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Examining the product and process of scenic beauty evaluations using moment-to-moment data and GIS: The case of Savannah, GA

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ABSTRACT

Growing out of a recent debate on aesthetics, and in particular scenic beauty, we added the term 'process' to our conceptualization of scenic beauty so it is broader and more dynamic than other traditional definitions. The purpose of this study is to evaluate the product (content of the environment such as tree characteristics) and process (spatial and temporal patterns of change perceived such as frequency, maximum, minimum, and average quality) of scenic beauty tourist evaluations to better understand what and how it is experienced in real-time. Five city street corridors in Savannah, GA, were video recorded with a roadside view during the spring, summer, and winter (2008–2009). Visitors (N = 130) were asked to evaluate the scenic beauty of a video by turning a hand-held dial (Perceptual Analyzer) and completing a questionnaire. Moment-to-moment data, post-video evaluations, and GIS tree data were used to develop a scenic beauty map, evaluation timelines for each season, and a model predicting willingness-to-pay for a trolley tour. The specific tourism product-based characteristics of the urban forest (tree groupings, height, diameter or DBH, age, condition, and species) that contribute to scenic beauty support what is reported in the literature, thus further validating the mapping of real-time data. Both quality (i.e., average scenic beauty) and quantity (i.e., positive changes in scenic beauty per minute) related measures were both significant process-based predictors of tourists' willingness-to-pay for scenic beauty. The only product-based variable that was significant was an overall measure of quantity of visitor experiences (i.e., eventful measure). The quality of scenic beauty may be only part of the story.

1. Introduction: the argument for an ecological approach

Scenic beauty and aesthetics are elusive, complex, and evolving concepts (Qin et al., 2008). The origin of the term aesthetics is from Greek *aisthētikos* meaning 'relating to perception by the sense'. The sense 'concerned with beauty' was coined in 18th century Germany (Oxford Dictionary, n.d.). In recent times, the concept of scenic beauty has been understood as a *product* of the landscape according to the reactions of persons experiencing that landscape (Qin et al., 2008). This paper applies a broader definition that also includes the *process* of how scenic beauty is perceived. This expanded definition grows out of the following debate about the need for an ecological aesthetic, and some examples of the theoretical, methodological, and managerial implications of this new definition are documented in our Savannah, GA case study.

Gobster (1999) proposed the study of aesthetics should not focus on the scenic aesthetic, based on the world of art, composition, and the European ideal, but instead should focus on the ecological aesthetic. Gobster (1999) promoted the human-environment interaction and the involvement of all senses. Most important to our study, he used terms such as 'dynamic', and 'active' to describe this interaction opposed to the scenic aesthetics' 'static' and 'passive' descriptions. Kroch and Gimblett (1992) suggest landscape preferences involves more than evaluations of a static photo, but instead preferences for landscapes is related to human's use of multi-sensory functions. On these lines, Hull et al. (1992) suggest we know very little about *how* real places are experienced. Citing the Transactionalist viewpoint, Aitken (1991) describes person-environment connections as:

> "That of understanding person-in-environment contexts as a function of particular ongoing transactions between persons

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> and environments···The focus is on change as an integral part of people's experience. Change is initiated by an event which creates imbalance and transformation. Events are a nexus of behavioral, environmental and temporal features, as such it is important not to fragment a person-in-environment whole artificially by studying behaviors or environments separately." (p. 107)

This suggests using photographic representation of a temporal event, such as a scenic drive, may not be the best option. By dividing a temporal event into a series of static snapshots we may lose the dynamic interactions, transitions, and changes between the person and the environment. This relationship is best studied as a whole unit, or a continuous event. Ecological psychology supports this concept. Gibson (1986) states "the deep seated notion of the retinal image as a still picture [should be] abandoned" (p. 238), indicating we do not perceive the environment as a series of snapshots but instead that humans continually pickup changes in the environment and understand them as unfolding events.

By adopting an ecological framework, Pierskalla et al. (2013) recently validated a global measure (i.e., eventful) to quantify the unfolding events that are perceived in outdoor recreation. The researchers used discriminant validity analyses to establish that 'Quality' (1 = poor to 7 = excellent) and 'Eventful' (1 = not much happened or uneventful to 7 = a lot happened or eventful) are two different constructs of a fishing experience. For example, color and health of rainbow trout is a better predictor of a quality fishing experience and catching a larger number of large fish is a better predictor of the quantity of the experience (eventful). The researchers suggest that the struggles associated with catching large fish may result in an eventful experience that consists of several unfolding event units such as casting a line in the water, pumping and lifting the fishing rod, reeling, etc. "Events are substantial, spatiotemporal things that can have or exhibit properties and that can enter into relations with other propertied things, that is other events" (Bingham, 2000; p. 30). Hull et al. (1992) described a similar unit of recreation in terms of experience patterns. "Experience patterns capture the dynamic nature of a recreation experience and thus might prove useful as units of analysis in the management and study of recreation resources" (p. 240). The eventful measure might also compliment traditional measures of quality when assessing scenic beauty of urban forests.

Scenic beauty (as well as other recreational opportunities), within an ecological framework, describes how the relationship between humans and the environment unfolds when it is conceptualized as the activity—movement—setting sequence of language (e.g., driving-along-a street) (Pierskalla et al., 2007). For example, driving (activity) along (movement/preposition) roadside trees (setting) is a style of change (quantity of events) that can afford positive or negative evaluations (quality of events). This conceptual definition recognizes that a perceptual experience is a dynamic process of changing quality, unbounded, active, and experiential and is among the key concepts in our study.

1.1. Purpose of study

We selected the urban forests of Savannah, Georgia as our study location to demonstrate how the ecological framework can be used to better understand what elements of an urban forest contribute to tourists' perceptions of scenic beauty, and how those elements are perceived over time. Given that one of the most popular ways for visitors to experience Savannah's scenic beauty is by riding a trolley (activity) through (movement/preposition) the urban forest (setting), it is an ideal place to better understand the spatial patterns, physical content, and temporal aspects that make up this recreational experience, but to do so, a more dynamic concept of scenic beauty is required. In summary, scenic beauty is not simply represented by a fixed scene or experienced as a static moment in time, but rather it is both a product and process that results from the interaction between an observer and the physical features of the landscape. By adding the term 'process', our conceptualization of scenic beauty, within an ecological framework, is broader and more dynamic than other traditional definitions. The purpose of this study is to evaluate the product (content of the environment such as tree characteristics) and process (spatial and temporal patterns of change that is perceived such as frequency, maximum, minimum, and average quality) of scenic beauty evaluations to better understand what and how it is experienced in real-time. Those two general approaches to research (product and process) are described in detail in the literature review.

2. Literature review

Two general approaches in tourism and leisure research can be used to examine recreation opportunities such as scenic beauty (Mannell and Iso-Ahola, 1987). (1) 'Product-based' research often involves quantitative assessments of leisure after the on-site experience has been completed (i.e., post hoc). This approach is more useful when documenting 'what' experiences (e.g., enjoying forest squares, healthy trees, and an overall eventful experience) are considered important and attained by visitors. (2) 'Process-based' approaches that are quantitative in nature often involve examination of the immediate conscious experience of the actual, real-time nature of the experience itself, and it can reveal the anatomy of the experience. This approach better answers the question of how an experience (e.g., frequency of scenic beauty events and additive quality of each of those events), is attained (Patterson et al., 1998; Borrie et al., 2001). Additional differences between product-based and process-based approaches have been documented in several other papers (e.g., Mannell and Iso-Ahola, 1987; Stewart and Hull, 1992).

We categorized theories (e.g., psychophysical and ecological approaches) and methodologies (e.g., spatial mapping, post hoc assessments, and experience sampling method) used to study scenic beauty as either a product or process-based approach to help better understand them and to identify and address the gaps in the literature. Although a few studies of the general outdoor recreation experience were included, emphasis is placed on studies of urban forests, roadside trees, and scenic beauty when possible.

2.1. Scenic beauty as a product of the landscape

The psychophysical approach to assessment of aesthetic quality of natural environments is among the most often used by researchers (Zube et al., 1982; Daniel and Meitner, 2001), and it has been especially effective when describing the content of the environment that contributes to scenic beauty (i.e., a product-based approach). The psychophysical paradigm relies on stimulus-response theory (Daumants, 2003). The biological basis of this theory suggests that humans prefer landscapes that inform them of survival behaviors such as habitat, spatial relationships, harm avoidance, potential for movement, and location of food and water resources (Parsons and Daniel, 2002; Daumants, 2003). Specifically, people in the US and elsewhere prefer natural environments, fairly open areas with low ground cover, water, and occasional clumps of trees and shrubs (Parsons and Daniel, 2002); solitary edge trees (Fry and Herlin, 1997); canopy trees (Lamb and Purcell, 1990); street trees with large diameters (Buhyoff et al., 1984); street trees over 25 feet tall (Kalmback and Kielbaso, 1978); environments with moderate levels of complexity (Ulrich, 1977); areas of textural homogeneity or ordered complexity (Ulrich, 1977); spreading and globular tree shapes (Summit and Sommer, 1999); and seasonal/temporal affects (Buhyoff and Wellman, 1979; Gramann and Rudis, 1994).

Geographic Information Systems (GIS) is a developing technology that has often been used effectively to describe the content of the environment that may contribute to scenic beauty. For example, Grêt-Regamey et al. (2007) predicted willingness-to-pay (WTP) responses for views using GIS-based variables such as slope, aspect, and distance. Using GIS, Uzun and Müderrisoğlu (2011) obtained maps that represent seven factors of visual landscape quality including landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications. Schirpke et al. (2013) examined the visible landscapes using GIS-based modeling. Frank et al. (2013) used landscape metrics such as Shannon's Diversity Index, Shape Index, and Patch Density as indicators of scenic beauty. Chamberlain and Meitner (2013) developed GIS-based images that enable planners to identify viewsheds along a highway route that are more likely to receive emotional peak responses. Chhetri and Arrowsmith (2003) used stepwise multiple regression analysis to understand the predictability of scenic attractiveness through biophysical variables (GIS data) of a geographic space. Kanga et al. (2011) used a geospatial approach to identify the most valuable sites for different classes of nature-based tourism including adventure and scenic beauty. These are examples of studies that represent a shift toward the development of GIS tools to assess the physical content of scenic beauty. However, what is lacking in the literature are studies that integrate time into the analysis of dynamic displays of scenic beauty and map process-based data in the temporal and spatial context of the medium.

2.2. Adding the process of perceiving scenic beauty

According to Gibson's (1950) ecological perception theory, perception is an act and perception and action are mutually tied. Through an extensive program of research, Gibson (1986) "showed in convincing fashion how movement enhances the process of perceiving environmental features; or stated more precisely, how action is a critical facet of the perceptual process" (Heft and Nasar, 2000; p. 302). The ecological approach suggests that recreationists simply read information about the environment directly from the stimulus array through movement from the eyes, head, body, and the like. The light, sounds, smells, tactual sensation, and taste of objects in the environment make up the type of information that is perceived. This information flows as the perceiver moves through the environment, runs his/her hand over an object, or examines how food tastes and feels in his/her mouth. This theory was first developed by Gibson (1950) in ecological psychology but only applied in outdoor recreation since the 1980s (Hammitt, 1983; Pierskalla and Lee, 1998; Pierskalla et al., 2004; Mausner, 2006). Gibson's work may also prove useful as a framework that accounts for a broader definition of scenic beauty as a both a product (content of the environment) and a process (pattern and style of change perceived over time through human movement).

A frequently used approach for measuring human experience over time is the Experience Sampling Method (ESM). This process-based approach has been used extensively to measure the quality of the real-time experience where a collection of assessments of the present moment are collected (Havitz and Mannell, 2005). This method is useful because real-time assessment may capture satisfaction (or as it relates to this study, setting preferences) as it varies during the experience (Stewart and Hull, 1992), and it allows the research to investigate the algorithms (e.g., frequency, maximum values, minimum values) that contribute to a dependent variable such as WTP for scenic beauty. This body of literature suggests that reliance on introspection, limits of recall capabilities, and context variability during post hoc assessments may lead to different results when compared to real-time assessments. For example, Fenwick and Rice (1991) note recall problems associated with measuring consumer response after exposure of commercials, particularly with 'feeling' commercials where it is possible that the viewer's emotional state will change during a 15-s ad. Jarman (2005) also used a continuous response system (real-time assessment) that provided feedback in 1-s intervals to pinpoint the strongest and weakest arguments made during a 2004 Presidential debate and to ensure that information was not 'lost between the cracks'. The following studies, although limited, are examples of how this type of methodology has been used to examine scenic beauty and related phenomena and to identify the benefits of ESM and needs for future research.

Heft and Nasar (2000) and Siniscalchi et al., (2007) compared dynamic and static displays of environmental scenes. In the first study, Heft and Nasar (2000) videotaped segments along a route presenting transition events as the dynamic displays while they treated the freeze frames from each segment as static displays. Results indicated that preference ratings were higher for static displays, but preference ratings in the dynamic condition were more strongly correlated with a wider range of variables. In the second study, the authors used continuous audience response technology (CART) to compare static and dynamic representations of hiking experiences in real-time. That is, respondents provided feedback in 1-s intervals during the video evaluations, and those measures were compared with evaluations of snapshots taken from the same video. Results suggest context does matter when assessing restorative character. Though photos can represent important perceptual events, researchers should focus their attention on discovering where important events take place during an experience and capturing them in their entirety to better reproduce the experience.

Mausner (2006) captured a hiking experience by equipping hikers with a head mounted video camera and microphone to understand the human-environment interaction. Participants were encouraged to talk about anything that captivated them or caught their attention. Later, video segments were created to use in interviews with the hikers to recount their experiences. She concluded the video method, based on Gibson's ecological theory, allowed her to capture multisensory information, data about the hiker's movement through the environment, and the movement of natural features. She suggested video captured the temporal dimension in a manner static photos could not.

Finally, Qin et al. (2008) used a process-based methodology to examine scenic beauty that most closely resembles our study's methodology. They recorded continuous scenic preferences of landscape visualizations (i.e., highway landscapes), in the form of video clips that were statistically generated using GIS. They used a custom-built input devise (similar to a slider volume control on a sound board) to collect the real-time data 2 times per second. They made several conclusions including their observation of increased preferences when a vehicle crests a hill and begins downhill, but more statistical analysis was needed to better understand the rate, frequency and rhythm of perceived change. Using an ecological framework, our paper intends to answer their call for additional process-based studies to better understand the dynamic experience associated with perceiving scenic beauty.

> "In the future, more studies are necessary to investigate the representational validity of various presentation methodologies for the use in quantifying perceptual characteristics of natural landscapes. As well, issues surrounding temporal aspects in highway landscape such as rate, frequency and rhythm of change need to be further investigated. This paper presents an initial concept whereby dynamic ratings are made in real-time. Furthermore, it suggests the possibility of creating dynamic, realistic simulations of natural real-life scenes in order to better understand

how landscape elements and artificial objects affect a driver experience." (p. 10)

2.3. Summary

A review of previous studies revealed several gaps in the literature and needs for future research that are addressed in this paper. The contribution of this research was to:

1. Promote a theoretical rationale for using dynamic displays;
2. Present a new application of continuous audience response technology (CART) for real-time response measurement and scenic beauty mapping;
3. Begin to identify significant algorithms (i.e., frequency, maximum, minimum, and average evaluations of scenic beauty) and other product-based measures (i.e., quality and eventful) that have a positive contribution (both quality and quantity) to tourists' scenic beauty experiences and WTP.

3. Methodology

3.1. Study area

Since visitors can be drawn to cities or towns not only by beautiful tree blossoms or city parks, but also by the general aesthetic quality of well-planted and maintained streets, city beautification through urban forest programs is increasingly gaining popularity among leaders of both large cities and rural small towns. In the city of Savannah, Georgia, USA (our study location), urban forests are one of the top tourism attractions (Deng et al., 2010). The forest squares (or small park squares) along with trees along streets and neighborhoods are a major part of the beauty of Savannah, the fourth largest city in Georgia and the largest city in Chatham County (Fig. 1). Urban forests as seen today in the city are a result of over one century's efforts in tree planning, planting and maintaining. Savannah has been recognized by the National Arbor Day Foundation as a Tree City USA and has also received Tree City USA Growth Awards for advancements made in its urban forest programs. The estimated monetary value of the urban forests' non-priced benefits to tourists is $11.55 million annually or $2.10 per tourist based on the estimated median WTP (Majumdar et al., 2011). In 2009, the total number of tourist visits in Savannah was about 11 million with direct spending of $1.63 billion in the city.

Architect John Massengale has called Savannah's city plan the most intelligent grid system in America that is currently organized around 22 nature-dominated woodened and gardened squares (an additional square was added after our study was completed). Each square has a unique name and aesthetic character, and they all are located within the Savannah historic district. The squares are bounded to the north and south by small one-way streets that run east-to-west and west-to-east. The squares are a major interest for millions of tourists each year and are often experienced by guided trolley tours offered by local businesses (Erwin, n.d.). Overall, Savannah appears to represent a near ideal site for demonstrating an ecological approach for scenic beauty assessment.

3.2. Data collection

Five streets (Bryan, State, Hull, Harris, and Taylor Streets) in the historic district of Savannah, were selected for this study because they encompass all 21 forest squares. A handheld camcorder was used to collect video-taped simulated drives along each of the five streets (resulting in 5 separate videos) during 3 seasons (June 2008, January 2009, and March 2009). Given there is little green color variation in this subtropical city throughout the year, we made seasonal comparisons between winter and the peak tree blooming season that takes place between March and June. All 15 of the videos were created on the same day of the week (Wednesday), during the same time period (8:00 am–10:00 am), and captured the same southern roadside views. The length of the video clips varied from 4 to 6-min depending on the length of the street. To help avoid perceptual narrowing (i.e., a decline in the ability to perceive less familiar content), the simulated drives consisted of nontask-relevant aspects of the roadside environment, low traffic conditions, and a slow rate of speed (<10 mph) (Parsons et al., 1998). A 1-min video clip of Forsyth Park, was also collected each season and used as a practice video to start the data collection sessions.

Continuous audience response technology (CART) was used to collect moment-to-moment responses from respondents about the scenic beauty of video-taped simulated drives through the five Savannah streets. The perception analyzer system technology was provided by Dialsmith, LLC and has traditionally been used to conduct focus groups and market research, and to measure audience reaction to video such as advertisements, films, and campaign messages "so everything that is perceived is also recorded... Nothing slips through the cracks" (Dialsmith, 2014). In our study, CART allowed us to develop a timeline that recorded continuous measurement of scenic beauty change in response or reaction over the course of time, and was used to pinpoint aspects of a video viewers liked or disliked. Data were entered continuously by our study respondents using a handheld dial. The data were automatically recorded by a computer during each second of the video evaluations.

Data collection took place under a gazebo located in Rousakis Plaza/River Street. A convenient sampling method was used to collect information from visitor groups walking in the plaza during five days (Wednesday–Sunday) each study season. As many as four adult visitors from each group could participate during each session that lasted about 15 min.

The researchers started each session by explaining the purpose of the study: "Would you be willing to share your perceptions about Savannah's scenic beauty by watching and evaluating short video clips totaling about 5 min? Since programs to improve Savannah's scenic beauty cost money, we are also interested in finding out what you are willing to pay for a travel experience through the city. Your opinions will be compared with other people to help improve scenic beautification programs." To help respondents become familiar with the handheld dials, they were asked to enter some basic information such as the session and dial numbers. Next, the researchers asked respondents to rate the scenic beauty of video collected by researchers while driving through parts of Savannah. "Your evaluation of scenic beauty should be based on everything you see during the video. Please rate the scenic beauty on a scale from 0 (very low scenic beauty) to 100 (very high scenic beauty) as you progress down a street located in Savannah. If you feel the scenic beauty has improved, turn the dial to the right (100 = very highest scenic beauty). While watching the video, if you feel the scenic beauty has decreased, turn the dial to the left (0 = very lowest scenic beauty). To familiarize you with the evaluation process, let's begin by having you rate the scenic beauty of a short 1-min practice video of Forsyth Park. Please turn your dial to 50 (the midpoint) before we begin. Please begin rating the scenic beauty when the video begins." After the practice evaluation was completed, the instructions were repeated and respondents were systematically assigned a final video from one of the five simulated drives that were made the same week data were collected.

Following the video evaluation, respondents were asked to complete a short questionnaire. First, they were asked to write down what they saw that contributed positively or negatively to scenic beauty in the final video, and then evaluate the overall eventfulness (1 = very uneventful or not much happened to 7 = very eventful or a

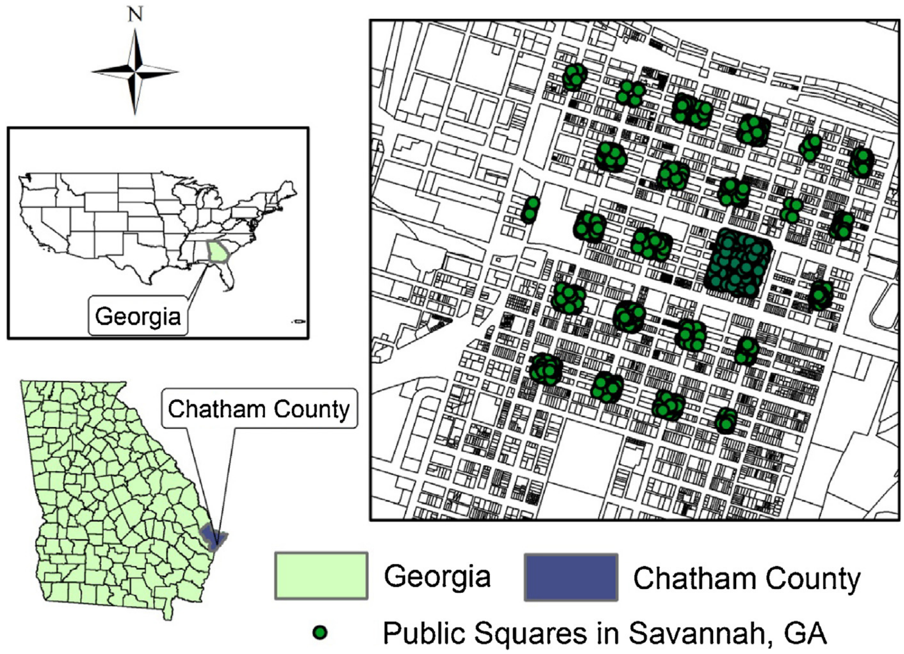

Fig. 1. Location of Savannah, Georgia.

lot happened) and quality (1 = poor to 7 = excellent) of the video. Respondents were then asked how much they would pay for a 90 min guided trolley tour (with on and off privileges) of Savannah that would include the viewing opportunities from the final video. The scale consisted of $2 increments from $0 to $50. This payment card technique for contingent valuation (CVM) elicitation is similar to other methods recently published (e.g., Legget et al., 2003; Jim and Chen, 2006; Notaro and Salvo, 2010; Majumdar et al., 2011). Finally, respondents reported basic demographic information.

3.3. Data coding

Data were downloaded into the Statistical Package for the Social Sciences (SPSS) Version 22.0. The pattern of change in scenic beauty reported by study participants were coded by counting the number of positive changes in scenic beauty (positive dial turns), negative changes in scenic beauty (negative dial turns), and total changes in scenic beauty (total dial turns) that were made by each participant during the video and dividing those numbers by video length (in min). Additionally, scenic beauty ratings were coded from the CART data (0–100 scale) and included the maximum and minimum scenic beauty values, as well as the average scenic beauty from each participant across each video.

In addition, videos were coded by timestamp with macro level visual descriptions of each scene (building, intersection, wall, forest square, landscaping, etc.). The data could be mapped to the CART moment-by-moment preference data and geocoded to other landscape level data (e.g., types and properties of trees, location of squares, etc.).

3.4. Data analysis

CART data were used to develop scenic beauty maps using ESRI ArcGIS 9.1's spatial analyst extension. Since CART captures participant rating for each second of video watched, each participant had a time series of data for the entire video. Data were averaged across each second of video, e.g., the mean of all participant ratings at second one of each video, then second two. . .until the last second of each video. Once completed, the resultant mean CART timestamp for each video was geocoded and analyzed using the inverse distance weighted (IDW) algorithm that was utilized to develop a visual representation of the scenic beauty of each street's viewshed based on a previously published technique (Siniscalchi et al., 2006) to visualize point data, discover "hot spots" or important areas of change, and create a continuum of scenic preference ratings. The preference continuum was overlaid with other GIS tree data including type, height, diameter (measured as diameter at breast height or DBH), growth/age, and condition of trees provided by the City of Savannah. Due to the independence of raters in each data collection period, a series of ANOVAs and independent samples *t*-tests were conducted to determine scenic preference among trees and create a series of video corridor timeline attributes.

The timeline attributes that were coded from the process-based CART data (i.e., average, maximum, minimum, total changes, positive changes, and negative changes in scenic beauty measures) and post video evaluations or product-based data (i.e., overall scenic beauty and eventful measures) were examined as possible predictors of willingness-to-pay for a trolley tour that included views shown in the video. The model was developed using multiple stepwise regression analysis. Stepwise regression generates a linear equation that predicts willingness-to-pay for a trolley tour (dependent variable) as a function of the CART data and post video evaluations (independent variables). Independent variables with statistically significant ($p < 0.05$) partial correlation were sequentially added to the equation. The stability of the model was examined using a bootstrap validation method (Efron, 1979). That is, stepwise regression analyses were repeated for 100 bootstrap samples to verify the initial selection of independent variables that were included in the model.

4. Results

4.1. Sample profile

A total of 130 Savannah visitors participated in the study during the summer (n = 46, 71.9% response rate), winter (n = 47, 51.6% response rate), and spring (n = 37, 54.4% response rate). Just less than half of the respondents were female (47.6%), with an aver-

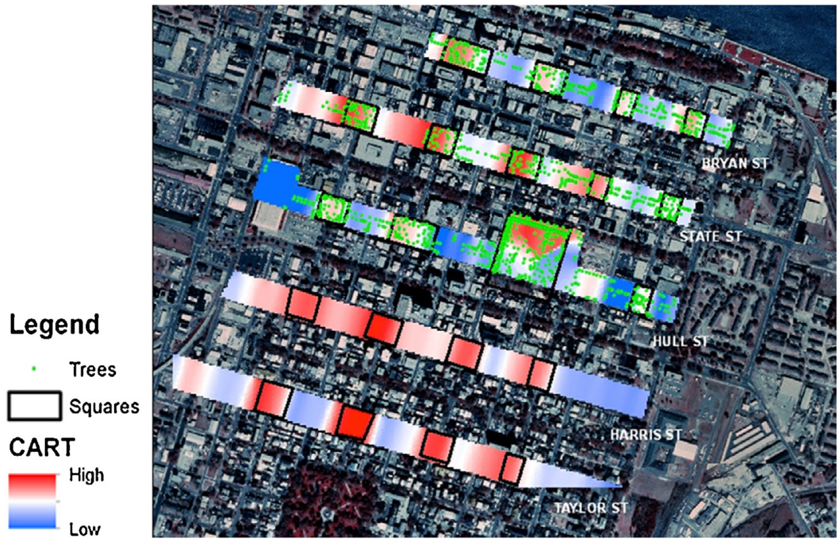

Fig. 2. Spatial context of scenic beauty evaluations, Savannah, GA.

age age of 52 years. About half of the respondents (48.9%) also traveled with a partner or significant other and only 8.9% traveled alone. Slightly more than a quarter of visitors (26.4%) reported a household income over $100,000.

4.2. Process of scenic beauty perceptions

The spatial (Fig. 2) and temporal context (Fig. 3) of visitor perceptions of Savannah's landscape characteristics are reported to better understand the process of scenic beauty perceptions. The spatial map (Fig. 2) illustrates the overall responses to the video-taped simulated drives through five Savannah streets. The responses ranged from high (shown as red) to low scenic beauty (shown as blue). Individual trees (green points) and forest squares (black outline) are highlighted. Although not documented in this paper, a timestamp was also created for all fifteen videos to help make associations between the scenic beauty measure and landscape features shown in the videos. As expected, the scenic beauty of the nature-dominated areas (e.g., forest squares, tree lined streets and landscaping) were rated more highly when compared to artifact-dominated views (e.g., buildings and cars). The distinction between forest squares and the artifact-dominated views in between squares is especially clear. The five streets examined begin and end without a forest square; and therefore, begin and end with lower evaluations. All of the squares generally peaked at $M = 75$ on a 100-point scale, setting a high standard for road-side scenic beauty (Fig. 3). The lowest evaluations and greatest variation between squares were observed along Hull Street, wherein rating dropped below $M = 25$ during 10 distinct moments (mostly during the spring season). The temporal pattern of responses shown in the timelines (Fig. 3) for each of the three seasons is similar and suggest the measurement procedure is reliable (i.e., producing stable and consistent results over time).

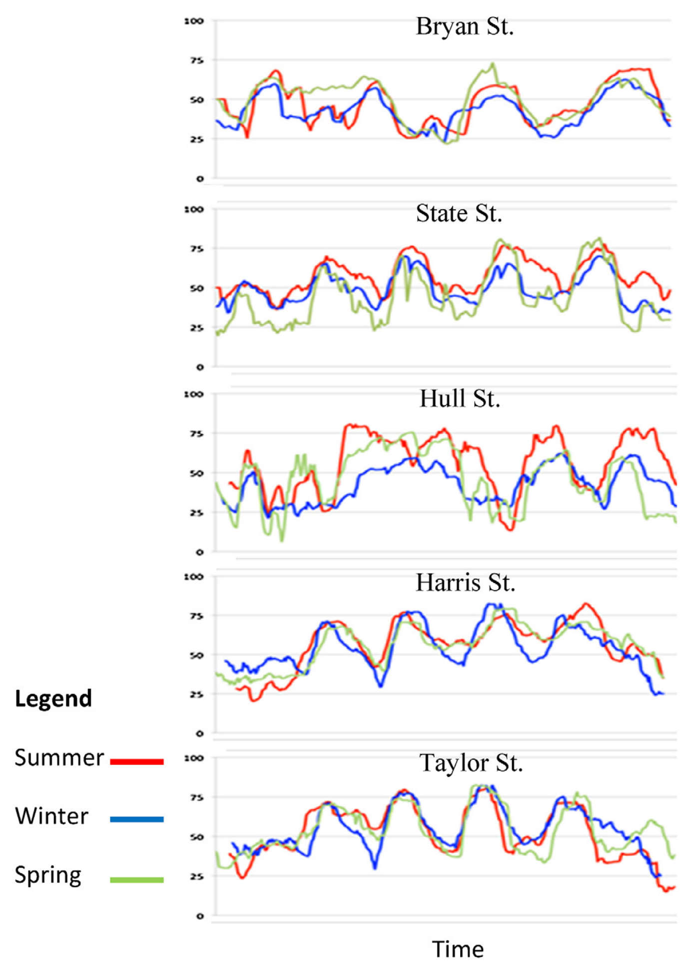

Fig. 3. Temporal context of scenic beauty evaluations, Savannah, GA.

4.3. Product of scenic beauty perceptions

The specific content of the urban forest was examined to better understand the product of scenic beauty perceptions. Scenic beauty preferences were compared among different tree species by season (Fig. 4). Tree species were rated highest in summer and spring (during the peak tree blooming season). Specifically, tree species such as eastern redbud, olive, palm, and cherry were rated more highly than other species. Magnolia also stood out as a more preferred tree in spring and summer.

Analysis of the preference data derived from the IDW preference continuum overlay indicated significant differences ($p < 0.001$) among scenic value across all main effects (i.e., season and tree characteristics) (Table 1). Trees present in squares had the strongest

Table 1
Results from ANOVAs: Tree characteristics by season.

Presence in Square Source	df	MS	F	p	Effect	Power
Presence in Square	1	66001	475.3	<0.001	0.122	>0.999
Season	2	23962	172.6	<0.001	0.091	>0.999
Presence in Square × Season	2	476	3.4	0.033	0.002	0.645
Within	3429					
Total	3435					
Tree Height Source	df	MS	F	p	Effect	Power
Tree Height	4	4108	26.9	<0.001	0.030	>0.999
Season	2	12074	79.0	<0.001	0.044	>0.999
Tree Height × Season	8	483	3.2	0.001	0.007	0.970
Within	3420					
Total	3435					
Tree DBH Source	df	MS	F	p	Effect	Power
Tree DBH	4	2090	13.4	<0.001	0.015	>0.999
Season	2	20425	131.1	<0.001	0.071	>0.999
Tree DBH × Season	8	249	1.6	0.119	0.004	0.718
Within	3420					
Total	3435					
Tree Growth Source	df	MS	F	p	Effect	Power
Tree Growth	2	6557	42.5	<0.001	0.024	>0.999
Season	2	13863	89.9	<0.001	0.050	>0.999
Tree Growth × Season	4	419	2.7	0.028	0.003	0.756
Within	3426					
Total	3435					
Tree Condition Source	df	MS	F	p	Effect	Power
Tree Condition	3	1023	6.5	<0.001	0.006	0.971
Season	2	2432	15.4	<0.001	0.009	0.999
Tree Condition × Season	6	45	0.3	0.943	0.001	0.131
Within	3423					
Total	3435					

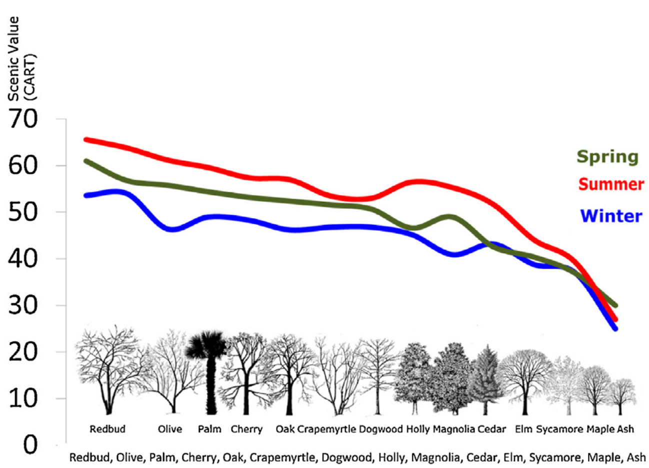

Fig. 4. Scenic beauty values by tree species and season.

effect size among all tree characteristics that were examined. Small effect sizes reported in Table 1 suggests that more variables would have been helpful in the analysis, but the lack of data to derive meaningful results from a large 6-way factorial design (all tree characteristics by season), as suggested by Ribe (2005), was a limitation in our study.

Focusing on specific tree characteristics regardless of location in or out of squares, moderately tall (21–30′) or very tall (41–50′) trees were generally considered the most favorable across seasons and their mean preference values were significantly higher ($p < 0.001$), than smaller trees (0–10' and 11–20') and tall trees (31–40') in 4 of the 6 post hoc tests examined (Table 2). Correspondingly, trees with larger DBH (37″ or more) tended to be the most favorable in spring and summer ($p = 0.001$) with trees with moderate DBH (13–24″) being the most favorable in the summer and winter ($p < 0.001$). Mature trees were the most preferred across all seasons ($p < 0.005$) while tree condition was only a significant consideration in the winter when trees were rated as 'good' ($p = 0.024$). Assessing seasonal effects, though not significantly different in terms of preference, mean scores for tree height, DBH, growth level, condition, and presence in square tended to be highest in summer, followed by spring, then winter.

4.4. Combining and comparing process and product-based measures

The linear equation that predicts tourists' willingness-to-pay for a trolley tour (dependent variable) as a function of independent variables including process-based CART data (i.e., average, maximum, minimum, total changes, positive changes, and negative changes of scenic beauty measures from the video) and product-based post video evaluations (i.e., overall scenic beauty and eventful measures from the questionnaire) was generated using multiple stepwise regression. Equations for each step are presented in Table 3. The equation for step 1 includes overall quality (CART) and explains 6.7 percent of the variation in the dependent variable. Sequential stepwise regressions added the following statistically significant variables: positive changes in scenic beauty measure per minute (step 2) and eventful measure (step 3). The step 3 equation is the best fit for the data ($R^2 = 0.143$; *adjusted* $R^2 = 0.121$;

Table 2
Post Hoc Tests: Tree characteristics by season.

	Spring 09		Summer 08		Winter 09	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Presence						
in square	**57.3**	**9.8**	**62.3**	**9.5**	**53.7**	**7.5**
not in square	48.8	14.7	53.7	13.9	42.8	9.1
Height						
01–10 Ft	51.2	14.7	54.1	14	46.3	11.2
11–20 Ft	48.1	12.4	54.2	12.9	44.4	9.4
21–30 Ft	**55.1**	**15.2**	**61.6**	**11.3**	46.7	9.3
31–40 Ft	47.1	14.0	53.7	17.1	43.5	11.8
41–50 Ft	53.4	12.7	**58.2**	**12.4**	**48.6**	**10.5**
DBH						
1”–6”	49.8	14.2	54.6	13.8	53.4	12.9
7”–12”	52.2	13.9	56.9	12.3	55.3	13.2
13”–24”	53.1	13.8	**59.5**	**12.5**	**57.8**	**14.2**
25”–36”	53.3	12.6	57.7	13.1	55.5	13.5
37” or more	**55.3**	**13.2**	**59.0**	**11.5**	56.3	13.8
Growth						
Mature	**53.6**	**13.3**	**58.5**	**12.5**	**47.2**	**10.1**
Removal	49.5	13.5	54.1	13.2	44.8	10.2
Small	48.3	14.5	53.4	13.9	45.3	10.8
Condition						
Good	51.9	13.9	56.9	13.1	**46.7**	**10.3**
Fair	46.9	16.4	55.1	18.2	41.1	12.0
Poor	47.4	12.6	49.3	12.2	42.8	9.3
Dead	49.6	13.5	54.1	13.3	44.8	10.3

Note: Bold cells indicate significantly higher preference ratings.

Table 3
Summary of stepwise regression analysis for variables predicting willingness-to-pay for trolley tour.

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Average scenic beauty (CART)	3.929	0.041	0.273**	0.132	0.040	0.284**	0.109	0.041	0.235**
Positive changes in scenic beauty/min (CART)				0.235	6.527	0.187*	0.232	6.431	0.185*
Eventful (post-video)							0.884	0.414	0.189*
R^2		0.075			0.110			0.143	
F for change in R^2		9.669**			4.670*			4.559*	
adjR^2		0.067			0.095			0.121	

* $p < 0.05$.
** $p < 0.01$.

RMSE = 5.959; p < 0.001), and using unstandardized coefficients, it is defined as

$$WTP = \$\text{-}2.327 + (\$0.109 \times a) + (\$0.232 \times b) + (\$0.884 \times c)$$

Where *WTP* is willingness-to-pay for a trolley ride, *a* is average scenic beauty (process-based measure), *b* is positive changes in scenic beauty per minute (process-based measure), and *c* is eventful measure (product-based post-video measure), with the units given in the method section of this paper.

Collinearity between variables of the final model was examined and no problems were identified (i.e., no values of the condition index were above 15). Tabachnick and Fidell (1996) state that a condition index over 15 could be a problem. Additional validation of the final model was conducted by repeating the model formation procedure using 100 bootstrap samples, which verified the initial selection of independent variables. The bootstrap validation of stepwise regression analysis is a method of random resampling with replacement from the original data set (Mick and Ratain, 1994), first introduced by Efron (1979). The results are presented in Table 4 using a procedure and format published by Mick and Ratain (1994). The bootstrap samples validated the same model as the stepwise regression on the full data set. The number of significant variables entered in the final models varied from 1 to 4. There was a clear cutoff frequency among the variables entered: those consistently selected (>50%) and those rarely selected (<30%).

Table 4
Results of stepwise regression analysis on 100 bootstrap samples; Frequency of entering model.

Variable entered	Frequency
Average scenic beauty (CART)	0.76
Positive changes in scenic beauty/min (CART)	0.50
Eventful (post-video)	0.51
Maximum scenic beauty (CART)	0.29
Minimum scenic beauty (CART)	0.07
Total changes in scenic beauty (CART)	0.13
Negative changes in scenic beauty/min (CART)	0.04
Overall scenic beauty (post-video)	0.05

Willingness-to-pay for a 90 min guided trolley ride is the dependent variable that was examined in the regression analysis, and is a much more focused analysis than previous WTP studies conducted in Savannah that focused on the entire trip experience (e.g., Majumdar et al., 2011). The results indicate that willingness-to-pay is expected to increase $0.109 when the average scenic beauty (measured on a 100-point scale every second during the video evaluation) increases by one, holding all other independent variables constant. That is, a 10 percent increase in average scenic beauty would result in an additional dollar visitors are willing to pay for a trolley tour. Similarly, willingness-to-pay is expected to increase $0.232 when the number of positive dial turns that are recorded per minute increases by one. This result suggests repetition, subtle visual contrast, and variety are important temporal aspects of scenic beauty. Over the course of a 90 min trolley tour, this process-based variable may have the greatest potential for increases in willingness-to-pay. Finally, willingness-to-pay is expected to increase $0.884 when the overall eventful variable (measured on a 7-point scale) increases by 1. That is, visitors would be willing to pay an additional dollar if a more eventful experience opportunity (16% improvement) was provided. These results indicate that both the quality and quantity (especially quantity) of scenic beauty is important to visitors.

5. Discussion

Using an ecological framework, this study examined the urban forests in Savannah as both an aesthetic tourism product and a process that results from the interaction between an observer and the physical features of the landscape. Our study adds support for the application of this theory and the more dynamic and holistic concept of scenic beauty, and it demonstrates a methodology that incorporates both a product and a process-based approach. Both sets of results, product and process-based, can be used to help provide city planners with a more complete picture of their urban forests.

Although we could not isolate preference values for individual trees shown in the videos, trends suggest that certain physical content contribute more to scenic beauty regardless of the background architecture that was coded in the timestamps. Scenic beauty has long been viewed as a product of the landscape and physical content of the environment (see Qin et al., 2008). From a product-based perspective, the content of an urban forest (tree groupings, height, diameter or DBH, age, and condition) that contribute to scenic beauty were examined and generally support what is reported in the literature. Our findings suggest that trees in squares are preferred by tourists over trees not in squares and provide additional support for canopy or groupings of trees in the landscape (e.g., Lamb and Purcell, 1990; Parsons and Daniel, 2002). Moderately tall (21–30′) or very tall (41–50′) trees were considered most favorable across all seasons and supports Kalmback and Kielbaso's (1978) study findings of street trees in five midwestern USA cities. Correspondingly, trees with larger DBH (37″ or more) were rated most favorable in spring and summer and relatively high in winter. Tree condition was a significant consideration in the winter when trees were rated as 'good'. It is possible that tree care may be most critical to visitors during the non-peak flowering season. Finally, one of the most consistent results of tree preference across seasons in our study is tree maturity.

Trends also suggest that eastern redbud could be a preferred tree species in our study. This moderately tall and native species is a deciduous and flowering tree primarily grown for the pink to rose-colored blooms in March and April (when moderately tall trees were rated highest in our study). Eastern redbud has a vase like and spreading form, a preferred shape that has been reported in the literature (Lohr and Pearson-Mims, 2006; Summit and Sommer, 1999). This tree is becoming more popular in the nursery trade in the southern USA, and could make additional contributions to scenic beauty in Savannah. Other trees such as cherry and magnolia, were also preferred during the peak bloom season (spring and summer). These results suggest that colorful green is more important than pure green and supports findings in the literature. For example, Andrada et al. (2015) also found that respondents preferred urban forests that are mainly green with many other colors. Qin et al., (2013) examined visitors' responses to the color, size, and scents of major plants in Shanghai Botanical Garden, finding that color is one of the most important factors affecting visitors' overall satisfaction with vegetation. More recently, Plot and Akay (2015), in examining the relationships between the visual quality of urban recreational areas and the structural and vegetation landscape elements of these areas, found that plant and color compositions and plant species diversity are the most important factors that define the visual quality of landscape areas.

This paper also helps answer the call for more process-based studies of scenic beauty and investigations that validate real-time methodologies. More specifically, Qin et al. (2008) saw the need for research that addresses issues surrounding temporal aspects in highway landscapes such as rate, frequency and rhythm of change. Although the equipment they used was custom-built, the developing technology such as the perception analyzer system, perception analyzer online, and slidemetrix that are now provided by companies such as Dialsmith, LLC makes the equipment more accessible to researchers for basic research and monitoring programs. We argue that CART expands the repertoire of methods for examining perception-related phenomenon and is synonymous with a process-based approach.

From a process-based perspective, the best areas for scenic beauty in our study were identified along forest squares and provide a benchmark (near $M = 75$ on a 100-point scenic beauty scale) for the historic downtown area. The lowest evaluations in our study occurred in between forest squares, wherein, scenic beauty ratings dropped below $M = 25$. The lowest ratings were also reported at the beginning and end of the five streets that were examined. This finding suggests that urban forests in the squares contribute the most to the scenic beauty of the city.

When comparing process and product-based measures, it was the process-based CART measures that more completely represented the quality and quantity-sides of scenic beauty and may prove more useful in future research. In our study, moment-to-moment or process-based measurements (i.e., average, maximum, minimum, total changes, positive changes, and negative changes of scenic beauty measures) were included along with product-based measurements (i.e., overall scenic beauty and eventful post-video measures) in a regression analysis to predict willingness-to-pay responses. Quality (average scenic beauty) and quantity (positive changes in scenic beauty per minute) related measures were both significant process-based variables in the final regression equation.

It should be noted, the only product-based variable that was significant was an overall measure of quantity of visitor experiences (i.e., eventful measure). Considering that the underlying goal of outdoor recreation management has traditionally been to provide high quality outdoor recreation opportunities (Manning, 2011), recreation managers have focused primarily on defining quality recreation opportunities; but what is missing from this goal and the evaluation of this goal is the quantity of events individual recreationists perceive during a visit (Pierskalla et al., 2013). The overall goal of providing quality scenic beauty opportunities might only be part of the recreation story in Savannah.

Why did average scenic beauty (process-based measure) outperform overall scenic beauty (product-based measure) in the regression equation examined in our study? Literature on Experience Sampling Method (e.g., Havitz and Mannell, 2005) suggest there may be reliance on introspection, limits of recall capabilities, and context variability during product-based assessments that can lead to different results when compared to real-time assessments. Replication of this study with other populations is needed to extend the generalizability of the results and to better understand the complex relationships that might also exist between the two measures of productivity (e.g., quality × quantity).

Other process-based measures (e.g., maximum and minimum scenic beauty) were not significant predictors of tourists' willingness-to-pay responses in our study. Those measures may be more meaningful in landscapes that have a greater range of scenic beauty preferences. There are many other variables that may also play a role in user's willingness-to-pay for a trolley tour, but were not included in this study. For example, other temporal aspects of scenic beauty needs to be examined in future research, and perhaps we could borrow concepts from the art of music such as repetition, sequence, accents, pitch, and tempo. With a more dynamic understanding of scenic beauty as both a product and process that results from the interaction between an observer and the physical features of the landscape, future research can help tourism providers become more accountable for efficient use of resources and program effectiveness.

6. Conclusion

There are two competing methodologies (i.e., product and process-based) that have been used to examine recreation opportunities, but few studies have combined and compared the methods as it relates to scenic beauty evaluations. By adopting a similar definition of scenic beauty as both a product of the landscape and process of persons experiencing that landscape, we were able to further confirm previously published research, but also work towards new theoretical, methodological, and managerial insights and a more complete evaluation of the perception of Savannah's urban forest.

Theoretically, our results support a new application of the ecological approach as a way to understand the dynamic relationship between humans and the environment as it unfolds over space and time. That is, ecological perception theory provides additional concepts (e.g., events) when defining scenic beauty.

Methodologically, by integrating time into the analysis, CART expands the repertoire of methods that measure events as algorithms (e.g., overall average and frequency of positive changes in evaluations), and thus contributes to a more complete understanding of willingness-to-pay for an urban forest experience. Even small improvements in scenic repetition, subtle visual contrast, and variety can make important contributions to the local economy. Surprisingly, it is the quantity of perceptual events that may be the more important predictor of scenic beauty evaluations perhaps due to the importance of variety in outdoor recreation.

Finally and managerially, this study has several important practical implications. First, The city's Park and Tree Department can design, plant and manage urban forests based on these findings so as to maximize the scenic beauty of the city. In addition, planners may want to consider using those desired tree characteristics in promotional brochures Second, given areas between forest squares are less aesthetic, improvements to scenic beauty projects could be prioritized for these areas, especially during the spring season when evaluations dropped more frequently. Moreover, additional plantings such as eastern redbud can make a positive contribution to scenic beauty, especially in the spring. Future monitoring of scenic beauty might consider using $M = 25$ as a minimum acceptable scenic beauty rating. The addition of vegetative street entry and exist gateways could enhance first and lasting visitor impressions of the area, and perhaps give each street a unique theme or package of perceptual events. Third, providing tourists with more things to see and do during a trolley tour of the city can enhance the quantity of their experience, too. For example, strategically planting winter-blooming trees or trees in fruit can create ideal guided tour routes and destinations in winter, add quality to the visitor experience, and extend the shoulder season. Packaging together guided trolley tours (e.g., driving by forest squares) that highlight the visual qualities of the urban forest with walking tours (e.g., walking in a winter-blooming grove) that highlight a variety of fragrance can give visitors a more eventful experience. Adding trees that have colorful stems and bark can also add quality to a winter experience. High quality colorful green experienced in eventful ways (e.g., driving around squares, walking through squares, smelling fragrance on a blooming tree, and picnicking under a shade tree) is very important. Finally, willingness to pay associated with perceptions of scenic beauty in the city can justify the budget for urban forests, which is a significant implication for sound and appropriate planning, development, management, and maintenance of urban forests in the city, given its non-market value nature of scenic beauty and increasing competiveness of budgeting among city services.

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