5-2017

Seeing Community Through the Trees: Characterizing Resident Response to Urban-Tree Planting Initiatives

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May 2017

A THESIS

Submitted to the faculty of Clark University, Worcester,
Massachusetts, in partial fulfillment of the requirements for
the degree of Master of Arts in the department of International Development,
Community, and Environment

And accepted on the recommendation of

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ABSTRACT

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Urban tree planting initiatives have become common across cities in the United States. In order to advocate for sustainable urban forests, managers of urban planting initiatives must adopt a strong community framework, which includes community values in reforestation efforts. Clark University researchers conducted interviews and surveys with residents in six central Massachusetts cities and towns to assess why residents value urban trees and to characterize public response to reforestation efforts. Results indicate residents had positive experiences with tree planting programs, are most likely to value urban trees for aesthetic reasons, and commonly associate change in neighborhood character with Asian Longhorned Beetle related tree cutting. These findings can be used to inform future policy decisions and to increase participation in tree planting programs by appealing to characteristics residents value in urban trees.

Key Words: Worcester, Asian Longhorned Beetle, tree values, tree planting program, sustainable urban forest

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ACADEMIC HISTORY

Name: Eli Goldman Date: May 2017

Baccalaureate Degree: Global Environmental Studies

Source: Clark University Date: May 2016

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Introduction

Urban forestry efforts are often associated with planting and managing trees to maximize social, economic, and ecological benefits. (Dilley and Wolf 2013; Silvera Seamans 2013). To date, many Unites States' cities have sought to increase urban canopy cover to maximize environmental and social benefits. Examples include tree-planting initiatives in Los Angeles, Miami, Denver, and New York City (City and County of Denver, 2006, City of Los Angeles, 2006, Miami-Dade County, 2011, PlaNYC, 2013). While specific reasons for implementing tree-planting initiatives vary by program, tree-planting initiatives have become a method used by planners to increase green infrastructure and meet broad sustainability goals (Dwyer et al. 2000; Dilley and Wolf 2013; Silvera Seamans 2013; Roman, Battles, and McBride 2014). Ecological benefits related to increasing tree canopy include: moderating urban climate by shading buildings, lowering temperatures via evapotranspirational cooling, and forming barriers to block sound and wind (Mcpherson et al., 1988, Akbari et al., 1992, McPherson et al., 1993); intercepting storm water runoff and slowing water flows (Xiao et al., 1998, Nowak et al., 2007); and sequestering gaseous pollutants and carbon (McPherson et al., 1994, Nowak et al., 2002, McPherson et al., 2003). Urban tree canopy has also been shown to be

associated with a number of human-health benefits. These include reduced rates of cardiovascular disease and crime (G. H. Donovan and Prestemon 2012; Geoffrey H. Donovan et al. 2013). Based on national urban forest tree cover data, total compensatory value of the urban canopy in the United States is estimated at $2.4 trillion (David J. Nowak, Crane, and Dwyer 2002).

There are an estimated 3.8 billion trees planted on urban land in the United States, and urban land use in the contiguous states is expected to triple in size over the next several decades, reaching 8.1% by 2050 (Dwyer, Nowak, and Noble 2003; D J Nowak and Walton 2005). Massachusetts, the focus of this particular study, is estimated to reach sixty-one percent urban by 2050, nearly doubling in size since 1990 (D J Nowak and Walton 2005). As areas become more urban, a variety of anthropogenic factors (i.e. increased population density, degraded air and water quality, and increased temperatures) can be expected to have increased negative impacts on human health and well-being (Jackson 2003; Haines et al. 2006). As a result, sustaining urban canopy cover and providing ecosystem services will become increasingly important to maintaining human and environmental health (Dwyer, Nowak, and Noble 2003; Kuo 2003; D J Nowak and Walton 2005; Geoffrey H. Donovan et al. 2013; Pincetl et al. 2013; Roman, Battles, and McBride 2014). However, how residents respond

to variations in ecosystems services is poorly understood (Grove 2009; Mincey et al. 2013). This study hopes to bridge this research gap by assessing reasons why central Massachusetts residents value urban forests by examining periods of tree canopy loss and gain. In doing so, results from this study may inform reasons why residents value urban trees and associated ecosystem services.

In order to provide the benefits listed above, urban forests must be managed sustainably (Clark and Matheny 1998; Dwyer, Nowak, and Noble 2003). Increased total leaf area and tree biomass are positively associated with the amount of ecosystem services tree cover provides (McPherson 2014; Ko et al. 2015a; Ko et al. 2015b). Thus, there are two major ways land managers can increase ecosystem services provided by tree canopy. The first method is to increase the number of trees planted in a given area. For example, Seattle, Washington has set a goal to reach 30% canopy cover by 2037 (Dilley and Wolf 2013). Other cities, such as Los Angeles, California, have committed to planting an additional one million trees (Pincetl et al. 2013). The second method is to ensure that existing canopy grows to reach mature heights, thereby providing commensurately increased benefits (Roman et al. 2013; Koeser et al. 2014; Roman, Battles, and McBride 2014). Regardless of specific organizational strategies, those writing urban forest policies must advocate for urban forest sustainability to meet long-term

goals (Clark and Matheny 1998; Dwyer, Nowak, and Noble 2003; Mincey et al. 2013). This study uses interview and survey data collected between 2014 and 2015 to analyze public reaction to urban tree planting initiatives in central Massachusetts (see Figure 1) following large-scale tree cutting due to an Asian Longhorned Beetle outbreak (ALB, *Anoplophora glabripennis*) (Dodds and Orwig 2011; Hostetler et al. 2013). As a result, this study examines public response to efforts made to increase the urban canopy by planting trees, as well as management efforts taken to increase tree survivorship.

What is a sustainable urban forest?

Urban forests can be categorized as sustainable if canopy provides ecosystem services at a range of geographic and temporal scales (Dwyer, Nowak, and Noble 2003; Mincey et al. 2013). Forests of all types can be expected to undergo changes in system dynamics over time (Franklin et al. 2016). However, a variety of anthropogenic forcings speed up natural biological processes that impact stand structure and complexity. Alterations to land use and increased urbanization can result in changes in ground cover, viable space for tree recruitment and growth, and available resources (Dwyer, Nowak, and Noble 2003). Increased global trade has had significant impact on forest dynamics as well by introducing nonnative

pests. Over the past 150 years, nonnative insects have entered the United States at a rate of 2.5 species per year, causing billions of dollars in damage. The majority of these costs, over $2 billion, are borne by local municipalities (Lovett et al. 2016). In order to build sustainable urban forests, land managers must acknowledge and incorporate these factors into their plans. Consequently, researchers point to several key characteristics that are critical to achieving urban forest sustainability.

Building sustainable urban forests

Existing literature presents a framework that can be used to help urban forests managers and policy writers successfully adapt to changes in forest dynamics. This framework relies on implementing action based on five factors: understanding the surrounding social context, defining management goals and objectives, stating means to achieve goals, analyzing management outcomes, and assessing information collection and delivery (Dwyer et al. 2000). By considering the broader social context, community members and relevant organizations are able to express concerns, attitudes and values related to the urban forest. Setting discrete management goals and objectives allows urban forest managers to target specific benefits and forest functions. However, urban forests should be managed to preserve and enhance a variety of ecosystem functions as

opposed to focusing on a single function. Focusing on improving a single ecosystem function can have negative impacts on surrounding functions and decrease system resilience (Neville 2000; Bahadur, Ibrahim, and Tanner 2010; Ahern 2011; Catanzaro, Anthony, and Huff 2016). Thus, comprehensive and adaptive management strategies are important components of achieving urban forest sustainability (Dwyer, Nowak, and Noble 2003).

Effective strategies to achieve urban forest sustainability will include methods to review and evaluate program outcomes by monitoring overall impact, identifying areas in need of improvement, and altering strategies to better meet stated goals (Dwyer, Nowak, and Noble 2003). Collection and delivery of information is another critical component to achieving urban forest sustainability. It is critical that tree planting programs routinely collect relevant data through efforts such as tree inventories and canopy assessments. Doing so will better inform future decisions related to planting and management efforts (Dwyer, Nowak, and Noble 2003; Roman and Scatena 2011; Roman et al. 2013). Other critical elements which can enforce urban forest sustainability include community involvement through various stewardship efforts (Lu et al. 2010; Jack-Scott et al. 2013)

In a 1997 publication, Clark et al. establish a framework for urban forest sustainability. They define three primary components of a sustainable

urban forest: available vegetation resource, strong community framework, and appropriate management steps. Maximizing vegetation resources involves taking action to increase canopy cover, establishing a mix of young and old trees, ensuring diversity in the tree species that are planted, and preserving and managing regional biodiversity (Clark et al. 1997). Effective resource management will result in necessary staffing, funding, and programming to meet urban tree planting goals (Clark et al. 1997). While vegetation resource and resource management are informative areas of study, the emphasis Clark et al. place on community framework is of particular interest to this study.

Community framework for sustainable urban forests

A sustainable urban forest relies heavily on the shared vision and objectives held by community members. Engaging in this process involves cooperation aimed at increasing tree health and consensus building to establish goals that will best serve residents to maximize tree benefits. In order to achieve a community framework which advocates for sustainable forests, public agencies across a particular urban setting must act together to achieve related goals and objectives. Similarly, private land owners must embrace comprehensive urban-forest management goals. Thus, effective communication between organizations and residents is an important factor. Participation is increasingly important at the neighborhood level,

where residents are most likely to take action to increase quality of life (Clark et al. 1997). Because the average U.S. city is forty percent residential land, tree planting initiatives must engage private landowners and plant trees on residential properties in order to meet goals to increase urban tree canopy (Dilley and Wolf 2013; Locke and Grove 2016).

Increasing public knowledge and presenting trees as a significant community resource can lead to increased community participation. Communicating information effectively has the potential to create a positive feedback loop in which those who value urban trees elect officials with similar values who then support non-government groups that advocate for increased urban tree canopy (Clark et al. 1997). In turn, these elected officials and groups may further increase communication efforts and implement practices that increase urban forest sustainability (Clark et al. 1997; Romolini, Brinkley, and Wolf 2012). If urban forest managers are not able to communicate with residents effectively, their ability to provide the maximum possible community benefits decreases (Dwyer et al. 2000). Effective communication ensures that decision makers are able to engage citizen input that represents the values, attitudes, and concerns that residents have for the urban forest. Increased community engagement and participation related to urban forest management can have broader environmental implications as well. By participating in conversations related

to tree benefits, residents are exposed to other natural resource concepts, issues, and possible solutions to various environmental problems (Dwyer et al. 2000). Thus, it is hypothesized that engaging residents in conversations related to the urban forest has the potential to increase general environmental awareness related to a variety of issues.

Resident appreciation of urban forests

It is estimated that urban forests provide $400 billion annually in ecosystem services across US cities. As outlined above, these benefits serve to moderate urban climate, intercept storm water flows, and sequester a variety of gaseous pollutants (Mcpherson et al., 1988, Akbari et al., 1992, McPherson et al., 1993, Xiao et al., 1998, Nowak et al., 2007, McPherson et al., 1994, Nowak et al., 2002, McPherson et al., 2003). However, residents value urban trees for varying reasons. Some respond to economic incentives and base their appreciation for urban forests on cost savings (Heimlich et al. 2008). Others have environmental, emotional, or symbolic reasons for valuing urban forests (Schroeder and Ruffolo 1996; Barro et al. 1997; Lohr et al. 2004). Characterizing the underlying attitudes, values, and beliefs residents associate with trees will aid in gauging the response residents have to local tree planting initiatives (Jones, Davis, and Bradford 2012). The following is a review of common reasons attributed to resident appreciation of urban tree canopy (see Table 1).

Many residents attribute the value they place on urban forests to the aesthetic contribution trees can make to a given property or community. In 1989, a large hurricane struck South Carolina. In the following year researchers distributed a survey to residents who lived in areas that had experienced storm-related tree loss. Thirty percent of respondents identified the urban forest as the feature that was most special to them that had been damaged in the storm. Responses indicated that residents appreciated the urban forest due to its ability to characterize and differentiate spaces from another by increasing beauty. Survey results also showed that residents associate positive feelings and emotions with urban forest presence (Hull 1992).

Residents have also noted changes in fall colors and flowers as increasing local aesthetic value (Schroeder and Ruffolo 1996; Heimlich et al. 2008; Locke DH, Roman LA 2015). Tree height has been linked to increased aesthetics as well. Tall, closed canopies have the potential to have greater impact on local streetscapes by reducing wind speed, lowering noise, and increasing privacy (Schroeder and Ruffolo 1996; Schroeder and Coles 2006). Because increased tree canopy and biomass result in increases in ecosystem services, resident appreciation for large trees should be encouraged when appropriate (McPherson 2014; Ko et al. 2015a; Ko et al. 2015b).

Similar findings are supported by a 2008 study of Toledo, Ohio. Prior to tree cutting due to an Emerald Ash Borer outbreak, Toledo residents were surveyed to better understand why they value urban trees. In the face of canopy loss, residents indicated that replacing felled trees with large trees should be prioritized. Value was also placed on increased environmental quality due to cooling effects, wind reduction, and increased property value (Heimlich et al. 2008). Increased property value can be related to the aesthetic value trees provide to an urban setting, and is a common factor associated with valuing urban canopy (Schroeder and Ruffolo 1996; Schroeder and Coles 2006; Rosenow and Yager 2007; Freilicher et al. 2008; Heimlich et al. 2008; Locke DH, Roman LA 2015). Perceived increases in environmental quality are commonly attributed to the value residents place on trees. Examples include increased wildlife habitat and bringing nature closer to residential spaces (Schroeder and Ruffolo 1996; Schroeder and Coles 2006). There are cited health benefits to bringing nature closer to residential spaces. Hospital patients with windows looking out on trees have been shown to have shorter recovery times than those without views of trees (Ulrich 1984; Carreiro, Song, and Wu 1989; Neville 2000).

The following analysis characterizes reasons why central Massachusetts residents value urban forests and compares these reasons with those presented in Table 1. These findings are then used to help

characterize the status of a sustainable urban forest in Central Massachusetts.

Study Area

This study is confined to the 2012 Worcester County ALB Regulation Zone (see Figure 1). The regulation zone (337 km^2) was established by the Massachusetts Department of Conservation and Recreation (DCR) and includes Worcester, Boylston, West Boylston, Shrewsbury, and parts of Holden and Auburn. The regulation zone was issued under the regulatory authority provided by the Plant Protection Act of June 20, 2000, which permits the Massachusetts Secretary of Agriculture to "prohibit or restrict the movement in interstate commerce of any plant, plant part, or article, if the Secretary determines the prohibition or restriction is necessary to prevent the dissemination of a plant pest within the United States" (APHIS 2009).

Context and Organizations

The ALB, an invasive species to the United States that nests in and ultimately kills some species of hardwood trees, was first detected in Worcester, Massachusetts in 2008. Since then, over 30,000 trees have been cut in the ALB Regulation Zone in attempt to remove host trees and minimize impact of the outbreak. Before tree cutting began, urban tree canopy in Worcester provided over $2.3 million in total annual benefits. In

2008, eighty-one percent of street trees in Worcester were species that are proffered ALB hosts, making it highly susceptible to ALB damage (Freilicher et al. 2008). USDA officials feared that if efforts were not made to eradicate ALB, timber, tourism, and maple syrup industries throughout New England would suffer (Palmer et al. 2014).

The USDA performed field surveys within the ALB Regulation Zone to mark the number of ALB infested trees in the Regulation Zone. In order to do so, the USDA partnered with the Massachusetts Department of Conservation and Recreation (DCR). Unlike the USDA, the DCR was able to secure the legal rights to enter private property to assess levels of tree damage. After assessing the extent of the ALB outbreak, the USDA contracted to cut all host and potential host trees located within a quarter mile radius of an ALB infested tree. Many residents were not pleased with this large-scale tree cutting plan and voiced frustrations to local city councilors (Palmer et al. 2014).

In spring 2009, in response to resident reaction to tree cutting, the DCR secured $500,000 to fund reforestation efforts in areas that had experienced tree loss. Soon after, the DCR was awarded an additional $4.5 million from the American Recovery and Reinvestment Act (ARRA) to increase planting efforts. The DCR, which retains the authority to enter private land, has engaged in outreach efforts and successfully planted

thousands of trees at no cost to land owners on residential properties (Palmer et al. 2014).

The Worcester Tree Initiative (WTI) was formed during the same year with support from the then-Lieutenant Governor of Massachusetts, and a Massachusetts State Congressman. WTI increased reforestation efforts by hosting tree giveaways as well as educational tree stewardship trainings. Under the WTI model, residents who attend a tree-planting workshop and learn stewardship skills are given free trees to plant themselves. In fall 2014, through combined DCR and WTI efforts, 30,000 trees were successfully planted in the ALB Regulation Zone. Because residents in the study area went from living with extensive tree canopy cover, to experiencing large-scale tree cutting, and to engaging in reforestation efforts, this study area represents an optimal location to assess reasons residents value urban trees.

Data Collection and Methods

Researchers in the Human Environment Regional Observatory (HERO) at Clark University conducted semi structured interviews and distributed surveys to residents between summer 2014 and summer 2015. The interview sample was drawn from a data set of 17,000 juvenile trees that had been planted by the DCR. This data was provided by DCR, and only included

trees planted during or prior to spring 2012. The initial population of 17,000 tree records was reduced by eliminating trees that had been planted by private contractors and trees not funded by the ARRA. Taking this step, it is assumed that all trees in the sample were planted due to ALB reforestation efforts. This process reduced the potential sample size to 9,388 tree records.

A stratified random sample based on tree species was then performed using 500 tree points. By stratifying the sample based on species, the final potential sample included a sufficient number of species that had been planted less frequently by the DCR. This step was critical to a tree health assessment survey that was performed using the same data. Using this sample of 500 trees, a geographic cluster approach was implemented in ArcMap using a 50m buffer. This step allowed the sample to include nearby trees. Following these steps, the potential sample included 1,608 trees. 1,516 juvenile trees were ultimately surveyed in the summer of 2015, 205 of which were associated with an interview. In order to include perspectives from tree planting agencies, two additional interviews were conducted in fall 2016 with representatives from the WTI and DCR.

A web-based survey was distributed by HERO researchers in summer 2014 in order to assess resident perception of ALB management and policy decisions. The target population included residents from all six towns in the ALB regulation zone. The survey was built in Qualtrics and was distributed

via unique URLs across five platforms. These platforms included local media outlets, residents with prior interaction with the HERO program, residents associated with a WTI list serve, mailed post cards, and hand delivered post cards.

In order to devise the sample for mailings, 2000 points were generated and distributed across the study area. These points were then assigned to the nearest residential address and validated manually. 891 postcards with a web link to the survey were mailed to these addresses. 200 additional postcards were hand delivered to homes using methods similar to those described for 2015 interviews. The HERO program sent press releases to local news outlets, which contained a link to the survey. News outlets included *Worcester Magazine*, the *Telegram and Gazette*, and *InCity Times*. Flyers were posted in various community locations such as City Hall and the Worcester Public Library in effort to further elicit responses. Links to the survey were distributed via the WTI's list serve as well as to a list of residents who had previously interacted with the HERO program. The survey aimed to better understand perceptions about management and policy implications of the ALB in Central Massachusetts to inform future policy decisions. Questions ranged from levels of engagement with planting organizations to change in neighborhood character as a result of tree cutting and reforestation efforts. Ninety-five survey responses were

collected in summer 2014. Twenty-five responses came from the random sample, twenty-one responses were received from handouts and flyers, twelve from the WTI list serve, twenty-two from responses to press releases, and fifteen from residents with previous interactions with the HERO program (see Figure 2).

Short Interviews were conducted in 2015 alongside a larger effort to survey health characteristics of newly planted juvenile trees. After assessing tree health on a particular property, residents were asked to participate in a semi-structured interview. Interview topics focused on tree care, environmental awareness, resident relationship to tree planting agencies (WTI and DCR), change in neighborhood and community character, attitudes and feelings towards trees, and the process of receiving trees through local planting initiatives. This study focuses on the semi-structured interviews that were conducted rather than the tree health assessment data that was collected. A total of 79 interviews were conducted (some trees were on the same property; see Figure 4).

Interviews were transcribed and analyzed using inductive and deductive coding methods in NVivo in the summer of 2015 by HERO researchers. During the following year, all interviews were coded and analyzed a second time to further explore dominant themes. Matrix queries were performed in NVivo to examine overlap between pre-identified

themes. Matrix queries produce a tabular output, which compares nodes and attributes across the data set. In order to produce a query, NVivo prompts coded nodes to be placed in rows. A second set of nodes are then identified and are stored in columns. Through this process, areas of overlap, or divergence, among themes can be tabularly displayed.

Limitations

Due to the sampling methods used to conduct interviews and to distribute survey post cards, it is noted that much of the data set was collected by convenience sample. Field surveys and resulting interviews were conducted between Monday and Friday during normal business hours, which likely served as a limiting factor in reaching a broader range of residents, and reduced the final number of interview respondents. Additionally, the initial data set provided by the DCR placed emphasis on the city of Worcester, which lowered the potential to conduct interviews in other towns in the study area. Because researchers were given the same rights to enter private property as DCR employees, interviews were more likely to be conducted with residents who had received trees from DCR than WTI. It is noted that the City of Worcester has played a role in reforestation efforts as well. However, due to lack of available data, this study excludes the City as a planting agency.

Analyses

Five matrix queries were run to study interview data in regards to resident-stakeholder interaction and response to reforestation efforts. The first query examines reasons residents value urban trees. Query two explores whether or not how residents are exposed to tree planting agencies impacts their overall experience with the program. Query three adopts a more general approach by examining the relationship between overall resident interaction with tree-planting agencies (i.e. not exclusive to initial interactions) and quality of interaction. Query four examines whether or not residents' interaction with tree-planting agencies influences overall environmental awareness, while query five assesses relationship to tree-planting agencies and observed changes at the neighborhood and community level.

Survey responses were analyzed for trends using IBM SPSS, Qualtrics, and Microsoft Excel.

Results and Discussion

Of the seventy-nine semi-structured interviews conducted in summer 2015, the majority of interview participants were male (53%), white (86%), and retired (53%). The average age of interview participants was slightly above 60 years old (60.6). Ninety-five percent of interviewees reported

living in Worcester. Ninety-five survey responses were collected in summer 2014 (see Figures 2 and 3). While post cards were distributed using random sampling methods, a majority of survey responses came from convenience sampling methods. Survey respondents ranged across all income brackets. Unlike the interview sample, survey respondents included those who had and had not been impacted by ALB-related tree removal. Thirty-eight of survey respondents (55%) were female. The mean age of survey respondents, 45-54, was slightly lower than that of interview participants. Similar to interview participants, the majority of survey respondents identified as Caucasian and eighty percent reported living in Worcester.

Reasons to value trees

Together, the survey results and interview transcriptions provide in-depth understanding of the public response to organizational efforts to reforest central Massachusetts in the ALB Regulation Zone. Results from both are reported in this section. Overall, results indicate that residents are most likely to attribute increased aesthetics to explain their appreciation for trees:

> "I think it really has increased the beauty… This dogwood I enjoy, and I can see it from my kitchen window. And especially when it is in bloom right now I really enjoy it… I think it has been a huge benefit"

> "They have the most gorgeous flowers in the world and they smell so beautiful… I really like trees, you know… there's more greenery around"
>
> "I wanted something that would flower in the spring again, and both of them do flower in the spring, so it was nice to have something. And one of them is a darker leaf and the others are green leaf so it adds, I don't know, to the look of the property"
>
> "Well, there's aesthetic value"

This finding is supported by previous research (see Table 1). Increased aesthetics are often linked to increases in property value (Hull 1992; Schroeder and Ruffolo 1996; Schroeder and Coles 2006; Heimlich et al. 2008; Locke DH, Roman LA 2015). Eighty-four percent of survey respondents reported an observed change in the aesthetics of their neighborhood or residence, while forty-four percent reported an observed change in property value. However, this study does not examine whether or not property values actually changed as a result of tree cutting. Rather, this point is drawn from and informed by resident experience.

The second most recurring reason, based on coding counts, that residents cited in relation to their appreciation for trees was linked to ALB related tree cutting.

> "Trees bring you back to your childhood. When they cut that one down it really bothered me. It was something special to my father. He always liked it… it really made this area really special to me… We

> used to have beautiful, beautiful trees that were very tall trees and they're all gone"
>
> "I was really concerned that [the DCR] were just taking down the trees and that didn't sit too well with me"
>
> "When they first cut them down it looked so horrible"
>
> "There was a lot of shade. These trees don't give you any shade, they just, well, I'll been gone for years before they grow big enough"

Hull, 1992 found that residents were moved to tears when discussing tree loss and that respondents associated trees with particular memories related to family members or past events (Hull 1992). This finding is supported by this research.

Other recurring themes in the analysis included appreciation of trees linked to a desire to connect with nature, and the environment. Residents commented "trees attract lots of birds and wildlife," which provides "habitat for animals." Again, this finding is supported by Figure 5, which shows loss of wildlife as the third highest concern (58%) for residents when considering the future of the regional urban forest. Several studies have reported residents value urban trees because they serve to bring nature closer (Schroeder and Ruffolo 1996).

Relationship to stakeholders

The remaining queries examine residents' interactions with tree-planting agencies in relation to initial interaction, overall interaction,

environmental awareness, and change in neighborhood or community character. Despite –or perhaps because of—the negative reaction to tree cutting reported by Palmer et al. (2014), results indicate that residents tended to have positive initial interactions with tree planting programs. Initial interaction with DCR or WTI ranked highest in the number of coding references (40) compared to initial interactions through media (27), word of mouth (14), or community organizations (5). One couple described their initial interaction with the DCR in the following way:

> "We got some mailing and then telephone calls, so it was good. It wasn't hard, it was out there. It was almost a no brainer. 'We are giving free trees to people,' you know. Let's get with the program. Really, it was just one of those. It didn't require deep thought"

Others described positive initial interactions with organizations slightly differently:

> "They were out here cutting [trees], and I came out to talk to them about cutting the trees. You know, I had my shotgun threatening their lives. They thought they could buy me off with a couple of trees. Apparently it worked"

An interview with a representative from the DCR further informs this type of interaction. This interview outlined that many interactions and subsequent tree plantings occurred as a result of "door knocking" and conversations

with residents in the field. DCR staff clearly emphasized outreach in their work.

Results indicate initial interactions with DCR or the WTI led to effective delivery of services and information to many residents:

> "[The DCR] came up and visited us and checked our property for the Asian [Longhorned] Beetle when we had the Asian [Longhorned] Beetle problem. I don't think they took too many trees out, but they did a very good job of inspecting and keeping a close eye on the issue"
>
> "[The DCR] had a flyer and they said 'here's a list of trees. Just pick whatever you want'… and then in a couple days they would come back"
>
> "The day of the planting they definitely gave tips that I wouldn't have known otherwise… certainly for someone who's never planted a tree, they were helpful in helping me figure that out"

Interaction with tree-planting agencies served as an important means for residents to gain information about the ALB infestation, therefore further establishing resident interaction with such agencies as effective means of communication (see Figure 6). Residents who reported having their initial interaction with planting initiatives through an either the DCR or WTI directly were more likely to also report continued interactions (i.e. past initial tree planting) with tree-planting agencies when compared to the other four means of initial program interaction:

> "We started going to the meetings after the trees were removed. There was a lot of publicity for the Worcester Tree Initiative here. So that's how the majority of [the trees] came, my husband and I going to those workshops… we would go to meetings, like when they first started the informational meetings for the Asian Longhorned Beetle. So pretty early on they started letting us know. And then, after that, I feel like they had mailings and we were on an email list so we would get emails and phone calls all the time"

However, despite effective interaction with tree-planting agency members, survey results indicate that the majority of residents would like to have more information available via newspapers (70%) and the internet (52%). Survey results also indicate that residents would like more information available from tree-planting agencies via tree surveyors (31%) and public meetings (30%) (see Figure 6).

Residents tended to have positive long-term interactions with tree-planting agencies as well. A matrix query revealed fifty-four interview segments were coded as both relationship with tree-planting agencies and effective information:

> "You could preorder or many times they'd have extra trees and they would say 'would you like this [tree]? If you just wait until everybody's got their trees and we have some left you're welcome to them.' You can't beat that. And the quality of the product the trees were phenomenal and it was just get the hole dug, get them in the ground, and go from there… I would get emails reminding about upcoming events and programs and things… I can't always make things like that, but I like to see that [they are] going on"

> "We contacted the DCR… and they just said 'yep, we'll send somebody on down.' And it was two guys that came with a book and all the pictures and you know we talked about what our wishes were. It was so perfect"
>
> "I have to say I love the interaction I've had with people. Everyone has been very nice and informative and pleasant to work with, and I think if you didn't have those people on the front lines that were that way the program just couldn't be successful. But it was very easy to work with everybody, get your questions asked, and get information that you needed and also information that you didn't know you needed. And it was so wonderful. As I said, every interaction I've had with everybody at any organization and every different venue, people have been there. Outreach has been a great experience,"
>
> "It was well publicized and there was a load of trees and everybody was excellent"
>
> "Everybody's been very professional, very enthusiastic, very much willing to answer any questions and wanting you to be involved in what they were doing and happy that you wanted to be involved. So we had wonderful experiences with the groups that we've worked with whether it be the Worcester Tree Initiative or Department of Conservation and Recreation"

Based on these findings, it appears that WTI and DCR have deployed effective education and marketing campaigns. Because information was delivered effectively, it is believed that WTI and DCR are in good standing should they need to enact new programs. Examples of effective information delivery include site visits, consistent flows communication, and informative tree planting advice:

> "[WTI] came around and checked on the trees once or twice and I do remember maybe receiving an email"
>
> "The day of the planting [WTI] definitely gave tips that I wouldn't have known otherwise… certainly for someone who's never planted a tree they were helpful in helping me figure that out"
>
> "When we all went down to get our trees there was a bunch of people that worked for the Worcester Tree Initiative and at different times they would give us a small five-minute talk and they would spread out and walk around to everyone's yard and did some more private tutoring as we were planting"

The presence of state and federal funding to provide residents with free trees is a major contributor to DCR and WTI successfully planting over 30,000 trees. Through a series of public meetings, political support, online presence, and door knocking, WTI and DCR were then able to engage residents living in the ALB Regulation Zone to participate in programming. However, in order for these programs to continue to be successful, they must expand outreach efforts in order to reach those who were previously not included. Cultural heritage has been shown to impact reasons residents value urban tree canopy (Clark et al. 1997; Heimlich et al. 2008; Jones, Davis, and Bradford 2012). While not analyzed extensively in this analysis due to lack of data, WTI has engaged with local refugee populations to plant fruit-bearing orchards in the City. Such outreach demonstrates a different strategy than the educational events and door-knocking analyzed here. Overall, resident reaction to urban tree-planting

programs is largely a new research topic. Thus, this analysis of reactions to programs in central Massachusetts has potential to inform future studies and research questions.

Response to tree cutting

While less frequent, negative interactions with tree-planting agencies and areas of possible improvement are present in the data set. These comments tended to be focused on tree cutting programs rather than planting programs. Regarding tree cutting interview respondents said:

> "They came here and they said that [the trees] were potential harbors for the Asian Longhorned Beetle. So then he said there was some hole up there where [the beetles] have been eating. Show me them, when they chopped [the trees] down I said 'show me where the beetle is.' And they said it was not there. Then what they said made me really livered, that this might be some beetle excrement. What a pile of bologna. They could have been dead caterpillars. They didn't know what they were talking about"

> "For some people trees mean nothing, and for some people a tree might mean everything… Depending on where they're form and their culture and [to] approach them in that sense. That's the only recommendation that I'd make is just to be aware of that… It's really important [the Department of Conservation and Recreation is] very clear it's not them, it's the beetle's fault. You know, it's not their fault. They have to do it, it's because of the [Asian Longhorned Beetle]. They're not saying, 'oh we just don't like that tree'"

> "I think you don't really notice or appreciate what you have until you have to take it down. Taking all the maple trees down in the town really made a difference to the colors and things and that's why I wanted to add flowers because I felt like. And actually we are very fortunate because we still kept our maple trees because there were

> no beetles here. We were delighted that see still have our colors but I was very aware that some areas were devastated"

The data above suggests residents feel resentment to ALB tree cutting (also supported by the findings of Palmer et al. 2014). Previous studies have shown that people associate positive feelings and memories with tree canopy presence (Barro et al. 1997; Hull 1992; Lohr et al. 2004). These findings are supported by this research. Additionally, there is evidence to suggest that efforts to better educate the public on ALB tree cutting and policy could be improved. Evidence of possible need for improvements in communication include:

> "[The Department of Conservation and Recreation] needs to understand how to make exceptions to rules and work with exceptions to give a little bit more to people when they can. I can understand if the trees are totally infested with insects, yes, but it wasn't. So the impression was all wrong"

> "I think they should have had people from the neighborhood in input, you know"

By continuing to increase efforts to educate the public, tree-planting agencies have the potential to reduce negative resident reactions to ALB tree cutting and policy.

The majority of survey respondents (73%) reported having no input in creating ALB policy related to tree cutting and the regulation zone (see Figure 7). Because residents indicated wanting to receive future

information through public meetings, it is proposed that future policy decisions could use public meetings to elicit resident input when appropriate. However, public meetings have been used in the past to elicit community input in the study area regarding ALB policy. Despite having had input, residents still show resentment towards tree cutting programs. Tree planting initiative have the potential to mitigate this some of this resentment by continuing to engage residents in positive tree planting experiences.

Environmental Awareness

Previous research suggests that the presence of urban trees has the potential to make people consider broader environmental issues (Lohr et al. 2004). Interview and survey questions sought to elicit responses as to whether or not residents experienced greater environmental awareness due to involvement in reforestation by participating in planting programs. Residents who characterized themselves as having high levels of interaction with stakeholders were more likely to report increased awareness of environmental issues (59%) than those with low levels of interaction (42%) (see Figures 8 and 9). These findings indicate that intensive, ongoing stewardship efforts are an important part of increasing environmental awareness. Evidence of continued interaction with tree-

planting agencies leading to broader awareness of environmental issues if further supported by interview data:

> "I would say yes. I mean, just the fact that we were beneficiaries of that program for me made it more clear that there's a problem going on. It's more than just seeing the traps on the road and watching the cars parked on the side with people tromping in the woods. It's more than that, you know. There's a big initiative that needs to be that's going on to kind of combat [the ALB] issue. So yeah, in terms of the beetle my environmental awareness has increased certainly… you know education is key. Educate people"

Others commented "absolutely" when asked if reforestation efforts had increased their environmental awareness. Another finding indicates that residents who were interviewed were already environmentally aware and that their interactions with stakeholders did not increase awareness. This finding is validated by responses such as:

> "I have an environmental background so that's kind of what I do"
>
> "I've always been [environmentally] aware"

The interview sample is made of residents who chose to participate in the reforestation program based on their own free will. Thus, it is possible that respondents may be already be more environmentally aware than those who chose not to participate. However, results do show a connection between interaction with stakeholders and environmental awareness.

Future research questions such as why do residents choose not to participate in tree-planting programs may be of interest to explore this topic further.

Large disturbance events (i.e. large scale tree cutting) provide opportunities for increased community engagement and action through improving local institutions and creating problem solving networks (Berkes 2007). Thus, it is important that organizations such as WTI build on these opportunities to engage residents to take interest in the environment. Currently, WTI takes consistent action to educate the community on tree benefits and environmental awareness as a whole. Example educational programs include classroom presentations, the Urban Tree Stewards Program, community tree pruning events, and a partnership with the local Boys and Girls Club.

Neighborhood and community

Eighty-three percent of survey respondents reported experiencing change in neighborhood character due to tree loss (see Figure 10). The spatial distribution of these responses can be seen in Figure 11, and closely matches areas with observed tree loss. The following quotations from interviews illustrate the feeling of change in neighborhood character:

> "It looks nice down the road, trees on the edge start to bloom a bit, but it looks kinds of bare to me. I know it's going to take time… certain areas look better, but not as nice as it did five years ago
>
> "They have cut down a lot of trees and put back a lot of trees to help bring back the green. It will help. Of course it will"
>
> "Initially everyone was pretty devastated, you know, and there was definitely some there was a lot more negativity. And as things were starting to bloom it's definitely gotten better. I think that now since the trees it looks better. You know, initially it looked pretty horrid. I feel like now that the grass has come in and the trees are starting to bloom and grow everybody kind of feels better. The morale is better in the neighborhood"
>
> "There's no shade anywhere and it's sad. I mean those, like our neighbors, are sprouting really fast. It's nice because the shade and the fact that now it's starting to look like a neighborhood, you know. Falling back where it should be… It gives privacy, too. It's just nice. Starting to get back to where it should be"
>
> "I'm really into nature and what not so the lack of trees was making the place look a little too urban, you know. It's good for the environment to have as many trees as possible so it was negative on many levels when they cut them down. So it's been positive all across the board"
>
> "It definitely made the neighborhood better. A lot of the trees are kind of old and have been damaged over the years, so having a lot more of little ornamentals in the front yards just brightens up the neighborhood"
>
> "I like the end result, but it took three years or so to get back to where I was comfortable in the neighborhood. It was like devastating because it was so barren for a while"

Other interview responses noted neighborhood change, but were not as positive as those quote above:

> "It was gorgeous. Now look… I think it really makes a difference when you look at these neighborhoods without the trees. What a difference. It looks like a bomb went off after they took them down"
>
> "I feel there's a difference of course, but the replanting doesn't really mitigate the actual destruction of the trees. It's a nice gesture, but it doesn't mitigate it"

This finding is consistent with previous research, which indicates that an increased sense of community is an important reason why residents value urban trees (Schroeder and Ruffolo 1996; Locke DH, Roman LA 2015) (see Table 1). Tree height and size have been shown to influence the value residents attribute to urban trees, which supports negative reaction to tree cutting documented in this study (Barro et al. 1997). Overall, residents placed a large amount of appreciation on the visual and aesthetic value trees provide. Many of these comments were associated with wanting a larger number of flowering and ornamental trees planted:

> "Having a lot of little ornamental sin the front yards just brighten up the neighborhood"

The DCR has made a select number of species available for reforestation programs. This list includes ornamental trees as well as larger shade trees (Freilicher 2011). Survey and interview responses present a contradiction in that residents commonly report missing tall trees that have been cut, but wanting smaller ornamental trees planted in response. Planting initiatives

should use existing positive relationships with residents and successful communication and education strategies to explain benefits that result from planting trees with larger mature heights to residents (Koeser et al. 2014).

Conclusion

The goals of this study were to characterize resident response to urban tree planting initiatives in central Massachusetts and to assess reasons why residents value urban forests. Based on this study, WTI and DCR were effective in engaging with residents in order to reforest the ALB Regulation Zone following massive tree cutting. However, as noted, there are several limitations to this study. Surveys and interviews likely oversampled the same demographic and may not be representative of the entire ALB Regulation Zone. Future community forestry research in central Massachusetts could focus on outreach efforts made by tree-planting agencies specifically targeted at different ethnic or socio-economic groups.

Having a strong understanding of resident appreciation for urban forests will assist planting initiatives in engaging with community members to achieve planting goals (Dwyer, Nowak, and Noble 2003). Based on this study, DCR and WTI communicated effectively with a certain

demographic. However, a major limitation of this study is that the sample may be over representative of a certain older, white segment of the population. Thus, it is suggested that future studies seek to characterize the relationship between tree-planting agencies and residents across a variety of demographic variables.

While specific to particular geography and population, the findings of this study can be used to inform planting programs in other locations. One question remains as to whether urban tree-planting initiatives can be successful in the absence of large-scale tree cutting. While this study does not directly address this question, it does point to reasons why residents value urban forests. These values can be expected to hold true regardless of cutting programs. Additionally, many of the reasons residents living within the ALB Regulation Zone reported for valuing urban trees are reflected in past studies shown in Table 1. Having the capacity to provide residents with free or heavily subsidized trees to residents would likely serve to increase planting rates for any tree planting initiative regardless of tree-cutting programs as well.

Residents in the ALB Regulation Zone were most likely to mention loss of neighborhood character and decreased aesthetics as their major concern for the future of urban forests (see Figure 5). Similarly, changes in aesthetics and character were the two most common responses when

residents were asked to describe observed changes in their neighborhood or community (see Figure 10). These findings are supported by interviews, which show resident resentment towards ALB related tree cutting within the regulation zone. Despite resident appreciation of tall canopy prior to cutting, appreciation of smaller ornamental trees emerged as a dominant theme in regards to replanting efforts. Planting initiatives in Worcester should use residents' past appreciation for tall canopy as an opportunity to plant trees with greater mature heights, which will provide greater ecosystem services. The specific communication mechanisms would likely be via a range of media, including in person but also news and internet, as suggested by the survey findings.

Community involvement is an important aspect of achieving urban forest sustainability and is necessary to engaging with residents (Sommer 1997; Dwyer et al. 2000; Tidball and Krasny 2007). In this instance, data indicate that DCR and WTI were successful in reaching residents. This finding is supported by interviews with residents and further supported by survey results, which show that residents tended to have informative interactions with tree-planting agencies.

If cities are to meet their tree planting goals and increase ecosystem service delivery they will likely be required to increase planting efforts on privately owned land. Previous research shows that understanding the

surrounding social context and incorporating a shared community vision are important attributes to building sustainable urban forests (Clark et al. 1997; Dwyer et al. 2000). Thus, it becomes critical to characterize the various reasons that residents value urban forests. By reflecting these reasons in their communication and outreach efforts, tree-planting agencies are likely to increase resident participation, thereby increasing a shared community effort aimed at building a sustainable urban forest.

Figures

Study	Location	Sample size	Significant reasons for valuing urban forest (* most common factors)
Hull (1992)	Charleston, South Carolina	N=185	Aesthetics * Environmental quality * Energy conservation Nostalgia Positive emotions
Schroeder et al. (1996)	Downers Grove, Illinois	N=307	Aesthetics * Environmental quality * Shade/cooling * Property value Sense of community Brings nature closer
Lohr et al. (2004)	112 most populated metropolitan areas in the United States	N=2,004	Environmental quality * Shade/cooling * Positive emotions Noise reduction Wildlife habitat
Schroeder et al. (2006)	North Somerset/Torbay, United Kingdom	N=130	Aesthetics Environmental quality Property value Sense of community
Heimlich et al. (2008)	Toledo, Ohio	N=113	Aesthetics * Shade cool/cooling * Sense of community Property value Wind reduction Energy savings
Locke et al. (2015)	New Haven, Connecticut	N=171	Aesthetics* Environmental quality * Shade/cooling * Sense of community Wildlife habitat Property value

Table 1: Review of common factors attributed to resident appreciation of urban forests

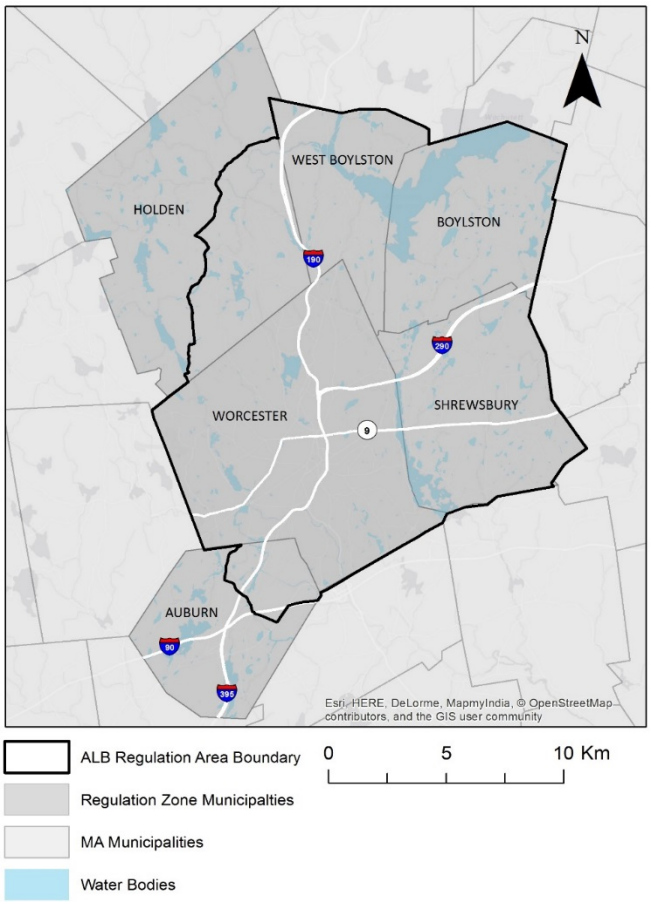

Figure 1: Study area map (source: HERO)

Survey Type	**Responses**
Random Sample	25
Handouts and Flyers	21
WTI List Serve	12
Press Release	22
Previous Interaction with HERO	15
Total:	**95**

Figure 2: Breakdown of survey responses by distribution type

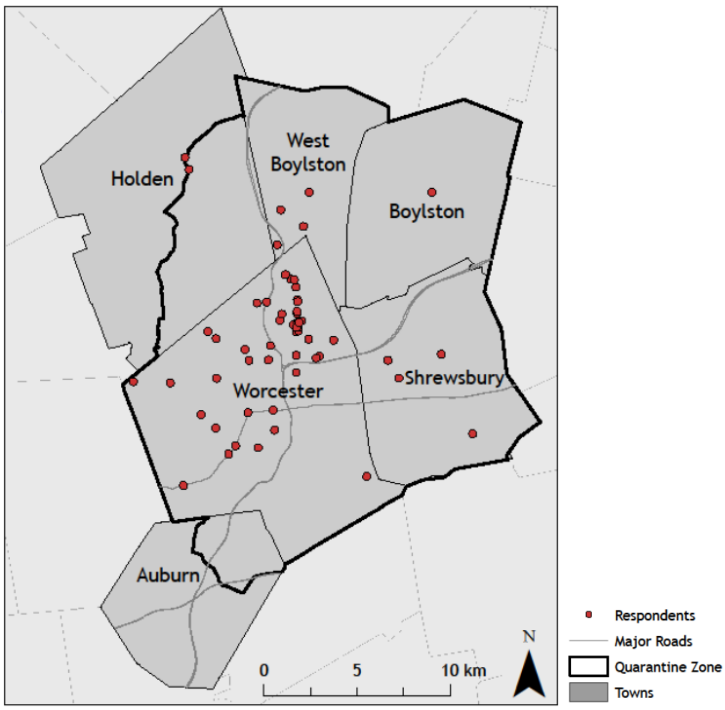

Figure 3: Distribution of survey respondents across study area (source: HERO)

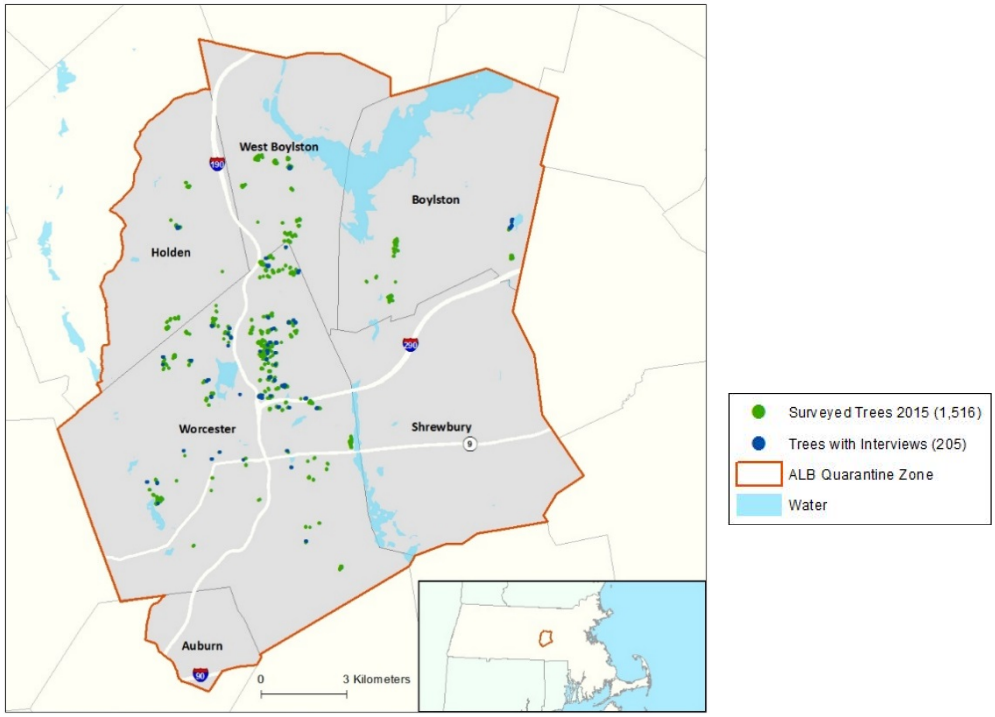

Figure 4: Distribution of interviews across study area (source: HERO)

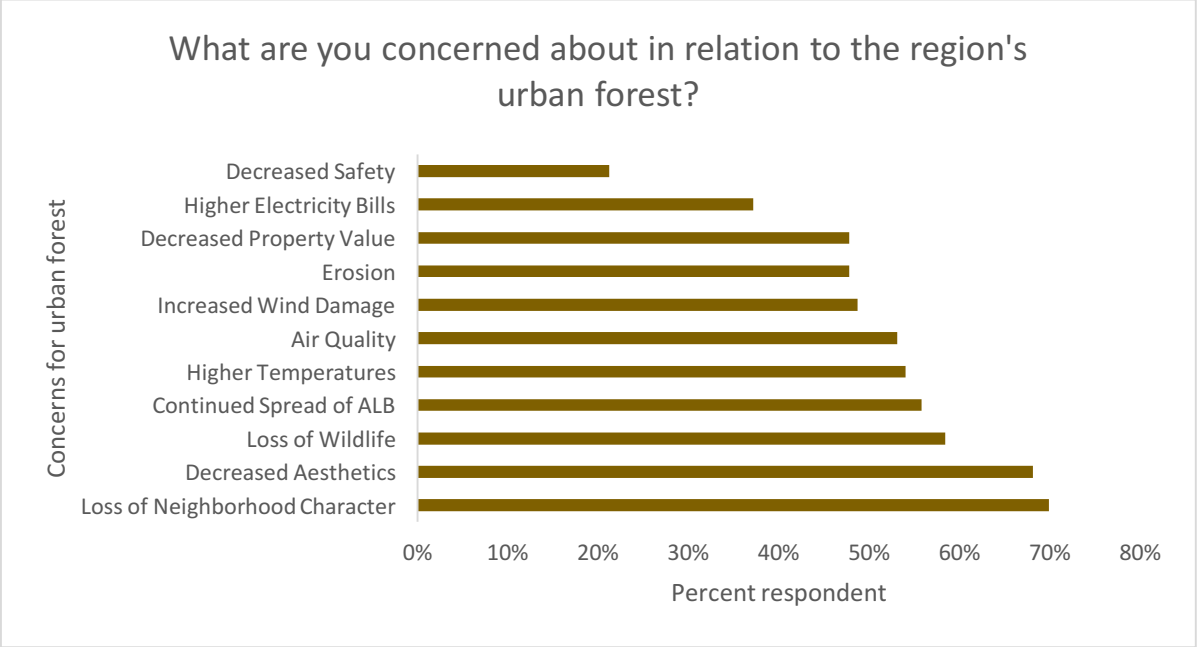

Figure 5: Survey responses indicating resident concern for the regional urban forest

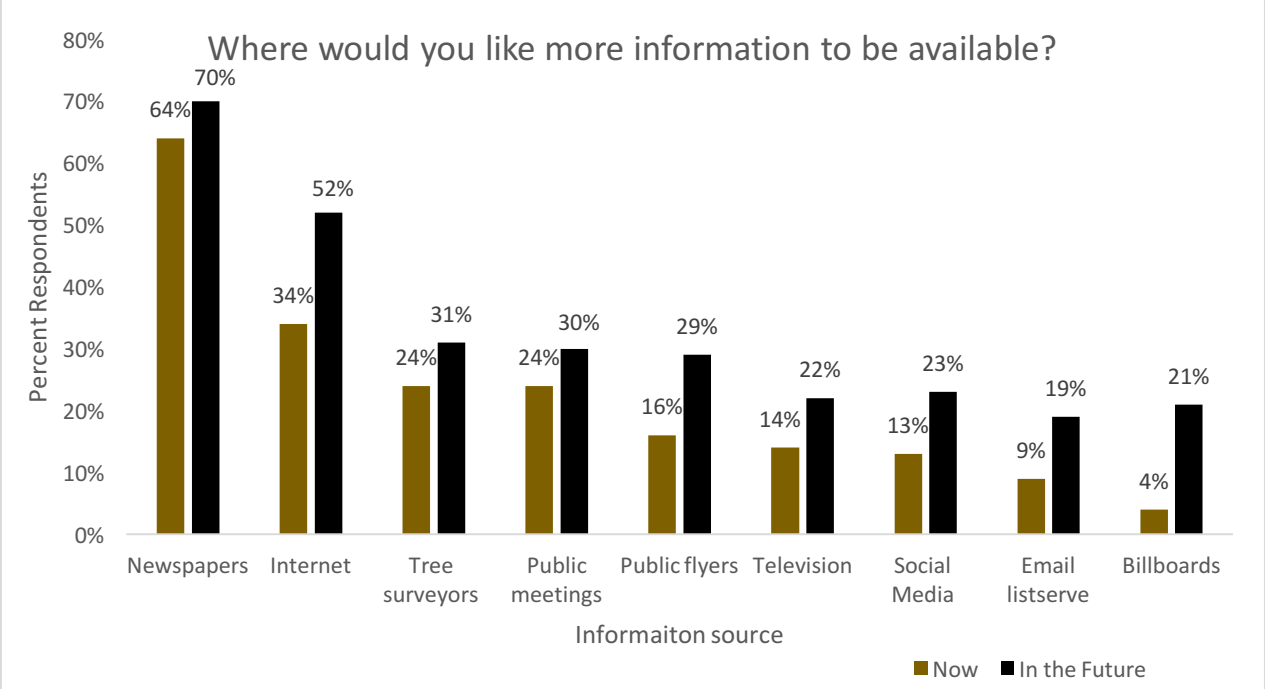

Figure 6: Survey responses indicating where residents currently receive informaion related to ALB policy and where they would like to receive more in the future

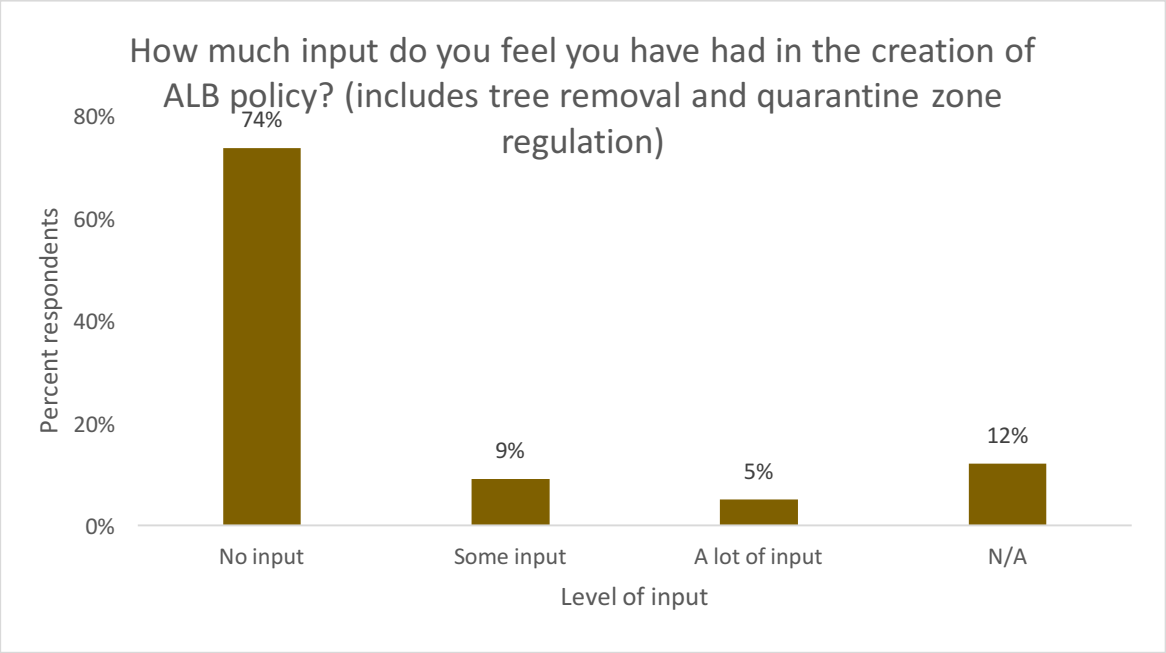

Figure 7: Survey responses indicating level of input residents reported having in creation of ALB policy

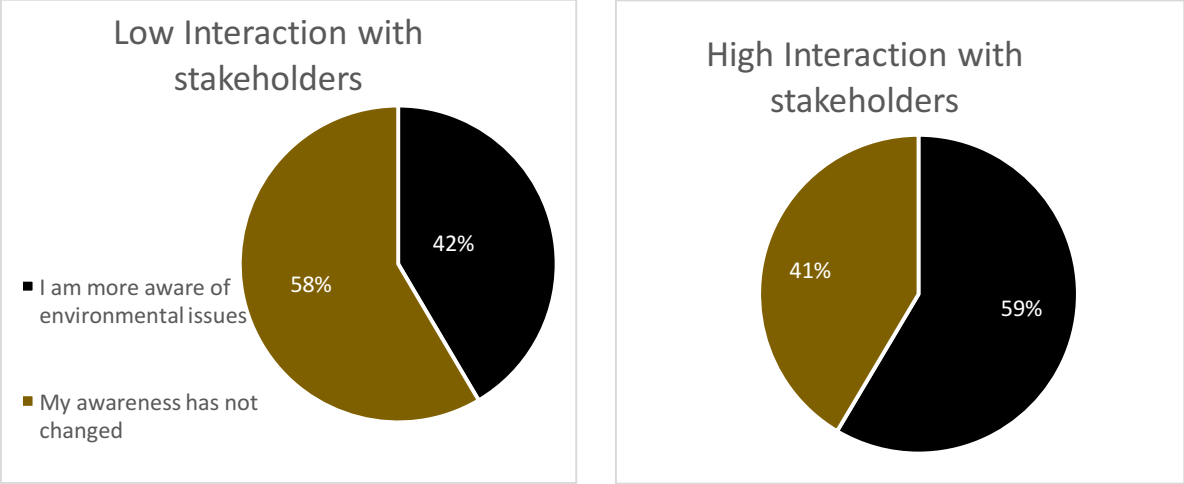

Figure 8: Survey responses showing relationship between level of interaction with stakeholders and change in envitoronmental awareness

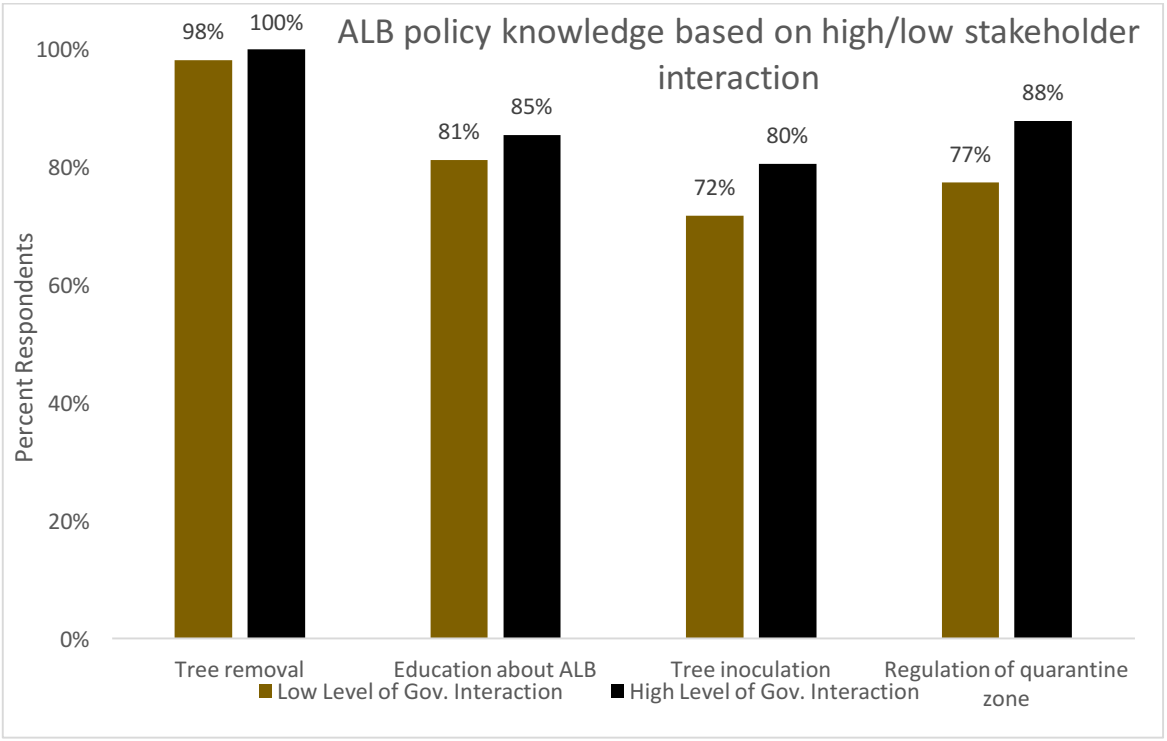

Figure 9: Survey responses indicating resident knowledge of ALB policy based on level of stakeholder interaction

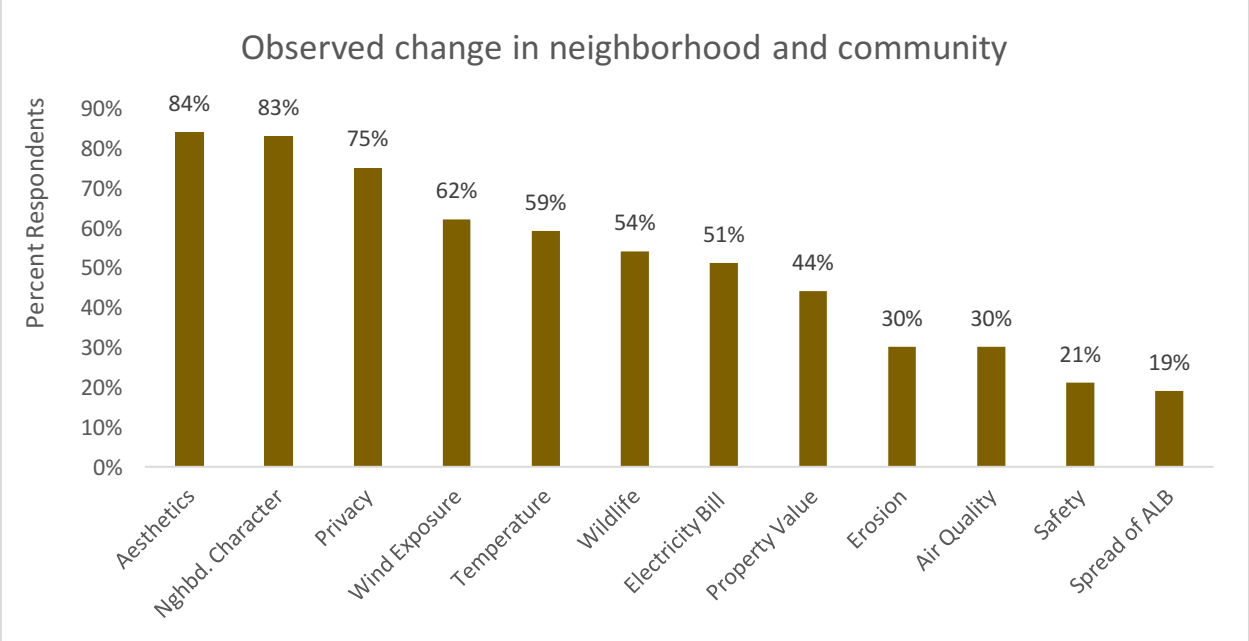

Figure 10: Survey responses indicating observed changes in neighborhood/community

Has the character of your neighborhood changed?

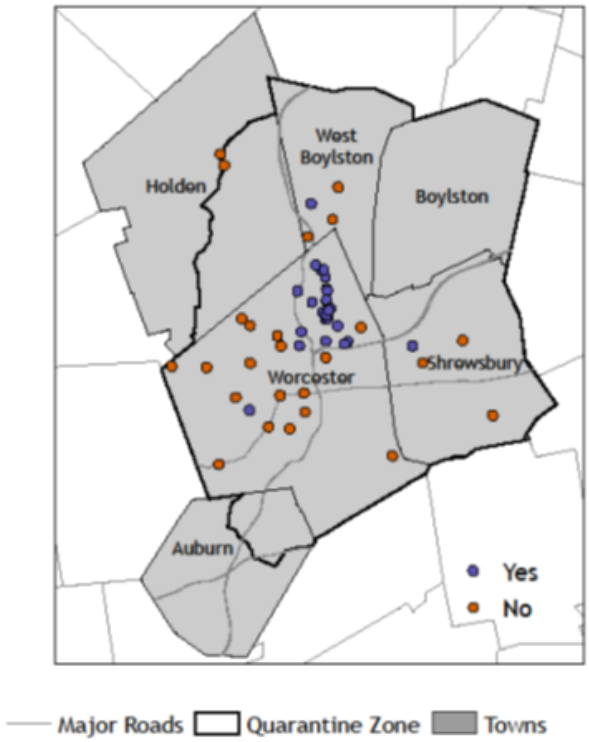

Figure 11: Distribution of survey responses indicating change in neigborhood character since beginning of ALB infestation (source: HERO)

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