Human-Environment Regional Observatory (HERO), 2014

Beetle Impact Assessment
Gaia Khairina  
Clark University
Anona Miller  
Appalachian State University
Hannah Rush  
Clark University

Amber Todoroff  
University of Florida
Andrew Varuzzo  
College of the Holy Cross

Place Making Assessment
Elizabeth Anderson  
Rensselaer Polytechnic Institute
Albert Bautista  
Humboldt State University
Benjamin Ewald  
Clark University

Alison Jackman  
Whittier College
Marina Khananayev  
Clark University
Amy Phillips  
Clark University
Introduction: The Beetle

Asian Longhorned Beetle (ALB)

- Wood-boring beetle
- Native to Eastern Asia
- Targets maples, poplars, elms, willows and other hardwoods

Worcester Infestation

- Discovered in Worcester in 2008
- 337km² regulation area in six towns
- Economic impacts on timber, sugaring, tourism
- Host tree removal
- Ongoing removal of 31,965 trees
- Greendale and Burncoat neighborhoods
- Recently Green Hill Park
Overarching Research Objectives

2012-2014

Examine the impacts of the ALB infestation on the physical environment, politics, and society of the Worcester area.

Beetle Impact Assessment (BIA) 2014
To measure the current conditions and mortality rates of DCR tree replantings (2010-2012) and what factors influence these.

Placemaking Assessment (PMA) 2014
To conduct a survey testing the findings of previous years, in order to make generalizations about the larger population within the Quarantine Zone.
Examine the impacts of the ALB infestation on the physical environment, politics, and society of the Worcester area.

**Beetle Impact Assessment (BIA)**
- To measure the current conditions and mortality rates of DCR tree replantings (2010-2012) and what factors influence these.

**Placemaking Assessment (PMA)**
- To conduct a survey testing the findings of previous years, in order to make generalizations about the larger population within the Quarantine Zone.
Three Year Study

2012

Background information about the ALB issue, stakeholder perceptions from interviews and media analysis in Worcester

2013

Interviewed policy makers in other towns

Gathered residents’ perceptions with focus groups

2014

Can past findings be applied to a broader Quarantine Zone population?
Relational Placemaking

- House
- Trees
- Town
- Government
- Special Places
- Community Groups
- Traditions
- Neighbors
- People
- Walking the dog
- Yard
- Transport systems
- Feeling
- Family
- Economic processes
- Landmarks
Mixed Methods

Quantitative Methods
- Multiple choice questions
- Graphs
- Charts
- Maps

Qualitative Methods
- Open ended questions
- Interviews
- Focus groups

Mixed Methods Study
2014 Methods

Survey
*Creation, writing questions based on past findings*

Sampling
*Strata*

Distribution of five surveys
*Unique URLs allow for respondent distinction*

Statistical Analysis
*Preliminary findings*
Creation of Survey

Past Findings

Importance of Trees
Damage from ALB
Community Strength
Resilience
New Networks
Sampling Strategy

1. Sample included residents from all six towns, of all income brackets, and those who were both affected or not by tree removal due to ALB.

2. 2000 points were generated and distributed equally by strata.

3. The points were assigned to the nearest residential address.

4. Each point was manually validated.

Front of postcard mailed to residents in Quarantine Zone
_survey_distribution

**PARTICIPATE IN RESEARCH!**

**RESIDENTS’ PERCEPTIONS OF THE ASIAN LONGHORNED BEETLE (ALB) INFESTATION**

Clark University’s Human-Environment Regional Observatory program is conducting research on resident perceptions of Asian Longhorned Beetle (ALB). The purpose of this study is to understand perceptions about the management and policy implications of the ALB in Central Massachusetts.

**LINK TO SURVEY**

www.bit.ly/clarkalsurvey

---

- Sent out 891 postcards
- Hand delivered over 200 postcards
- Press release sent to Telegram & Gazette, InCityTimes, and Worcester Magazine
- 30 flyers posted
- Link to survey included in Worcester Tree Initiative listserv newsletter
## Survey Responses

<table>
<thead>
<tr>
<th>Survey Type</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Sample</td>
<td>25</td>
</tr>
<tr>
<td>Handouts and Flyers</td>
<td>21</td>
</tr>
<tr>
<td>WTI List Serve</td>
<td>12</td>
</tr>
<tr>
<td>Press Release</td>
<td>22</td>
</tr>
<tr>
<td>Previous Interaction with HERO</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>95</strong></td>
</tr>
</tbody>
</table>
Analysis of Survey Responses

Using IBM SPSS and Qualtrics, various statistical analysis techniques were used to determine connections and trends within the survey data.

We ran:

• Basic Descriptive Statistics
• Correlation Matrix
• Chi Squared Analysis
Demographics

• **Female:** 38 (55%)
• **Male:** 31 (45%)
• **Mean age:** 45-54
• **Mean household income:** $120,000 - $130,000
• **Race:** Predominantly Caucasian
Location of Survey Respondents

Respondents' City/Town

- Worcester: 80%
- Shrewsbury: 7%
- West Boylston: 5%
- Holden: 3%
- Other: 5%

Map showing the location of survey respondents in the towns of Worcester, Shrewsbury, West Boylston, and Holden.
Respondents and Tree Canopy Loss Due to ALB
Respondents ranked the ALB infestation most impactful to the region.
Themes

Community Character

Mutual Communication
Residents have experienced change in **community character**

Residents are more **receptive to information** regarding environmental issues
What is Community Character?

Importance of Trees

“When they took at the trees out, it really did look like a warzone. It looks like, it looked like a tornado came through and just ripped everything out but the houses, and just stripped it.”

- Worcester Resident, 2013 Interview

“You could stand out on the street with your neighbors and talk right under that canopy. It was really comfortable, really pleasant. No one stands in the streets now. It's not someplace anyone gathers.”

- Worcester Resident, 2013 Interview
Community Character

When asked about changes in residences/neighborhoods due to tree loss, 83% of respondents stated they experienced change in neighborhood character.
Impact and Change in Neighborhood Character

Would you consider yourself to have been impacted by the ALB infestation?

Has the character of your neighborhood changed since the beginning of the ALB infestation?
Community Character Quotes

“After the trees were taken I felt the street had been defaced. It had a barren feel to it as if our homes were picked up and moved to another location.”

-Worcester Resident, Survey 2014

“Prior to the infestation our neighborhood was an area of beautiful tree lined streets. Shade was abundant and the neighborhood looked lovely. Now our area is barren and depressing.”

-Worcester Resident, Survey 2014
Residents have experienced change in community character

Residents are more receptive to information regarding environmental issues

USDA and DCR can communicate in effective and empathetic ways

Increased resident interest in ALB can open the door to interest in other environmental issues
Increased mutual communication can be linked to a greater understanding of ALB policy.

Residents identified preferred future channels of communication.

Bettering communication between government and residents can have positive long-term effects.

HERO 2013 Finding: Importance of Involvement

HERO 2013 Finding: Successful Response — Communication

2014
Interaction and Familiarity: Government

Interaction/Familiarity

- Communication via:
  - Email
  - Phone
  - Face to face
  - Newsletter
  - General knowledge of

High Interaction/Familiarity
- Self reported frequent or occasional interaction

Low Interaction/Familiarity
- Self reported no interaction or minimal interaction
- No knowledge of this group

45% Low Interaction with Government
55% High Interaction with Government
Mutual Communication

A greater knowledge of ALB policy was related to self-reported higher levels of government interaction.
Interaction and Familiarity: Environmental Organizations

Interaction/Familiarity

- Communication via
  - Email
  - Phone
  - Face to face
  - News Letter
  - General knowledge of

High Interaction/Familiarity

- Member of organization
- Attended Meeting/event
- On mailing list

Low Interaction/Familiarity

- Hadn’t heard of organization
- Knowledge of organization but no interaction with

33% Low Familiarity with Environmental Organizations
67% High Familiarity with Environmental Organizations
Respondents who were more involved with environmental organizations felt that **New England** had been protected by ALB policy.

![Bar chart showing the percentage of respondents who believed New England was protected or not protected based on familiarity with environmental organizations.](chart.png)

- **Low Familiarity with Environmental Organizations:**
  - Yes, New England was protected: 64.8%
  - No, New England was not protected: 35.2%

- **High Familiarity with Environmental Organizations:**
  - Yes, New England was protected: 85.9%
  - No, New England was not protected: 14.1%

(All values $p < .05$)
Residents want more information available through specific channels. Here are the percentages:

- **Newspapers**: 64% (Now), 70% (In the Future)
- **Internet**: 34% (Now), 52% (In the Future)
- **Tree surveyors**: 24% (Now), 31% (In the Future)
- **Public meetings**: 24% (Now), 30% (In the Future)
- **Public flyers**: 16% (Now), 29% (In the Future)
- **Television**: 14% (Now), 22% (In the Future)
- **Social Media**: 13% (Now), 23% (In the Future)
- **Email listserv**: 9% (Now), 19% (In the Future)
- **Billboards**: 4% (Now), 21% (In the Future)
Importance of Communication

“Keep talking to the residents - they know their neighborhood and can be a wealth of information. They need to be kept informed, and to be full participants in decision-making.”

“Dive right in. Educate the public continually.”

“[The] first response to any future ALB infestations...should be conducted by already trained ALB staff to minimize mis-information given to the public.”
Increased Awareness

Respondents who reported higher interaction with the USDA/DCR also reported greater awareness of environmental issues.

Low Interaction with USDA/DCR:
- I am more aware of environmental issues: 58%
- My awareness has not changed: 42%

High Interaction with USDA/DCR:
- I am more aware of environmental issues: 41%
- My awareness has not changed: 59%
Increased Awareness

Respondents are thinking about environmental issues.

- **Increased Wind Damage**
- **Erosion**
- **Decreased Property Value**
- **Higher Electricity Bills**
- **Decreased Safety**

**Environmental Concerns for the Future**

**Environmental Concerns Due to ALB**
Conclusions

Residents have experienced change in **community character**

**Potential for a citizen body that is more informed, responsive, and aware of environmental stewardship**

USDA and DCR can communicate in **effective** and **empathetic** ways

Increased resident interest in ALB can open the door to **interest in other environmental issues**
Overarching Research Objectives

Examine the impacts of the ALB infestation on the physical environment, politics, and society of the Worcester area.

Beetle Impact Assessment (BIA)
To measure the current conditions and mortality rates of the DCR’s replantings (2010-2012) and what factors influence these.

Placemaking Assessment (PMA)
To conduct a survey testing the findings of previous years, in order to make generalizations about the larger population within the Quarantine Zone.
Canopy cover decreased by 2% (2.46 km²) in the regulation zone from 2008 to 2010

- 47% urban development
- 25% ALB tree removal
- 15% timber harvest
- 6% ice-storm damage
- 7% other
Impact of Tree Loss

Tree removal resulted in a **temperature increase** in the regulation zone.

Burncoat and Greendale neighborhoods showed a **1-9°C (1.8-16°F)** increase from 2007 to 2010.
Impact of Tree Loss

Tree removal resulted in a temperature increase in the regulation zone.

Burncoat and Greendale neighborhoods showed a 1-9°C (1.8-16°F) increase from 2007 to 2010.
Benefits of Trees

- Energy
- Noise
- Wildlife
- Air Quality
- Property Value
- Community

Diagram showing the benefits of trees in various aspects such as energy, noise, wildlife, air quality, property value, and community.
Replanting

Worcester Tree Initiative (WTI)

23%

City of Worcester

15%

Department of Conservation and Recreation (DCR)

62%

Granville Ave. before (top) and after (bottom) replanting.
Replanting

Worcester Tree Initiative (WTI) 23%
City of Worcester 15%
Department of Conservation and Recreation (DCR) 62%

Granville Ave. before (top) and after (bottom) replanting.
DCR Replanted Trees

Density per km²

- **High**
- **Low**

Legend:
- Regulation Zone
- Towns in Regulation Zone
- MA Towns
The benefits of tree planting programs accrue over the years as trees mature.

Planting benefits dependent upon tree mortality and growth rate.

Benefits are maximized when more trees reach maturity.
What is the current overall condition and composition of the cohort?

What is the current and projected mortality rate of the cohort?

Do socioeconomic factors influence tree mortality?
Overview of Methods

Sample Design → Data Collection → Statistical and Spatial Analysis
Sample Design

1. Develop dataset
2. Species stratification
3. Randomized subsample
4. Subsample clustering
5. Sampled

Number of Trees

- 17,000
- 9,000
- 500
- 1,600
- 1,054
Species Distribution of Replanted Cohort and Sampled Trees

Percentage of Total Count

- Replanted Cohort (9,375)
- Sample (1,054)
Species Distribution of Replanted Cohort and Sampled Trees

Percentage of Total Count

- Serviceberry: 5.5%
- Blue Spruce: 4.6%
- Dogwood: 3.5%
- Northern White Cedar: 5.0%
- White Fir: 3.6%
- Total: 13.3%

Species included:
- Serviceberry
- Blue Spruce
- Dogwood
- Northern White Cedar
- White Fir
- Other species
Species Distribution of Replanted Cohort and Sampled Trees
Geographic and Land-Use Distribution of Sampled Trees

Percentage of Total Sample

- Single-family: 73.5%
- Institutional: 9.3%
- Natural Area: 5.6%
- Multi-family: 4.5%
- Maintained Park: 3.8%
- Cemetery: 1.1%
- Commercial: 0.8%
- Industrial: 0.8%
- Golf Course: 0.6%

Legend:
- Green: Sampled Trees
- Black: Replanted Trees
- White: Regulation Zone
- Gray: Towns in Regulation Zone
- Light Gray: MA Towns

Map showing geographic and land-use distribution of sampled trees.
Summary of Assessment
Characteristics

Health Characteristics
- Crown Dieback
- Crown Transparency
- Basal Sprouting
- Trunk Damage
- Pest Damage
- Overall Rating

Mortality Status
- Standing Dead
- Stump
- Removed/Missing

Size Metrics
- Height
- Diameter at Breast Height (DBH)
- Canopy Width
Crown Dieback

1-25%  
26-50%  
51-75%  
76-100%
Crown Transparency

1-25%

26-50%

51-75%

76-100%
Other Health Characteristics

- Standing Dead
- Basal Sprouting
- Trunk Damage
- Pest Damage
Overall Rating

Good
Fair
Poor
Critical
Size Metrics

Height

DBH

4.5 feet

Width
Research Questions

DCR Replanted Cohort
2010 - 2012

What is the current overall condition and composition of the cohort?

What is the current and projected mortality rate of the cohort?

Do socioeconomic factors influence tree mortality?
Shade vs. Ornamental Trees by Planting Season

<table>
<thead>
<tr>
<th>Season planted</th>
<th>Fall 2010</th>
<th>Spring 2011</th>
<th>Fall 2011</th>
<th>Spring 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage Out of Season Total</td>
<td>52%</td>
<td>50%</td>
<td>34%</td>
<td>19%</td>
</tr>
<tr>
<td>Ornamental</td>
<td>48%</td>
<td>50%</td>
<td>66%</td>
<td>81%</td>
</tr>
<tr>
<td>Shade</td>
<td>64%</td>
<td>50%</td>
<td>14%</td>
<td>19%</td>
</tr>
</tbody>
</table>
## Top 3 Species
### Front Yard vs. Back Yard

<table>
<thead>
<tr>
<th>Front Yard</th>
<th>Back Yard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogwood</td>
<td>White Fir</td>
</tr>
<tr>
<td>Japanese Tree Lilac</td>
<td>Eastern Red Cedar</td>
</tr>
<tr>
<td>Black Tupelo</td>
<td>Northern White Cedar</td>
</tr>
</tbody>
</table>

**Images:**
- Eastern Red Cedar
- White Fir
- Northern White Cedar
Tree Mortality and Condition Within Sample

**Trees in sample**
(1054)

- **Alive**
  - Good: 78.4% (622)
  - Fair: 16.5% (131)
  - Poor: 3.3% (26)
  - Critical: 1.8% (14)

- **Dead**
  - 24.6% (259)
Mortality Among Six Most Frequently Sampled Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Count of Individual Trees out of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Fir</td>
<td>54 %</td>
</tr>
<tr>
<td>Littleleaf Linden</td>
<td>10 %</td>
</tr>
<tr>
<td>Eastern Red Cedar</td>
<td>90 %</td>
</tr>
<tr>
<td>Dogwood</td>
<td>96 %</td>
</tr>
<tr>
<td>Japanese Tree Lilac</td>
<td>94 %</td>
</tr>
<tr>
<td>Serviceberry</td>
<td>26 %</td>
</tr>
</tbody>
</table>

(Dead) (Alive)
Mortality Among Shade vs. Ornamental Trees

*Chi-square test performed at a 95% confidence interval yielded p < 0.01*
Tree Mortality and Condition Within Sample

Trees in sample (1054)

Alive
75.4% (795)

- Good
  78.4% (622)

- Fair
  16.5% (131)

- Poor
  3.3% (26)

Dead
24.6% (259)

- Critical
  1.8% (14)
Projected Mortality Scenarios for DCR Trees Replanted 2010-2012

Total Planted 2010-2012
13,550

Remaining 2014
10,217

Half-Life of Total
6,775
Replanting Benefits Modeled By i-Tree

CO2 Sequestration
Aesthetics
Air Quality
Energy
Stormwater

Year
2014 2019 2024 2029 2034 2039 2044

Replanting Benefits Modeled By i-Tree (U.S. Dollars)

10.1% Annual Mortality Rate
7.3% Annual Mortality Rate
Adjusted Mortality Rate
Annual Replanting Benefits Using Three Sample Mortality Rates

- 10.1% Annual Mortality Rate
- 7.3% Annual Mortality Rate
- Adjusted Mortality Rate
Annual Replanting Benefits Using Three Sample Mortality Rates

- **10.1% Annual Mortality Rate**
- **7.3% Annual Mortality Rate**
- **Adjusted Mortality Rate**

**Total Benefits:** $3,975,402  
**ROI:** $0.88/$1.00
Annual Replanting Benefits Using Three Sample Mortality Rates

Total Benefits: $5,521,474
ROI: $1.27/$1.00
Annual Replanting Benefits Using Three Sample Mortality Rates

Total Benefits: $10,294,514
ROI: $2.29/$1.00
Shade Versus Ornamental Tree Benefits

**Average New Tree Cost:**
- $310

**Mature 24” DBH Pin Oak**
- $250 in Annual Benefits

**Mature 15” DBH Dogwood**
- $70 in Annual Benefits
Research Questions

DCR Replanted Cohort
2010 - 2012

What is the current overall condition and composition of the cohort?

What is the current and projected mortality rate of the cohort?

Do socioeconomic factors influence tree mortality?
Tree Mortality, Condition and Socioeconomic Variables

- Tree mortality and trees in good condition compared with socioeconomic variables at the Census Block Group (CBG) level:
  - Income
  - Education
  - Homeownership stability
  - Home value

- No significant relationships found
Targeted Areas for Future Replanting Efforts
Conclusions

• Half of the DCR replanted trees are estimated to still be alive in 2027.

• **Long-term replanting** should replace trees that experience mortality.

• Replanting benefits are maximized by planting **shade trees** and **limiting mortality**.

• **Focus replanting** in areas with increased land surface temperatures, canopy loss and where no replanting has occurred.
Conclusions

• PMA found that residents’ experience with change in community character increases their receptiveness to information regarding environmental issues.

• BIA found that maintaining a continuous replanting program is necessary to offset the high mortality rate of young trees and ensure that residents will benefit from Worcester’s urban forest in the future.
THANK YOU!

Any Questions?
Significant Correlations with Tree Mortality Rate

American Community Survey (2006-2010)

- **Income**
  - Household Income $75,000-$99,999 and Householder Age 45-64*
  - Household Income $45,000-$49,999 and Householder Age 25-44*

- **Homeownership Stability**
  - Owner Households by Year Householder Moved In:
    - 1970 to 1979*
    - 1980 to 1989*
    - 2005 or Later*

- **Property Value**
  - Home Value $125,000-$149,000*
Deciduous vs. Evergreen Tree Mortality
DCR Tree Planting Fall 2010-Spring 2012

- **Deciduous**
  - Alive: 78%
  - Dead: 22%

- **Evergreen**
  - Alive: 70%
  - Dead: 30%
White Fir Sub-Analysis

• Land-Use
  • 90% Single Family
  • 10% Natural Area

• Site-Type
  • 60% Back Yard
  • 30% Natural Area
  • 10% Front Yard

• Season Planted
  • 50% Spring 2011
  • 30% Fall 2010
  • 20% Fall 2011

• Season Mortality
  • 70% Fall 2011
  • 60% Fall 2010
  • 40% Spring 2011