HERO 2022
Stakeholder Presentation

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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

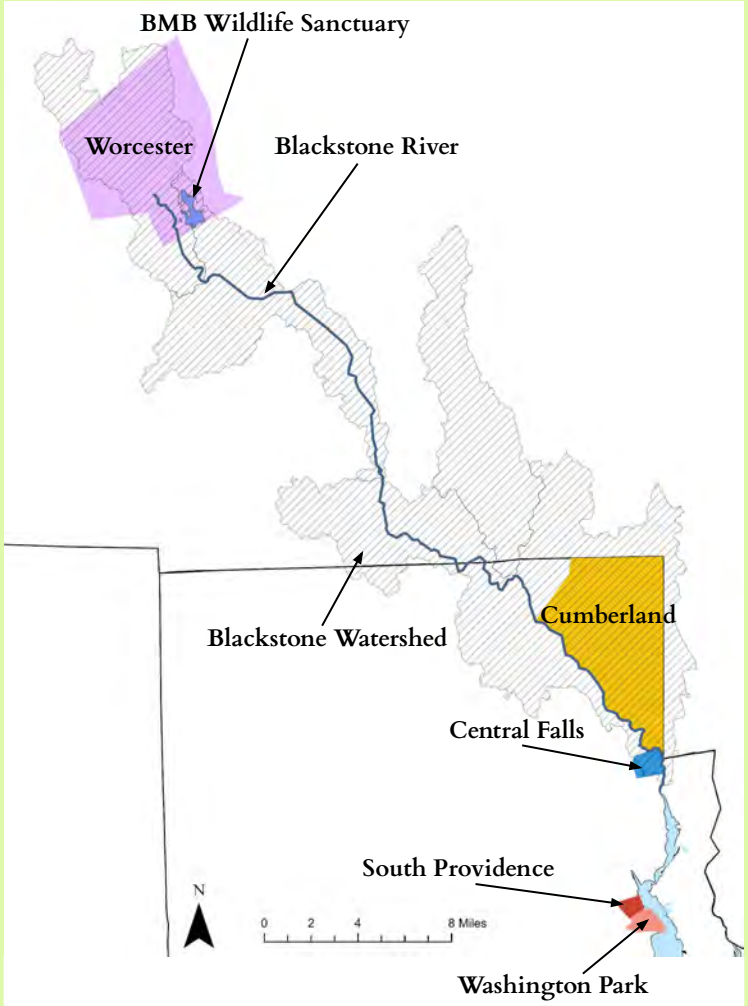
From left to right: Nicole Buckley, Charlotte Zieselman, Lucy Fleming, Danielle Hall, Nicholas Geron, Shradha Birdika, Apple Gould-Schultz, and Madeline Regenye

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



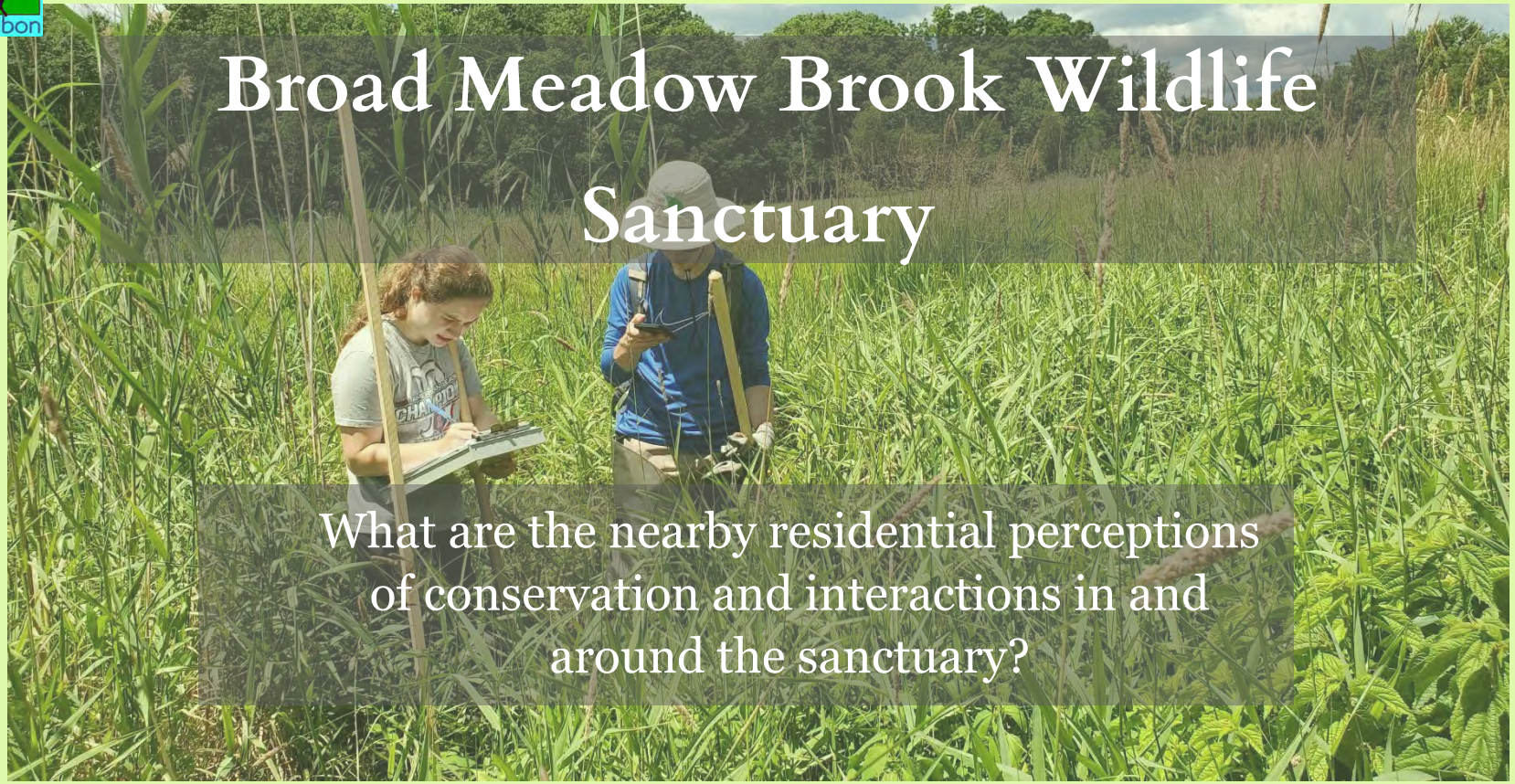
Outline

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
Protecting the nature *of Massachusetts*

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

- BMB Wildlife Sanctuary is a 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

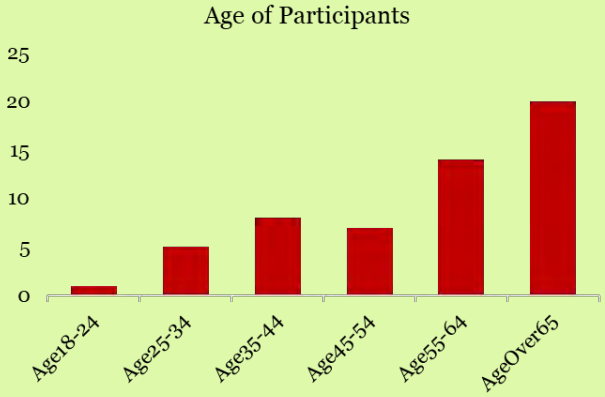

Massasoit Road
Blackstone River
146
Broad Meadow Brook Wildlife Sanctuary
N
0 0.07 0.15 0.3 Miles

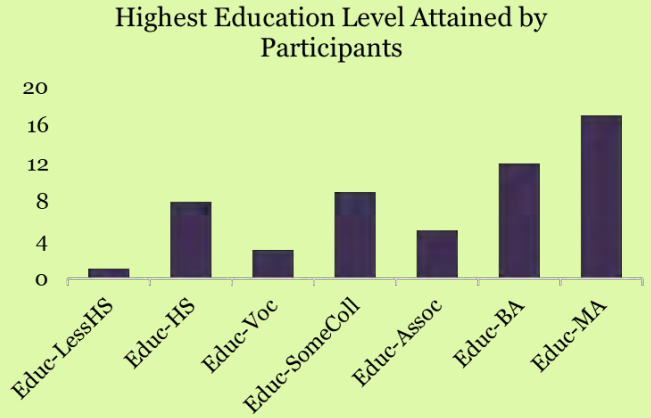
Broad Meadow Brook Neighborhood Survey

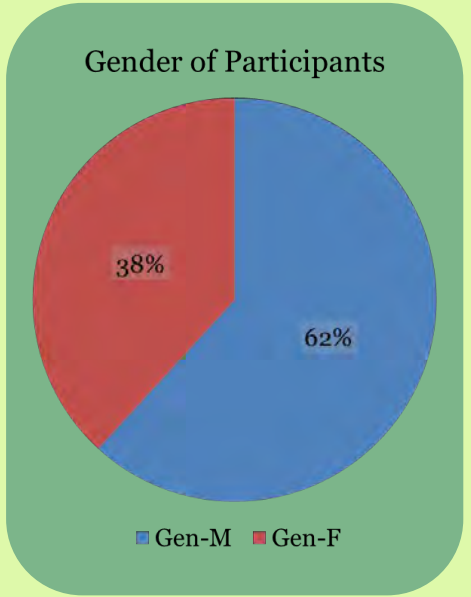
We interviewed 55 out of 286 neighborhood residents, focusing on their opinions on the Broad Meadow Brook Wildlife Sanctuary and the environment.

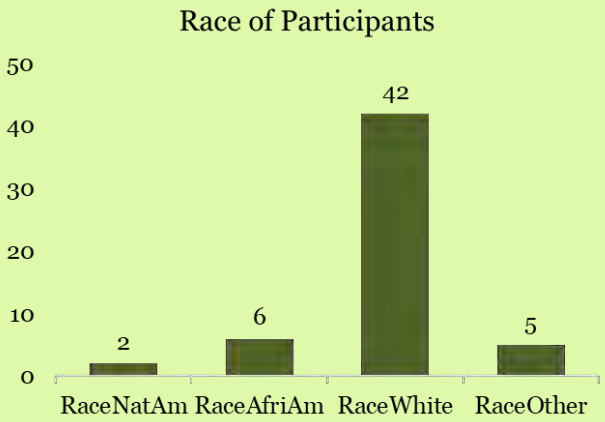
Pictures of front and back yards in Broad Meadow Brook Neighborhood

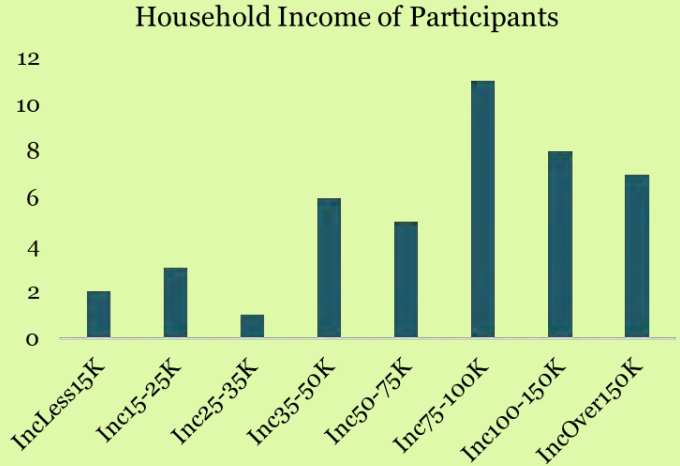
Broad Meadow Brook: Participant Demographics









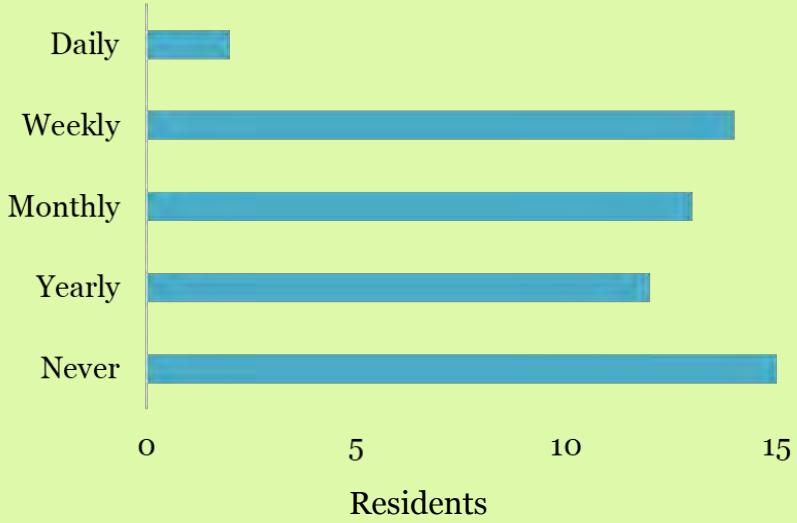


Worcester Demographics

	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

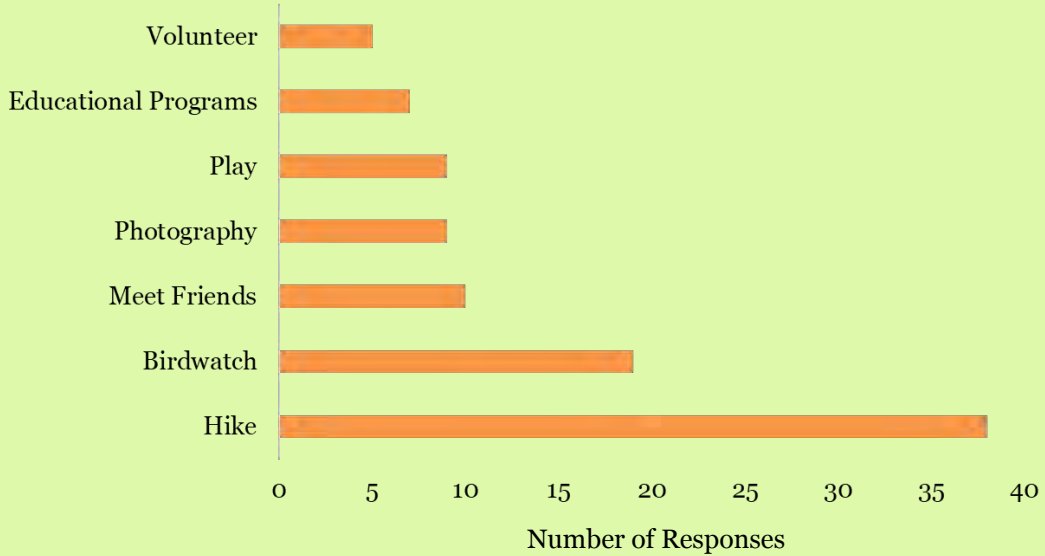
Resident Interactions with Broad Meadow Brook Wildlife Sanctuary

How often do you visit the sanctuary?



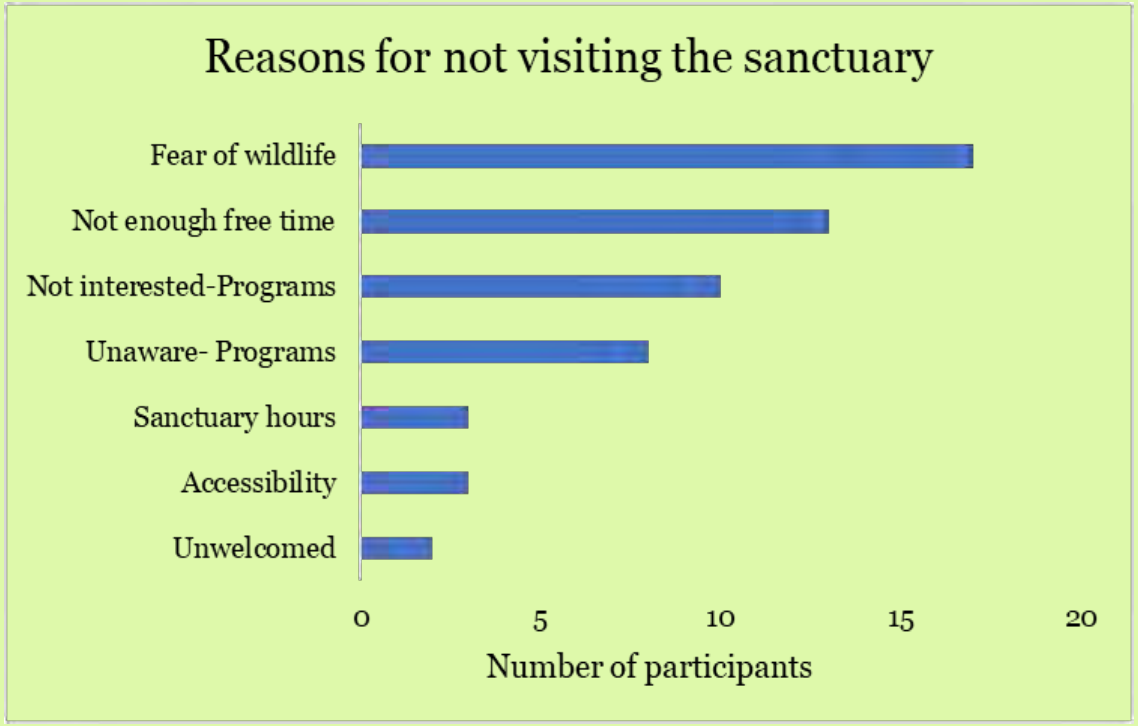
52% of participants visit the sanctuary at least once a month.

What activities do you enjoy at the sanctuary?



Hiking is the most popular activity, followed by birdwatching

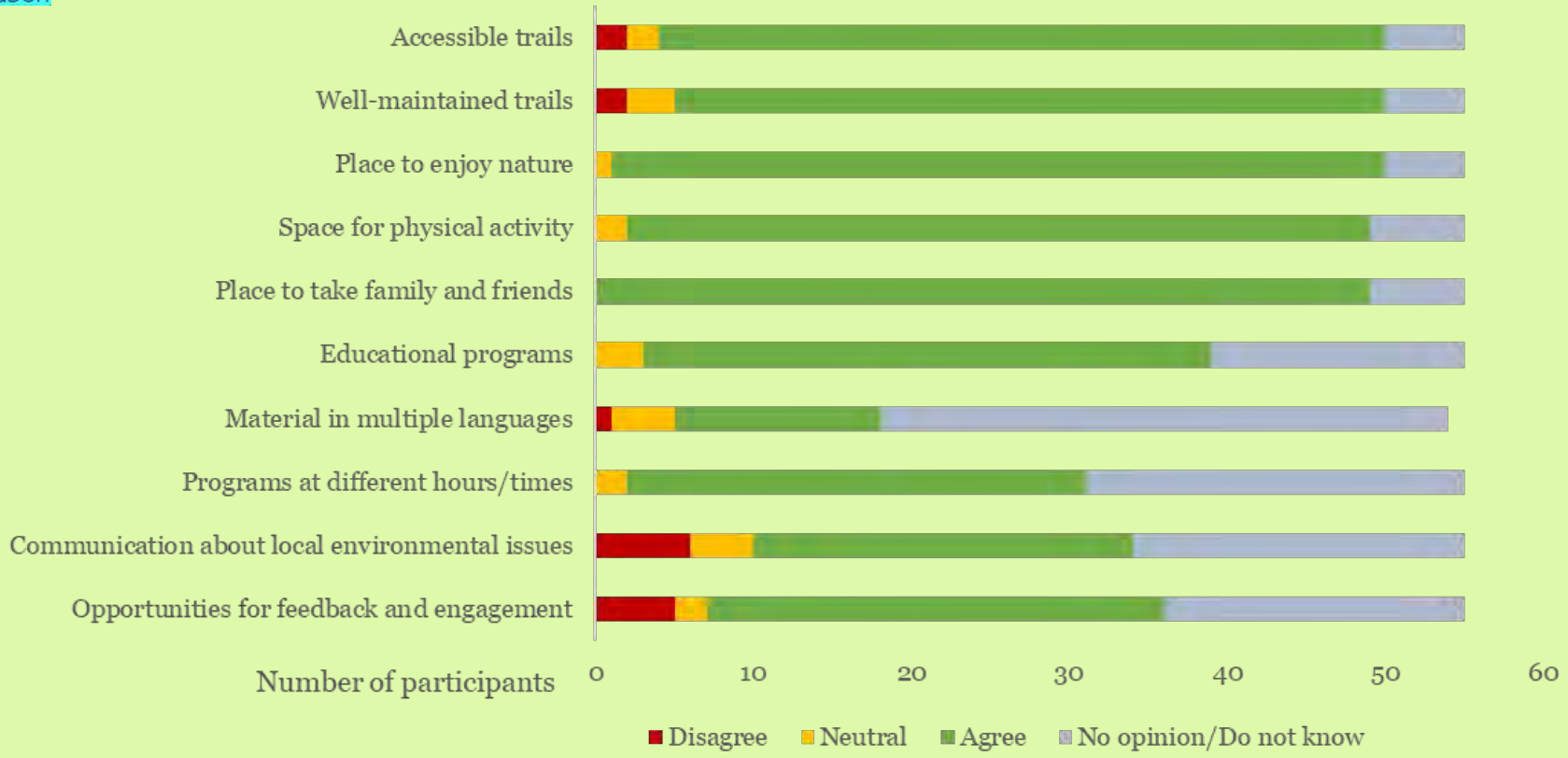
Resident Interactions with Broad Meadow Brook Wildlife Sanctuary



"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."

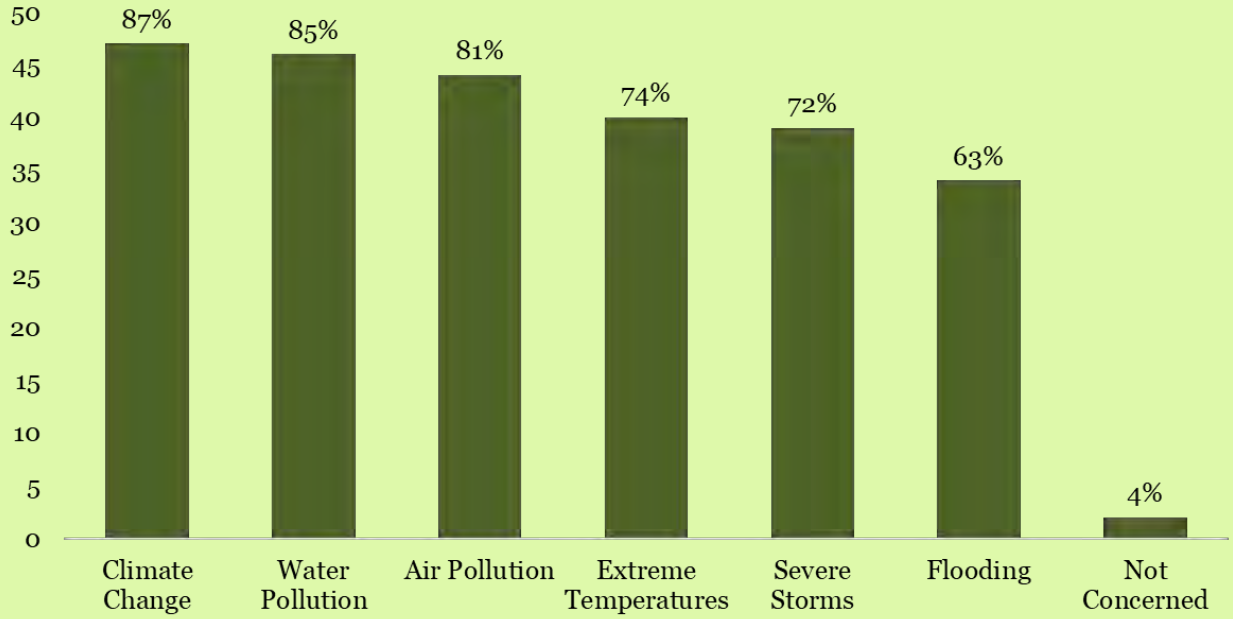
~ Resident, Broad Meadow Brook

Perceptions of Mass Audubon/BMB Wildlife Sanctuary



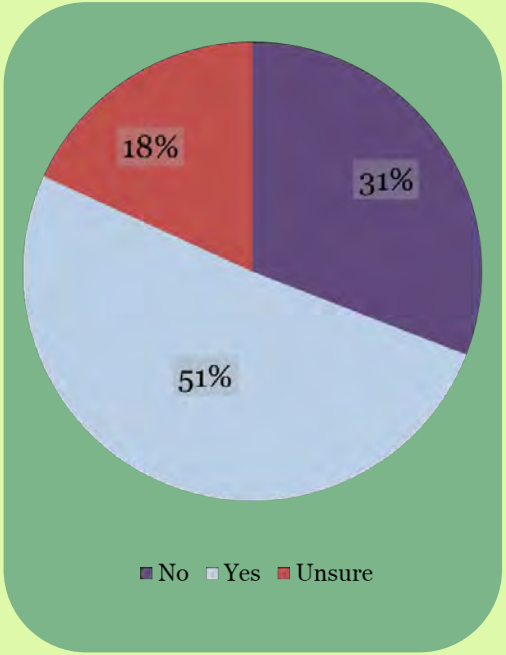
Participants Perception of Environment and Stewardship

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

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

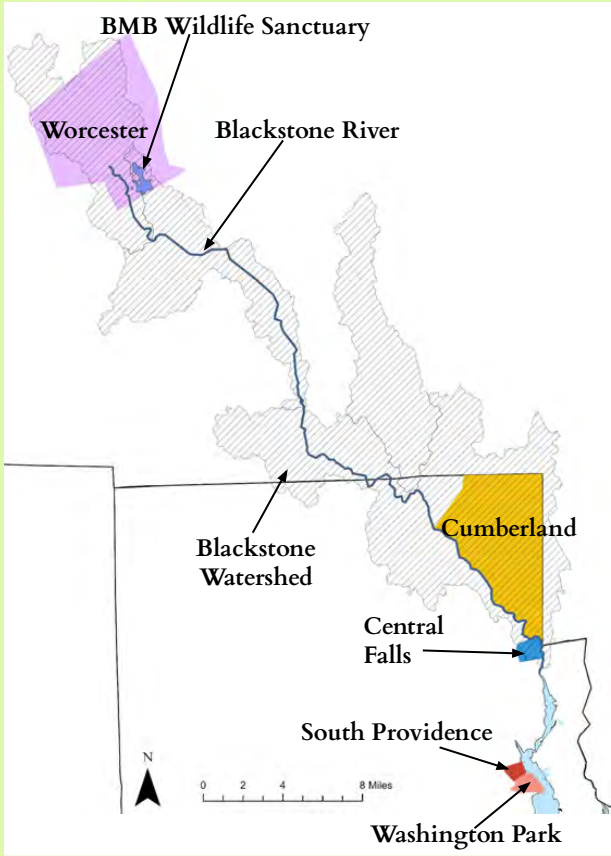
Almost all participants thought Broad Meadow Brook Wildlife Sanctuary does a good job providing accessible and well-maintained trails, but could do a better job communicating with residents.

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?

Photo:Street in Central Falls

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

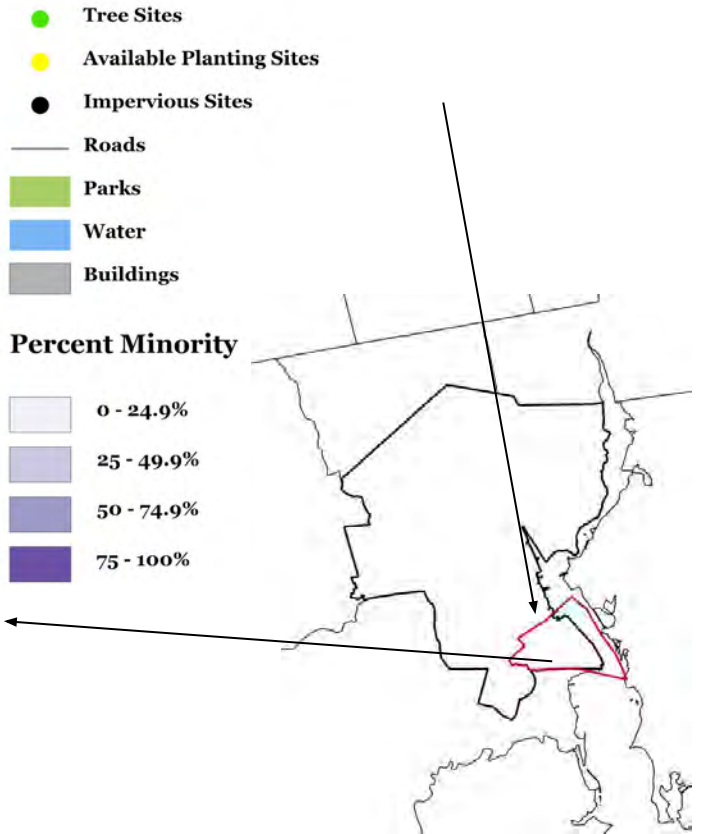
Planting Strip

Impervious Site

Available Planting Sites

Surveyed **287** Sites

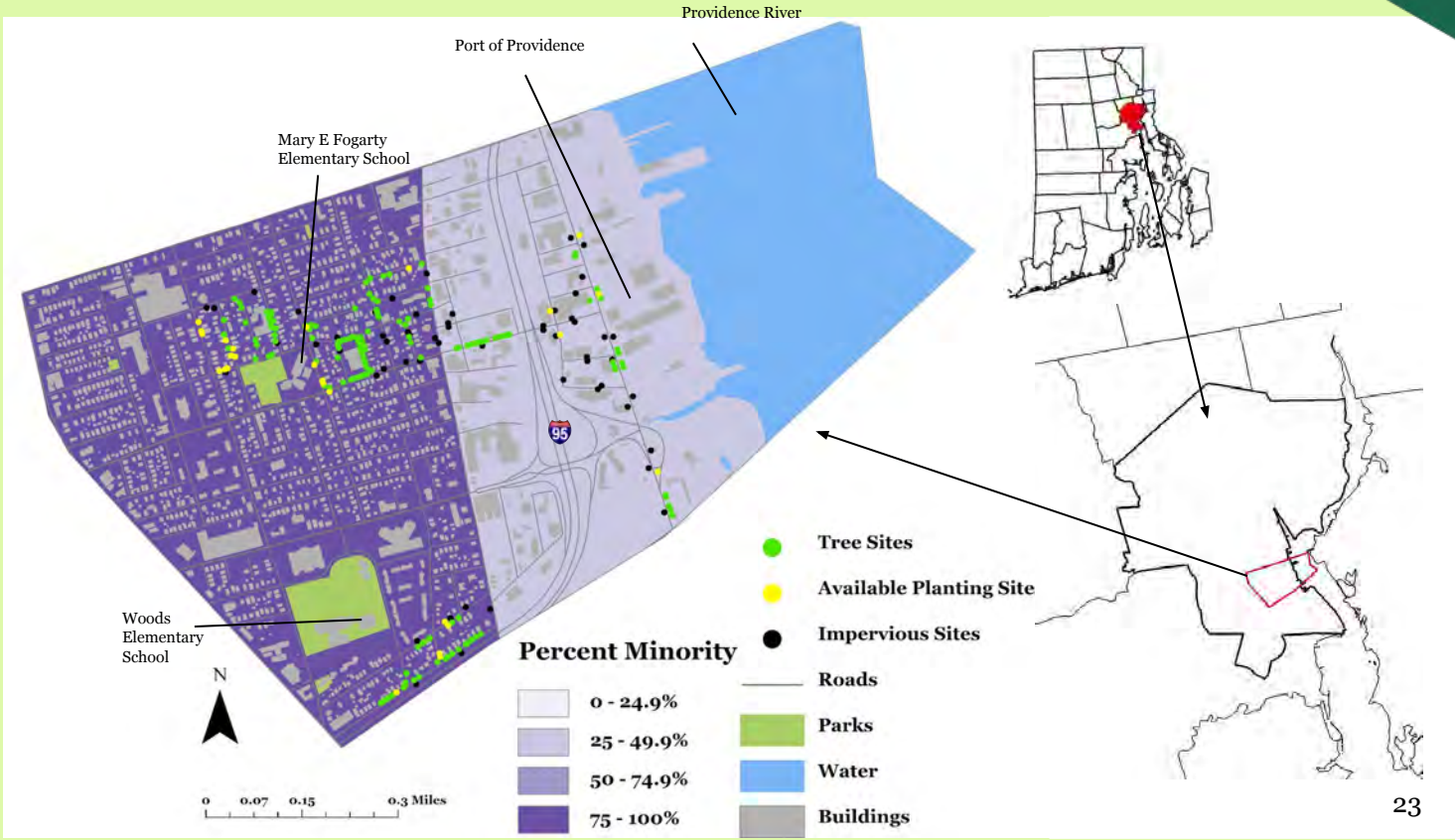
Washington Park



South Providence

Surveyed **230** Sites

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



Central Falls

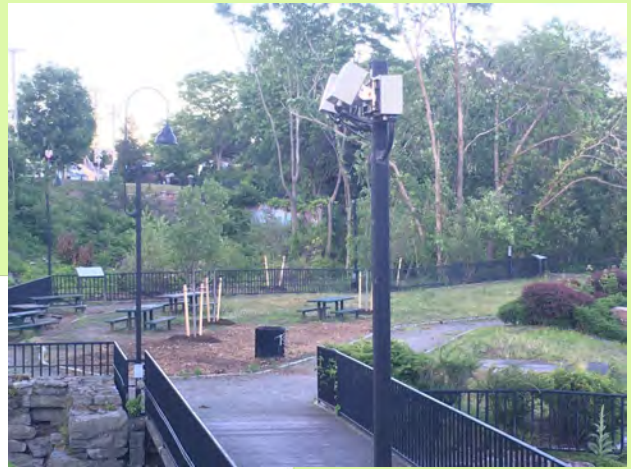
Surveyed **184** Sites

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

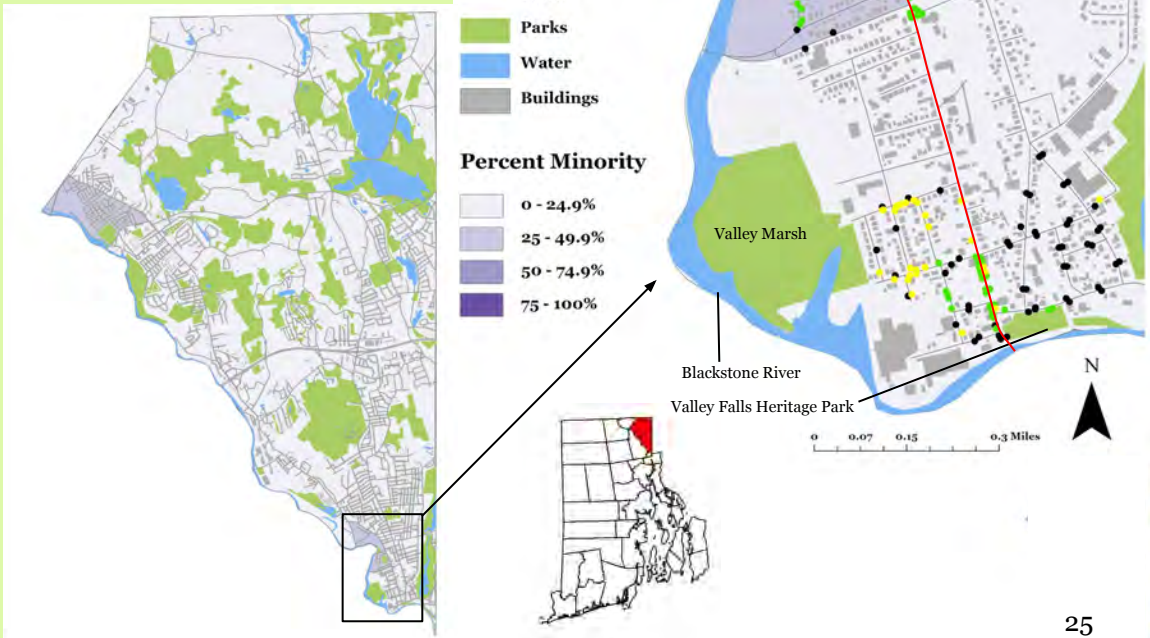
Cumberland

Surveyed **197** Sites

- 59 trees
- 27 available planting sites



Recent Tree Planting at Valley Falls Heritage Park



Residents' Perceptions of Urban Trees

Objectives:

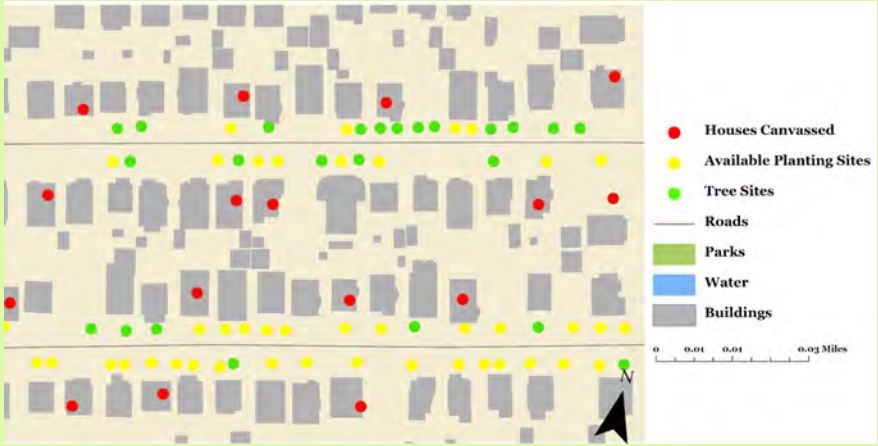
1. Survey residents to understand their perceptions and experiences with urban trees
2. Understand residents' concerns about the environment

Shradha leaving a flyer at a resident's door

Interview Sampling Strategies

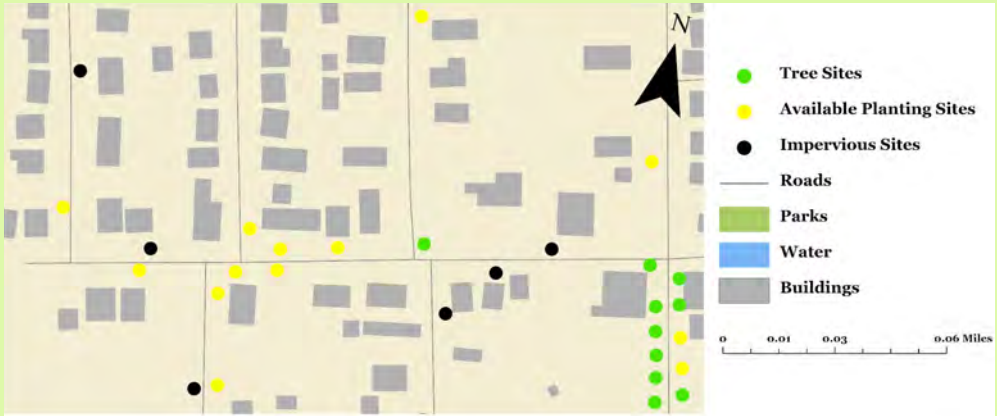
Washington Park

Strategy: All houses on curbless points
Knocked on 81 doors, interviewed 10 residents
Response rate: 12%

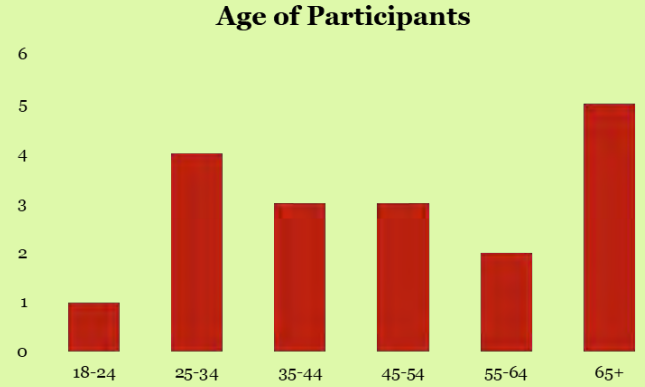


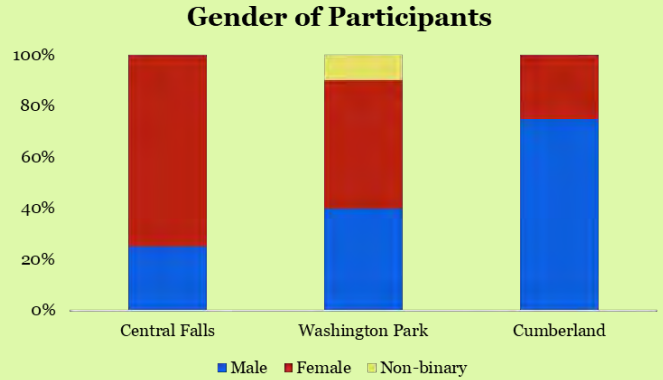
Central Falls and Cumberland

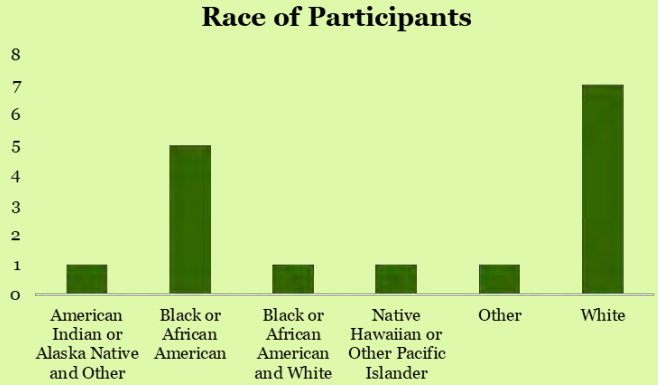
Strategy: Convenience Sampling
4 Interviews in Cumberland
4 Interviews in Central Falls

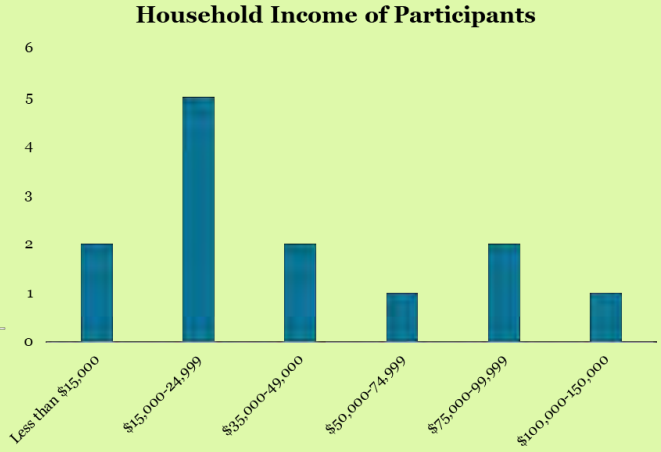


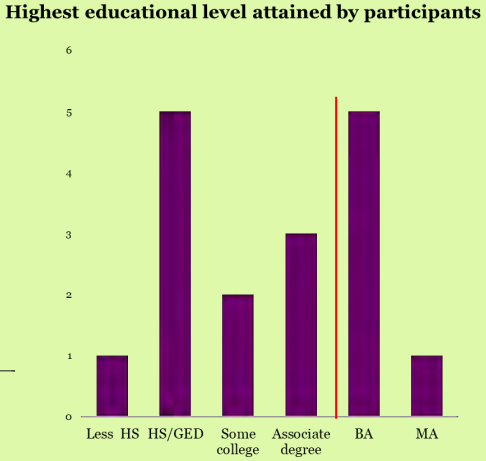
Demographics of Residents Interviewed











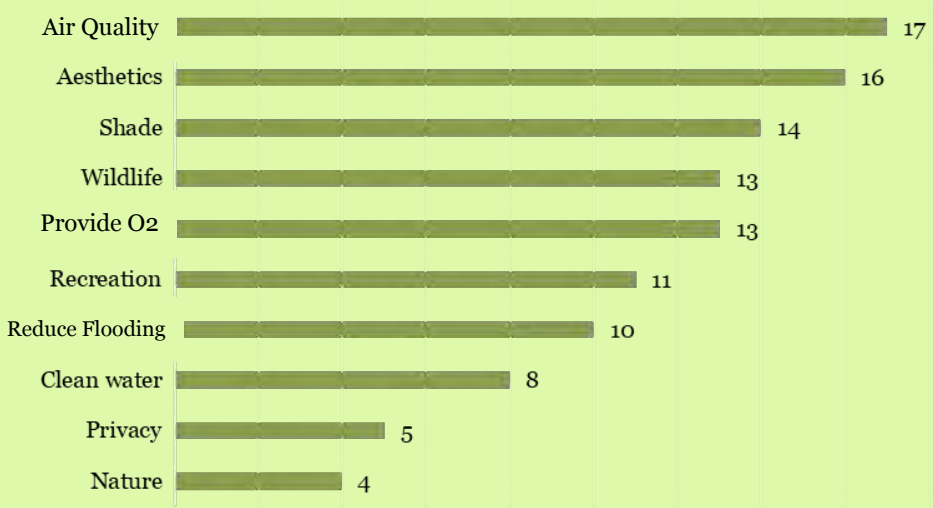
Comparison between Survey and City Demographics

	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.

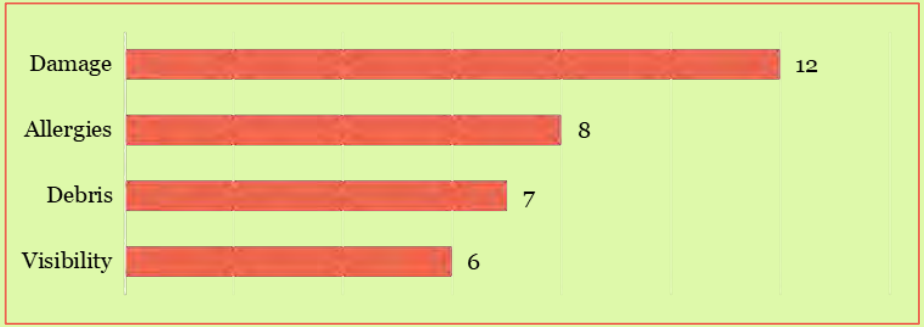
> "Do trees bring more air? yeah that they do!"
> ~ Resident, Washington Park

> "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

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.

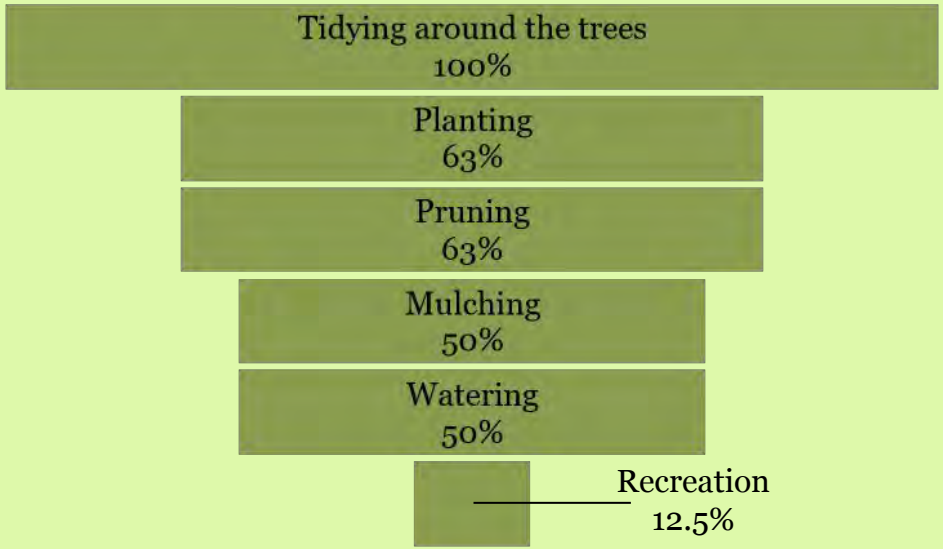
> "Uh, yeah, they're starting to lift up the brick."
>
> ~ Resident, Cumberland

> "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.”

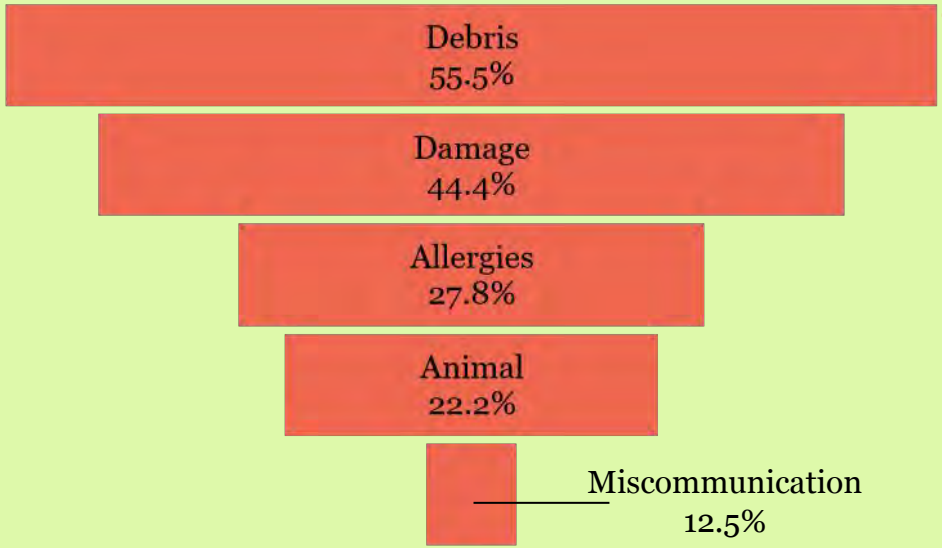
~ Resident, Cumberland

“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."

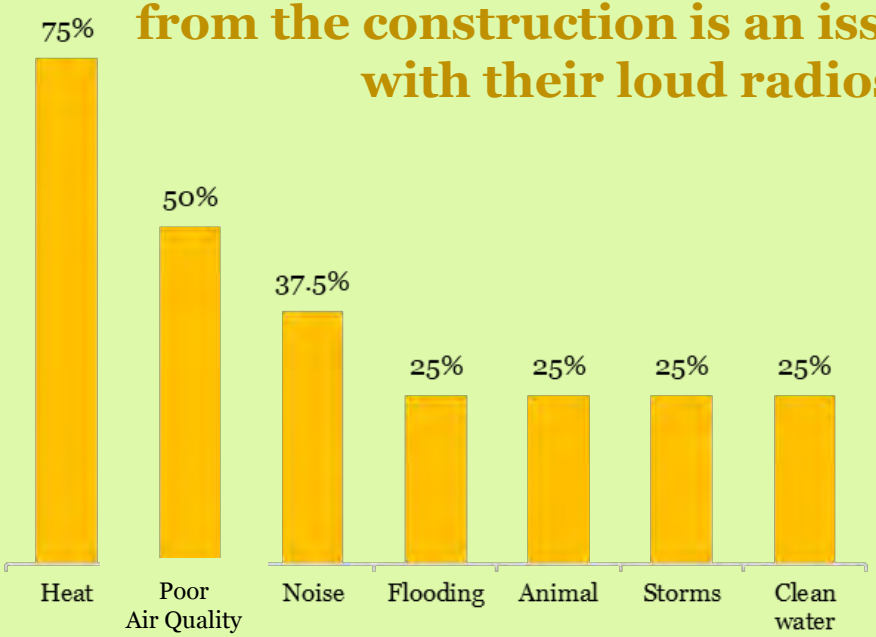
~ Resident, Washington Park

"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

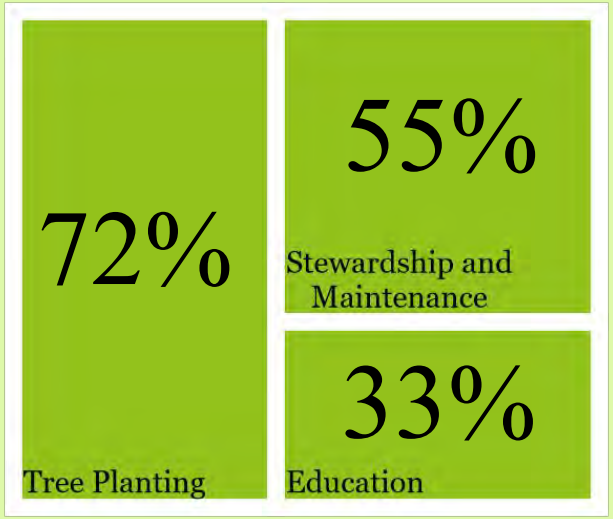
How should resources for trees be prioritized?

"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."

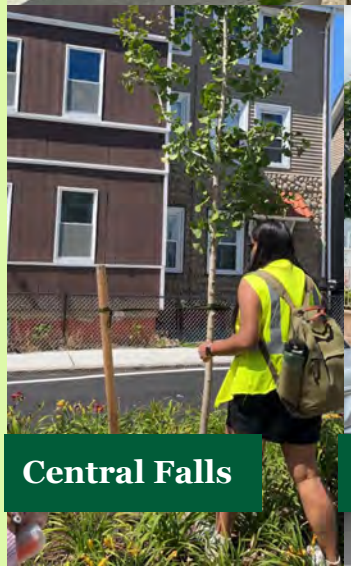
~ Resident, Washington Park

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

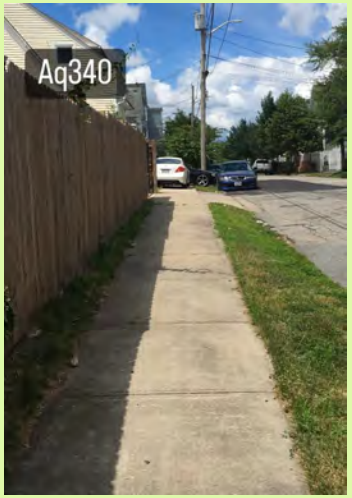
Sidewalk Cutout

Planting Strip

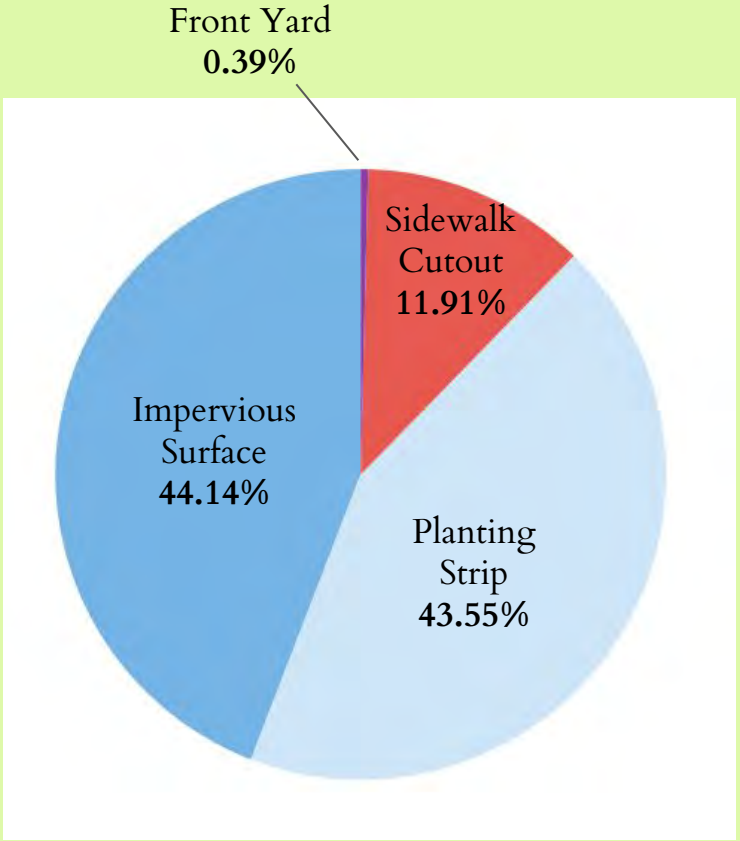
Impervious

Potential Planting Site Types

513 potential tree planting sites identified



Potential planting site in Washington Park

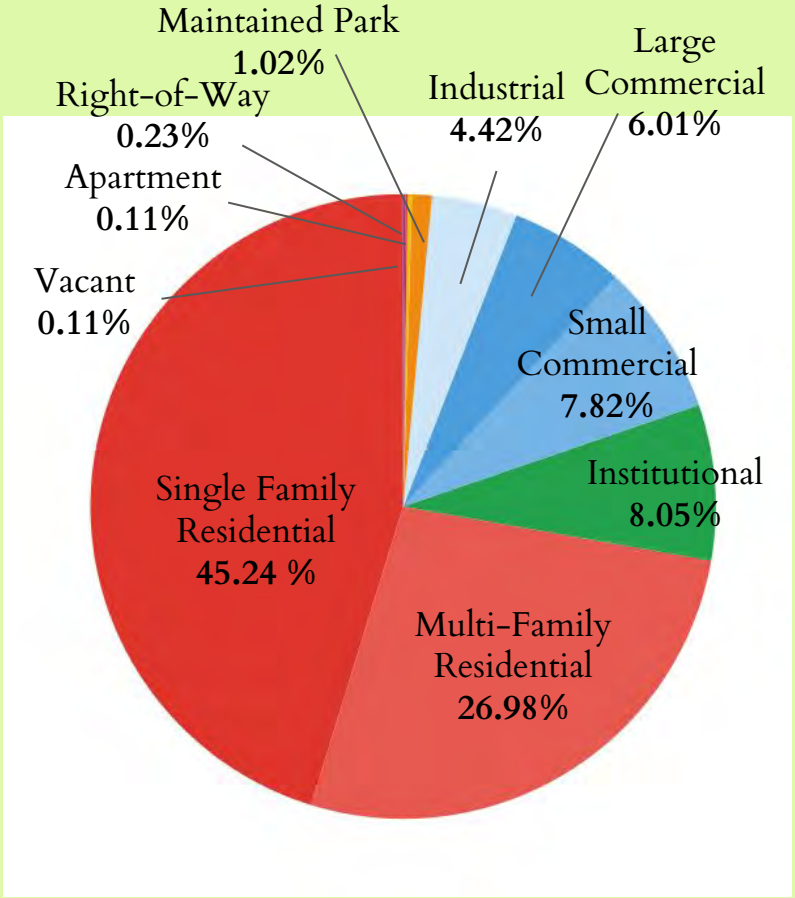


Potential planting site covered with trash in Washington Park

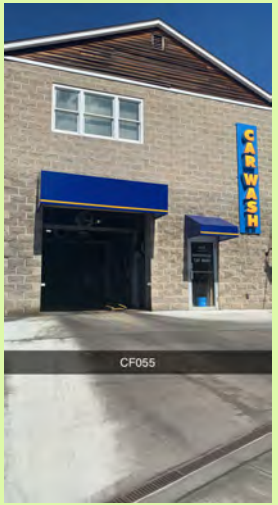
Land Use Types

Single Family Residence

Multi Family Residence



Small Commercial



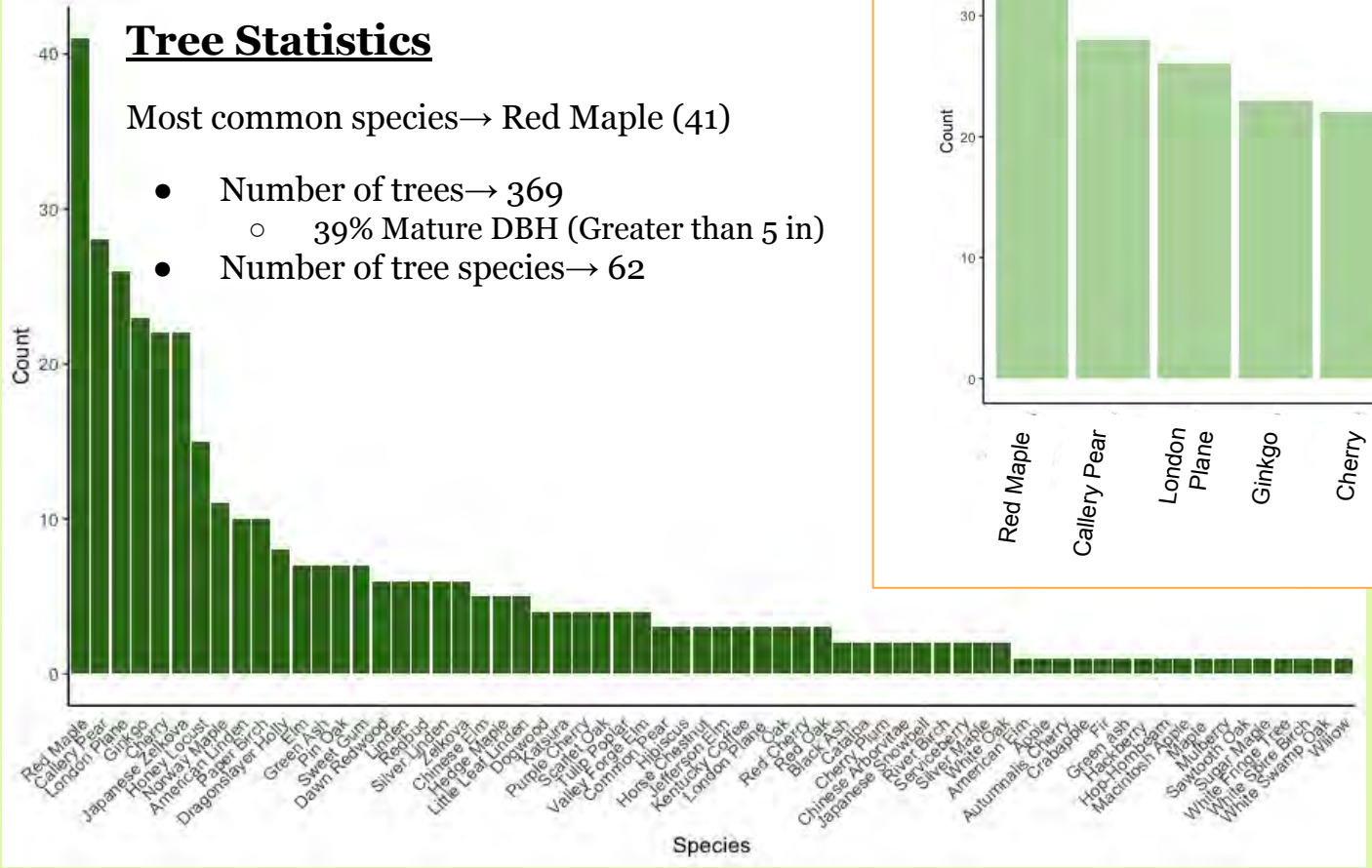
Industrial

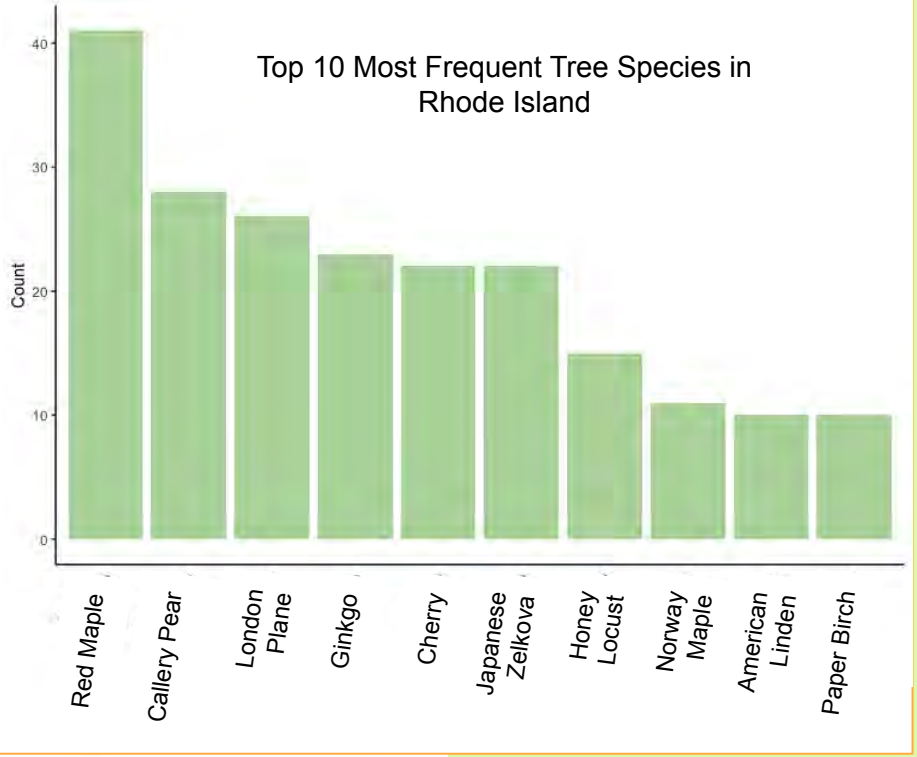
Rhode Island Tree Species

Tree Statistics

Most common species→ Red Maple (41)

- Number of trees→ 369
  - 39% Mature DBH (Greater than 5 in)
- Number of tree species→ 62





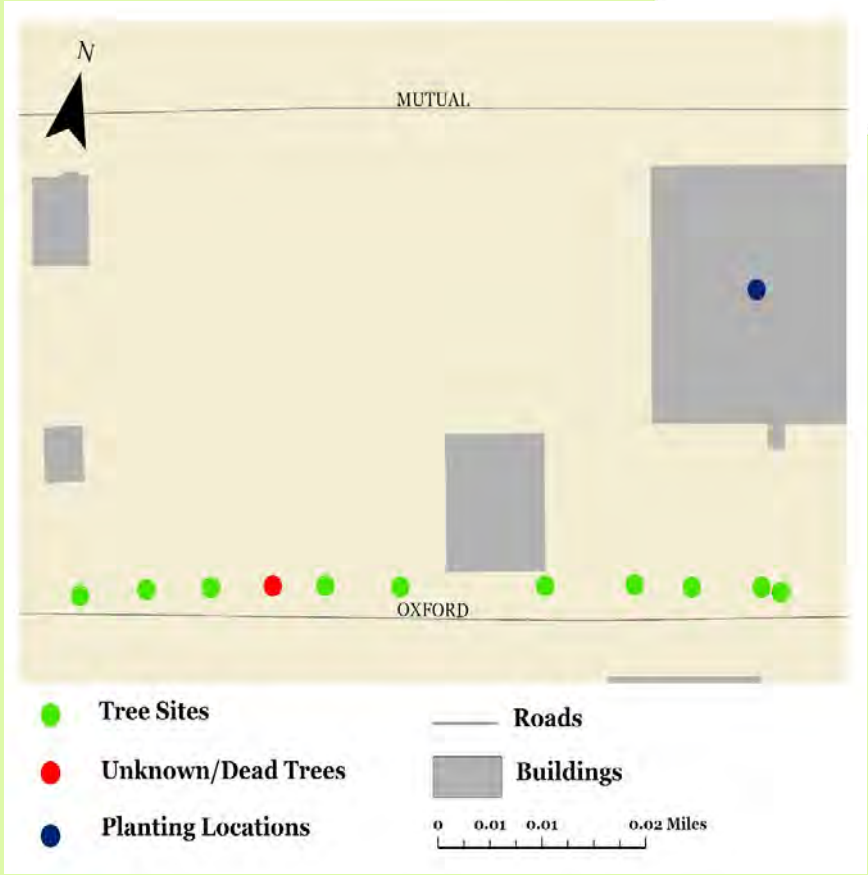
Groundwork Tree Survey

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

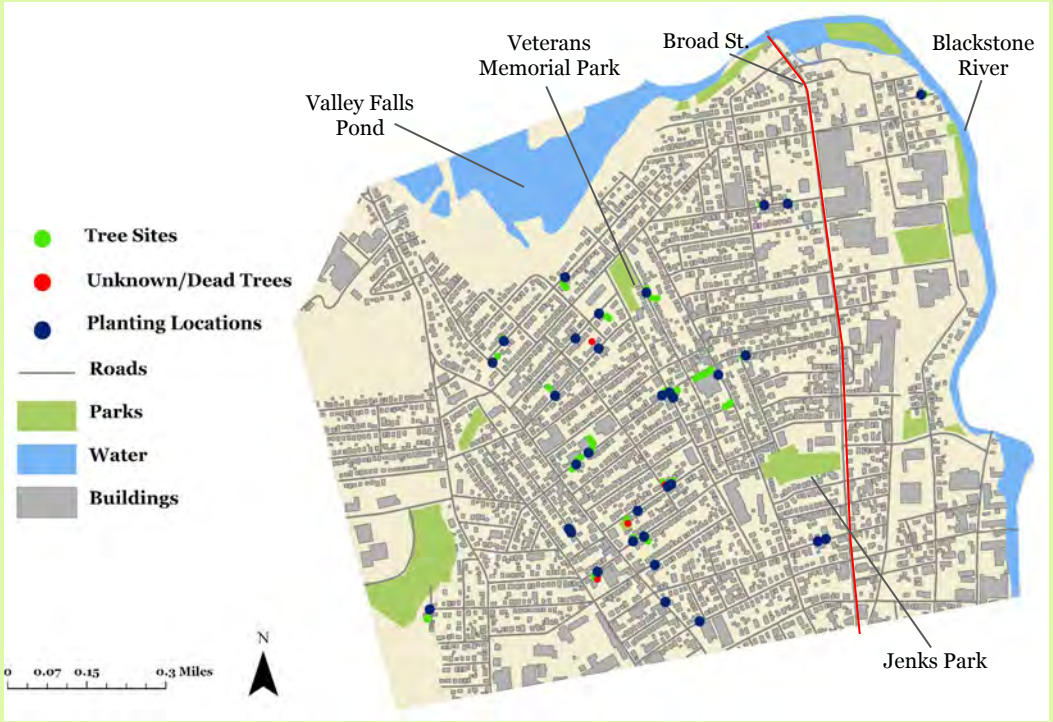


Groundwork Tree Survey

Tree Survivorship **92.55%**

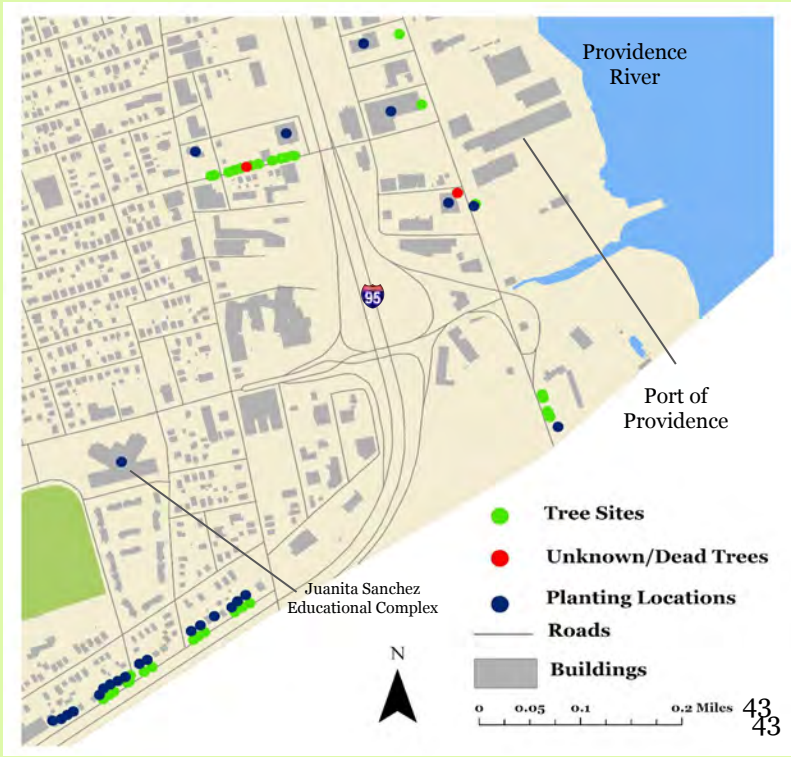
Central Falls

54 Trees, 1 Unknown, 4 Dead



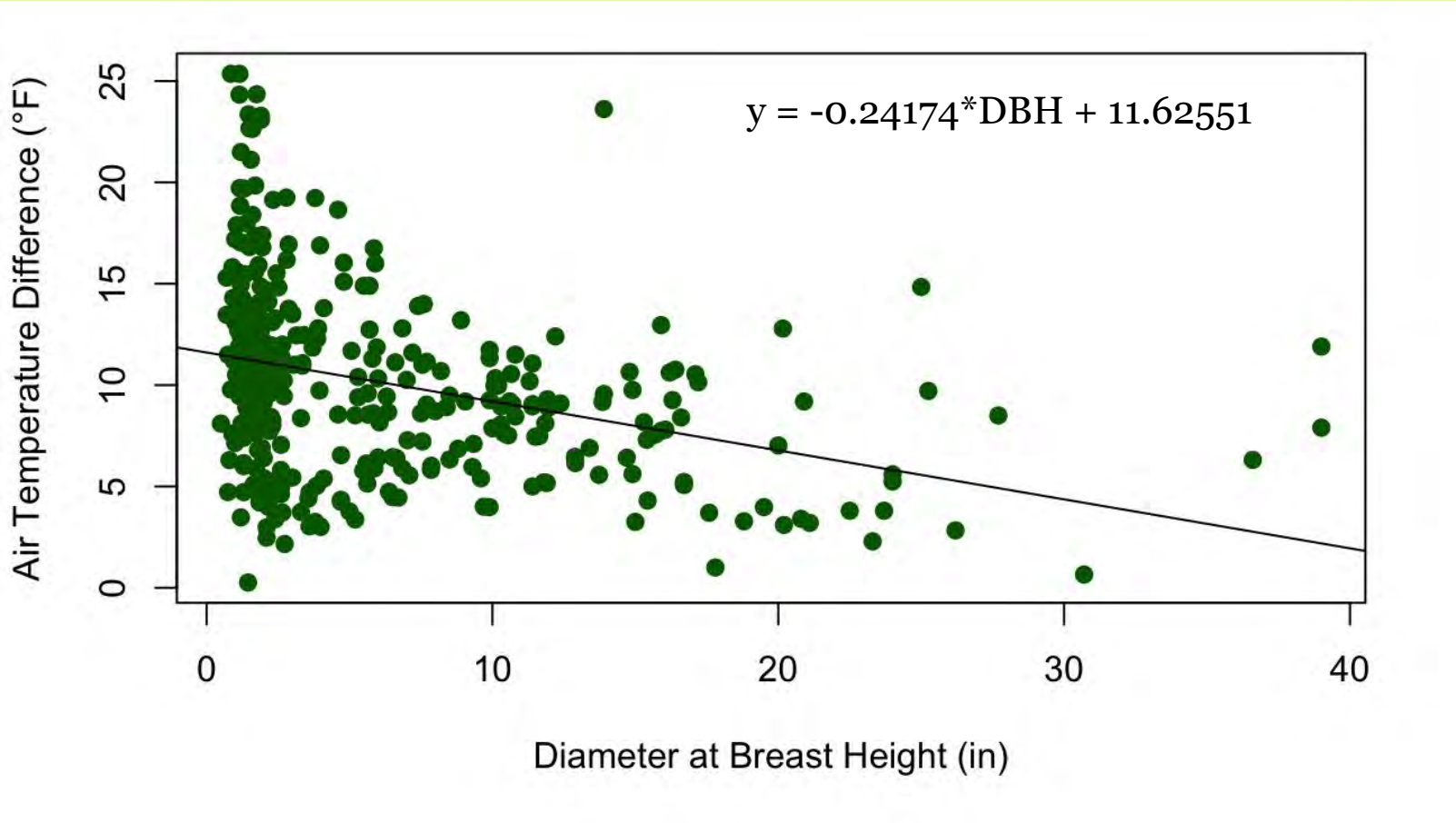
South Providence

33 Trees, 1 Unknown, 1 Dead



43

Impact of Trees on the Urban Heat Island Effect



Temperature and Air quality

Maximum Temperature Difference (℉)	25.36
Maximum Air Temperature (℉)	101.55
Maximum Heat Index (Real Feel) (℉)	113

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

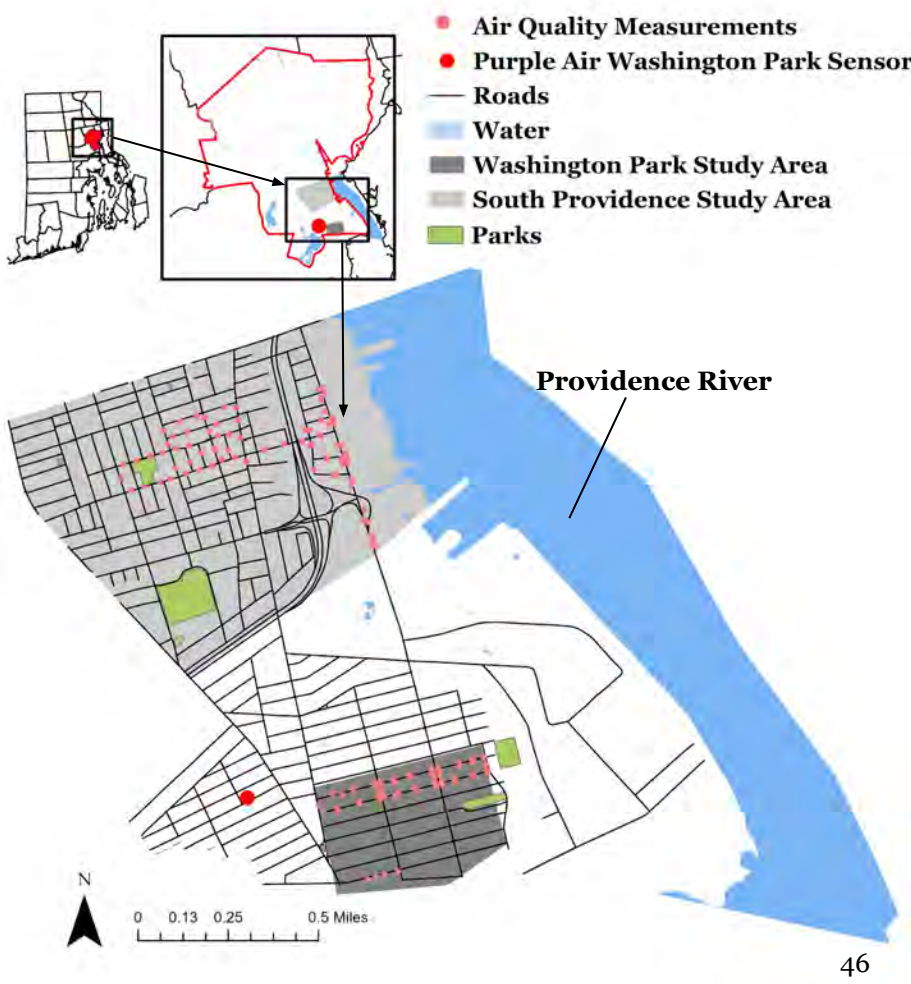
- Central Falls had the max temperature difference
- Washington Park had the maximum temperatures along with the maximum heat index

Regs taking an ozone measurement

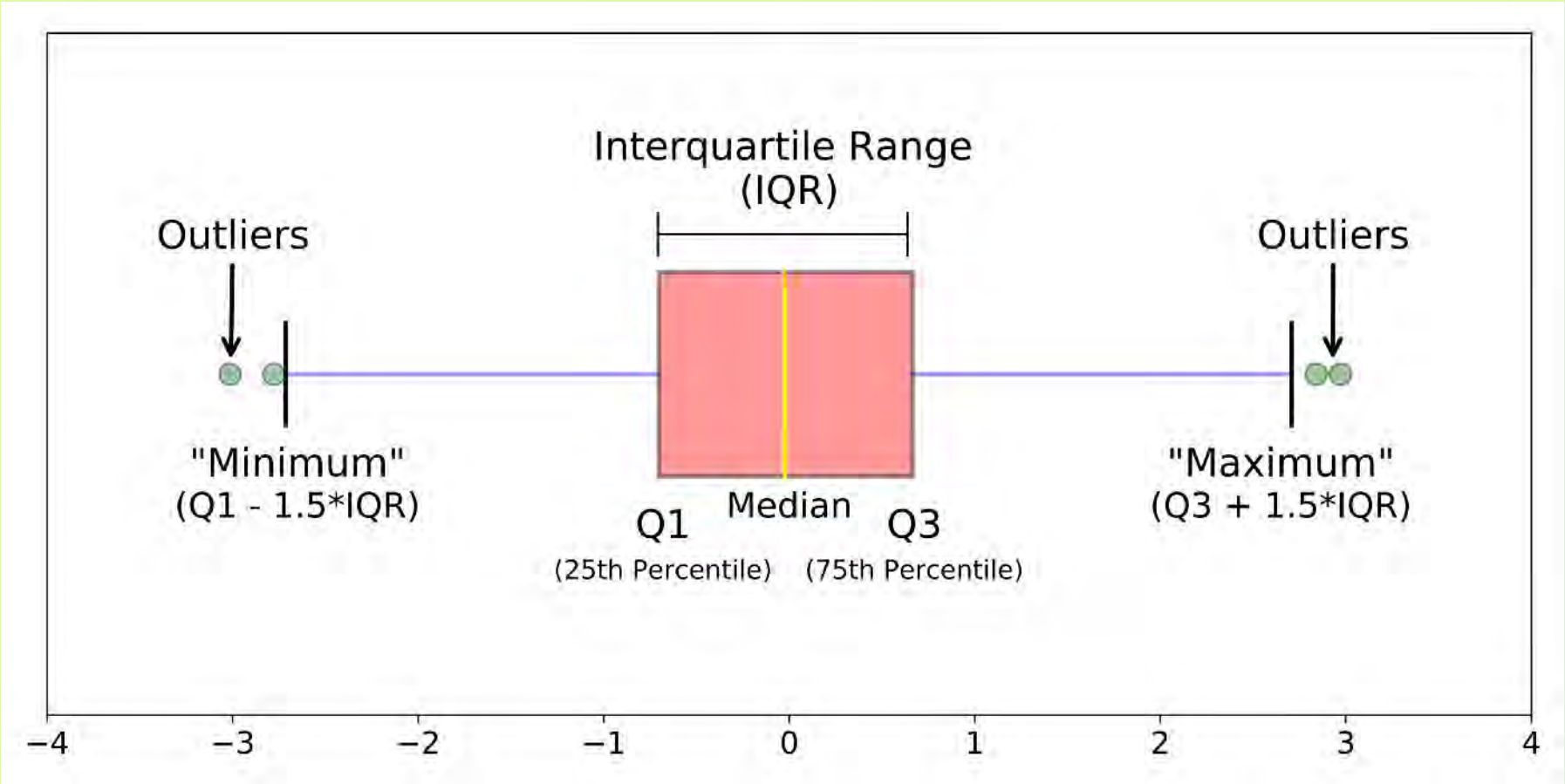
Air Quality Comparisons

Difference between HERO and Purple Air PM 2.5 Measurements

Average measurement difference	2.84 (µg/m3)
Aeroqual Standard Deviation	2.08 (µg/m3)
Purple Air Standard Deviation	3.94 (µg/m3)
Max Weekly Purple Air PM 2.5	586 (µg/m3)
Weekly Purple Air Std Deviation PM 2.5	13 (µg/m3)

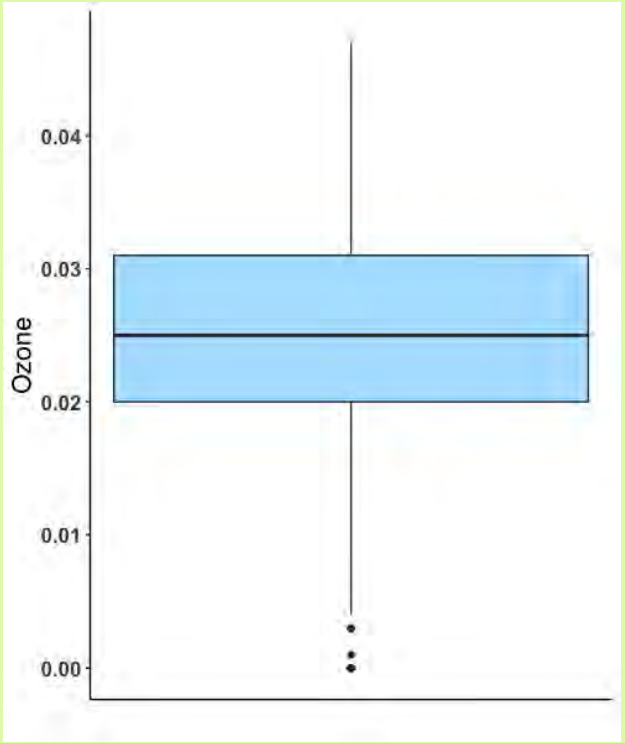


*On average, Purple Air reports higher PM measurements than collected by HERO using Aeroqual

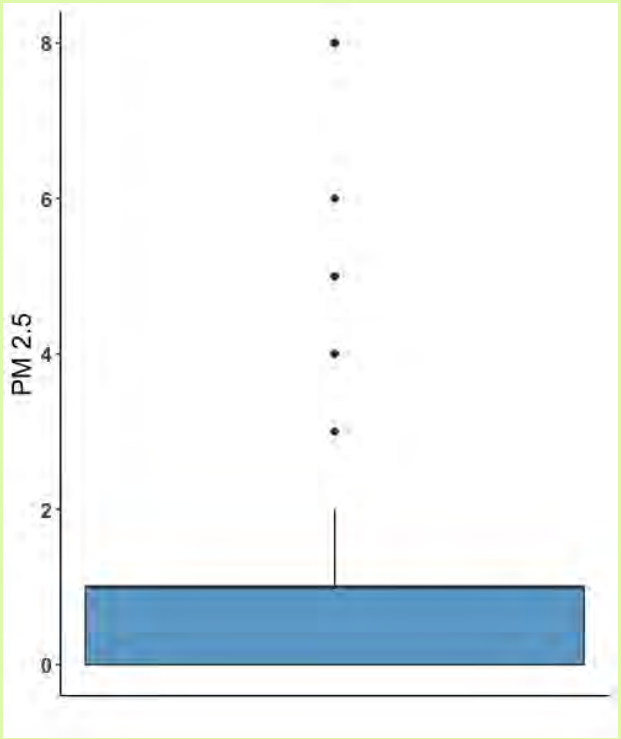

Interquartile Range
(IQR)
Outliers
Outliers
"Minimum"
(Q1 - 1.5*IQR)
"Maximum"
(Q3 + 1.5*IQR)
Q1
Median
Q3
(25th Percentile)
(75th Percentile)
−4
−3
−2
−1
0
1
2
3
4

Air Quality Statistics– All Sites

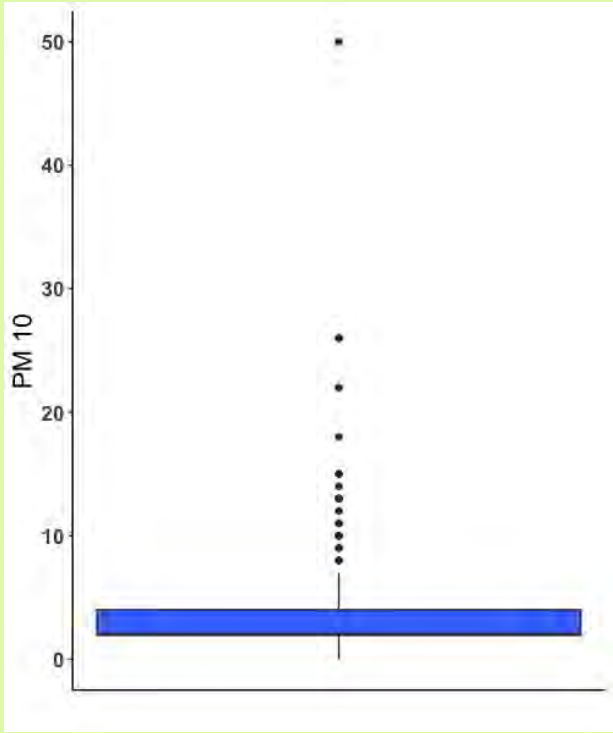
Ozone Observations



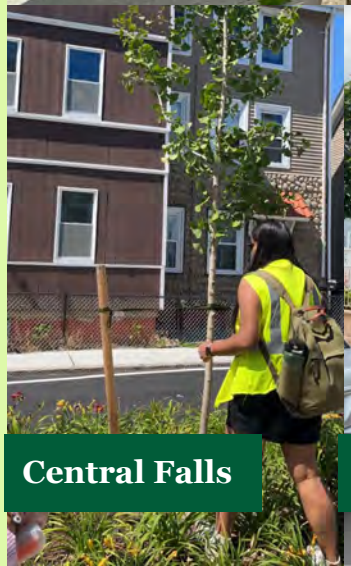
PM 2.5 Observations



PM 10 Observations

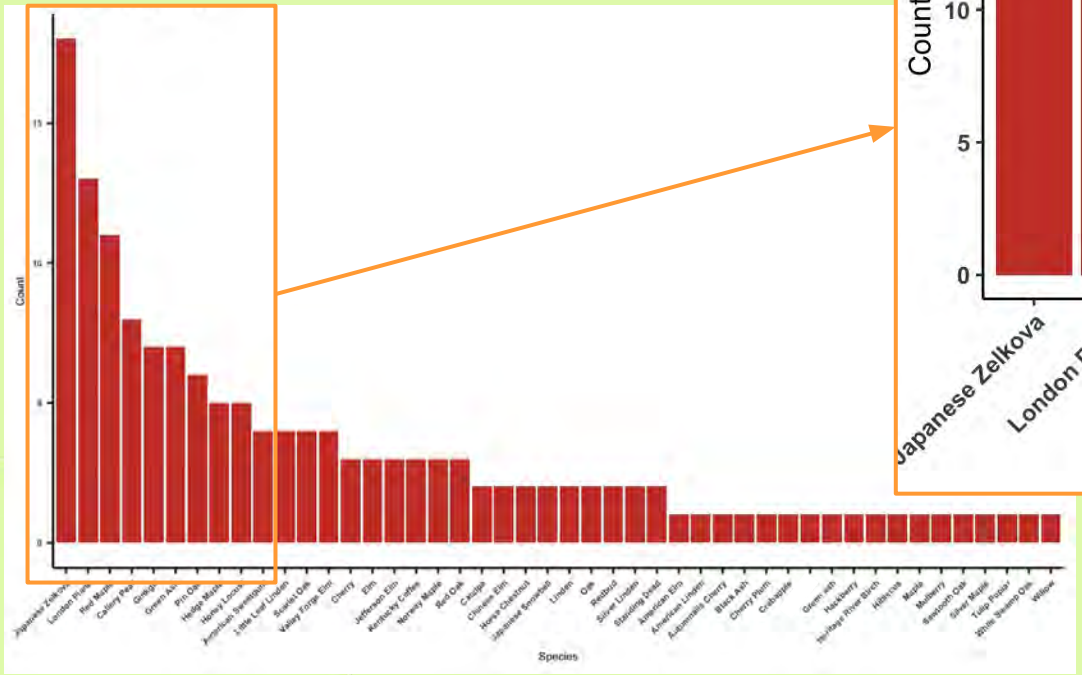


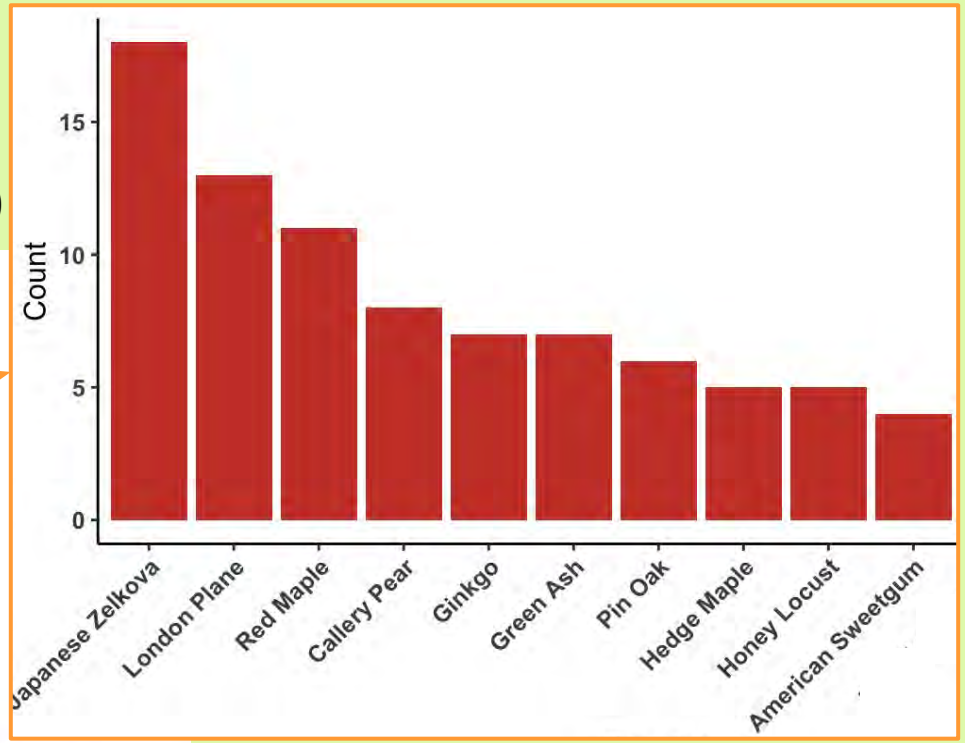
Neighborhood and City Summaries



South Providence

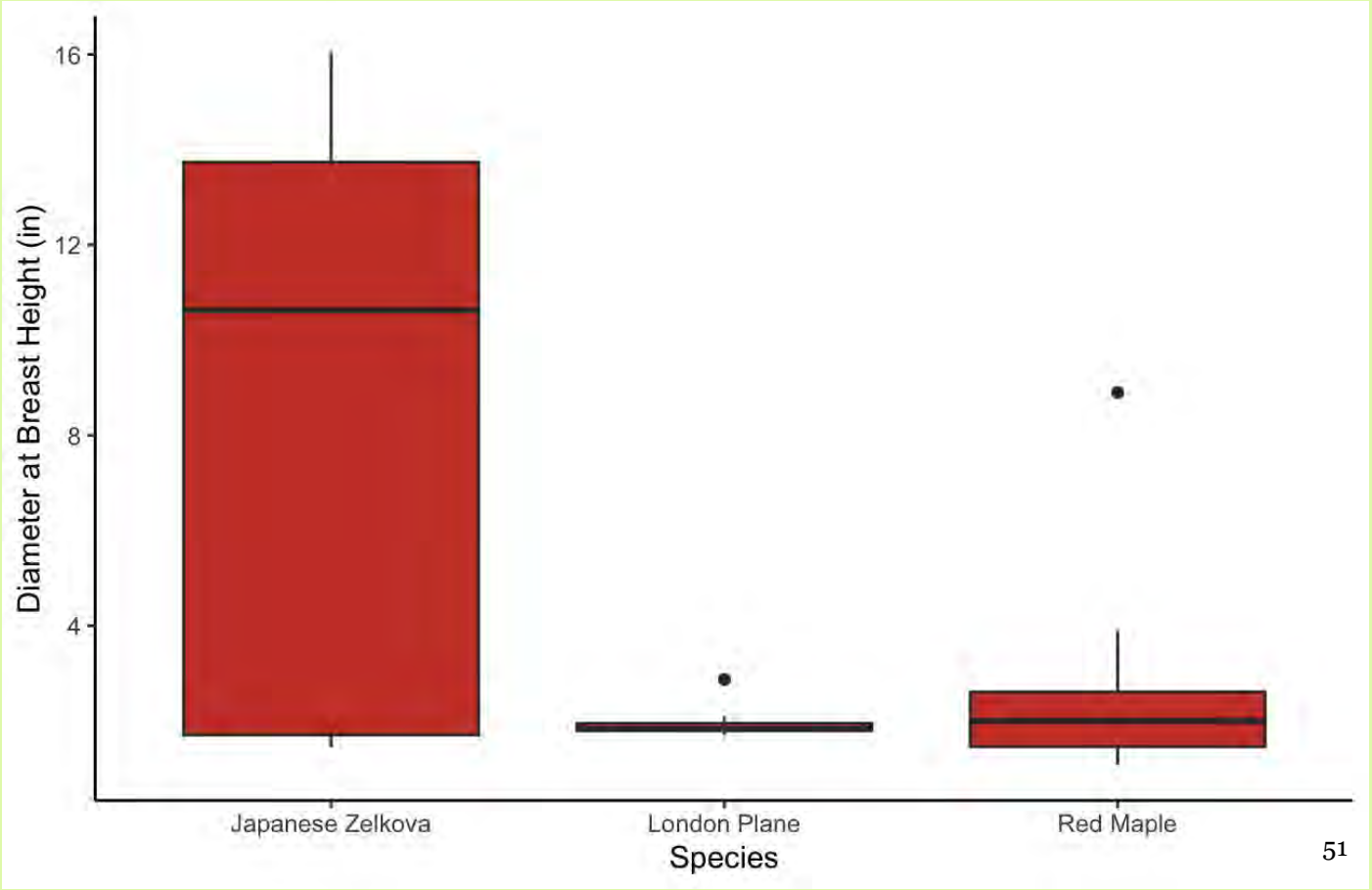
- **143** trees surveyed
- **35** trees planted by Groundwork (24%)
- **46** tree species
- **104** trees with less than 5 in DBH (73%)





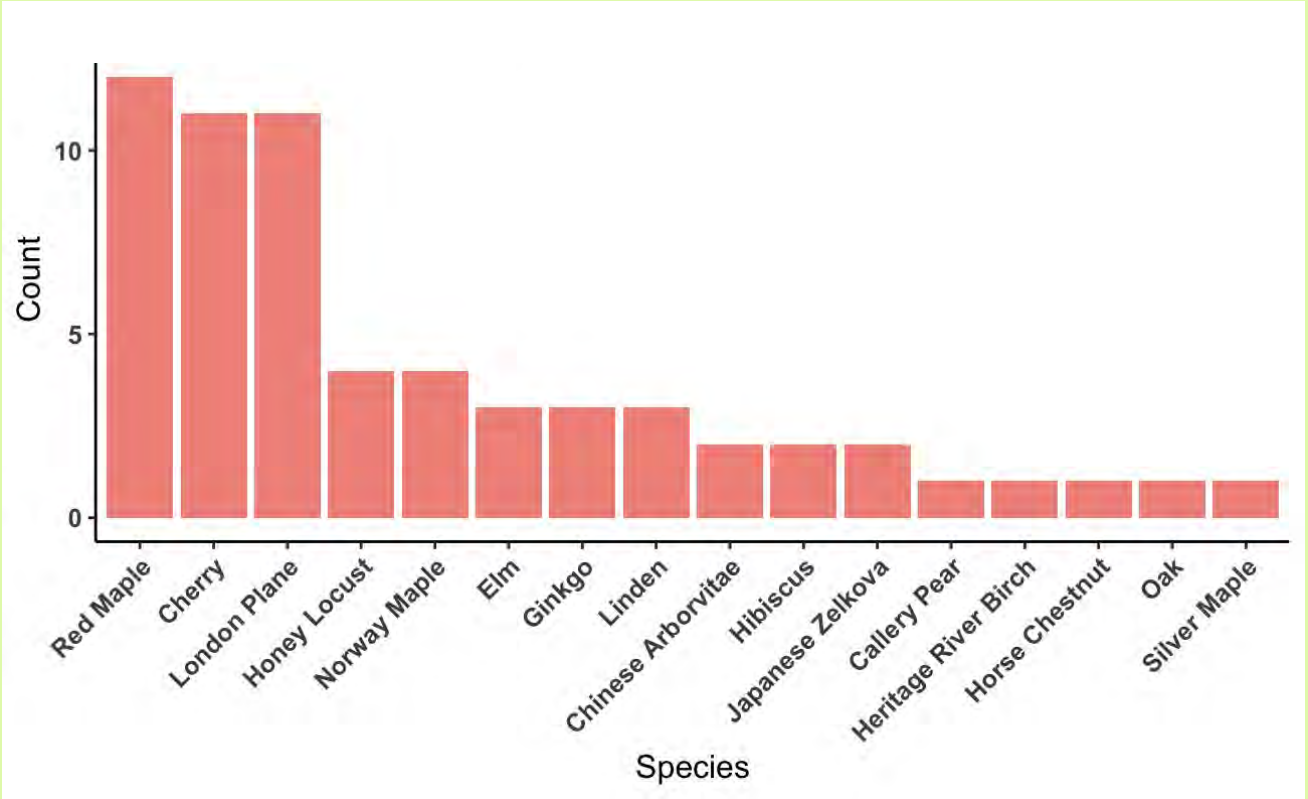
South Providence

Top 3 Species – Diameter at Breast Height Measurements



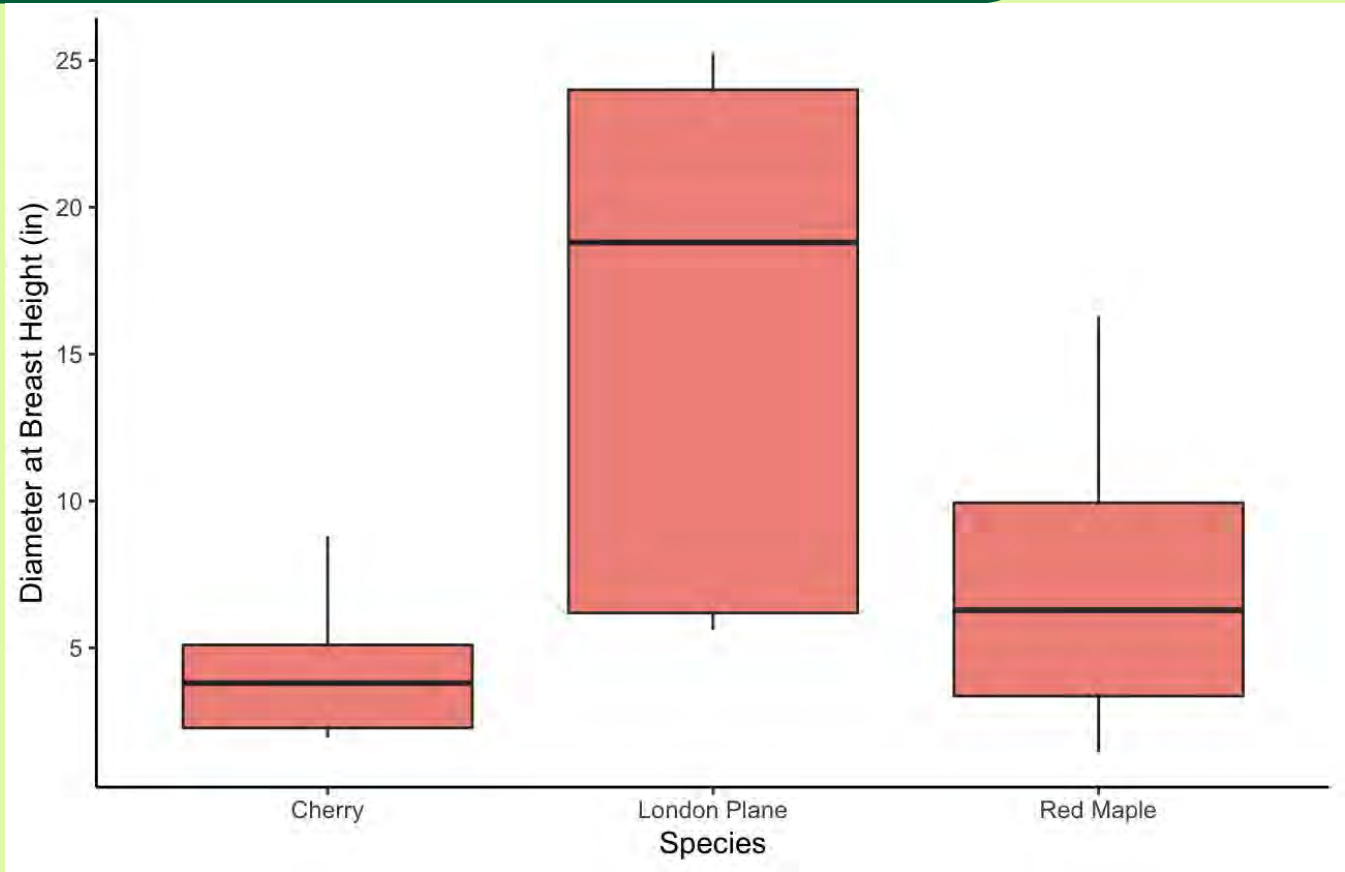
Washington Park

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



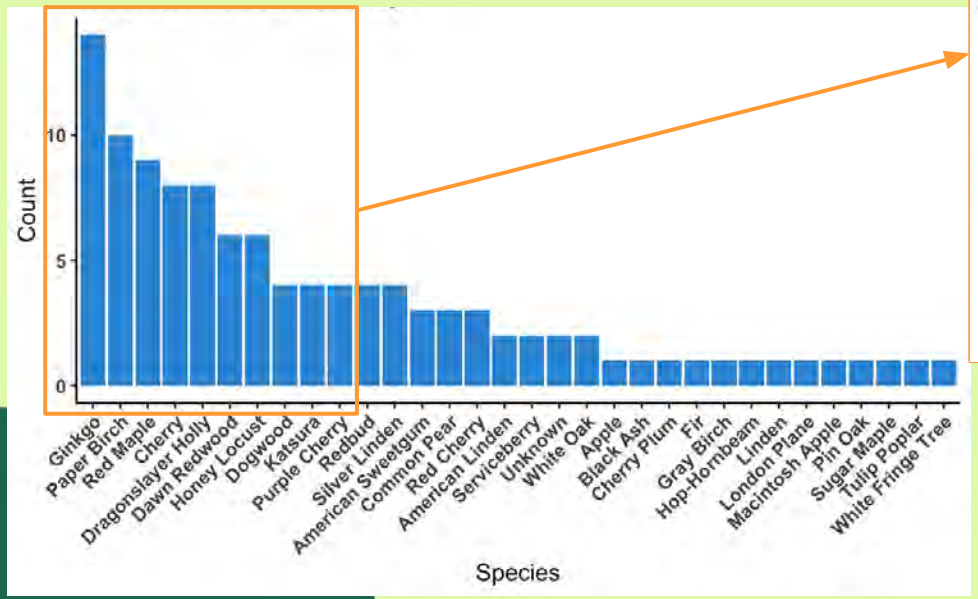
Washington Park

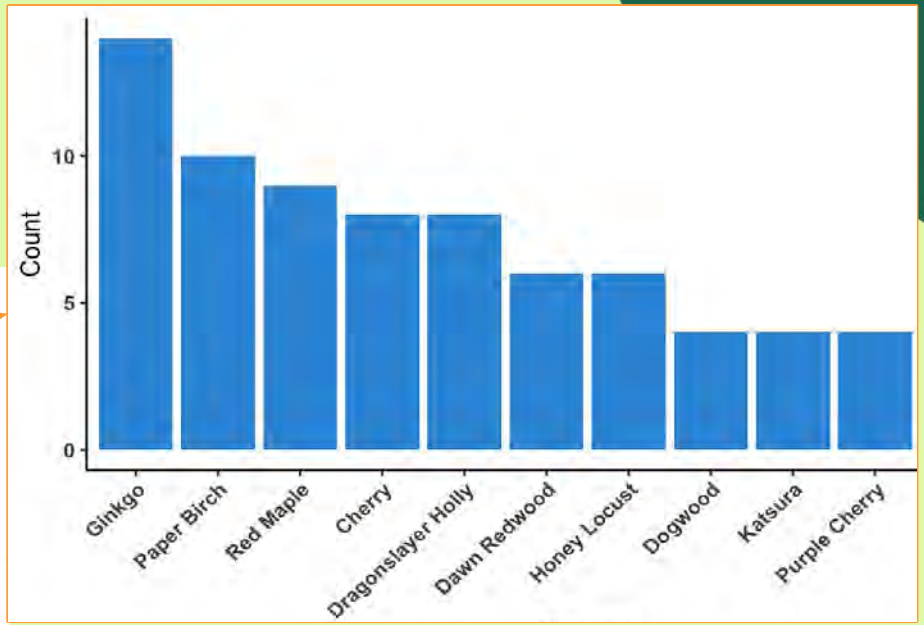
Top 3 Species – Diameter at Breast Height Measurements



Central Falls

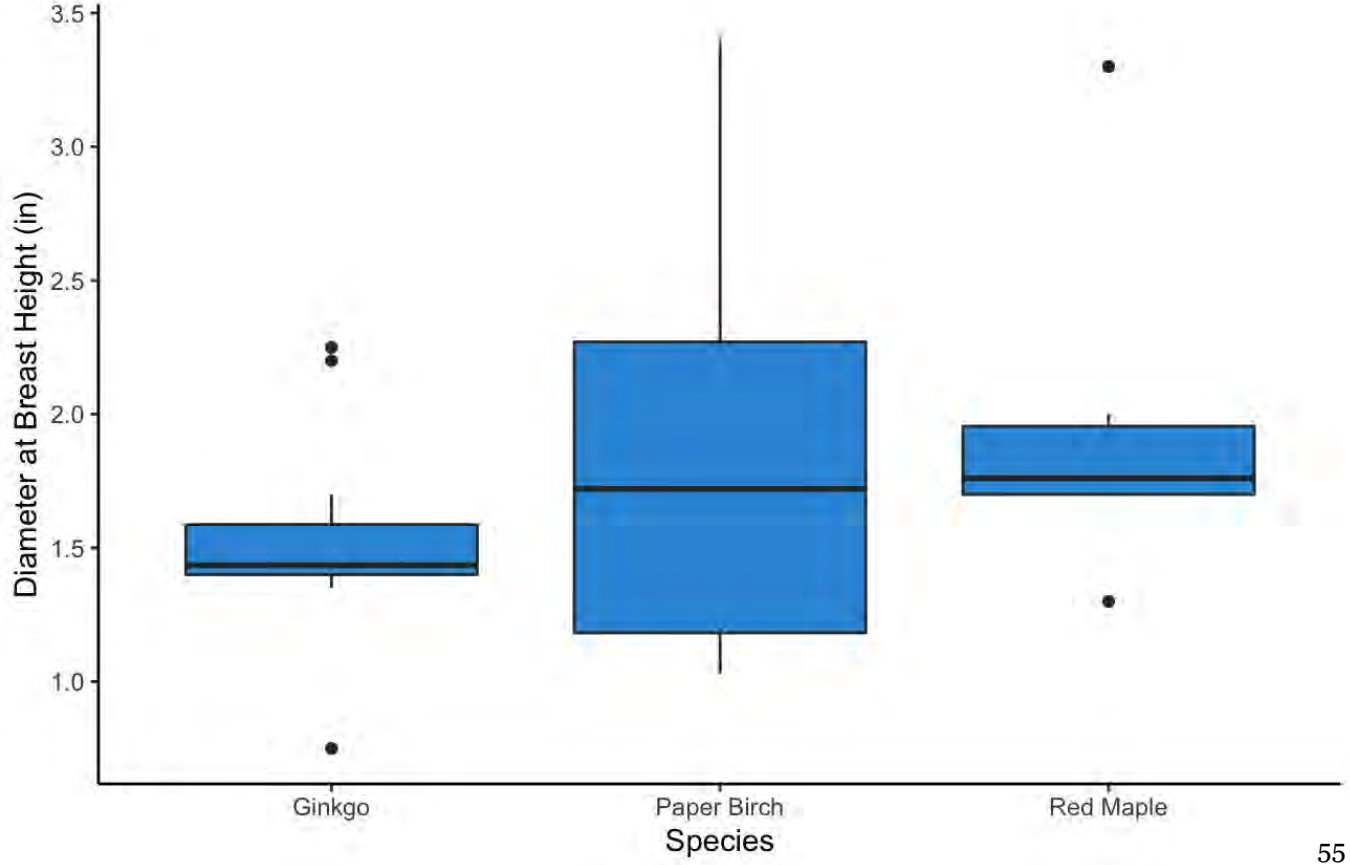
- **109** trees surveyed
- **32** tree species
- **87** trees with less than 5 in DBH (80%)
- **59** of the 109 were Groundwork trees (54%)





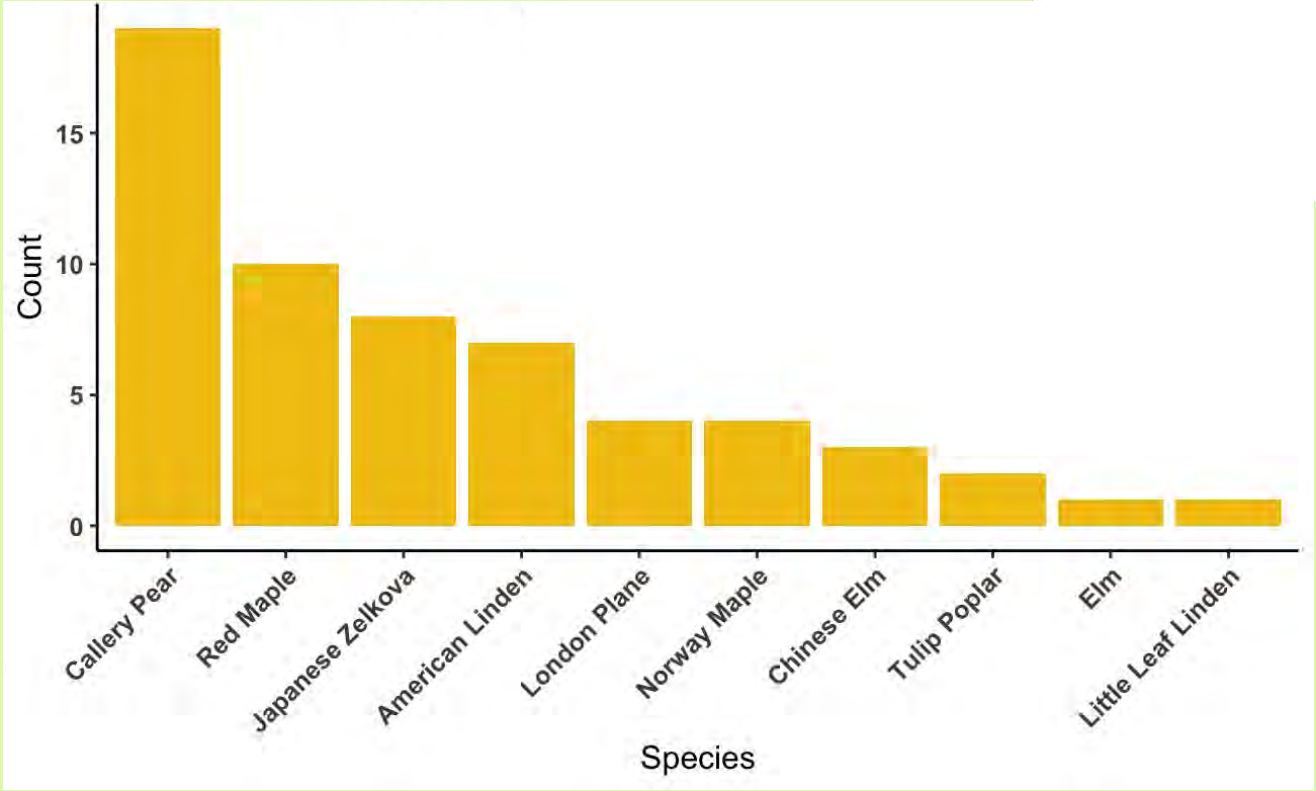
Central Falls

Top 3 Species – Diameter at Breast Height Measurements



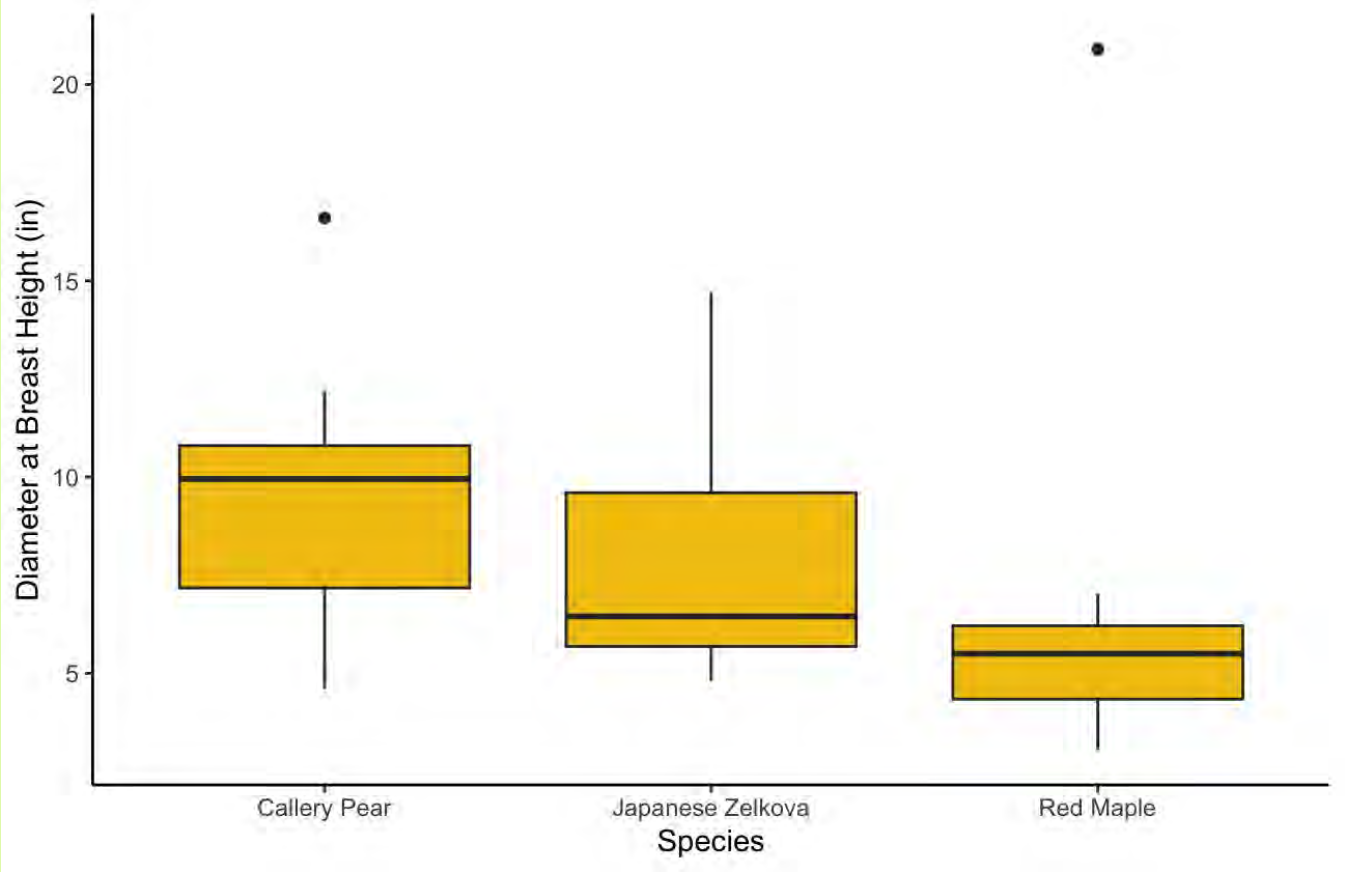
Cumberland

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



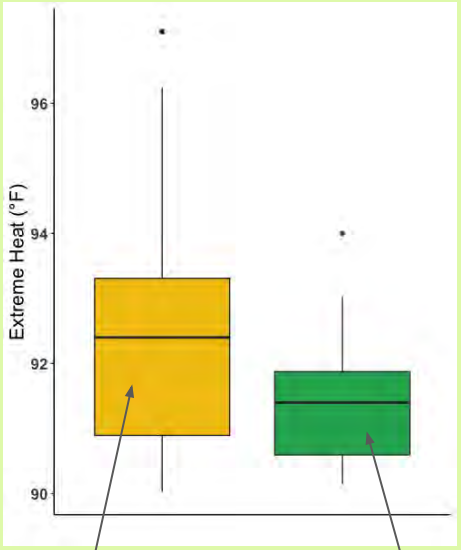
Cumberland

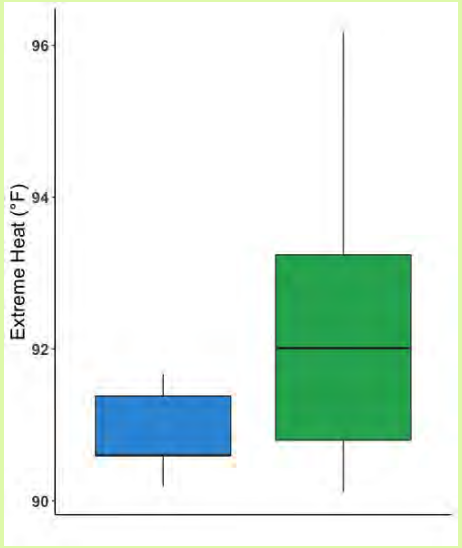
Top 3 Species – Diameter at Breast Height Measurements

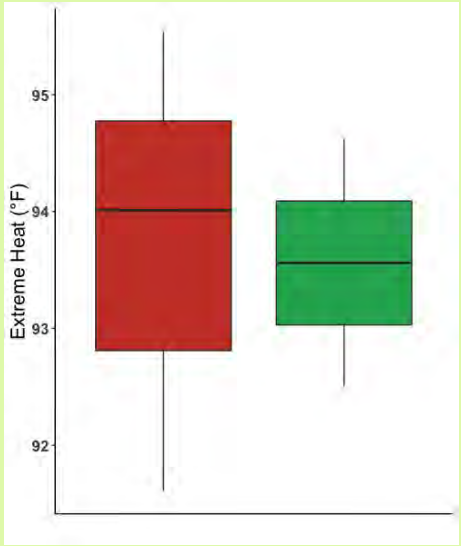


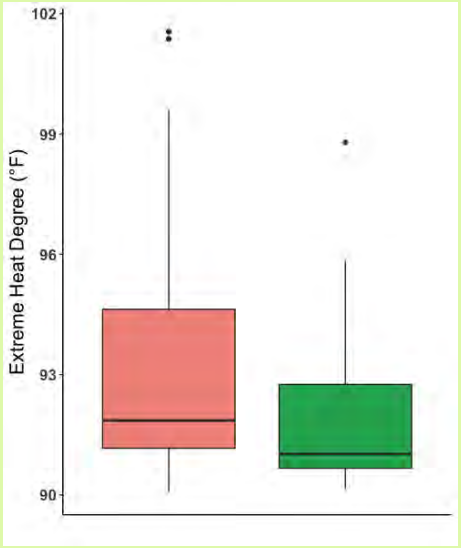
Extreme Heat

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

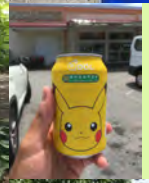
Jim Vandermillen

Bob O'Connor



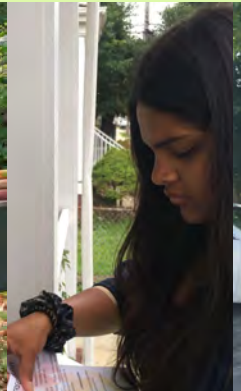






Questions?

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

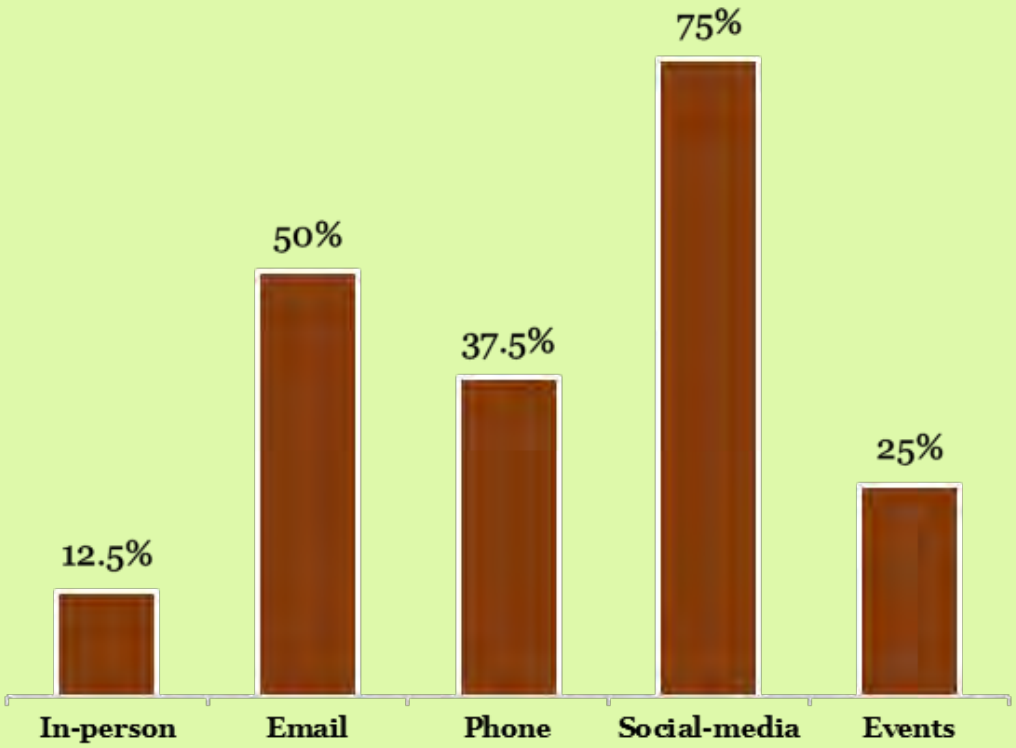
HERO team members in the field

U.S. Air Quality Index

AQI Category	Index Values	PM2.5(µg/m3) 24-hour	PM10(µg/m3) 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)

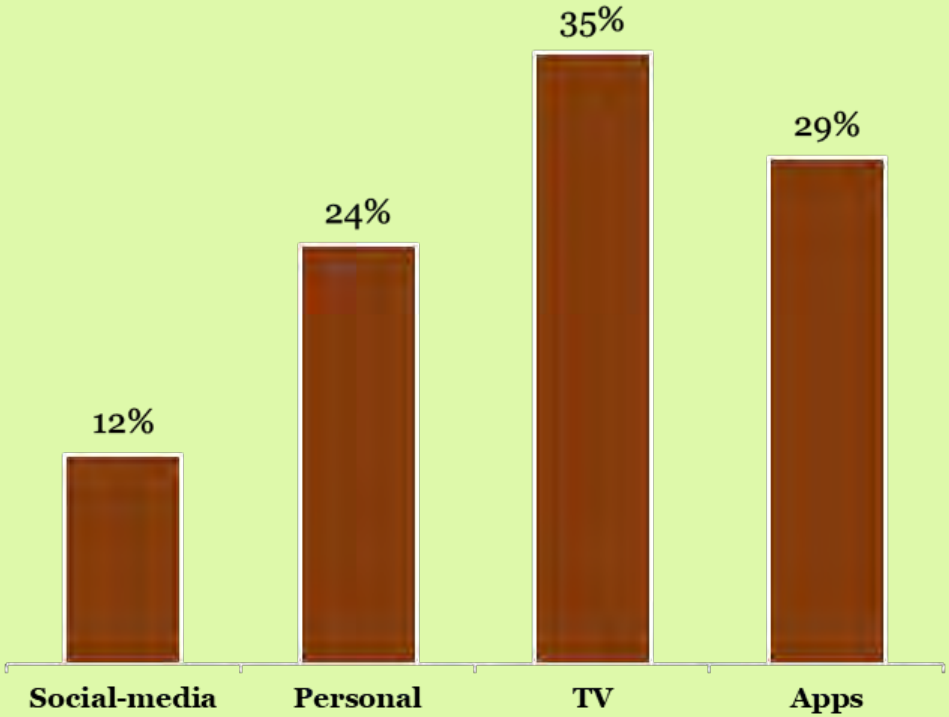
Residents' Preferred way of Communication with PVD Tree Plan

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?



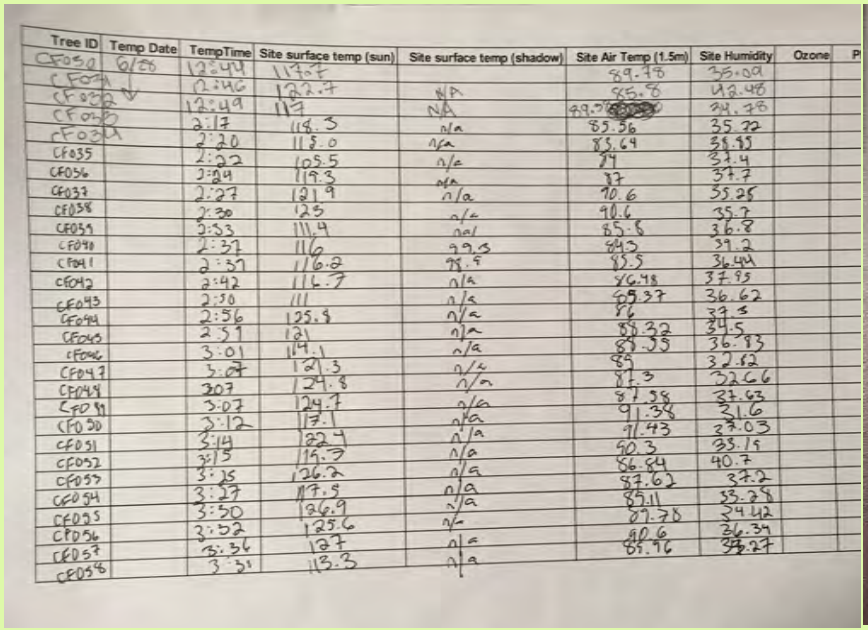
Comparison between Survey and City Demographics

	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%

*2019 ACS Data	Total Survey	All Cities Census*	Washington Park Survey	Providence Census*	Central Falls Survey	Central Falls Census*	Cumberland Survey	Cumberland Census*
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%

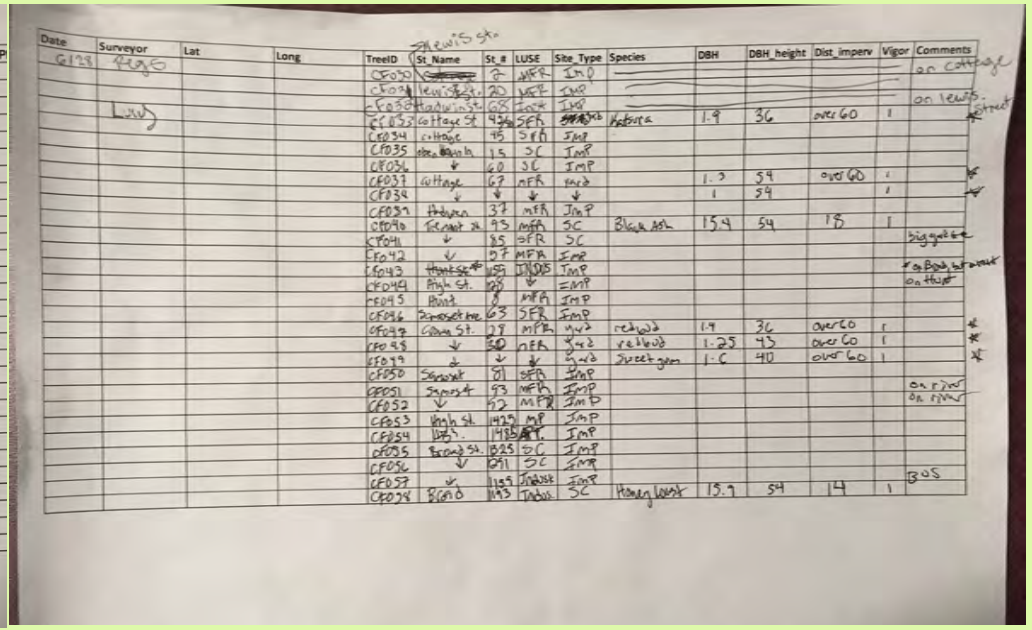
*2019 ACS Data

Tree and Temperature Survey Methods



Tree ID	Temp Date	TempTime	Site surface temp (sun)	Site surface temp (shadow)	Site Air Temp (1.5m)	Site Humidity	Ozone
CF050	6/28	12:44	117.7		89.78	35.09	
CF049		12:46	122.7	NA	85.8	48.48	
CF048		12:49	117	NA	89.78	34.78	
CF040		2:17	118.3	n/a	85.56	35.77	
CF041		2:20	118.0	n/a	85.64	38.93	
CF035		2:22	105.5	n/a	84	37.4	
CF036		2:24	119.3	n/a	87	37.7	
CF037		2:27	121.9	n/a	90.6	35.25	
CF038		2:30	125	n/a	90.6	35.7	
CF039		2:33	111.4	n/a	85.6	36.8	
CF042		2:37	116	99.3	84.3	39.2	
CF043		2:37	116.8	98.9	83.5	36.44	
CF044		2:42	116.7	n/a	86.48	37.95	
CF045		2:50	111	n/a	85.37	36.62	
CF046		2:56	125.9	n/a	86	37.5	
CF047		2:59	121	n/a	88.32	34.5	
CF048		3:01	119.1	n/a	87.55	36.83	
CF049		3:07	121.3	n/a	89	32.82	
CF050		3:07	124.8	n/a	87.3	32.66	
CF051		3:07	124.7	n/a	87.38	37.63	
CF052		3:12	117.1	n/a	91.38	31.6	
CF053		3:14	122.4	n/a	91.43	33.03	
CF054		3:15	119.3	n/a	90.3	33.19	
CF055		3:25	126.2	n/a	86.84	40.7	
CF056		3:27	117.9	n/a	87.62	37.2	
CF057		3:50	136.9	n/a	89.11	33.38	
CF058		3:52	125.6	n/a	89.78	34.42	
CF059		3:56	127	n/a	90.6	36.34	
CF060		3:31	113.3	n/a	89.96	35.27	

Air Temperature Survey Sheet

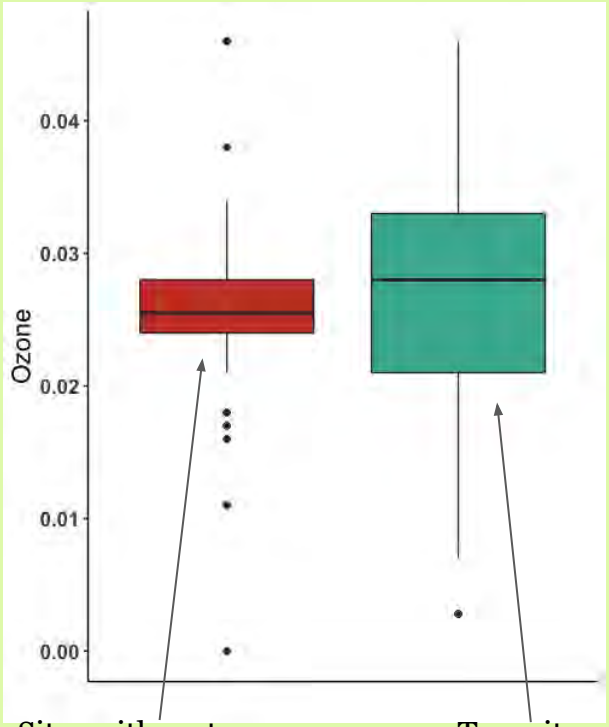


Date	Surveyor	Lat	Long	TreeID	St_Name	St_#	LUSE	Site_Type	Species	DBH	DBH_height	Dist_imperv	Vigor	Comments
6/28	Rags			CF050		8	MFR	Imp						
				CF049	Lewis St.	20	MFR	Imp						on cottage
	Lwd			CF048	Hadwin St.	65	Park	Imp						on lewis.
				CF053	Cottage St	936	SFR	Imp	Redbud	1.9	36	over 60	1	
				CF034	Cottage	95	SFR	Imp						
				CF035	Hadwin St.	15	SC	Imp						
				CF036	"	60	SC	Imp						
				CF037	Cottage	69	MFR	Park		1.3	54	over 60	1	
				CF038	"	"	"	"		1	54		1	
				CF039	Hadwin	37	MFR	Imp						
				CF040	Locust St	93	MFR	SC	Black Ash	15.4	54	18	1	
				CF041	"	85	SFR	SC						big yellow
				CF042	"	97	MFR	Imp						
				CF043	Hadwin St.	65	Park	Imp						
				CF044	High St.	108	"	Imp						
				CF045	Bond	8	MFR	Imp						
				CF046	Locust St.	63	SFR	Imp						
				CF047	Cross St.	28	MFR	Park	redbud	1.9	36	over 60	1	
				CF048	"	30	MFR	Park	redbud	1.25	43	over 60	1	
				CF049	"	"	"	Park	sweetgum	1.6	40	over 60	1	
				CF050	Locust	91	SFR	Imp						
				CF051	Locust	93	MFR	Imp						on pine
				CF052	"	92	MFR	Imp						on pine
				CF053	High St.	1429	MF	Imp						
				CF054	High St.	1435	MF	Imp						
				CF055	Locust St.	1025	SC	Imp						
				CF056	"	991	SC	Imp						
				CF057	"	1129	Indust	Imp						
				CF058	Cross	1145	Indus	SC	Honeylocust	15.9	54	14	1	BOS

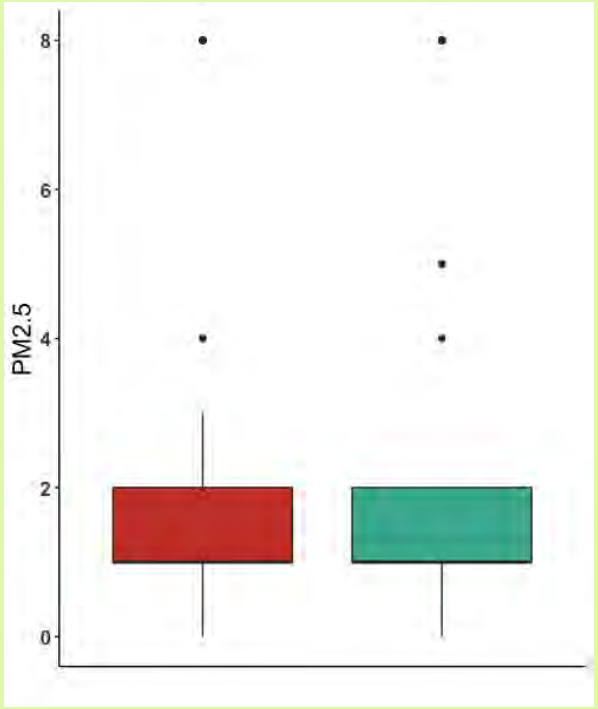
Tree Site Survey Sheet

South Providence

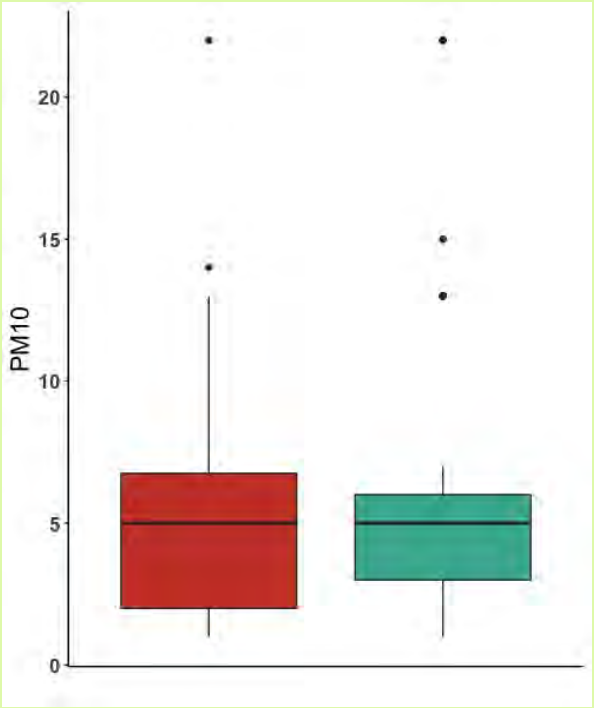
Ozone Observations



PM 2.5 Observations

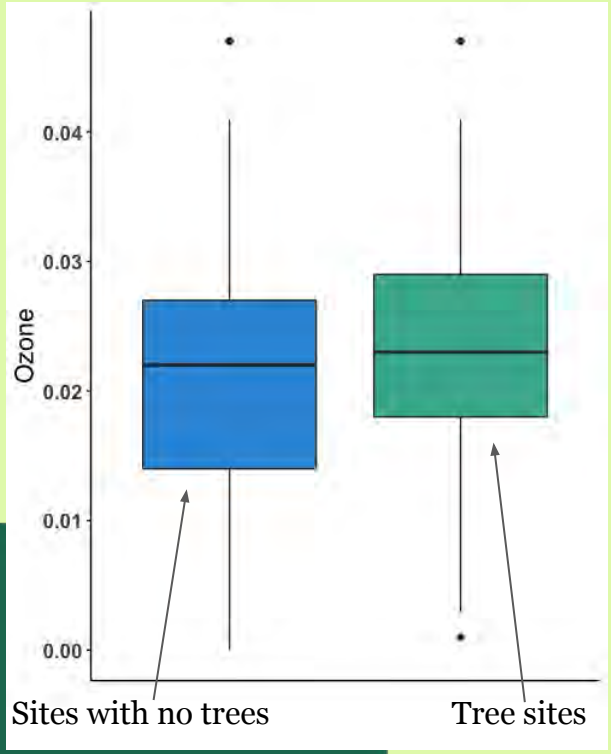


PM 10 Observations

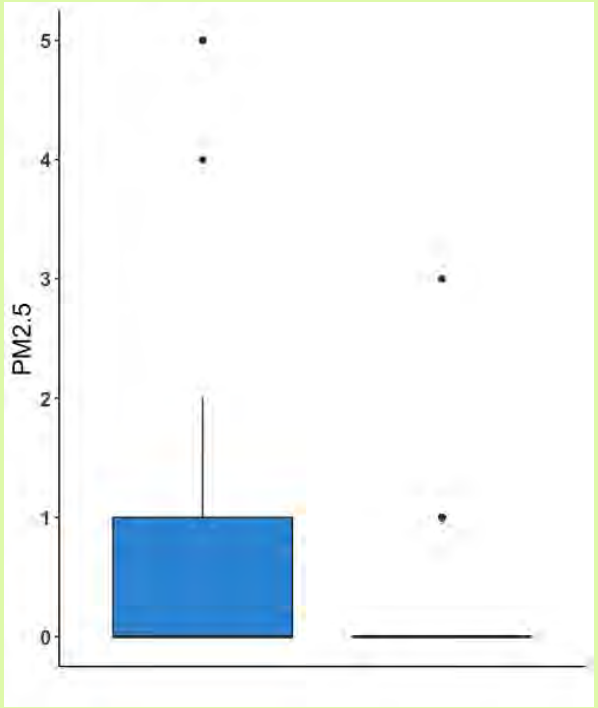


Central Falls

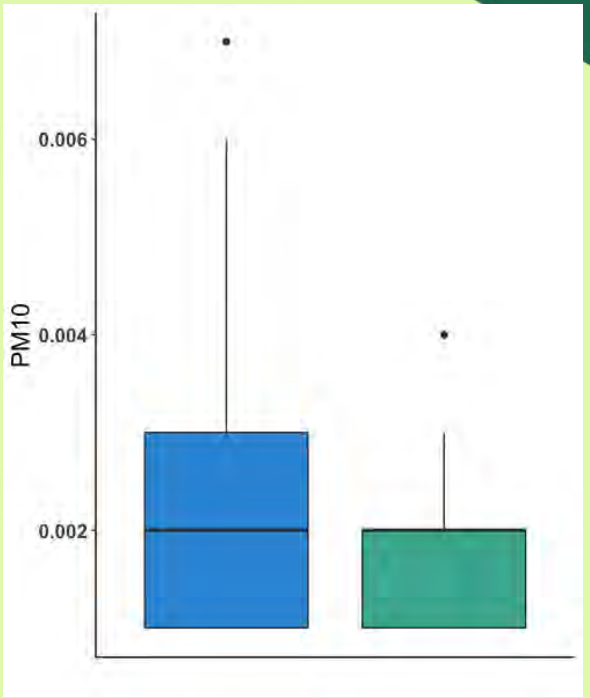
Ozone Observations



PM 2.5 Observations

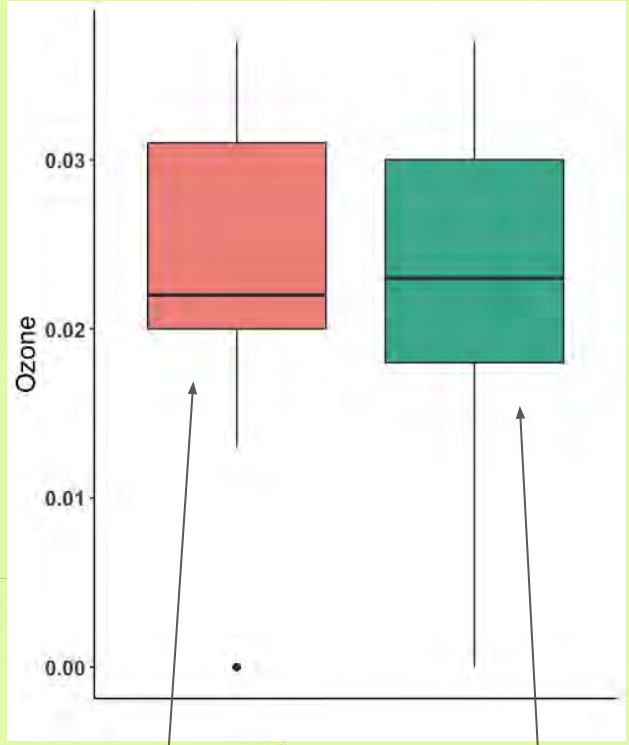


PM 10 Observations

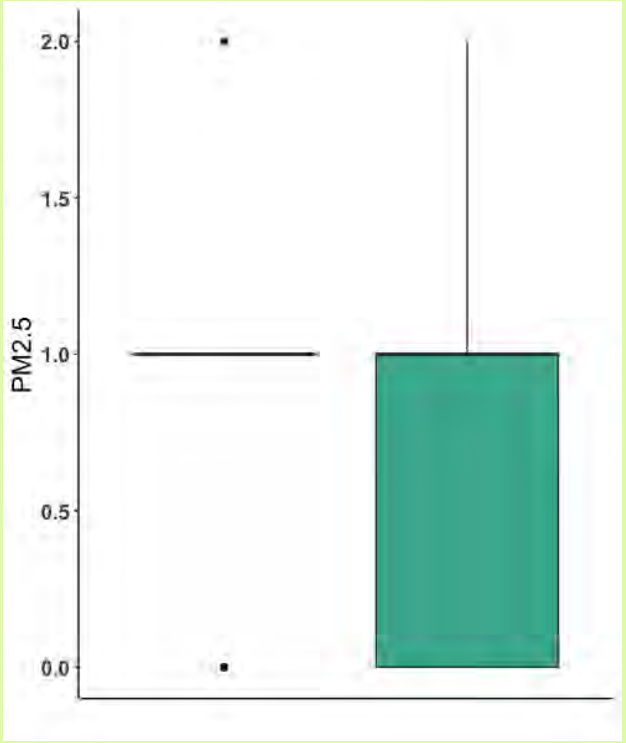


Washington Park

Ozone Observations



PM 2.5 Observations



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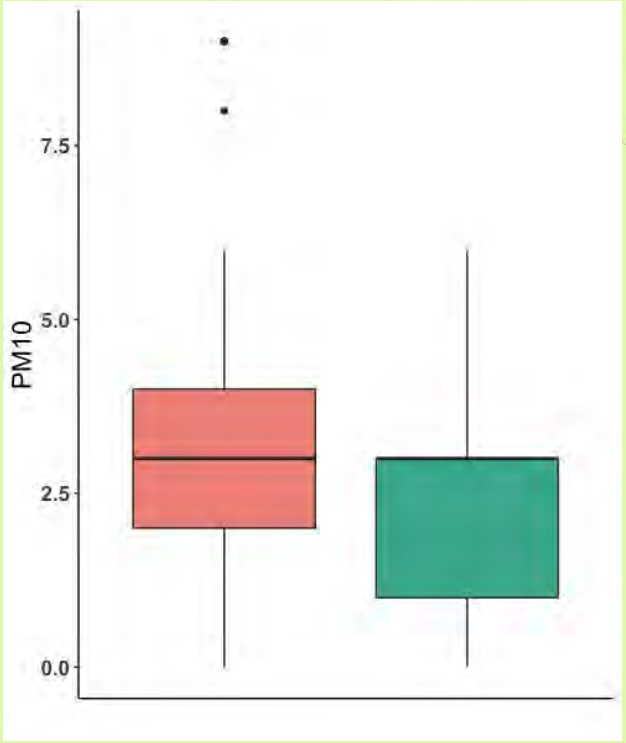
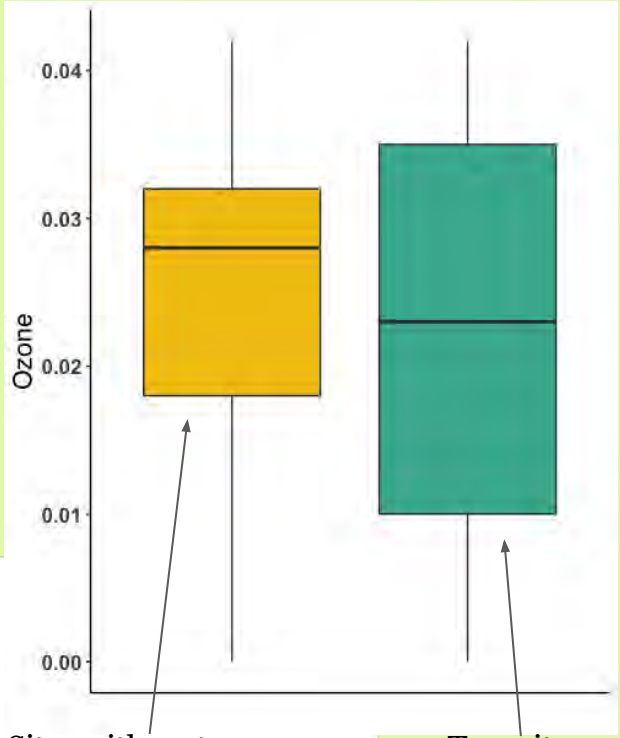


Cumberland

Ozone Observations



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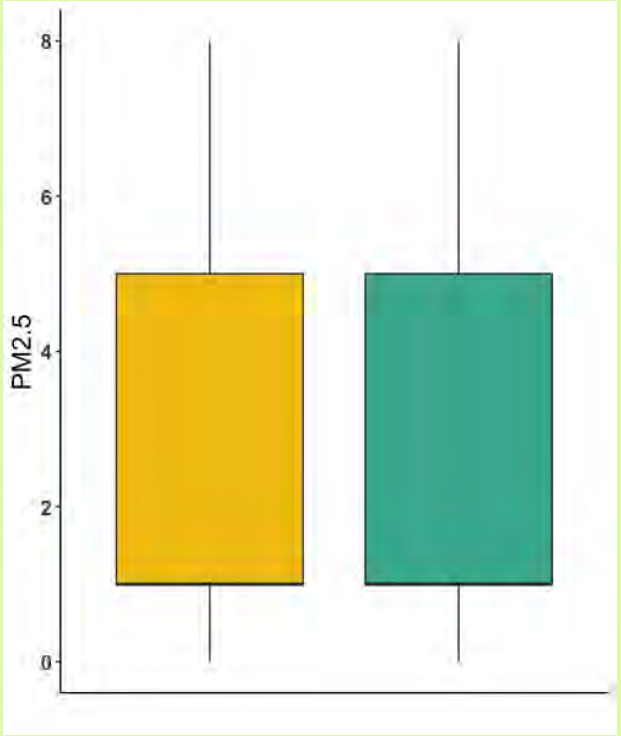
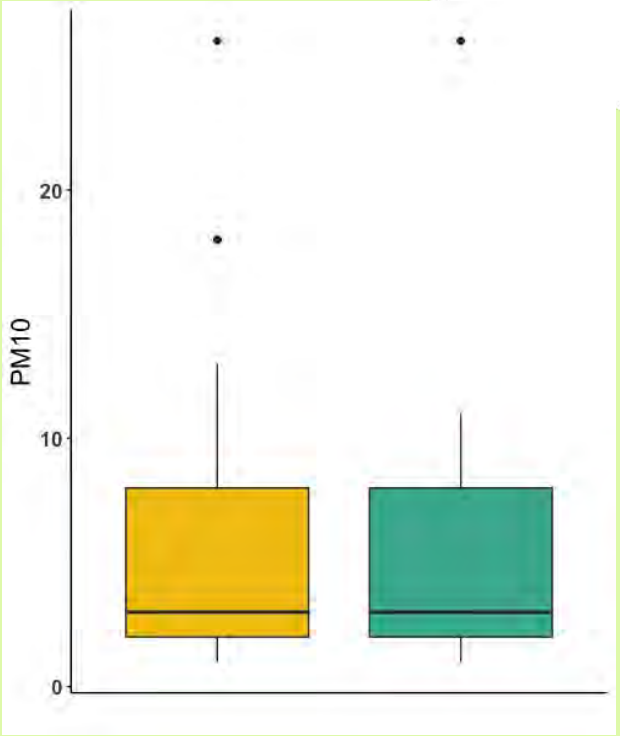
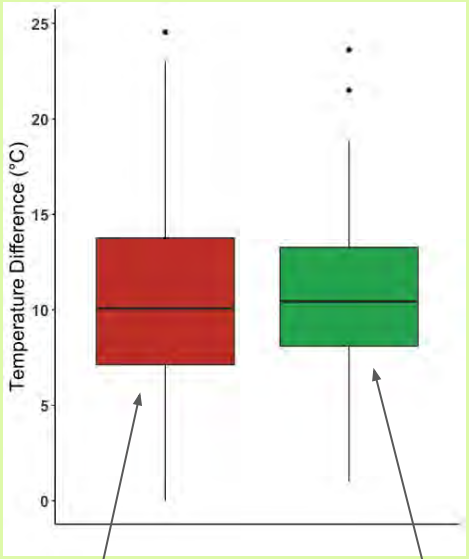


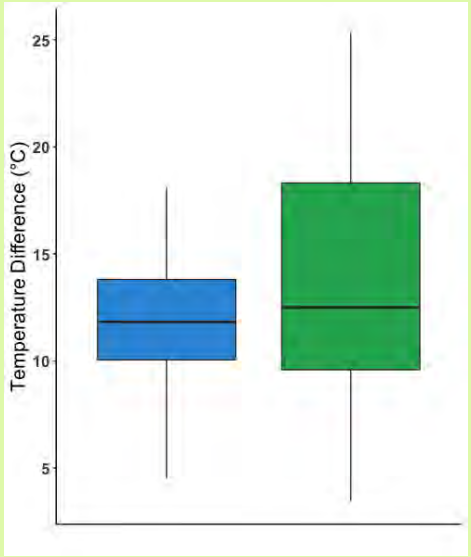
PM 10 Observations

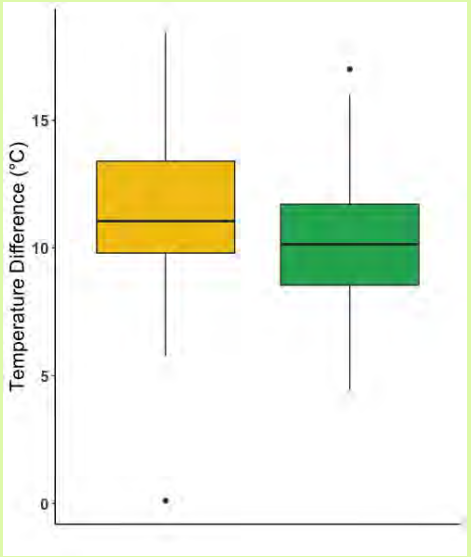


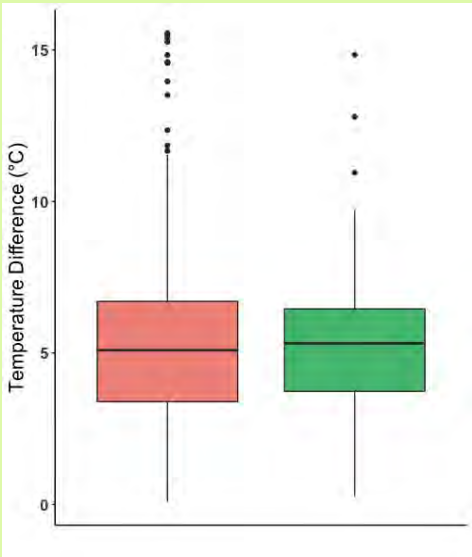
Air Temperature Difference

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.