# Outline

1. **Introduction**
   - Tree Planting Programs
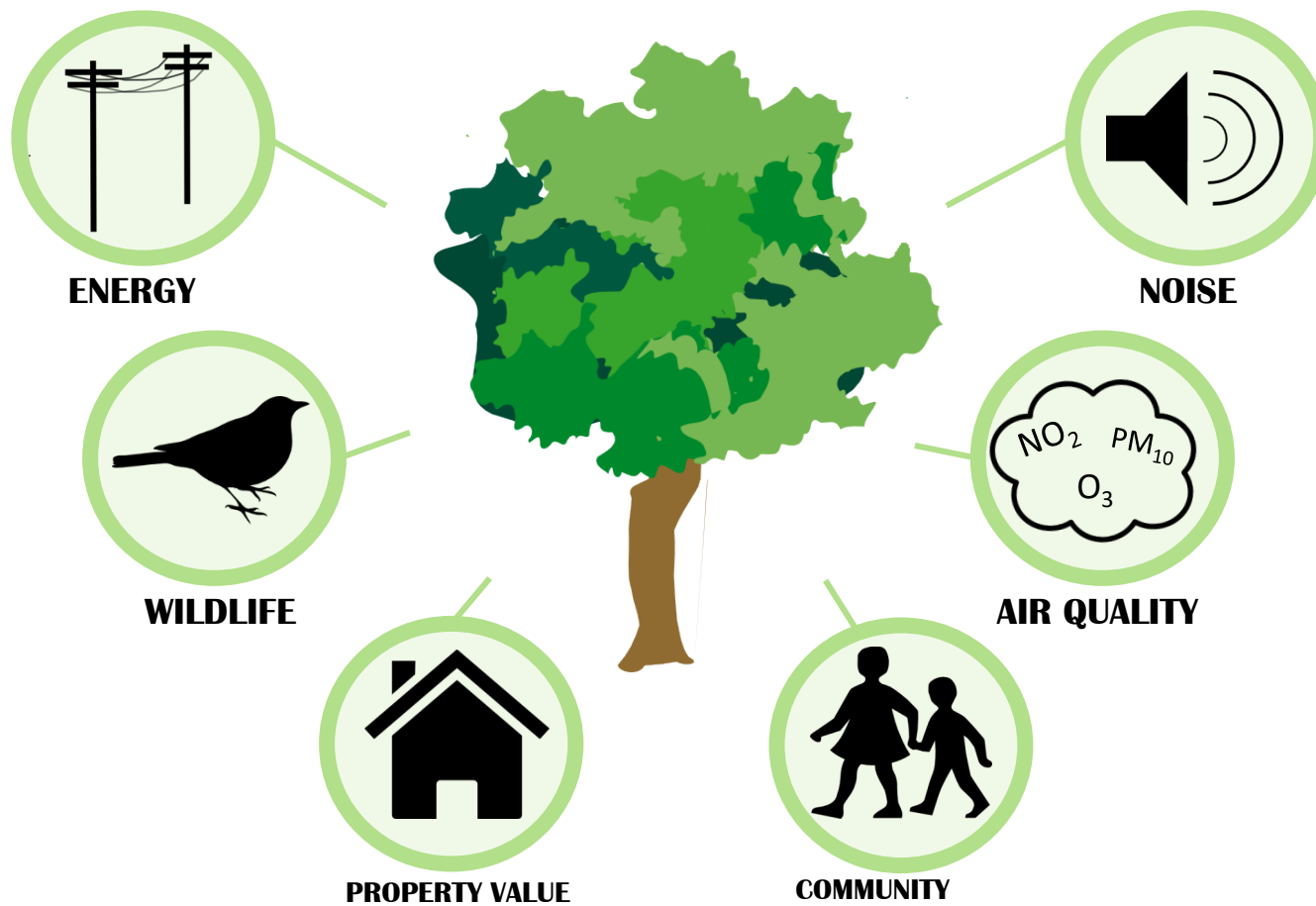   - The HERO Program

2. **Tree Survey**
   - Data Collection
   - Data Analysis: Survivorship, Condition and Size

3. **Interview Response**
   - Data Collection
   - Emerging Themes

4. **Summary and Future Directions**

# Benefits of Trees

ENERGY

NOISE

WILDLIFE

$NO_2$  $PM_{10}$
$O_3$

AIR QUALITY

PROPERTY VALUE

COMMUNITY

# Tree Planting

**Initial Goal**:

Plant 30,000 trees to replace those that were cut in the ALB Quarantine Zone (Worcester, Boylston, West Boylston, Shrewsbury, Holden and Auburn)

**Organizations:**

- **The Massachusetts Department of Conservation and Recreation (DCR)** assists communities and nonprofits to manage community trees and forest ecosystems
- **Worcester Tree Initiative (WTI)** promotes urban forestry and stewardship in the City of Worcester and surrounding communities
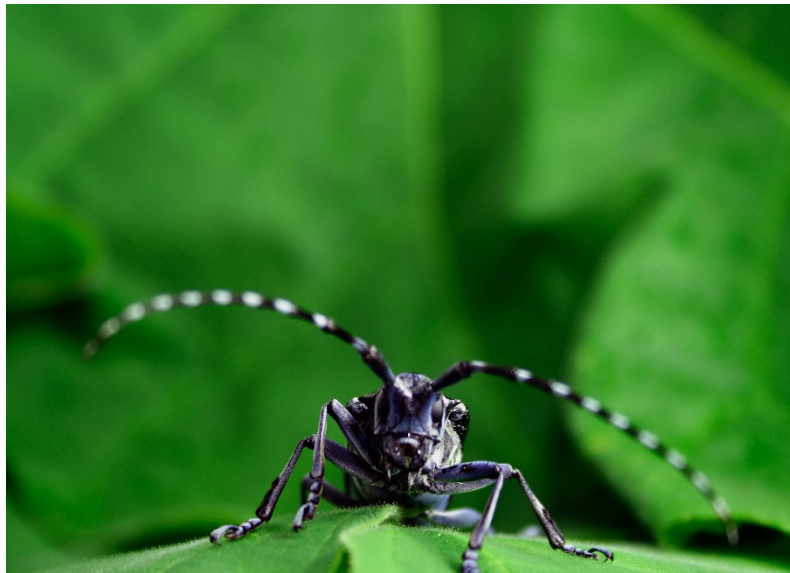
# The HERO Program

The Human Environment Regional Observatory program analyzes the causes and consequences of global environmental changes at local scales

**Past Research:**
- Beetle Impact Assessment
- Place Making Assessment

**Current Research:**
- Tree Planting Assessment
- Resident Experience Assessment

# Broad Goals

1. Characterize the survivorship and health of the newly planted trees (planted by the DCR)

2. Characterize residents' experiences of the planting program (conducted by DCR and WTI)
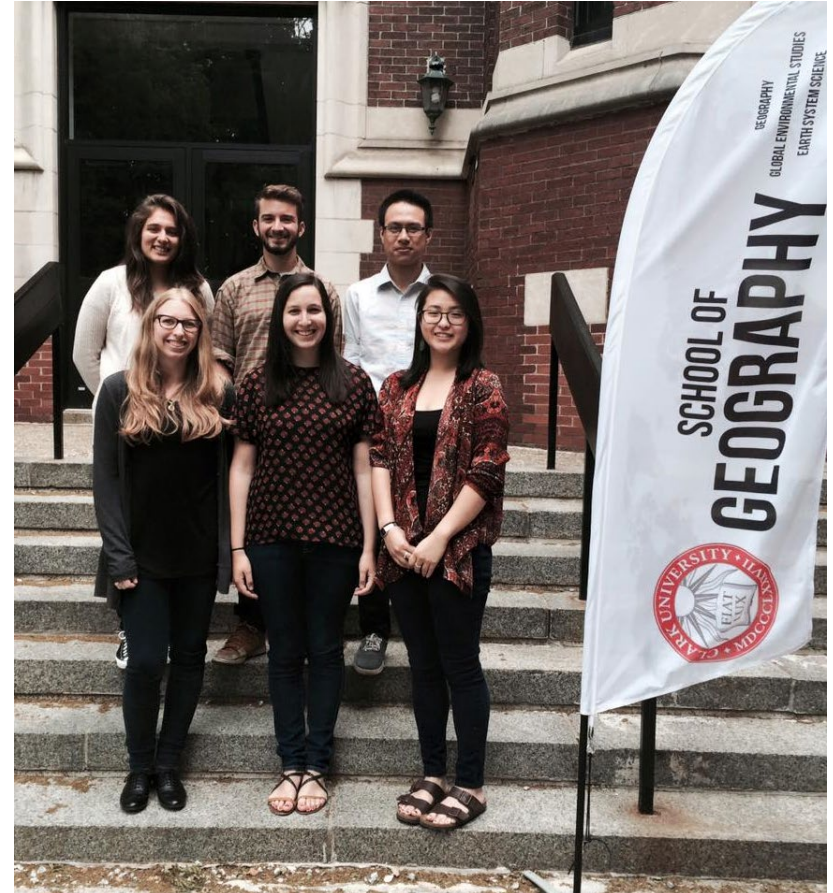
# Our Team

**Members:**

- 6 Clark undergraduate fellows
- 2 Clark graduate students
- 3 Professors

**Activities:**

- Attended training sessions
- Measured tree health
- Conducted interviews with residents
- Began to analyze data



*Isabel Miranda, Eli Goldman, Chung Truong Nguyen*
*Ali Filipovic, Hannah Rosenblum, Yuka Fuchino*

# Data Collection

**Surveyed trees:**
- 1,516

**Interviews:**
- 67 short
- 12 long

**Online survey:**
- 3, ongoing

# Research Questions

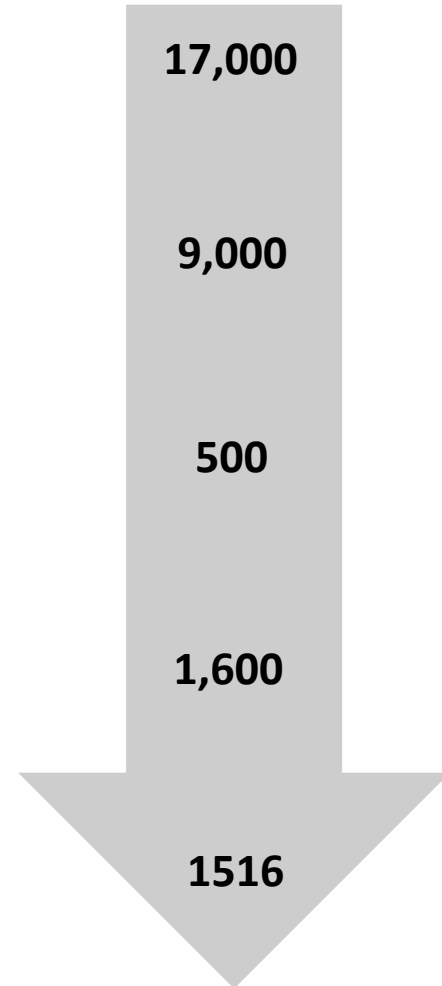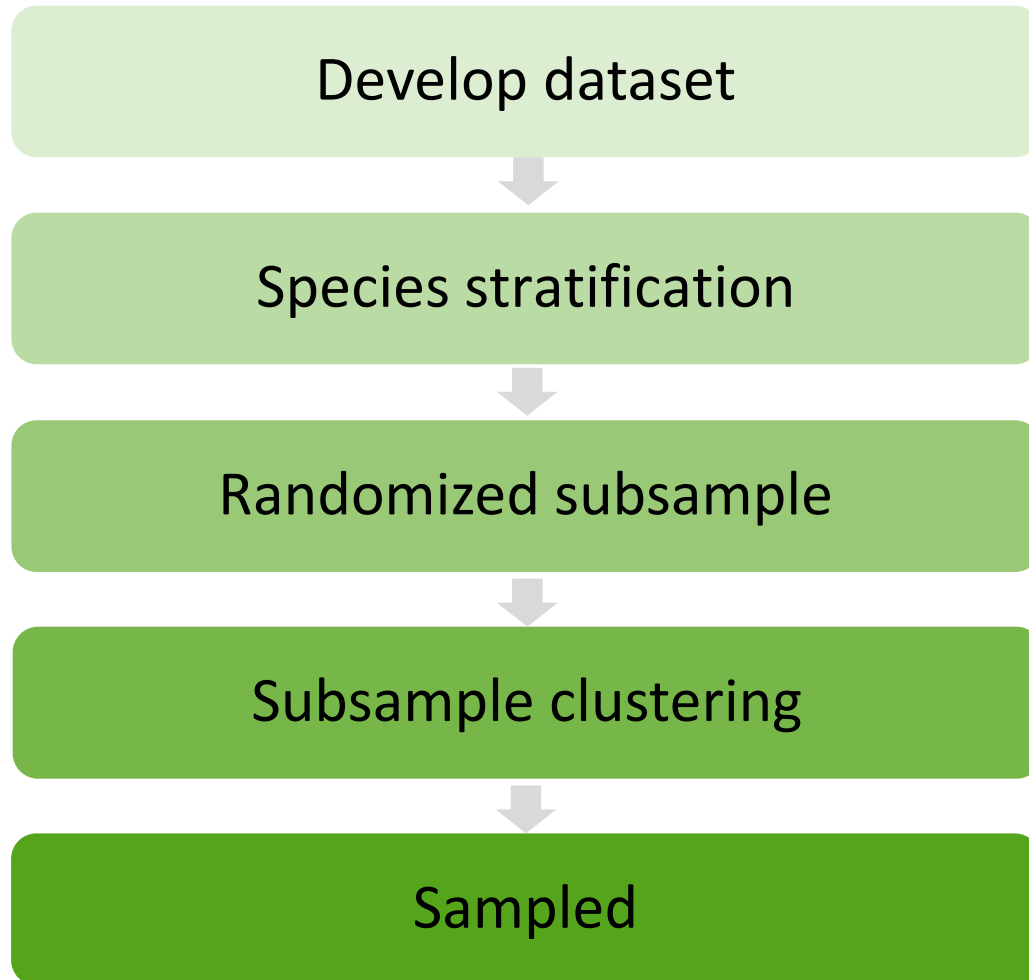What is the current **survivorship** of the planted trees?

What is the current overall **condition** and **composition** of the planted trees?

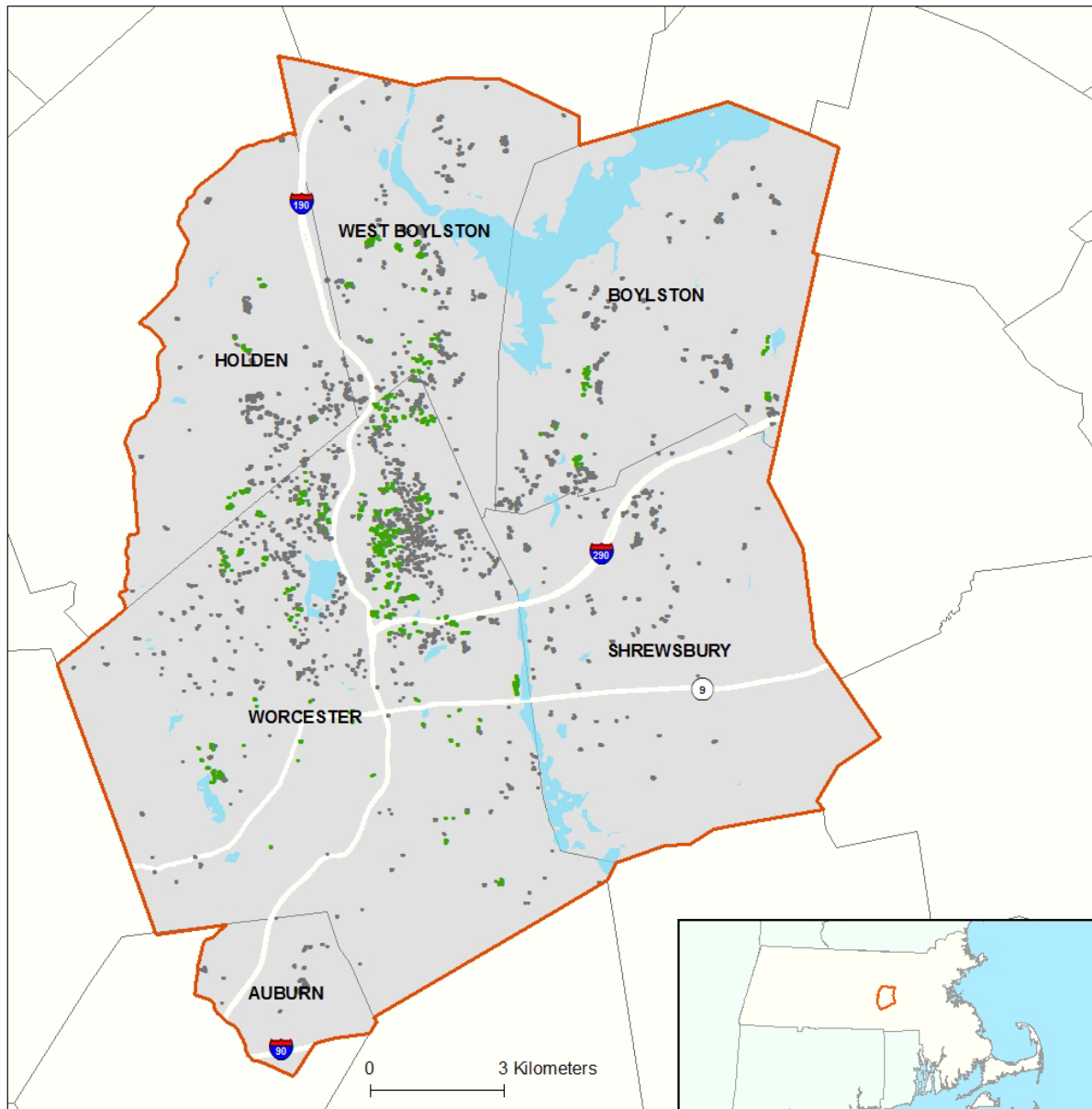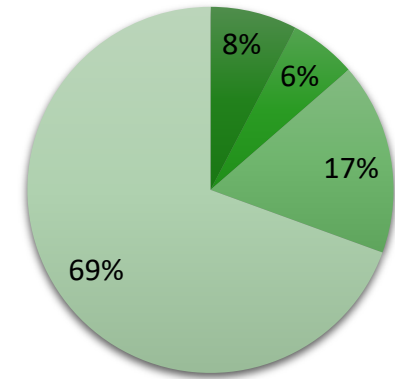What are the **residents' experiences** with the tree planting process?

# Sample Design

| Process | Number of Trees |
|---|---|
| Develop dataset | 17,000 |
| Species stratification | 9,000 |
| Randomized subsample | 500 |
| Subsample clustering | 1,600 |
| Sampled | 1516 |

# 2015 Study Area



**Distribution of Surveyed Trees**

8%
6%
17%
69%

- Boylston
- Holden
- West Boylston
- Worcester

N

Surveyed Trees 2015 (1,516)
DCR Planted Trees (9,375)
ALB Quarantine Zone
Water

WEST BOYLSTON
BOYLSTON
HOLDEN
SHREWSBURY
WORCESTER
AUBURN

0        3 Kilometers

# Summary of Assessment Characteristics

# Size Metrics



**Height**

4.5 feet

**DBH**

**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**

# Tree Survivorship and Condition Within Sample
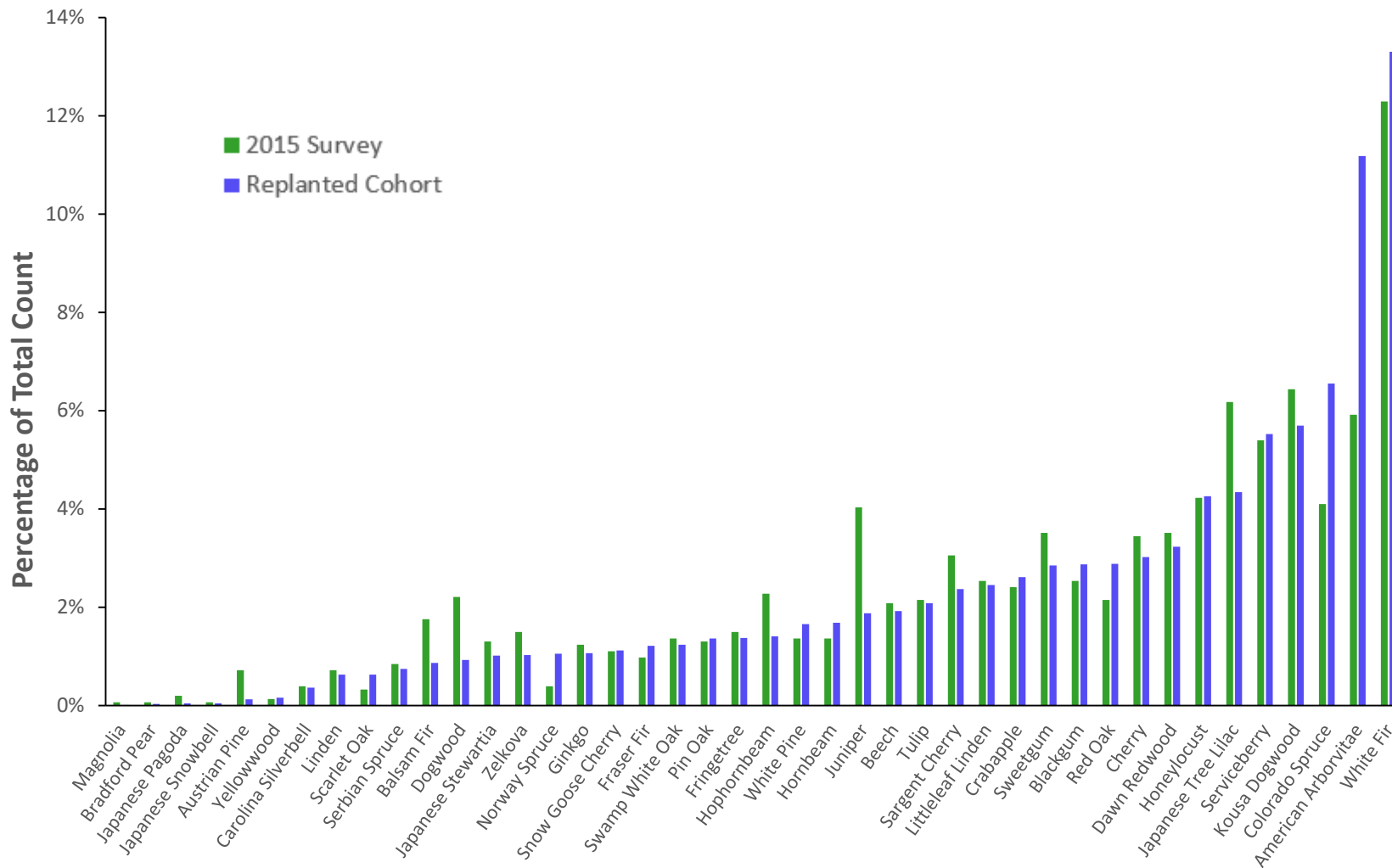
```
                    Trees in Sample
                        (1516)
                           |
        ┌──────────────────┴──────────────────┐
        ▼                                      ▼
      Alive                                  Dead
  77.64% (1177)                          22.36% (339)
        |
  ┌─────┬─────────┬──────────┐
  ▼     ▼         ▼          ▼
Good   Fair     Poor     Critical
87.47% 10.22%   1.69%     0.62%
(984)  (115)    (19)       (7)
```

# Species Distribution of Planted and Sampled Trees

# Species Distribution of Planted and Sampled Trees
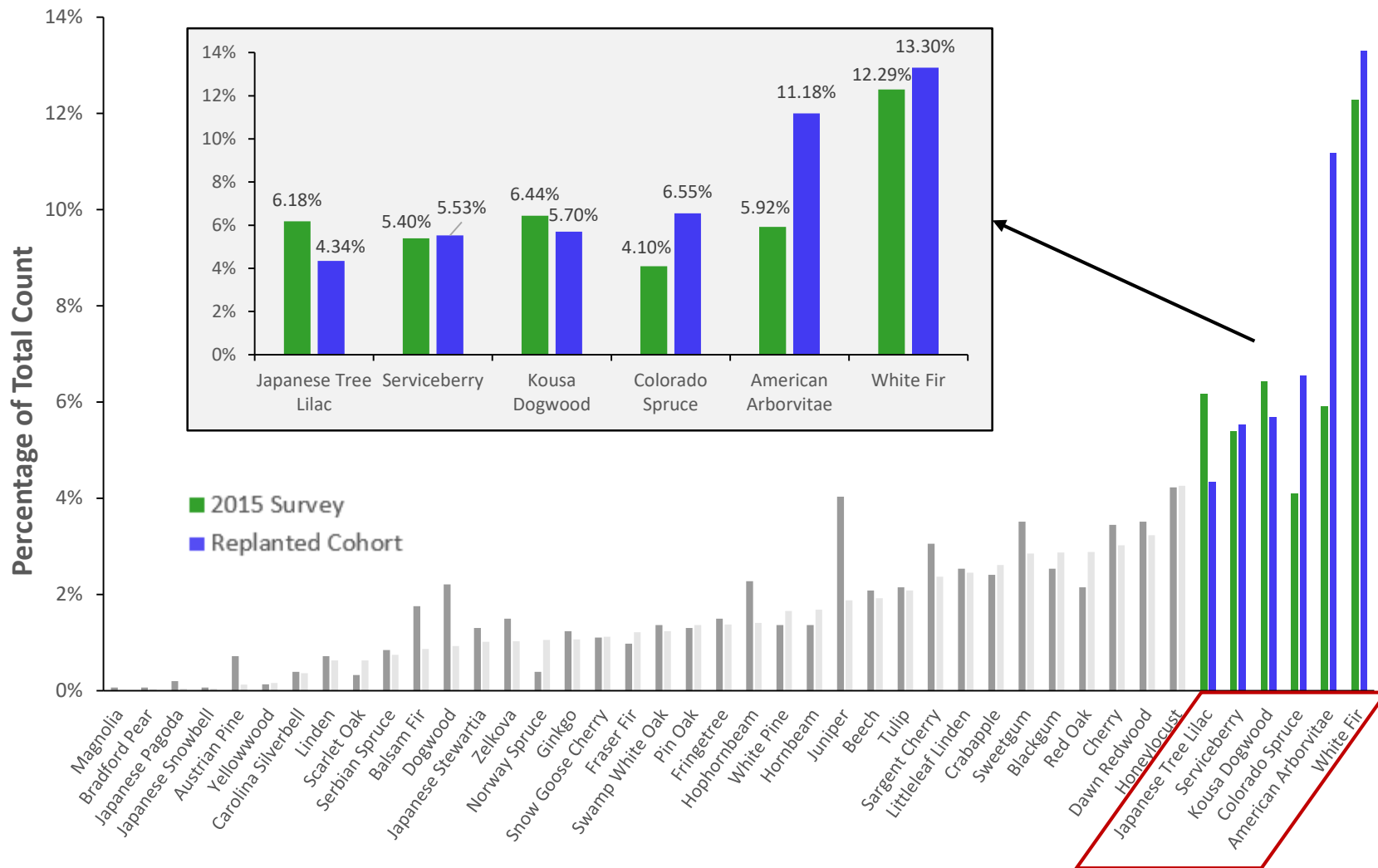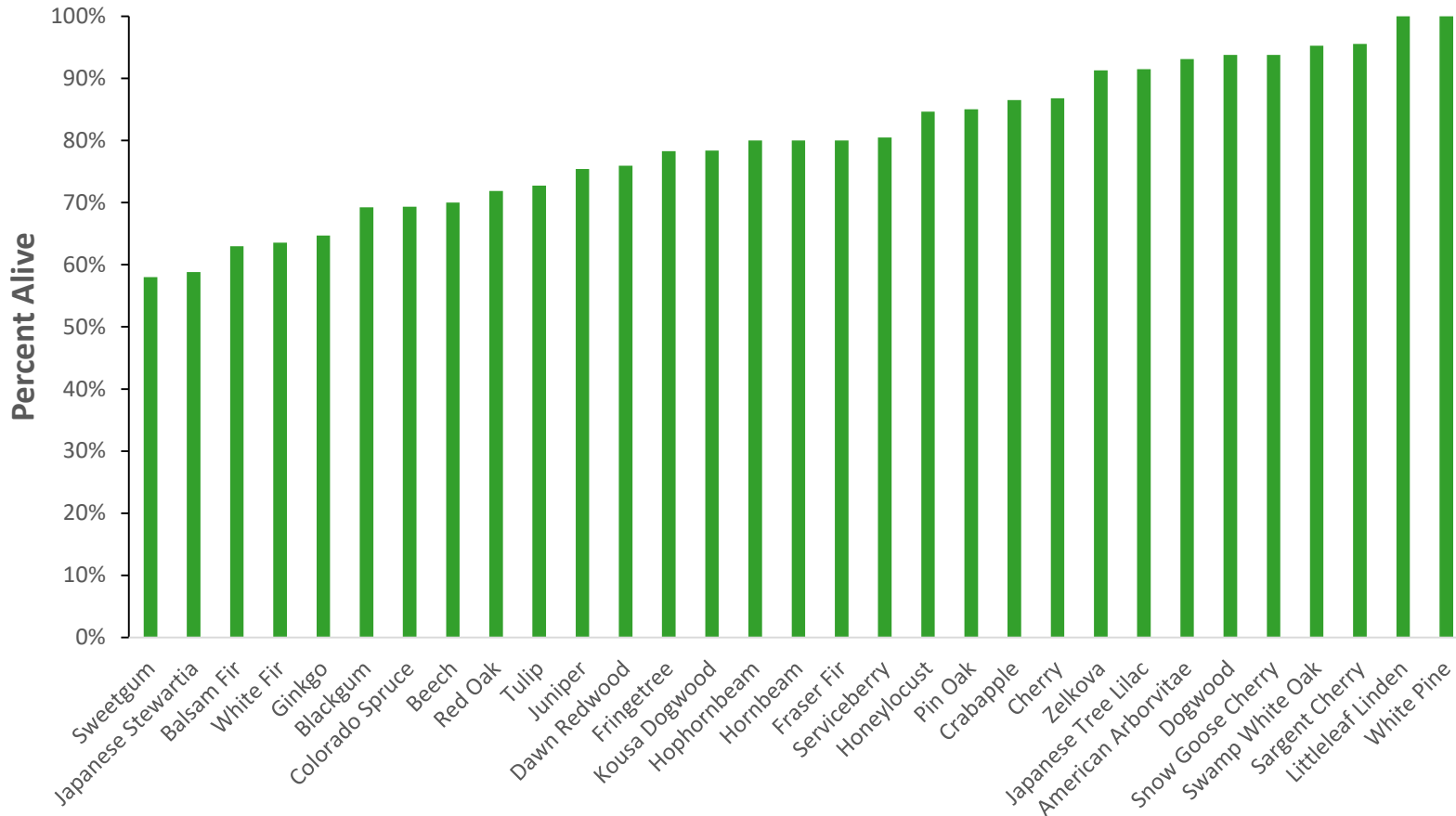
20

# Survivorship Status by Species

# Investigating Survivorship

1. Native vs. Non-Native

2. Shade vs. Ornamental

3. Site Type

4. Land Use

5. Planting Season

# Survivorship Status by Native vs. Non-Native

**Native Species**
**76%**
221
703

**Native Species (without White Fir)**
**79%**
155
588

**Non-Native Species**
**82%**
97
467

■ Alive ■ Dead
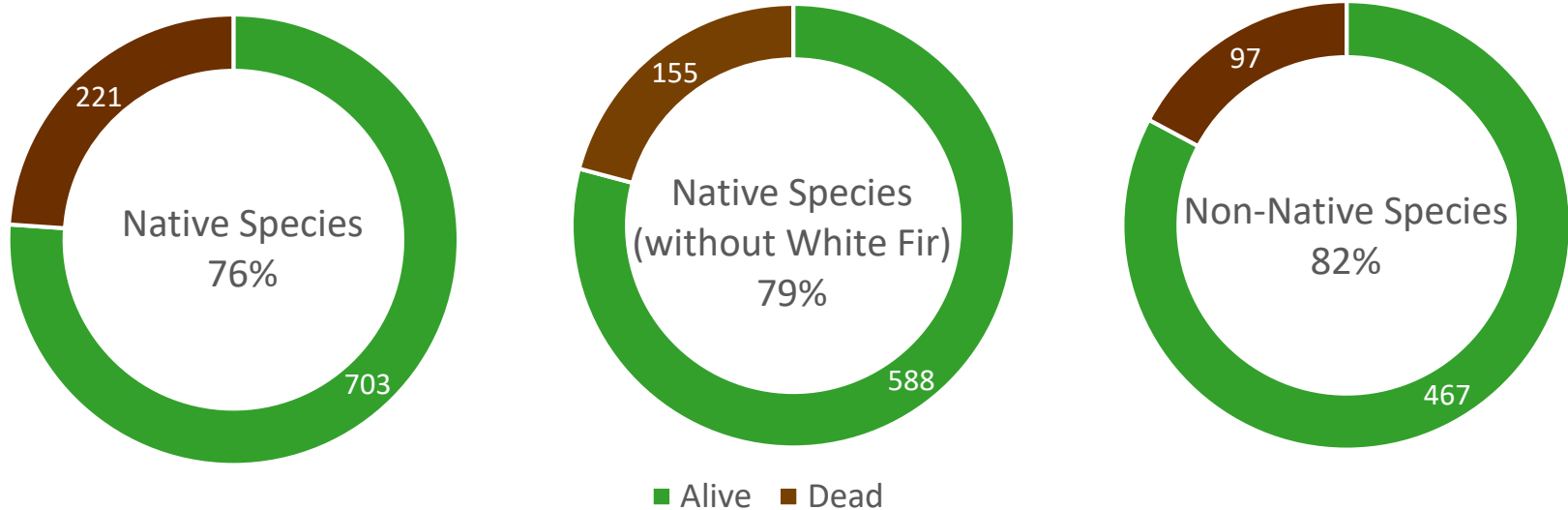
**Most frequently planted native species**
White Fir
American Arborvitae
Serviceberry
Honeylocust
Colorado Spruce

**Most frequently planted non-native species**
Cherry
Kousa Dogwood
Japanese Tree Lilac
Dawn Redwood
Littleleaf Linden

# Survivorship Status by Shade vs. Ornamental



Shade Trees
76%
222
687

Shade Trees
(without White Fir)
79%
156
550

Ornamental Trees
84%
97
503

■ Alive ■ Dead
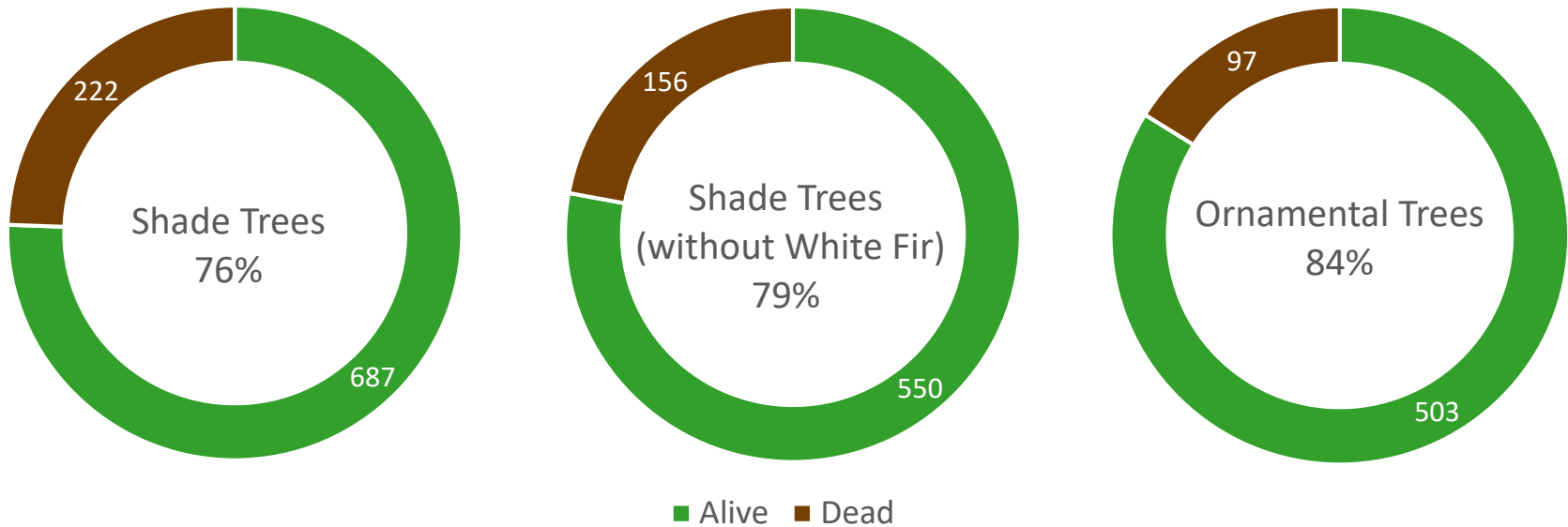
**Most frequently planted shade species**
White Fir
American Arborvitae
Honeylocust
Colorado Spruce
Dawn Redwood

**Most frequently planted ornamental species**
Cherry
Kousa Dogwood
Japanese Tree Lilac
Serviceberry
Juniper

# Survivorship Status by Site Type



Percentage of Survivorship Total

Front Yard: 92% (445) Alive, 8% (41) Dead

Back Yard: 84% (673) Alive, 16% (124) Dead

Legend: ■ Alive ■ Dead
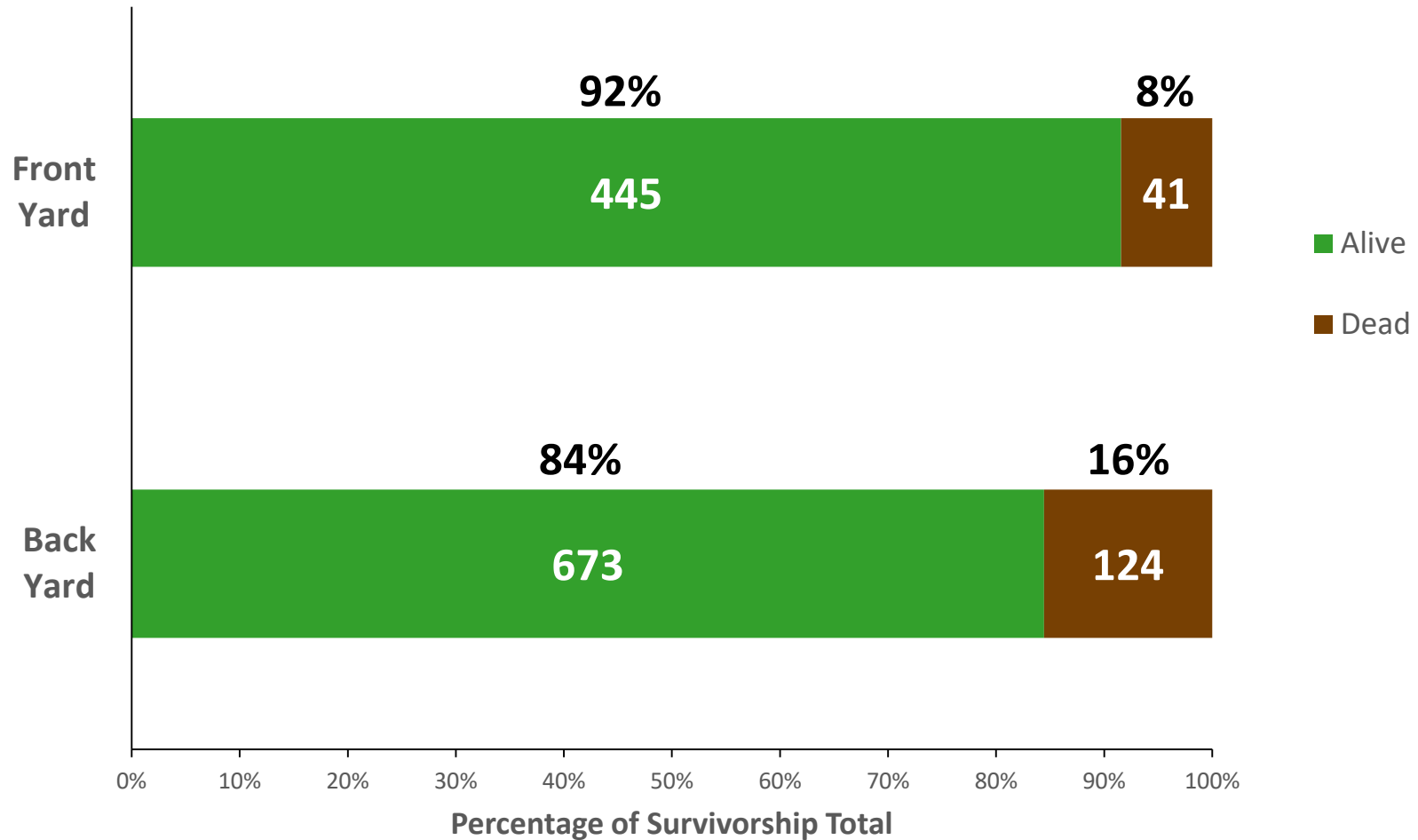
# Survivorship Status by Land Use



**Legend:** ■ Alive  ■ Dead

Others: 9

Park: 67% (26) / 33% (13)

Commercial: 86% (30) / 14% (5)

Multi-Family: 91% (71) / 9% (7)

Single-Family: 86% (1010) / 14% (159)

X-axis: Percentage of Survivorship (0% – 100%)
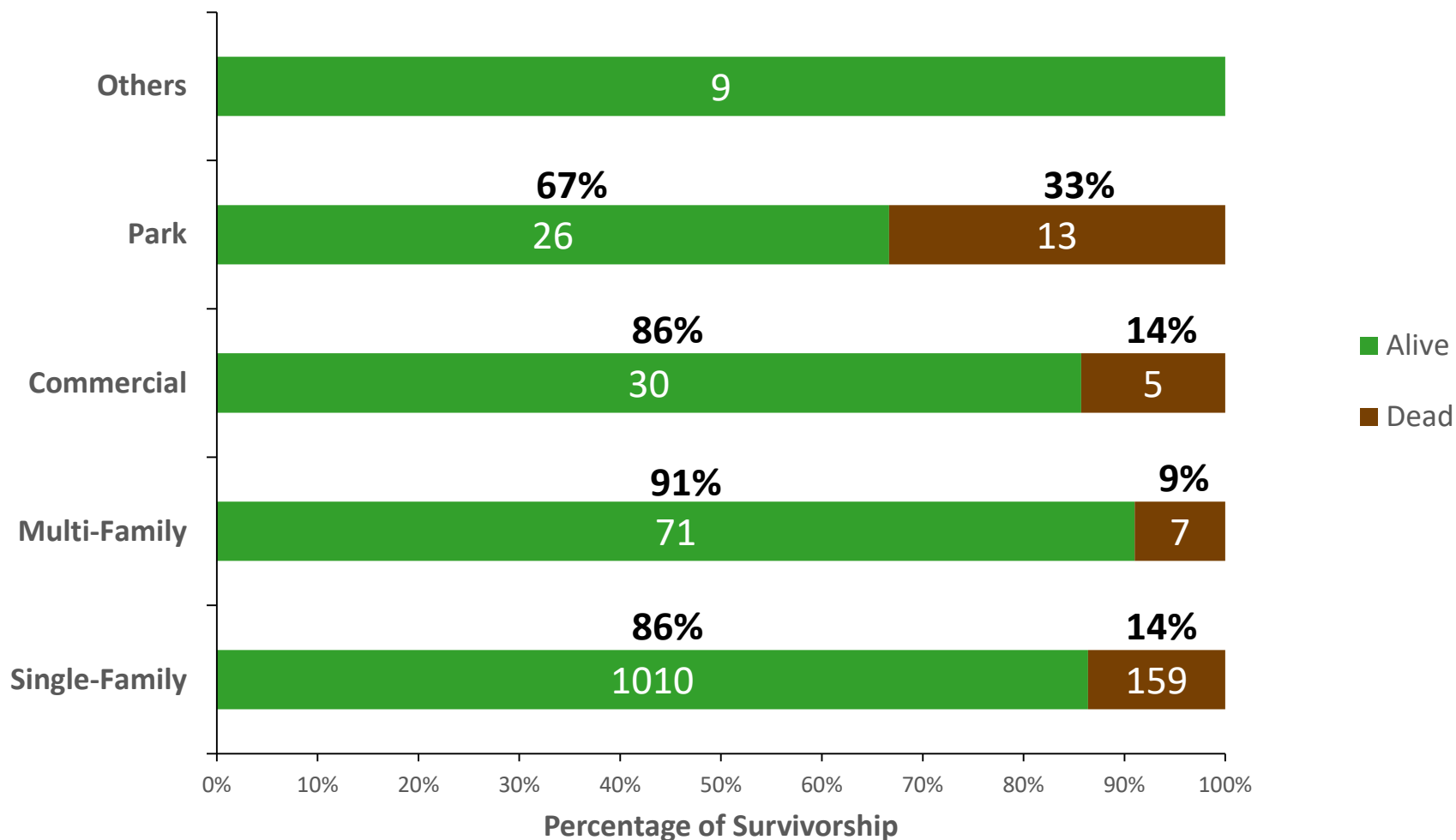
# Survivorship Status by Planting Season



**Spring 2012**
- 83% — 205 (Alive)
- 17% — 41 (Dead)

**Spring 2011**
- 78% — 514 (Alive)
- 22% — 149 (Dead)

**Fall 2011**
- 69% — 251 (Alive)
- 31% — 111 (Dead)

**Fall 2010**
- 85% — 191 (Alive)
- 15% — 35 (Dead)

Legend: ■ Alive ■ Dead

X-axis: 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

**Percentage of Survivorship**
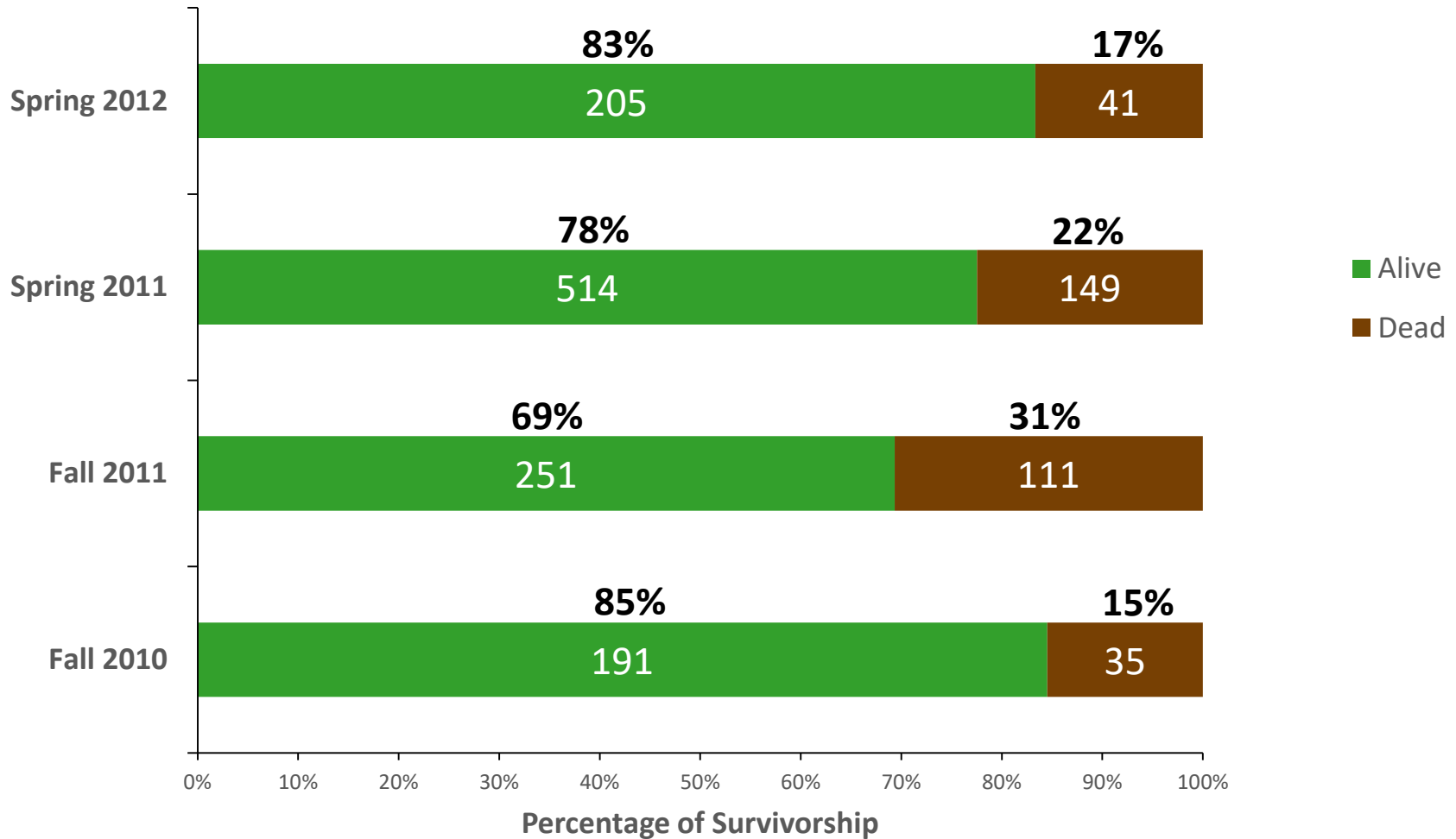
# Survivorship by Census Block

## Tree Survivorship Density

## Population Density
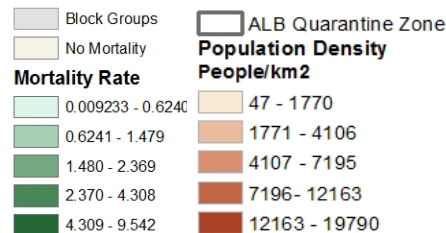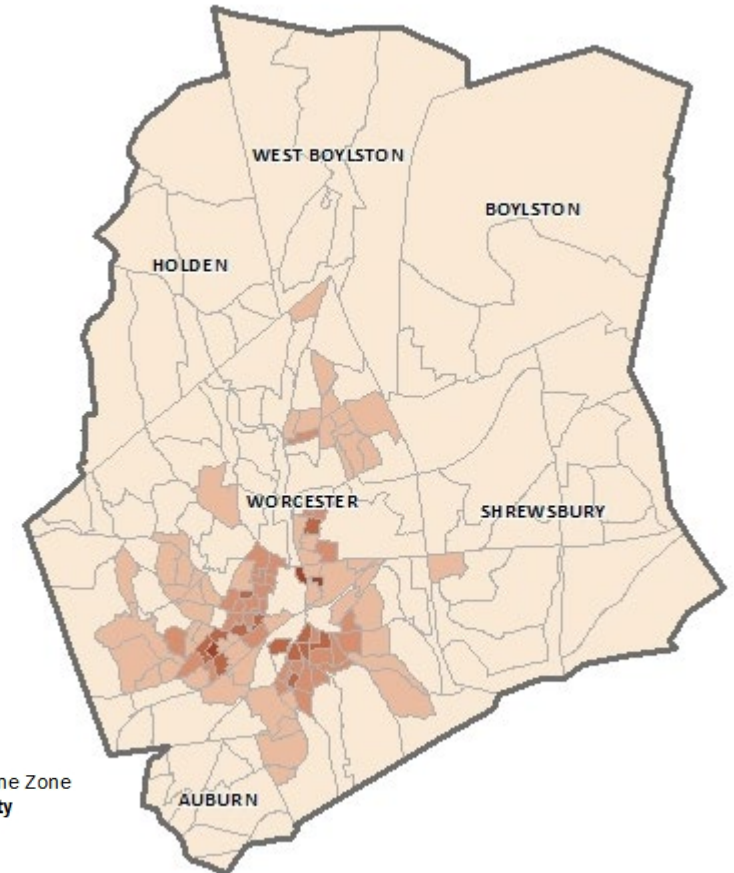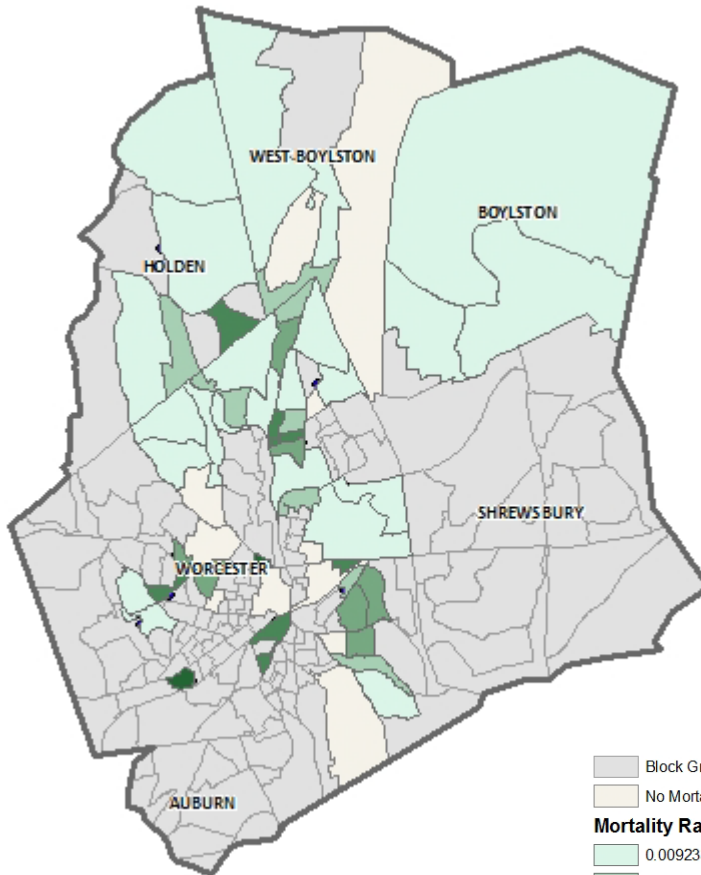


N

0    5 Kilometers

Block Groups
No Mortality
**Mortality Rate**
0.009233 - 0.624
0.6241 - 1.479
1.480 - 2.369
2.370 - 4.308
4.309 - 9.542

ALB Quarantine Zone
**Population Density People/km2**
47 - 1770
1771 - 4106
4107 - 7195
7196 - 12163
12163 - 19790

# Count of Tree Condition in 2014 and 2015

# Condition of Re-Surveyed Trees
n = 342



Bar chart legend: 2014 (green), 2015 (blue). Categories: Good (257, 260), Fair, Poor, Critical. Y-axis: Count of Sample Trees.

Pie chart: 71%, 24%, 5%
- Good to Dead (15)
- Fair to Dead (5)
- Critical to Dead (1)
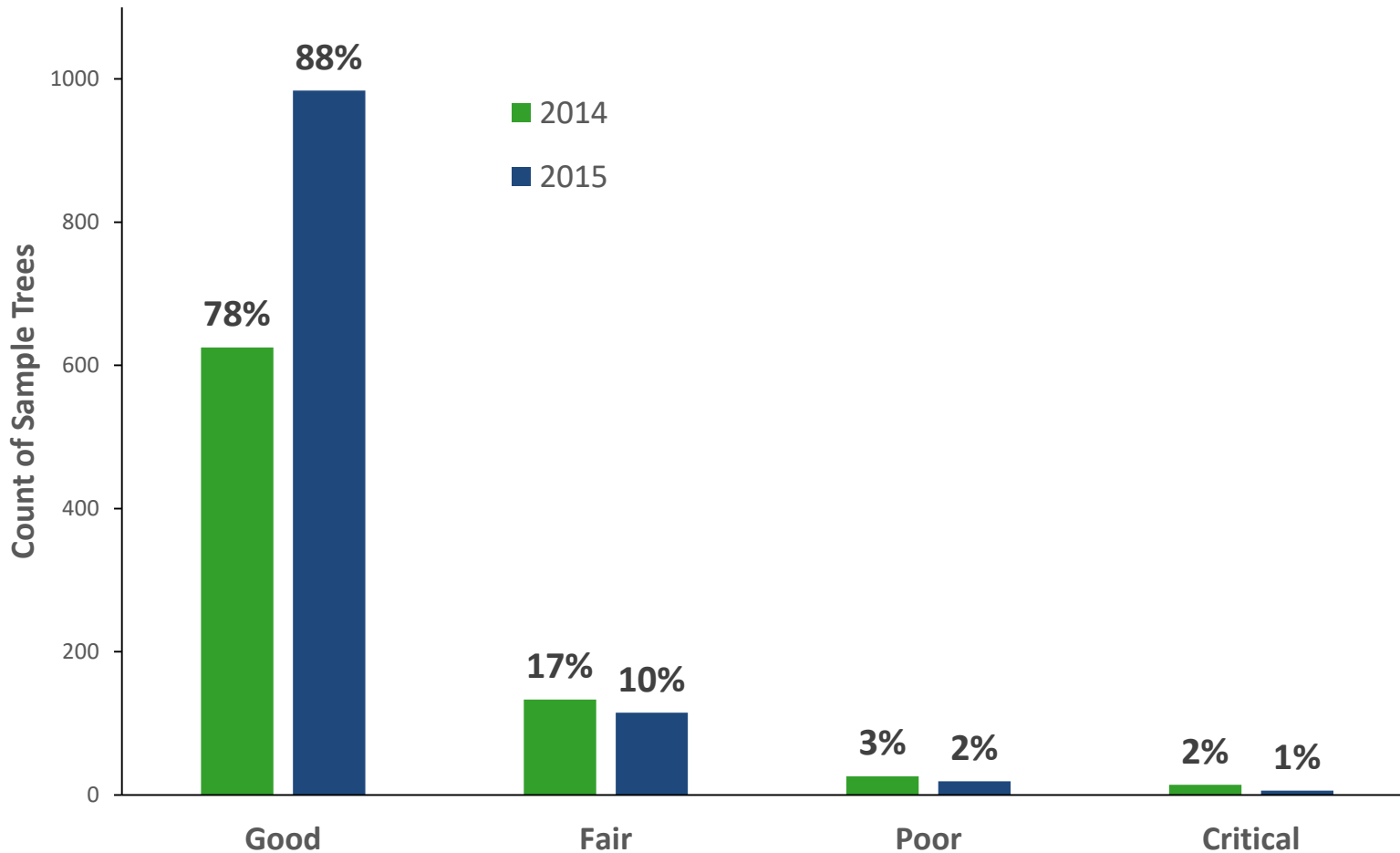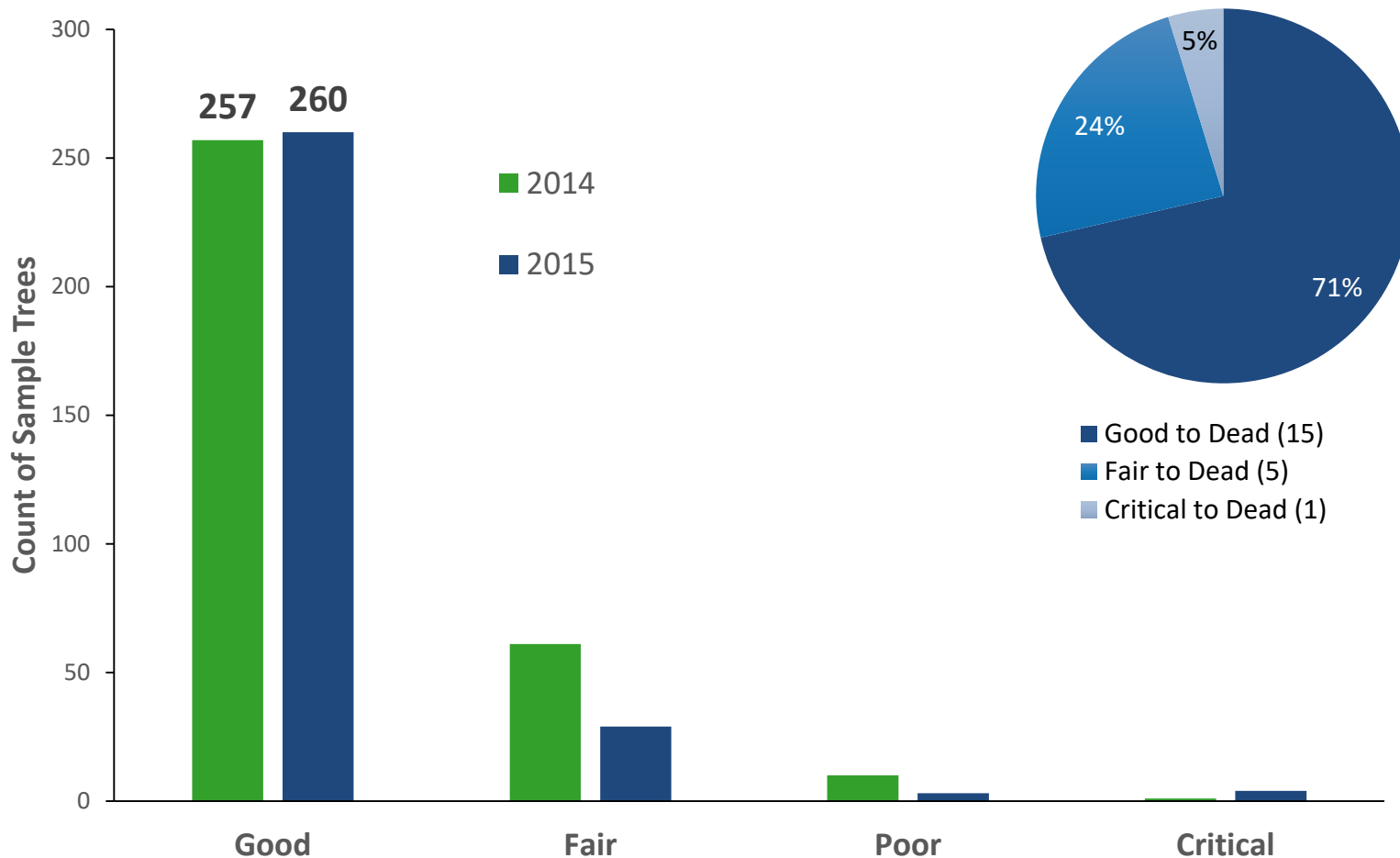
# Average Heights by Species 2014 and 2015
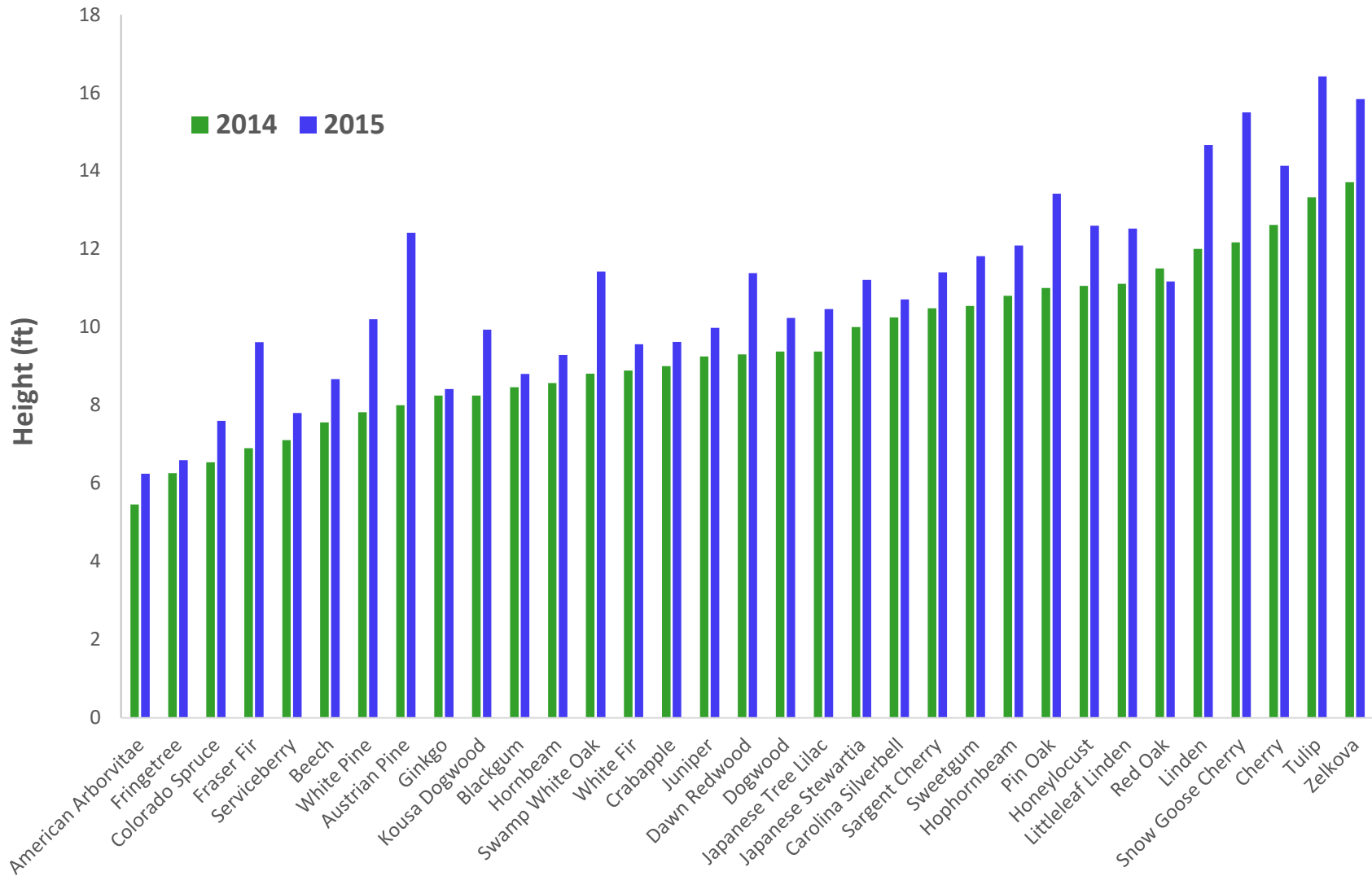
# Average Heights by Species 2014 and 2015
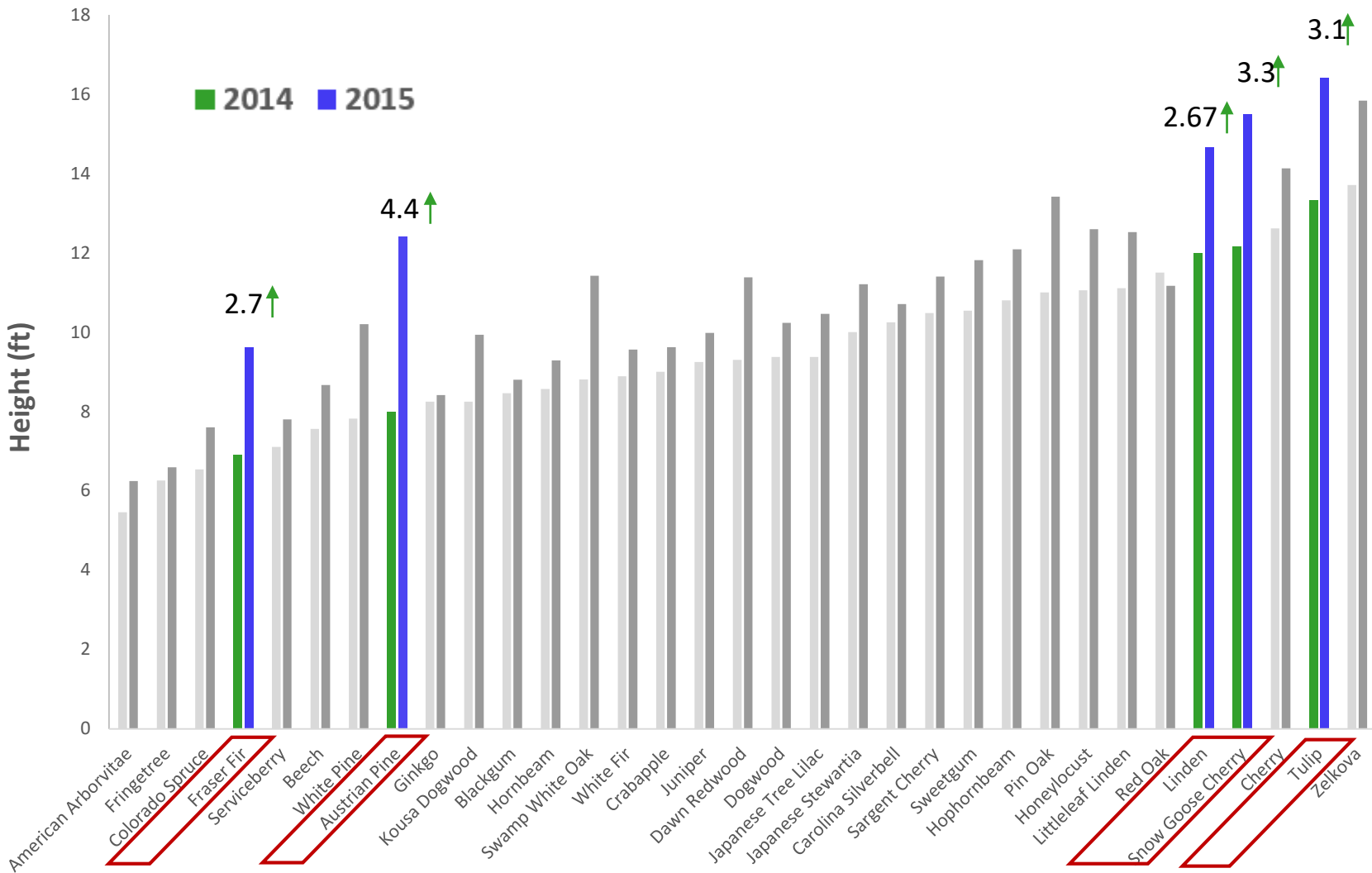
# Average Diameter at Breast Height (DBH) by Species 2014 and 2015

# Average Diameter at Breast Height (DBH) by Species 2014 and 2015

# Resident Experience Assessment

## Interviewees

- 67 Short Interviews (3 to 5 minutes)
- 12 Long Interviews (20 to 40 minutes)

# Resident Interview Response
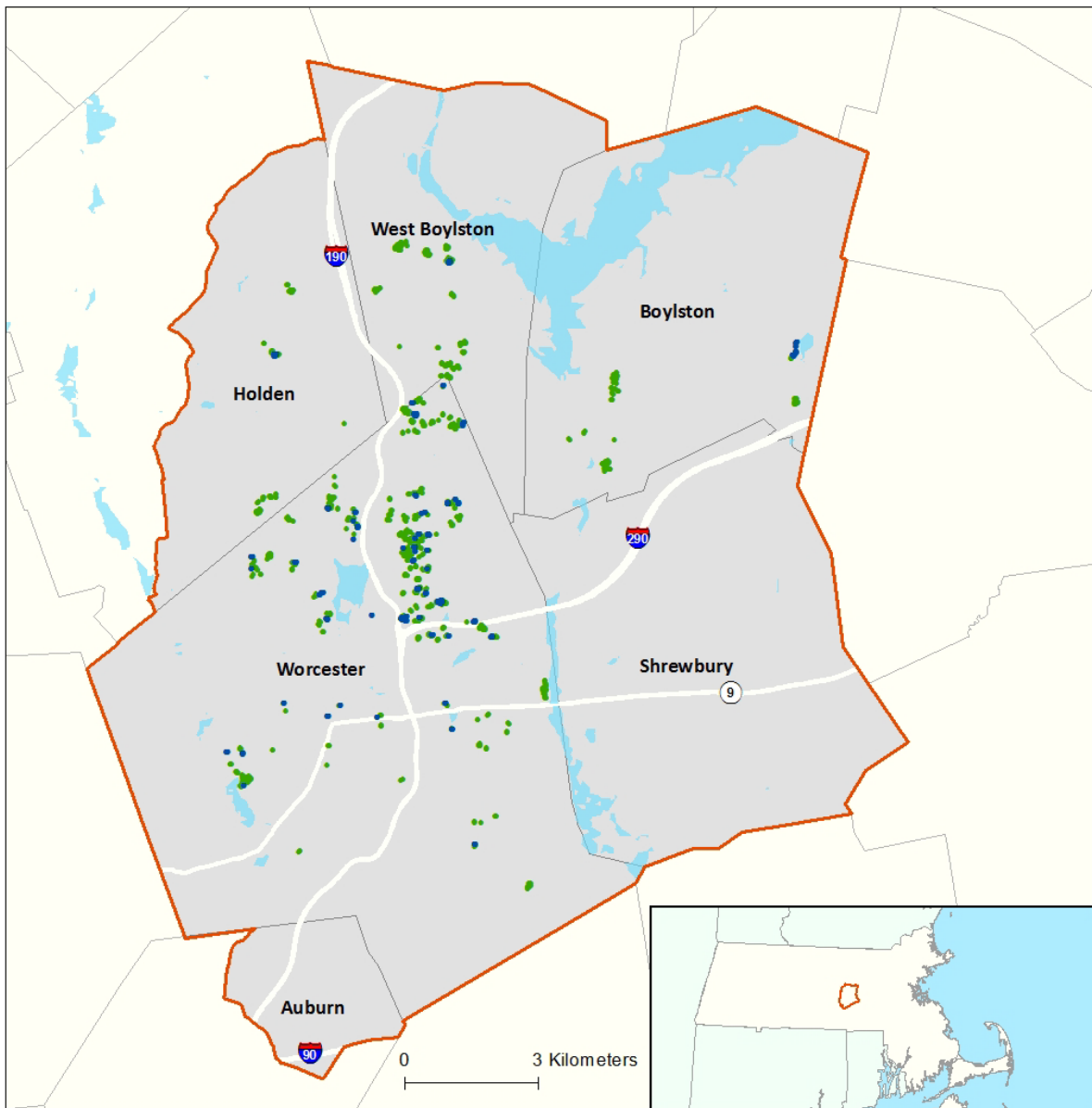


Number of Interviewees by Municipality
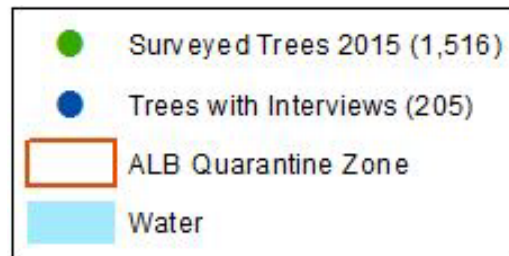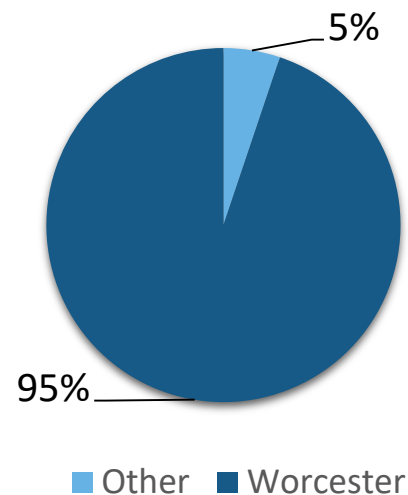
# Demographics of Interviewees

53% Male

47% Female

Average Age: 60.6
86% White
53% Retired
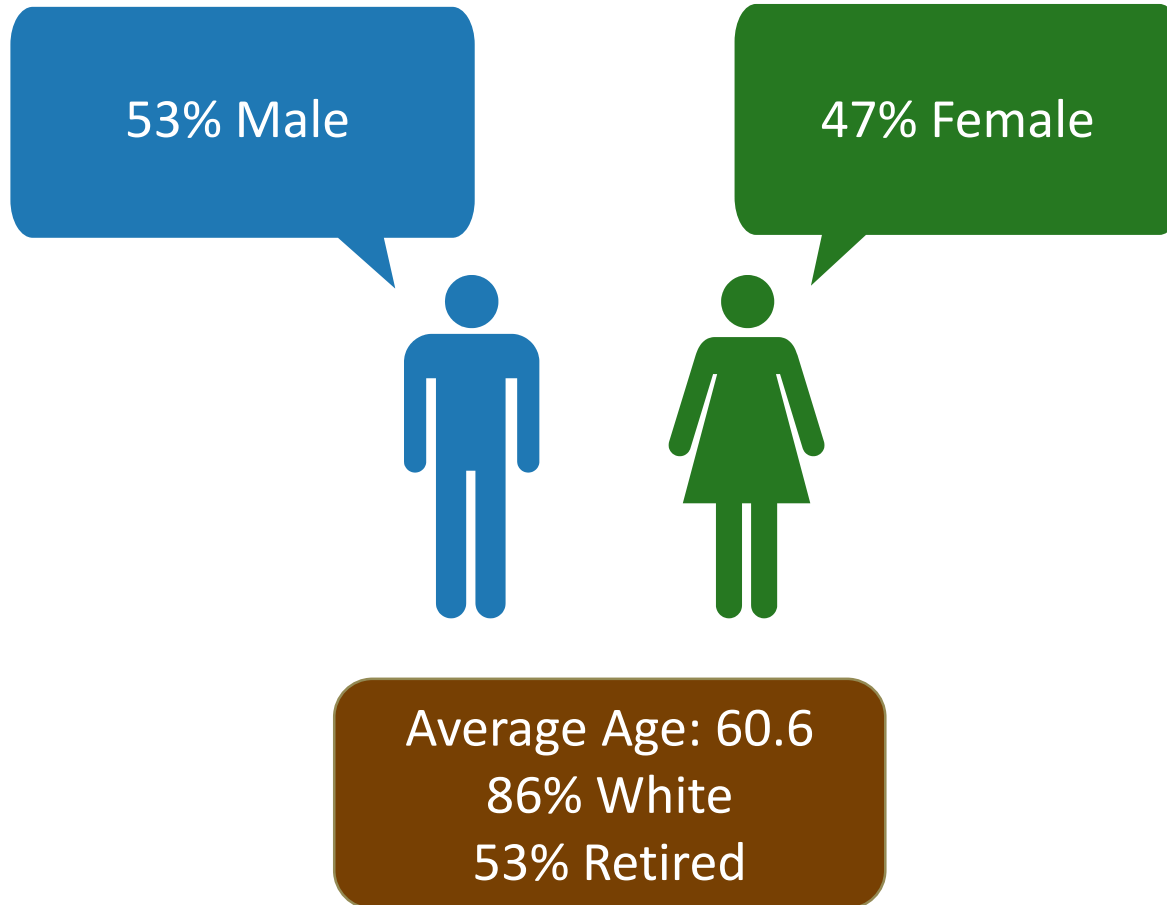
# Short Interview Questions

**1. How did you come to have this tree?**
- How did you hear about the (DCR or WTI) program?
- How or why did you decide to get a tree?
- How did you choose the species and location of your tree(s)?
- If they have both DCR and WTI trees, ask:
  - How did you hear about both programs?
  - Which trees did you get first? DCR or WTI?
  - Why did you choose the species you chose for each program?

**2. Tell me about the care of your tree:**
- Did you find it hard to care for your tree(s)?
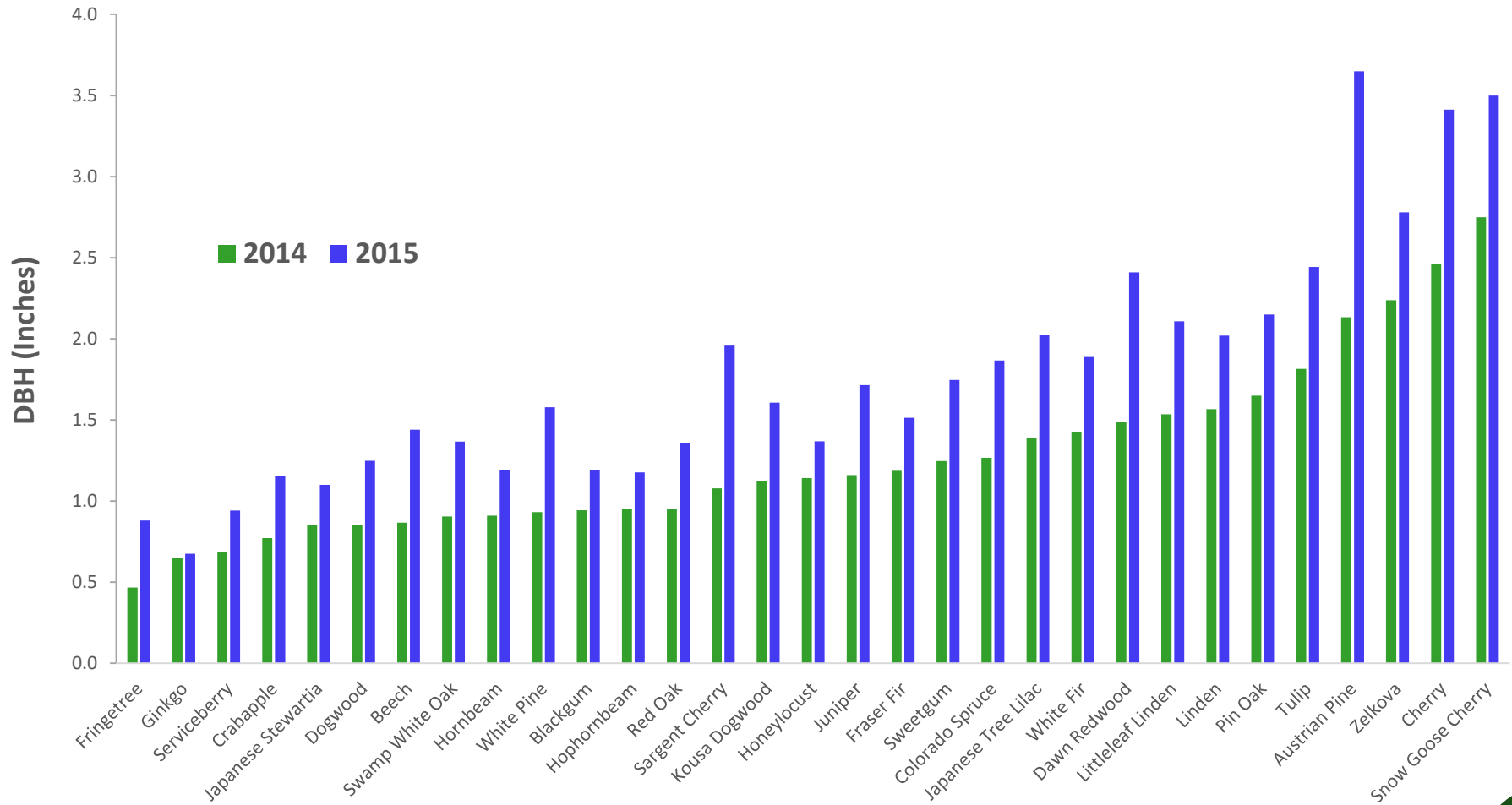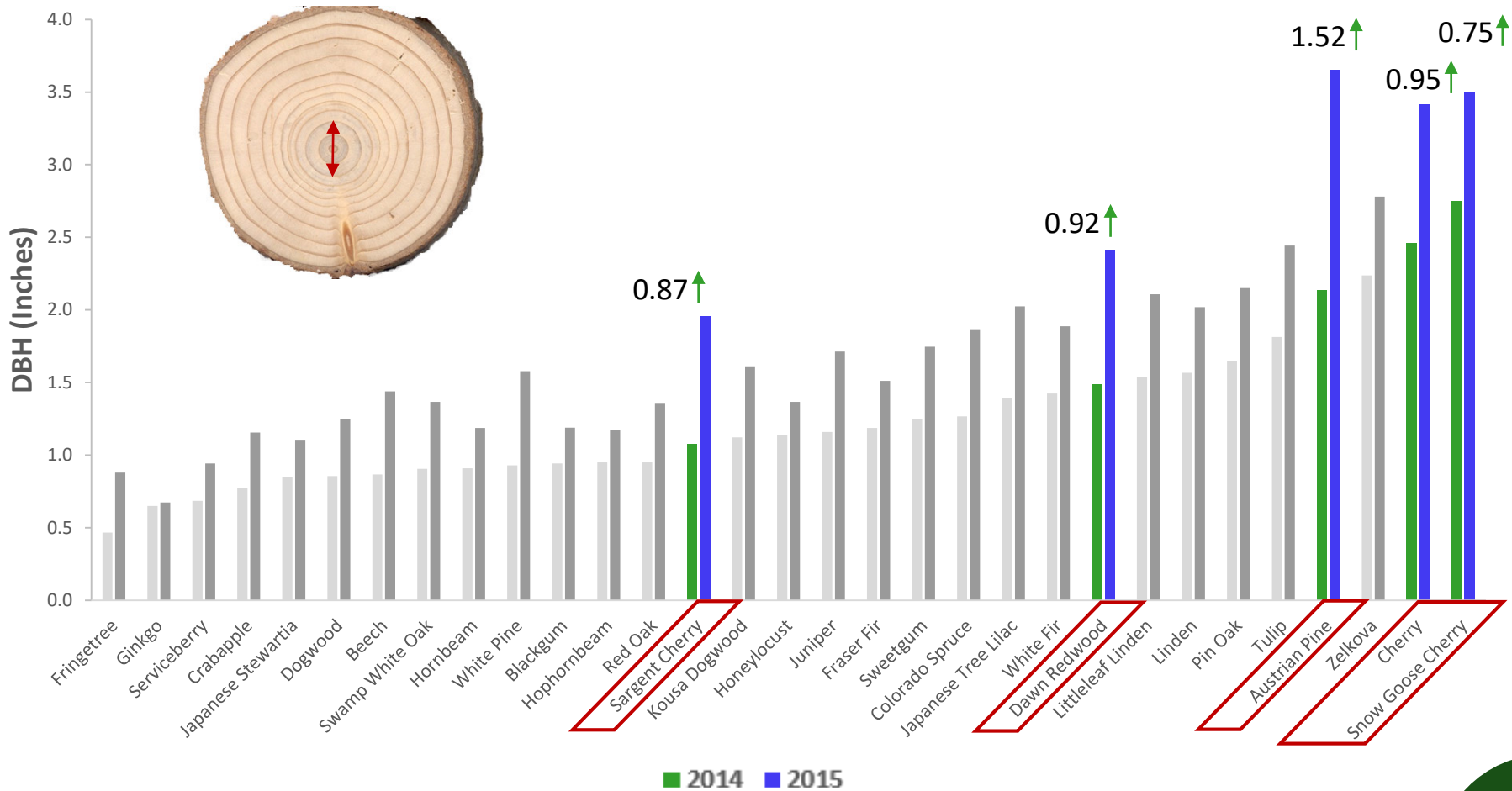- Now that it is older, do you water it as much?
- Do you or have you ever pruned your tree?
  - If yes, how often do you prune your tree?

**3. Do you feel there has been a difference in your neighborhood as a result of the tree-planting effort?**
- Do you have a close relationship with your neighbors?
  - Do neighbors help each other out in caring for trees?
- Are there any community replanting efforts? Tell me about them

**4. Have tree-replanting efforts affected your environmental awareness? If so, how?**
- Do you talk about trees more often?
- Do you discuss trees with your neighbors?

**5. Have the tree-replanting efforts helped you to be more aware of environmental issues or groups?**
- WTI, Massachusetts Audubon, Tower Hill Botanical Garden, Greater Worcester Land Trust
- Climate Change, weather, wildlife conservation

38

# Identifying Themes in the Data



How Did You Get Your Tree?

Tree Care

Other:
2008 Ice storm
Tree cutting

Interview Questions

Feelings

Neighborhood & Community

Environmental Awareness

Relationship with Stakeholders

# Identifying Themes in the Data



- How Did You Get Your Tree?
- Other: 2008 Ice storm Tree cutting
- Tree Care
- Feelings
- Interview Questions
- Neighborhood & Community
- Environmental Awareness
- Relationship with Stakeholders

# Tree Care: Burdens and Limitations

## Questions

- In what ways are trees burdensome?
- What is the hardest part of maintaining your tree?

| **Inherent to Trees** | **Watering** | **Age or Condition** |
|---|---|---|
| "There's **no hard part**, for me. I'm very happy to have them"<br>– Resident | "Oh we had to water them for two years – all of them we watered and watered, it was **quite an expense on our water bill** unfortunately. We were not too happy with that. **But now we have the nice trees**."<br><br>– Resident | "**We're trying**. We're in our 80s so it's not easy."<br><br>– Resident<br><br>"Well, **I was watering** up until this past year, and then I became handicapped."<br><br>– Resident |

**Tree Care**

41

# Tree Care: Watering Results

```
        ┌─────────────────────┐
        │    Interviewees     │
        │        (41)         │
        └─────────────────────┘
```

| Initial Watering | No Watering |
|---|---|
| 87.8% (36) | 12.2% (5) |

**Continued Watering**

31.66% (15)
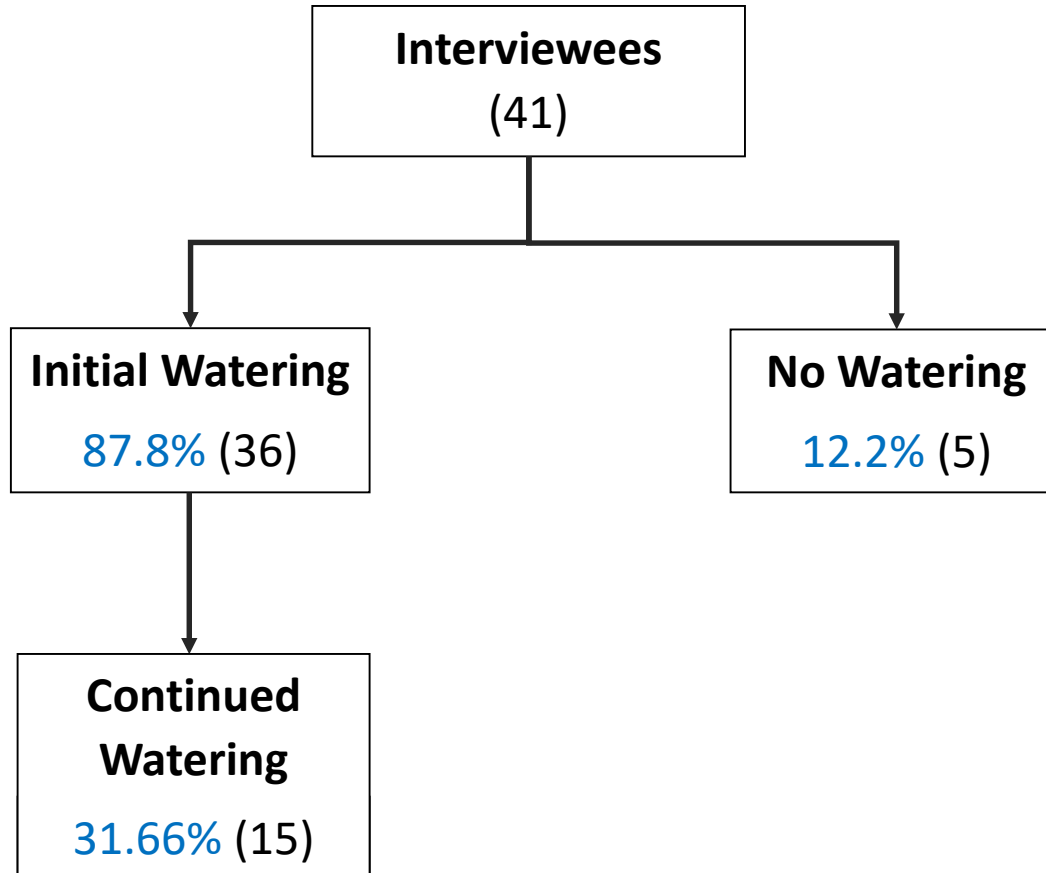
**Tree Care**

# Tree Care: Motivations

**Personal**

**Neighborhood**

**Environmental Awareness**

"**I enjoy botany**, certain aspects of plant life, and to make my yard more beautiful and then environment more beautiful. Plant a tree."

-Resident

"Since they've replanted trees it seems that people are **paying more attention** to how their houses look, you know."

-Resident

"**If you have green** you have a fabulous feeling of the environment and how it positively impacts your life."

-Resident

**Tree Care**

# Identifying Themes in the Data



How Did You Get Your Tree?

Other:
2008 Ice storm
Tree cutting

Tree Care

Interview Questions

Feelings

Neighborhood & Community

Environmental Awareness

**Relationship with Stakeholders**

# Stakeholder Interactions

**DCR and WTI**

"It was **very easy to work with everybody**, get your questions asked, and get information that you needed and also information that you didn't know you needed."
— Resident

"We **had wonderful experiences** with the groups that we've worked with whether it be the Worcester Tree Initiative or the DCR."
— Resident

"The DCR, they **do good work**. I think they are limited with their budget and personnel but they do a good job."
— Resident

**Relationship with Stakeholders**

# **Summary**

**Tree Planting Assessment**
- Survivorship was 77.6% (79.6% without White Fir)
  - Survivorship increased from 75.6% in 2014
- The high survivorship rate was hypothetically linked to greater care of ornamental/non-native/front yard trees
- Opportunity to improve communication about shade/native/back yard trees and their ecosystem services

**Resident Experience Assessment**
- Most residents were appreciative of the tree planting programs and had a positive feeling regarding the WTI and DCR
- The majority of residents watered their trees and didn't feel burdened by their trees

# Future Directions

- Link interview data with tree survey data to better understand neighborhood attitudes

- Explore the relationships between income, demographics, and tree survivorship

- Investigate ecosystem services of planted trees

# Acknowledgements

**Special thanks to:**

Clark University and the O'Connor Fund

Principal Investigators
- John Rogan
- Deborah Martin
- Verna DeLauer

Managers
- Arthur Elmes
- Michelle Andrews

Our interviewees
Former HERO cohorts
Visiting lecturers

Staff Support
- Brenda Nikas-Hayes
- Pamela Dunkle
- Rachel Levitt
- Kayla Peterson
- Michael Krikonis

DCR, especially Kathryn Aroian, Shawn Cameron, and Jenny Pezzullo

WTI, especially Ruth Seward, Derek Lirange, and Peggy Middaugh

# Thank You!

# Highest Survivorship

| Native | White Fir | American Arborvitae | Serviceberry |
|---|---|---|---|
| Non-Native | Japanese Tree Lilac | Kousa Dogwood | Cherry |

| Shade | White Fir | American Arborvitae | Honeylocust |
|---|---|---|---|
| Ornamental | Japanese Tree Lilac | Kousa Dogwood | Serviceberry |

| Front Yard | Japanese Tree Lilac | American Arborvitae | Kousa Dogwood |
|---|---|---|---|
| Back Yard | White Fir | Kousa Dogwood | Juniper |

# Other Planting Program Studies

**Table 1**

Early (<10 years since planting) urban tree survival rates for past cited planting program studies.

| Source | Location | Species | % survival (*n*) | Yrs since planting | Notes |
|---|---|---|---|---|---|
| Impens and Delcarte (1979) | Brussels, Belgium | Numerous | 88.7 (2905) | 1 | Average survival and number planted for 4 assessment periods |
| Sklar and Ames (1985) | Oakland, CA, United States | Numerous | 0.5 (2000) | <10 | Federal inner-city planting program |
| | | | 60–70 (1500) | <10 | Community-based inner-city planting program; includes replacements |
| Gilbertson and Bradshaw (1990) | Liverpool, United Kingdom | Numerous | 77.3 (401) | 3 | |
| Nowak et al. (1990) | Oakland/Berkley, CA, United States | Robinia pseudoacacia Magnolia grandiflora Platanus × acerifolia | 65.4 (254) 63.8 (199) 81.5 (27) | 2 2 2 | |
| Miller and Miller (1991) | Wisconsin, United States | Numerous | 67.5 (2048) | 4 | Average survival across 10 species and 3 cities |
| Gerhold et al. (1994) | Pennsylvania and Maryland, United States | Malus spp. | 94–100 (unknown) | 3 | Range of survival for 10 cultivars planted in 12 communities |
| Yang and McBride (2003) | Beijing, China | Sophora japonica | 83.1 (450) | <1 (11 wks) | Large trees planted bare root with the majority of main structural roots/scaffold branches removed |
| | | Fraxinus chinensis | 62.7 (300) | | |
| Thompson et al. (2004) | Iowa, United States | Numerous | 91 (932) | 4 | Average for 21 cities/towns |
| Lu et al. (2010) | New York, NY, United States | Numerous | 91.3 (45,094) | 2 | |
| Jack-Scott (2011) | Philadelphia, PA, United States | Numerous | 95 (590) | 1–5 | Bare root stock; excludes missing/removed trees |
| | | | 96 (573) | 1–5 | Balled-and-burlapped stock; excludes missing/removed trees |
| Roman and Scatena (2011) | Philadelphia, PA, United States | Acer campestre | 78.8 (151) | 2–10 | |
| Jack-Scott et al. (2013) | New Haven, Connecticut, United States | Numerous | 73.8 (1393) | 4–16 | |
| Roman et al. (2013) | Oakland, CA, United States | Numerous | 80.3 (unknown) | 1–4 | |

# Replanting Survivorship



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.
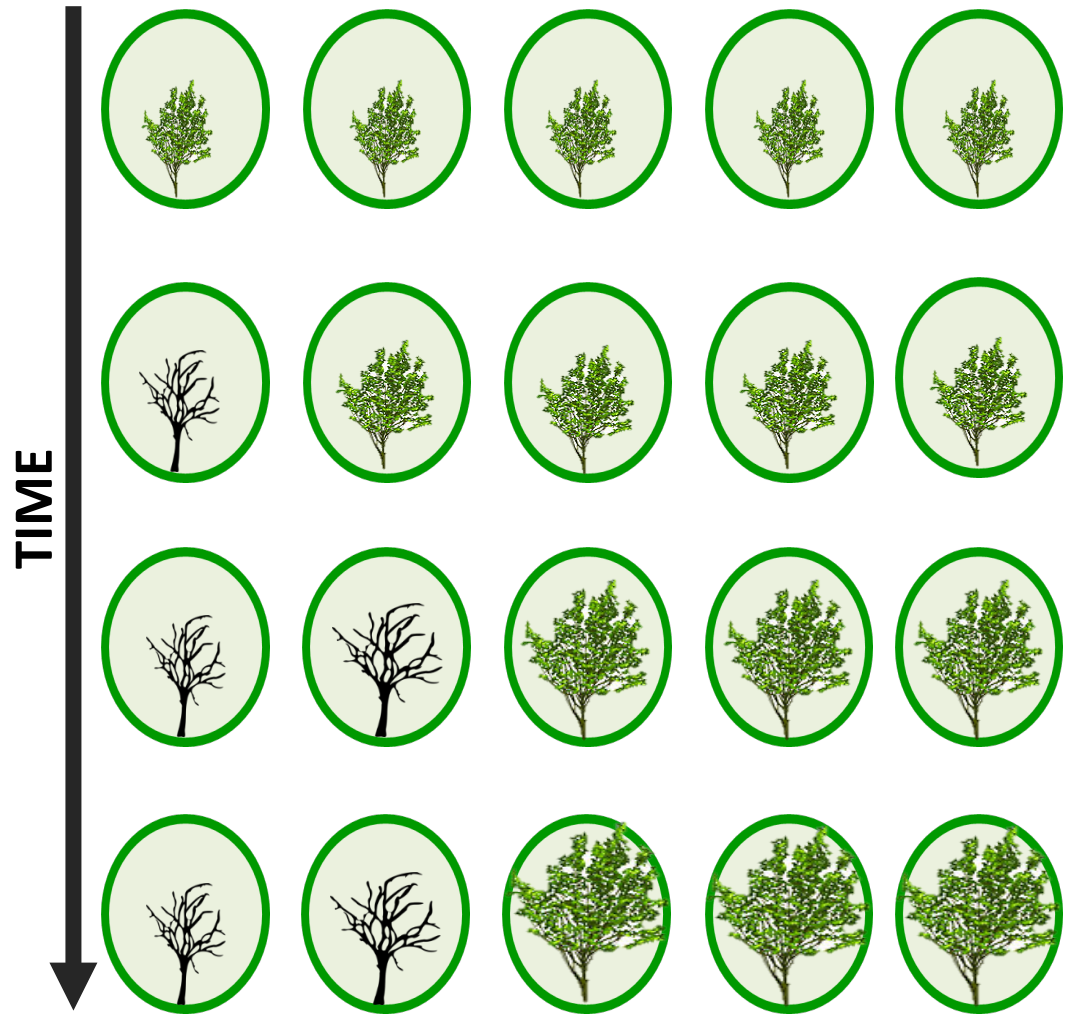
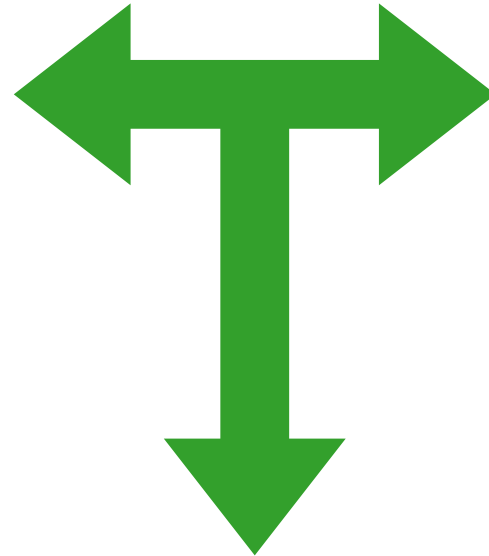# Mixed Methods

**Tree Replanting Assessment**

Tree-size metrics
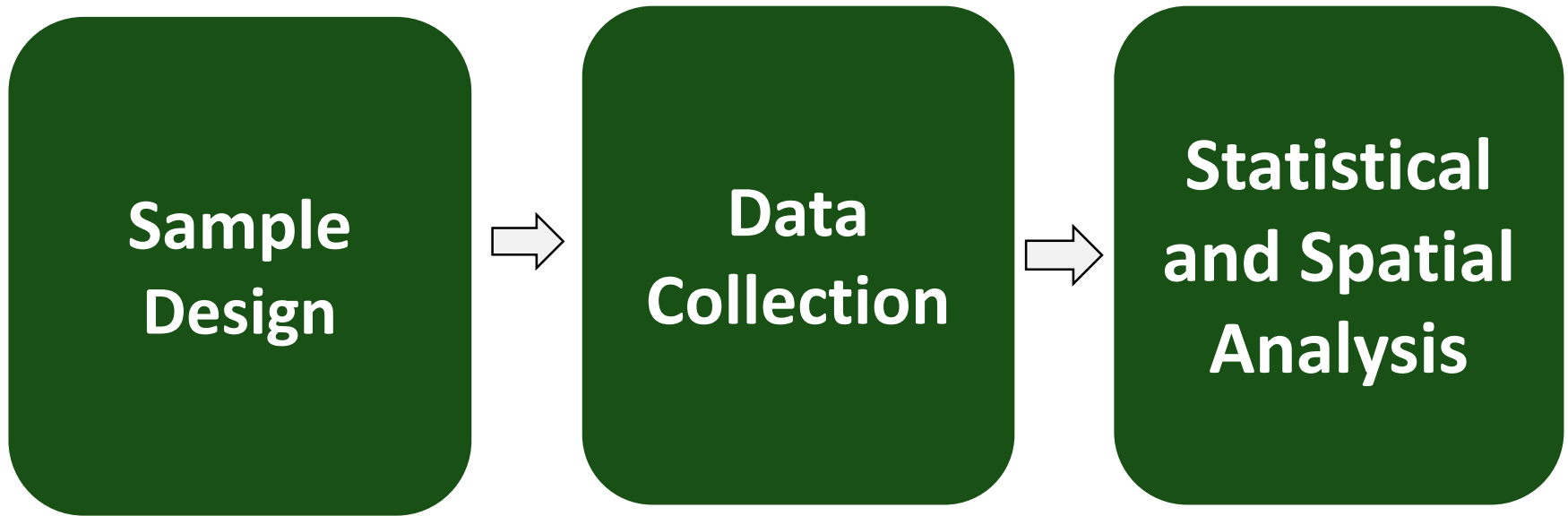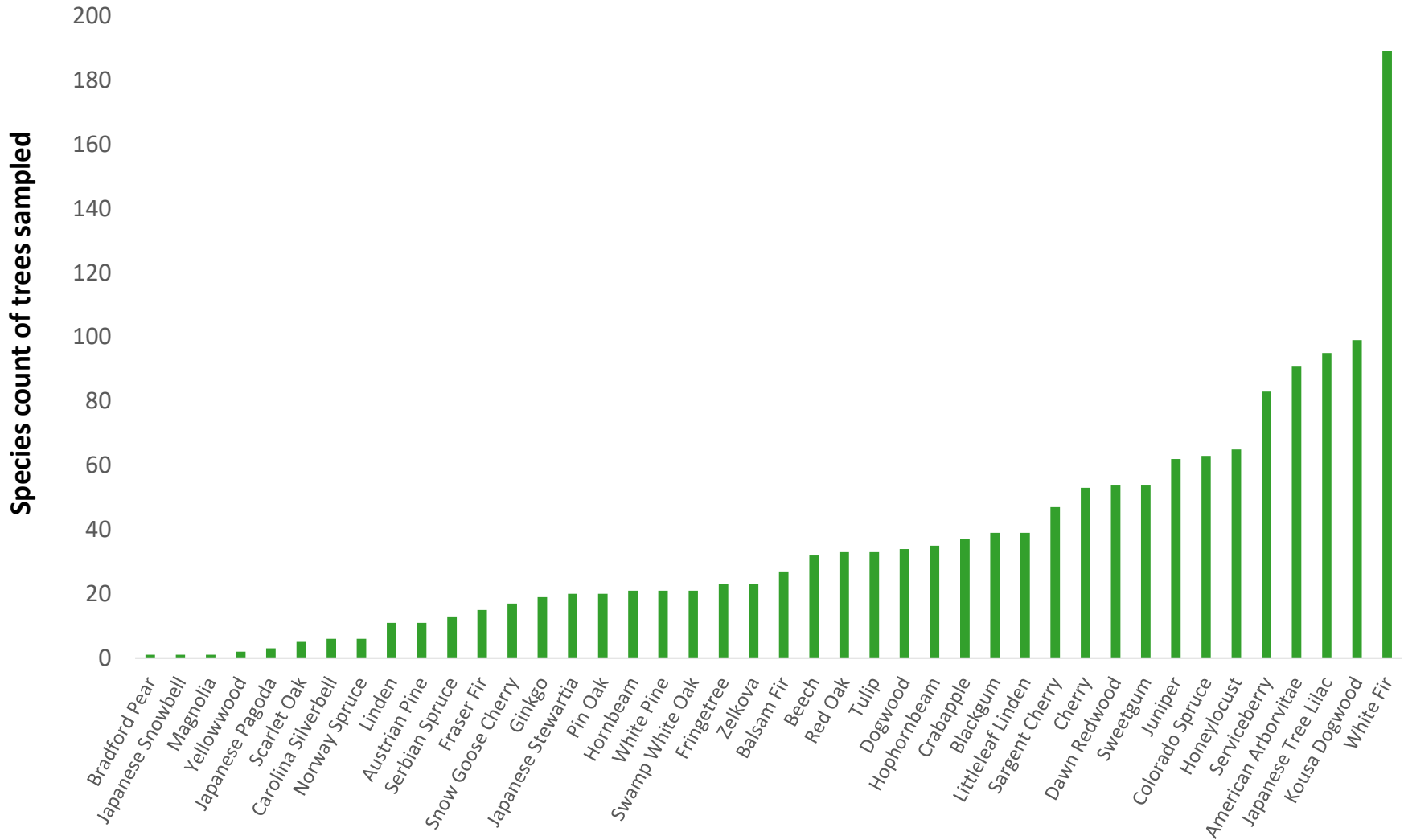
Maps

**Resident Experience Assessment**

Surveys

Interviews

Mixed Methods Study

# How did we choose our trees?

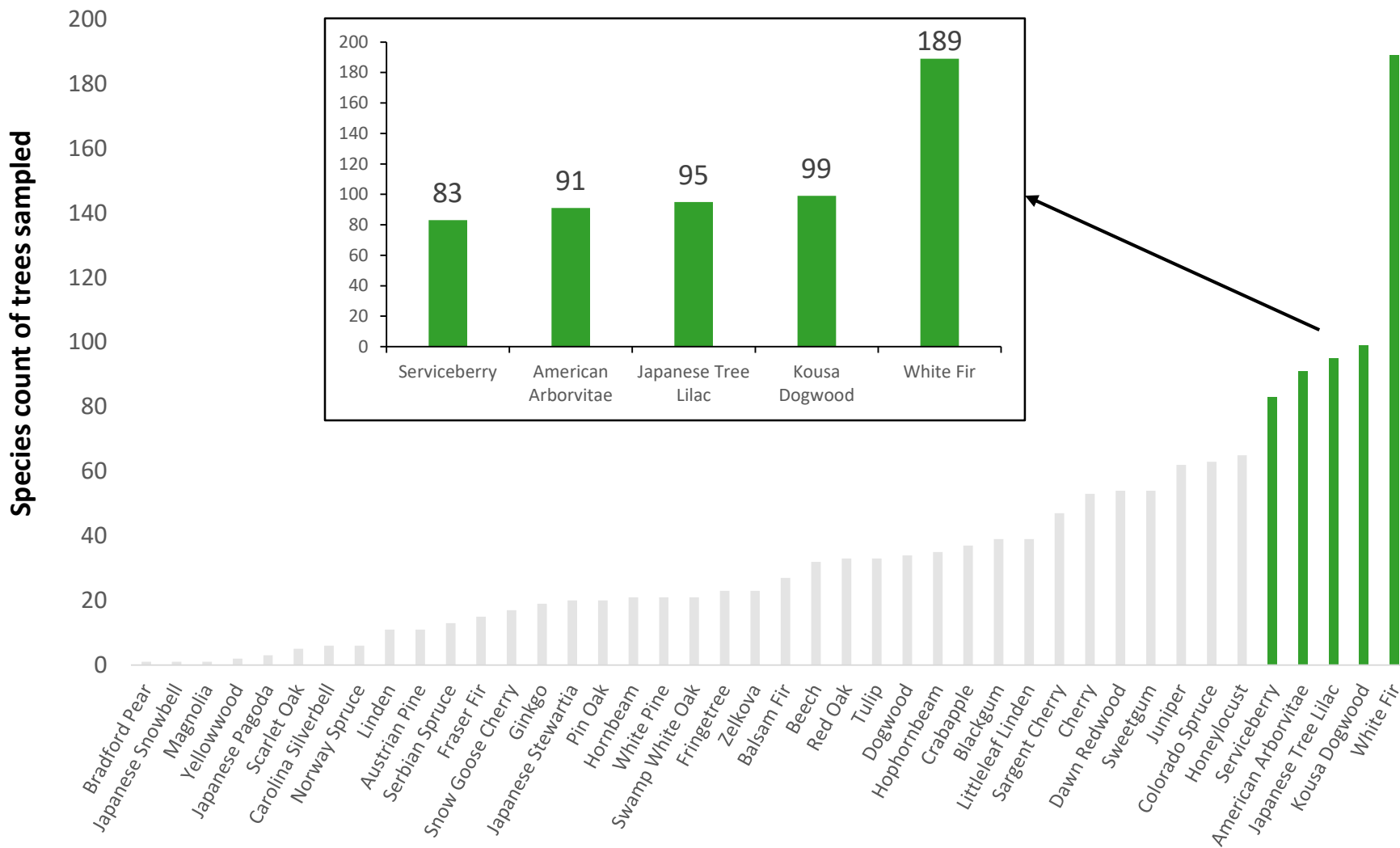**Sample Design** ⇨ **Data Collection** ⇨ **Statistical and Spatial Analysis**
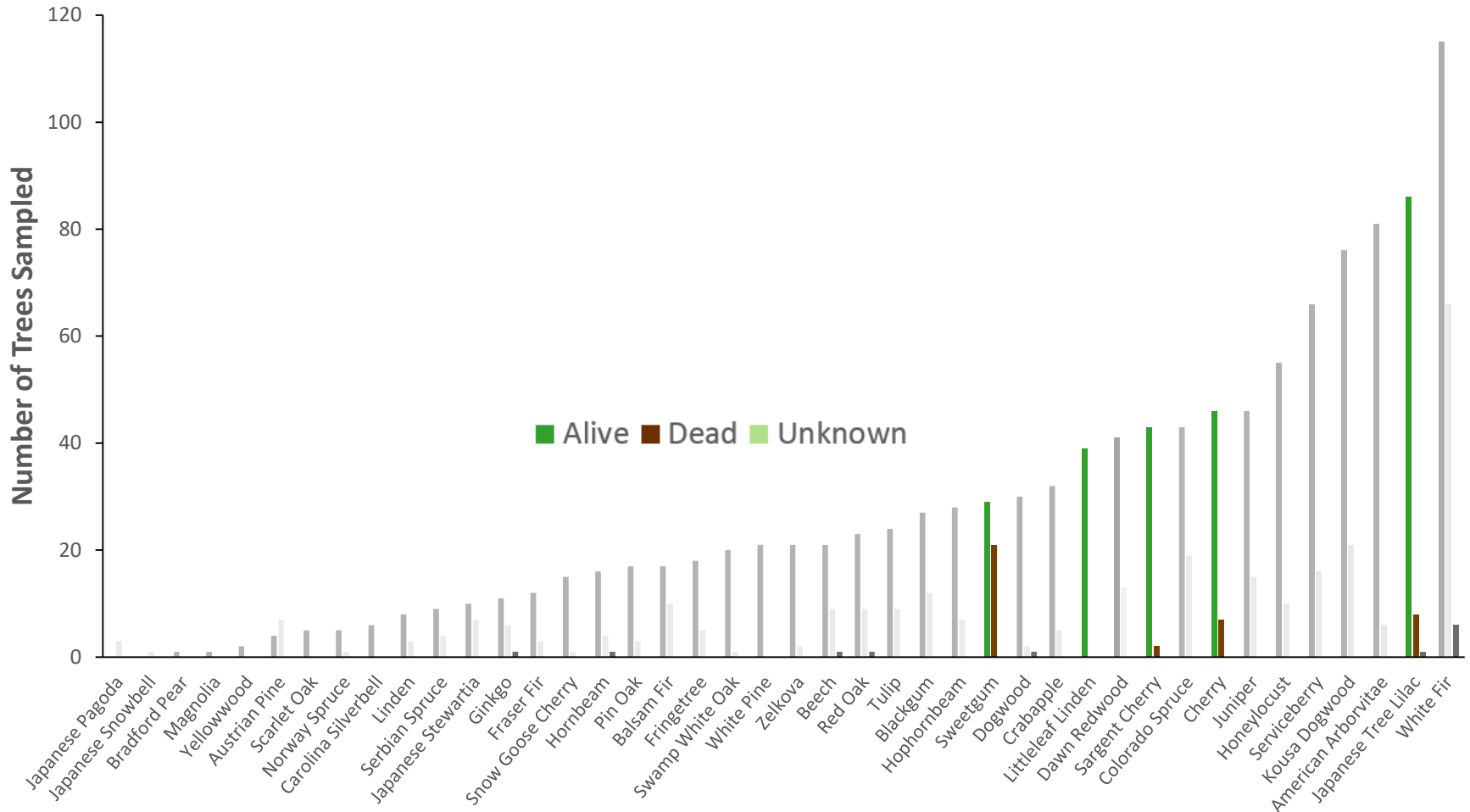
Species Count

Species count of trees sampled

# Species Count
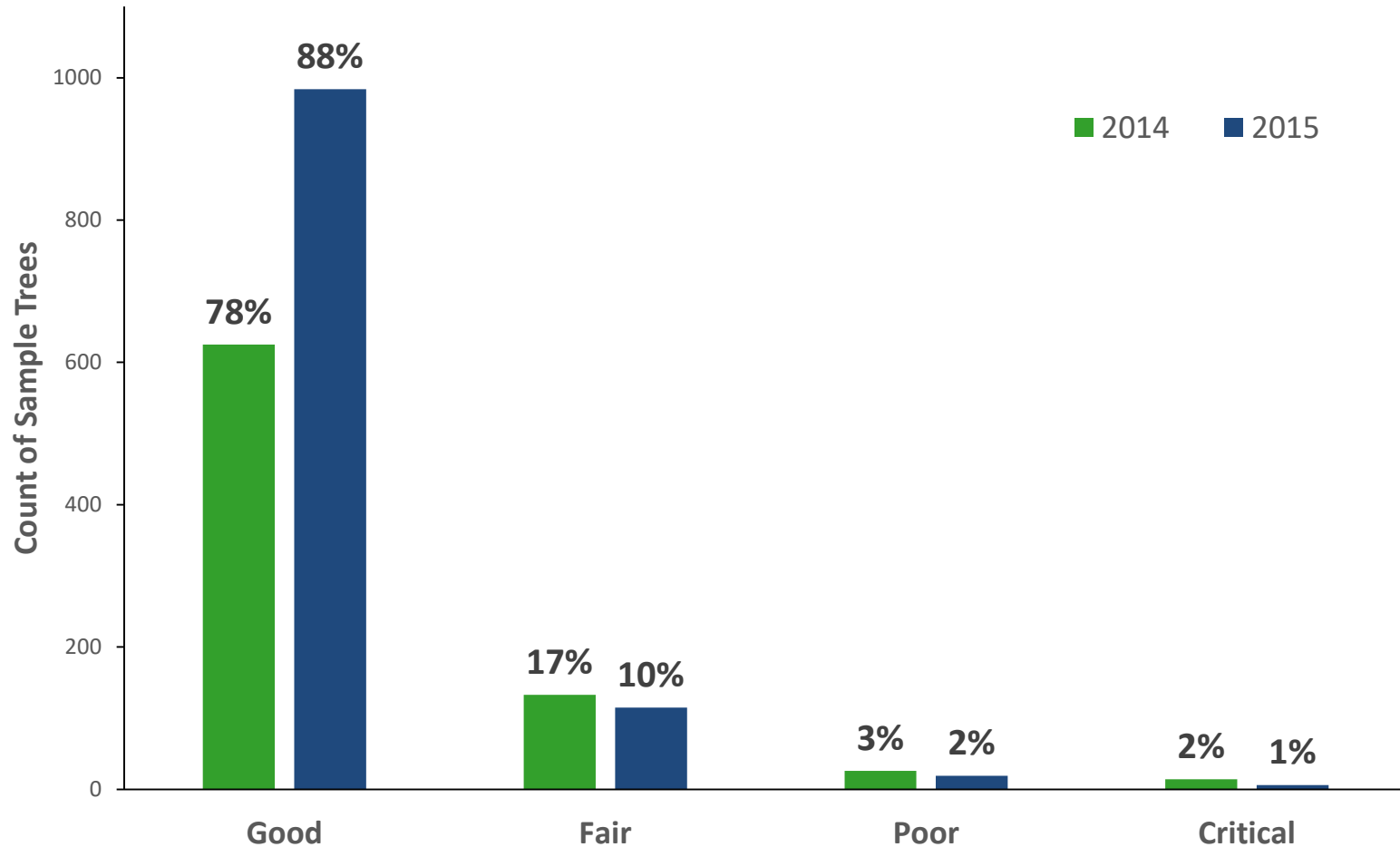
# Survivorship Status by Species

# Investigating Survivorship

1. Native vs. Non-Native

2. Shade vs. Ornamental

3. Site Type

4. Land Use

5. Planting Season

# Count of Tree Condition in 2014 and 2015

# Condition of Re-surveyed Trees in 2015