Residential Occupant Characteristics and Tree Mortality

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ABSTRACT

Urban forests are integral components in maintaining urban ecosystem health and provide many ecosystem services. This study investigates the survival of urban trees in Sacramento, CA planted by the Sacramento Tree Foundation's Shade Tree Program (STP). STP distributes approximately 10,000 trees annually to properties in Sacramento County to shade buildings and reduce summer cooling needs. However, the program faces challenges with tree survival. In this study, I investigated the connection between home occupant characteristics and urban tree mortality within STP. I collected data from the Multiple Listing Service (MLS) relator's database and Sacramento County Assessor's Office to track home foreclosure, new home ownership and owner occupancy. I analyzed 429 properties within Sacramento that received trees from STP in 2007. Renter occupancy was the only variable that had a significant effect on tree planting ($p=.007$) and tree survival ($p<0.001$). Trees on properties that experienced foreclosure and new home ownership had a higher rate of tree mortality, but this difference was not statistically significant. The results from this study will aid in tailoring outreach and tree care protocol from the Sacramento Tree Foundation. This study highlights the need for more research on the connection between occupant characteristics and urban ecology.

KEYWORDS

foreclosure, renter, Multiple Listing Service, urban ecology, urban forestry, tree mortality

INTRODUCTION

Urban trees are an integral component of urban environments and provide a diverse set of benefits to city ecosystems. Urban trees reduce air pollution, increase property and rental values, decrease urban heat island effects, and decrease the demand for residential air conditioning in the summer (Donovan and Butry 2011; Simpson and McPherson 1998). Based on economic models of tree costs and benefits, the ecosystem services from urban forests range between $38 to $56 per tree annually (McPherson et al. 2011). Demand for urban trees is correlated with income and there is a growing demand for trees in cities (Zhu and Zang 2008). Given the many benefits and increasing demand for urban trees, cities across the country have implemented large-scale urban forest initiatives.

Urban forestry programs throughout the United States are actively planting trees, yet low long-term survival predictions for these trees may hinder program effectiveness (Morani et al. 2011). Previous estimates from an urban forestry program in Sacramento, CA revealed that in the first three years of the program 23% of planted trees were either dead or missing, and 30 year survival predictions ranged from 58-60% (Hildebrandt and Sarkovitch 1998). Long-term tree survival is important in program planning. To compensate extra trees may need to be planted initially to compensate for tree mortality in the first years after planting (Nowak et al. 2004). Furthermore, cost-benefit analysis models for urban forestry programs are sensitive to assumed mortality rates (Hildebrandt and Sarkovitch 1998; Morani et al. 2011). While urban forest initiatives face considerable difficulties with tree mortality the underlying factors influencing tree mortality have yet to be studied.

Although biophysical characteristics of the planting site influence tree survival on residential properties, occupant characteristics and tree neglect could be an integral component in tree survival rates. Trees delivered through urban forestry programs are young saplings that need special care and attention immediately after being transplanted (SMUD 2009). In addition, tree care in the first four years after planting has long-term survival implications (Miller and Miller 1991). One cause of tree neglect could be home vacancy. The 2007 economic downturn had a substantial impact on foreclosure rates and home vacancy (Whitaker 2012). According to the Federal Reserve Bank of New York, about 1.85 million Americans received notices of foreclosure in 2010 compared to approximately 700,000 in 2000 (Federal Reserve Bank of New York, 2011). When homes are foreclosed they may be vacant for a period of time ranging from

months to years (DeMuth 2012). During this time the care of the yard and trees is the responsibility of the proprietor, which is usually a bank or other lending agency (D. Covill, personal communication). When a home is foreclosed its value decreases significantly and if neglected, the property and yard will fall into disrepair (Immergluck and Smith 2006). In addition to negligence from foreclosure and vacancy, tenants not invested in the long-term value of the property could neglect trees planted on renter occupied properties. Rental properties with trees have higher rental rates; however, the association between renter occupancy and tree mortality remains unknown (Donovon and Burty 2011). This study explores the connection between occupant characteristics and tree death using longitudinal tree survival from the Shade Tree Program in Sacramento, CA.

METHODS

Study System

The Sacramento Tree Foundation's Shade Tree Program (STP) distributes trees to properties throughout Sacramento County to reduce summer cooling needs by planting trees that shade buildings (Simpson and McPherson 1998). The program is funded by the Sacramento Municipal Utility District (SMUD). Most trees are distributed to residential properties, and those receiving trees are responsible for tree planting and maintenance. Residents are visited by STP staff and receive a 15-45 minute consultation and a folder of educational material. However, previous program studies indicate that much of the educational material is not used (Aames 2010). STP is the nation's largest shade tree program and distributes over 10,000 trees a year across Sacramento County (Hildebrandt and Sarkovitch 1998). Trees delivered through the STP are small saplings that require attention and are sensitive to neglect from property occupants.

STP is an ideal system to study the effect of occupant characteristics urban tree survival because the Sacramento Tree Foundation keeps detailed records on all trees distributed through the program. In addition, Sacramento County has been severely affected by the housing downturn, with 1 in 113 homes foreclosed in 2010, resulting in many vacant properties (Riede 2010). My research is based upon trees distributed in 2007 on 429 private residential yards throughout Sacramento County.

Data Collection Methods

I obtained tree mortality data from an existing dataset of 500 shade trees distributed in 2007. These trees were tracked annually beginning in 2008 and assessed based on growth and condition. These 500 trees represent a simple random sample of the 13,594 trees that were distributed in 2007 by the STP in Sacramento County. However for my research I only analyzed 429 trees. I tracked trees planted exclusively on residential properties and excluded trees that were distributed to apartment complexes and schools. These properties were not included because yard maintenance on these properties is not the responsibility of the resident. I also excluded mobile homes from the analysis because the process of foreclosure on a mobile home is drastically different than a single-family residential home (D. Covill, personal communication).

Table 1. Trees excluded from analysis. 71 trees had to be excluded from the analysis because the property that they were distributed to was determined ineligible for foreclosure or residents were not responsible for tree care.

Number of Trees	Reason for Exclusion
14	Planted at mobile home
11	Opt-out
8	Database problems
5	Could not find in MLS
3	Planted at school
3	Planted at condominium
3	Planted at apartment complex
2	Planted at business
1	Planted on residential acreage
21	Other

During field monitoring, trees were classified as alive, standing dead (absence of green leaves and live buds), removed after planting, or never planted (L. Roman, personal communication). Trees that were never planted were either observed in container during field visits or missing. Additional conversations with residents were used to determine whether missing trees were removed after planting or never planted. I had two outcomes of interest: planted vs. not planted (trees remained in distribution container) and survived vs. not survived. If trees were not planted they were not declared dead until they died in the container. I defined survivorship during the study period as the number of trees alive each year divided by the number of trees planted in 2007.

To understand how property factors relate to tree mortality, I used the Multiple Listing Service (MLS) to gather information on the ownership and history for the properties in my dataset. The MLS is a proprietary realtor database that aggregates information from public city records and current market sales activity into one report (Covill, personal communication). Although all information in the MLS is available to the public and could be collected from various city offices, I chose to use the MLS to access all the information in one report. I gathered data on changes in home ownership, foreclosure and renter vs. owner occupancy based on the MLS report for each home in my sample. In addition to the MLS, I collected supplementary data on 44 properties from the Sacramento County Assessor's office. The data from the County Assessor's office was used to clarify renter vs. owner occupancy for homes where this distinction was ambiguous on the MLS report.

Interpreting Multiple Listing Service and County Assessor's Reports

To detect changes in home ownership, instances of foreclosure, and determine renter vs. owner occupancy, I had to make inferences based on select data from the MLS. To detect home foreclosure, I developed a series of parameters based on the "market sale and history" section of the report. If the buyer of a home was a bank, I labeled the transaction a foreclosure and recorded the date (denoted as "Sale Recording Date" in the MLS) and the name of the bank or lending agency. If the "Document Type" for the home sale was a "Trustee's Deed" I also considered that transaction a foreclosure.

I developed a similar set of parameters to determine if a home was renter or owner occupied. This process was not as definitive as the foreclosure classification and was based on three metrics. First, I looked at the "Owner Information" portion of each MLS report and recorded the field labeled "Owner Occupied" which was displayed "yes" or "no". Second, I looked at the tax exemptions filed on the "Tax" portion of each MLS report and recorded if the property owner had filed for a "Homeowner Tax Exemption", which was displayed "yes" or it did not appear. Finally, I looked at the mailing address for the tax records of the property. If the tax address matched the physical address of the property I recorded the home as owner occupied. If these fields contradicted each other I placed the most emphasis on the tax address for the property matching the physical address for the property.

Table 2. The process for classifying homes as renter vs. owner occupied. Homes were determined renter or owner occupied by combining several fields of MLS data. The process of evaluating that data is summarized in the following table.

"Owner Occupied"[1]	**"Homeowner Tax Exemption"[2]**	**Tax address matches physical address[3]**	**Final verdict on occupancy status**
Yes	Yes	Yes	Owner occupied
Yes	Null	Yes	Owner occupied
Yes	Null	No	Renter occupied
Yes	Yes	No	Renter occupied
No	Null	No	Renter occupied

1. Owner Occupied: official documentation on the state level whether the residence is renter or owner occupied. This field appears as "Owner Occupied" (y/n) in "Ownership Information" portion of MLS.
2. Homeowner Tax Exemption: whether the individual has filed for a homeowner tax exemption since owning the home. This field appears in the "Tax Information" portion of the MLS
3. Address from the "Ownership Information" portion of the report, and physical address from Sacramento Tree Foundation (STF) records.

The MLS report only displays the current "Owner Occupied" status, "Homeowner Tax Exemption", and tax address fields for the current owner of the property. Therefore, if a home changed hands over the course of the study period it was impossible to determine the owner vs. renter occupied data for past owners based on the MLS report. This was the case for 44 properties in my study sample. I determined the owner vs. renter occupied status for these homes based on a report from the County Assessor displaying the tax address for each owner from 2007-2011. If the tax address matched the physical address of the property I recorded the home as owner occupied. If the tax address was a P.O. Box in Sacramento I considered the property owner occupied.

To determine instances of new homeownership I reviewed the "Ownership Information" portion of the MLS report. This section of the report gives the name, deed type, and sale date for each transaction for the property since the home was constructed. In my dataset I recorded the sale data for each ownership change within the study period.

Data Analysis

I used chi-squared tests of association to analyze my data. I compared tree planting status (planted vs. not planed) in 2008 with property foreclosure, new home ownership and renter vs. owner occupancy. I compared tree survival (2008-2011) with property foreclosure, new home ownership, and renter vs. owner occupancy. I chose to analyze these factors over the course of

the entire study because tree mortality is a cumulative process (Franklin et al. 1987). Stress from neglect by one occupant could affect long-term tree survival. I used chi-squared test of association to test understand the significance of each variable on tree mortality. I interpreted my data in the statistical program R.

RESULTS

I analyzed a total of 429 trees distributed throughout Sacramento County in 2007. During the 2007-2011 study period, there were 51 instances of foreclosure (some homes were foreclosed upon more than once). The highest rate of foreclosure was in the 2007 calendar year, in which 19 properties were foreclosed. Between 2007 and 2011 86 homes in the study were rental properties and 314 homes were exclusively owner occupied. 115 homes changed ownership over the course of the study. In terms of tree outcomes, 66 trees were never planted. Of the trees that were planted, 147 trees were observed standing dead and 129 were observed removed. Tree mortality was highest in 2008. Tree death continued throughout the course of the study with 71% cumulative survivorship in 2011 (Figure 1).

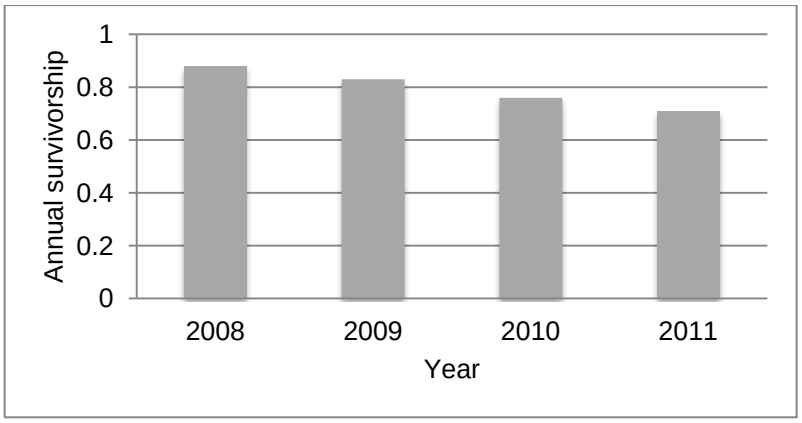

Figure 1. Tree survivorship. Cumulative survivorship for shade trees distributed in 2007. Survivorship is defined as the number of trees alive in a given year divided by the total number planted (363 trees).

Trees Planted and Property Characteristics

Trees in this study were distributed throughout 2007. During the first field visit in the summer of 2008, 66 were not planted. Properties that were renter occupied from 2007-2008 had a statistically significant higher rate of not being planted ($p=0.007$). Foreclosure and new

ownership in 2007-2008 did not have a significant effect of tree planting (p=0.177 and p=1.00, respectively).

Table 3. Tree planting in 2008. 66 trees were not planted following distribution in 2007. There were a significantly greater number of unplanted trees on renter occupied properties (p=0.007).

	Not Planted	Planted
Renter vs. Owner 2007-2008		
Renter Occupied	19	55
Owner Occupied	47	308
Foreclosure 2007-2008		
Foreclosed	5	14
Not Foreclosed	61	349
New Owner 2007-2008		
New Owner	10	55
Same Owner	56	308

Post-Planting Tree Mortality and Property Characteristics

There was a higher rate of tree mortality in homes that were foreclosed in the study period, but this difference was not statistically significant (p=0.632). There was a higher rate of tree mortality in homes that had a new owner in the study period, but this difference was not statistically significant (p=0.551). There was a higher rate of tree mortality in homes that were renter occupied at some point in the study period and this difference was statistically significant (p<0.001).

Table 4. Tree survival after planting. Tree survival compared to property characteristics throughout the entire study period. There were a significantly greater number of dead trees on renter occupied properties (p<0.001).

	Died	Survived
Renter vs. Owner 2007-2011		
Renter Occupied	47	39
Owner Occupied	100	243
Foreclosure 2007-2011		
Foreclosed	19	32
Not Foreclosed	128	250
New Owner 2007-2011		
New Owner	42	73
Same Owner	105	209

DISCUSSION

Urban forestry programs aim to increase urban forest cover and provide ecosystem services, yet are met with striking levels of tree mortality (Lu et al. 2010; Roman and Scatena 2011). The causes of urban forest mortality are nuanced and can be challenging to quantify (Hildebrandt and Sarkovich 1998). The goal of this study was to understand the effect of residential occupant characteristics on tree survival, given the context of the recent economic recession. My study investigated the association between home foreclosure, changing ownership, and rental properties on tree mortality in Sacramento County. However, the findings indicate that only rental status had a significant effect on tree planting and tree survival. Homes that were foreclosed upon or had a new resident had higher rates of tree mortality, but the difference in mortality was not statistically significant.

Unplanted Trees

Many trees were not planted after the Sacramento Tree Foundation (STF) distributed them in 2007. The distribution of unplanted trees was significantly higher on rental properties. This finding suggests additional attention from the STF immediately following tree distribution, especially on renter occupied properties, would increase tree survival. This suggestion is echoed by the conclusions of a focus group conducted through the STF assessing resident impressions of the STP. Participants suggested a check-in call after tree delivery as the most helpful way to assure trees were planted in the first months of tree care (Robinson 2011). This focus group did not differentiate if respondents were renters or owners. This would be a useful subject for future research.

Post-planting tree mortality

Homes that had been foreclosed anytime within the 4-year study period had a higher rate of tree death. However, the difference in mortality between foreclosed properties and non-foreclosed properties was not statistically significant. When a home is foreclosed the bank or agency that owns the property is in charge of yard maintenance and upkeep (D. Covill, personal

communication). Additionally, 25% of counties across the country have adopted vacant property registration and maintenance ordinances to regulate the upkeep of vacant homes (DeMuth 2012). The lack of significance in the association between home foreclosure and tree death should be studied in greater detail beyond the scope of my research.

Homes that changed hands at any point throughout my 4-year study had a higher rate of tree mortality. Yet similar to home foreclosure, this difference was not statistically significant. Given the perpetuating volatility in the housing market home sales and new home ownership turnover will persist (Case and Quigley 2008). The scope of this study could underestimate the effect of new homeownership on urban ecology. There is little existing scientific literature discussing the association between residential home sales and yard health, but the results of this study highlight the stress put on urban ecosystems by home movement. Additionally, new owners of properties may have been unaware their trees came from STP. They would not have received the educational materials from STF and may not have the same investment in tree care. While the results of this study did not indicate a significant relationship between new homeownership and tree survival, the conditions in the housing market could necessitate further research into urban ecosystems and home sales.

Rental properties had significantly higher rates of mortality. This result could be associated with renters neglecting tree maintenance. This assessment is echoed in analysis of other urban forestry programs that report homeowners are more likely to order a tree for their property (Perkins et al. 2004). Rental properties with at least one tree are valued higher than properties with no trees (Donovan and Butry 2011). Furthermore, the recent economic downturn has not affected the price of rentals to the same extent it has affected the value of homes (Nemeroff 2012). Financially, it is in the best interest of the landlord to keep his/her trees alive (Donovon and Butry 2011; Treiman and Gartner 2006). The combination of a flourishing rental market, financial benefits of trees, and high rates of tree death on rentals necessitate additional research into the cause of tree death on rental properties. Anecdotal field data from this study indicates that a breakdown in landlord tenant communication is one of the factors that contribute to tree death (L. Roman, personal communication). Investigating this breakdown in communication is the next step in understanding the impact of rental properties on tree survival.

Limitations

This research is a case study on tree survival within the STP. The characteristics of my study system may pose some limitations on the implications of my findings. The financial crisis had a significant effect on the Sacramento housing market and the area led the nation in home foreclosure between 2007 and 2011 (Shaw 2011). This high foreclosure rate in Sacramento could limit the significance of my findings on foreclosure and tree death. Even with the limited scope of the case study, lessons learned from this research should be taken into consideration in other residential urban forestry programs.

My study design may have underestimated the effect of home foreclosure on tree mortality for one important reason: I did not include homes that were sold as a short sale. Short sales, a popular alternative to foreclosure, give homeowners the opportunity to sell their home at a discounted price rather than default on their mortgage (Clauretie and Daneshvary 2009). Given the recent magnitude of the financial crisis there has been a dramatic increase of homes sold as short sales (Collins 2012). I did not account for these homes in my analysis because this information was not available for all homes in the MLS. Short sales are a specialized type of real estate transaction and are not officially documented by the county or any other agency (D. Covill, personal communication). However, as short sales are an alternative to foreclosure they could have an impact similar to home foreclosure on tree survival.

In addition to home vacancy there could be other factors contributing the tree neglect on foreclosed properties. Studies on residents whose homes have been foreclosed reveal that the process of foreclosure has vast health and wellness implications (Libman et al. 2012). Residents in foreclosed homes have significantly higher rates of depression and are at a greater risk of being uninsured compared to the general population (Pollack and Lynch 2009). Therefore, financial hardship and the threat of foreclosure could impact tree care even before an individual has defaulted on their mortgage. Thus, occupant characteristics that extend beyond home ownership and foreclosure status could be associated with tree survival.

Future Directions

This research contributes to broader knowledge about environmental impacts of the 2007 financial crisis. The long-term effects of increased foreclosure rates, short sales, bank owned properties, and home sales are all important areas for future research in urban ecology. Occupant characteristics associated with tree survival will be important to identify as urban forestry programs expand. Findings from this study and similar studies will be used to better design urban ecology programs to thrive in ever changing urban areas.

The results of this study indicate that renters are less effective in proper yard maintenance as compared to property owners. It would be beneficial to understand the specific barriers that impede renters from properly caring for their trees. Interviews and surveys with renters addressing the health and maintenance of their yard would aid in understanding renter occupant characteristics that are associated with tree mortality. The results of this research could improve outreach on proper yard care to homes at risk for tree mortality.

Broader Implications

This study looks at human impacts on urban ecology, specifically residential characteristics and tree health. My research has implications for urban forest management in my study system and other urban ecology initiatives across the US. The findings of this research will be used to improve tree survival in the STP, but lessons learned in this research can be applied beyond forestry. STF will use the findings of my study to craft more effective outreach to the populations most at risk for tree mortality. My strongest recommendation to STF is to track owner vs. renter occupied properties when delivering trees and to continue with long-term monitoring of these trees. In addition, I would suggest that the STF reach out rental properties after trees are distributed to follow-up with additional support on tree maintenance and care. Beyond practical applications in Sacramento, my results could be used to improve long-term tree planting success, taking into account the impact of home characteristics on tree mortality. STP is a high-volume program, and lessons learned within STP are particularly relevant for Million Tree Programs in other cities throughout the US including: New York City, Los Angeles, Phillidelphia, and Denver. Moreover, any urban forestry organization could use the methods and

MLS protocol developed in this research to analyze their own study populations and identify property characteristics associated with mortality. Understanding the role of private residents and homeowners in urban forestry programs is crucial to improving program success and tree survival.

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