 34 years	= 1 if yes, 0 otherwise	.364	.482
X8	Age between 34 and 56 years	= 1 if yes, 0 otherwise	.362	.481
X9	Annual income less than U.S. $40, 000	= 1 if yes, 0 otherwise	.557	.497
X10	Annual income between $40,000 and $74, 000	= 1 if yes, 0 otherwise	.253	.435
X11	White people	= 1 if yes, 0 otherwise	.735	.442
X12	Gender (male)	= 1 if yes, 0 otherwise	.387	.488

98% of the respondents recognized that urban trees provide positive values, including aesthetics, shade, and improved air quality to people and their communities. The survey also found that urban trees play an important role in people's decisions on where to locate—75% said trees are important in selecting a home, while 77% said trees are important in selecting a community to live in. The survey also revealed that many Alabama residents have performed at least one type of tree care activity. In the survey, several questions were asked regarding statewide urban forestry issues. It is surprising to note that 43% strongly believed that tree topping is a legitimate tree care option, with an additional 38% stating that they somewhat agreed with this practice. When asked about utility tree trimming, 69% agreed that utility companies should be allowed to prune trees on private property when necessary.

An important aspect of the survey was to investigate attitudes toward supporting community forestry program activities from a variety of perspectives (Table 2). As shown in Table 2, although personal attitudes toward supporting community forestry program activities were similar in terms of contributing time and money, respondents seemed slightly more likely to contribute time. A great majority of the respondents wished, but in decreasing order, local, state, and federal government would provide financial support for community forestry programs.

Results based on an ordered probit model are presented in Table 4. First, all five models fit well, as judged from the chi-squared statistic. In addition, the threshold parameter estimate (Mu) is statistically significant, suggesting the reasonableness of grouping the outcome variables into the three categories of "very likely/very important," "likely/not so important," and "not likely/not important."

Results corresponding to the willingness to donate time and willingness to donate money models (Table 4) show that knowledge of natural resource–related programs, having a full-time job, being in the age group of younger than 56 years, and earning an annual income greater than U.S. $75,000 increased the probability of donating time or money to community forestry programs and activities. Race, gender, and residence were not statistically significant. The only difference between the two models pertained to the significance of the variable *families with children age younger than 16 years*, which was significant only in the willingness to donate time model.

Differences and similarities between the two models become more visible when we look at the estimated results on marginal effects (Table 5). Thus, we find that in the case of individuals who were more aware of natural resource–related management programs, their willingness to donate time and money increased by 5% (i.e., –.03 to .02) to 6% (i.e., from –.04 to .02). In

Appendix 5

Table 4
Results for Ordered Probit Models (Observations = 506)

Variable	Description	Willingness to Donate Time (y1)	Willingness to Donate Money (y2)	Attitude Toward Local Government Role (y3)	Attitude Toward State Government Role (y4)	Attitude Toward Federal Government Role (y5)
		Coefficient (t ratio)	Coefficient (t ratio)	Coefficient (t ratio)	Coefficient (t ratio)	Coefficient (t ratio)
ONE	Constant	–.543 (1.916)	–.699 (2.407)	.826 (2.637)	.637 (2.318)	.319 (1.185)
X1	Be aware of the forestry, services and programs	.109 (3.999)	.082 (3.100)	.059 (1.877)	.061 (2.013)	.098 (3.333)
X2	The resident place	–.012 (.113)	.096 (.890)	.031 (.265)	–.129 (1.129)	–.180 (1.686)
X3	Full-time job individuals	.232 (1.588)	.194 (1.449)	–.102 (.624)	–.042 (.265)	–.059 (.400)
X4	Part-time job individuals	.136 (.618)	.250 (1.057)	.229 (.930)	.373 (1.482)	–.002 (.008)
X5	Retired individuals	.132 (.620)	–.008 (.034)	.330 (1.443)	.304 (1.565)	.134 (.665)
X6	Family with children	.183 (1.474)	.133 (1.115)	.244 (1.776)	.232 (1.727)	.204 (1.643)

Appendix 5

X7	Age younger than 34 years	.329 (1.589)	.786 (3.427)	.307 (1.311)	.665 (3.233)	.599 (2.981)
X8	Age between 34 and 56 years	.281 (1.449)	.656 (3.119)	.336 (1.573)	.545 (2.933)	.622 (3.292)
X9	Annual household income below U.S. $40,000	–.177 (1.350)	–.215 (1.674)	–.042 (.276)	–.027 (.191)	–.048 (.355)
X10	Annual household income between $40,000 and $74,000	–.360 (2.082)	–.235 (1.421)	–.110 (.600)	–.204 (1.172)	–.137 (.833)
X11	White people	–.078 (.669)	–.014 (.121)	.151 (1.159)	.076 (.609)	–.241 (1.965)
X12	Gender (male)	.009 (.078)	–.026 (.226)	–.081 (.619)	–.326 (2.705)	.012 (.103)
Mu (1)		1.359 (17.016)	1.206 (16.761)	1.000 (11.979)	1.009 (12.695)	.910 (13.697)
Chi-square (12)		41.69	76.53	18.35	42.73	47.11
Log-likelihood		–477.61	–490.08	–388.73	–431.95	–488.47
Res Log-likelihood		–498.45	–528.35	–397.91	–453.32	–512.02

contrast, in the case of individuals who were in the age class 34 to 56, the probability of their willingness to donate time increased by 16.5% percent (i.e., from –.11 to .05) whereas the corresponding increase in the probability of their willingness to donate money was 43% (i.e., from –.27 to .16). This relatively higher valuation of time by this class of individuals is understandable, and we concluded that it is easier for them to donate money than time.

Results corresponding to the three models—financing urban forestry is local government responsibility, financing urban forestry is state government responsibility, and financing urban forestry is federal government responsibility—showed the influence of certain variables on attitudes toward urban forestry. For instance, individuals, who are aware of natural resource–related programs, have a family with children of age 16 years or younger, and are younger than age 56 years, are more likely to regard the local, state, and the federal government as being responsible for financing urban forestry initiatives. In this respect, results of these models are similar to the willingness to donate time and money models. There are differences as well though. For instance, retired employees rather than full-time employees are more likely to regard the local or state government as being responsible for urban forestry initiatives. Likewise, individuals belonging to the non-White race are more likely to regard federal government as being responsible. In terms of marginal effects, age continued to have the largest impact on attitude. Thus, individuals in the age group *younger than age 56 years* were more likely to assign responsibility to the local, state, and federal government by a factor of 10% to 25%, according to marginal effect estimate.

Discussion and Implications

Our results show that public attitudes toward urban trees in general are positive. More than 90% of citizens appreciated urban trees in choosing their residential location and community. A majority of people also supported urban tree activities, including tree topping, tree ordinances, particularly for builders and developers on public property. However, individual support for urban forestry programs and activities did not seem broad based. A majority of people considered the promotion and development of urban forestry programs as a local, state, and/or federal government responsibility. The hypothesis that individual attitudes depend on personal characteristics could partially be supported by the analysis. An interesting finding is that the knowledge of public urban tree programs has a positive relationship with favorable attitudes toward urban forestry initiatives. As

Appendix 5

Table 5
Marginal Effects of the Ordered Probit Models
(Observations = 506)

	Willingness to Donate Time			Willingness to Donate Money			Attitude Toward Local Government Role			Attitude Toward State Government Role			Attitude Toward Federal Government Role		
Variable	$y_i = 0$	$y_i = 1$	$y_i = 2$	$y_i = 0$	$y_i = 1$	$y_i = 2$	$y_i = 0$	$y_i = 1$	$y_i = 2$	$y_i = 0$	$y_i = 1$	$y_i = 2$	$y_i = 0$	$y_i = 1$	$y_i = 2$
X1	–.04	.02	.02	–.03	.01	.02	–.01	–.01	.02	–.01	–.01	.02	–.03	–.01	.04
X2	.01	.00	.00	–.04	.01	.02	.00	–.01	.01	.02	.03	–.05	.05	.03	–.07
X3	–.09	.05	.05	–.08	.03	.05	.01	.02	–.04	.01	.01	–.02	.02	.01	–.02
X4	–.05	.03	.03	–.10	.04	.06	–.03	–.05	.08	–.06	–.08	.14	.00	.00	.00
X5	–.05	.03	.03	.00	.00	.00	–.04	–.07	.12	–.05	–.07	.12	–.03	–.02	.05
X6	–.07	.04	.04	–.05	.02	.03	–.03	–.05	.09	–.04	–.05	.09	–.05	–.03	.08
X7	–.13	.07	.06	–.31	.11	.19	–.04	–.07	.11	–.11	–.14	.25	–.15	–.09	.24
X8	–.11	.06	.05	–.26	.10	.16	–.04	–.08	.12	–.09	–.12	.21	–.16	–.09	.25
X9	.07	–.04	–.03	.08	–.03	–.05	.01	.01	–.02	.01	.01	–.01	.01	.01	–.02
X10	.14	–.07	–.07	.09	–.03	–.06	.01	.03	–.04	.03	.04	–.08	.04	.02	–.06
X11	.03	–.02	–.02	.01	.00	.00	–.02	–.03	.05	–.01	–.02	.03	.06	.04	–.10
X12	.00	.00	.00	.01	.00	–.01	.01	.02	–.03	.06	.07	–.12	.00	.00	.01

Appendix 5

the analysis in the current research provides tentative directions as to how the general public considers urban forestry, future research on urban forestry needs to investigate the level of willingness to donate time and money for community forestry programs.

It is widely believed that the stated preference and revealed preference are different but have some relationship (e.g., Adamowicz et al., 2004). It could be interesting to see the difference between stated preferences (willingness to pay) and revealed preference regarding supporting urban forestry. In addition, future study should also consider Ajzen's (1991) theory of planed behavior (TPB) to examine what effect the public urban forestry attitudes have on intended and actual willingness to pay. Finally, it is noteworthy that although telephone surveys often result in a higher response rate, the quality of data may not be good because respondents may not like to reveal their perceptions, attitudes, and household incomes as openly on the phone as they would in a face-to-face interview. As the reader of this article will note, we did not ask how much they were willing to donate either in open-ended questionnaire or in close-ended questionnaire. This concern was addressed in our 2005 survey with more properly worded questions.

Note

1. The use of ordinary linear regression (OLS) to ordinal responses such as "very important," "somewhat important," "somewhat unimportant," "not at all important" would be inappropriate because the spacing of these outcome categories cannot be assumed to be uniform (Liao, 1994, p. 37).

References

Adamowicz, V., Boxall, P., Haener, M., Zhang, Y., Dosman, S., & Marois, J. (2004). Assessing the impact of forest management on Aboriginal hunters: Evidence from stated and revealed preference data. *Forest Science*, *50*(2), 139-152.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179-211.

Balram, S., & Dragicevic, S. (2005). Attitudes toward urban green spaces: Integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. *Landscape and Urban Planning*, *71*, 147-162.

Bradley, G. (1995). *Urban forest landscapes: Integrating multidisciplinary perspectives*. Seattle: University of Washington Press.

Clark, T. N., Iloyd, R., Wong, K., & Jain, P. (2002). Amenities drive urban growth. *Journal of Urban Affairs*, *24*(5), 493-515.

Appendix 5

Dwyer, J. F., McPherson, E. G., Schroeder, H. W., &. Rowntree, R. A. (1992). Assessing the benefits and costs of the urban forest. *Journal of Arboriculture*, *18*(5), 227-234.

Dwyer, M. C., & Miller, R. W. (1999). Using GIS to assess urban tree canopy benefits and surrounding greenspace distributions. *Journal of Arboriculture*, *30*(1), 102-106.

Fraser, D. G. E., & Kenney, W. A. (2000). Cultural background and landscape history as factors affecting perceptions of the urban forest. *Journal of Arboriculture*, *26*(2), 106-112.

Gooch, G. D. (1995). Environmental beliefs and attitudes in Sweden and the Baltic States. *Environment and Behavior*, *27*, 513-539.

Gorman, J. (2004). Residents' opinions on the value of street trees depending on tree allocation. *Journal of Arboriculture*, *30*(1), 36-43.

Greene, H. W. (2003). *Econometric analysis* (5th ed.). Delhi, India: Pearson Education.

Kellert, S. R. (1979). *Public attitudes toward critical wildlife and natural habitat issues* (U.S. Fish and Wildlife Service). Washington, DC: Government Printing Office.

Kellert, S. R. (1980). Public attitudes, knowledge and behaviors toward wildlife and natural habitats. *Transactions of the North American Wildlife and Natural Resources Conference*, *45*, 111-124.

Liao, F. T. (1994). *Interpreting probability models*. Thousand Oaks, CA: Sage.

Lohr, I. V., Pearson-Mims, C. H., Tarnai, J., & Dillman, D. A. (2004). How urban residents rate and rank the benefits and problems associated with trees in cities. *Journal of Arboriculture*, *30*(1), 28-34.

Lorenzo, A. B., Blanche, C. A., Qi, Y., & Guidry, M. M. (2000). Assessing residents' willingness to pay to preserve the community urban forest: A small-city case study. *Journal of Arboriculture*, *26*(6), 319-324.

Manzo, L. C., & Weinstein, N. D. (1987). Behavioral commitment to environmental protection: A study of active and non-active members of the Sierra Club. *Environment and Behavior*, *19*(6), 673-694.

Martinez, T. A., & McMullin, S. L. (2004). Factors affecting decisions to volunteer in nongovernmental organizations. *Environment and Behavior*, *36*(1), 112-126.

McPherson, E. G., Simpson. J. R., Peper, P. J., & Xiao, Q. (1999). Benefit-cost analysis of Modesto's municipal urban forest. *Journal of Arboriculture*, *25*(5), 235-248.

Orland, B., Vining, J., & Ebreo, A. (1992). The effect of street trees on perceived values of residential property. *Environment and Behavior*, *24*(3), 298-325.

Ozguner, H., & Kendle, A. D. (2005). Public attitude towards naturalistic versus designed landscapes in the city of Sheffield (UK). *Landscape and Urban Planning*, *74*(2), 139-157.

Pearce, J. L. (1993). *Volunteers: The organizational behavior of unpaid workers*. London, New York: Routledge.

Rauwald, K. S., & Moore, C. F. (2002). Environmental attitudes as predictors of policy support across three countries. *Environment and Behavior*, *34*(6), 709-739.

Sanders, R. A. (1984). Estimating satisfaction levels for a city's vegetation. *Urban Ecology*, *8*, 269-283.

Saz-Salazar, S., & Garcia-Menendez, L. (2001). Willingness to pay for environmental improvements in a large city. *Environmental and Resource Economics*, *20*, 103-112.

Scott, D., & Willits, F. K. (1994). Environmental attitudes and behavior: A Pennsylvania survey. *Environment and Behavior*, *26*, 239-260.

Sullivan, W. C. (1994). Perceptions of the rural-urban fringe: Citizen preferences for natural and developed settings. *Landscape Urban Planning*, *29*, 85–101.

Summit, J., & McPherson, E. G. (1998). Residential tree planting and care: A study of attitudes and behavior in Sacramento, California. *Journal of Arboriculture*, *22*(2), 89-97.

Appendix 5

Tahvanainen, L., Tyrväinen, L., Ihalainen, M., Vuorela, N., & Kolehmainen, O. (2001). Forest management and public perceptions—Visual versus verbal information. *Landscape and Urban Planning*, *53*, 53-70.

Thompson, R., Hanna, R., Noel, J., & Piirto, D. (1999). Valuation of tree aesthetics on small urban-interface properties. *Journal of Arboriculture*, *25*(5), 225-233.

Tyrvainen, L. (2001). Economic valuation of urban forest amenities in Finland. *Journal of Environmental Management*, *62*, 75-92.

Yen, S. T., Boxall, P. C., & Adamowicz, W. L. (1997). An econometric analysis of donations for environmental conservation in Canada. *Journal of Agricultural and Resource Economics*, *22*(2), 246-263.

Yaoqi Zhang is assistant professor of forest economics and policy at the School of Forestry and Wildlife Sciences, Auburn University. He graduated with a bachelor's degree from Fujian Agriculture and Forestry University in 1986, and received his master's degree from Chinese Academy of Forestry in 1990. He worked and studied in University of Helsinki from 1993 to 2000 and received his PhD in 2001. Then he worked as a postdoctoral fellow and research associate in the University of Toronto and University of Alberta from 2001 to 2003 before he came to Auburn University. He is interested in economics and policy of natural resource and environment.

Anwar Hussain is assistant research professor at the Department of Forestry, Mississippi State University. He holds MS and PhD degrees from the University of Minnesota, Twin Cities. Currently he is working on the competitiveness of the United States in international forest products trade, forestry-related environmental regulations, and wildlife-associated recreation economics.

Jinyang Deng is assistant professor at the Division of Forestry and Natural Resources, West Virginia University. He received his PhD from the University of Alberta in 2004. He is specialized in recreation and leisure studies. He has broad study areas and interests, including ecotourism destination evaluation, GIS application in tourism planning and management, sustainable tourism development, environmental attitudes and recreation and/or tourism, and cross-cultural aspects of leisure/tourism.

Neil Letson is working in the Alabama Forestry Commission (AFC) and serves as Alabama Urban Forestry Coordinator for the Alabama Cooperative Extension System. He received a BS in forestry from the University of Tennessee at Knoxville in 1974. He started with the AFC as the District Urban Forester in the Bay Minette area where he helped initiate the Tree City USA program in several communities following Hurricane Frederick. He began as the agency's Treasure Forest Coordinator, with a limited role as the state urban forestry coordinator. Not long after this move, he became the agency's full-time state urban forestry coordinator, which he continues today.

Appendix 6

Arboriculture & Urban Forestry 2009. 35(3): 165–171

ARBORICULTURE & URBAN FORESTRY
Scientific Journal of the International Society of Arboriculture

Tree Ordinances as Public Policy and Participation Tools: Development in Alabama

Yaoqi Zhang, Bin Zheng, Brenda Allen, Neil Letson, and Jeff L. Sibley

Abstract: Following a brief overview of the historical evolution of tree ordinances in the United States, this paper focuses on the development of tree ordinances in the state of Alabama to demonstrate how the tree ordinances evolve into law and the role such ordinances have on urban trees. Even though tree ordinances have a long history in the United States, they have been rapidly developing since the 1970s. Among the 100 municipalities that have some type of tree ordinance in Alabama, based on this investigation, the major responsibilities of tree ordinances include: having a tree commission (board), defining tree planting, removal and replacement of trees on public land, public tree protection and care, tree species selection, and dead tree removal on public and private property. Considering the broadness and complexity of urban trees, this paper indicates tree ordinances provide not only a legal framework, but also an effective tool to engage public participation and awareness of urban trees in the process of formulating, implementing, and amending of the tree ordinances. Development of tree ordinances requires government support, citizen participation, and consideration of local resources.

Key Words: Green Law; Landscape Ordinance; Public Attitude; Public Survey; Southeast United States.

As a legal framework, tree ordinances are developed to provide authority, offer guidance to residents, and specify the rights, responsibilities and minimum standards to regulate human relationships regarding trees. They also frame and coordinate individual interests concerning trees. Tree ordinances can help society adapt to economic and societal forces in a meaningful way by promoting proper urban forest management.

When utility companies need to remove or trim trees on private lands, what rights do landowners have? When accidents happen, such as damage caused by falling trees, who is responsible? On public land, what are the rights and responsibilities for local government and each citizen concerning trees? Who is the governing authority and management organization for urban forests and what should the budget level be? Tree ordinances are an effective public policy and planning tool to help local governments and policymakers better manage trees.

This paper first introduces the nature of public goods of urban trees, which theoretically justify the importance of tree ordinances to urban forestry. What follows is a brief review of the historical background of tree ordinances in the United States to show practical causes leading to the emergence and development of tree ordinances. Included is an examination of the development of tree ordinances in Alabama based on a collection of tree ordinances. From said examinations, tree ordinances evolve in response to change in each city in providing a legal framework. Meanwhile, the process of developing tree ordinances is an effective tool to engage public and stakeholders' participation, and an important educational tool to raise public awareness of urban trees and the environment.

ROLE OF TREE ORDINANCES FOR SUSTAINING PUBLIC GOODS OF URBAN TREES

Urban forests are economic goods that provide a variety of benefits. Trees in urban landscapes moderate temperature and microclimates, thereby saving energy (Heisler 1986; Oke 1989; McPherson 1990). Urban trees can improve air quality (Smith 1981; Nowak and McPherson 1993), help stabilize soils, reduce erosion, improve groundwater recharge, control rainfall runoff and flooding (Sanders 1986), provide animal habitat to sustain biodiversity (Johnson 1988), make neighborhoods more aesthetically appealing, and add to the value of property (Schroeder 1989). Evidence also shows that urban forests may reduce human stress levels (Ulrich 1984), promote social integration of older adults with their neighbors (Kweon et al. 1998), and provide local residents with opportunities for emotional and spiritual fulfillment that help them cultivate a greater attachment to their residential areas (Chenoweth and Gobster 1990). The presence of trees and "nearby nature" in human communities generates numerous psychosocial benefits. Hospital patients were observed to recover more quickly and require fewer painkilling medications when they had a view of nature (Ulrich 1984). Having trees within high-density neighborhoods lowers levels of fear, contributes to less violent and aggressive behavior, encourages better neighbor relationships and better coping skills (Kuo 2003). Office workers with a view of nature are more productive, report fewer illnesses, and have higher job satisfaction (Kaplan 1993).

Urban forests can also be a potential detriment if not well-managed and maintained. All trees, no matter how long-lived, eventually decline and die. Therefore, trees impose some risk during their life cycles. Destruction of property, personal injury, and even death can be caused by falling trees. Some trees create potential hazards to the public and risks to the owners (Mortimer and Kane 2004). During and immediately following catastrophic storm events, urban trees are more prone to disruptive results due to clogged streets and accesses, disrupted utility service, damaged property, loss of city services, increased debris removal, increased recovery costs, and a threat to public safety (Letson 2001; USDA Forest Service 2003). In many regions of the U.S., urban trees contribute to the potential of wildfire hazards (Long and Randall

2004). The risk of wildfire depends on nearby land use, vegetation near homes, and building design and materials. The presence of and spatial configuration of various tree species can also be a concern.

Urban trees have positive and negative impacts on neighborhoods and the surrounding community. Positive impacts include what both tree owners and other citizens can enjoy, negative impacts indicate what citizens may suffer from. Trees are also a type of public good that causes a free rider problem where people obtain the benefits without bearing the costs. There are many potential conflicts involving trees and people within the community. These externalities and conflicts usually result in a call for laws and regulations—such as tree ordinances—as legal provisions adopted by local or community governments.

Since trees in urban settings are part of the landscape and are used for public and private benefit, tree ordinances are often specified in the context of green laws and landscape ordinances. In many states and communities, a tree ordinance is often a component of a landscape ordinance that has been enacted to: 1) establish urban tree management programs, 2) establish new landscape plantings following construction, and 3) preserve existing natural amenities, including historic trees, forest lands, wetlands, and unique habitats. In the western and southern United States, these laws are usually called ordinances with the exception of Florida, where they are referred to as landscape codes. In other parts of the country they are found in sections of zoning ordinances and municipal codes (Abbey 1999), which are a systematically arranged, comprehensive collection of laws.

With other green laws and landscape ordinances, tree ordinances are used as public policies to shape the urban and suburban landscape. Tree ordinances are also a planning tool. Abbey (1998) argued that "laws are now supporting design, and designers are assisting with the establishment of law. Many of such green laws are being written by design professionals." Tree ordinances have been developed to supplement zoning, tree planting, and conservation, especially for new development sites. Tree ordinances are also used to provide a framework for new home builders and public citizens and to delegate responsibility to a public official, such as a director of parks and recreation or a director of public work, for planting and maintaining street trees (Barker 1975). Tree ordinances have been approved or considered as effective policy tools to promote urban trees in the United States (e.g., Davis 1993; Cooper 1996; Schroeder et al. 2003; Galvin and Bleil 2004).

Tree ordinances are usually initiated in response to community motivations as well as political will. Public attitude and preference are important when developing or amending tree ordinances. Usually, as a community grows and expands, population density increases and conflicts rise. Tree ordinances were initially written for protection of public trees, but have gradually moved toward greater regulation. In recent years, serious attention has been given to the importance of municipal liability (Tereshkovich 1990). Many tree ordinances have emerged due to a specific, local issue where there is a conflict between trees, people, or some other interests. For example, off-street parking and vehicle use area (PVA) landscape requirements were a very common "first-generation-limited-use" type of landscape ordinance in many U.S. cities (Abbey 1998). Similarly, Frischenbruder and Pellegrino (2006) uses eight recent case studies to generalize the proposal of using greenways to reclaim nature in Brazilian cities. The following sections will first demonstrate the development of tree ordinances in the United States, then provide further information using tree ordinances in the state of Alabama as a case study. The conclusion generalizes how to use tree ordinances as a public policy and participation tool to promote urban forestry.

TREE ORDINANCES IN MANY UNITED STATES CITIES

Legislation has been widely used to protect trees and to develop urban forests for a very long time in Europe (Schmied and Pillmann 2003). In the United States, the earliest tree ordinance was drafted around 1700 by William Penn in order to set standards for tree planting in some of the early settlements around Philadelphia (Zube 1971). This law is also considered as the earliest of all recorded landscape ordinances (Abbey 1999). The Territory of Michigan enacted a law that specified which trees that could be planted on boulevards and squares in the City of Detroit in 1807. In Mississippi, the commission charged with selecting the state's capital city recommended that every other block be filled with native vegetation or be planted with groves of trees in 1821 (Zube 1971).

During the late 18th Century, trees were established in village greens and streets throughout the eastern United States to emulate those found in European cities. By the 1890s, management of public shade trees had clearly become an important part and duty of municipal governance. To address the ambiguous problem between private property and the public right-of-way, "Nail" laws (using nails to distinguish which shade trees were public) were adopted in the New England area to enable towns to take definite steps to distinguish which shade trees were public: Massachusetts in 1890, Connecticut in 1893, Rhode Island and New Hampshire in 1901, Vermont in 1904, and Maine in 1919 (Ricard 2005). Washington D.C. passed a tree ordinance in 1892 to prevent girdling, bricking, wounding, destroying or harming trees in any manner on public or private property or to use them to tie horses. In Maine, the Supreme Court ruled in 1907 that private property such as tress was subject to reasonable regulatory limitations (Durkesen and Richman 1993).

Even though tree ordinances appeared a century ago, only in recent decades have tree ordinances and related green laws become widely adopted in American cities. In 1976, The National Arbor Day Foundation unveiled its Tree City USA recognition program that requires a tree ordinance as one of its four requirements of designated communities. In 2006, there were 3,213 Tree City USA communities, suggesting that an additional number of municipalities have tree ordinances now. Tree ordinances have primarily been used to protect public trees. As of 1984, only one hundred communities nationwide with tree protection laws on private land could be identified (Coughlin et al. 1984). A Michigan State University survey of over 1000 communities reported that 13% had tree preservation ordinances and restrictions on cutting trees on private property (Kielbaso 1989). In a Missouri survey, 22% of respondents said they had a "comprehensive tree ordinance" on public property, but only 13% of respondents stated their communities had a "comprehensive tree ordinance" that defined tree preservation requirements during development (Treiman and Gartner 2004). Since different surveys employed different standards and for various purposes, interpretation of results has varied application. However, it is clear that the United States is currently experiencing a revolution in green laws and tree ordinances that began in the mid-1980s and has continued to increase.

The field of urban forestry as well as tree ordinances is developing hand in hand with urbanization. After World War II, America's demographics shifted toward urban areas with more people living in cities than in rural areas for the first time in history. Along with this urbanization was an increase in the amount of developed acres, built space, and impervious surface. Urban sprawl is viewed as a national problem facing American people. A decreasing supply of environmental services is reflected in deteriorated water and air quality as more greenspace is replaced by impervious surface. As discussed earlier, tree ordinances are not just for protecting trees. More importantly, they are often used for regulating relationships among people. In many cases, legal issues and court decisions call for more specific laws regarding tree matters (Merullo and Valentine 1992). The current generation of regulations is increasingly strident and sophisticated (Duerksen and Richman 1993).

Urban forestry and tree ordinances have also evolved with economic development. By the mid-1970s, as Americans were becoming wealthier, urban areas were becoming increasingly crowded. As urban citizens experienced more stress in their daily lives, they began seeking outlets. Dickerson et al. (2001) reported strong community characteristics in educational level, annual per-capita income, average price of home, total population, and poverty level to have a strong relationship with municipal tree ordinances. Education about the ecological, psychological, and economic value of trees and the environment has also promoted the demand for urban trees. The growing demand for urban trees from both public and private land, and a growing number of legal issues engage community motivations and political will to have tree ordinances and to use such as public policy and planning tools for community development.

CASE OF ALABAMA: THE DEVELOPMENT OF TREE ORDINANCES

Alabama is comparatively a rural state with some representative characteristics for most of the southern United States. The development of tree ordinances in Alabama to some degree can reflect many other states in the south.

Urban trees are an important part of Alabama's history, with tree planting being the most common "community forestry" activity. Currently, Alabama has more than 200 million urban trees, covering 48% of the urban areas, and 6.3% of the state (Dwyer et al. 2000). Since Alabama has such a favorable climate for tree growth and abundant forest resources, the presence of trees is sometimes taken for granted. Many of the state's urban trees were planted and have received some level of management. As early as 1763, the British planted live oaks along the streets of Mobile. In the early 1800s, mulberry trees were planted along the streets of Cahaba, the state's first capital city, and evidence exists of experiments with other tree species as well (Letson 2002). Compared with other states, Alabama has maintained a relatively rural identity longer than most. Therefore, Alabama's urban forest is relatively less-managed even though it has a much better climate for urban trees and does not suffer from the insect and disease pests that devastated large portions of northern and eastern urban forests. Only since the 1960s, as Alabama has become more urban, have city trees become even more important to people.

The Town of Silverhill in Baldwin County, passed the first recorded tree ordinance in 1935, which defined the pruning zone around its street trees. In Mobile County, adjacent to Baldwin County, the City of Mobile, the third largest city in Alabama, was the second city to have a tree ordinance. The original tree ordinance was passed and the state's first Tree Commission was formed in 1961. The Mobile Tree Commission holds the distinction of being the only one enacted by a state legislative act. Authority was given to the city to protect live oaks in specific areas. Subsequently, Mobile's tree ordinance was included in the "Zoning Ordinance of the City of Mobile" that was first adopted in May 1967, and later amended in April 1992 and November 2005.

Twenty-nine years after the formation of Mobile Tree Commission, Foley became the second Alabama city to create a tree commission, through a local municipal ordinance. Huntsville, the fourth largest city, is also one of the early Alabama cities to have a tree ordinance, adopting its tree management ordinance in August 1981. In the 1980s and 1990s a trend developed, spreading tree boards and ordinances across the state (ACES 2002). Tree ordinances and green laws became more and more important to local governments interested in managing Alabama urban forests.

Since tree ordinances can be incorporated with other acts, regulations, and codes, it is often difficult to determine which cities have tree ordinances. The Tree City USA list from the National Arbor Day Foundation, which requires a city to have a tree ordinance for such recognition, has 81 Alabama cities on the list. However, the reality is that some cities do have tree ordinances that are not on the Tree City USA list.

A survey was conducted to collect and assemble comprehensive information regarding tree ordinances in Alabama in 1996, followed by a second survey in 2006 to gain more updated information. Both surveys used similar methodology, which was to identify tree ordinances in all cities and towns in Alabama. Letters were sent to each municipal clerk or mayor requesting information regarding landscape or tree ordinances, or city codes regulating trees if they did not have landscape or tree ordinances. Meanwhile, there was a search for tree ordinances on city websites. In cases when the survey did not receive a response, there was an e-mail follow-up with phone calls, and a second letter. A total of 300 surveys were sent to the most populated cities and towns. Since Alabama is comparatively a rural state, all cities and towns with more than or close to 1000 people were contacted. The study received approximately 130 responses in each of the two surveys: some respondents sent their tree or landscape ordinances or website addresses while others simply replied that they did not have an ordinance.

Since there were not many cities that had tree ordinances, the two surveys were combined with the information collected from other sources. It was determined that 83 municipalities have some type of tree or landscape ordinance addressing matters related to trees. In about 20 cities, the City Code contains at least some regulations specifically dealing with trees, landscape and zoning ordinances, city beautification, and other parameters. Only approximately 20 cities have self-contained and well-developed tree ordinances or landscape regulations (meaning the ordinance is independent rather than included in the city code). These cities include Abbeville, Ashville, Auburn, Decatur, Dothan, Eufaula, Fairhope, Florence, Gulf Shores, Helena, Hoover, Huntsville, Mobile, Moundville, Opelika, Red Bay, Tuscumbia, and others.

After reviewing and examining the tree ordinances collected in Alabama, a summary of the major components was created (Table 1). From the compilation, the top six issues addressed were: 1) having a tree commission or board, 2) tree planting, removal and replacement on public land, 3) public trees protection and care; 4) tree species selection recommended to be planted,

5) dead or deceased tree removal on private property, and 6) definition of street trees. Except for Mobile and Huntsville, all other cities have developed their tree ordinances after 1985.

Table 1: Major issues addressed by tree ordinances in Alabama cities.

Issues Addressed	# of cities
Amended at least once	13
Having tree commission (board)	73
Tree planting, removal and replacement on public land	70
Public trees protection and care	68
Tree species selection recommended to be planted	57
Dead or deceased tree removal on private property	51
Definition of street trees	34
Nuisance trees	32
Private trees protection	32
Spatial requirement (e.g., distance from curb, sidewalk, street corners and fireplugs, distance between trees)	31
Penalty for violation	27
Arborists licensed and bonded	20
Tree topping, pruning and corner clearance	19
Tree removal and protection on development sites	12
Tree preservation and planting credit	9
Heritage trees	5
Tree protection close to or under utilities line	1

Data sources: Authors' compilation from surveys conducted in 1996 and 2006. The data set included 81 cities.

TREE ORDINANCES AS PUBLIC POLICY AND PARTICIPATION TOOLS

Almost all Alabama cities regulating trees have city tree commissions (or tree boards) that take the responsibilities of initiating and amending the tree ordinances (Table 1). In Alabama, tree ordinances have most often started following the establishment of a city tree commission (board). Tree commissions play an important role in engaging public participation technically and politically. For example, the first tree ordinance in Montgomery (the capital of Alabama) was passed in 1984. Montgomery formed a five-member tree commission filled exclusively by city personnel to allow the city to meet one of the Tree City USA standards. In 2001, local citizens formed the Montgomery Tree Committee (MTC). The group's intent was to create an informally structured urban tree advocacy group that would promote a municipal urban forestry program. The MTC wrote a project proposal for the City of Montgomery to develop a comprehensive urban forestry plan. The proposal was approved by the U.S. Forest Service and awarded funds to implement the plan in 2002. With the committee's efforts, the City of Montgomery hired its first urban forester in 2004. In September 2005, Montgomery passed an ordinance providing minimum landscape requirements for off-street parking. The MTC, incorporated as a nonprofit membership organization and in 2006, was recognized as a nonprofit 501(c)(3) corporation by the Internal Revenue Service. The MTC began working with the City of Montgomery to merge ordinances and tree regulations to create a comprehensive and functional tree ordinance in November 2007. The revised ordinance gave the urban forester and the municipal government policies, guidelines, and authority needed to manage trees on public property.

Tree ordinance development involves various stakeholders, particularly builders, utility companies, and new home owners. For example, Huntsville, the fourth largest city in Alabama, adopted its tree ordinance in August 1981. Huntsville's tree ordinance primarily addressed right-of-way trees and responsibility for their care, causing some conflicts among the utility companies, the owners of right-of-way trees, and the City. At the time, the development of the tree ordinance proved to be a complicated process. According to former City Forester Chuck Weber (1982), Huntsville passed another landscape ordinance "Zoning Ordinance of the City of Huntsville, Alabama" in 1989 which included Article 71, "Off-Street Parking and Vehicle Use Area (PVA) Landscaping Requirements." The essential purpose of this ordinance was to improve the visual appearance of PVA while preserving trees and other landscape elements so as to protect streams and watercourses from excessive runoff.

In February of 2004, Huntsville's City Council adopted a complete revision of the city's standards for tree work, paying more attention to forest management and education than regulation. Negotiations took place for over two years before the Tree Commission arrived at wording which all parties could agree. The more challenging issue was related with power-line clearances. Huntsville has a long growing season and tremendous species diversity, but these assets mean either severe line-clearance pruning or frequent re-pruning of fast-growing trees. The compromise that broke the logjam was to increase the clearance distance around distribution lines to 4.57 m (15 ft) for nine fast-growing species (hackberry/sugarberry, box elder, silver maple, tree-of-heaven, cottonwood, princess tree, Siberian elm, black cherry, and loblolly pine), while leaving the clearance for other species at 3 m (10 ft).

The new tree ordinance in Huntsville reflects compromise and collaboration between utility companies, city government, and individuals. While the utility companies had an obligation to provide safe and reliable utility service to its customers, some trees were topped and became unsightly. The city and utility company worked out a solution to completely remove old, poorly trimmed trees, and replant them with new ones on private property. The new tree ordinance required utility companies to cut and remove trees at their expense, the city to take responsibility for planting new trees, with private households responsible for tree maintenance.

In the City of Auburn, the tree commission, developers, and builders worked together in an attempt to keep mature trees on private property. For every large tree retained, the developer or builder receives credit for two to three trees. The Auburn landscape ordinance is targeted at developers and is designed to encourage the planting and retention of larger growing, long-lived tree species and to discourage problem species such as "Bradford" pears and crapemyrtles.

Tree ordinances are also an important tool in planning and coordinating within governmental agencies and being consistent with other codes and regulation. For example, Mobile's tree ordinances are included in several places such as the Zoning Ordinance of the City of Mobile, Subdivision Regulations for the City of Mobile, and The Land Use Administration Section of Urban Development. The Mobile Planning Commission requires a buffer planting strip or a wooden privacy fence of 1.83 m (6 ft) in height.

In Auburn, the city's tree and green ordinances are mostly defined in the Auburn Landscape Regulations and the Auburn Zoning Ordinance of 2006. Proposals made by the Auburn Tree Commission go to the City Planning Committee which refines and adapts them prior to referral to the Auburn City Council for approval. The City appointed an urban forester in charge of city trees and provides "Best Practices" to developers and private citizens. In the Auburn Zoning Ordinance, the most related components are land use classification, requirement of open space, buffer-yard, plant materials, and minimum plant size.

Public support is critical for the approval and implementation of tree ordinances. According to a survey report (Zhang et al. 2007), over 85% of the respondents would support their local government developing tree ordinances imposing guidelines on builders and developers regarding trees on new construction sites. The survey indicated that about 75% of the public would support a local tree ordinance imposed on public property, with less support for tree ordinances to govern trees on private property. The survey results imply that before passing a tree ordinance to govern trees on private property, a careful and well planned communication plan must be developed to gain public support. This is not surprising since the "taking issue" of private property rights has been a big concern across the United States. Tree and land ordinances face similar "taking issue" challenges (Durkesen and Richman 1993). As population increases and land development expands, trees on private property must be included in tree ordinances. Cooper (1996) demonstrated a successful example of using tree ordinances to protect and replace trees on private lands.

CONCLUSION

Tree ordinances emerge and evolve in response to urban, societal, and economic changes. Just as other laws and regulations target specific issues, tree ordinances are governing policies for urban tree management. In the United States and in Alabama more specifically, regulations on public land are more developed and have received more public support compared with private land management. Tree ordinances are gradually evolving to address emerging issues of growth and conflict. Several cities in Alabama have amended their tree ordinances due to meet these dynamics. When situations change and new conflicts emerge, a tree ordinance should be amended. For example, it was primarily in conflicts among utilities companies and owners of right-of-way trees in the City of Huntsville that led to the change of the city tree ordinances. Tree ordinances are specifically designed as public policy and planning tools for individual municipalities and must meet local needs (Miller 1997). From this aspect, we anticipate the integration of tree ordinances with environmental protection (e.g., riparian buffer) and new developments will become more important.

Unlike many laws and regulations, tree ordinances are more successful when they include public participation and citizen leadership. Financial support from federal and local government and private sources often play a critical role in helping nongovernment organizations and citizens effectively participate. For example, city tree commissions are usually established through the public taking responsibility for developing and amending tree ordinances in the U.S., and especially in the Alabama. At the same time, developing tree ordinances is a great opportunity to engage public participation, solve local issues through negotiation and compromise, and create a policy that works for the community.

More importantly, tree ordinance implementation and compliance is largely dependent on public participation considering many tree ordinances contain regulations that are voluntary, difficult to monitor, and effectively enforce. Citizens should be strongly encouraged to participate in administration of tree ordinances with decision-making authority, or in an advisory role. Nichols (2007) suggests citizen bodies such as tree commissions, vegetation committees, tree review boards, urban forestry advisory boards, environmental commissions, and planning commissions must be involved. A wide public participation can not only help address the issues of the stakeholders of a city, but also provide an education tool for the public about tree ordinances, with eventual help in implementation.

LITERATURE CITED

Abbey, D.G.B. 1998. U.S. Landscape Ordinances: An Annotated Reference Handbook. John Wiley & Sons, Inc., New York.

Abbey, D.G.B. 1999. Green Laws, Building Landscapes in the Twenty-first Century, in Proceedings 1999 ASLA annual meeting, American Society of Landscape Architects, Washington D.C.

ACES (Alabama Cooperative Extension System). 2002. Urban and community Forestry: Alabama's Five-Year Strategic Plan. ANR-1220, Alabama Cooperative Extension System, AL.

Barker, P.A. 1975. Ordinance control of street trees. Journal of Arboriculture. 1:212–216.

Chenoweth, R.E., and P.H. Gobster. 1990. The nature and ecology of aesthetic experiences in the landscape. Landscape Journal 9: 1–18.

Cooper, J.C. 1996. Legislation to protect and replace trees on private land: Ordinances in Westchester county, New York. Journal of Arboriculture 22:270–278.

Coughlin, R.E., D.C. Mendes, and A.L. Strong. 1984. Private Trees and Public Interest: Programs for Protecting and Planting Trees in Metropolitan Areas. Research Report Series No. 10, Univ. of Pennsylvania Department of City and Regional and City Planning, University of Penn., Philadelphia., PA. 158 pp.

Davis, R.L. 1993. Street tree trends in Kansas and the influence of community factors. Journal of Arboriculture 19:201- 208.

Dickerson, S.D., J.W. Groninger, and J.C. Mangun. 2001. Influences of community characteristics on municipal tree ordinances in Illinois, U.S. Journal of Arboriculture 27:318–325.

Duerksen, C.J., S. Richman. 1993. Tree Conservation Ordinances, American Planning Association, Planning Advisory Service Report # 446, Chicago.

Dwyer, J.F., D.J. Nowak, M.H. Noble, S.M. Sisinni. 2000. Connecting people with ecosystems in the 21st century: an assessment of our nation's urban forests. Gen. Tech. Rep. PNW-GTR-490. U.S. Department of Agriculture, Forest Service, PNRS. Portland, OR.

Frischenbruder, M.T.M., and P. Pellegrino. 2006. Using greenways to reclaim nature in Brazilian cities. Landscape and Urban Planning 76: 67–78.

Galvin, M.F., and D. Bleil. 2004. Relationship among tree canopy quality, community demographics, and tree city program participation in Maryland, U.S. Journal of Arboriculture 30:321–327.

Heisler, G.M. 1986. Effects of individual trees on the solar radiation climate of small buildings. Urban Ecology 9:337–359.

Johnson, C.W. 1988. Planning for avian wildlife in urbanizing areas in America desert/mountain valley environments. Landscape and Urban Planning 16:245–252.

Kaplan, R. 1993. The role of nature in the context of the workplace. Landscape and Urban Planning 26 (1-4):193–201.

Kielbaso, J.J. 1989. City Tree Car Program: A Status Report. In G. Moll and S. Ebenreck, Shading Our Cities. Island Press, Washington, D.C.

Kuo, F.E. 2003. The role of arboriculture in a healthy social ecology. Journal of Arboriculture 29:148–155.

Appendix 6

Kweon, B.S., and W.C. Sullivan, A.R. Wiley. 1998. Green common spaces and the social integration of inner-city older adults. Environment and Behavior 30(6):832–858.

Letson, N. 2001. Making Our Urban Forests Safer. ANR-1210, Alabama Cooperative Extension System, Auburn, AL.

Letson, N. 2002. Urban & Community Forestry: Alabama's Five-Year Strategic Plan. Alabama Cooperative Extension System, ANR-1220, Auburn, AL.

Long, A., and C.K. Randall. 2004. Wildfires risk assessment guide for homeowners in the Southern United States. School of Forest Resources and Conservation, University of Florida, Gainesville.

McPherson, E.G. 1990. Modeling residential landscape water and energy use to evaluate water conservation policies. Landscape Journal 9:122–134.

Merullo, V.J., and M.D. Valentine. 1992. Arboriculture and the Law. International Society of Arboriculture, Champaign, IL. 110 pp.

Miller, R.W. 1997. Urban Forestry: Planning and managing urban greenspaces. Prentice Hall, New Jersey.

Mortimer, M., and B. Kane, 2004. Hazard tree liability in the United States: uncertain risks for owners and professionals. Urban Forestry and Urban Greening 2:159–165.

Nichols, S.S. 2007. Urban Tree Conservation: a White Paper on Local Ordinance Approaches. Montgomery Tree Committee. Montgomery, Alabama.

Nowak, D.J., and E.W. McPherson. 1993. Quantifying the impact of trees: the Chicago Urban Forest Climate Project. Unasylva 173(44): 39–44.

Oke, T.R. 1989. The micrometeorology of the urban forest. Philosophical Transactions of the Royal Society of London 324(Series B):335–349.

Ricard, R.M. 2005. Shade Trees and Tree Wardens: Revising the History of Urban Forestry. Journal of Forestry 107 (July/August):230–233.

Sanders, R.A., 1986. Urban vegetation impacts on the hydrology of Dayton, Ohio. Urban Ecology 9:361–376.

Schmied, A., and W. Pillmann. 2003. Tree protection legislation in European cities. Urban Forestry and Urban Greening 2:115–124.

Schroeder, H.W. 1989. Environment, behavior and design research on urban forests. In E.H. Zube & G.T. Moore (Eds.), Advances in Environment, Behavior and Design (pp. 87–117). New York: Plenum.

Schroeder, H.W., T.L. Green, and T.J. Howe. 2003. Community tree programs in Illinois, U.S.: a statewide survey and assessment. Journal of Arboriculture. 29(4): 218-225.

Smith, W.H. 1981. Air pollution and forests. Springer, New York.

Tereshkovich, G. 1990. Texas municipal tree and landscape ordinances. Journal of Arboriculture 16:62-65.

Treiman, T., and J. Gartner. 2004. Community forestry in Missouri, U.S.: Attitudes and Knowledge of local officials. Journal of Arboriculture 30(4):243-250.

Ulrich, R.S. 1984. View through a window may influence recovery from surgery. Science 224:420–421.

USDA Forest Service. 2003. Urban Tree Risk Management: A Community Guide to Program Design and Implementation. NA-TP-03-03, USDA Forest Service NE Area, St. Paul, MN.

Weber, C.C. 1982. A Tree Management Ordinance for Huntsville, Alabama. Journal of Arboriculture 8:81–82.

Zhang, Y., A. Hussian, J. Deng, and N. Letson. 2007. Public Attitudes Toward Urban Trees and Supporting Urban Tree Programs. Environment and Behavior 39:797-814.

Zube, E. 1971. Trees in Woodlands in the Design of the Urban Environment. In Trees and Forest in an Urbanizing Environment. Planning Residential Development Service No. 17. The University of Massachusetts Press, Amherst, Massachusetts. pp. 145–150.

Acknowledgments. This study was financially supported by the Alabama Urban and Community Forestry Assistance program, and National Urban and Community Forestry Advisory Council Competitive Program. During our survey and interviews, we have received great support from many cities' urban foresters and clerks who sent us the tree and landscape ordinances and answered many specific questions.

Yaoqi Zhang (Corresponding Author)
School of Forestry and Wildlife Sciences
Auburn University
Auburn, AL 36849, U.S.
Yaoqi.Zhang@auburn.edu

Bin Zheng
School of Forestry and Wildlife Sciences
Auburn University
Auburn, AL 36849, U.S.

Brenda Allen
School of Forestry and Wildlife Sciences
Auburn University
Auburn, AL 36849-5418, U.S.

Neil Letson
Alabama Cooperative Extension System
P.O. Box 302550
Montgomery, AL 36130-2550, U.S.

Jeff L. Sibley
Department of Horticulture
Auburn University
Auburn, AL 36849-5418, U.S.

Appendix 6

Résumé. À partir d'une brève revue de l'évolution historique des arrêtés sur les arbres aux États-Unis, cet article met l'accent sur l'évolution des arrêtés dans l'état d'Alabama afin de démontrer comment les arrêtés sur les arbres ont évolué vers une législation et le rôle que ces arrêtés ont sur les arbres urbains. Même si ces arrêtés sur les arbres ont une longue histoire aux États-Unis, ils se sont rapidement développés dans les années '70. Parmi les 100 municipalités qui ont certains types d'arrêtés en Alabama, les sujets majeures de ces arrêtés sur les arbres incluent, et ce en se basant sur cette enquête: présence d'une commission de l'arbre, définition de la plantation d'arbres, abattage et remplacement des arbres sur le territoire public, protection et entretien des arbres publics, sélection des espèces d'arbres, abattage des arbres morts sur propriétés publique et privée. Du fait de la complexité et de l'étendue des arbres urbains, cet article fait mention que les arrêtés sur les arbres fournissent non seulement un cadre légal, mais qu'ils sont aussi un outil efficace pour favoriser la participation et la conscientisation publique dans le processus de formulation, d'implantation et d'amendement des arrêtés sur les arbres. Le développement de ces arrêtés sur les arbres requièrent le support du gouvernement, la participation des citoyens et la prise en compte des ressources locales.

Zusammenfassung. Ein kurzer Überblick über die historische Entwicklung von Baumschutzsatzungen in den Vereinigten Staaten. Dieser Artikel fokussiert auf die Entwicklung von Baumschutzsatzungen im Staat Alabama, um zu demonstrieren, wie sich Baumschutzsatzungen im Recht entwickeln und welche Rolle solche Satzungen für die betroffenen Bäume haben. Obwohl Baumschutzsatzungen eine lange Geschichte in den Vereinigten Staaten haben, fand seit den 70ger Jahren eine rasche Entwicklung statt. Unter 100 Kommunen in Alabama, die eine Form von Baumschutzsatzung haben, schließen die Hauptaufgaben dieser Satzungen, basierend auf dieser Untersuchung, folgendes ein: es gibt einen Baumausschuss, es gibt Vorschriften zur Pflanzung, Fällung und Ersatzpflanzung von Bäumen auf öffentlichem Grund, öffentlicher Baumschutz und Baumpflege, Baumartenauswahl und Totholzbeseitigung auf öffentlichem und privatem Grund. In Anbetracht der Breite und Komplexität von urbanem Baumbestand, zeigt dieser Artikel, dass Baumschutzsatzungen nicht nur ein legales Regelwerk liefern, sondern auch ein effektives Werkzeug sind, um die Öffentlichkeit auf den Prozess von Entwicklung, Festsetzung und Durchsetzung solcher Baumschutzsatzungen aufmerksam zu machen und daran zu beteiligen. Die Entwicklung von Baumschutzsatzungen erfordert Unterstützung der Landesregierung, Teilnahme der Bevölkerung und einen Einbezug von lokalen Ressourcen.

Resumen. Siguiendo un breve repaso de la evolución histórica de las ordenanzas de árboles en los Estados Unidos, este reporte se enfoca al desarrollo de ordenanzas de los árboles en el Estado de Alabama para demostrar cómo las ordenanzas de árboles evolucionan en leyes y el rol que tales ordenanzas tienen en los árboles urbanos. Aunque las ordenanzas de árboles tienen una larga historia en los Estados Unidos, se han desarrollado más rápidamente desde los 1970s. Entre 100 municipalidades que tiene algún tipo de ordenanza en Alabama, con base en esta investigación, las principales responsabilidades de las ordenanzas de árboles incluyen: una comisión del árbol, definición de plantación de árboles, remoción y remplazo en áreas públicas y propiedades privadas. Considerando la amplitud y complejidad de los árboles urbanos, este reporte indica que las ordenanzas de árboles proveen no solamente una estructura legal, sino también una herramienta efectiva para lograr la participación pública y la conciencia de los árboles urbanos en el proceso de formulación, implementación y mejoramiento de las ordenanzas. El desarrollo de las ordenanzas de árboles requiere soporte gubernamental, participación ciudadana y consideración de recursos locales.