



WPI

An Evaluation of the Impacts of the *Greening the Gateway Cities* Pilot Program

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Abstract

Low tree canopy in American cities contributes to numerous environmental, economic and health problems. Planting trees can help lower energy use, improve air quality, and increase quality of life. We worked with the Massachusetts Office of Energy and Environmental Affairs and the Department of Conservation and Recreation to evaluate the impacts of its *Greening the Gateway Cities* tree planting program in Fall River and Chelsea. Our group conducted interviews with officials and residents to understand how they define success and developed a methodology for assessing success using tree coverage models and input from residents. Finally, we provided recommendations to improve the program's outreach and advertising, communication, tree planting & maintenance, and survey development methods.

Executive Summary

An Evaluation of the Impacts of the *Greening the Gateway Cities* Pilot Program Rachael Lanni, Stephen Kosmo and Michelle Addai

Abstract

Low tree canopy in American cities contributes to numerous environmental, economic and health problems. Planting trees can help lower energy use, improve air quality, and increase quality of life. We worked with the Massachusetts Office of Energy and Environmental Affairs and the Department of Conservation and Recreation to evaluate the impacts of its *Greening the Gateway Cities* tree planting program in Fall River and Chelsea. Our group conducted interviews with officials and residents to understand how they define success and developed a methodology for assessing success using tree coverage models and input from residents. Finally, we provided recommendations to improve the program’s outreach and advertising, communication, tree planting & maintenance, and survey development methods.



The Problem

Urban neighborhoods and their residents often suffer from a number of environmental, economic and public health problems that stem from increased urbanization, industrialization, a lack of trees, and old, inefficient infrastructure. On a global scale, cities are responsible for 67% of total energy consumption with the rate in urban areas within the United States being higher than most other developed countries (Sustainable Urban Futures, 2016). Consequently, high amounts of carbon dioxide emissions negatively affect the wellbeing of urban residents and the environment. An important cause of these problems in many cities of the U.S. is the decline in tree canopy, which has decreased nationally at a rate of nearly 4 million trees per year (Nowak, 2012). The lack of tree canopy coverage is a primary concern specifically for the urban neighborhoods of Massachusetts; high pollution levels in Boston were attributed to loss of tree coverage (Nowak, 2012).

Quality of life is also negatively affected, as stated by a resident of Cambridge, “it’s not just the lack of sun and daylight that make people feel gloomier in the winter – it’s the lack of greenery” (Bolton, 2014, para 2).

Therefore, the Commonwealth of Massachusetts hopes to increase urban tree canopy to mitigate energy use, high utility bills for residents, storm water runoff, and poor

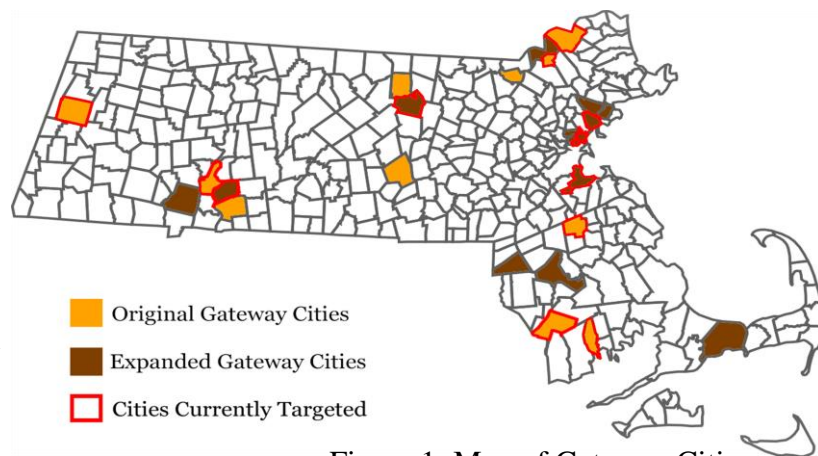


Figure 1: Map of Gateway Cities

air quality (Heat Urban Impacts, 2016). The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) along with the Department of Conservation and Recreation (DCR) has implemented *Greening the Gateway Cities (GTGC)*, a tree-planting program in Massachusetts, to benefit communities by reestablishing previously lost tree canopy. Figure 1 displays the Gateway Cities across the state. The EEA and DCR have already implemented its program in select Pilot Cities, including Chelsea, Fall River and Holyoke, outlined in red in Figure 1 above. These three Gateway Cities were all chosen to start the program because they had ample planting room and a need for canopy, as well as a high elevation for windiness, and available local partners. Over 5,000 trees have been planted in total in an attempt to reduce energy consumption (Cahill, 2015). The EEA and DCR estimates that the program will lower energy use by 10% and save homeowners approximately \$230 per year (EEA, 2016).

Goal

The goal of this project was to evaluate the *GTGC* tree planting program and its impacts on residents and the environment, as well as provide recommendations for future program improvements.

Methods

To achieve our project goal we completed three objectives:

1. Identified various factors that stakeholders in *Greening the Gateway Cities* may use to assess success of the program.

We interviewed Mat Cahill, the *GTGC* program coordinator and Hilary Dimino, the Chelsea city tree forester, with questions focused on whether or not the EEA and DCR's goal was being met and other potential ways of measuring success. We also interviewed local partners and participating residents, in order to identify measures that each group of stakeholders used to define success.

2. Assessed the extent to which programs in participating Pilot Gateway Cities have met the EEA and DCR's standards of success.

We found the existing tree canopy using GIS mapping. We then created a methodology that took existing GIS data on land use, tree canopy location, and tax parcel data to create heat maps of tree canopy in Chelsea and Fall River. These maps provide percentages of land covered by tree canopy for each tax parcel in the areas targeted by the program.

3. Determined how the *Greening the Gateway Cities* program has impacted urban residents.

We interviewed 44 residents from Chelsea and Fall River who had received trees to gather their opinions about the program. We developed three kinds of surveys to conduct with residents in these cities. The surveys targeted residents who participated in the *GTGC* program, residents who had heard about the program and did not participate and the lastly residents who had not heard about the program. We surveyed 21 residents total from both cities.

Findings

We analyzed the data we gathered from literature reviews, computer simulations, interviews and surveys, and then were able to identify elements that contributed to or hindered the success of the *GTGC* tree planting program.

Measures of Success in the Pilot Cities

Finding 1: Stakeholders in *GTGC* measure program success in a variety of ways, including percent increase in tree canopy, high rate of tree survival, and overall improvements to health, relationships, and communities.

Finding 2: Based on stakeholders' measures for defining success and computer simulations, both Fall River and Chelsea have represented successful participants in the Gateway Cities tree planting program, but can further benefit from the addition of trees. Figures ES.1 and ES.2 show locations of high and low tree canopy for Fall River and Chelsea.

Contributors to Success of the Program

Finding 3: The ability of local partners to facilitate tree planting programs played a key role in program success.

Finding 4: Residents' willingness to participate in the *GTGC* tree planting program was influenced by their connection with staff, planters, and foresters.

Finding 5: Seeing tree plantings around different sections of a city stimulated resident interest in the *GTGC* program.

Finding 6: The provision of additional resources for street tree maintenance has been crucial for tree survival.

Chelsea Tree Canopy Percent Change per Tax Parcel



Figure ES.2: Percent Change in Tree Canopy for a Sample Block in Chelsea

Fall River Tree Canopy Percent Change per Tax Parcel



Figure ES.1: Percent Change in Tree Canopy for a Sample Block in Fall River

Limitations that Hinder Program Progress/Success

Finding 7: Some renters lack authority to decide on program participation without getting approval from landlords, which potentially limits program success.

Finding 8: Inefficient communication between program and city officials can diminish residents' confidence in program implementation.

Finding 9: A lack of public awareness of the specifics of the program hindered its implementation in Chelsea and Fall River.

Finding 10: Water restrictions due to drought can hinder program progress in Gateway Cities.

Recommendations

Our recommendations fall under four general themes: Outreach and Advertising Strategies, Program Communication, Tree Planting and Maintenance and Development of Methodology for Future Evaluation.

Outreach and Advertising Strategies

Recommendation 1: The EEA and DCR should raise awareness about the ongoing tree planting program by using local news media and newspapers, and having local partners spread information through word of mouth to supplement door fliers in each participating Gateway City.

Recommendation 2: The EEA and DCR should have students and youth groups involved in *GTGC* tree planting program, in order to facilitate increased awareness of the program to overcome the barrier created by lack of awareness.

Program Communication

Recommendation 3: The EEA and DCR should endeavor to build residents' confidence in program implementation by ensuring that there is effective and regular communication between program staff and city officials.

Recommendation 4: The EEA and DCR should provide additional support to foresters and staff knocking on doors to gather tree planting orders, in order to better promote and implement the program.



Tree Planting and Maintenance

Recommendation 5: The EEA and DCR should carefully consider expanding tree plantings outside of the set quadrants within each Gateway City.

Recommendation 6: The *GTGC* program foresters should emphasize to residents that there is an available help line that residents can call for questions about their trees.

Recommendation 7: For cities without a local support system, the EEA and DCR should regularly check with city officials to see if trees are being properly maintained during the first year of the program and ensure that there is a maintenance calendar for doing so.

Development of Methodology for Future Evaluation

Recommendation 8: The EEA and DCR should consider using a survey as a tool to measure program success, in order to gauge residents' response to the program.

Deliverables

By completing our research objectives, we provided the following deliverables to supplement our recommendations for the EEA and DCR:

- An assessment framework consisting of measures for evaluation, an evaluation process, and a data analysis tool, all of which can help analyze the success of future cities.
- A preliminary survey template can be used by the EEA and DCR to gather feedback about the impact of the program on the community. This can help the EEA and DCR get a larger sample of opinions as to what residents consider most important in deciding whether or not to participate in tree planting programs and thus know what areas to improve on in raising awareness about the program.

Conclusion

Cities throughout the country face the negative impacts of low tree canopy and the cities of Massachusetts are not immune to these impacts. The *Greening the Gateway Cities* tree planting program implemented by the Massachusetts Office of Energy and Environmental Affairs (EEA) and the Department of Conservation and Recreation (DCR) seek to mitigate these negative effects such as storm water runoff, air pollution and high energy costs by increasing tree canopy in Gateway Cities of Massachusetts. In this project, we sought to evaluate the impacts of the *GTGC* tree planting program on the residents and other stakeholders involved. We used Chelsea and Fall River as case studies for our evaluation.

Our literature review, computer simulations, interviews and surveys have informed us that the program has been a success in the Pilot Cities. This success is due in part to the efforts of local partners. Their role in community outreach was instrumental in stimulating interest of residents for the program. The resources provided to and by the local partners were also key to the program's success. Foresters sent out to the cities helped plant the trees correctly, and taught residents how best to care for their trees. Even though the program was successful, there are still areas for improvement. A careful consideration and application of the findings and recommendations developed as part of our project can help bring the EEA and DCR a step closer in ensuring the success of the *GTGC* tree planting program in other Gateway Cities. In the long run, Massachusetts can reach its goal of mitigating the negative impacts of low tree canopy- storm water runoff, high energy use, air pollution, and poor public- in its urban areas.

Authorship

Abstract- *All*

Executive Summary- *All*

Acknowledgements- *All*

1.0 Introduction- *All*

2.0 Background- *All*

2.1 The Role of Urban Tree Canopy on Cities- *Rachael*

2.2 Low Tree Canopy in Cities of Massachusetts- *Michelle*

2.2.1 Massachusetts Energy Reduction Plan- *Rachael*

2.3 Assessing Success of Tree Planting Programs- *Stephen*

2.3.1 Using Computer Models to Estimate Benefits- *Stephen*

2.3.2 Measuring Actual Benefits- *Michelle*

2.3.3 Limitations of Measuring Success- *Stephen*

2.4 Summary- *All*

3.0 Methodology- *All*

Objective 1: Identified various factors that stakeholders in Greening the Gateway Cities may use to assess success of the program- *Rachael and Stephen*

Objective 2: Assessed the extent to which programs in participating Pilot Gateway Cities have met the EEA and DCR's standards of success- *Stephen*

Objective 3: Determine how the Greening the Gateway Cities program has impacted urban residents- *Michelle and Rachael*

3.4 Summary- *All*

4.0 Results- *All*

Finding 1- *All*

Finding 2- *Stephen and Rachael*

Finding 3- *Michelle*

Finding 4- *Rachael*

Finding 5- *Michelle*

Finding 6- *Michelle*

Finding 7- *Stephen and Rachael*

Finding 8- *Rachael and Stephen*

Finding 9- *Michelle and Stephen*

Finding 10- *Stephen*

4.4 Summary - *Michelle*

5.0 Recommendations and Conclusion- *All*

Recommendation 1- *Michelle and Stephen*

Recommendation 2- *Michelle*

Recommendation 3- *Michelle*

Recommendation 4- *Rachael*

Recommendation 5- *Rachael*

Recommendation 6- *Michelle and Rachael*

Recommendation 7- *Michelle and Rachael*

Recommendation 8- *Stephen*

5.5 Deliverables - *Michelle*

5.6 Conclusion- *Stephen*

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Table of Contents

Abstract.....	ii
Executive Summary.....	iii
Authorship.....	viii
Acknowledgements.....	ix
Table of Contents	x
List of Figures and Tables.....	xii
Chapter 1: Introduction	1
Chapter 2: Background	2
2.1 The Role of Urban Tree Canopy on Cities.....	2
2.2 Low Tree Canopy in Cities of Massachusetts	3
2.2.1 Massachusetts Energy Reduction Plan	4
2.3 Assessing Success of Tree Planting Programs	5
2.3.1 Using Computer Models to Estimate Benefits	5
2.3.2 Measuring Actual Benefits.....	5
2.3.3 Limitations of Measuring Success	6
2.4 Summary	6
Chapter 3: Methodology.....	7
Objective #1: Identified various factors that stakeholders in <i>Greening the Gateway Cities</i> may use to assess success of the program.....	7
Objective #2: Assessed the extent to which programs in participating Pilot Gateway Cities have met the EEA and DCR’s standards of success.....	8
Objective #3: Determined how the <i>Greening the Gateway Cities</i> program has impacted urban residents.....	8
Chapter 4: Results.....	9
4.1 Measures of Success in the Pilot Cities.....	9
4.2 Contributors to Success of the Program	13
4.3 Limitations that Hinder Program Progress/Success	15
4.4 Summary	16
Chapter 5: Recommendations and Conclusion.....	17
5.1 Outreach and Advertising Strategies.....	17
5.2 Program Communication	17

5.3 Tree Planting and Maintenance	18
5.4 Development of Methodology for Future Evaluation	19
5.5 Deliverables	19
5.6 Conclusion	20
References.....	21
Appendices	24
Appendix A.i: Mapping Plan for Cities with Trees Already Planted	24
Appendix A.ii: Mapping Plan, Potential Cities Where Tree Planting Has Not Started	25
Appendix B: Interview Questions for <i>GTGC</i> Staff/Experts	26
Appendix C: Interview Questions for Nonprofits	27
Appendix D: Questions for Surveying Residents in Fall River	28
Appendix E: Questions for Surveying Residents in Chelsea	30
Appendix F: Resident Mail Survey	32

List of Figures and Tables

Figure 1: A map of the Massachusetts Gateway Cities.....	4
Table 1: How Stakeholders Define Success of the <i>GTGC</i> Program.....	9
Table 2: Tree Growth Estimates for Planting Zones in Chelsea and Fall River.....	10
Figure 2: Percent Tree Canopy in a Sample Block in Fall River.....	11
Figure 3: Percent Tree Canopy in a Sample Block in Chelsea.....	12

Chapter 1: Introduction

Urban communities suffer from a number of environmental, economic and public health issues. Some of these negative issues include increased levels of air pollution, increased pollution in storm water runoff, and increased levels of energy usage (Akbari, 2005). On a global scale, cities are responsible for 67% of total energy consumption with urban America consuming more than most other developed countries (Sustainable Urban Futures, 2016).

There are numerous causes of negative environmental impacts, such as increased urbanization, industrialization, a lack of trees, and old, inefficient infrastructure. An important cause in many U.S. cities is a decline in tree canopy; urban tree canopy has decreased nationally at a rate of nearly 4 million trees per year (Nowak, 2012). Low tree canopy is a primary concern for urban Massachusetts; in Boston for example, high pollution levels were attributed to a loss of 0.3 square meters of tree coverage per capita annually between 2003 and 2008 (Nowak, 2012). Quality of life is also negatively affected, as stated by a resident of Cambridge, “it’s not just the lack of sun and daylight that make people feel gloomier in the winter – it’s the lack of greenery” (Bolton, 2014, para 19).

Therefore, many cities have begun exploring how to increase tree canopy to reduce the various negative impacts facing urban neighborhoods. Many case studies across the country show how increased tree canopy can mitigate these negative impacts. For example, urban tree canopy has been shown to reduce air pollution by keeping “pollutants already in the air from becoming even more volatile” (Benefits of Urban Trees, 2014). A separate study in Sacramento, CA used tree shade simulations to determine a weighted annual average savings of 156 kilowatts per hour per mature tree based on trees planted for 178 residences (Simpson, 2002).

Massachusetts hopes to use similar methods to measure the effects of increased urban tree canopy, such as energy reduction, decreased storm water runoff, improved air quality, and less greenhouse gas emissions (Heat Urban Impacts, 2016). The MA EEA and DCR have started *Greening the Gateway Cities (GTGC)*, a tree-planting program which aims to benefit communities by increasing tree canopy. The EEA and DCR have already implemented its program in select Pilot Cities, including Chelsea, Fall River and Holyoke. They have planted over 5,000 trees total in an attempt to reduce energy consumption (Cahill, 2015). The EEA and DCR estimate that the program will lower energy use by 10% and save homeowners approximately \$230 per year (EEA, 2016). However, it is unknown how accurate these estimates are. Furthermore, the EEA and DCR’s focus on energy savings is only one measure of success. These limitations prevent the EEA and DCR from accurately measuring the socioeconomic benefits of increased tree coverage and justifying the success of their program.

The goal of this project was to evaluate the *GTGC* tree planting program and its impacts on residents and the environment, as well as provide recommendations for future program improvements. In order to accomplish this goal, we first identified various measures that stakeholders may use to assess success of the program. These stakeholders include the EEA and DCR, local partners, and participating residents. Secondly, we assessed the extent to which programs in Chelsea and Fall River have met all stakeholders’ measures of success. Lastly, using these measures identified from the first objective, we evaluated how the *GTGC* program has impacted urban residents. Completing these objectives enabled us to develop a methodology and recommendations for the EEA and DCR to use to assess the *GTGC* program in the future. Utilizing this proposed methodology can help the EEA and DCR in facilitating the expansion of the program, for the continued benefit of urban Massachusetts communities.

Chapter 2: Background

This chapter illustrates how increased tree canopy can benefit urban residents, cities and the local environment by mitigating multiple negative environmental and public impacts. First, we discuss the influences of tree canopy and the various ecosystem services associated with tree planting. We then examine the effects of low tree canopy in urban areas of Massachusetts and the role of the Massachusetts Office of Energy and Environmental Affairs and Department of Conservation and Recreation with its *Greening the Gateway Cities (GTGC)* tree planting program mitigating the negative effects of low tree canopy. Finally, we provide insight into what other cities have done to combat the many problems caused in part by low tree canopy, as well as the limitations and success they have encountered in the process.

2.1 The Role of Urban Tree Canopy on Cities

American cities that have lost a significant amount of tree canopy also suffer from the loss of the various ecosystem services that are provided by trees. Many of these impacts on cities include:

- Improving social environments
- Reducing energy consumption
- Increasing property values
- Decreasing air pollution and greenhouse gas emissions
- Improving storm water management

Ecosystem services vary when the amount of tree canopy varies within a city.

If tree canopy is present and ample, cities are able to benefit in a number of ways. However, when tree canopy is lacking, many ecosystem services are not present, which in turn can negatively impact residents and their local environment.

First, trees provide a number of social benefits to urban residents, such as facilitating friendlier interactions, discouraging crime, encouraging healthier lifestyles, and positively influencing community perceptions. Adults and children experience healthier relationships when around greener urban areas (Prow, 1999). In a photo simulation study, residents identified settings with trees as places where they would feel the safest (Prow, 1999). Moreover, tree shaded sidewalks encourage pedestrian activity, which can improve the physical health of city dwellers and reduce stress (McPherson, 1992). Cities with large hospitals may also be doing their patients a favor by planting trees, as recovery times tend to be shorter when patients have views of trees, parks or other greenery from their hospital rooms (McPherson, 1992).

Second, increased tree canopy reduces energy consumption, by providing shade in the summer and blocking winds in the winter. During the summer, shade trees cool buildings by preventing direct sunlight and cool the air through evaporation (Troy, 2012). In Toronto, planting urban trees was estimated to reduce “residential energy costs for air conditioning by \$9.7 million annually, based on 2008 electricity prices” (Swaka, 2013, pg 2). A study in Chicago found similar results, in which privately planted trees reduced energy use from air conditioning by anywhere from 10 to 50% (McPherson, 1994). In the winter, urban tree canopy can lower wind speeds by as much as 50%, resulting in an average of 15% reduction in energy use for heating (McPherson, 1995). Therefore, increasing tree coverage is able to conserve energy year-round, greatly reducing the costs of utilities throughout urban cities. On average, the addition of one tree can save a building up to \$200 on heating and cooling bills combined annually (Troy, 2012).

Third, increased tree canopy contributes to increased property values in urban neighborhoods, which may have lacked green space due to urbanization. A study conducted on residential property values around the metropolitan area of Atlanta found that houses with trees sold for about 5% higher than those without them (Anderson, 1985). Trees add to the value of a community as a whole too, because neighborhoods with lower property values experience a greater positive economic impact from tree planting (Wolf, 2007). On average, increases in tree canopy has been qualitatively correlated to an increase in business generation, tax revenues, income levels, employment, worker productivity, and amount of customers (Coder, 1996).

Fourth, additional trees absorb larger amounts of carbon dioxide together, in order to help fight air pollution. On average, a single tree is able to store nearly 13 pounds of carbon every year (Evans, 2001), with urban forests being able to store upwards of 5.6 million metric tons of carbon (McPherson, 1997). Fewer trees results in fewer cleaning agents for the air, leading to an increase in air pollutants, such as CO₂ (McPherson, 1997). Increasing tree coverage also contributes more oxygen to the environment which helps fight climate change by offsetting pollution from car emissions and greenhouse gases (Evans, 2001).

Finally, increased tree canopy reduces the amount of storm water runoff that can carry harmful pollutants throughout city streets. The bark and leaves of trees catch rain, then form an extremely moist layer of soil which discourages the runoff (Fazio, 2010). A single mature tree, located in an urban setting, itself can intercept between 500 and 760 gallons of storm water annually (Cotrone, 2016). Furthermore, a North Carolina study found that when urban forests were converted to suburban greenery, the infiltration rate decreased by nearly 8 inches per hour (Cotrone, 2016). Therefore, increasing tree coverage in urban areas can help decrease flooding, as well as keep contaminated pollutants out of the water.

2.2 Low Tree Canopy in Cities of Massachusetts

Low tree canopy is associated with a number of negative environmental and public health problems such as storm water runoff, high energy costs and air pollution caused by high carbon emissions (EEA, 2016). Cities of Massachusetts are not immune to these negative effects. For example, due to a beetle infestation in Worcester in 2008 and a tornado in Springfield in 2011, both towns suffered massive tree loss. Over 29,000 trees were removed in Worcester, and Springfield saw destruction of nearly 44% of tree canopy in the affected areas (Morzuch, 2013). Furthermore, a study done in Lawrence, Massachusetts found that the city had less than optimal tree canopy compared to other cities of its size across the country. These cases lead to several studies showing how the effects of low tree canopy such as storm water runoff, poor air quality, and high carbon emissions could be reduced in order to enhance quality of life and contribute to energy savings (O'Neil-Dunne, 2010).

In Massachusetts, addressing the various negative impacts of low tree canopy within cities falls under the responsibility of the Massachusetts Office of Energy and Environmental Affairs. The EEA was established in 1975 with an overall mission to “safeguard public health from environmental threats and to preserve, protect, and enhance the natural resources of the Commonwealth,” which it attempts to accomplish primarily through increased energy efficiency. The EEA and DCR have already begun implementing its own tree planting program, *Greening the Gateway Cities (GTGC)*, throughout the state in order to increase tree canopy throughout Massachusetts, while additionally reducing energy consumption and greenhouse gas emissions (CECP, 2015).

2.2.1 Massachusetts Energy Reduction Plan

The Gateway Cities are “former industrial hubs” which make up 30% of the state’s population (Christenson, 2014, para 1). Over the past few decades, these cities have suffered “job and population declines as well as the burdens of aging infrastructure” (Christenson, 2014, para 2). Figure 1 is a map showing where the Gateway Cities are distributed throughout the state of Massachusetts:

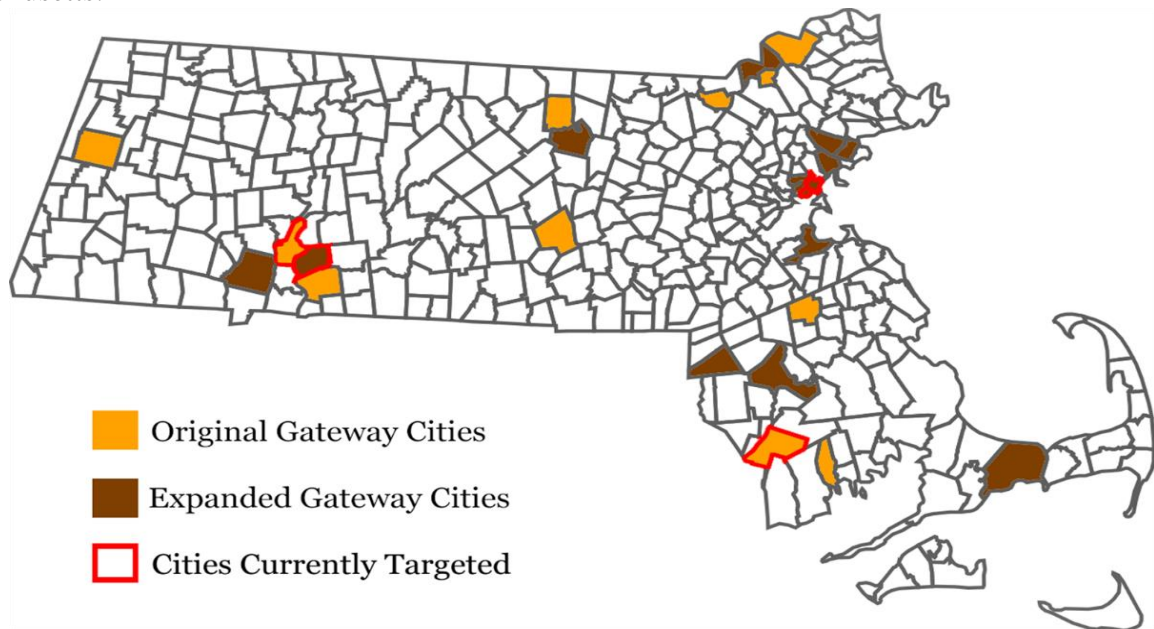


Figure 1: A map of the Massachusetts Gateway Cities

The pilot program initially included Chelsea, Holyoke and Fall River, and expanded in 2015 to also include Revere and Chicopee. The program has a goal of planting fifteen thousand trees across Chelsea, Holyoke and Fall River “to reach the goal of increasing tree canopy by 10 percent” over the next 30 years (NASF, 2014, para 5). Evidence of success of the tree planting program in pilot cities can justify the expansion of *GTGC* and brings the state closer to reaching its target goal of reducing energy costs for businesses and private homeowners by a total of \$84 million in 2020 (Bowles, 2010).

For this program to be economically viable, expected energy savings must outweigh the costs and maintenance of planting trees throughout the communities. In the program's pilot cities by 2015, a total of 3,688 trees have been planted at a cost of \$461 per tree (GGC Report, 2015, pg 8). With the target of 15,000 trees planted, the pilot program alone could cost a total of \$6.9 million. However, this is only 8% of the above predicted \$84 million expected savings. Therefore, developing a methodology to assess the success of the tree planting program can help justify further expansion of the program to other cities in the state.

2.3 Assessing Success of Tree Planting Programs

In many past tree planting programs implemented in the United States, success was measured by comparing simulated benefits and the actual benefits from the program. However, this method has several limitations, such as simulations not accounting for variance, and the time needed to observe actual benefits.

2.3.1 Using Computer Models to Estimate Benefits

Past tree planting programs have used computer models to estimate success. California implemented a tree planting program across the state with a goal to increase tree canopy by planting approximately 75,000 trees (Simpson, 1996). To determine the success of this program in mitigating energy use, a software program called the Shadow Pattern Simulator simulated the amount of shade different tree orientations would have on a building, based on cardinal direction, distance from the building, and tree size (Simpson, 1996). Using the data from this simulation in conjunction with weather and energy use data from 11 of California's 16 climate zones, the study estimated that the program would result in energy savings of approximately 21% (Simpson, 1996). Six years after the program's implementation, the simulations were compared to actual energy savings data, with results showing the actual energy savings to be within a margin of error of simulations (Simpson, 2002).

Chicago similarly used the Shadow Pattern Simulator in conjunction with Micropas, a weather simulation software, in order to see how shading from tree canopy affects energy use (McPherson, 1994). These simulations found that increasing tree cover by 10%, or approximately three trees per building, decreased annual cooling costs by 21% and annual heating use by 4% (McPherson, 1994). Together, both studies indicate that computer models can accurately measure real life benefits of tree canopy and help prove success of tree planting programs.

2.3.2 Measuring Actual Benefits

When examining actual benefits of a tree planting program, there are many factors to consider, including tree survival rate, the total number of trees planted in a community, and the perception of participating residents. Past tree planting programs have taken various approaches when analyzing the success of their programs.

In Sacramento, researchers defined success as having a higher rate of tree planting compared to tree removal (Dilley, 2013). The researchers then asked residents who planted more trees what they enjoyed about them and "found shade and aesthetics to be the main reasons residents chose to plant trees; energy savings, environmental benefits, privacy, and property values were of lesser importance" (Dilley, 2013, pg 269). Shade and aesthetics can also be important measures of success, because both stimulate resident interest and participation in the program. Residents can still experience additional economic, environmental, and health benefits, even if doing so was not their motivation for initially joining the tree planting program.

In a study conducted in selected urban areas of California and Pennsylvania, success was determined through annual tree survival rate (Roman, 2015). The study areas were very successful by this measure, as evident in their high tree survival rate compared to that of other urban areas in the country. In East Palo Alto, California, the annual survival rate of a total of 568

trees planted was 99.4 % after a period of six years. This high rate was also recorded in Kingsessing (150 trees planted) and Powelton (94 trees planted), Pennsylvania with 98.4% and 95.4% annual survival, respectively, within the same period of time (Roman, 2015). The greatest reason for such high tree survivability was the contribution from local partners in helping to implement the planting project. Local groups enhanced their staffing capacity through intensive volunteer and youth internship programs, which mixed professional arborists with novices learning for the first time about the role of trees (Roman, 2015). The study concluded with the assertion that “stewardship played a vital role” in the success of the tree planting program, in order to provide additional maintenance help during the most important first few years of program implementation when trees were still very young (Roman, 2015, pg 1180).

2.3.3 Limitations of Measuring Success

Comparing real world data to simulations is an effective, but limited method to measure success. For example, when estimating energy savings in California, the main limitation was the size of the sample used for the simulation. The sample used had large variance in energy use; with air conditioning, the range of energy use was between 5-100 kWh. If only the two houses at the end of the range are used, the average energy use is 52.5 kWh, whereas the actual average was only 26 kWh (Simpson, 2002). Thus demonstrating how simulated results could differ greatly from actual results.

For the researchers in Chicago, the main limitation was reliability of information. Due to a “lack of research-based guides,” much of the data used in the simulations had to be extrapolated (McPherson, 1994, pg 123). At the time, the US Forest Service was only in its second year of providing research on the various effects of urban forests (US Forest Service, n.d.). Thus, the researchers in Chicago had to rely on empirical research wherever possible. However, data such as compensation for damaged trees could not be supported due to large variance in the small sample of data collected (McPherson, 1994). In the years since, the research on urban forestry has progressed to the point where it has its own subsection in the US Forest Service website, with new research being posted regularly (US Forest Services, n.d.).

Time is another limitation to consider when quantifying the success of a tree planting program because most benefits are unable to be measured until a tree has fully matured. For the tree planting program in Sacramento, the simulations were done in 1992, and empirical data was not taken until 2002.

2.4 Summary

Overall, much is known about the process of analyzing tree planting programs. However, the process has many flaws and limitations. The EEA and DCR have already started implementing their own tree planting program in Massachusetts and hopes to prove that the program has been successful. In order to prove this success, the flaws and limitations in past programs must be taken into account with respect to Massachusetts.

Chapter 3: Methodology

The goal of this project was to evaluate the *Greening the Gateway Cities* tree planting program and its impacts on residents and the environment, as well as provide recommendations for future program improvements. In order to accomplish this goal, we focused on two Pilot Cities, Fall River and Chelsea, and completed the following objectives:

Objective #1: Identified various factors that stakeholders in *Greening the Gateway Cities* may use to assess success of the program.

Objective #2: Assessed the extent to which programs in participating Pilot Gateway Cities have met the EEA and DCR's standards of success.

Objective #3: Determined how the *Greening the Gateway Cities* program has impacted urban residents.

Completing these objectives enabled us to develop a methodology for the EEA and DCR to use to assess the *GTGC* tree planting program in the future, which includes:

1. GIS and iTree methods for measuring the increase in tree canopy in Gateway Cities and
2. Suggestions for a survey to be conducted with residents

Objective #1: Identified various factors that stakeholders in *Greening the Gateway Cities* may use to assess success of the program.

In order to determine what constitutes success of the *GTGC* tree planting program, we first examined different perspectives on ways to gauge success. This was done by answering several research questions: Who are the various stakeholders? How successful does each stakeholder expect the program to be? What does each stakeholder hope to get out of the program? We answered these questions using case studies of past tree planting programs and interviews with: residents in Chelsea and Fall River, officials from the EEA and DCR, members of the various non-profits that partnered with the program, and other urban forestry experts.

To identify what measures the EEA and DCR used to define success, we interviewed Mat Cahill, the *GTGC* program manager and coordinator, as well as Hilary Dimino, the Chelsea city tree forester, with questions focused on whether or not this goal was being met and other potential ways of measuring success (Appendix B). Proof of concept for these measures were tested using mapping on three potential Gateway Cities, North Adams, Greenfield and Athol.

Local partners working with the program in select Gateway Cities were interviewed to determine their measures for success. The partners we focused on were Chelsea Green Roots and the Fall River Tree Program. We also worked with those same partners to ask residents about their thoughts on the tree planting program in order to determine the community's perception of success (Appendix D and E).

Along with information from the local partner interviews, a methodology similar to the one used for the EEA and DCR was also used to interview residents. We primarily interviewed residents by phone. We also worked with Adela Gonzalez, the Junior Organizer from Green Roots to interview residents on the streets of Chelsea. For Fall River, Mary Ann Wordell, the Fall River nonprofit tree program co-manager helped our team attend a neighborhood meeting that was used as a focus group.

While determining which factors make the *GTGC* tree planting program successful, we also considered a possible limitation in doing so. While we aimed to include as many factors as

possible, we also understood that we simply could not have included them all. When analyzing our recommendations, it should be noted that these are not the only ways to determine success.

Objective #2: Assessed the extent to which programs in participating Pilot Gateway Cities have met the EEA and DCR's standards of success.

As was determined above, the amount of canopy increase was an important factors of success for the EEA and DCR. To find the amount of canopy increase, our team answered several research questions: What is the existing canopy? What is the maximum potential increase? What was the actual increase? The questions were answered using a combination of GIS mapping, groundwork, research, and interviews with foresters from Chelsea and Fall River.

First, existing canopy was found using GIS mapping. The University of Vermont used a combination of GIS mapping and analysis of satellite imagery data to find a heat map of the existing and potential tree canopy in Lawrence, MA (O'Neil-Dunne, 2010). Our team created our own methodology (Appendix A.i) that took existing GIS data on land use, tree canopy location, and tax parcel data to create our own heat maps of existing tree canopy in Chelsea and Fall River. Once existing canopy was found, research was done to find the expected canopy growth. To find this increase, we needed to know the location and species of the trees planted, we grew tree canopy in GIS, as well as the expected survival rate for the trees. The former was provided using GIS databases, and the later was found through the interviews with foresters.

Objective #3: Determined how the *Greening the Gateway Cities* program has impacted urban residents.

Determining how the tree planting program has impacted residents provided further insight for program improvements. We gathered input from two sources:

Interviews: We interviewed a total of 44 residents in both Chelsea and Fall River over the phone with the set of semi-structured interview questions we had developed (Appendix D and E). The EEA and DCR provided us with the list of residents who participated in the program in Chelsea, while Mary Ann Wordell provided us with a list of residents from Fall River. The interview questions which revolved around reasons for opting for a tree, whether the tree had impacted a resident's personal life and what benefits the resident hoped for, provided us with the opportunity for a friendly, yet interactive discussion with residents.

Surveys: We developed three surveys for residents in Chelsea and Fall River: The first targeted residents who participated in the *GTGC* program; the second targeted residents who had heard about the program, but did not participate; the last targeted residents who had not heard about the program. In Chelsea, we were accompanied by Adela Gonzalez with Chelsea Green Roots who acted as a translator because a majority of the residents spoke Spanish. We surveyed 8 residents total. In Fall River we surveyed 12 residents in a neighborhood meeting. The protocol for this meeting as well as the topics discussed can be found in Appendix D and E.

Completing our objectives through the methodology presented enabled us to achieve our goal and make recommendations for improving the *GTGC* tree planting program. In our next two chapters we present our findings obtained through the completion of our objectives, discuss implications of our findings and then provide our recommendations derived from these findings for the future expansion of the program.

Chapter 4: Results

We analyzed information gathered from literature review, our computer simulations, interviews and surveys to determine the major factors that contributed to the successes and limitations of the *Greening the Gateway Cities* tree planting program. Our findings are presented in the following three categories, 1) Measures of Success in the Pilot Cities, 2) Contributors to Success of the Program, 3) Limitations that Hinder Program Progress/Success.

4.1 Measures of Success in the Pilot Cities

Finding # 1: Stakeholders in GTGC measure program success in a variety of ways, including percent increase in tree canopy, high rate of tree survival, and overall improvements to health, relationships, and communities.

Table 1 displays each stakeholder group, including the EEA and DCR, local partners and residents, and what we found for how they primarily define success of the tree planting program.

Table 1: How Stakeholders Define Success of the *GTGC* Program

Stakeholders	Indication of Success	Outcome
EEA and DCR	5% increase in tree canopy Decrease in energy usage (2% per 1% increase in canopy for summer, 1.5% per 1% increase in canopy for winter) >80% tree survival rate	Residents are satisfied with their trees and would recommend the program
Local Partners	>80% tree survival rate Gets residents involved in community Improves community outlook	Residents are satisfied with their trees and would recommend the program Educates residents Creates jobs Decrease in energy usage
Residents	Tree survival Improves community outlook Reduces stress, healthier living, improves social relationships	Decrease in energy usage Increase in property value

First, the Office of Energy and Environmental Affairs and Department of Conservation and Recreation indicate program success through a 5% increase in tree canopy and a measurable decrease in energy usage, following the mission of the agency (Table 1). Based on past GIS mapping, the EEA and DCR had an original goal to plant 5 trees per acre in each of the pilot cities, chosen because it was expected to correlate with a 10% increase in tree canopy (Mat Cahill, personal communication, September 23, 2016). A 10% increase in canopy is anticipated to result in an average of +10% in energy savings in summer and +10% savings in the winter (Mat Cahill, personal communication, September 23, 2016). However, initial mapping of trees

planted showed numbers much lower than 10 trees per acre. Therefore, success was simplified to a 5% increase in tree canopy on plantable land.

Second, for local partners, success of the program was defined as having 80% or more of street trees and residential trees surviving within the first two years of planting (Table 1). The outcome of this was that the overall outlook of the community was improved and more residents were more likely to have a stronger involvement with the local partners.

Third, residents' view of success as indicated from interviews and survey was seeing trees survive and mature as well as experiencing benefits such as beautification of the community and a healthier environment in the long run (Table 1).

Finding # 2: Based on stakeholders' measures for defining success and computer simulations, both Fall River and Chelsea have represented successful participants in the Gateway Cities tree planting program, but can further benefit from the addition of trees.

Fall River:

According to the EEA and DCR's measures of success, we determined that Fall River has been a successful participating Pilot City. As can be seen in Table 2, calculations show an expected tree canopy increase of 3.2%, or 29.5 acres over 20 years. While the percent change is much lower for the entire city, this is because the EEA and DCR were only concerned with the change for plantable land in the neighborhoods where planting was focused. Plantable land was defined as areas in zones where planting was possible, without buildings or existing tree cover.

Table 2: Tree Growth Estimates for Planting Zones in Chelsea and Fall River

City	Total Acres	Total Plantable Acres (% of total)	Estimated Additional Canopy from planting (Acres)	Percent of plantable land covered by additional canopy (After 20 yrs)	Percent of total planting zone land covered by additional canopy (After 20 yrs)
Chelsea	972	443 (45.6)	31.6	7%	3.25%
Fall River	2261	916 (40.5)	29.5	3.2%	1.3%

While this does not quite meet the EEA and DCR's goal of 5% increase, Fall River is still in the process of planting more trees and this number is expected to increase. Furthermore, even a 3.5% increase is expected to lead to a 7% decrease in energy use in summer and a 5.25% decrease in the winter (Mat Cahill, personal communication, September 23, 2016). In addition to canopy increase and energy reduction, the majority of the trees planted are healthy, with an expected survival rate of 80-85% (Mary Ann Wordell and Andy DeSantis, personal communication, September 26 and 21, 2016). These calculations were based on an average mature tree crown diameter of 50'. Figure 2 is a heat map of the change in tree cover for a sample neighborhood in Fall River. In the map, many blocks are red, denoting no increase. It should be noted that as only 40.5% of Fall River was plantable, some of the red blocks fall into areas where planting was not possible, thus understating the increase. In Figure 2, a major

portion of the map is yellow, meaning an increase of less than 5%. However, even though the city has only just started implementing the program, there are still blocks that are estimated to see greater than 5% increase, with some blocks having increases of 83%.

Fall River Tree Canopy Percent Change per Tax Parcel

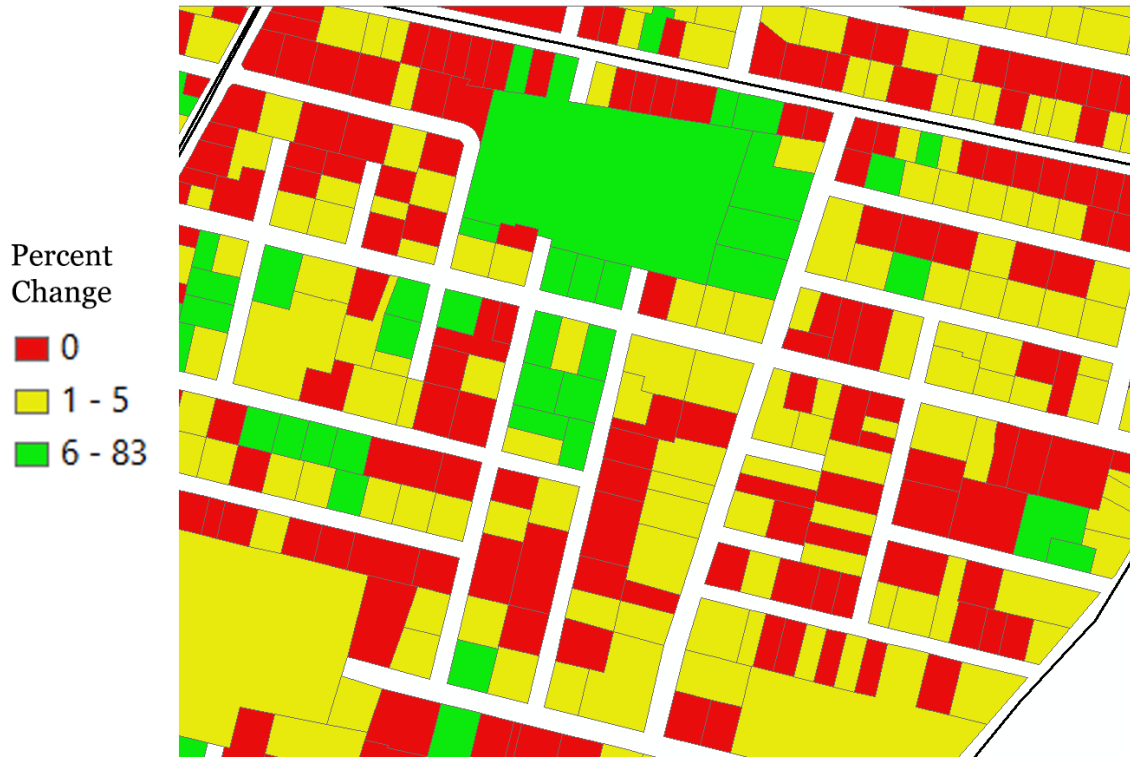


Figure 2: Percent Change in Tree Canopy for a Sample Block in Fall River

Fall River remained a success when looking at its role in the program through the eyes of local partners too. Ms. Wordell, the Fall River local co-manager, noted that most trees have held up well since the initial plantings and that the majority of residents were extremely receptive to the program (Mary Ann Wordell, personal communication, September 26, 2016). Program managers were especially happy to see a barren spot in the Sandy Beach neighborhood have over 75 trees planted, calling it “absolutely beautiful now.” As evidenced through mapping Fall River’s urban tree canopy increase, residents and Ms. Wordell also agreed that there is additional planting room within the city. Ms. Wordell noted that Sandy Beach especially has prime land for more trees, specifically within the Housing Authority land and around a local bread company (Mary Ann Wordell, personal communication, September 26, 2016).

Participating residents agreed that the tree planting program has been an overall success in their city too. One resident stated that the addition of trees has “certainly improved shading on the property” (Fall River resident phone interviews, personal communication, September 28, 2016). Another resident noted that the program “beautifies the neighborhood”, and stated that they wish more residents would sign up for the program (Fall River resident phone interviews,

personal communication, September 28, 2016). Some residents emphasized how the program has benefited their community as a whole, with tree plantings all down their streets.

Chelsea:

According to the EEA and DCR’s measures of success, Chelsea has been another successful Gateway City in the Pilot Program. The expected increase in tree canopy in Chelsea is almost four times as high as the goal for the program. As seen above in Table 2, calculations show an expected increase of 7% in plantable areas, or 31.6 acres, in 20 years. The increase in tree canopy should result in 14% energy savings in the summer, and 10.5% energy savings in the winter (Mat Cahill, personal communication, September 23, 2016). Furthermore, the trees are expected to have an 80% survival rate over two years (Mat Cahill, personal communication, September 23, 2016). Below is Figure 3, a heat map of the change in tree canopy for downtown Chelsea. As the program is wrapping up in the city, a large amount of the area is already green, meaning an expected increase of over 5%. However, there is a large amount of area that is yellow, or less than a 5% increase. There is also red area with no increase in tree canopy, yet this again is understated as in Fall River, because only 45.6% of total land was plantable.

Chelsea Tree Canopy Percent Change per Tax Parcel



Figure 3: Percent Change in Tree Canopy for a Sample block in Chelsea

The increase in Chelsea’s canopy is an area similar to the expected increase in Fall River, only 2 acres more. However, it is a much larger percent increase because of the smaller area targeted in Chelsea. The planting zones in Fall River covered 2261 acres, whereas Chelsea’s

planting zones were only 972 acres. Even though Chelsea meets the goal for success, there is still room for improvement in the city. A tree inventory “listed 476 open planting sites available” (Andy DeSantis, personal communication, September 21, 2016).

GTGC program staff further agreed that Chelsea has been an overall success, especially serving as the program’s first pilot city. The EEA and DCR have met 65% of their initial 2000 trees planted goal in the city so far. Mat Cahill, *GTGC* program manager, said part of the reason Chelsea was chosen to plant in first was due to how difficult it could be in such a tightly packed city, saying that “if we can do it there, we can do it anywhere” (Mat Cahill, personal communication, September 23, 2016). Furthermore, Andy DeSantis, Chelsea’s tree warden agreed, stating “A definite yes as an overall successful program.” A recent tree inventory for Chelsea found an increase from 2,000 trees in 2009 to almost 4,000 currently (Andy DeSantis, personal communication, September 21, 2016). In addition to reaching the goal for increased tree canopy, Mr. DeSantis added that “Subjectively the City looks greener. I think there is more awareness of the public shade trees.”

We determined that local partners working with *GTGC* also deemed the program a success in Chelsea, based on the improvements the program has brought to the city. One worker from a local Chelsea company stated that “Generally speaking, the company’s relationship with nonprofits has improved since we have made an effort to be more environmentally friendly” (Chelsea phone interviews, personal communication, September 30, 2016). By planting trees, relationships between community groups has been positively affected. Furthermore, Maria Belen Power, who runs Green Roots and formerly part of the Chelsea Collaborative, noted that the tree planting program most importantly brought “benefits to a low income community of color” (Maria Belen Power, personal communication, September 21, 2016). This was accomplished not only through environmental justice by adding trees, but also by creating jobs and educating residents about the benefits of trees.

Measures of program success from residents were found to further prove success of *GTGC* in Chelsea. Most residents appreciated the aesthetics of their tree plantings, saying that both their property and streets looks improved. One resident stated that the tree “Makes you smile when you come outside and gives you something to think about, worry about, and just emotionally and psychologically makes you feel better” (Chelsea resident phone interviews, personal communication, September 30, 2016). More so, it was the pride that accompanied having the tree to take care of that the resident liked the best. Another resident enjoyed that the program’s trees provided a “conversation starter” or “bonding piece” for neighbors, who they otherwise would not have spoken to (Chelsea resident phone interviews, personal communication, September 30, 2016).

4.2 Contributors to Success of the Program

Finding # 3: The ability of local partners to facilitate tree planting programs played a key role in program success.

Local partners have contributed significantly to success of the program by acting as the connection between the EEA, DCR and residents. Hilary Dimino, the EEA and DCR’s Chelsea and Revere forester, noted that the support from the Chelsea Collaborative greatly influenced a resident’s decision to get trees because of the broad network the Collaborative had with the residents. Since the Collaborative had already familiarized themselves with the people of the city through events and services, the foundation of trust had been laid. Ms. Dimino also noted that

“having one core central nonprofit group working collectively for the betterment of the city is helpful” for program implementation (Hilary Dimino, personal communication, September 21, 2016). Ms. Dimino stated that outreach was much easier in Chelsea compared to Revere, where a local organization has yet to be found to work with, and that she missed the help from the Chelsea Collaborative.

Ms. Dimino, when asked about a specific resident in Chelsea, was able to identify the resident’s full name as well as the tree species that was planted on the resident’s property. This indicated that program staff had an interest in remembering pertinent information about the participating residents. Doing so, along with the help from community partners like the Chelsea Collaborative to provide a network, positively influences success of the program.

The Environmental Chelsea Organizers (ECO) team was a subsection of the Chelsea Collaborative and a youth movement working toward social and environmental justice in Chelsea. They have helped in facilitating the *GTGC* program. This team, made up of a diverse group of students with the ability to speak Spanish fluently, participated in outreach programs to alert the community about the ongoing tree planting program. This overcame the language barrier for some residents, raised awareness, and invited more residents to participate. Andy DeSantis, the former Chelsea tree warden, noted that occasionally the local partner is called for another tree planting on private residential property (Andy DeSantis, personal communication, September 21, 2016).

Finding # 4: Residents’ willingness to participate in the *GTGC* tree planting program was influenced by their connection with staff, planters, and foresters.

We found that the EEA and DCR foresters played a significant role in determining resident participation in the program. Mat Cahill stated that urban forestry is not just about the forest, but is often more social, with foresters interacting with the communities (Mat Cahill, personal communication, September 23, 2016). Thus, foresters were experts in both tree care and community outreach. Ms. Dimino emphasized that using buzzwords was important to convince residents when knocking on their doors, as they were more likely to participate if the benefits of doing so were explained to them. Mr. Cahill added that trees take serious commitment and cannot just be handed out like light bulbs, immediately benefiting the owner.

Residents in Fall River also added to our understanding of the importance of foresters in the tree planting program’s success. Many residents stated that the arborists and foresters were extremely helpful in determining the best placement and care for their trees. Some residents remember getting a tree that was not the best quality, and it was replaced right away. One Fall River resident in the Maplewood neighborhood had trouble with winter moths infesting the trees (Fall River resident phone interviews, personal communication, September 28, 2016). This resident noted how helpful the program staff was when they agreed to come spray the trees, saying that they were comfortable enough to call whenever a question came up about tree care and maintenance. Therefore, having a connection to the *GTGC* professionals enabled residents to feel more comfortable in participating in the program.

Finding # 5: Seeing tree plantings around different sections of a city stimulated resident interest in the program.

Ms. Dimino stated that in the course of planting trees in certain sections of Chelsea, residents from other sections of the city had shown interest in getting trees as well (Hilary Dimino, personal communication, September 21, 2016). When residents noticed that their neighbors were getting trees, it stimulated their interest in having trees planted on their property.

Similarly, our interview with Ms. Wordell from Fall River, suggested that same observation as we had heard from Ms. Dimino. In Fall River where the tree planting was only implemented in two sections of the city, residents from other sections showed interested and therefore questioned city officials as to why their sections were not considered, evidently being unhappy about it.

Finding # 6: The provision of additional resources for street and residential tree maintenance has been crucial for tree survival.

Andy DeSantis, the tree warden from Chelsea, indicated that a local watering company hired by the DCR watered the street trees in Chelsea which greatly enhanced tree survival (Andy DeSantis, personal communication, September 21, 2016). He further expressed how beneficial it would be if local watering services were a part of the program for the early stages of the young street trees. Furthermore, the city also provided water barrels for residents who had received trees in order to easily supply the trees with water. This helped contribute to a high survival rate for the trees both on the street and residential properties, in contrast to Fall River where street trees were found dying during the initial phase of the program due to the lack of a local organization to care for the trees. With an 85% survival rate of since, the trees planted in Fall River have held up well (Mary Ann Wordell, personal communication, September 26, 2016).

4.3 Limitations that Hinder Program Progress/Success

Finding # 7: Some renters lack authority to decide on program participation without getting approval from landlords, which potentially limits program success.

Greening the Gateway Cities was originally planned as an energy efficiency program targeted at renters (Mat Cahill, personal communication, September 23, 2016). However, trying to target renters proved to be problematic. Analysis of field work conducted in Chelsea and Fall River found that, although only 21 people were interviewed, 2 people did not get a tree because their landlord did not approve of the request. In Chelsea, 70% of all properties are rental. Getting energy savings to residents in rental properties is problematic because there is a “distinction between those who can legally make changes to the property and those who accrue the savings” (Bianchi, 2011, pg 28).

Finding # 8: Inefficient communication between program and city officials can diminish residents’ confidence in program implementation.

A limitation to program success in both Chelsea and Fall River included inefficient communication between the EEA, DCR and the various local partners involved in the program. Interviews with EEA, DCR staff and local partners also showed room for improvement with program communication. Local program managers ran into challenges being the facilitators between residents and those implementing the program. The EEA and DCR did not clearly keep the local partners up to date on the planting plans, so the local partners could not explain to residents certain program aspects, such as planting quadrants or delays in tree planting. Ms. Wordell from Fall River had concerns about promising trees to residents, before finding out that the EEA and DCR canceled planting for the season. This inefficient communication added to residents’ lack of confidence in program implementation. Mat Cahill stated that residents were hesitant when told they could get a free tree due to uncertainty that the promise would be kept.

Finding # 9: A lack of public awareness of the specifics of the program hindered its implementation in Chelsea and Fall River.

Of the 21 residents interviewed in both Chelsea and Fall River, 14 were aware of the *GTGC* program. Of these 14, 8 did not receive a tree due to concerns over where they could put it on their property. Overall, 14 residents were unaware that there would be experts and foresters to aid them with these questions of space and viability. Furthermore, even though some residents who received trees noted that they were able to call the *GTGC* program foresters and arborists to ask for help with their specific issues with their tree's upkeep, others were not aware of this available helpline. One resident expressed, "I took care of the trees, and did what I had to do for a couple of months. One is not healthy and I did not know who to call. I would like to find out if they can send somebody to take a look at it. I got two trees and one looks unhealthy, skinnier than the other one" (Chelsea phone interviews, personal communication, September 30, 2016).

Finding # 10: Water restrictions can hinder program progress in Gateway Cities.

Although the EEA and DCR had a set schedule for this fall season to expand the tree planting program in other Gateway Cities, the planting schedule had to be delayed, due to the statewide drought declared in the month of August. The statewide drought caused many cities to impose some kind of water restriction which prohibited outdoor watering. The EEA and DCR were concerned that following the current tree planting schedule may lead to a decrease in the survival rate of the young trees that were planted, thereby hindering the progress of the program.

4.4 Summary

Our team completed an evaluation of the *GTGC* tree planting program on two pilot cities, Chelsea and Fall River. Following this evaluation, we identified strategies that could be effective when expanding the program in additional Gateway Cities. We also identified factors that affect program implementation and the role that each stakeholder plays in making the program a success. Our recommendations, based on these findings, can be found in the next chapter.

Chapter 5: Recommendations and Conclusion

By taking into consideration the major factors that contributed to the success of tree planting in both Fall River and Chelsea, as well as the limitations and challenges that were encountered in the process, we proposed a set of recommendations that the EEA and DCR should consider in their expansion of the *Greening the Gateway Cities* tree planting program.

5.1 Outreach and Advertising Strategies

Recommendation 1: The EEA and DCR should raise awareness about the ongoing tree planting program by using local news media and newspapers, and word of mouth to supplement door fliers in each participating Gateway City.

The main form of advertisement for the tree planting program in Chelsea was through handouts that were placed on resident doors. As indicated in Finding # 11 residents in Chelsea were generally not aware of certain aspects of the program such as foresters aiding them with their concerns as to where to have trees. In Fall River, Ms. Wordell, the nonprofit tree planting co-manager informed neighborhood groups by word of mouth. She also used the local news media to notify residents about the program. That way, the *GTGC* program could be heard by people regardless of whether they are at home, work, or anywhere else. We therefore recommend that the EEA and DCR ensure, via the local partners, that the program is being advertised using the local news media, as well as having city officials spread the word by mouth to supplement door fliers in each Gateway City while emphasizing that experts will be at the aid of residents.

Recommendation 2: The EEA and DCR should have students and youth groups involved in *GTGC* tree planting program, in order to facilitate increased awareness of the program to overcome the barrier created by lack of awareness.

As indicated in Finding #3, students and youth groups can facilitate more outreach in the community. Since youth are also more likely to share information with their peers and parents, we recommend that the EEA and DCR involve more students and youth groups in tree planting programs. One way to do so would be to establish a *Greening the Gateway Cities* Internship in participating cities. Local partners that host internships can supervise and help the youth learn more about the various ecosystem services provided by trees. They can also spread the word about the ongoing tree planting program and be involved in tree maintenance activities such as watering. By so doing, more residents can hear about the program and hopefully be more likely to participate.

5.2 Program Communication

Recommendation 3: The EEA and DCR should endeavor to build residents' confidence in program implementation by ensuring that there is effective and regular communication between program staff and city officials.

Indicated by Finding #8, Ms. Wordell, the co-manager of the nonprofit tree planting program in Fall River, expressed concerns about the inefficient communication between city officials and EEA/DCR staff during the initial phase of program implementation. This lack of communication led to a lack of support from residents during the program. We therefore recommend that the EEA and DCR ensure that there is regular communication between staff and

city tree planting coordinators, to ensure that the city coordinators are kept up to date with any changes that could hinder the EEA and DCR from staying according to schedule. By doing this, the program coordinators will also be able to keep residents up to date. This lays a foundation of trust for program implementation.

Recommendation 4: The EEA and DCR should provide additional support to foresters and staff knocking on doors to gather tree planting orders, in order to better promote and implement the program.

The EEA/DCR should also train its staff on additional outreach and resident support, based on Finding #4. Interviews conducted with current EEA/DCR staff established the importance of gaining resident participation through explaining the benefits of trees both quickly and effectively at their doors. A training protocol currently teaches volunteers and staff how to correctly interact with residents, but can also teach foresters which buzzwords are best for facilitating resident participation, combined with their expertise in the subject. The goal with this recommendation is to ensure that the EEA and DCR remain consistent in its message about the *GTGC* program and its goal between different residents, neighborhoods, and Gateway Cities.

5.3 Tree Planting and Maintenance

Recommendation 5: The EEA and DCR should carefully consider expanding tree plantings outside of the set quadrants within each Gateway City.

As indicated by Finding #2, there are additional plantable zones. Also in our interview with Ms. Dimino, the DCR forester, we were informed that tree plantings were done in certain quads of the city. If a resident from a nonparticipating quad had requested for a tree, the foresters could not plant a tree on that residential property if it was out of the specified quad. Finding #4 also indicated that residents from different sections of Fall River outside of the Maplewood and Sandy Beach neighborhoods, where tree plantings were not done, expressed interest in trees. Although the EEA and DCR may prioritize certain quads over others, we recommend that the EEA and DCR increase flexibility of the program by allowing foresters to provide trees to all residents who are interested and who have appropriate criteria for participating, but are not in the specified quads. If not, residents could lose interest by the time the tree planting could have been extended to their quad. Therefore, we agree with Maria Belen Power that the program should aim to “take whoever you can get.”

Recommendation 6: The *GTGC* program foresters should emphasize to residents that there is an available help line that residents can call for questions about their trees (care, general program info, etc).

Residents in the Pilot Cities for the *GTGC* program appreciated having the program’s continued support, especially during the beginning years of the tree plantings. As indicated in Finding #9, residents often had questions about the care and maintenance of their tree(s). Some residents asked for new trees when the ones they received were poor quality. Others had general maintenance questions about tree watering and what to do when they had insect infestations in their trees. We therefore recommend that the *GTGC* program foresters should emphasize to residents that there is an available helpline for any further questions after trees are planted. Trees can therefore be kept in the absolute best condition during the most crucial years of their lives.

Recommendation 7: For cities without a local support system, the EEA and DCR should regularly check with city officials to see if trees are being properly maintained during the first year of the program and ensure that there is a maintenance calendar for doing so.

From our interview with Ms. Dimino, the DCR forester, there was no set schedule in place to remind residents to water their trees. The foresters on occasion, after seeing trees that were poorly maintained on residential properties, sought to remind residents to do so. Our interview with Ms. Wordell, the local tree planting co-manager in Fall River also indicated that the street trees were poorly maintained during the initial phase of the program. We therefore recommend the EEA and DCR should ensure that a tree maintenance calendar is put in place and rigorously followed so that city tree program coordinators can follow the schedule in reminding residents to constantly water their trees, especially for cities where majority of residents have no experience with caring for trees. We also recommend the EEA and DCR setup robo-calls as watering reminders, based on the above calendar, for all residents that received a tree.

5.4 Development of Methodology for Future Evaluation

Developing a methodology for future evaluation of the program will help the EEA further analyze the progress of the *GTGC* tree planting program.

Recommendation 8: The EEA and DCR should consider using a survey as a tool to measure program success, in order to gauge residents' response to the program.

Based on Finding #1 reasons for program participation varied throughout the cities. For example, some residents found aesthetic reasons to be an important measure of success, while others considered air quality as most important. A more systematic and thorough assessment of program success can be achieved by gathering feedback from all stakeholders. We therefore recommend that a mail survey be used to gather responses from residents in participating Gateway cities (Appendix F). The survey could also gauge what the various reasons were for program participation and include the program helpline for residents with questions. This will help the EEA and DCR understand what residents consider most important in deciding to participate in the program and thus know what areas to improve on in raising awareness.

5.5 Deliverables

We believe that the recommendations presented in this report are reliable and feasible to a certain extent, for increasing awareness and resident participation in the *GTGC* program. Suggested further research would be able to provide more reliable information because of the presence of a wider range of opinions and public involvement levels from other participating Gateway Cities. We recommend that the EEA and DCR use our developed methodology to further strengthen the results of this project and provide the EEA/DCR with the following:

First, an assessment framework consisting of measures for evaluation, an evaluation process, and a data analysis tool. These can help analyze the success of the program in future cities (Appendix A.i and A.ii). Second, a preliminary survey template for informing the EEA and DCR about the impacts of the program on community. A survey can help the EEA and DCR get a larger sample of opinions as to what residents consider most important in deciding whether or not to participate in tree planting programs and thus know what areas to improve on in raising awareness about the program (Appendix F).

5.6 Conclusion

Cities throughout the country face the negative impacts of low tree canopy and the cities of Massachusetts are not immune to these impacts. The *Greening the Gateway Cities* tree planting program implemented by Massachusetts Office of Energy and Environmental Affairs (EEA) and Department of Conservation and Recreation (DCR) seek to mitigate these negative effects such as storm water runoff, air pollution and high energy costs by increasing tree canopy in Gateway Cities of Massachusetts. In this project, we sought to evaluate the impacts of the *GTGC* tree planting program on the residents and other stakeholders involved. We used Chelsea and Fall River as case studies for our evaluation.

Our literature review, computer simulations, interviews and survey have informed us that the program has been a success in the pilot cities. This success is due in part to the efforts of local partners. Their role in community outreach was instrumental in stimulating interest of residents for the program. The resources provided to and by the local partners were also key to the program's success. Foresters sent out to the cities helped plant the trees correctly, and taught residents how best to care for their trees. Even though the program was successful, there are still areas for improvement. A careful consideration and application of the findings and recommendations developed as part of our project can help bring the EEA and DCR a step closer in ensuring the success of the *GTGC* tree planting program in other Gateway cities. In the long run, Massachusetts can reach its goal of mitigating the negative impacts of low tree canopy- storm water runoff, high energy use, air pollution, and poor public- in its urban areas.

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Appendices

Appendix A.i: Mapping Plan for Cities with Trees Already Planted

1. Using GIS and iTree Canopy, redefine planting zones to more accurately break up cities by potential canopy
 - a. iTree Canopy Cover Classes
 - i. Impervious Impossible (Cannot plant trees; roads, heavily industrial)
 - ii. Forested (Not helpful to plant here; heavily forested)
 - iii. Impervious Possible (Can plant trees, but impractical to; parking lot)
 - iv. Plantable Residential Property (Can plant; private housing)
 - v. Plantable Other (Parks, greenery)
 - vi. Water
 - vii. Trees (single trees)
2. Create a heat map of existing tree canopy percent per acre by combining LiDar data layers intersected with GIS mapped city tax parcels
3. Find tree survival rate, take random sample of X% of trees where X is the survival rate
4. We found on average, individual tree canopy grows to approximately 50' in diameter in 20 years (Arbor Day Foundation, 2016).
 - a. Find estimate for canopy increase by creating 25' buffer around each surviving tree
5. Create second heat map with new coverage
6. Compare percent increase from first heat map to second
7. The city is a success if the realistic expected canopy covers 5% of plantable residential property

Table of Existing Tree Canopy used for Methodology

City	Current Canopy acres per total planting zone acres (%)	Current Canopy acres per plantable acres in zones (%)	Trees planted per total planting zone acres (average per acre)	Trees planted per plantable acres in zones (average per acre)	Trees planted per plantable acres in zones without existing canopy (average per acre)
Chelsea	176/972(18%)	176/558(32%)	1250/972(1.3)	1250/558(2.2)	886/443 (2)
Fall River	535/2261(24%)	535/1174(46.6%)	1307/2261(0.6)	1307/1174(1.1)	1059/916 (1.16)

Appendix A.ii: Mapping Plan, Potential Cities Where Tree Planting Has Not Started

1. Use iTree to find canopy cover classes
2. Analyze existing tree canopy percent and/or tree coverage per acre heat map which combines LiDar data layers intersected with GIS mapped city tax parcels
3. Analyze the heat map to determine residential areas where tree canopy is low
 - a. Break up these areas into several planting zones
4. Find what a 10% increase in tree canopy in is in acreage in the plantable residential property in each planting zone
5. Divide the above number by .045 to find the trees needed to meet 20% increase

Appendix B: Interview Questions for *GTGC* Staff/Experts

Mat Cahill, *GTGC* Tree Planting Program

1. What measures did the EEA take in facilitating the program in Chelsea?
 - a. Why was Chelsea chosen for the pilot program?
2. How were the residents informed about the program?
 - a. What was the attitude from the majority of the residents that were reached out to?
 - b. Was there a difference in the change in attitude as the program was implemented (initial reaction vs reaction as program progressed)
 - c. What were the various reasons from those who refused to participate?
3. Are there policies in place for the upkeep of these trees?
 - a. Who is responsible for this?
4. What would you define as success for the program?
5. At what point will the EEA declare that the program has been successful?
6. Are there any other factors we should consider in measuring the success of the program?
7. What were components of the program that your organization particularly liked?
 - a. What could have been done better?
 - i. Why wasn't it done?
8. How is the drought currently affecting the program?
 - a. Has the progress of the program been hindered temporarily?
9. What would you suggest is the best way to reach out to both residents who participated in the program and those who did not?

Hilary Dimino, Chelsea *GTGC* Forester

Andy DeSantis, Chelsea Tree Warden

1. How did you first get involved with the *GTGC* tree planting program?
2. What is your role within the program?
3. Do you think that the tree planting program has been an overall success in Chelsea? Why or why not?
 - a. Do you have any evidence of success?
 - b. What did you particularly like about the program?
 - c. What could be improved within the program?
 - i. Are there limitations preventing this from currently being done?
4. What was the attitude from the majority of the residents that were reached out to?
 - a. What were the various reasons from those who refused to participate?
5. What are some general policies in Chelsea for the upkeep of the program trees?
6. Who is responsible for taking care of the trees?
7. In general, how well are the trees planted from *Greening the Gateway Cities* holding up in Chelsea?
8. Does Chelsea have a current tree inventory?
9. Do you think that Chelsea has additional room for more trees to be planted?
10. How has the nonprofit Chelsea Collaborative/Green Roots helped with program implementation?

Appendix C: Interview Questions for Nonprofits

Maria Belen, Green Roots, Chelsea, MA

1. How did your organization first get involved with the *GTGC* tree planting program?
2. What was the role of your organization in facilitating the program?
3. What was the attitude from the majority of the residents that were reached out to?
 - a. What were the various reasons from those who refused to participate?
4. Are there policies in place for the upkeep of these trees? Who is responsible for this?
5. Has any follow up been done since the trees were planted?
6. From the standpoint of your organization, was the tree planting program successful in Chelsea? Why or why not?
 - a. How was success decided?
 - b. Do you have any evidence of success?
 - c. What were components of the program that your organization particularly liked?
 - d. What could have been done better?
 - i. Why wasn't it done?
7. What would you suggest is the best way to reach out to both residents who participated in the program and those who did not?

Mary Ann Wordell, Fall River Tree Program Co-Manager

11. How did you first get involved with the *GTGC* tree planting program?
12. What is your role within the program?
13. Do you think that the tree planting program has been an overall success in Chelsea? Why or why not?
 - a. Do you have any evidence of success?
 - b. What did you particularly like about the program?
 - c. What could be improved within the program?
 - i. Are there limitations preventing this from currently being done?
14. What was the attitude from the majority of the residents that were reached out to?
 - a. What were the various reasons from those who refused to participate?
15. What are some general policies in Chelsea for the upkeep of the program trees?
16. Who is responsible for taking care of the trees?
17. In general, how well are the trees planted from *Greening the Gateway Cities* holding up in Chelsea?
18. Does Chelsea have a current tree inventory?
19. Do you think that Chelsea has additional room for more trees to be planted?
20. How has the nonprofit Chelsea Collaborative/Green Roots helped with program implementation?

Appendix D: Questions for Surveying Residents in Fall River

Transcript for Resident Phone Interviews- Fall River

Good Afternoon,

My name is _____ and I am a student from Worcester Polytechnic Institute (WPI) working with the Massachusetts Office of Energy and Environmental Affairs (EEA) on a project that is evaluating the impacts of tree planting on urban neighborhoods of Massachusetts.

Mary Ann Wordell, who is the Fall River tree planting program manager, gave us your information to ask you a few questions about your experience with the program.

Is now a good time to talk? Your participation in this interview is completely voluntary, anonymous and you can withdraw at any time. We sincerely appreciate your time and participation, as your insight will greatly help with our project. Do you mind if our conversation is recorded for future reference?

Questions for Residents with Trees

1. Why did you choose to have a tree planted in your yard?
2. Are you happy about your decision to have a tree planted? What has been your favorite part of having a tree?
3. Who decided where to plant the tree?
4. How has maintenance and care for the tree been for you?
5. Have you seen a difference in your personal life since the addition of the tree?
 - a. Any noticeable changes in utility bill costs?
 - b. Any noticeable changes in your mood?
6. Have you noticed any changes within your neighborhood since the addition of the tree?
7. Do you think this tree will be a benefit to you in the future? If so, then how?
 - a. Energy savings/Lower heating and cooling bills
 - b. Improved property value
 - c. Safer, friendlier environment for kids/neighborhood
8. Would you suggest the tree planting program to a friend?

Transcript of Project Introduction

South End Neighborhood Association (SENA) Meeting- Fall River

Good Evening,

Our names are _____ and we are students from WPI working with the Office of Energy and Environmental Affairs on a project that is evaluating the *GTGC* tree planting program.

We understand that some of you have had trees planted and participated in the program, while others have not. In an effort to understand residents' perception of the program, we have developed a survey with a few questions for you to answer tonight. One side of the survey has questions for those who received a tree, and the back has questions for those who did not.

Your participation in this survey is completely voluntary and your identity and answers will be kept anonymous. We appreciate your time and help with this piece of our project.

Survey Questions SENA Meeting, Fall River

Please answer the following survey questions about the tree planting program in Fall River. You may answer more than once for the same question, circle all that apply.

Did you have a tree planted through the *Greening the Gateway Cities* program?

- a) Yes- Complete Section 1
- b) No- Complete Section 2

Section 1: Got a Tree

- 1) Why did you choose to have a tree(s) planted in your yard?
 - a) Looks, I like trees
 - b) Shade and privacy
 - c) Other: _____
 - d) I don't know
- 2) How did you hear about the program?
 - a) Flyer on door
 - b) Advertisement in water bill
 - c) Local newspaper
 - d) Other: _____
 - e) I don't know
- 3) In what ways do you think that the agency can better support you and your tree(s)?
 - a) Help line- general care questions
 - b) Local support group
 - c) Other: _____
 - d) I don't need additional support from the agency/program

Section 2: Did Not Get a Tree

- 1) Did you hear about the program when it was being offered? If so, then how?
 - a) No
 - b) Yes (please circle one below)
 - i) Flyer on door
 - ii) Advertisement in water bill
 - iii) Local newspaper
 - iv) Other: _____
 - v) I don't know
- 2) Why did you not have a tree planted?
 - a) Did not hear about the program at the time
 - b) I don't think there is space on my property for one
 - c) Renter, so I could not decide
 - d) Other: _____
 - e) I don't know
- 3) What is the best way to reach you or notify you of city programs/events?
 - a) Flyer on door or in mailbox
 - b) Social media
 - c) Local newspaper
 - d) Other: _____
 - e) I don't know

Appendix E: Questions for Surveying Residents in Chelsea

Transcript for Resident Phone Interviews- Chelsea

Good Morning/Afternoon,

My name is _____ and I am a student from WPI working with the state environmental agency that funded the tree planting program in Chelsea in order to see how the program is doing.

We understand that you had a tree planted on your property and were wondering if you'd be willing to answer a few questions about your experience with the program.

Is now a good time?

Your participation in this interview is completely voluntary, anonymous and you can withdraw at any time. We sincerely appreciate your time and participation, as your insight will greatly help with our project.

Questions for Residents with Trees

Same questions asked as those over the phone in Chelsea

Questions for Residents without Trees

1. Have you heard about the Greening the Gateway Cities tree planting program in your area? If yes, how did you hear about the program?
2. Why didn't you have a tree planted?
 - a. Have not heard about the program and/or never got the option to
 - b. Busy schedule, so could not schedule an appointment to have one planted
 - c. Busy schedule, so caring for it could have been difficult
3. Do you regret your decision to not be involved in the program?
4. Have you noticed any changes within your neighborhood since the addition of trees in other parts of it?
5. Do you think planting a tree on your property could benefit you in the future? If so, how?
 - a. Energy savings/Lower heating and cooling bills
 - b. Improved property value
 - c. Safer, friendlier environment for kids/neighborhood
6. Knowing more about the program now, would you be open to planting a tree in your yard?

Surveys for Interviewing Residents in Chelsea

In-Person on Broadway Street

Residents Unaware of the Program

1. How are you notified of events or other programs in Chelsea?
2. Have you noticed more trees in your neighborhood lately?
3. Would you have opted to get a tree if possible?
4. Is there anywhere you would like to see more trees planted in the city?

Residents Aware of the Program and Received a Tree

1. Are you happy with your decision to get a tree?
2. What influenced your decision?
 - a. Energy savings, storm water reductions, lower air pollution, increased property value, aesthetics, shade, other
3. Has the tree(s) been easy to care for?
4. What do you think the program can improve on?
5. Have you noticed a change in your neighborhood since the addition of the trees?
6. Would you recommend the program to a friend?

Residents Aware of the Program and Did Not Receive a Tree

1. What reasons most influenced you to not get a tree?
 - a. Too busy to take care of it, do not like trees, decision was not mine, other
2. If the decision wasn't your own, then who decided?
3. What were their reasons against getting a tree?

Appendix F: Resident Mail Survey

1. Are you happy with your tree(s)?
 - a. Yes
 - b. No
2. Which of the following services would you use (check all that apply):
 - a. Help Line
 - b. Local Tree Care Support Team
 - c. Other
3. How could we best inform you about programs like this in the future:
 - a. Fliers
 - b. Posters
 - c. Site Visits
 - d. Local news
 - e. Newspapers Advertisements
 - f. Booklets
 - g. Other
4. What reason was most important when deciding to get your tree(s)?
 - a. Energy Savings
 - b. Like the look
 - c. Neighbors all got one
 - d. Other
5. Do you expect your tree(s) to save you money on your utility bills in the future?
 - a. Yes
 - b. No