

HERO 2022 Stakeholder Presentation

**Shradha Birdika, Nicole Buckley, Lucy Fleming,
Danielle Hall, and Charlotte Zieselman**



The Human-Environment Regional Observatory (HERO) Program



**An undergraduate research experience, held by the
Clark University Graduate school of Geography in
which students explore human-environment
relationships in New England**

Previous Research

- **Land use modeling**
- **Urban forestry
stewardship**
- **Urban Heat Island
Effect**

Meet the Research Team



From left to right: Nicole Buckley, Charlotte Zieselman, Lucy Fleming, Danielle Hall, Nicholas Geron, Shradha Birdika, Apple Gould-Schultz, and Madeline Regenye

Undergraduate Research Cohort

Charlotte Zieselman, Lucy Fleming, Shradha Birdika, Nicole Buckley, Danielle Hall

BMB Team

Dr. Rinku Roy Chowdhury, Sarah Hughes, and Spandan Pandey

Team Managers/Graduate Mentors

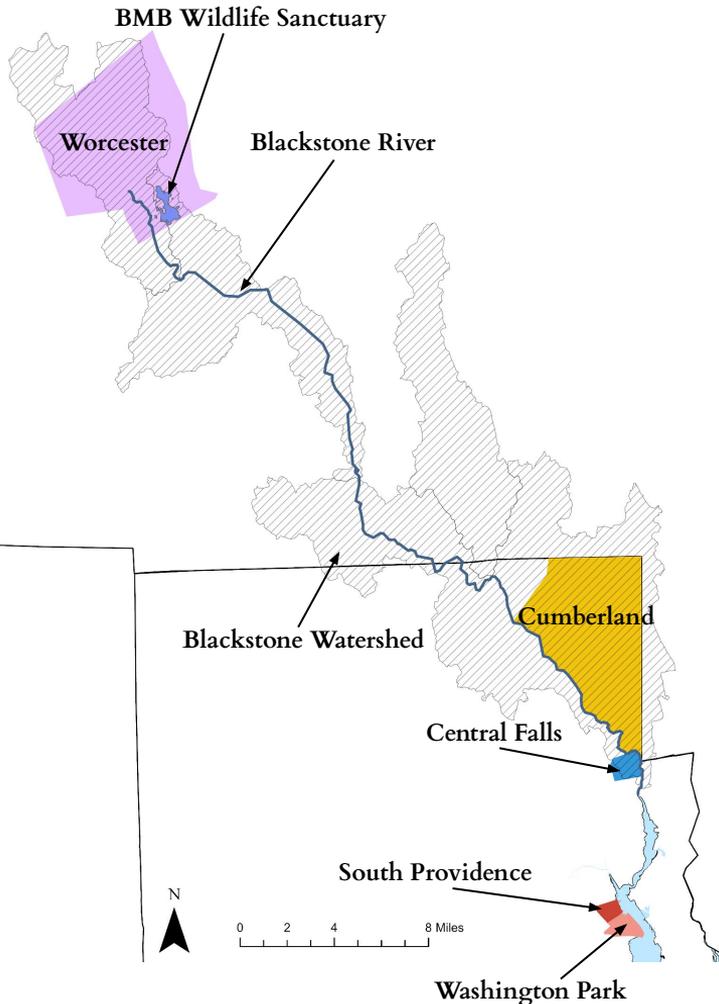
Nicholas Geron, Veronica Apple Gould-Schultz, and Madeline Regenye

Directors

Dr. Deborah Martin and Dr. John Rogan

Outline

Measuring environmental conditions and people's perceptions of urban forestry and conservation



Broad Meadow Brook–Worcester, MA



Cumberland, Central Falls, and Providence, RI



Broad Meadow Brook Wildlife Sanctuary

What are the nearby residential perceptions
of conservation and interactions in and
around the sanctuary?



Mass Audubon's Broad Meadow Brook Wildlife Sanctuary

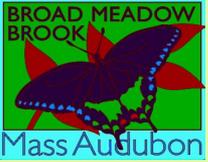


Mass Audubon is the largest nature-based conservation organization in the New England region.

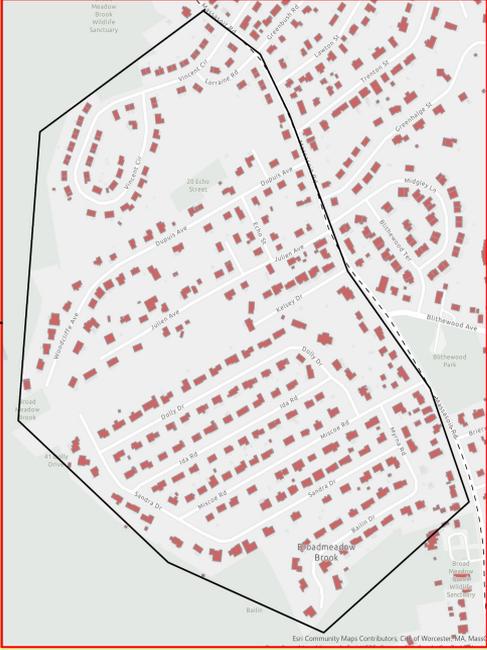
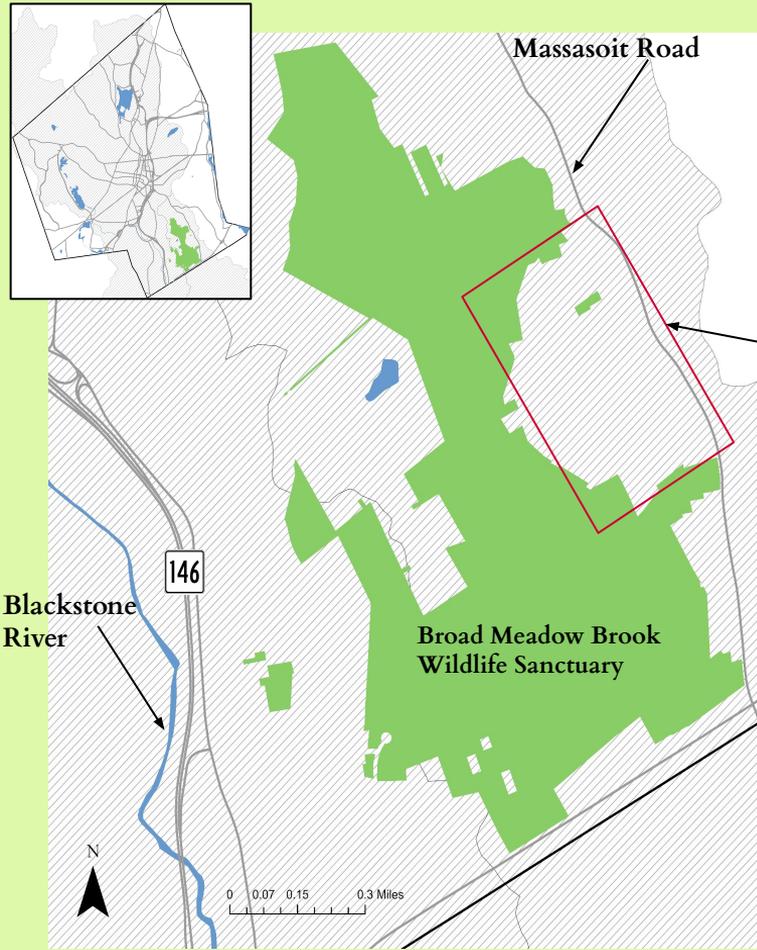
- BMB Wildlife Sanctuary is a 400-acre conservation area that opened to public on June 20, 1991.
- **Broad Meadow Brook Wildlife Sanctuary** is fed primarily by urban storm drainage from its surrounding neighborhood.
- The sanctuary is currently undergoing ecological restoration, aiming to improve wetland health and function, promote growth of native biota, and reduce flooding downstream in residential neighborhoods.



Sarah and Shradha interviewing a resident



Study Area



Broad Meadow Brook Neighborhood Survey

We interviewed 55 out of 286 neighborhood residents, focusing on their opinions on the Broad Meadow Brook Wildlife Sanctuary and the environment.

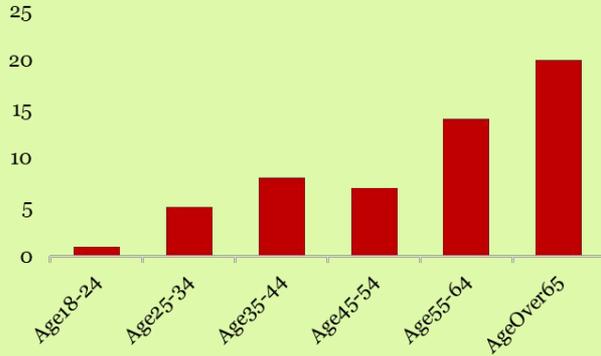


Pictures of front and back yards in Broad Meadow Brook Neighborhood

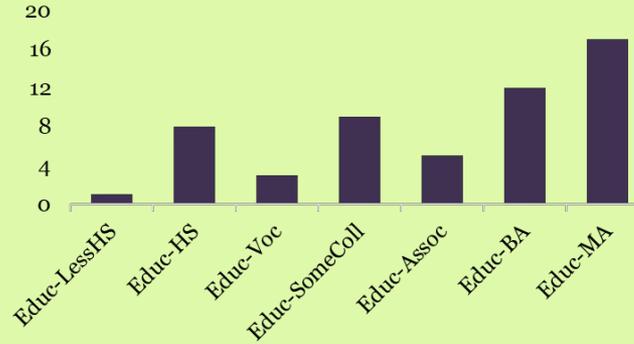


Broad Meadow Brook: Participant Demographics

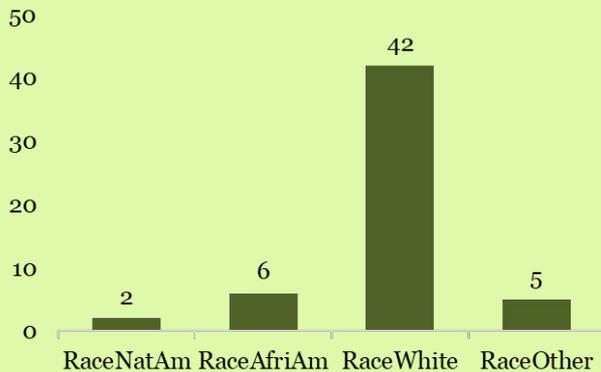
Age of Participants



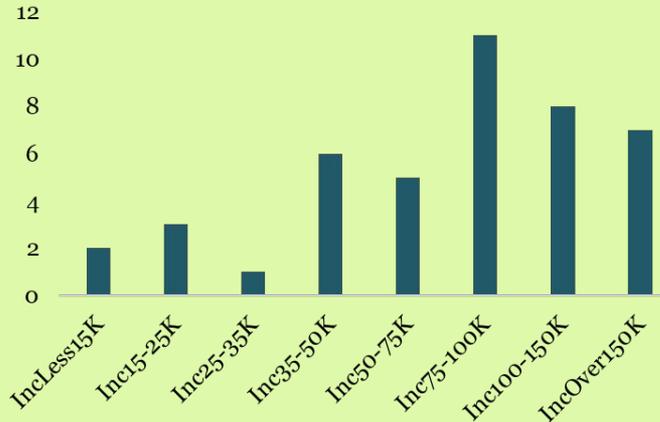
Highest Education Level Attained by Participants



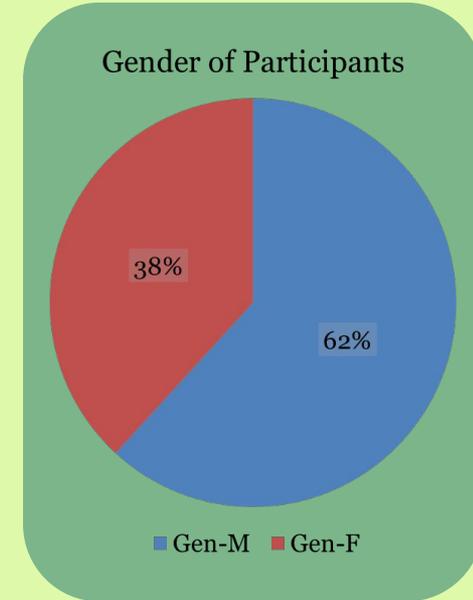
Race of Participants



Household Income of Participants



Gender of Participants





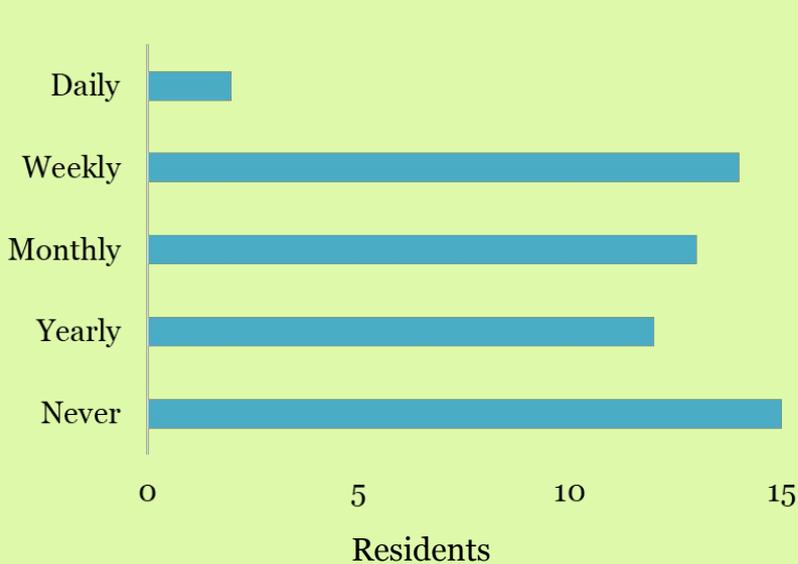
Worcester Demographics

	Our Survey	Census Tract	Worcester
Median Age	55-64	37	35
Population with a Bachelor's Degree	53%	31%	31%
% Minority	24%	29%	47%
Median Income	\$75-100k	\$61,420	\$51,647
Gender	62% male	49% male	49% male



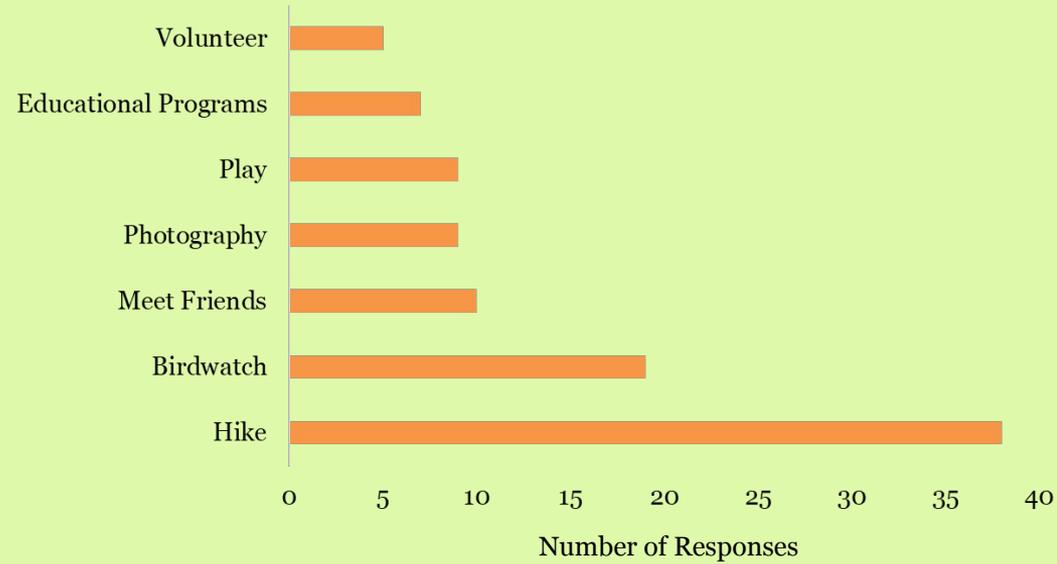
Resident Interactions with Broad Meadow Brook Wildlife Sanctuary

How often do you visit the sanctuary?



52% of participants visit the sanctuary at least once a month.

What activities do you enjoy at the sanctuary?

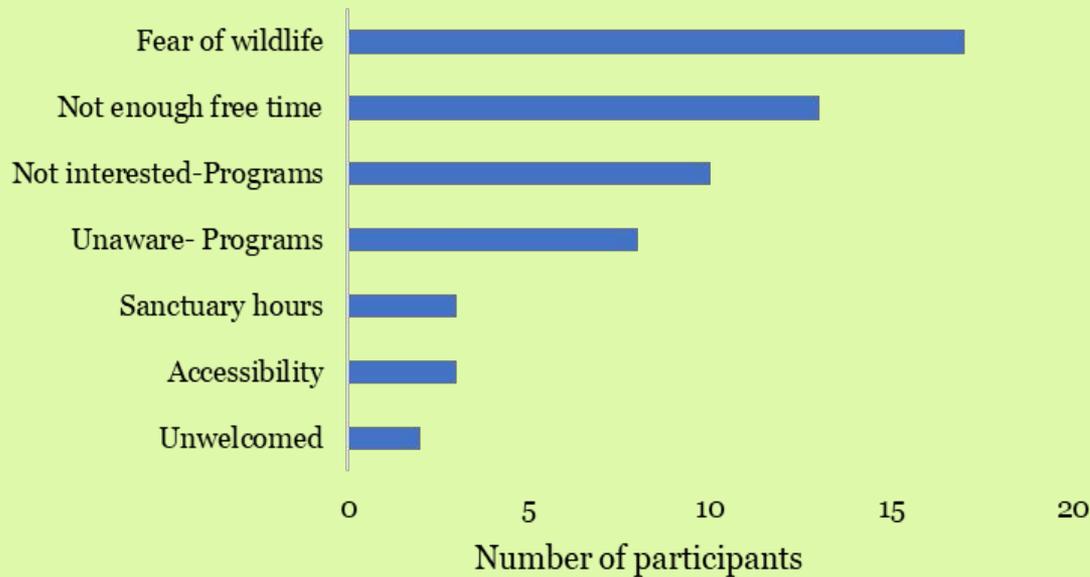


Hiking is the most popular activity, followed by birdwatching



Resident Interactions with Broad Meadow Brook Wildlife Sanctuary

Reasons for not visiting the sanctuary

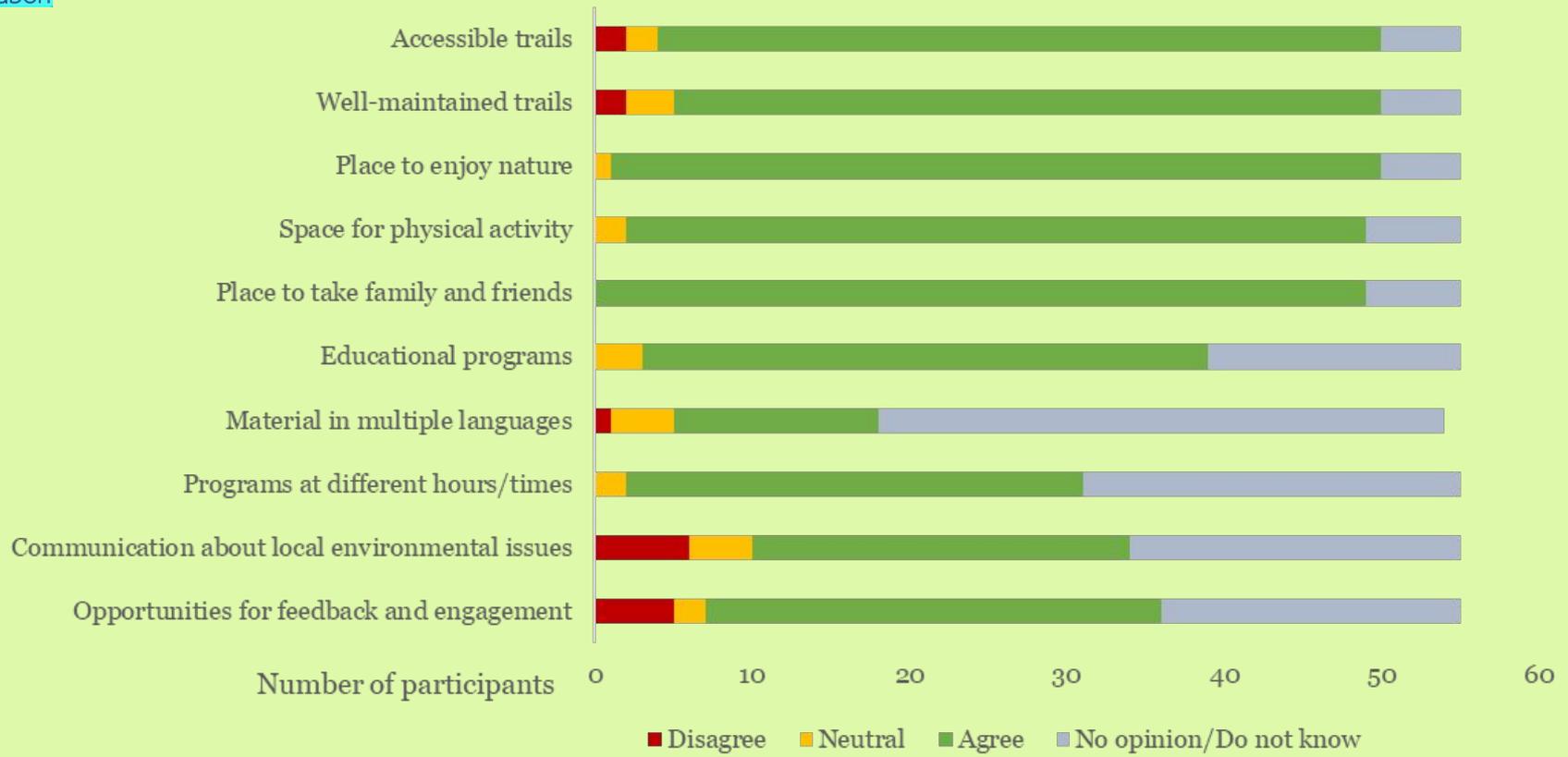


“We looked at the summer camps but it was really restrictive for the times they offer. [...] Give some kind of lessons 3 hrs long, I’d have done it. More options for kids under 8. That’s something they can do to improve.”

~ Resident, Broad Meadow Brook



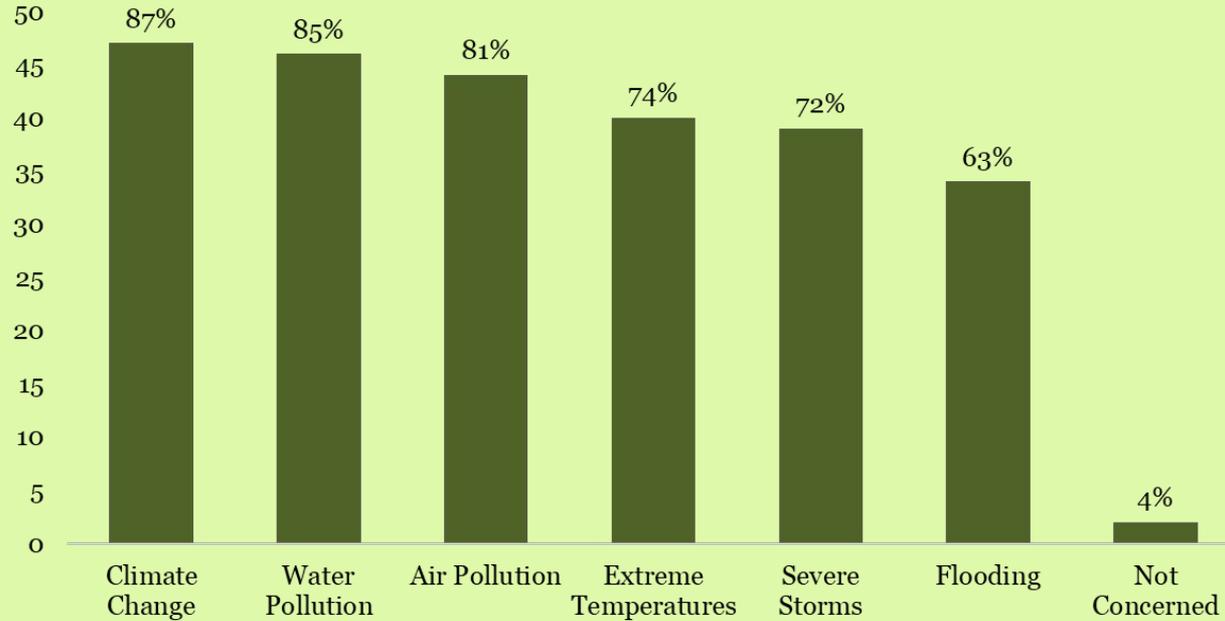
Perceptions of Mass Audubon/BMB Wildlife Sanctuary





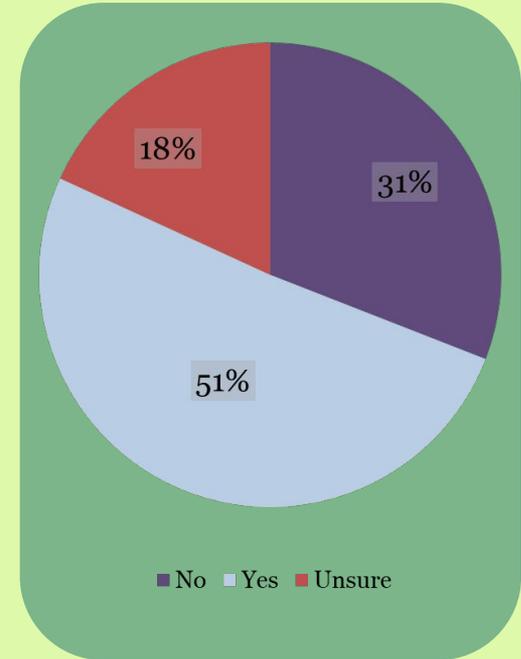
Participants Perception of Environment and Stewardship

Which environmental issues are you concerned about?



Climate change was residents' top concern, followed by water pollution.

Do you think the way residents here care for their lawn and home affects the quality of water in neighboring streams and water bodies?



Roughly half believe residents' lawn and home care affect water pollution ¹⁴



Broad Meadow Brook Wildlife Sanctuary Survey Summary and Future Work

Over half of residents reported visiting at least once a month, but 27% have never been, with some participants noting fear of wildlife and lack of free time as barriers

Almost all participants thought Broad Meadow Brook Wildlife Sanctuary does a good job providing accessible and well-maintained trails, but could do a better job communicating with residents.

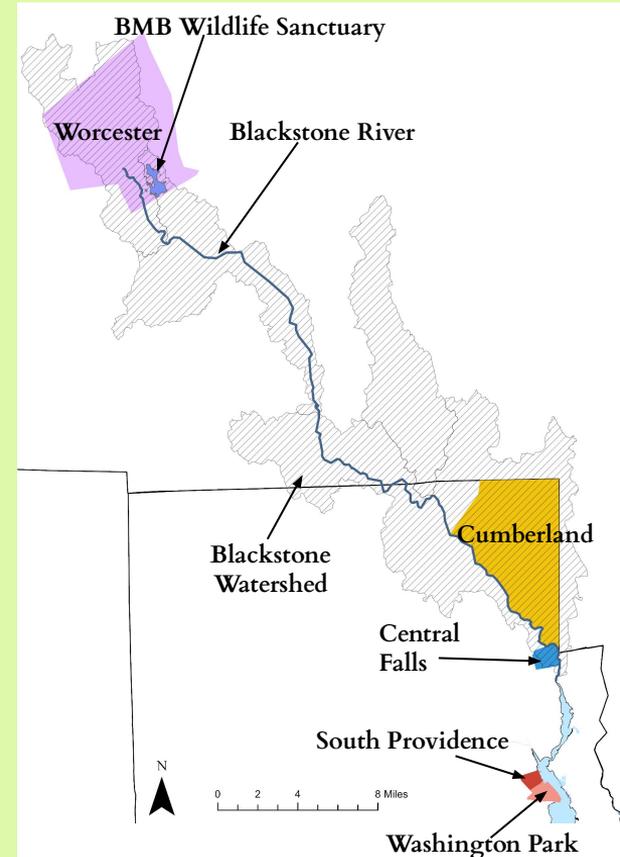
Residents are generally concerned about global environmental issues, especially climate change and pollution.



Past HERO Fellows David Henriques and Sarah Hughes installing acoustic monitors with Prof. Sangermano at BMB

Future Work

- Further analyze interview data
- Ongoing vegetation survey and acoustic monitoring



Urban Tree Canopy Analysis in Rhode Island

How do human and biophysical interactions impact the urban environment and inform urban forestry efforts to create a more resilient and equitable city?



Groundwork Rhode Island

Groundwork is a national nonprofit organization that strives to develop the resiliency of urban communities by providing economic opportunities while encouraging environmental stewardship.

Towns, cities, and neighborhoods identified as places where urban forestry can be most beneficial:

- Central Falls
- Cumberland
- Washington Park, Providence
- Lower South Providence, Providence



HERO team and Groundwork RI members looking at sites and a newly dug out sidewalk cut out with Groundwork in RI



Environmental Justice

Environmental justice seeks to address the inequitable access to environmental harms and benefits.

Criteria for Environmental Justice:

- High percent minority
- High percent foreign-born
- Low household income
- Lack of English proficiency



Street with few trees in South Providence



Street with a Tree Tunnel in Washington Park

Urban Tree Canopy Services and Disservices

Services

- Reduce local land surface temperature
- Reduce runoff and flooding
- Improve air quality
- Reduce energy use
- Moderate climate
- Provision of wildlife habitat
- Improve mental and physical health
- Cultural and personal significance
- Improve aesthetics



Callery Pear in Cumberland, RI

Disservices

- Risk of property damage
- Tree litter
- Tree care burden
- Insects
- Allergies
- Perception that tree planting poses the threat of gentrification



Research Goals



How do human and biophysical interactions impact the urban environment and inform urban forestry efforts to create a more resilient and equitable city?

Residents' Perceptions of Urban Trees

Objectives:

1. Survey residents to understand their perceptions and experiences with urban trees
2. Understand residents' concerns about the environment

Survey of Trees and the Urban Landscape

Objectives:

1. Survey Groundwork tree planting
2. Survey current distribution of trees and potential planting locations
3. Understand the impact of trees on heat and pollution



Types of Sites

Tree Site



Sidewalk Cutout



Planting Strip



Impervious Site



Available Planting Sites



Surveyed **287**
Sites

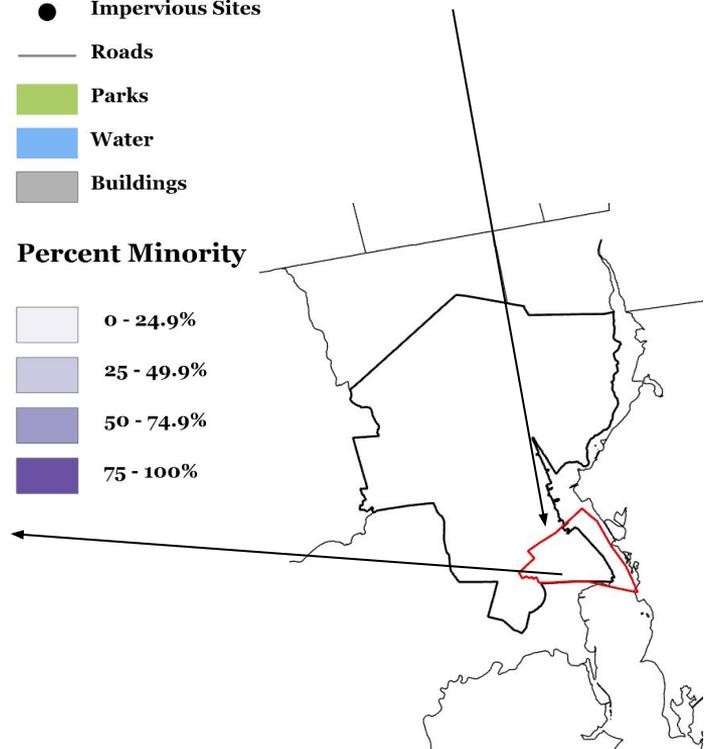
Washington Park



- Tree Sites
- Available Planting Sites
- Impervious Sites
- Roads
- Parks
- Water
- Buildings

Percent Minority

- 0 - 24.9%
- 25 - 49.9%
- 50 - 74.9%
- 75 - 100%

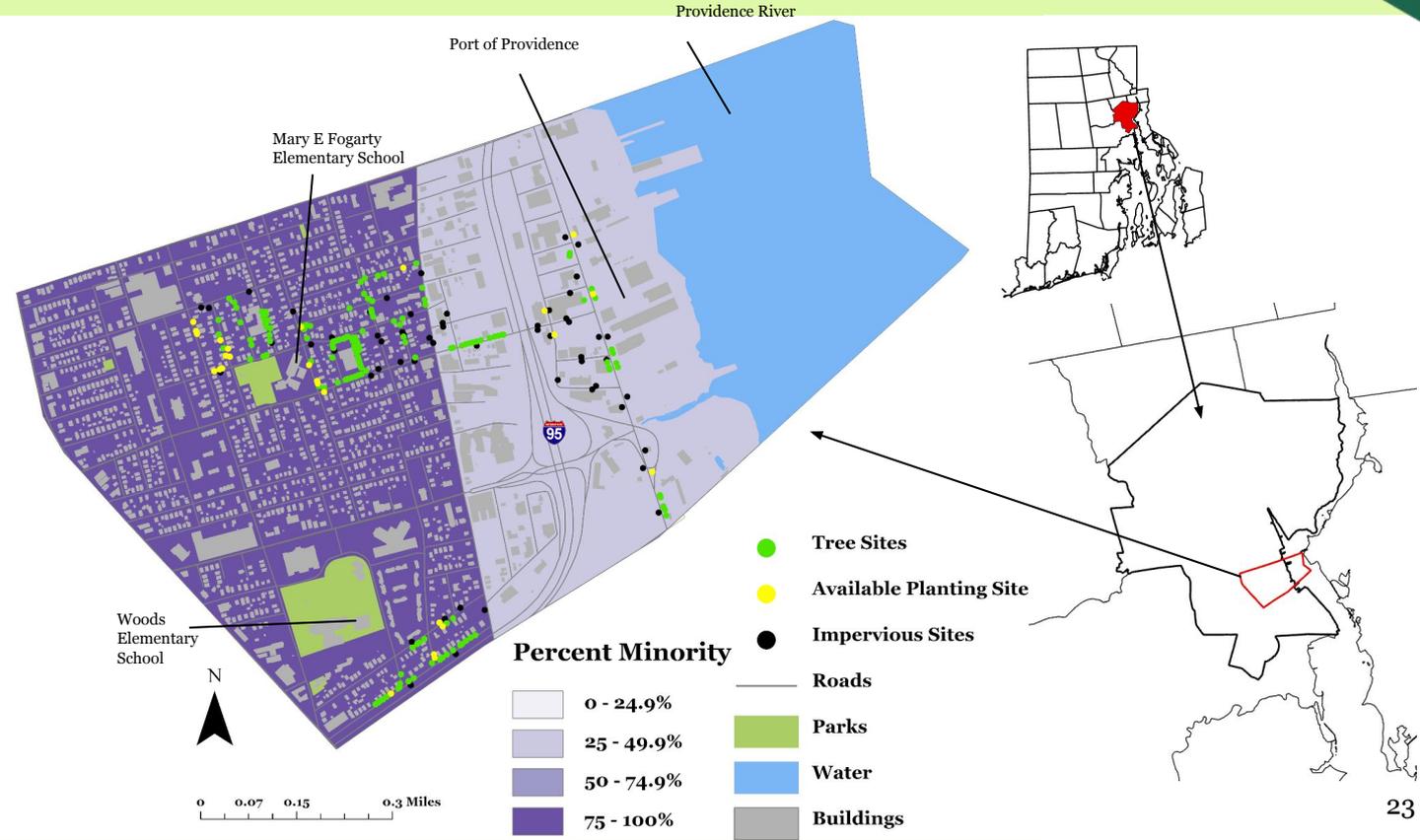




South Providence

Surveyed 230 Sites

- 143 trees
- 35 of the 143 were Groundwork trees (24%)
- 26 available planting sites





Central Falls

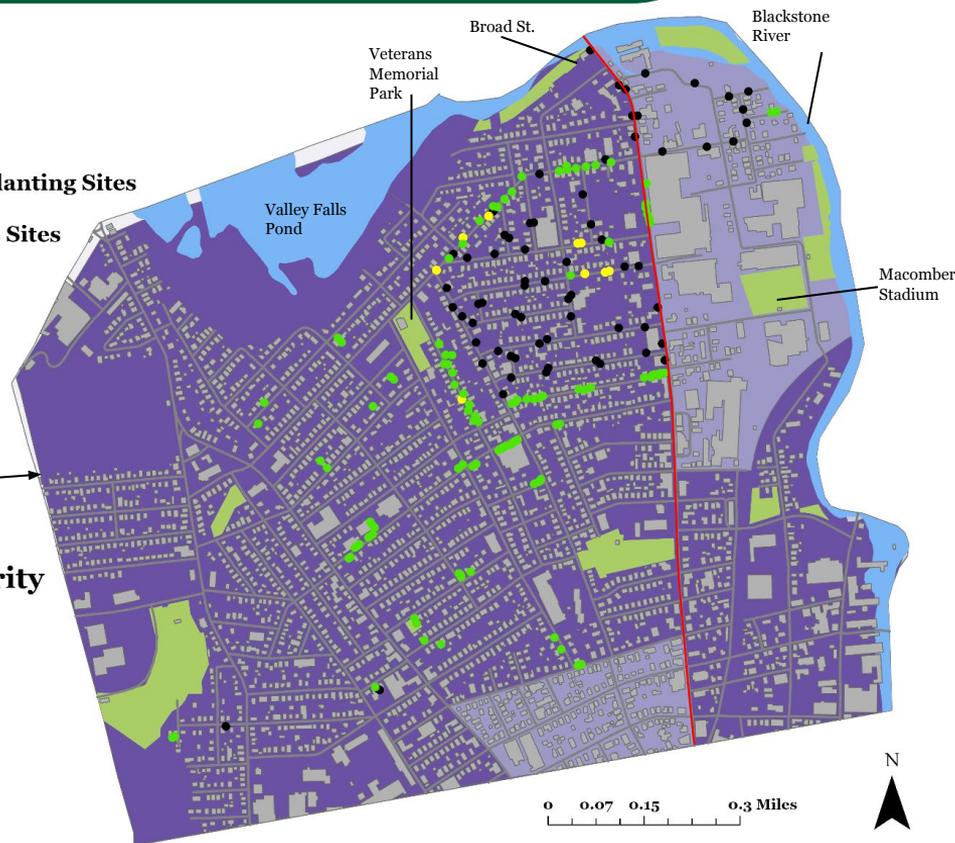
Surveyed 184 Sites

- 109 trees
- 59 of the 109 were Groundwork trees (54%)
- 9 available planting sites

- Tree Sites
- Available Planting Sites
- Impervious Sites
- Roads
- Parks
- Water
- Buildings

Percent Minority

- 0 - 24.9%
- 25 - 49.9%
- 50 - 74.9%
- 75 - 100%





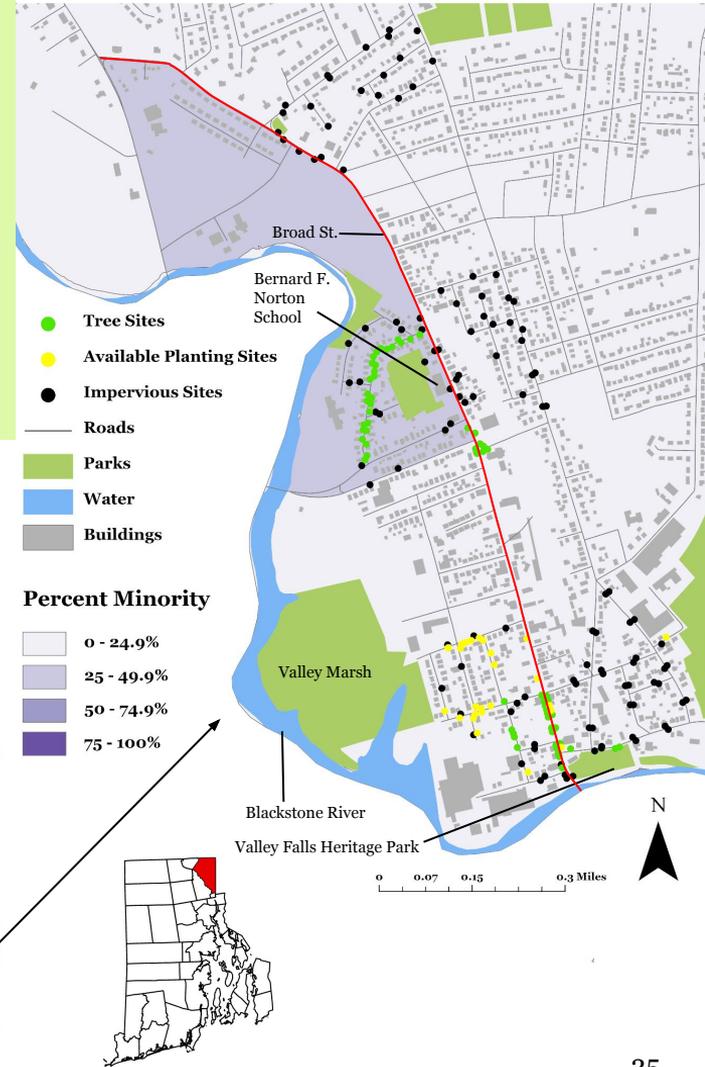
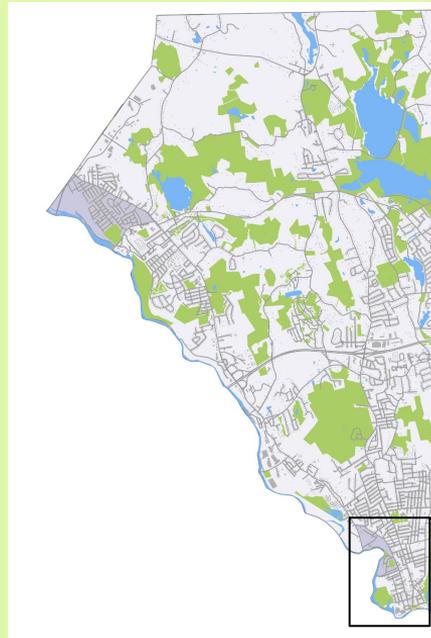
Cumberland

Surveyed 197 Sites

- 59 trees
- 27 available planting sites



Recent Tree Planting at Valley Falls Heritage Park





Residents' Perceptions of Urban Trees

Objectives:

1. Survey residents to understand their perceptions and experiences with urban trees
2. Understand residents' concerns about the environment



Shradha leaving a flyer at a resident's door



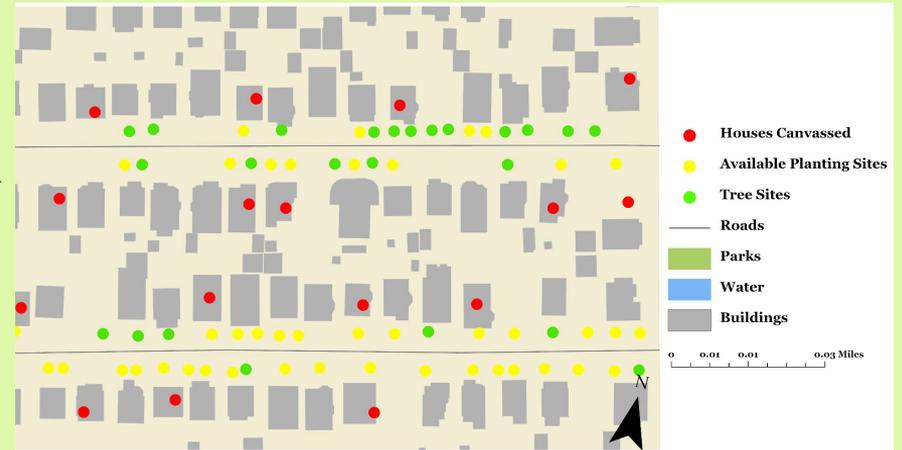
Interview Sampling Strategies

Washington Park

Strategy: All houses on curbless points

Knocked on 81 doors, interviewed 10 residents

Response rate: 12%



Central Falls and Cumberland

Strategy: Convenience Sampling

4 Interviews in Cumberland

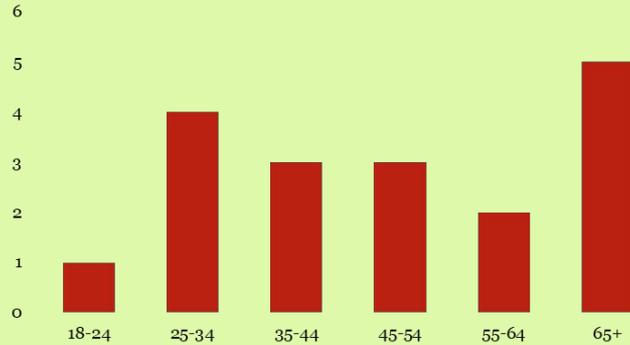
4 Interviews in Central Falls



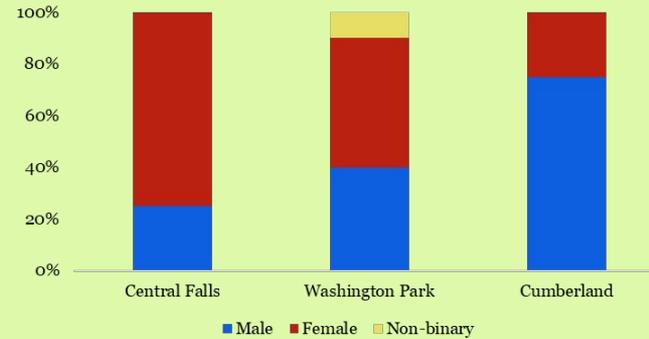


Demographics of Residents Interviewed

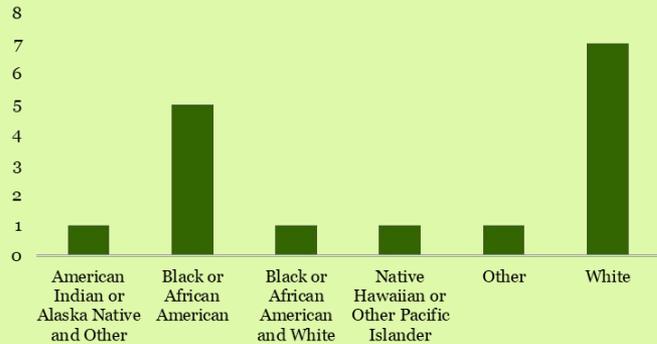
Age of Participants



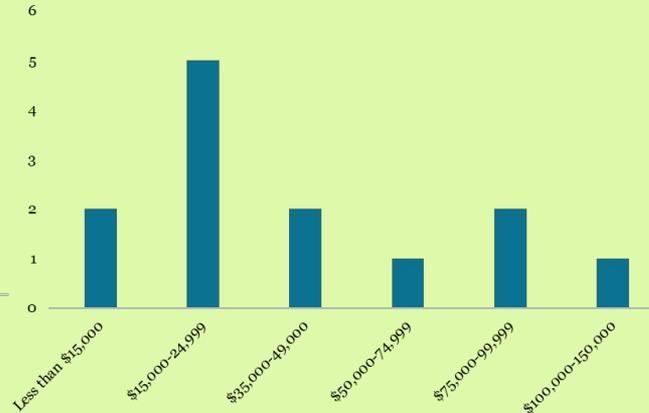
Gender of Participants



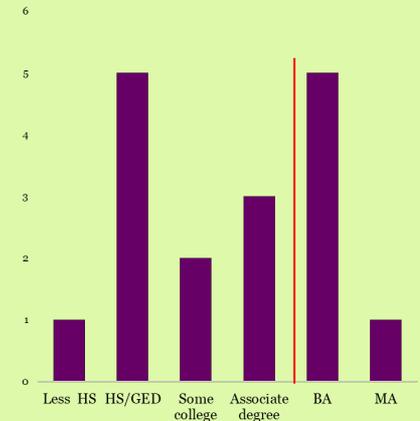
Race of Participants



Household Income of Participants



Highest educational level attained by participants





Comparison between Survey and City Demographics

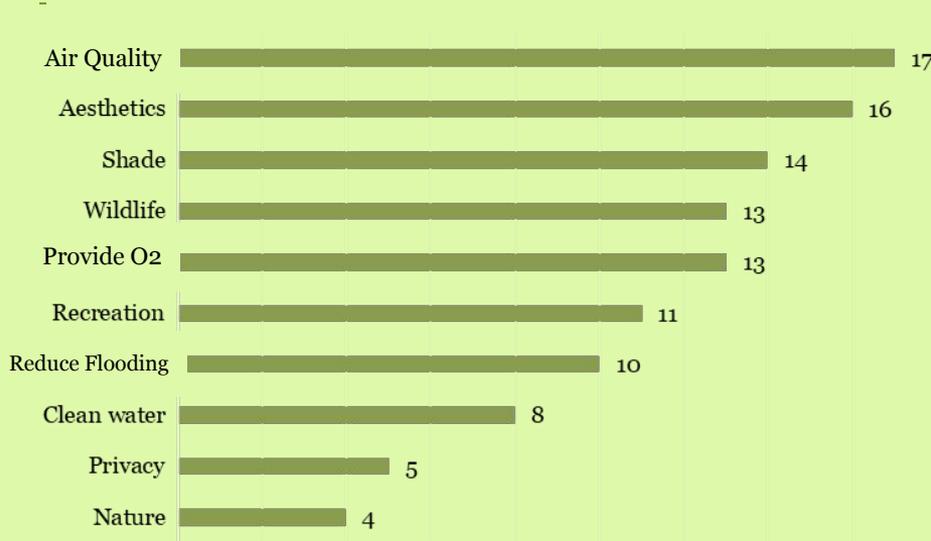
	Total Survey	All Cities Census*
Median Age	45-54	34.4
Median Income	\$15,000-24,999	\$59,078
Average Non White	59%	43%
Average Educational Attainment	33%	34%
Average Female	50%	51%

*2019 ACS Data



Positive Perceptions about Trees

What benefits or impacts of trees do you appreciate the most?



The highest perceived benefit is trees' role in improving air quality.

“Do trees bring more air? yeah that they do!”
~ Resident, Washington Park

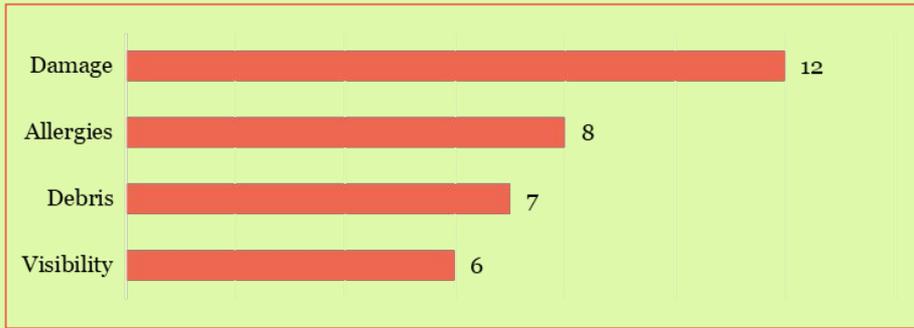
“I think trees help a lot between cooling the earth and [providing] oxygen, obviously. So yeah, they're a good thing.”
~ Resident, Cumberland

“I think [trees] are better for air quality, it makes it look better. And the better the neighborhood looks, the more pride, hopefully, people will take in it and stop doing this to it. (referring to the litter)”
~ Resident, Central Falls 30



Negative Perceptions about Trees

Which of the following are potential negative impacts of having trees in your neighborhood?



The biggest concern that stood out was property or car damage from mature trees.

“Uh, yeah, they're starting to lift up the brick.”

~ Resident, Cumberland

“I don't have trees, originally, because I don't want the damage.”

~ Resident, Central Falls

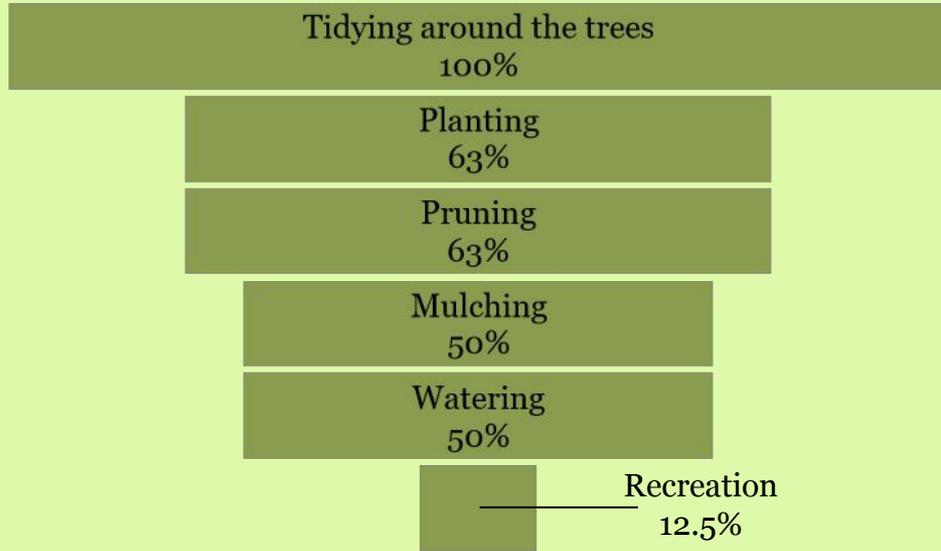
“So I think that number one should be probably fix the trees and the sidewalk conflict and then help the residents with the tree related damage and maintenance.”

~ Resident, Washington Park



Positive Interactions and Experiences with Trees

Have you engaged in tree stewardship before?



“When I first planted my trees, I had bought a Japanese Maple for the front yard. And then I forgot the name of the other one, it was a shade tree that we planted in the backyard. And we lived at that house for 19 years.”

~ Resident, Cumberland

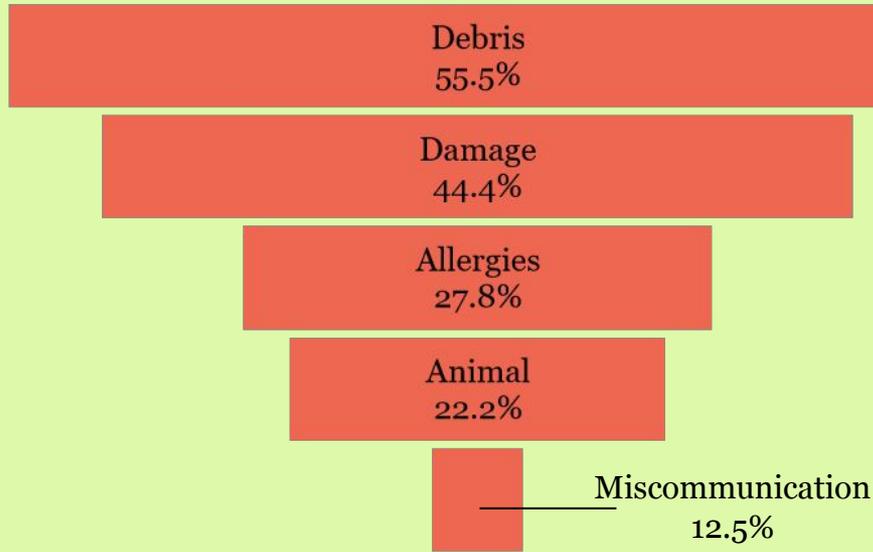
“Yeah. We've always planted something. You know, buying fruit trees for father's day and flowering trees for Mother's Day.”

~ Resident, Central Falls



Negative Interactions and Experiences with Trees

Which of the following tree issues have bothered you the most?



“We had what originally was a weed that grew up and started breaking the cement wall. It was on the property line so we had taken it down. It was black from all the tree leaves and everything was a real mess.”

~ Resident, Cumberland

“This tree right here drops like sap all over your car. So you can't park under it.”

~ Resident, Washington Park

“I got one crabapple tree and it just does nothing but drop the crab apples everywhere.”

~ Resident, Central Falls



Most common environmental concerns

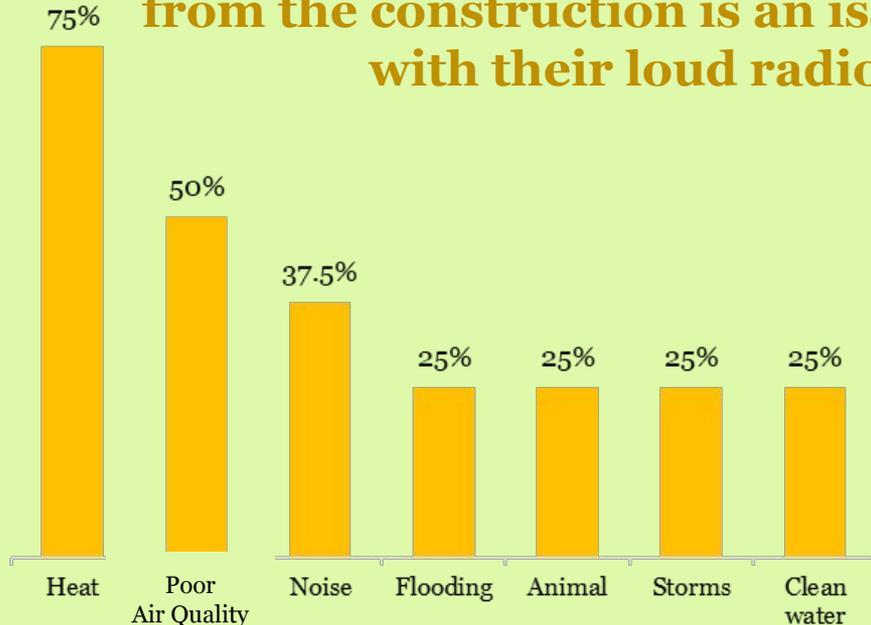
What are the most pressing environmental issues your neighborhood faces?

“Because there's a lot more traffic here than it used to, noise pollution due to all the traffic from the construction is an issue. And people with their loud radios in the car too.”

~ Resident, Central Falls

“I think [temperature and air quality] are important everywhere, to be honest with you.”

~ Resident, Cumberland



“There have been increases in flooding though. [Trees] might help with some of the flooding.”

~ Resident, Central Falls



Residents' desired allocation of resources

How should resources for trees be prioritized?

“So I think that number one should be probably fix the trees in the sidewalk conflict and then help with like help the residents with the tree related damage and maintenance.”
~ Resident, Washington Park

“I think that around here, it's a nice thing to have as much trees as possible.”
~ Resident, Washington Park



“If it was up to me, there will be trees everywhere.”
~ Resident, Central Falls

“I do think it would be cool if there were more environmental regulations, that people had to follow to keep trees, not just chop them down and more education, definitely.”
~ Resident, Washington Park



Survey of Trees and the Urban Landscape

Objectives:

1. Survey Groundwork tree planting
2. Survey current distribution of trees and potential planting locations
3. Understand the impact of trees on heat and pollution



South Providence



Central Falls



Washington Park



Cumberland



Tree and Temperature Survey Methods

Air Quality and Temperature

- Air Temperature
- Relative Humidity
- Land Surface Temperature (LST)
- Particulate Matter (2.5 /10)
- Ozone



Nicholas taking air temp and humidity



Apple and Prof. Martin surveying a tree

Street Tree Survey

- Diameter at Breast Height (DBH)
- Distance to Impervious Surface
- Vigor



Danielle and Lucy taking DBH



Site Types

Sidewalk Cutout



Planting Strip



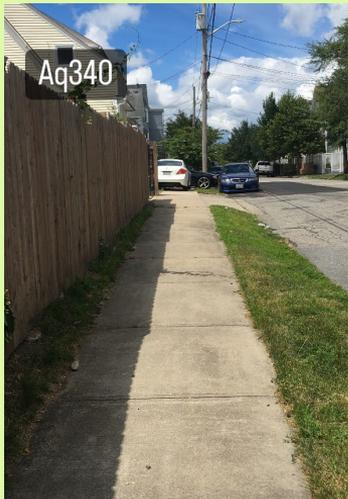
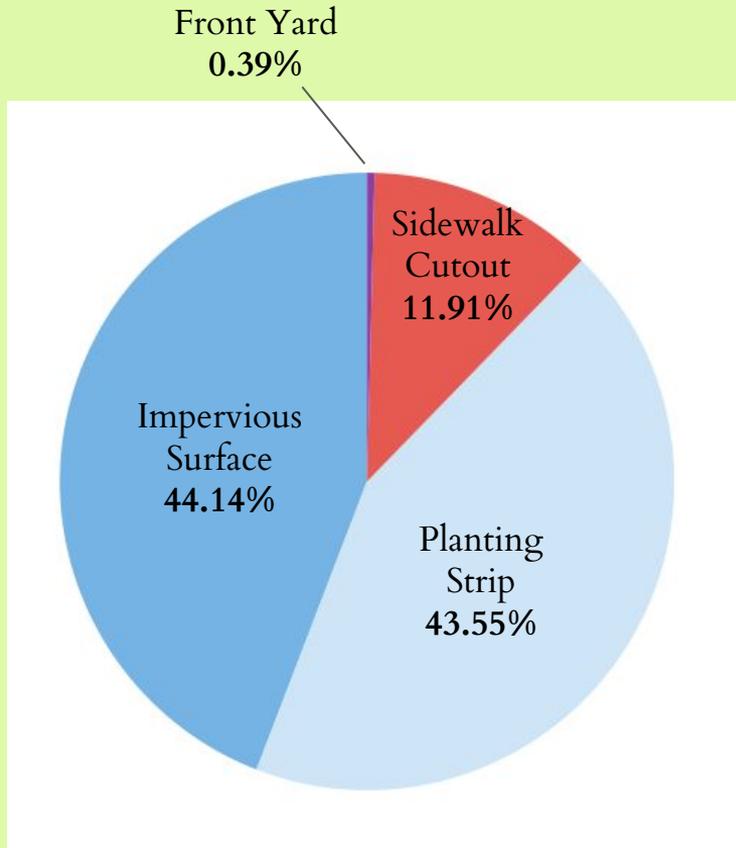
Impervious





Potential Planting Site Types

513 potential tree planting sites identified



Potential planting site in Washington Park



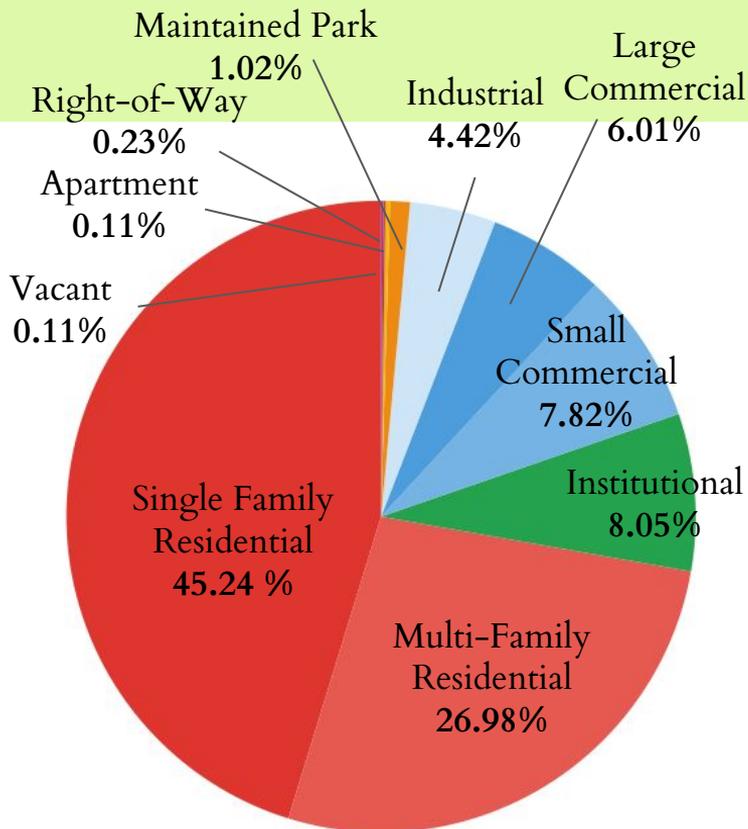
Potential planting site covered with trash in Washington Park



Land Use Types

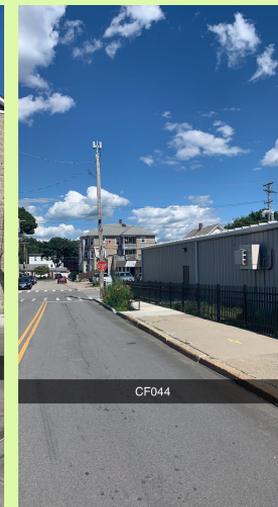
Single Family Residence

Multi Family Residence



Small Commercial

Industrial



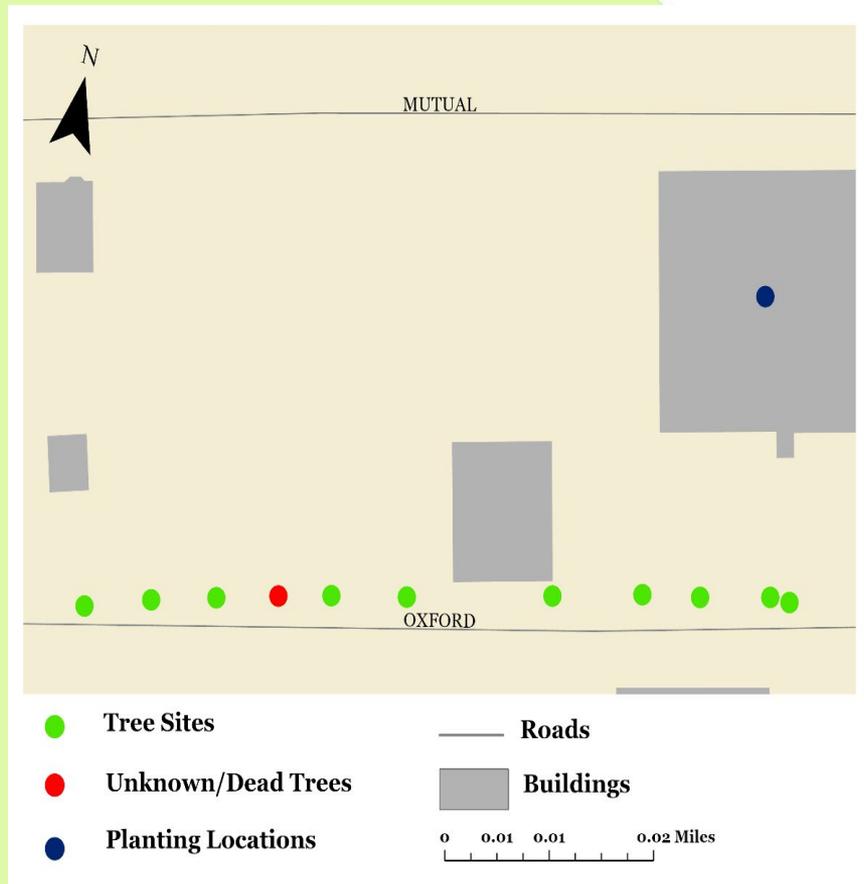
Groundwork Tree Survey

126 Total Trees Planted by Groundwork

- **73** Trees in Central Falls
- **53** Trees in South Providence

94 Total Surveyed by HERO

- **59** in Central Falls
- **35** in South Providence



Groundwork Tree Survey

**Tree
Survivorship**

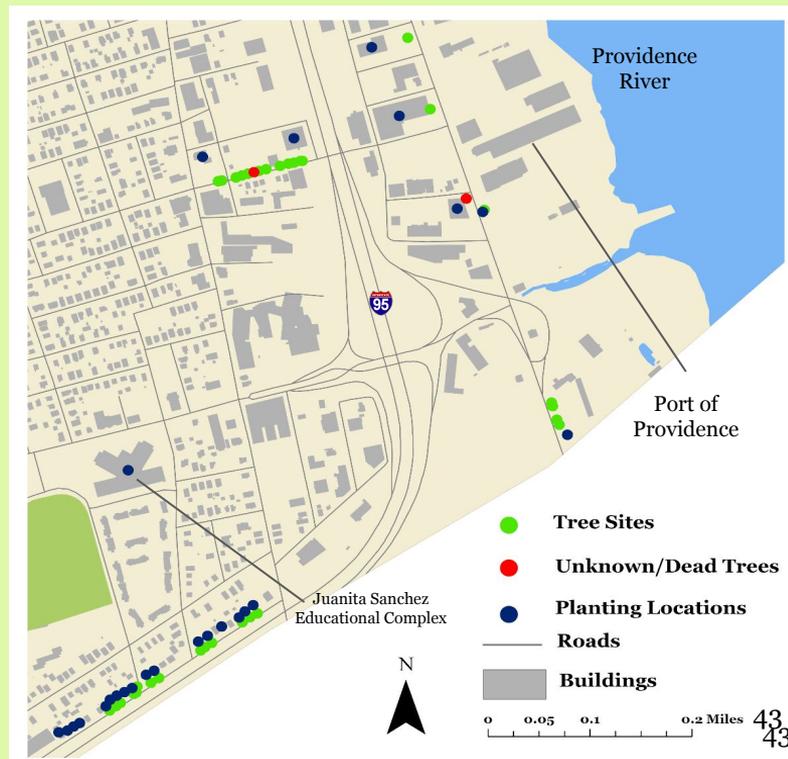
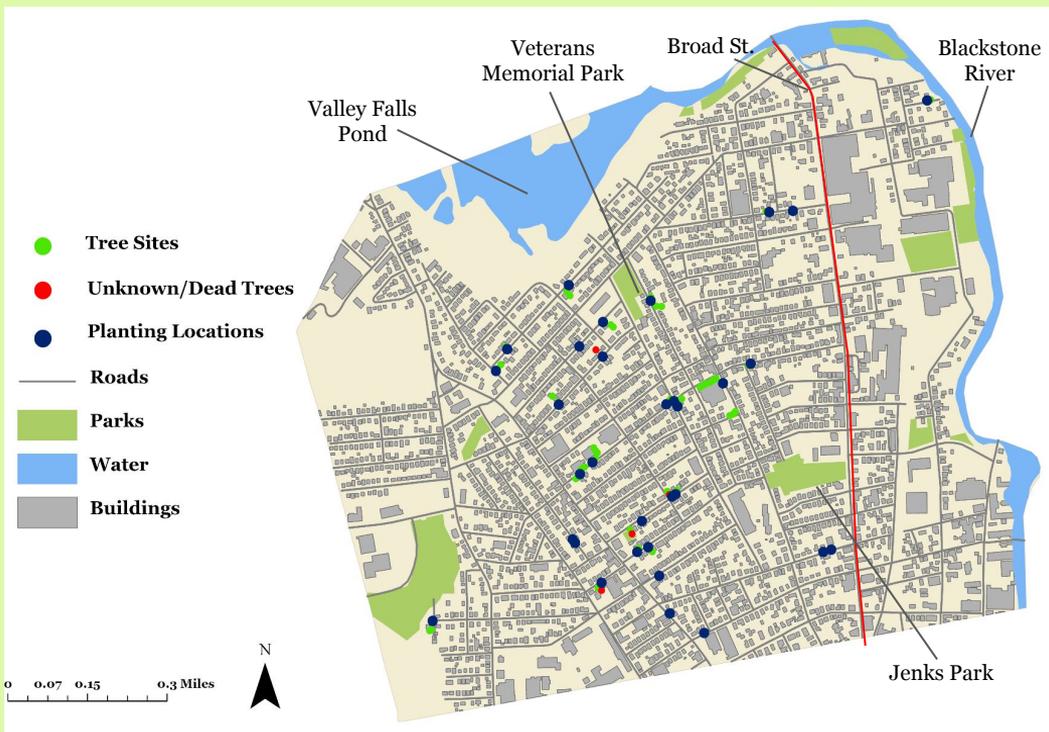
92.55%

Central Falls

54 Trees, 1 Unknown, 4 Dead

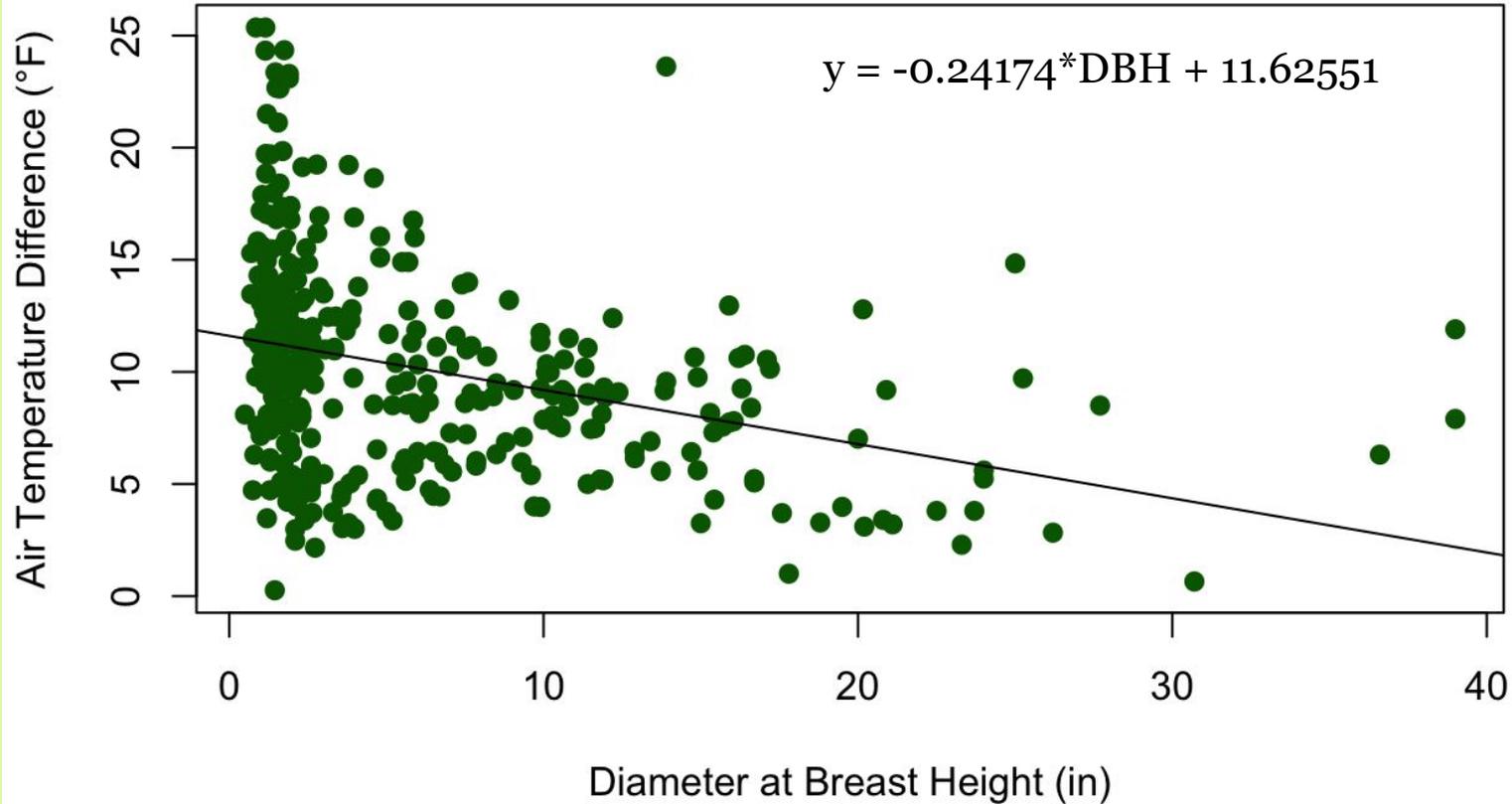
South Providence

33 Trees, 1 Unknown, 1 Dead





Impact of Trees on the Urban Heat Island Effect



Temperature and Air quality



Maximum Temperature Difference (°F)

25.36

Maximum Air Temperature (°F)

101.55

Maximum Heat Index (Real Feel) (°F)

113

All of our measurements of ozone and particulate matter were within the EPA's healthy standards

- Central Falls had the max temperature difference
- Washington Park had the maximum temperatures along with the maximum heat index



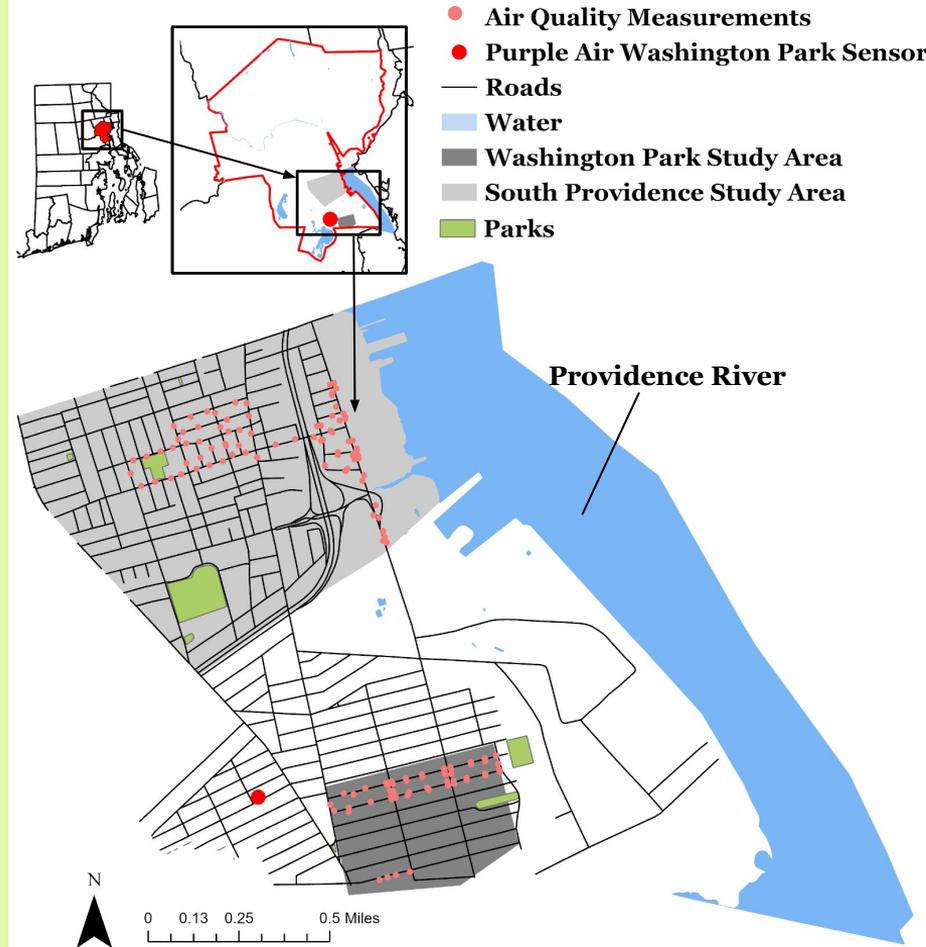
Regs taking an ozone measurement

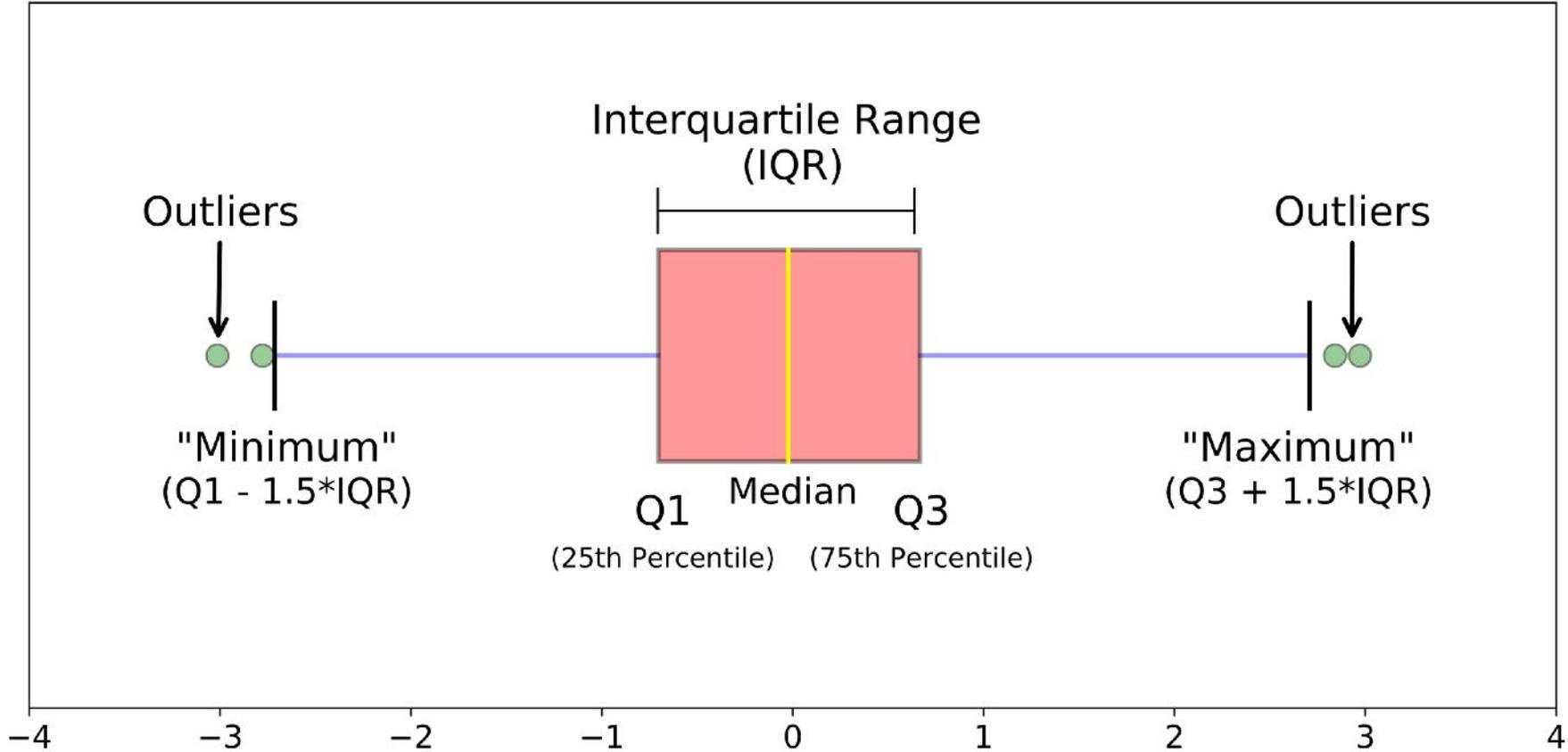
Air Quality Comparisons

Difference between HERO and Purple Air PM 2.5 Measurements

Average measurement difference	2.84 ($\mu\text{g}/\text{m}^3$)
Aeroqual Standard Deviation	2.08 ($\mu\text{g}/\text{m}^3$)
Purple Air Standard Deviation	3.94 ($\mu\text{g}/\text{m}^3$)
Max Weekly Purple Air PM 2.5	586 ($\mu\text{g}/\text{m}^3$)
Weekly Purple Air Std Deviation PM 2.5	13 ($\mu\text{g}/\text{m}^3$)

*On average, Purple Air reports higher PM measurements than collected by HERO using Aeroqual





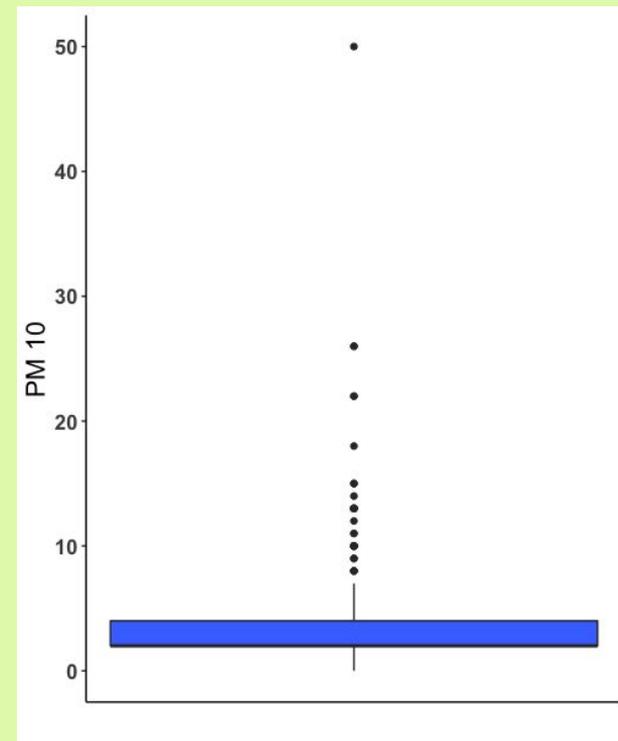
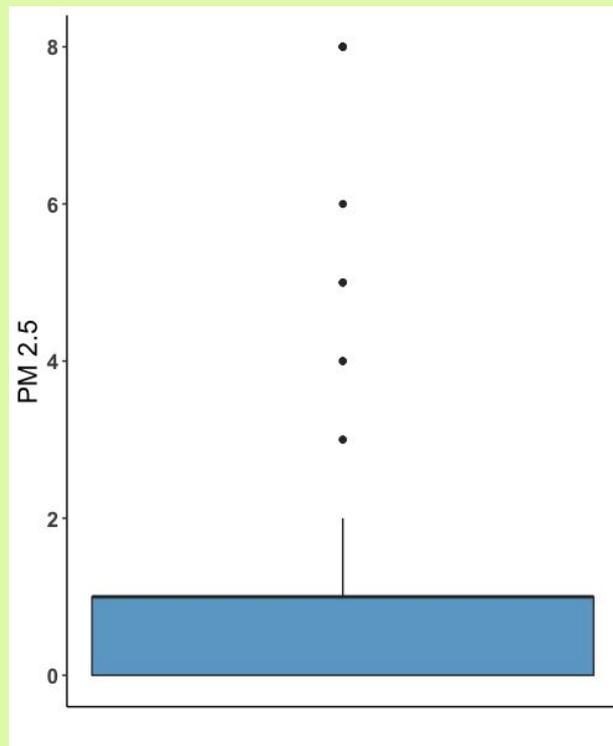
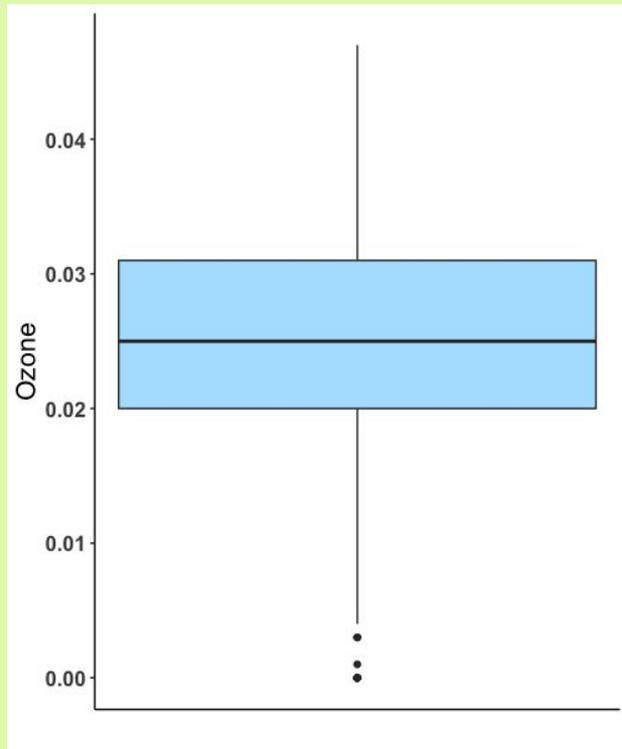


Air Quality Statistics- All Sites

Ozone Observations

PM 2.5 Observations

PM 10 Observations





Neighborhood and City Summaries



South Providence



Central Falls



Washington Park

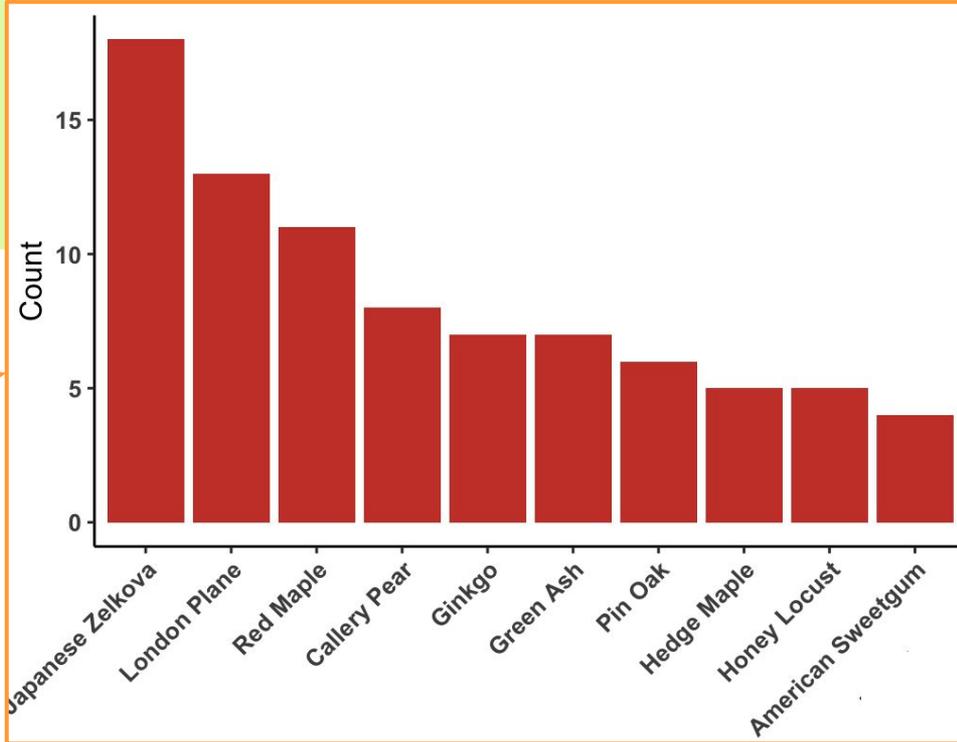
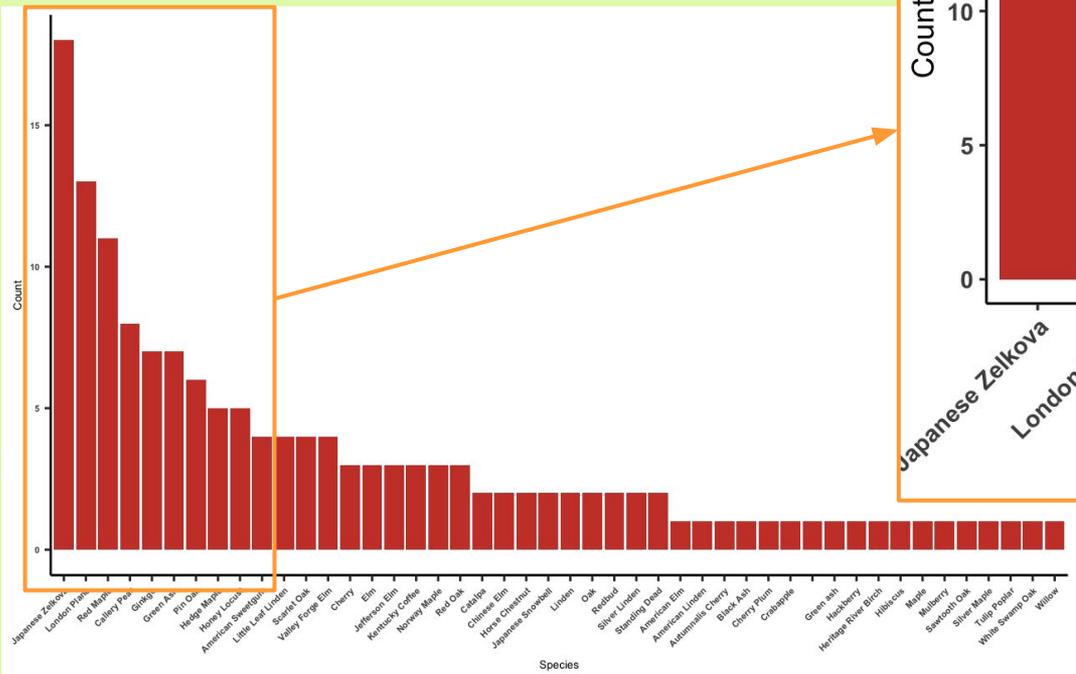


Cumberland



South Providence

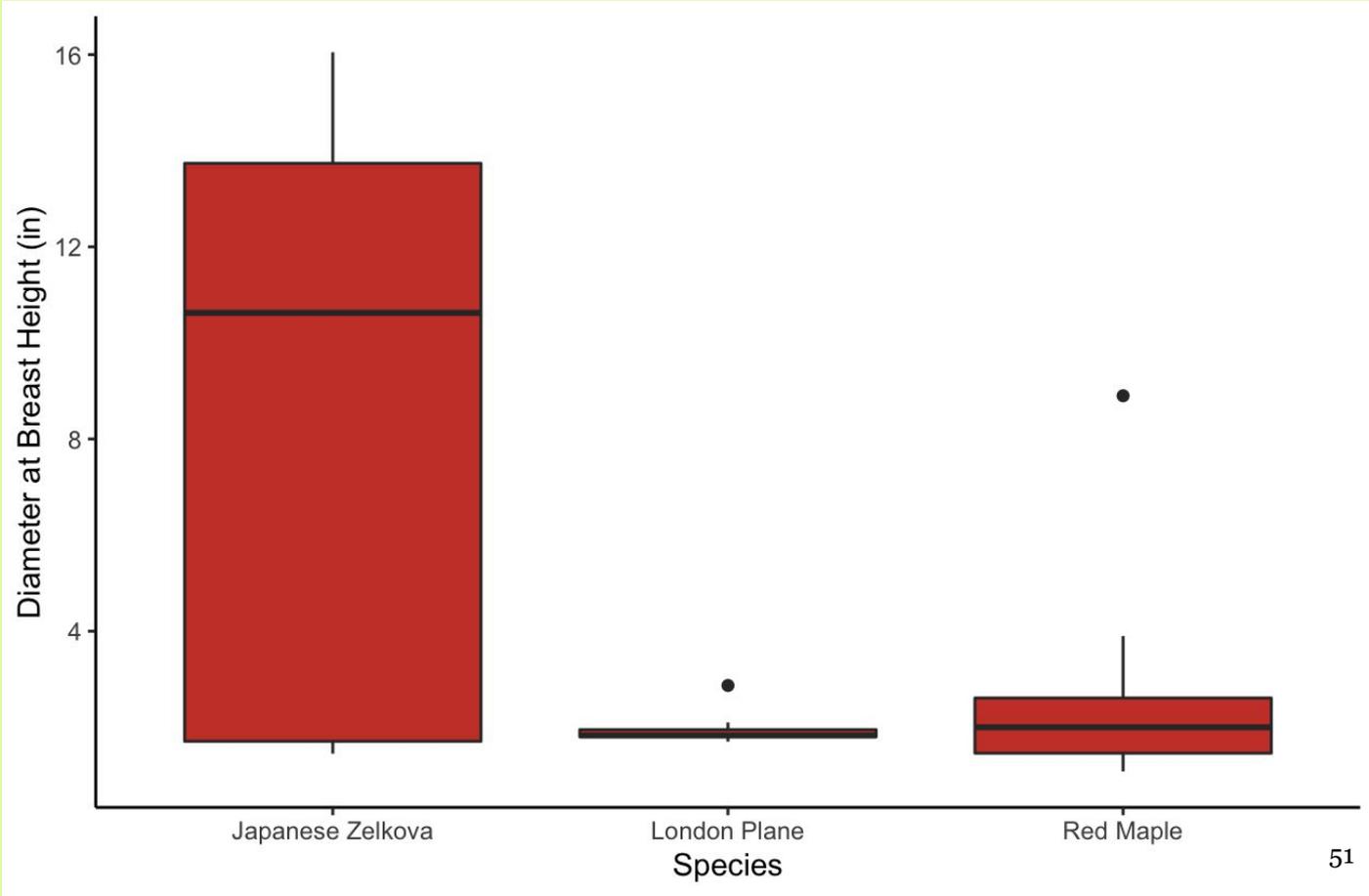
- **143** trees surveyed
- **35** trees planted by Groundwork (24%)
- **46** tree species
- **104** trees with less than 5 in DBH (73%)





South Providence

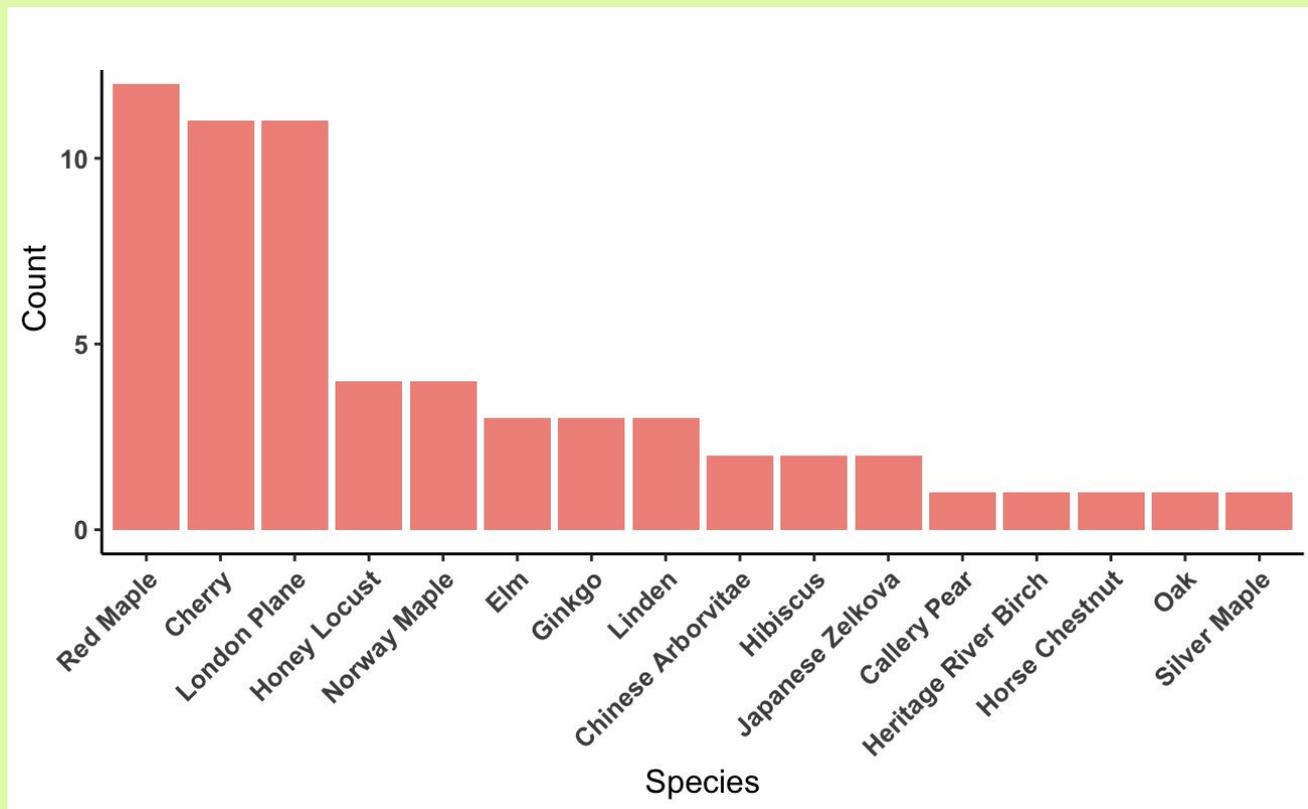
**Top 3 Species –
Diameter at Breast
Height Measurements**





Washington Park

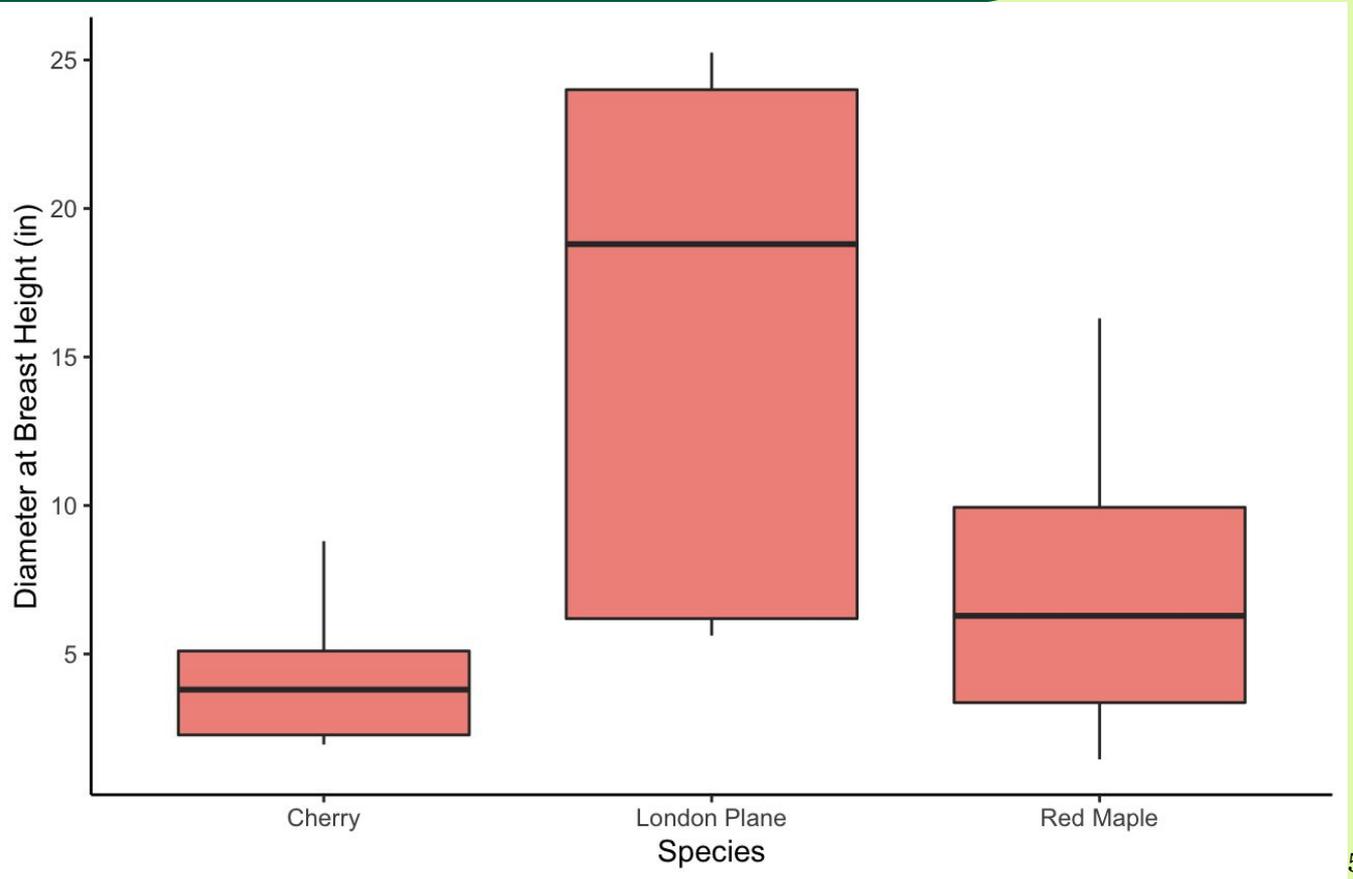
- **62** trees surveyed
- **16** tree species
- **21** trees with less than 5 in DBH (34%)





Washington Park

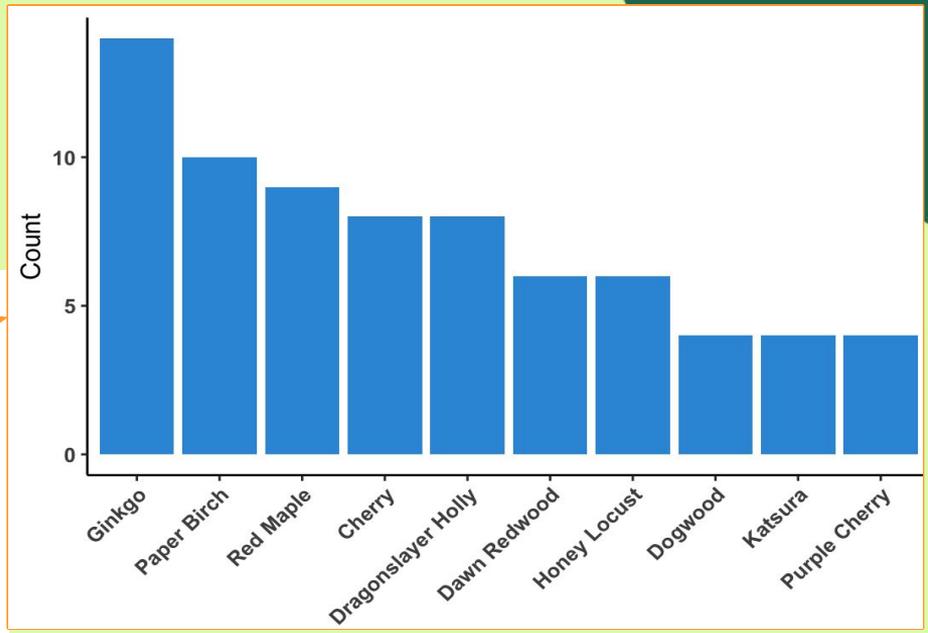
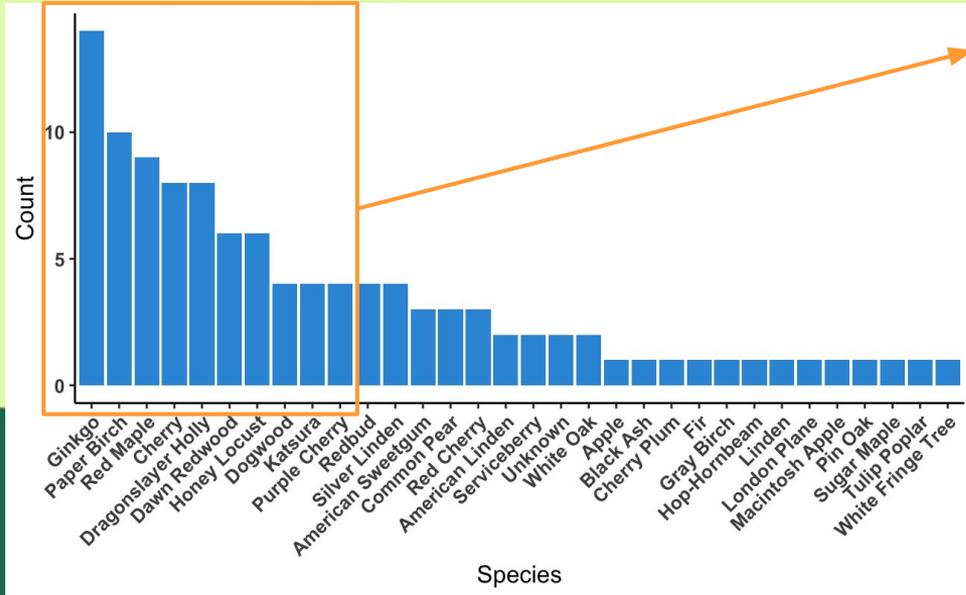
**Top 3 Species –
Diameter at Breast
Height Measurements**





Central Falls

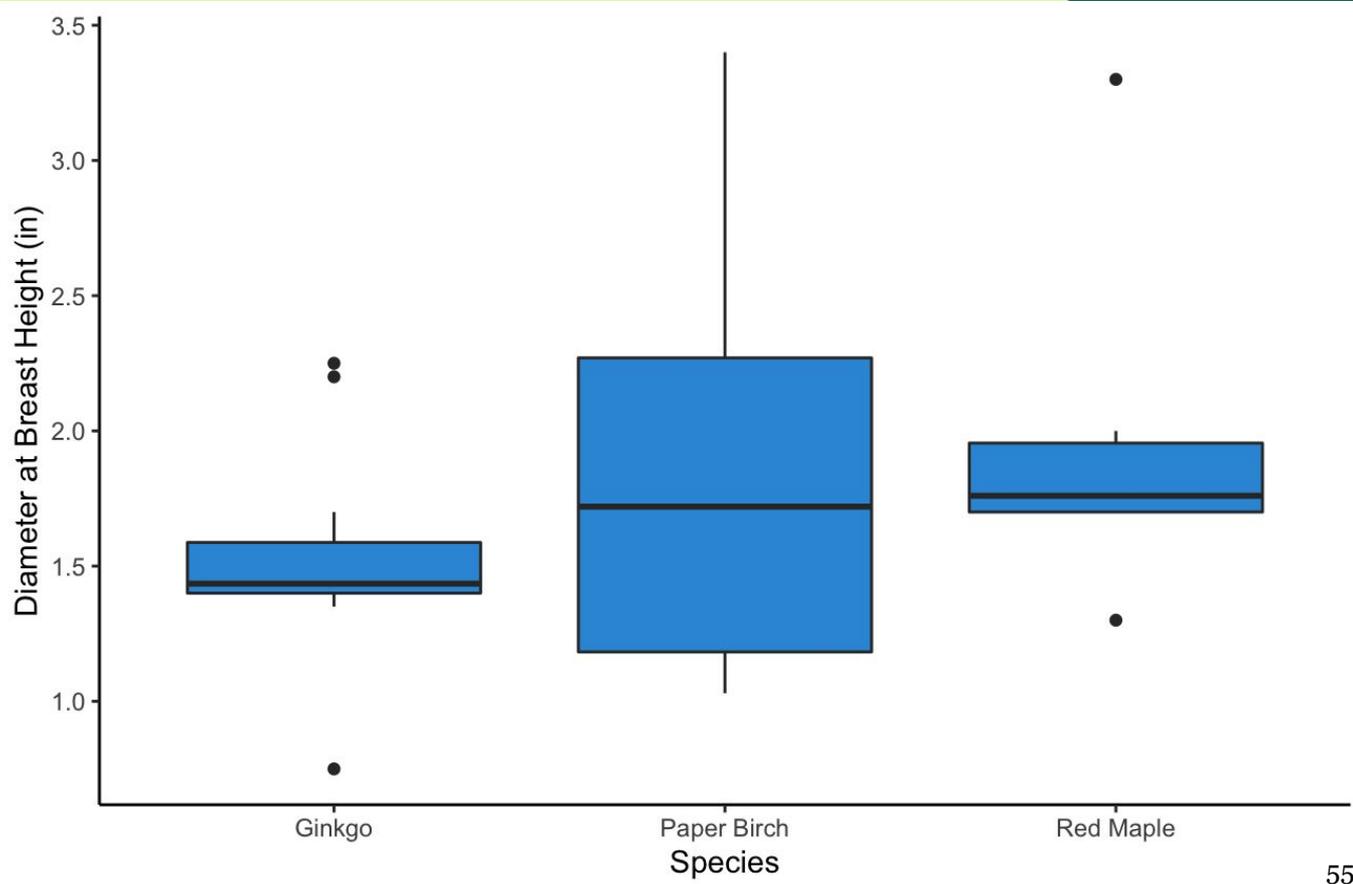
- **109** trees surveyed
- **32** tree species
- **87** trees with less than 5 in DBH (80%)
- **59** of the 109 were Groundwork trees (54%)





Central Falls

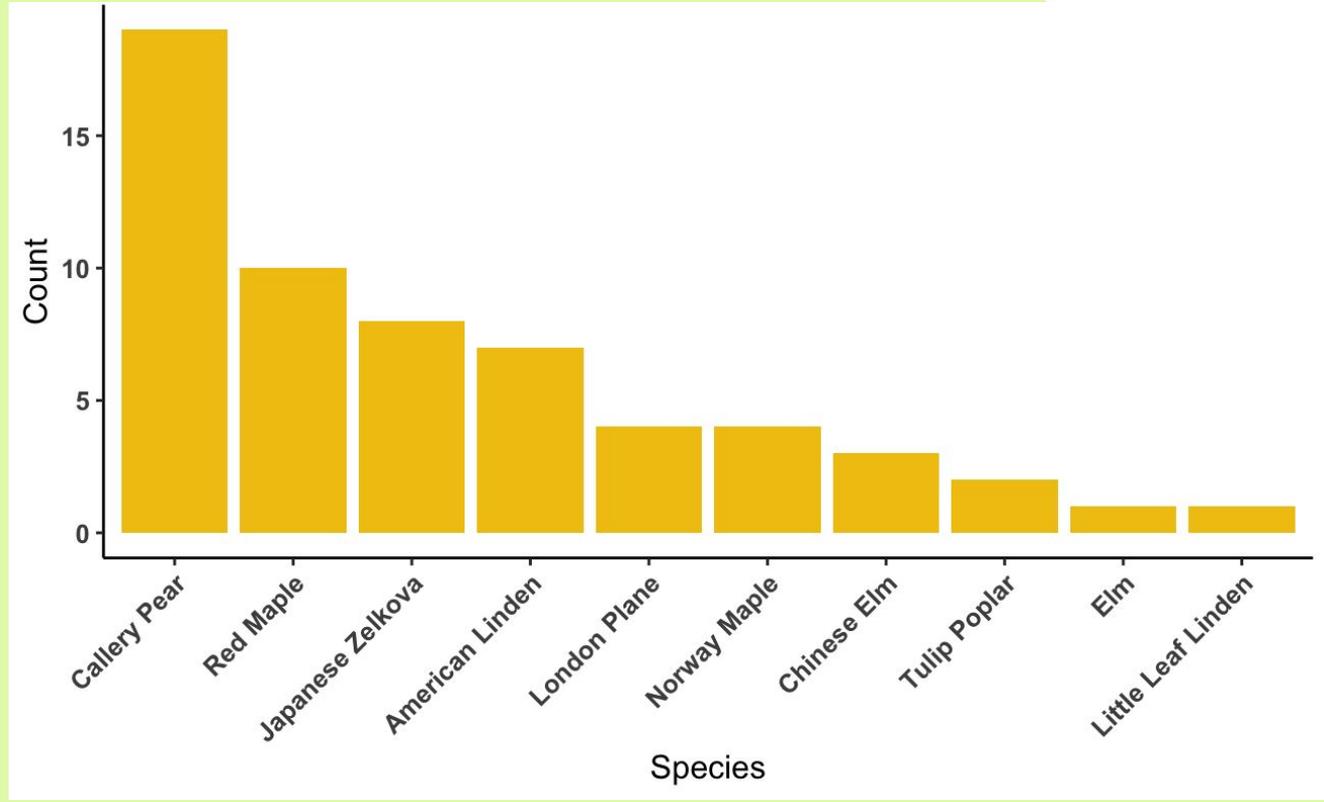
**Top 3 Species –
Diameter at Breast
Height Measurements**





Cumberland

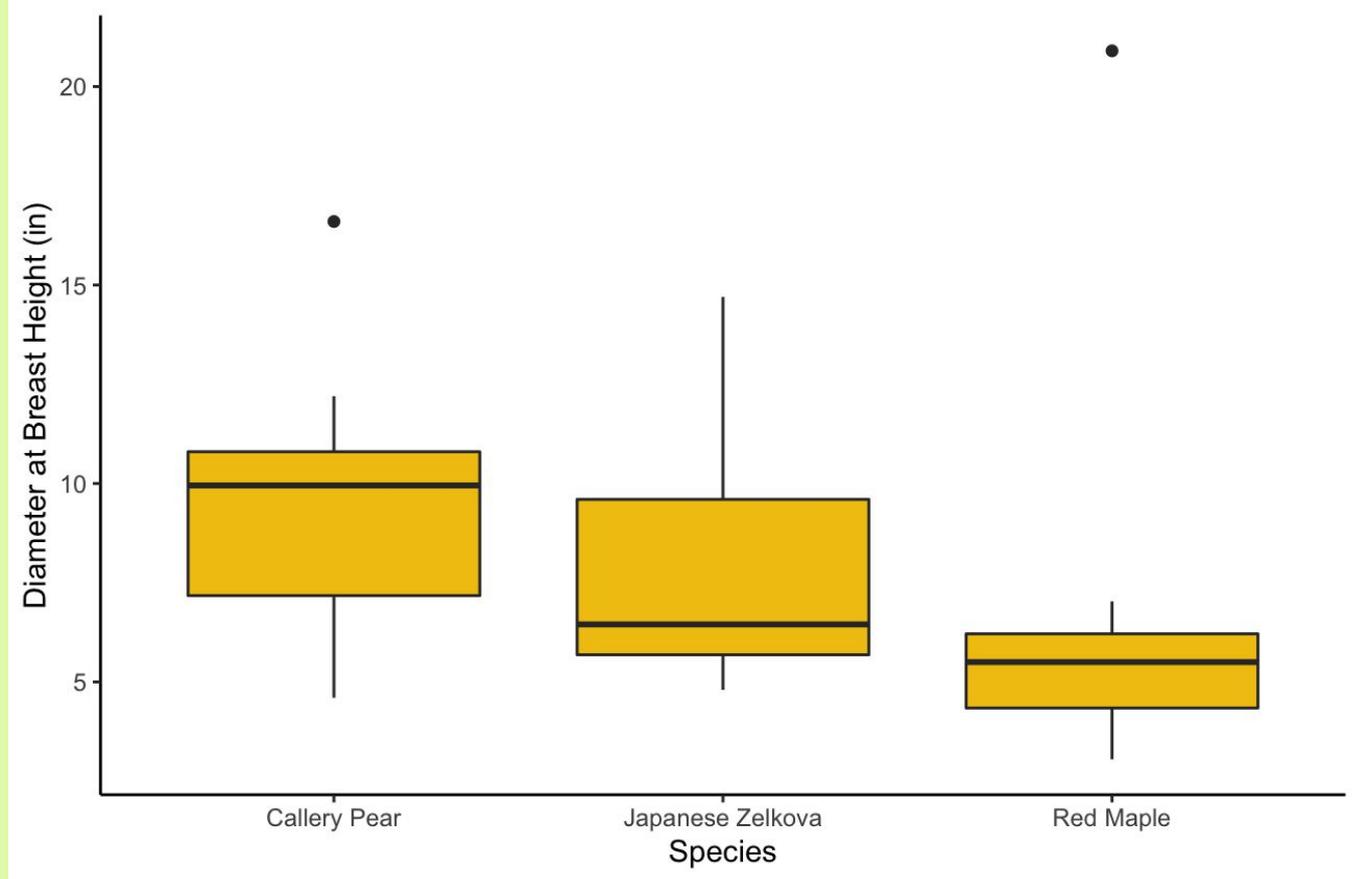
- **59** trees surveyed
- **10** tree species
- **10** trees with less than 5 in DBH (17%)





Cumberland

Top 3 Species – Diameter at Breast Height Measurements





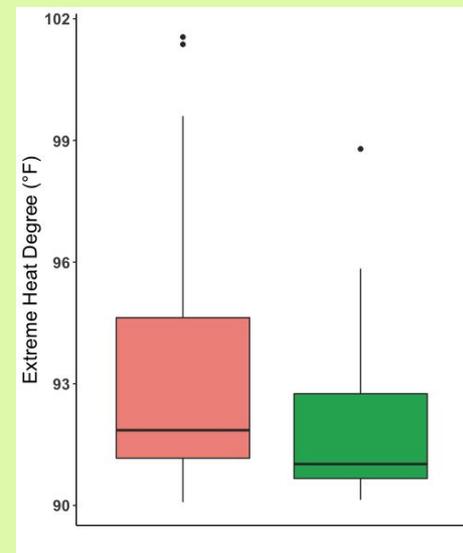
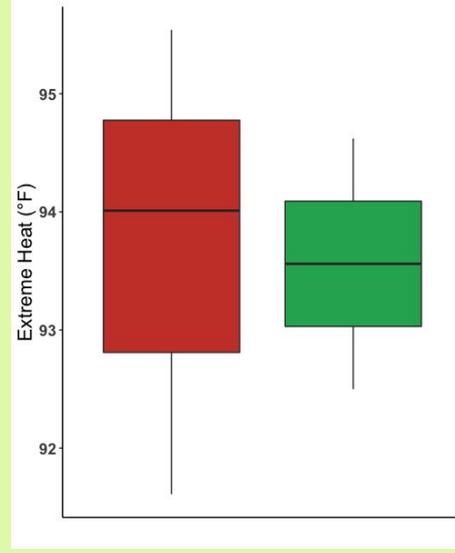
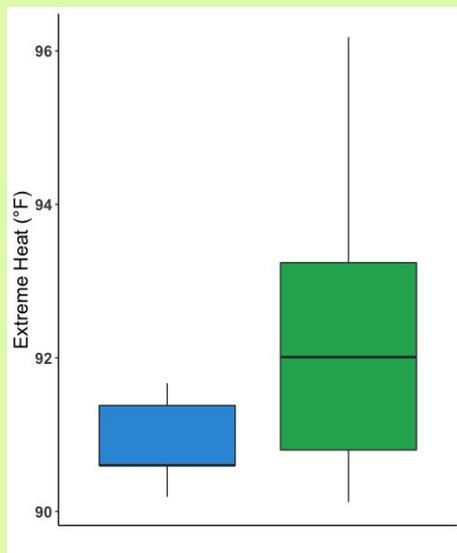
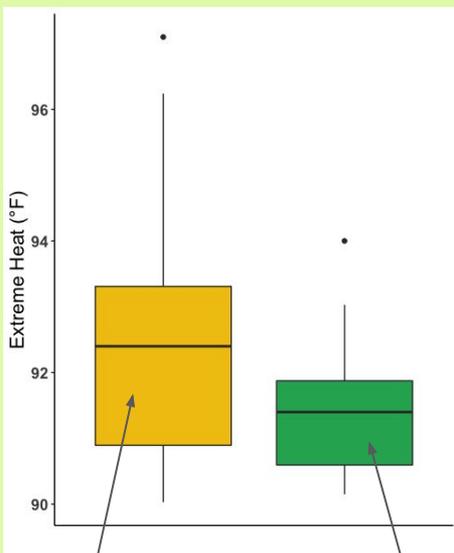
Extreme Heat

Cumberland

Central Falls

South Providence

Washington Park



Sites with no trees

Tree Sites

Extreme heat was observed more frequently in sites without trees

In Cumberland, fewer extreme heat observations were seen because 83% of trees are older, and larger

Survey of Trees and the Urban Landscape Takeaways



Paper Birch in Central Falls, RI

- Cumberland and Washington Park have older tree populations while Central Falls and South Providence have many young trees
- Small differences urban heat island metric across sites with and without trees on days with extreme heat in Cumberland, Washington Park and South Providence
- Urban heat island was reduced with increase in DBH. Every 4 inches of increase led to a 1°F decrease
- Japanese Zelkova and London Plane were some of the most frequently planted and largest trees
- Groundwork trees are doing well with a survivorship rate of 92.55%

Summary

	South Providence	Central Falls	Cumberland	Washington Park
Total trees	143 of 230 sites 62.2%	109 of 184 sites 59.2%	59 of 197 sites 29.9%	62 of 287 sites 21.6%
Planting in available sites	26 of 230 sites 11% Ocean St Harriet St	9 of 184 sites 4.8% Hunt St Tremont St	27 of 197 sites 13.7% Jones St Titus St	218 of 287 sites 75.9% Ohio Ave Indiana Ave

- Though there were more trees found in South Providence and Central Falls, there were fewer available tree planting sites identified in those locations
- Washington Park has the greatest potential for tree planting in terms of available planting sites, while Cumberland had the greatest need



Conclusions

How do human and biophysical interactions impact the urban environment and inform urban forestry efforts to create a more resilient and equitable city?



HERO fellows in the field



HERO and Groundwork surveying trees

- Better communication between urban residents and weather and air quality forecasts
- Residents had generally very positive perceptions of trees benefits for air quality and aesthetics and were in favor of more tree planting
- South Providence and Central Falls demonstrate tree planting is possible while there is a lot of opportunity in Cumberland and Washington Park

Acknowledgements

Broad Meadow Brook

Martha Gach

Clark University

Pamela Dunkle

Brenda Nika Hayes

Aidan Giasson

Yaa Poku

Dr. Rinku Roy Chowdhury

Groundwork Rhode Island

Amelia Rose

Jacq Hall

Sarah Hashem

City of Cumberland

Jonathan Stevens

City of Central Falls

Jim Vandermillen

Bob O'Connor



Questions?
Thank you!



Quotes for Broadmeadow Brook survey

“We looked at the summer camps but it was really restrictive for the times they offer. But even if it was a designated week, even have a walkup thing, or offer some summer camp stuff, teaching what is on woods or take to a new trail. give some kind of lessons 3 hrs long, I'd have done it. More options for kids under 8. That's something they can do to improve.”

Future Steps

- Further explore the relationship between extreme heat and air quality
- Impact of tree species on extreme heat
- Expand areas of interest in Woonsocket, Cumberland, Central Falls, and Lincoln



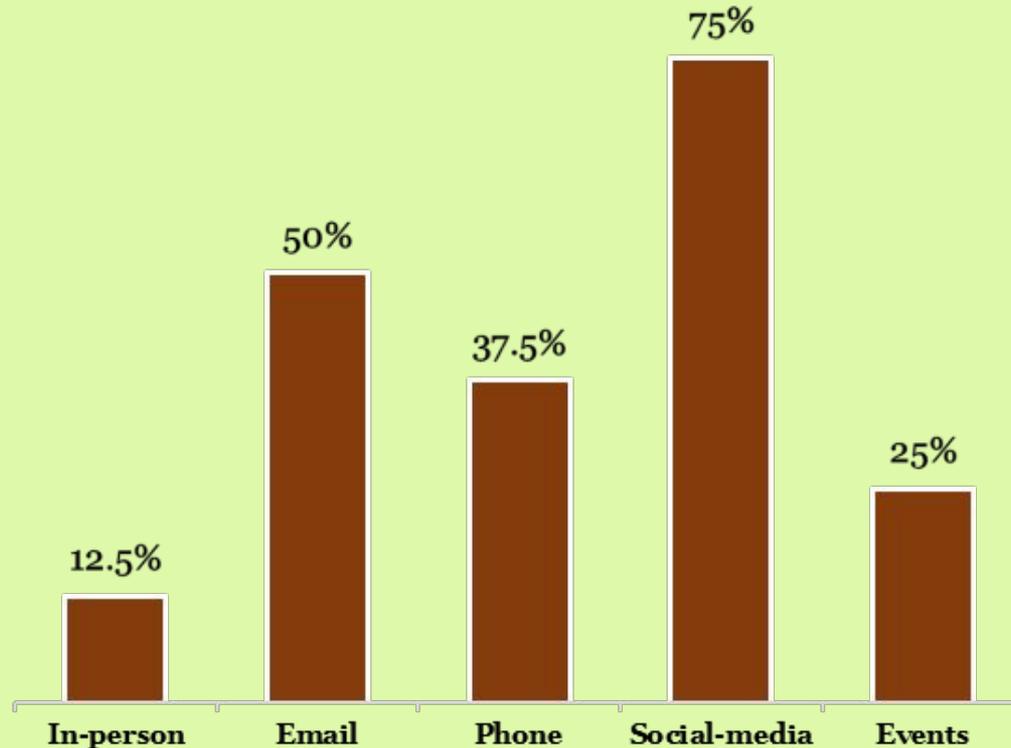
HERO team members in the field

U.S. Air Quality Index

AQI Category	Index Values	PM_{2.5}($\mu\text{g}/\text{m}^3$) 24-hour	PM₁₀($\mu\text{g}/\text{m}^3$) 24-hour	O₃ (ppm) 8-hour
Good	0 - 50	0.0 – 12.0	0 - 54	0.000 - 0.054
Moderate	51 - 100	12.1 – 35.4	55 - 154	0.055 - 0.070
Unhealthy for Sensitive Groups	101 – 150	35.5 – 55.4	155 - 254	0.071 - 0.085
Unhealthy	151 – 200	55.5 – 150.4	255 - 354	0.086 - 0.105
Very Unhealthy	201 – 300	150.5 – 250.4	355 - 424	0.106 - 0.200
Hazardous	301 – 400	250.5 – 350.4	425 - 504	(2)

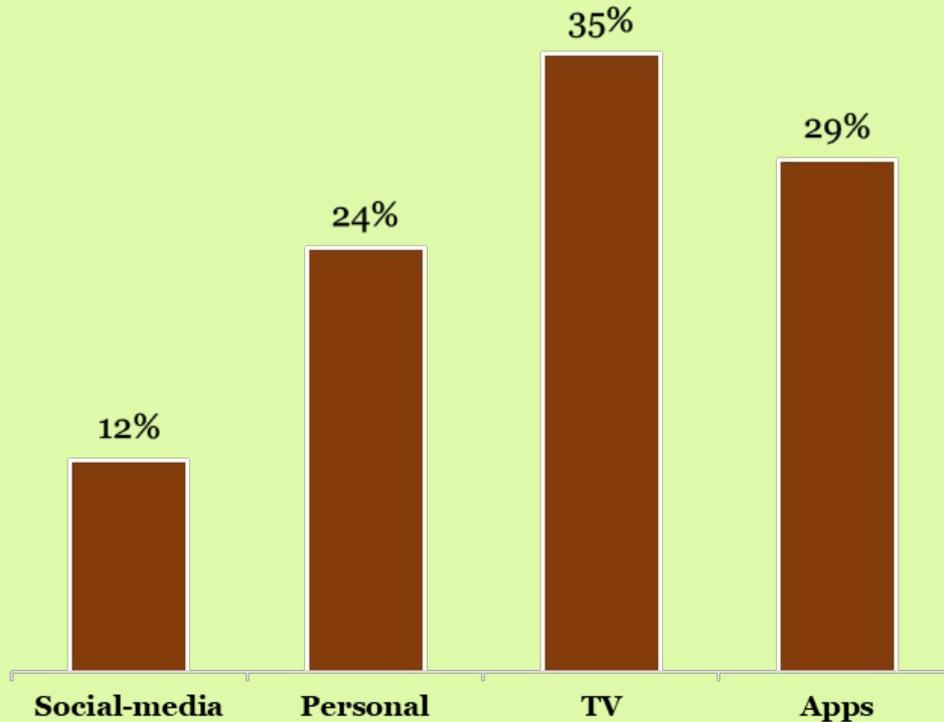
Residents' Preferred way of Communication with PVD Tree Plan

What, in your opinion, are the best ways for the PVD Tree Plan to communicate with you and your community?



Most common sources of information about Air Quality

What is your main source of information regarding air quality in the neighborhood?





Comparison between Survey and City Demographics

	Total Survey	All Cities Census*
Median Age	45-54	34.4
Median Income	\$15,000-24,999	\$59,078
Average Non White	59%	43%
Average Educational Attainment	33%	34%
Average Female	50%	51%

	Total Survey	All Cities Census*	Washing ton Park Survey	Providen ce Census*	Central Falls Survey	Central Falls Census*	Cumberl and Survey	Cumberl and Census*
*2019 ACS Data								
Median Age	45-54	34.4	45-54	30.6	45-54	30.1	55-64	42.5
Median Income	\$15,000-24,999	\$59,078	\$15,000-24,999	\$45,610	\$15,000-24,999	\$34,689	\$75,000-99,999	\$96,936
Average Non White	59%	43%	70%	67%	33%	51%	50%	12%
Average Educational Attainment	33%	34%	25%	34%	40%	9%	25%	57%
Average Female	50%	51%	50%	52%	75%	49%	25%	52%

*2019 ACS Data



Tree and Temperature Survey Methods

Tree ID	Temp Date	Temp Time	Site surface temp (sun)	Site surface temp (shadow)	Site Air Temp (1.5m)	Site Humidity	Ozone	P
CF030	6/20	12:44	117.4		89.78	35.04		
CF031		12:46	122.27	NA	85.0	42.48		
CF032		12:49	117	NA	89.0	34.78		
CF033		2:17	118.3	NA	83.36	35.72		
CF035		2:20	118.0	NA	83.64	38.83		
CF036		2:22	109.5	n/a	87	37.4		
CF037		2:24	119.3	NA	87	37.7		
CF038		2:27	121.9	n/a	70.6	35.28		
CF039		2:30	125	n/a	90.6	35.7		
CF039		2:33	111.4	na	85.8	36.8		
CF040		2:37	116	99.5	84.3	37.2		
CF041		2:37	116.8	99.5	82.5	36.42		
CF042		2:42	116.7	n/a	86.48	37.83		
CF043		2:30	111	n/a	89.37	36.62		
CF044		2:36	125.8	n/a	86	37.8		
CF045		2:57	121	n/a	84.32	34.5		
CF046		3:01	114.1	n/a	87.35	36.83		
CF047		2:07	121.3	n/a	87.3	32.62		
CF049		2:07	124.8	n/a	87.38	22.66		
CF049		3:07	124.7	n/a	87.38	31.93		
CF050		3:12	117.1	n/a	91.38	31.6		
CF051		3:14	122.4	n/a	91.43	27.03		
CF052		3:15	116.7	n/a	90.3	23.15		
CF053		3:25	126.7	n/a	86.84	40.7		
CF054		3:27	117.9	n/a	87.62	37.2		
CF055		3:50	126.9	n/a	87.11	33.29		
CF056		3:52	125.6	n/a	87.78	24.42		
CF057		3:36	127	n/a	89.6	36.34		
CF057		3:51	113.3	n/a	87.96	38.27		

Air Temperature Survey Sheet

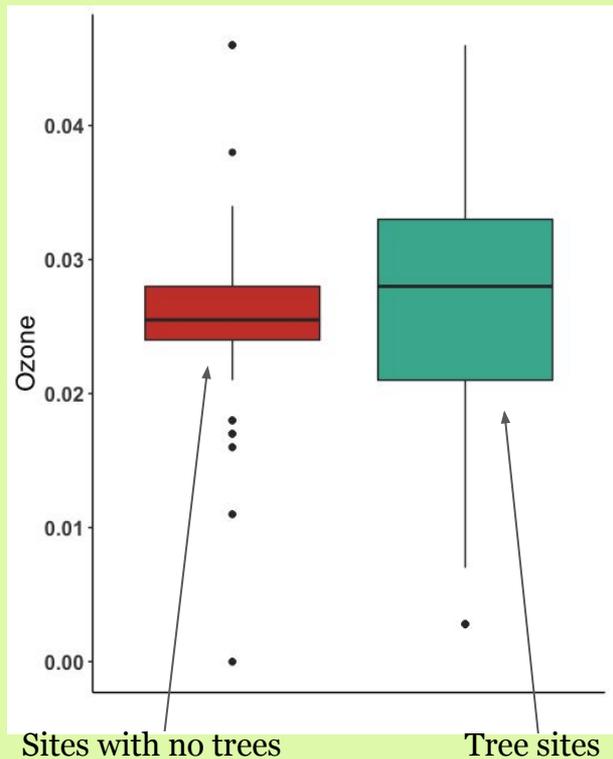
Date	Surveyor	Lat	Long	TreeID	St Name	St #	LUSE	Site Type	Species	DBH	DBH height	Dist. imperv	Vigor	Comments
6/23	Rago			CF030	Leaves	7	MFP	Imp						on cottage
				CF031	Leaves	20	MFP	Imp						
				CF032	Leaves	65	MFP	Imp						on leaves
				CF033	Leaves	426	MFP	Imp						on leaves
				CF034	cottage	45	SC	Imp	Hollock	1.9	36	over 60	1	
				CF035	oak	15	SC	Imp						
				CF036	cottage	60	SC	Imp		1.3	54	over 60	1	
				CF037	cottage	67	MFP	Imp		1	54		1	
				CF038										
				CF039	hollock	37	MFP	Imp						
				CF040	leaves	93	MFP	SC	Black ash	15.4	54	18	1	big tree
				CF041										
				CF042										
				CF043	Hollock	150	MFP	Imp						on tree
				CF044	High St.	160		Imp						
				CF045	Hollock									
				CF046	leaves	63	MFP	Imp						
				CF049	leaves	37	MFP	Imp	redwood	1.4	36	over 60	1	
				CF049		30	MFP	Imp	redwood	1.25	43	over 60	1	
				CF050					Sweet gum	1.6	40	over 60	1	
				CF051	leaves	81	MFP	Imp						
				CF052	leaves	93	MFP	Imp						on river
				CF053	leaves	92	MFP	Imp						on river
				CF053	High St.	1425	MFP	Imp						
				CF053	leaves	1485	MFP	Imp						
				CF055	leaves	1525	SC	Imp						
				CF056		211	SC	Imp						
				CF057		115	Indus	Imp						
				CF078	Birch	143	Indus	SC	Honey locust	15.7	54	14	1	305

Tree Site Survey Sheet

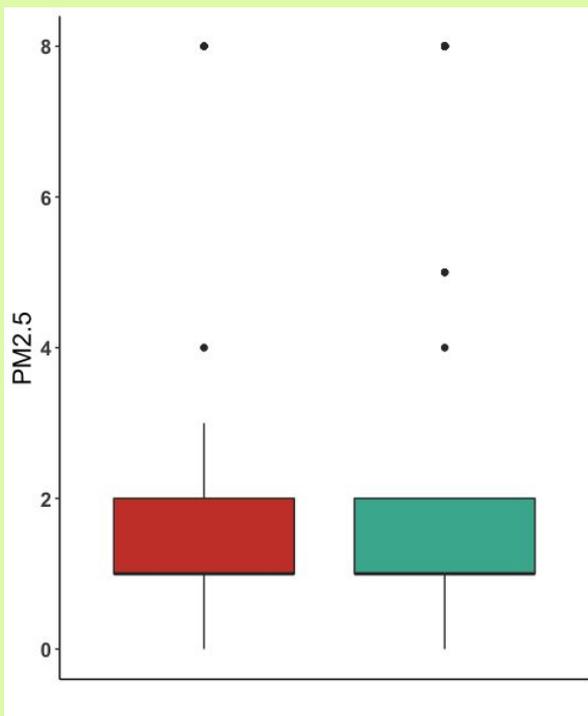


South Providence

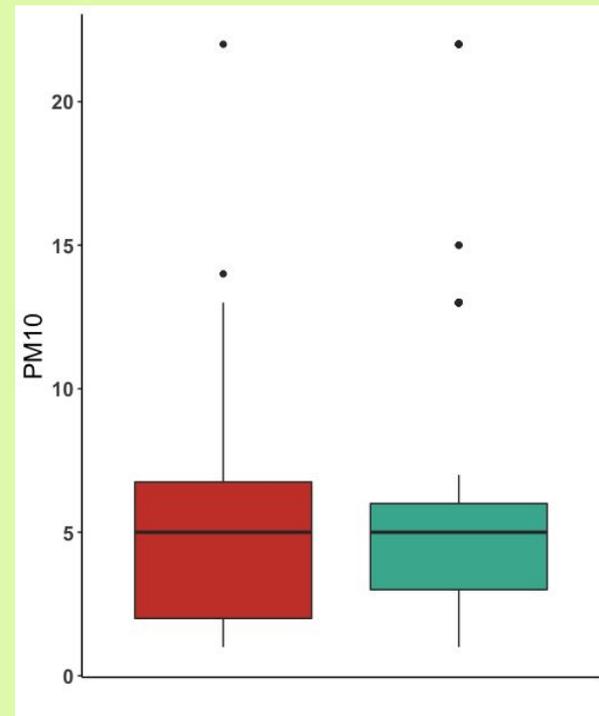
Ozone Observations



PM 2.5 Observations



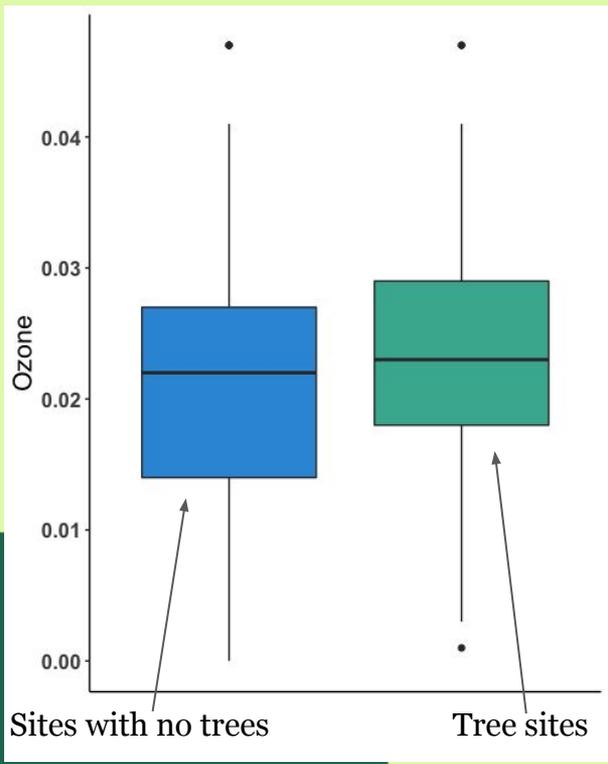
PM 10 Observations



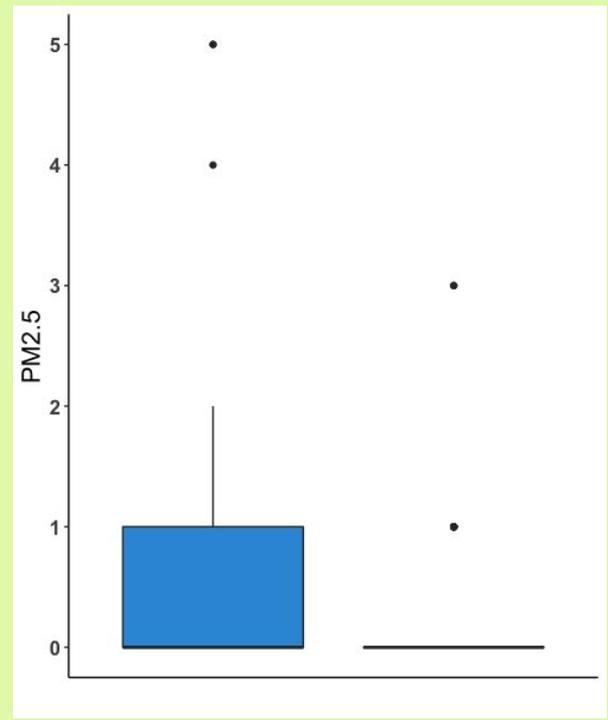


Central Falls

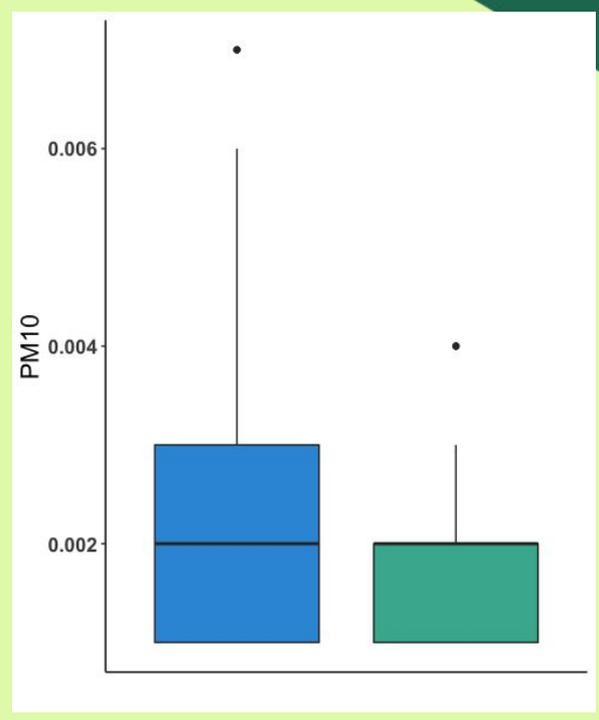
Ozone Observations



PM 2.5 Observations



PM 10 Observations



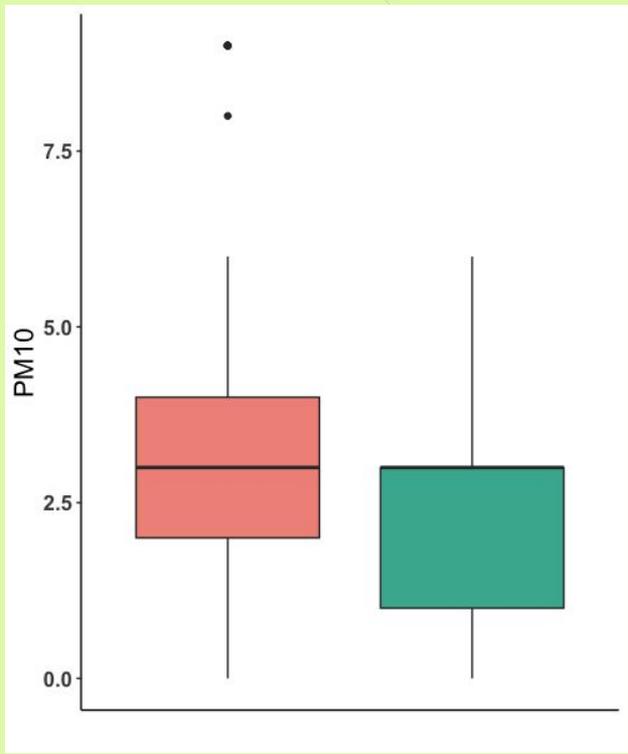
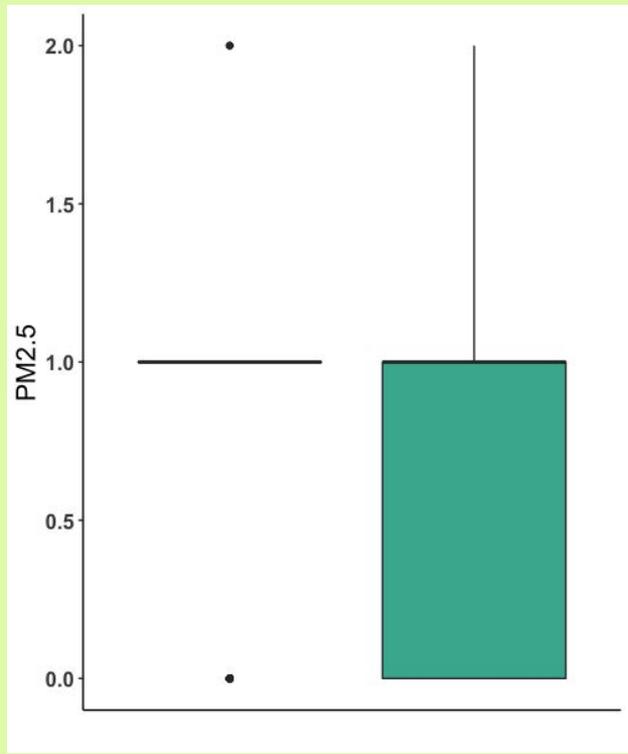
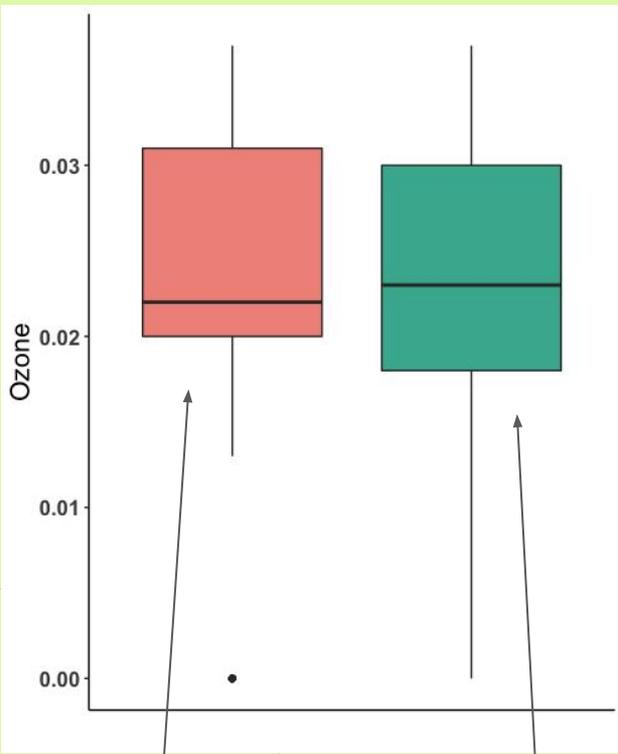


Washington Park

Ozone Observations

PM 2.5 Observations

PM 10 Observations



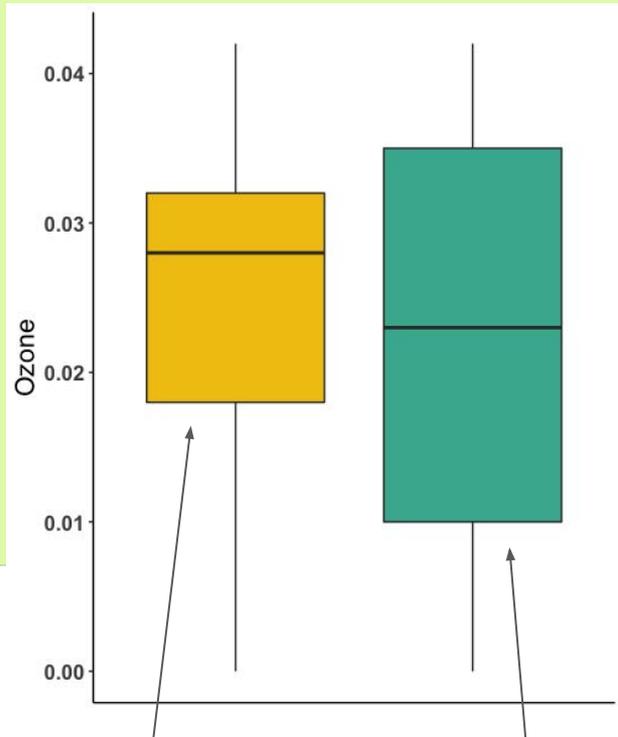
Sites with no trees

Tree sites



Cumberland

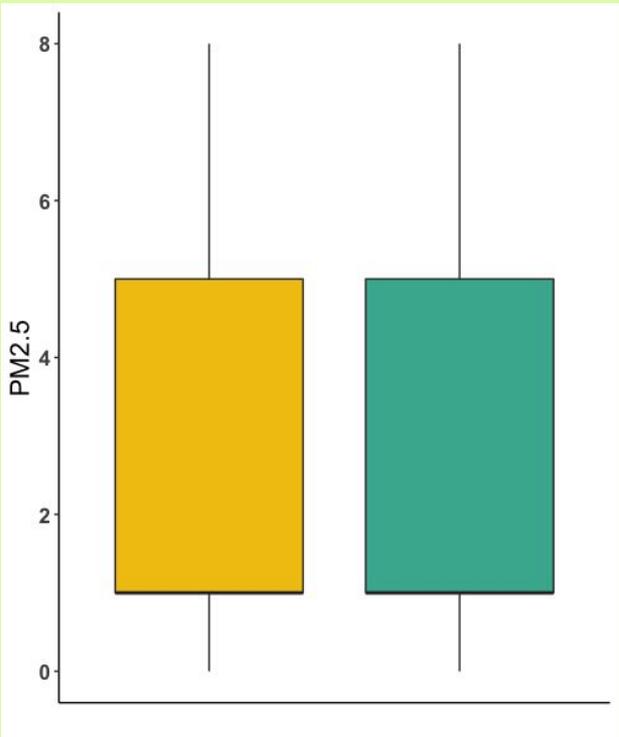
Ozone Observations



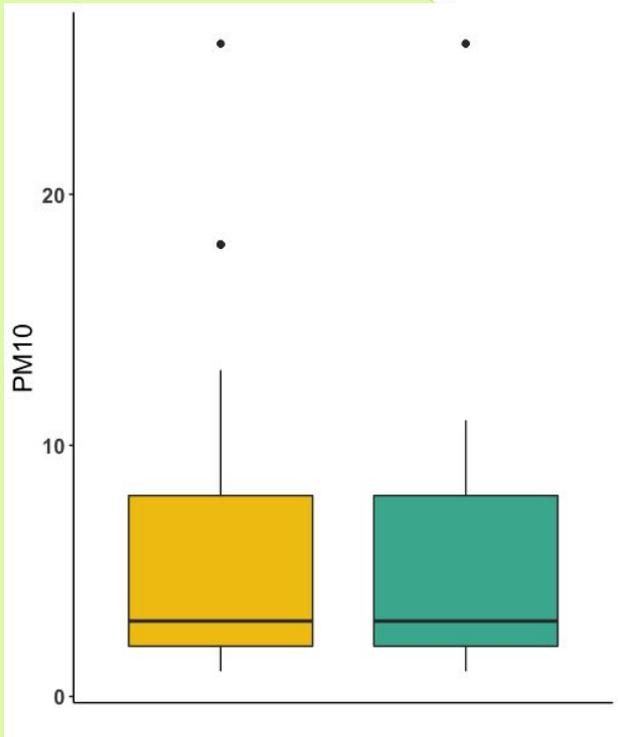
Sites with no trees

Tree sites

PM 2.5 Observations



PM 10 Observations





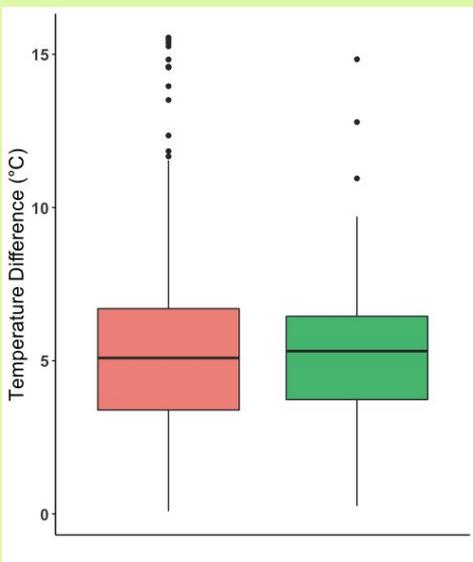
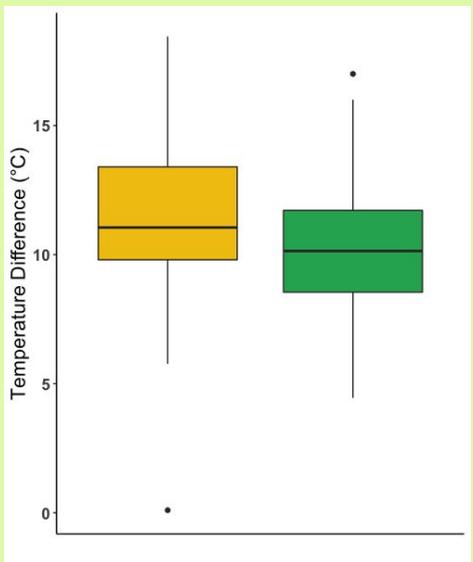
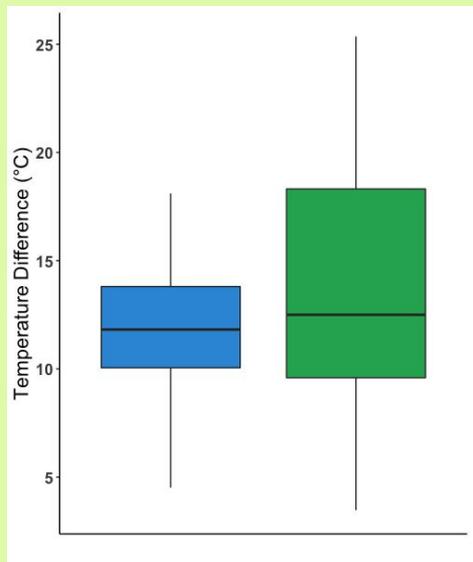
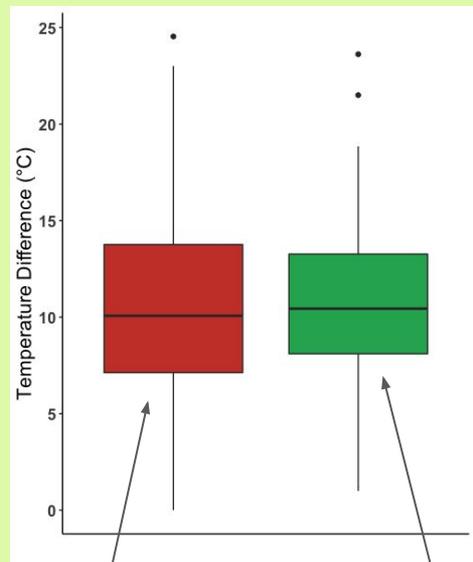
Air Temperature Difference

South Providence

Central Falls

Cumberland

Washington Park



Sites with no trees Tree Sites

Cumberland - The landscape of Cumberland allows for larger temperature differences, given it is less densely populated than other locations

References

Air Quality Comparisons:

- Johnson, K., A. Holder, S. Frederick, G. Hagler, AND A. Clements. PurpleAir PM2.5 performance across the U.S.#2. Meeting between ORD, OAR/AirNow, and USFS, Research Triangle Park, NC, February 03, 2020.
- Lin, C., Gillespie, J., Schuder, M. D., Duberstein, W., Beverland, I. J., & Heal, M. R. (2015). Evaluation and calibration of Aeroqual series 500 portable gas sensors for accurate measurement of ambient ozone and nitrogen dioxide. *Atmospheric Environment*, 100, 111-116.