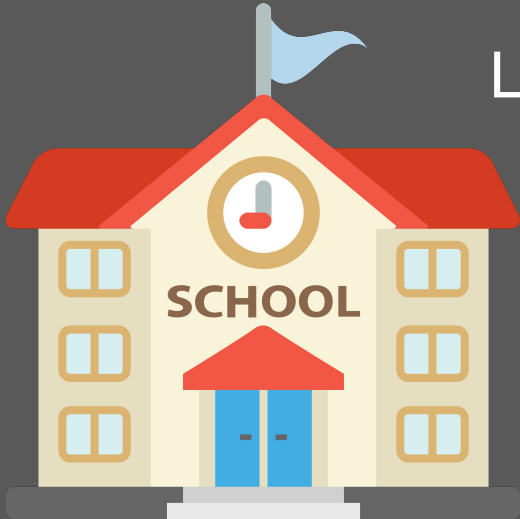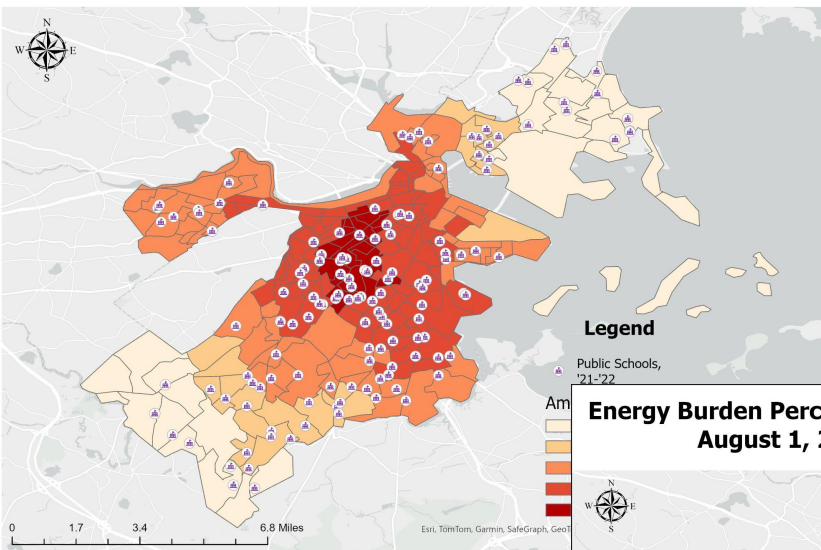# Heat and Schools in Boston:

Associations with test scores and an analysis of Boston Public Schools as potential cooling centers
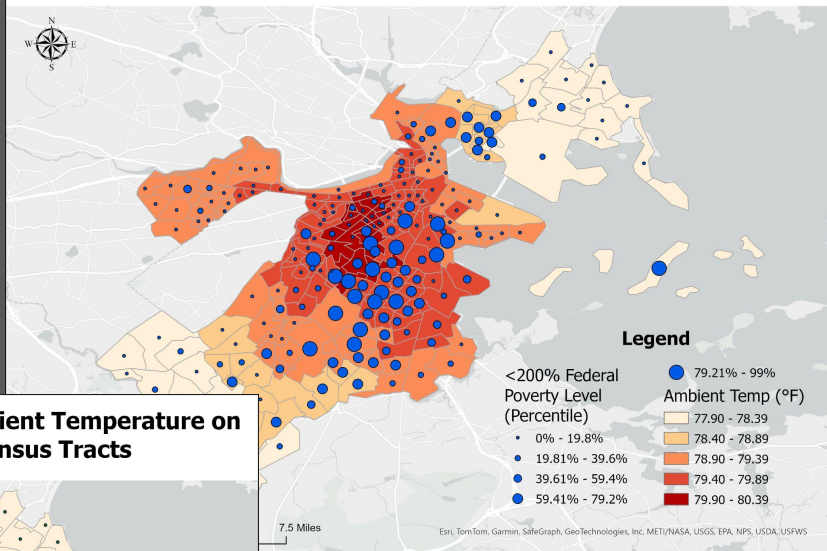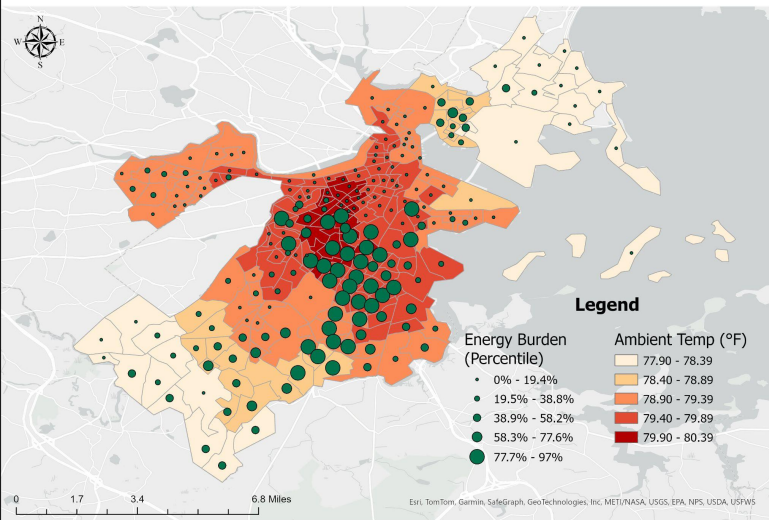
Lindsay Kastner & Grace Betts

Boston Public Schools (2021-22 School Year) and Ambient Temperature on August 1, 2022 Across Boston Census Tracts

Percent Population Below 200% Federal Poverty Level (Percentile, 2015-19) and Heat (Aug 1, 2022) Across Boston Census Tracts

Energy Burden Percentile (2018) and Ambient Temperature on August 1, 2022 Across Boston Census Tracts

Legend

Public Schools, '21-'22

Am

Legend

<200% Federal Poverty Level (Percentile)
- 0% - 19.8%
- 19.81% - 39.6%
- 39.61% - 59.4%
- 59.41% - 79.2%
- 79.21% - 99%

Ambient Temp (°F)
- 77.90 - 78.39
- 78.40 - 78.89
- 78.90 - 79.39
- 79.40 - 79.89
- 79.90 - 80.39

Legend

Energy Burden (Percentile)
- 0% - 19.4%
- 19.5% - 38.8%
- 38.9% - 58.2%
- 58.3% - 77.6%
- 77.7% - 97%

Ambient Temp (°F)
- 77.90 - 78.39
- 78.40 - 78.89
- 78.90 - 79.39
- 79.40 - 79.89
- 79.90 - 80.39

Over 1 in 3 schools in the hottest tracts are also in tracts with the highest 20% of energy burden

Over 1 in 3 schools in the hottest tracts are also in tracts in the lowest 40% of income
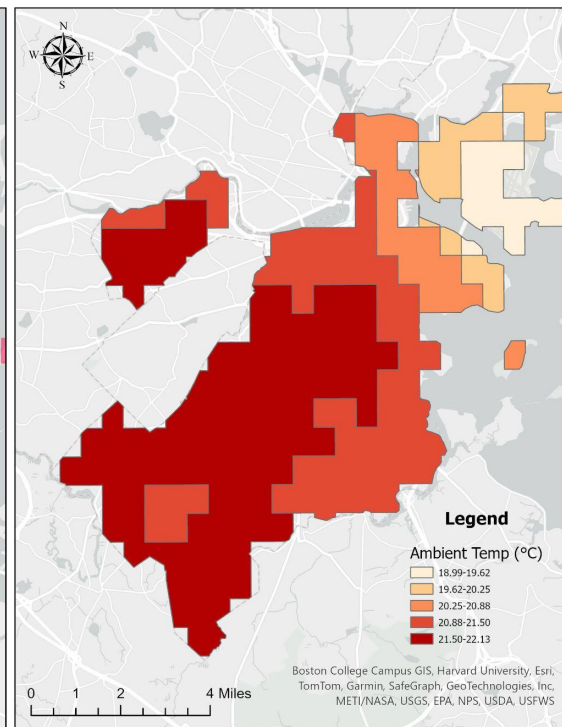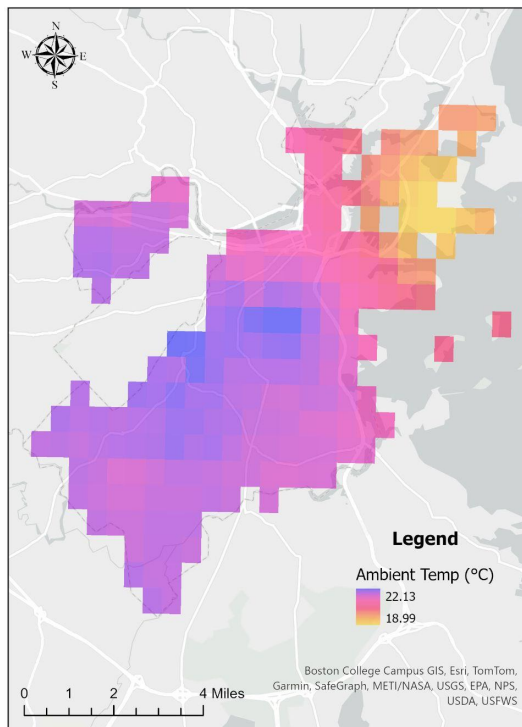
Dataset	Sources	Geographic Resolution	Geographic Extent	Type	Date
School shapefile	National Center for Education Statistics[1]	Address	U.S.	Point	2021-22 school year
School demographics & MCAS scores[2]	Massachusetts Department of Education[3]	School	Massachusetts	Excel	2024
Ambient Temperature	PRISM Climate Group[4]	800m	U.S.	Raster	Aug 18, 2022
Energy Burden	Low-Income Energy Affordability Data (LEAD) Tool via the Climate and Economic Justice Screening Tool[5]	Census tract	U.S.	Polygon	2018
Population	American Census Bureau, Decennial Census[6]	Census tract	U.S.	Polygon	2020

Ambient Temperature on August 18, 2022 Across the City of Boston, Raster to Polygon Heat Groups

Raster → Polygon

Hottest areas centered around Jamaica Plain and Roxbury.

Legend
Ambient Temp (°C)
22.13
18.99

Boston College Campus GIS, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Legend
Ambient Temp (°C)
18.99-19.62
19.62-20.25
20.25-20.88
20.88-21.50
21.50-22.13

Boston College Campus GIS, Harvard University, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Boston Public Schools

- 114 schools (with complete demographic information)
- 65 elementary schools (used in regressions)
- 71.4% low-income students
- 30% African American; 6% Asian; 0.2% Native American; 46% Hispanic; 15% White; 0.1% Native Hawaiian & Pacific Islander; 4% multi-race

Percent of Low Income Students in Boston Public Schools and Max Ambient Temperature on August 18, 2022 Across
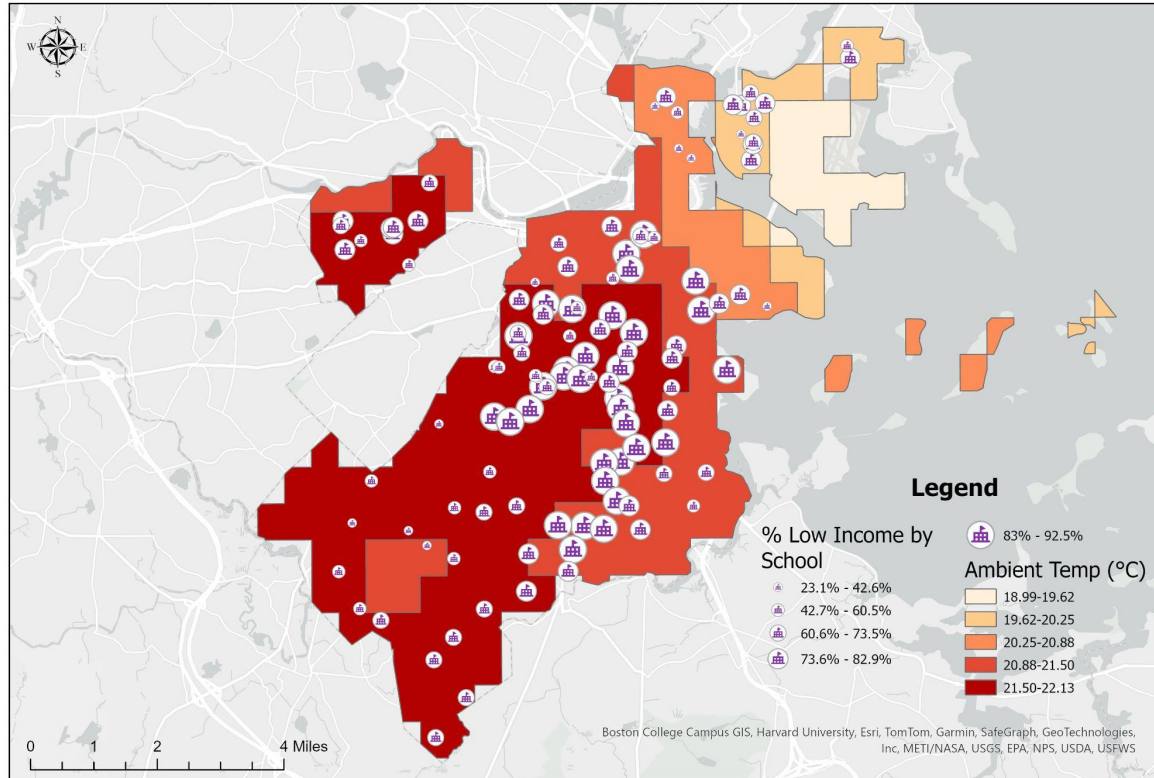
Heat Group	# of Schools	Avg % Low Income
Hottest	61	71.0 ± 16.2
	33	76.6 ± 14.9
	9	56.3 ± 25.7
	11	71.1 ± 12.8
Coolest	0	-

21/46 schools with highest % low-income students are in hottest heat group

Legend

% Low Income by School
- 23.1% - 42.6%
- 42.7% - 60.5%
- 60.6% - 73.5%
- 73.6% - 82.9%
- 83% - 92.5%

Ambient Temp (°C)
- 18.99-19.62
- 19.62-20.25
- 20.25-20.88
- 20.88-21.50
- 21.50-22.13

Boston College Campus GIS, Harvard University, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS

0   1   2   4 Miles

Is heat associated with test scores?

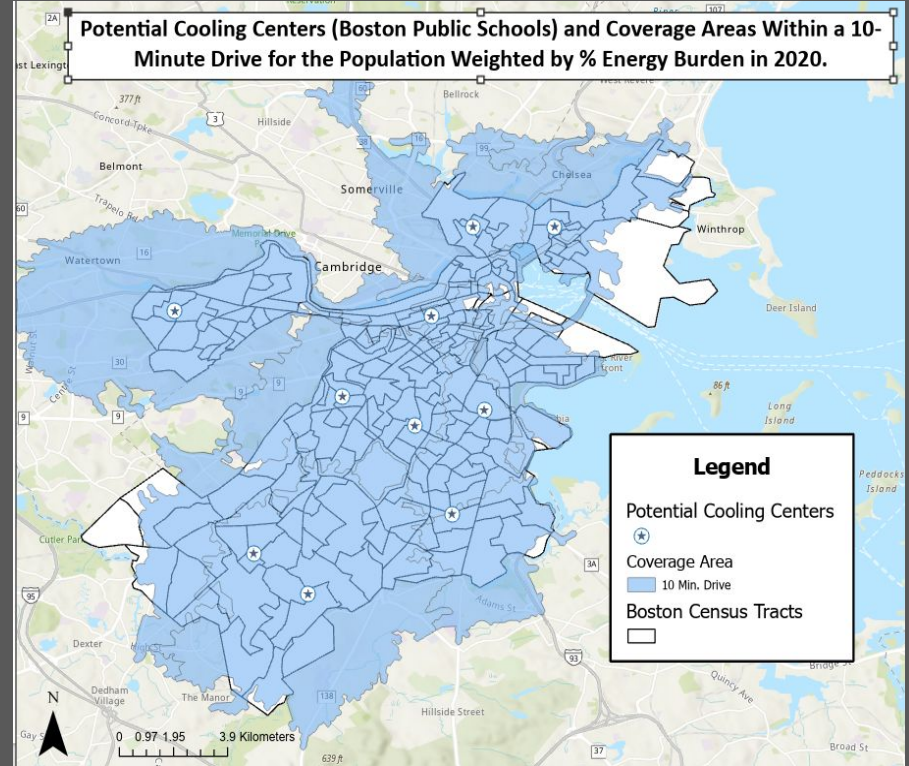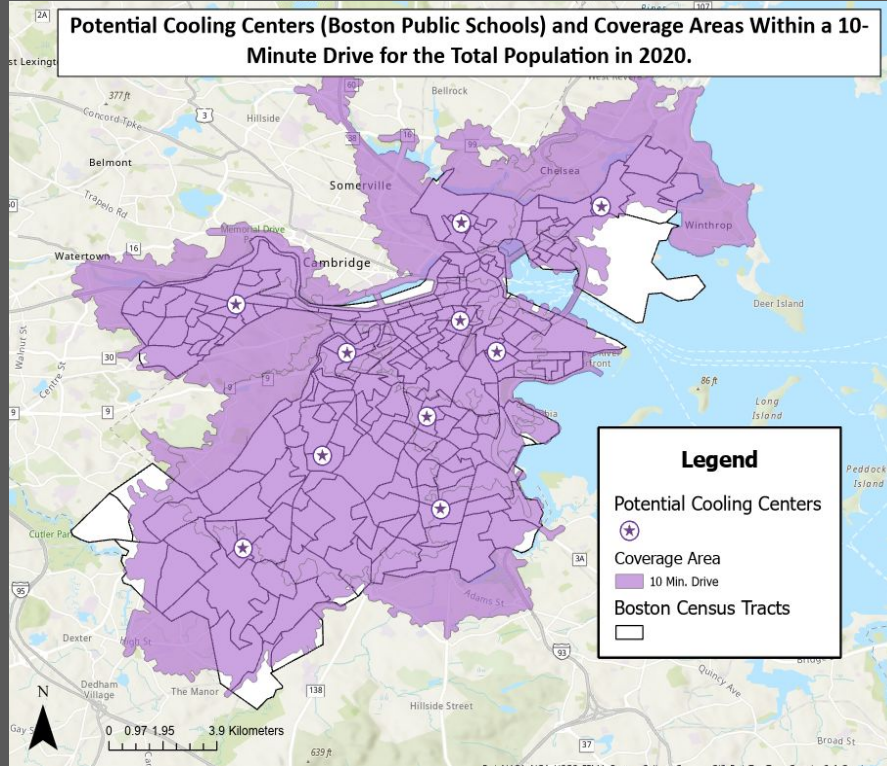|	Variable	B ± se	p
Model 1 **Adjusted R² = 0.47**	Intercept	565.88 ± 36.04	0
	Ambient Temperature	-2.42 ± 1.66	0.15
	% Low Income	-0.41 ± 0.07	<.01
	Opportunity Index	-1.82 ± 6.57	0.78
Model 2 **Adjusted R² = 0.48**	Intercept	568.20 ± 34.78	0
	Ambient Temperature	-2.53 ± 1.60	0.12
	% Low Income	-0.43 ± 0.05	0
Model 3 **Adjusted R² = -0.01**	Intercept	514.36 ± 47.57	0
	Ambient Temperature	-1.42 ± 2.23	0.53

Network Analysis

Parameters:

❖ Location-Allocation
    +   Service Area

❖ Maximize Coverage

❖ Towards Facilities

❖ 10 Facilities **Chosen**

❖ **5,000** meter Search
  Tolerance

	Coverage N (%)	Population Type
Driving Time: 10 Minutes	671,833 (99.4%)	Total (n = 675,654)
	251,727.67 (100%)	% Energy Burden (n = 251,727.67)
Walking Time: 10 Minutes	174,607 (25.8%)	Total (n = 675,654)
	95,902.41(38.1%)	% Energy Burden (n = 251,727.67)

Network Analysis: **10-Minute Driving Time**

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Drive for the Total Population in 2020.

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Drive for the Population Weighted by % Energy Burden in 2020.
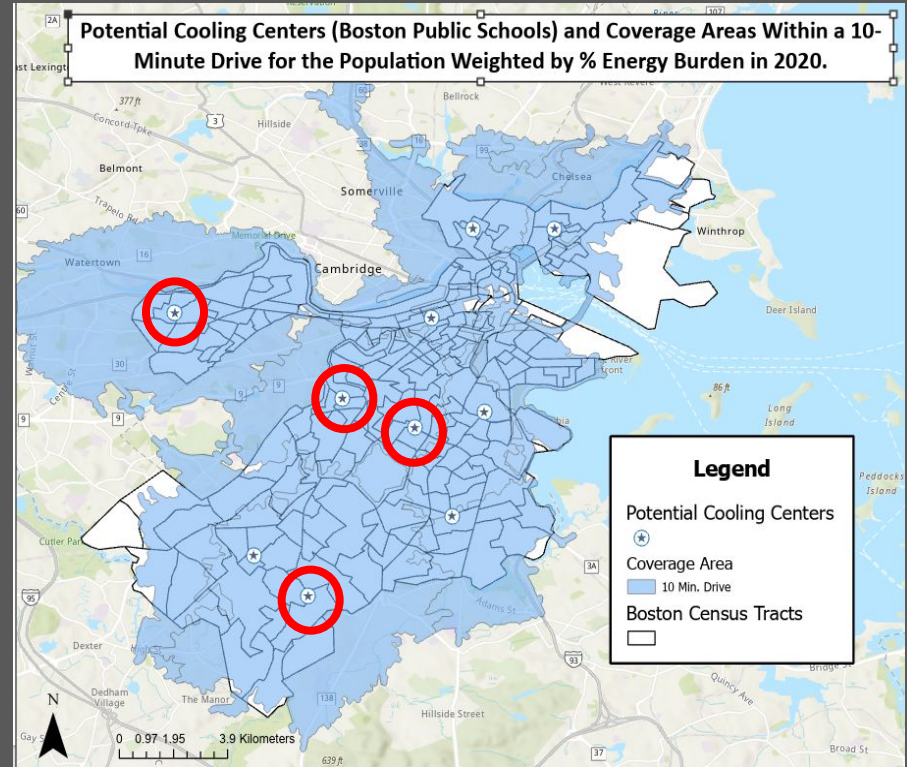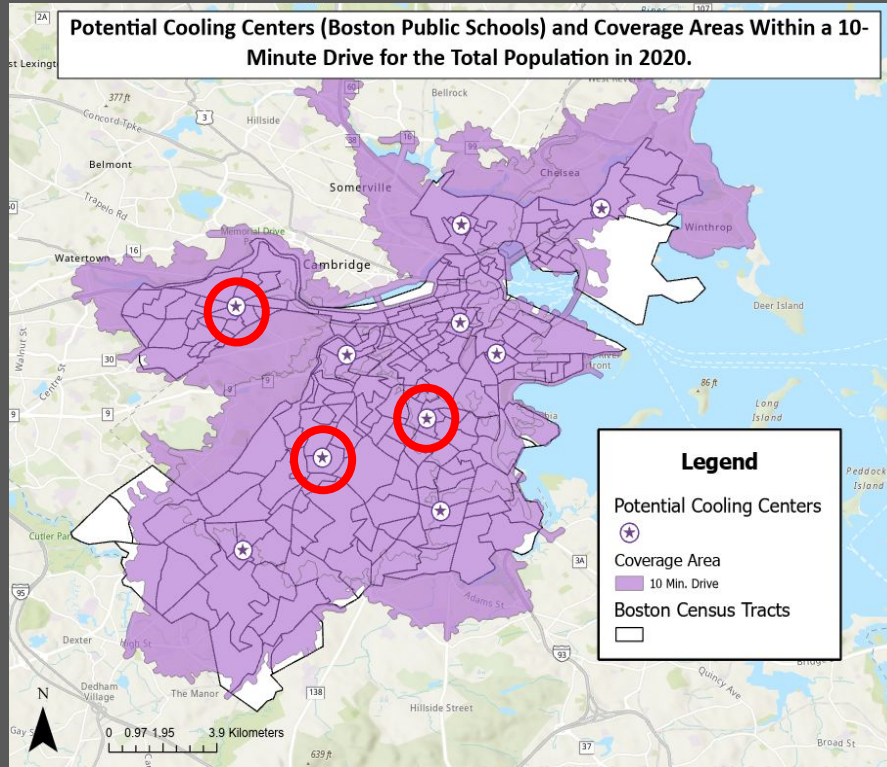
Ambient Temperature on August 18, 2022 Across the City of Boston, Raster to Polygon Heat Groups
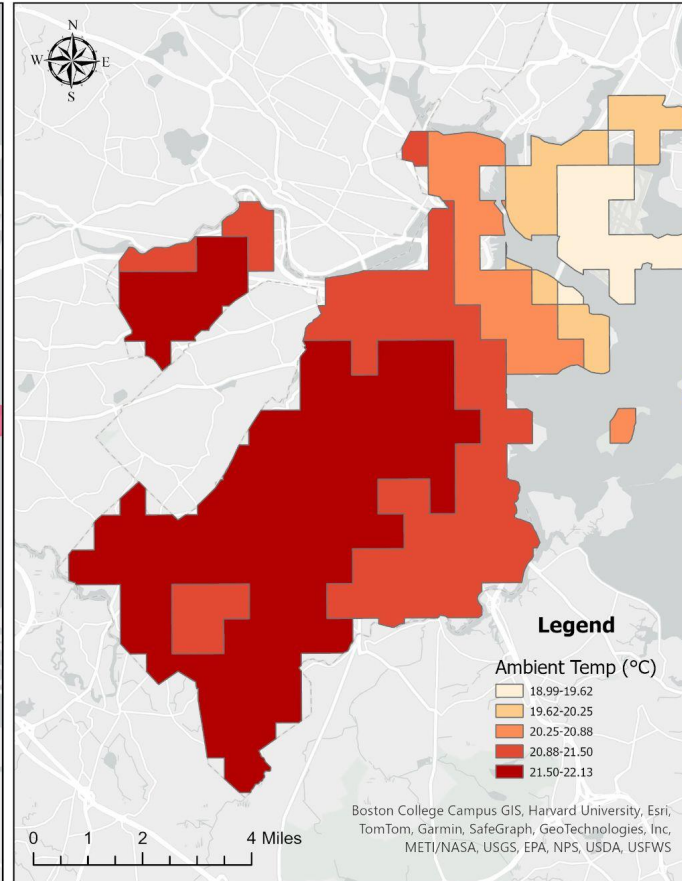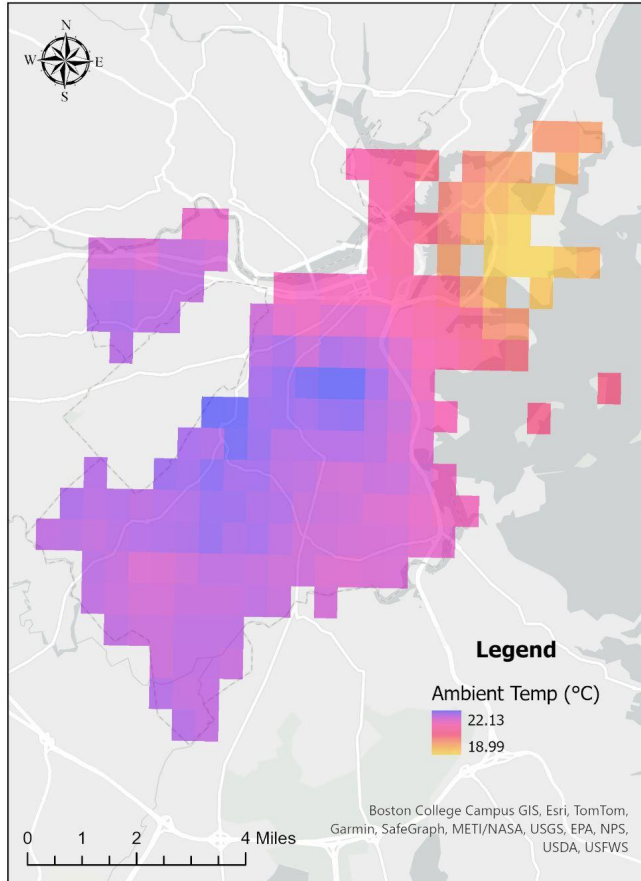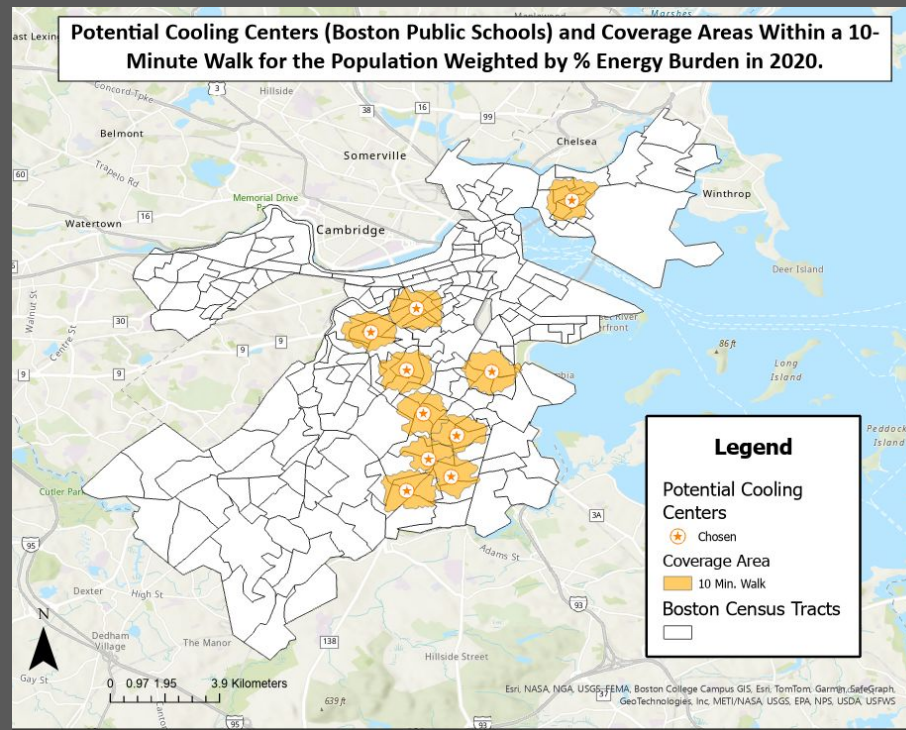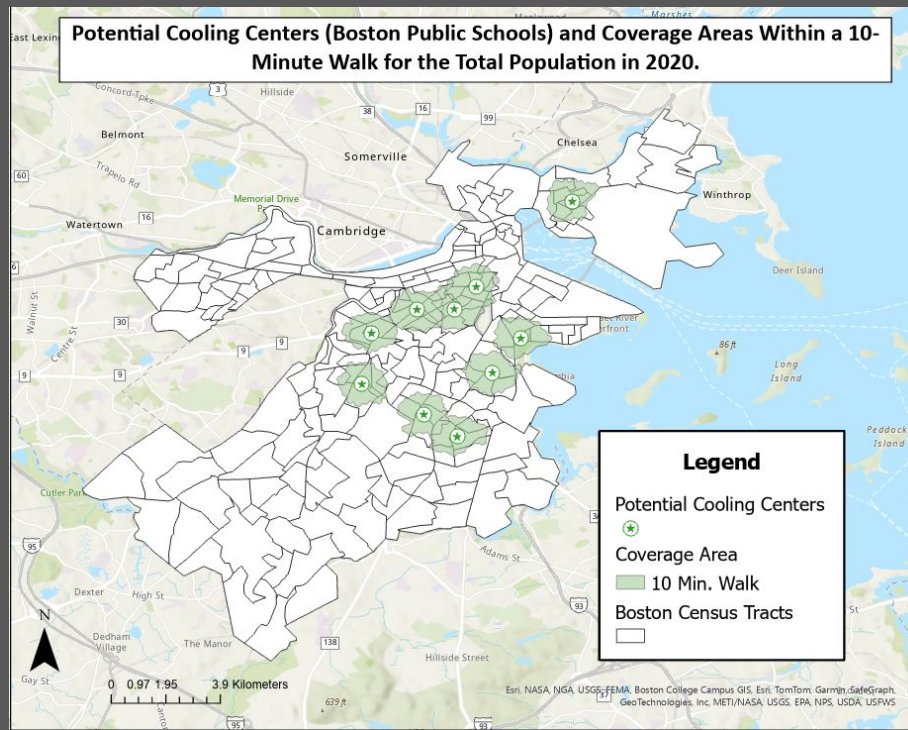
Network Analysis: **10-Minute Driving Time**

Cooling centers in the top temperature quartile indicated by red circles

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Drive for the Total Population in 2020.

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Drive for the Population Weighted by % Energy Burden in 2020.

Legend

Potential Cooling Centers

Coverage Area
10 Min. Drive

Boston Census Tracts

Network Analysis: **10-Minute Walking Time**

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Walk for the Total Population in 2020.

Potential Cooling Centers (Boston Public Schools) and Coverage Areas Within a 10-Minute Walk for the Population Weighted by % Energy Burden in 2020.

Ambient Temperature on August 18, 2022 Across the City of Boston, Raster to Polygon Heat Groups

Legend

Ambient Temp (°C)

22.13
18.99

Boston College Campus GIS, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Legend

Ambient Temp (°C)

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Boston College Campus GIS, Harvard University, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS

0 1 2   4 Miles

Network Analysis: **10-Minute Walking Time**

Cooling centers in the top temperature quartile indicated by red circles
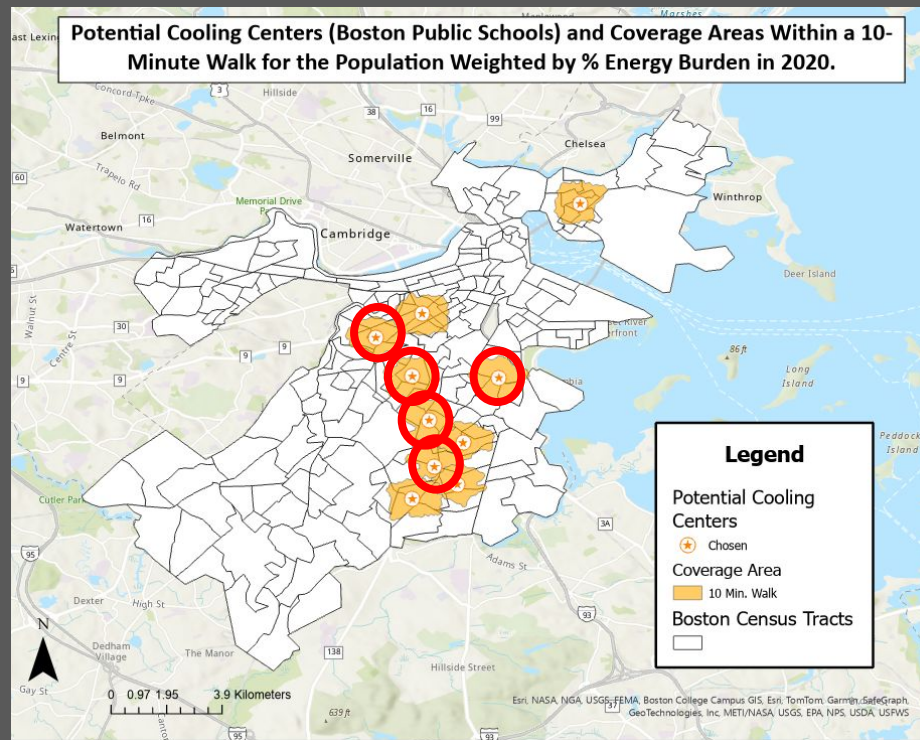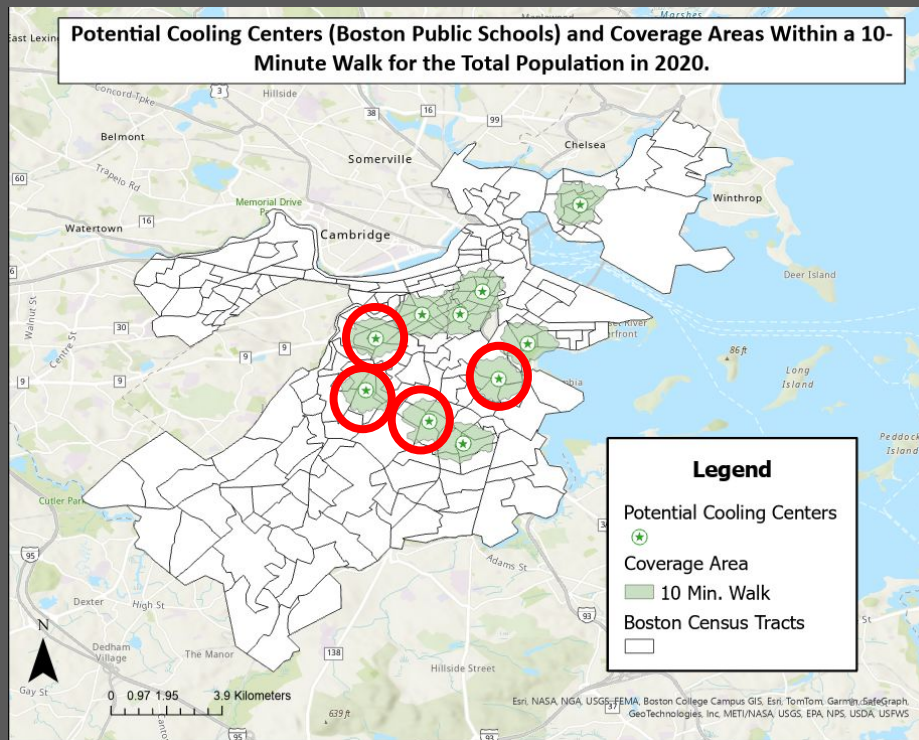
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