MEASURING ACCESS TO IMPROVE PUBLIC HEALTH PHASE II

INNOVATION WEBINAR
22 OCTOBER 2025

Project Team

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MassDOT

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Outline

- **Project Scope**
- **Access Metrics**
  - Walking and Walkability
  - Biking and Level of Traffic Stress (LTS)
  - Transit and Microtransit
- **Access and Demographics**
- **Access and Public Health**
- **Conclusions**

Project Objectives

1. To develop methods to account for transportation modes and services (such as walkability, bikeability, and microtransit service) the quality and connectivity of transportation infrastructure in metrics of access based on travel time and/or cost.

2. To present metrics of access and equity that account for the locations of vulnerable or disadvantaged populations and how these align with the transportation system.

3. To identify metrics and tools that serve for planning transportation infrastructure and services that provide access to critical locations associated with public health.

4. To recommend metrics and analyses that can be reproduced with available data to be incorporated into a data dashboard or tool that supports ongoing planning and investment decisions.

Overall Approach to Measuring Access

Transportation Network

- Road Network
- Fixed Route Transit (GTFS)

Critical Destinations

- Food Retailers
- Healthcare (Urgent Care, ER, Community Health Centers)
- Colleges and Technical Schools
- Recreation/Parks

Spatial Analysis

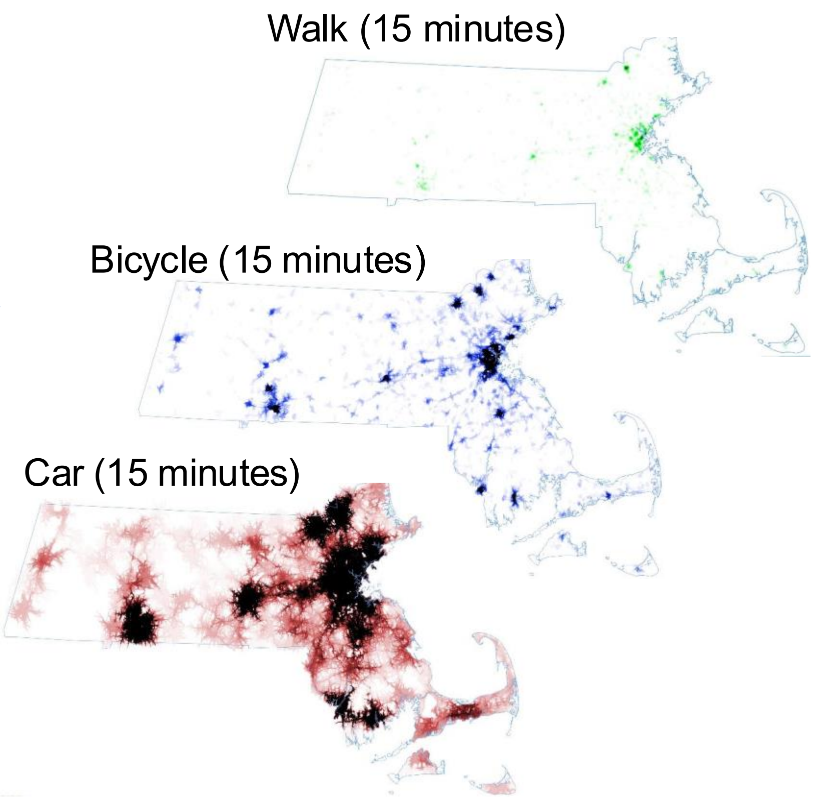
conveyal

Reachable destinations by

- Walk
- Bicycle
- Fixed Route Transit
- Car

Statewide Maps of Access

e.g., Food Retailers



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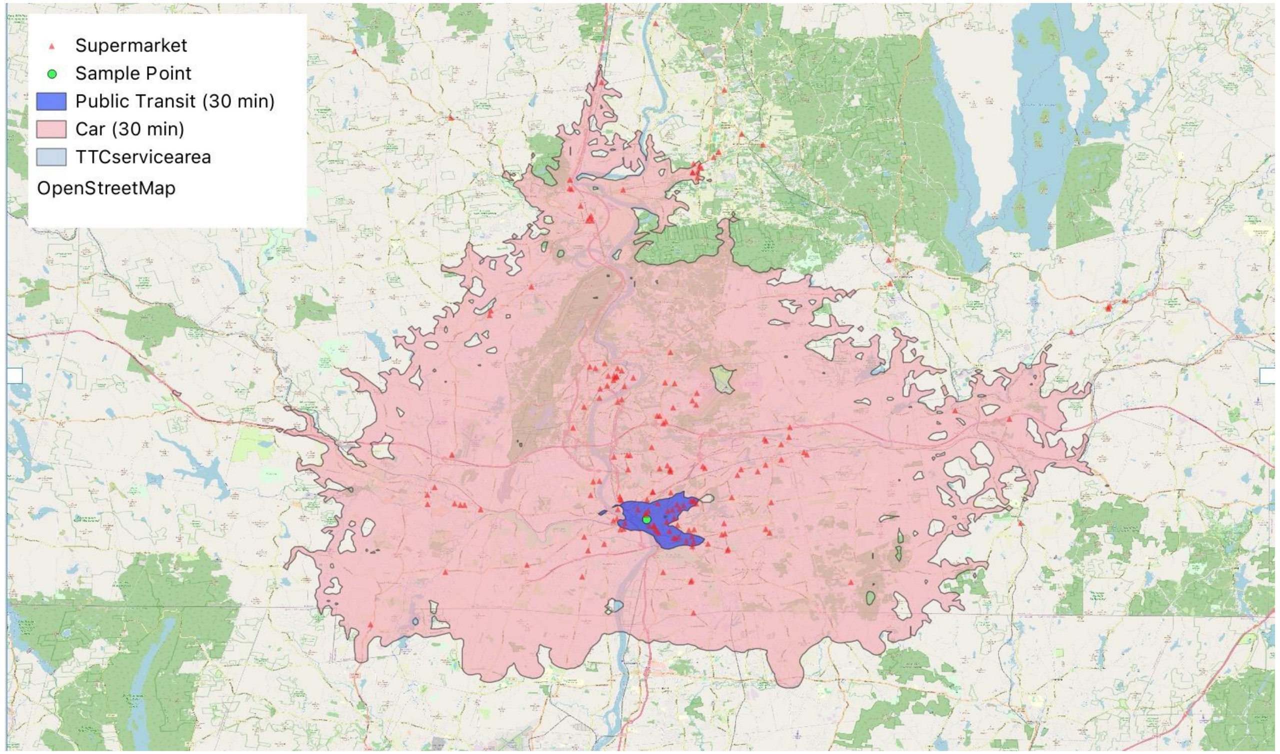
Overall Approach to Measuring Access

Access is measured by the number of destinations that can be reached within an isochrone.



Springfield, Massachusetts
Wednesday, 2/8/2023, 7am-9am

30 min. by car → 160 supermarkets

30 min. by transit (50th percentile) →
31 supermarkets

Access to Critical Destinations

The methods developed for measuring food access can be applied to any set of destinations.

Food Access
Food Retailers (supermarkets)
MAPC Healthy Food Access Data (www.mapc.org/our-work/expertise/public-health/healthy-food-access)

Healthcare Providers
Urgent Care & Community Health Centers
MassGIS Urgent Care Centers and Retail Clinics (https://www.mass.gov/info-details/hpc-datapoints-issue-8-urgent-care-centers-and-retail-clinics)

Higher Education
Community Colleges, Technical and Vocational Schools
MassGIS Colleges and Universities (www.mass.gov/info-details/massgis-data-colleges-and-universities)

Recreation
Parks and Recreation Areas
MassGIS Protected and Rec. Open Space(https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace#downloads)

Access Metric for Walkability

Walking access should account how safe and comfortable a community is for walking.

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Access Metric for Walkability

Comparing literature on determinants of walkability and data sources for scoring it, US EPA's **National Walkability Index (NWI)** provides a consistent metric across all census block groups

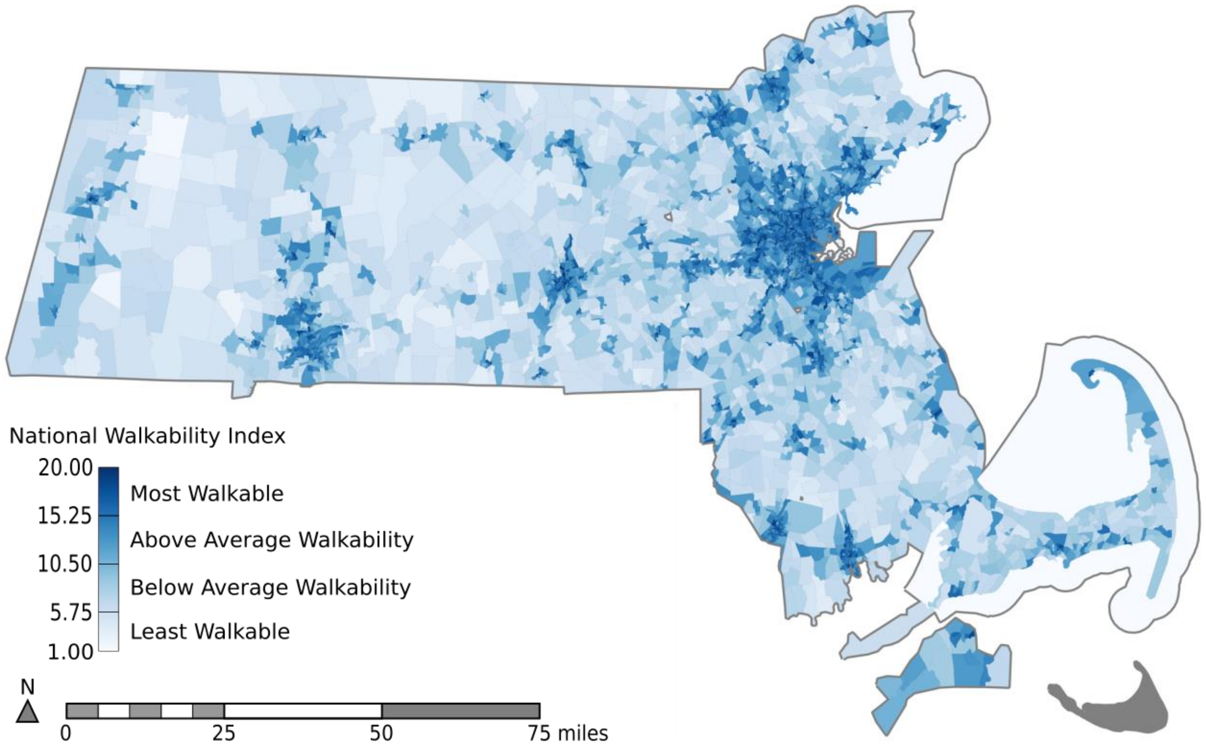
$$NWI = \frac{w}{3} + \frac{x}{3} + \frac{y}{6} + \frac{z}{6}$$

with 4 weighted components, based on ranking into 20 quantiles:

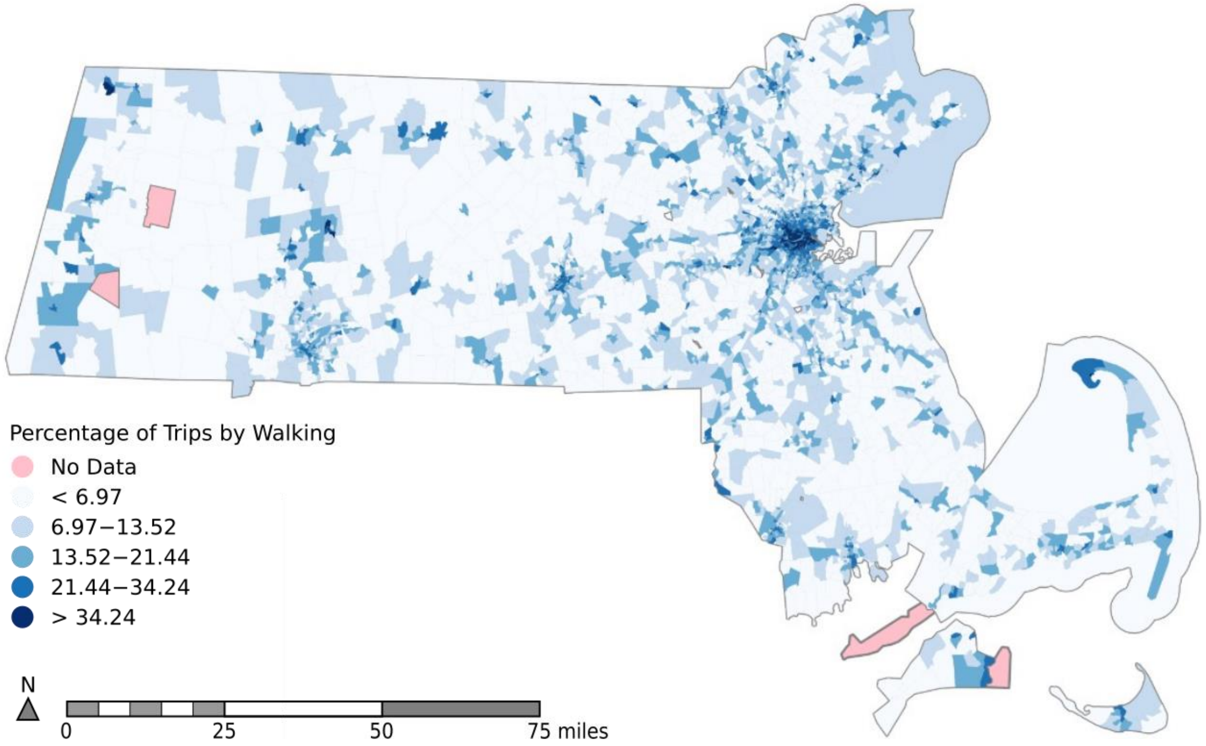
- w ranked intersection density
- x ranked proximity to transit
- y ranked employment mix
- z ranked employment and household mix

Access Metric for Walkability

National Walkability Index (NWI)



Walk Mode % (from Replica)

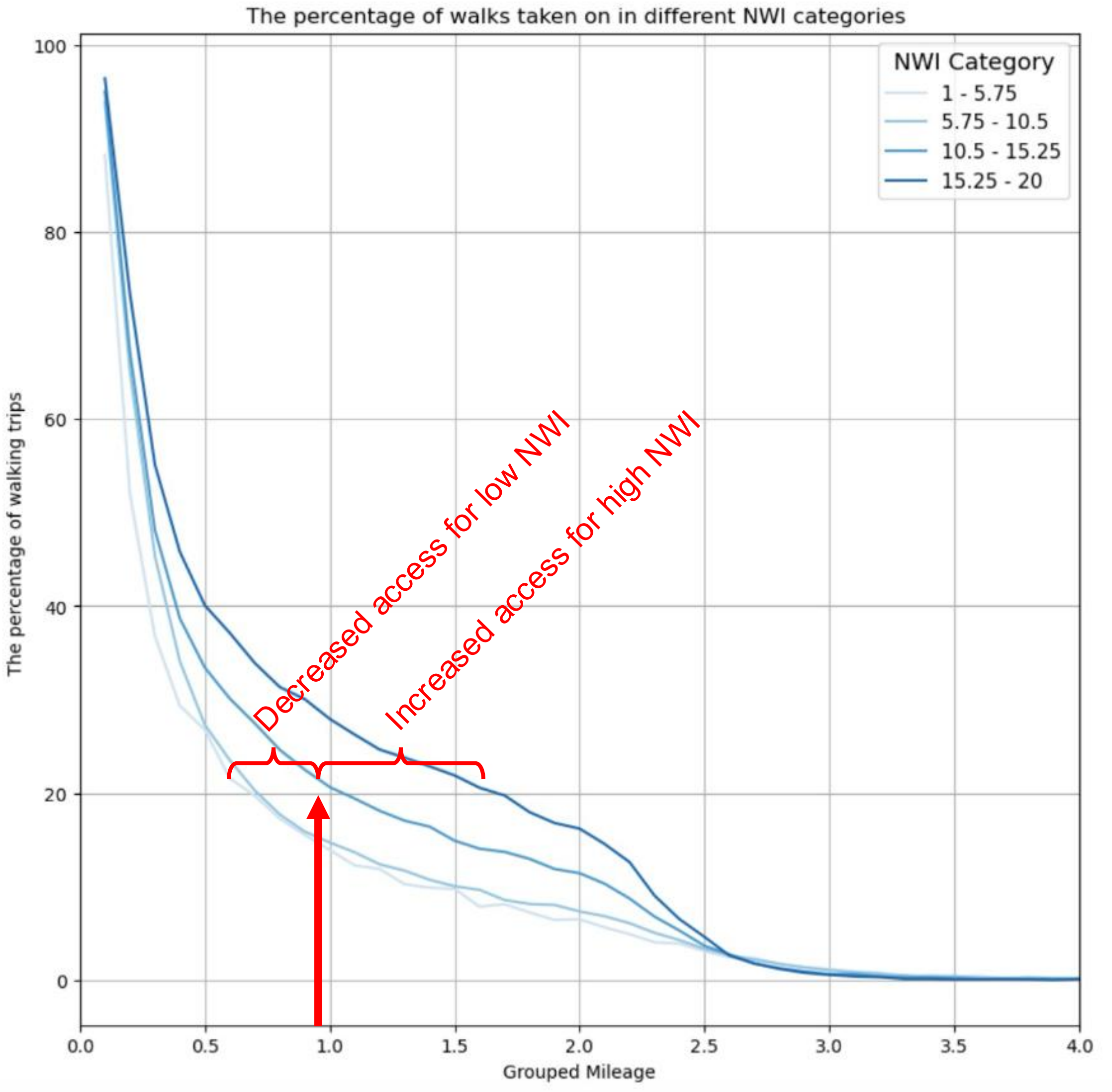


Access Metric for Walkability

Walk Mode %in MA by Distance
Separated by NWI

- At the average NWI in Massachusetts of 11.27, 1-mile trips have walk mode share of 20%.
- At lower NWI, 20% mode share corresponds to only 0.65 miles.
- At higher NWI, 20% mode share corresponds to 1.6 miles.

The accessible distance by walking is scaled proportionally.



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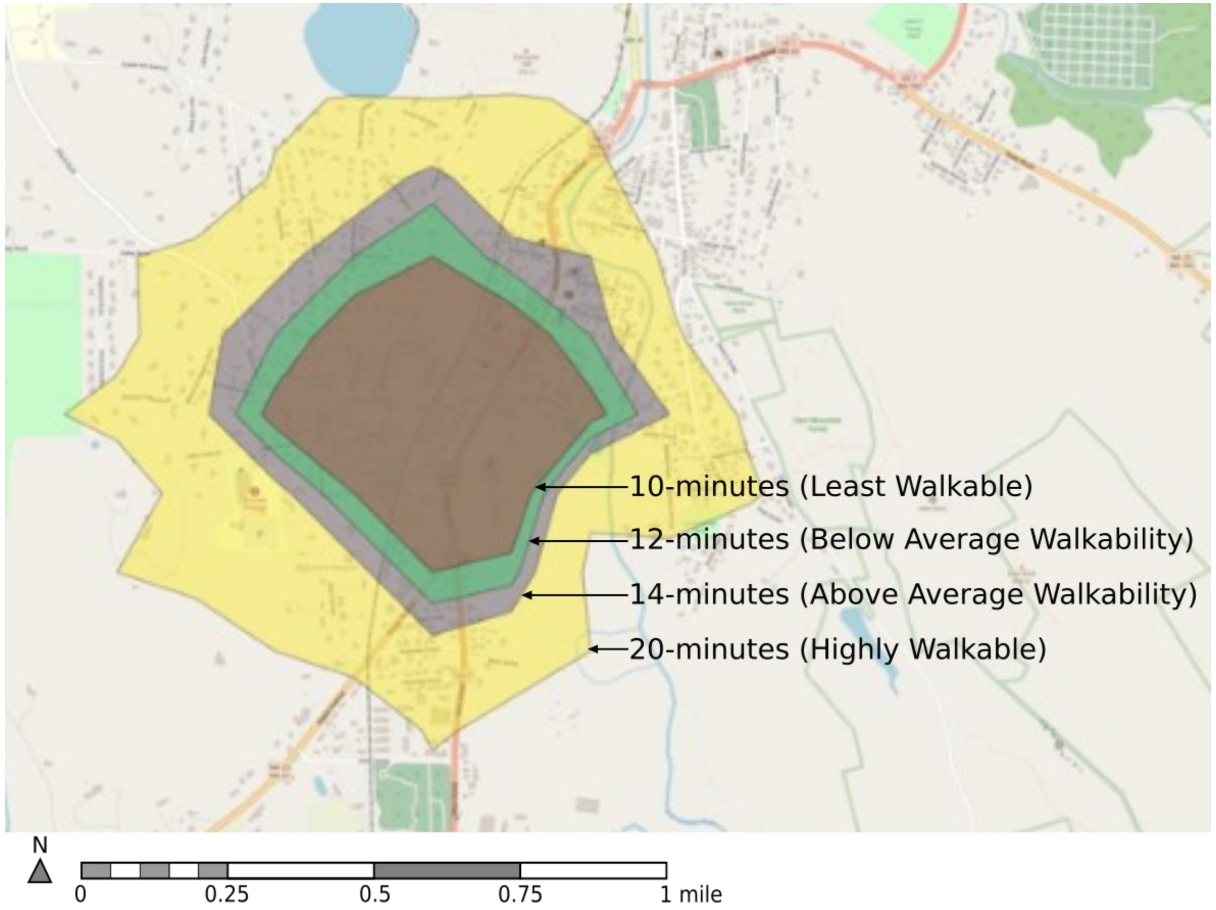
Access Metric for Walkability

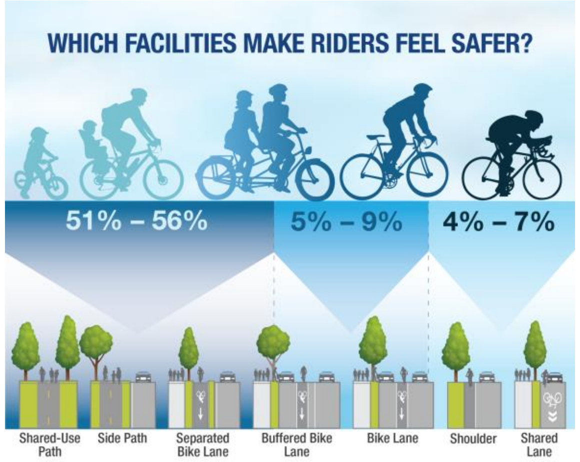
Example **Great Barrington, MA**

Adjusting effective travel time limit for walkability changes the reachable area within which destinations are counted.



Access Metric for Biking

Bicycle access should account for the streets and paths that people feel comfortable using.



Source: FHWA Bikeway Selection Guide

Level of Traffic Stress (LTS) classifies streets based on size, speed, traffic volume, and bicycle infrastructure to determine which groups are likely to feel comfortable. (Furth et al., 2016)

Level	Rider Type (Geller, 2006)	Infrastructure
LTS 1	Unlikely rider (31%)	Physically separated from traffic or very low-speed traffic with only occasional interactions with motor vehicles
LTS 2	Interested but concerned (56%)	Either physically separate of exclusive bicycle zone (e.g., bike lane) beside a well-confined traffic stream
LTS 3	Enthused and confident (9%)	Mixed traffic, requiring regular negotiation with low-speed vehicles, or a bike lane in close proximity to faster traffic
LTS 4	Strong and fearless (4%)	Requires riding near higher speed traffic or regularly negotiating with moderate-speed vehicles

Access Metric for Biking

Each link from the Road Inventory (2024) and Bike Inventory (2024) is classified based on LTS v2.2 definitions. (Furth, 2022)

1. Fully separated bike path → LTS 1
2. Separated bike lane → LTS 2
3. Roads with conventional bike lanes → Table 2.3
4. Roads without bike lanes → Table 2.4

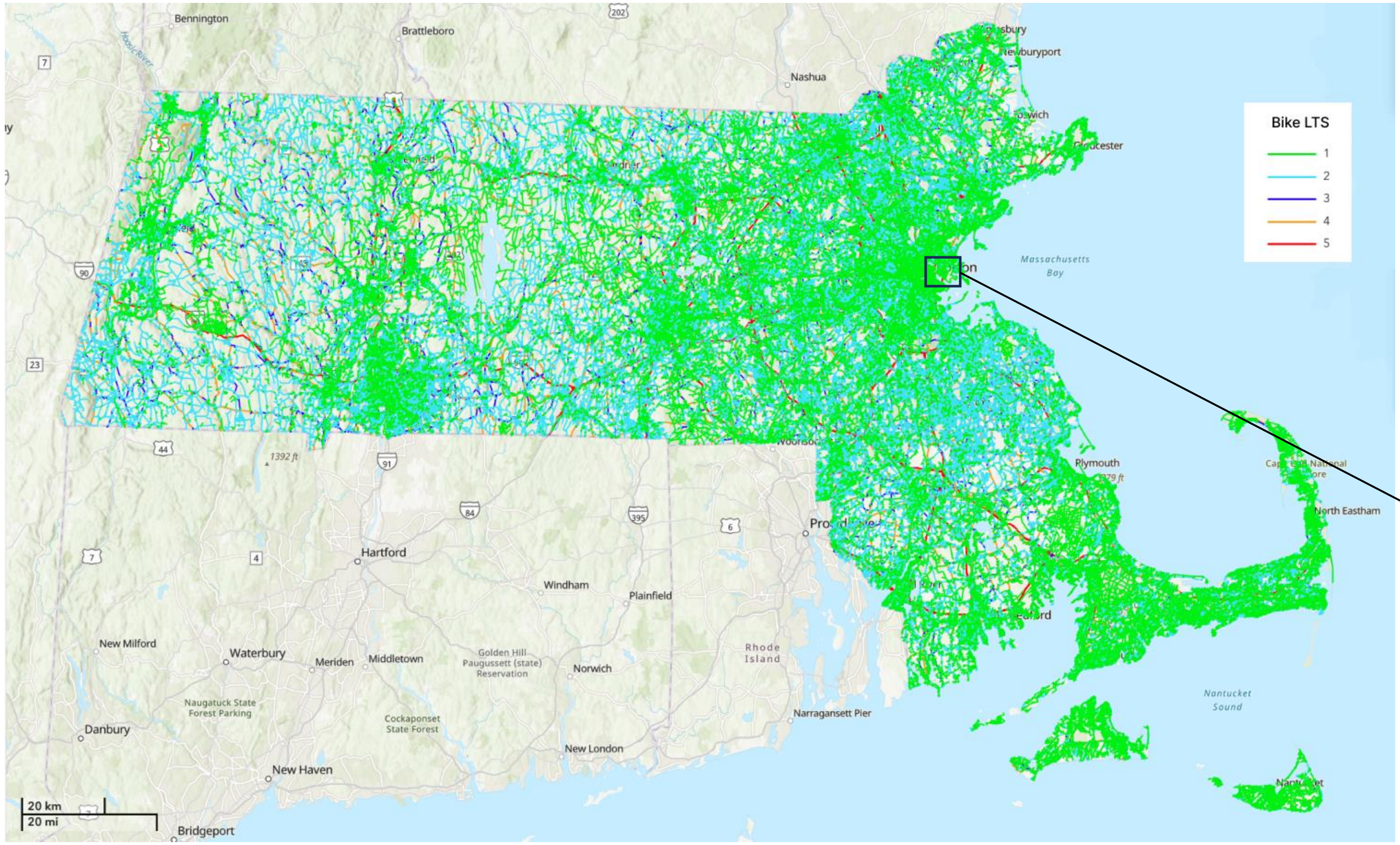
Table 2.3 LTS for Roads with Bike Lanes

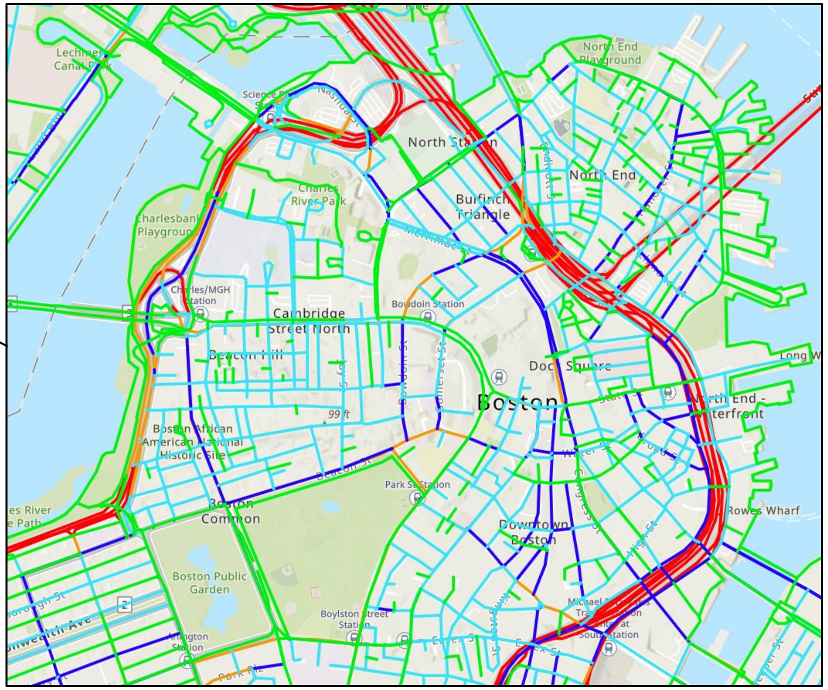
# Lanes	AADT	Speed Limit (mph) ≤ 25	30	35	40	45+
1 thru lane per direction or contraflow	≤ 1500	1	1	2	3	3
1 thru lane per direction or contraflow	> 1500	2	2	2	3	3
2 thru lanes per direction		2	2	2	3	4
3+ lanes per direction		3	3	3	4	4

Table 2.4 LTS for Roads without Bike Lanes

# Lanes	AADT	Speed Limit (mph) ≤ 25	30	35	40	45+
1 thru lane per direction or contraflow	≤ 1500	1	1	2	3	3
1 thru lane per direction or contraflow	> 1500	2	2	2	3	3
2 thru lanes per direction		2	2	2	3	4
3+ lanes per direction		3	3	3	4	4

Access Metric for Biking

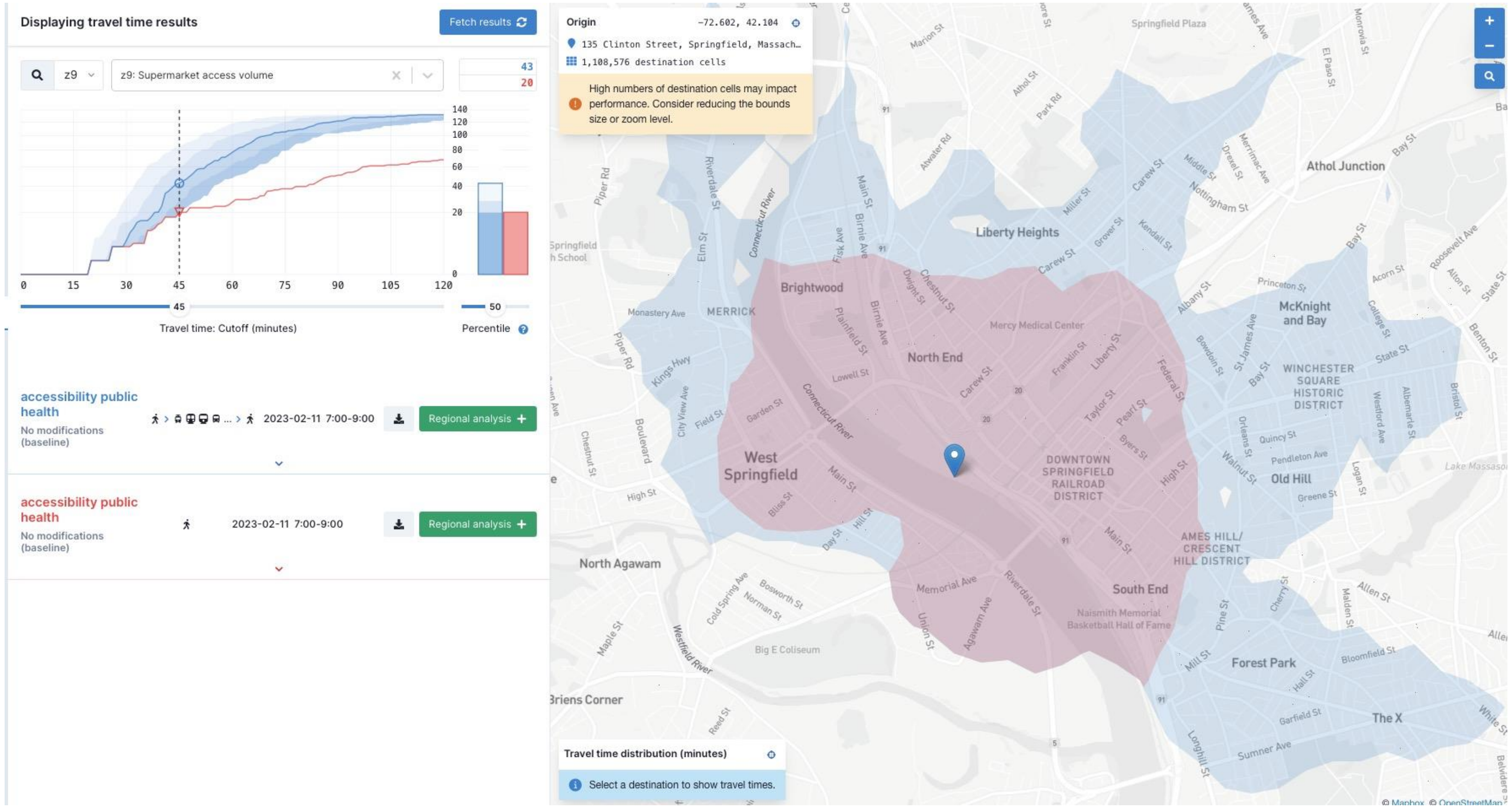




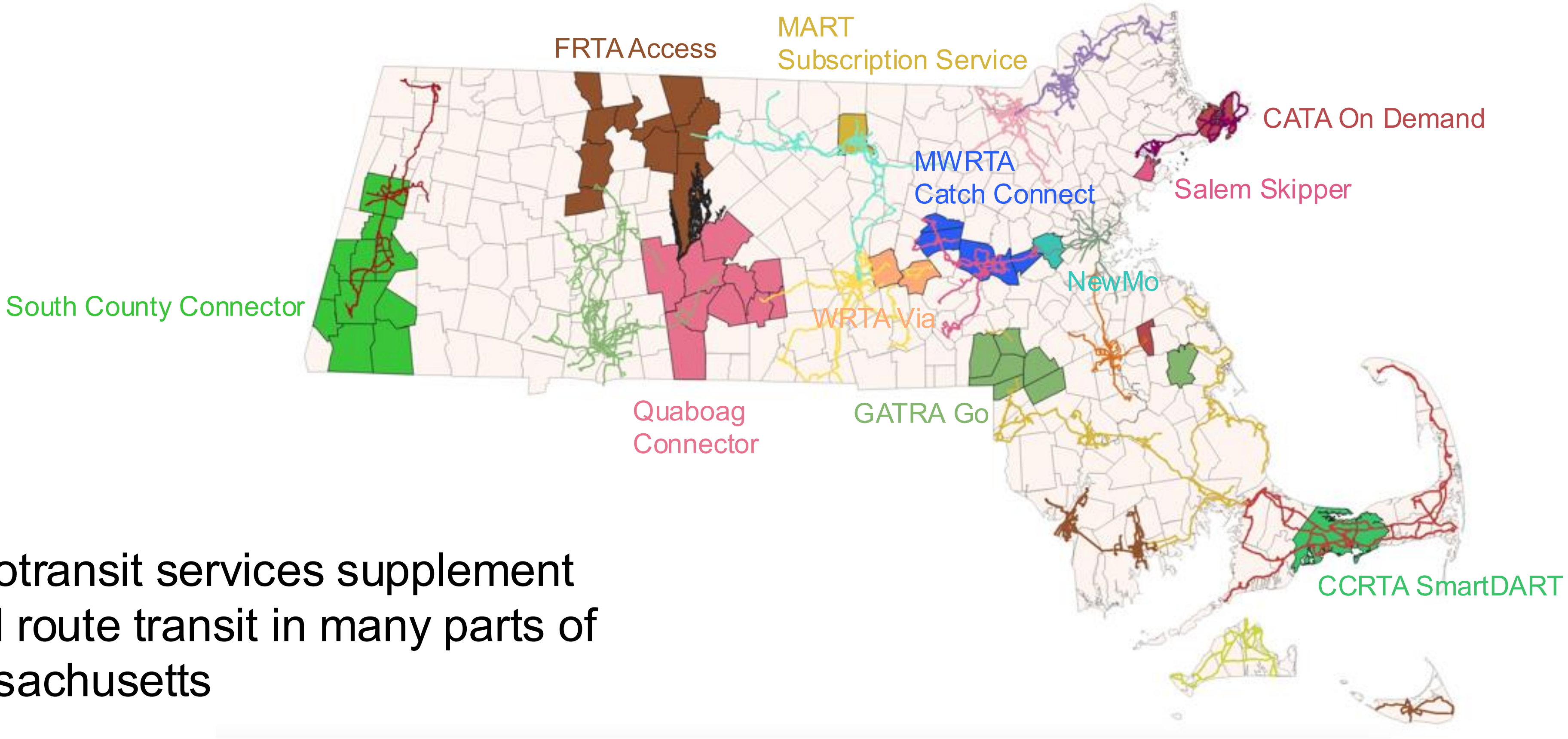
https://umass-amherst.maps.arcgis.com/apps/dashboards/3aa28477a7c74dde9ca481150be1702a

Access Metric for Transit

- Conveyal computes isochrones for fixed route transit
- Food retailer data from Massachusetts Food Systems Database
- Transit-reachable area is calculated by percentile, because headway affects waiting time.



Access Metric for Microtransit



Microtransit services supplement fixed route transit in many parts of Massachusetts

Access Metric for Microtransit

Customers either reserve a trip in advance or request service on-demand.

Depends on
- Number of vehicles
- Size of service area
- Other customers

Depends on
- Trip distance/Size of service area
- Sharing with other customers

Access Metric for Microtransit

Using data from the South County Connector (Great Barrington) and Quaboag Connector (Ware), we have been evaluating the effective waiting time and ratio of microtransit in-vehicle time to car travel time.

3 Months (February – April 2024)

- Date/Time of Pick-up Request, Schedule, and Actual
- Date/Time of Drop-off Schedule and Actual
- Lat/Long of Pick-up and Drop-off Locations
- Vehicle ID
- Vehicle Capacity

$$T_m = \frac{v_m}{v_c}(T - t_w)$$

T_m is modified travel time constraint for microtransit

v_m/v_c is the ratio of microtransit to car speed

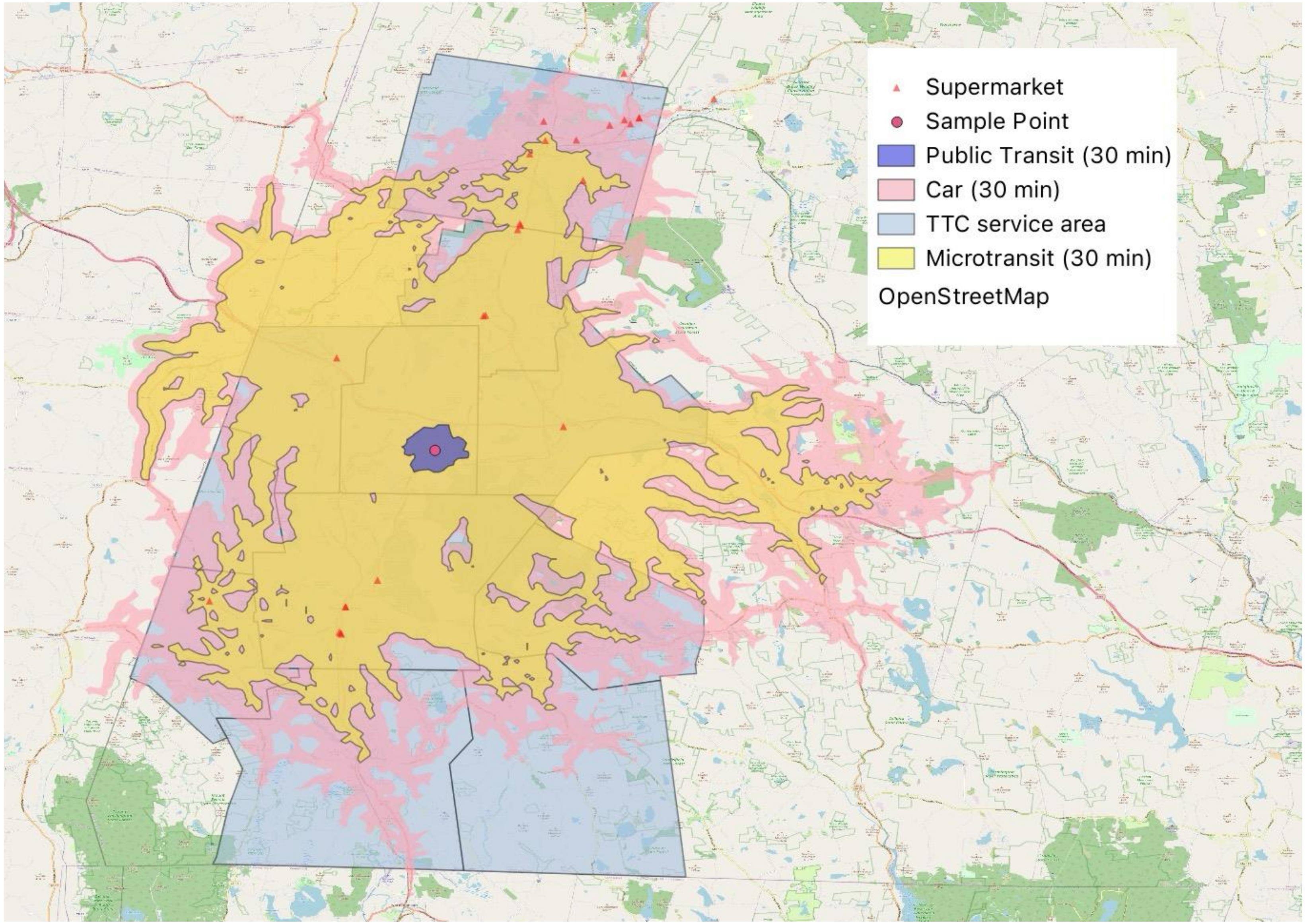
T is the travel time constraint

t_w is the waiting time for pick-up

For South County Connector: $t_w = 5$ minutes waiting $\frac{v_m}{v_c} = 0.80$

Stockbridge, MA

- Car (30 minutes): 23 stores
- Fixed-Transit (30 minutes, 50th percentile): 0 stores
- Microtransit (30 minutes ≈ 20 minutes in car): 15 stores



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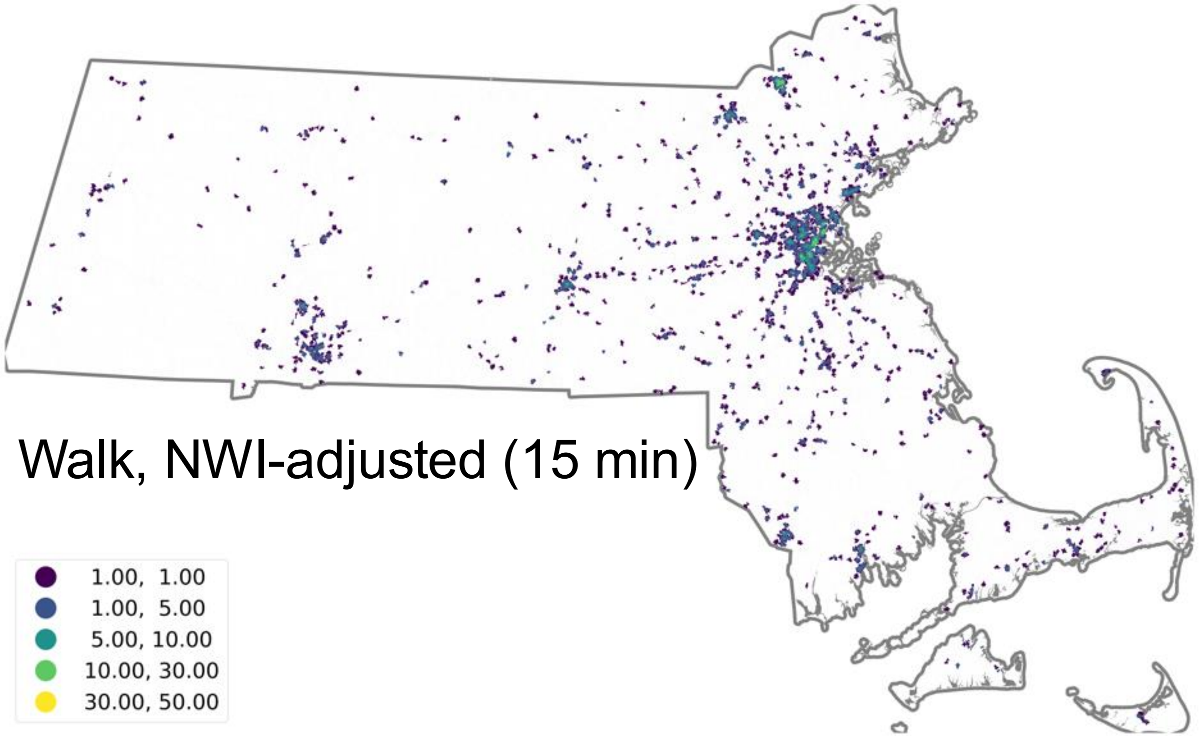
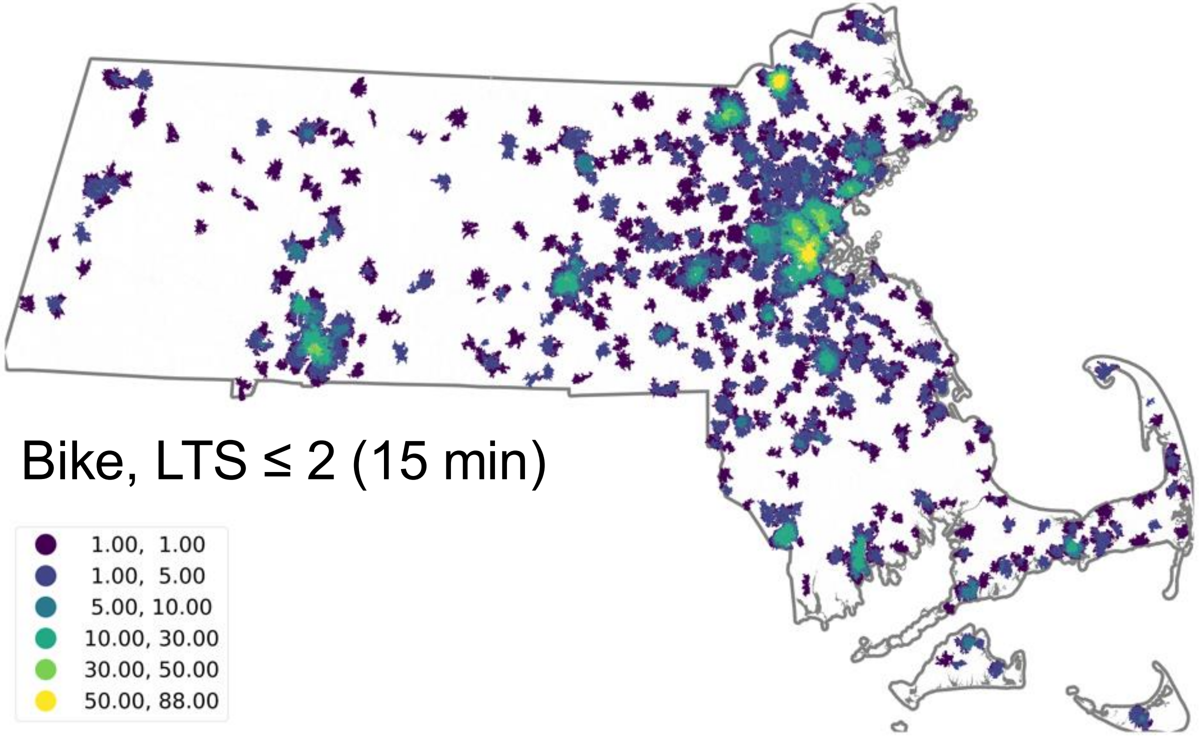
Comparing Access to Food Retailers

Access is measured at a spatial resolution of 1 unit Web Mercator Projection Zoom 9 (305 m)



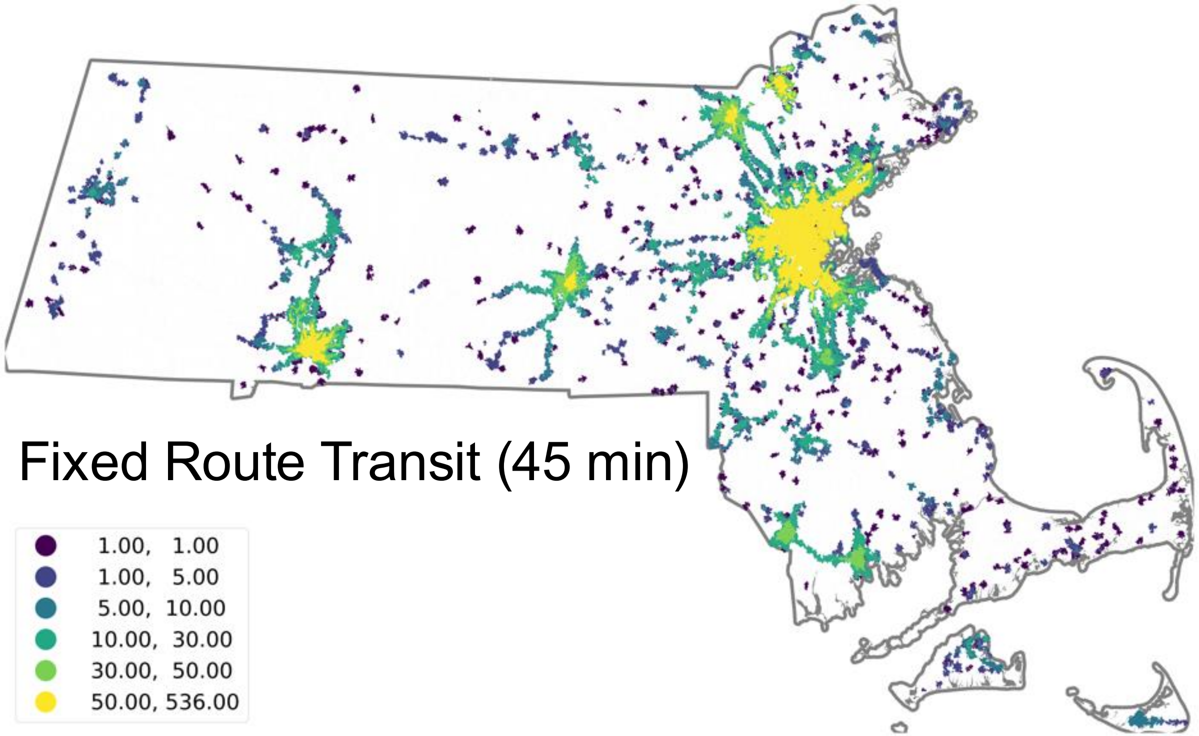
Walk, NWI-adjusted (15 min)



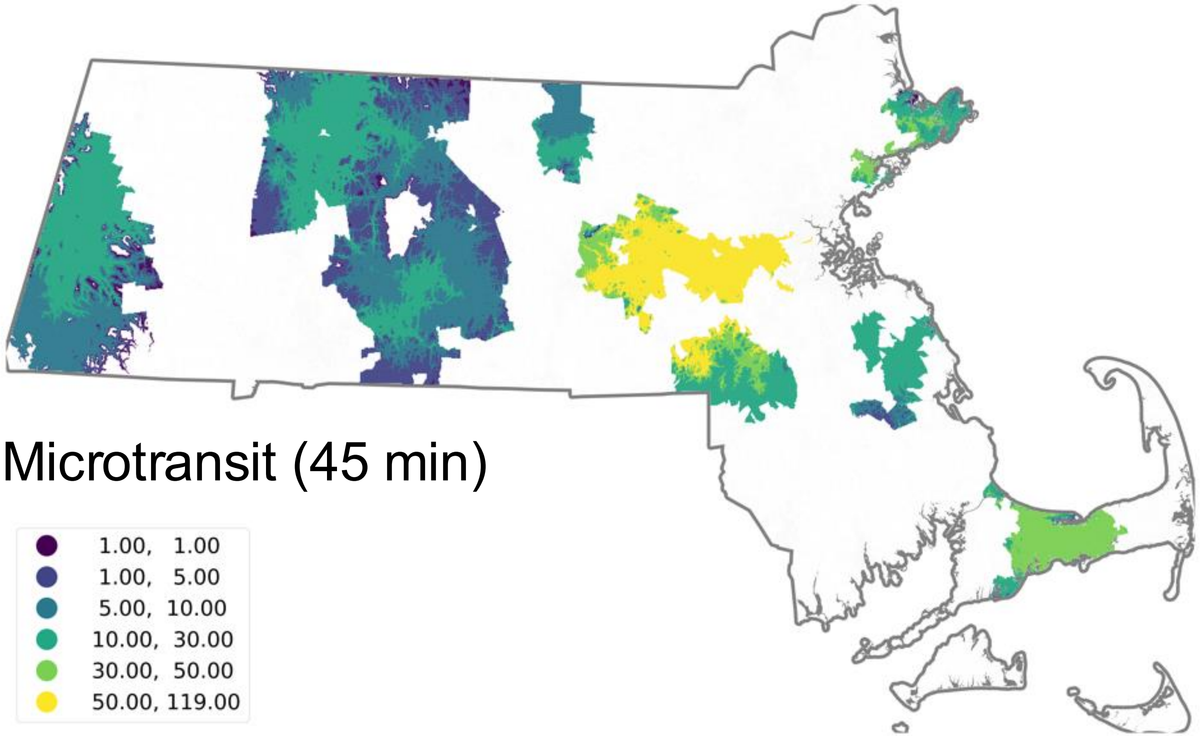
Bike, LTS ≤ 2 (15 min)

Comparing Access to Food Retailers

Microtransit provides expanded transit access within service areas.

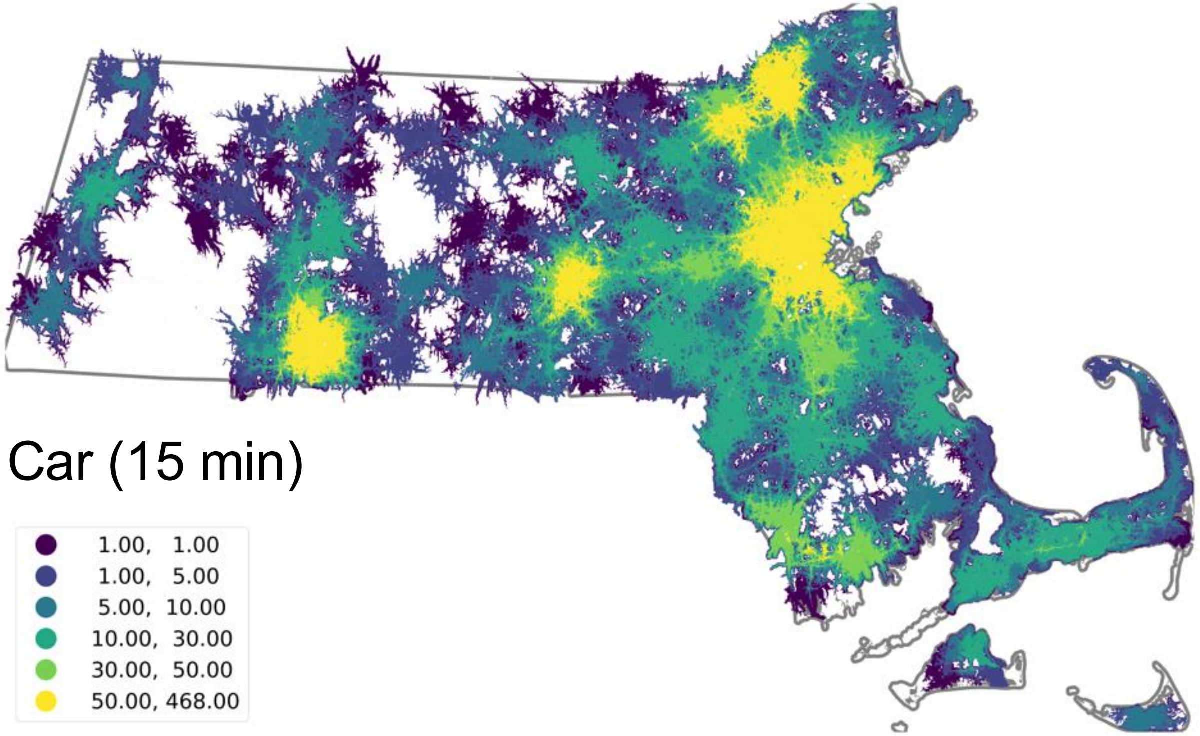


Fixed Route Transit (45 min)



Microtransit (45 min)

Comparing Access to Food Retailers



Car (15 min)

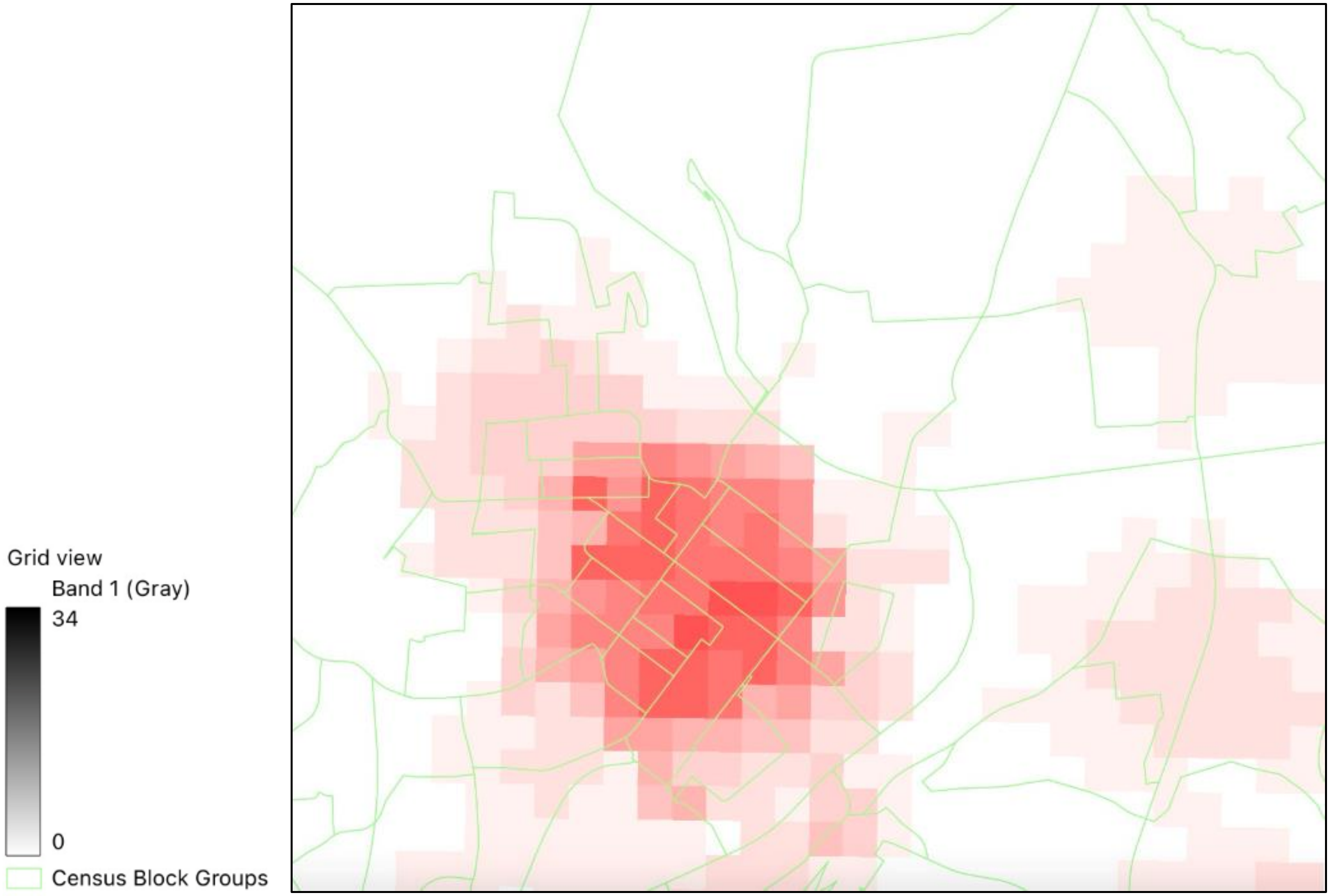
https://umass-amherst.maps.arcgis.com/home/item.html?id=098c4c84f94f481d9daee7259d1b3d14

Linking Access to Demographics

Census block group data includes characteristics of REJ+ designation.

- Seniors
- Disabilities
- Low-Income
- 0-Car Households

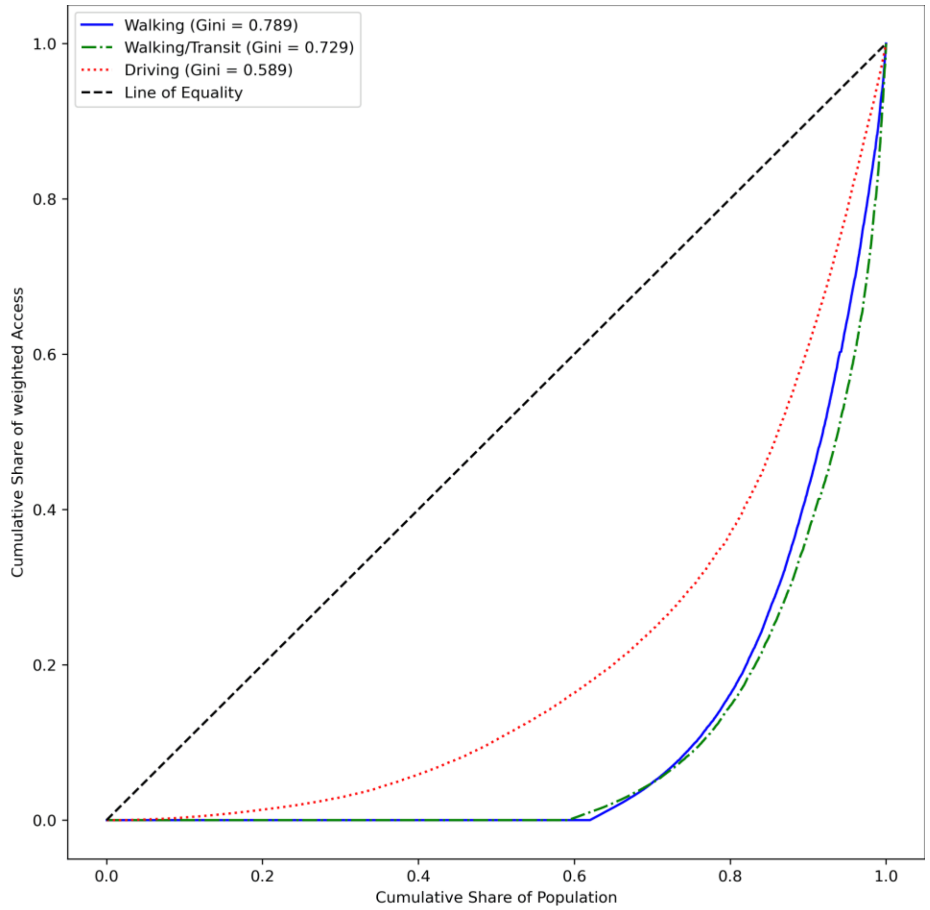
Access metrics are aggregated to census block groups.



Equity Analysis with Lorenz Curves

Statewide distribution in access can be measured by ranking block groups from lowest access to highest access:

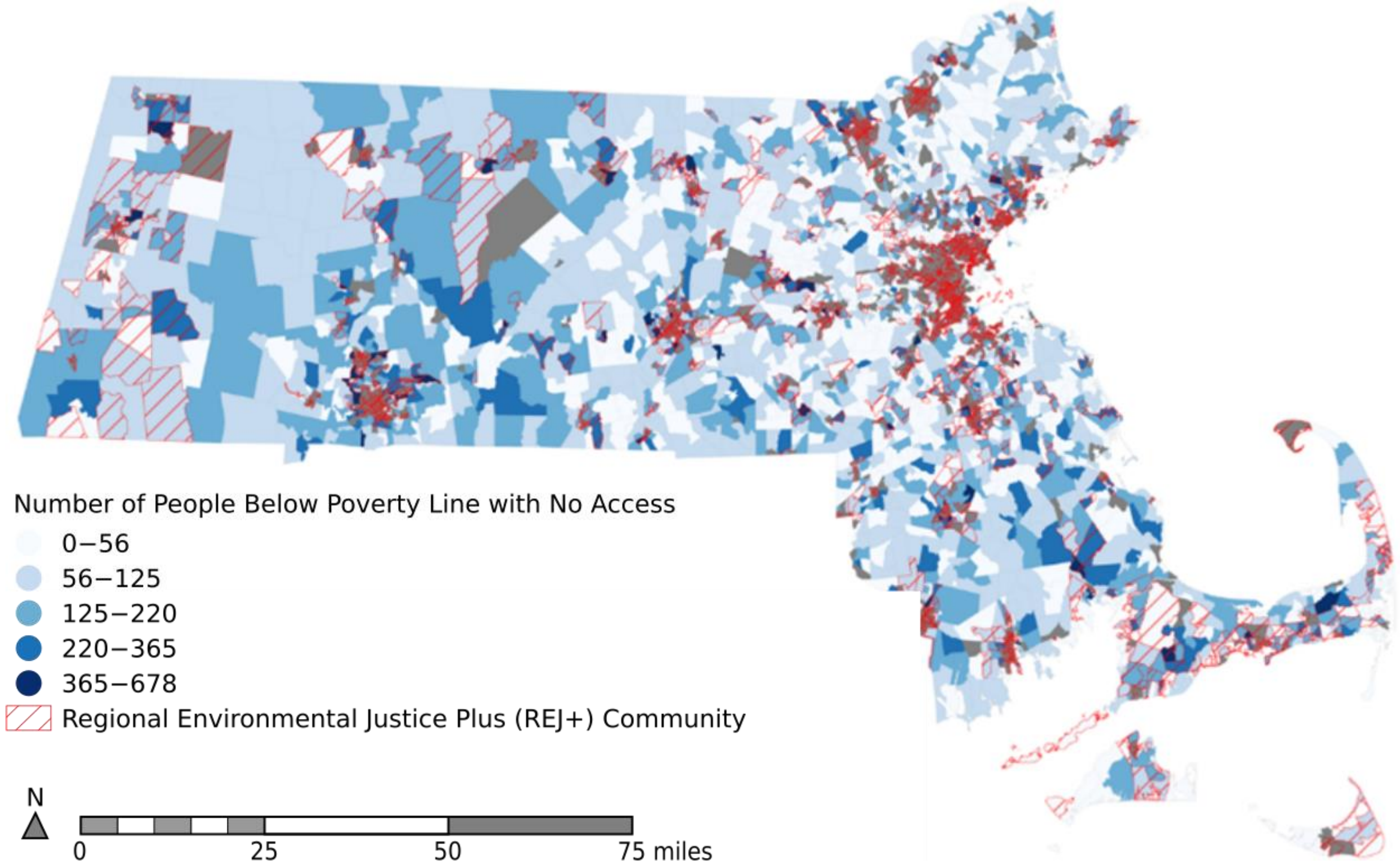
- Lorenz curve compares cumulative access to cumulative population
- Gini Coefficient measures equality (0 = equality, 1 = totally unequal)



Linking Access to Demographics

Households in Poverty

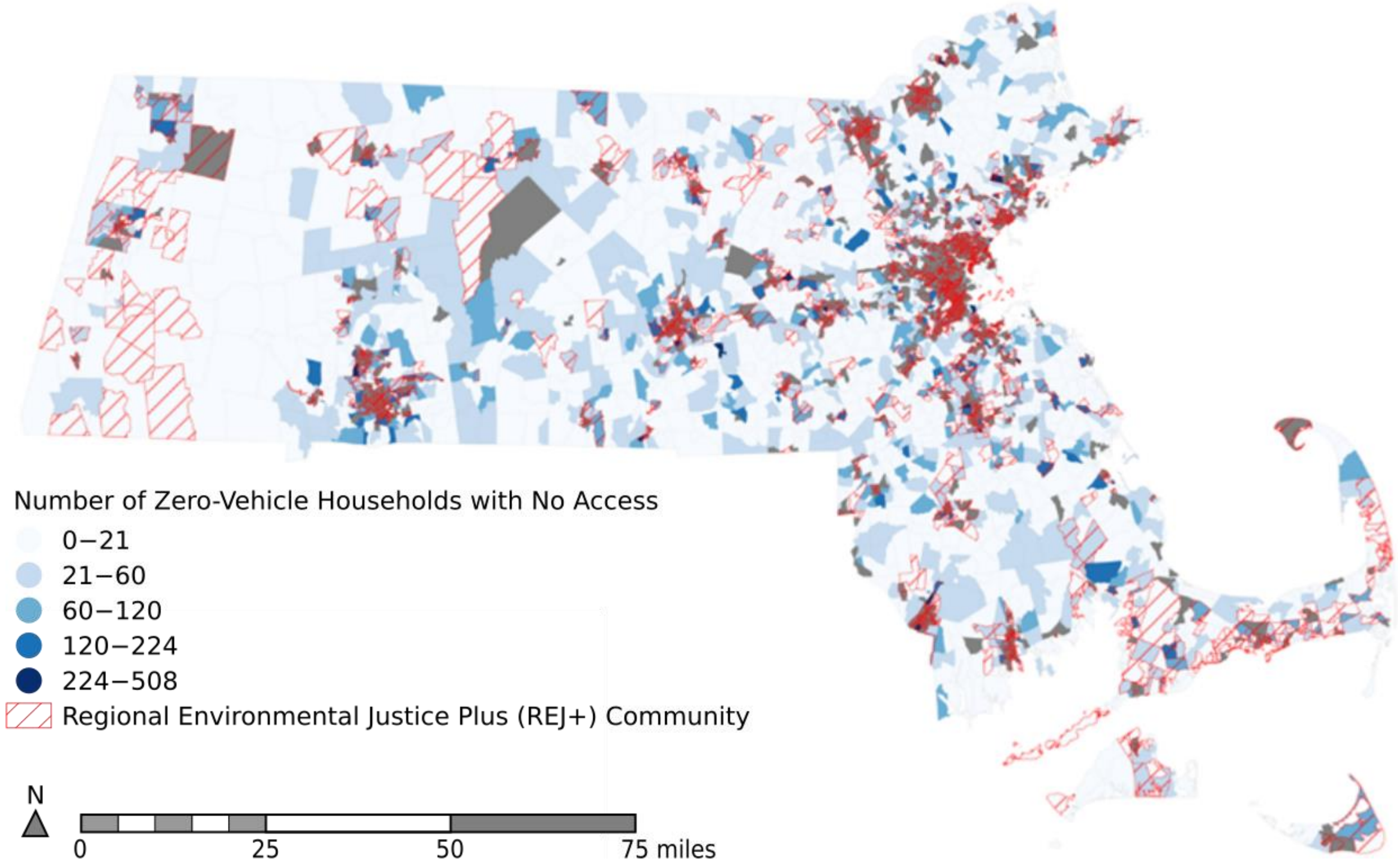
With No Access to
Supermarkets by Transit



Linking Access to Demographics

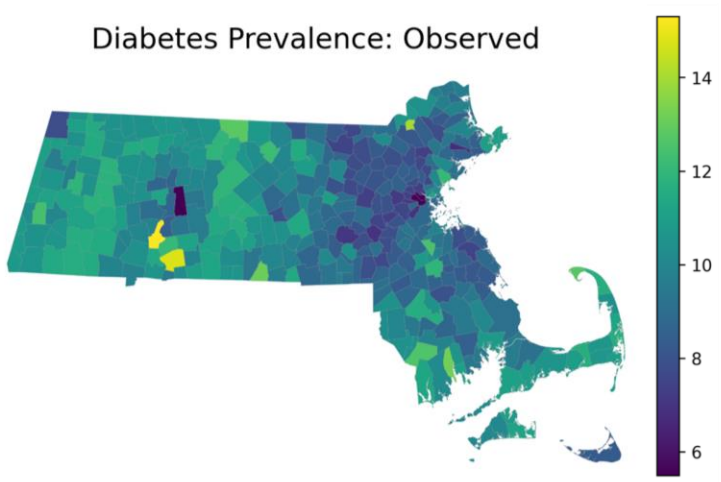
Zero-Vehicle Households

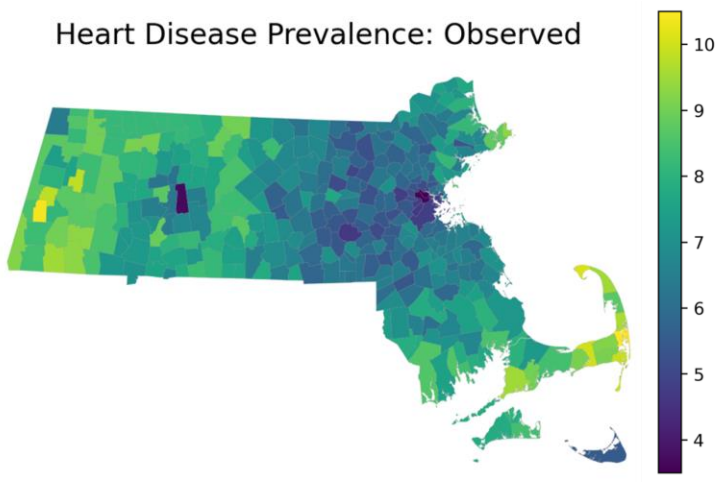
With No Access to Supermarkets by Transit

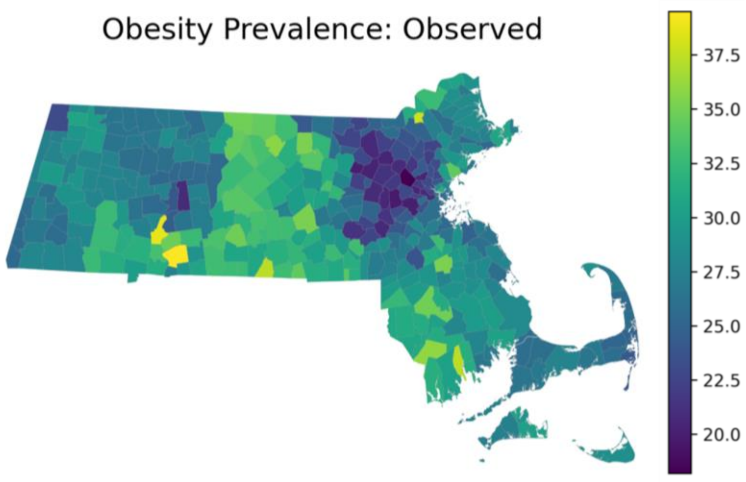


Linking Access to Public Health

Massachusetts Community Health data provides chronic disease rates (% of population) for each municipality

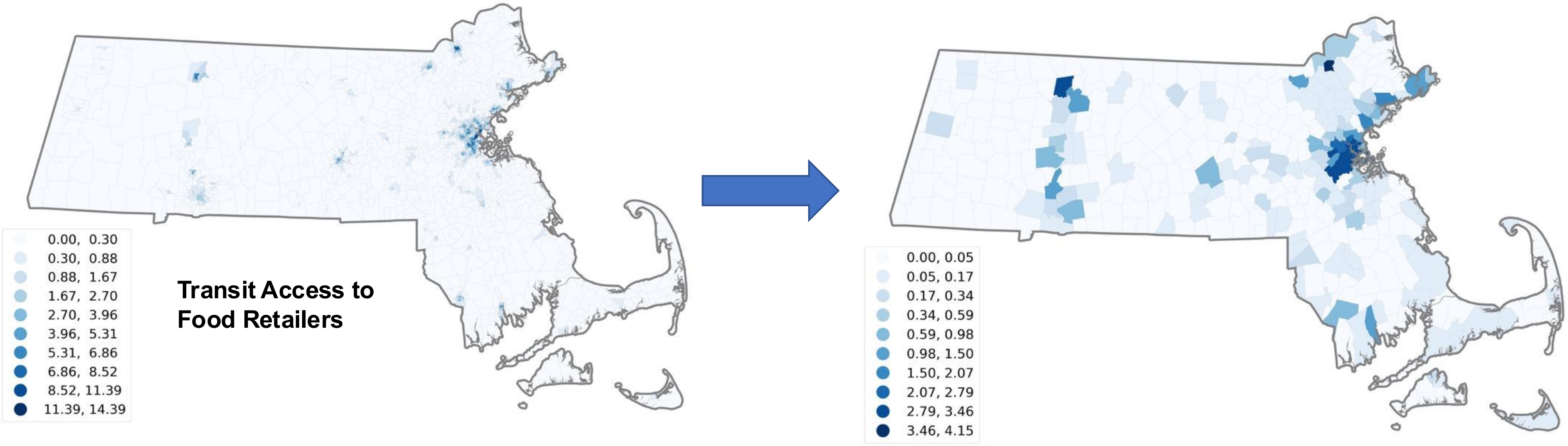






Linking Access to Public Health

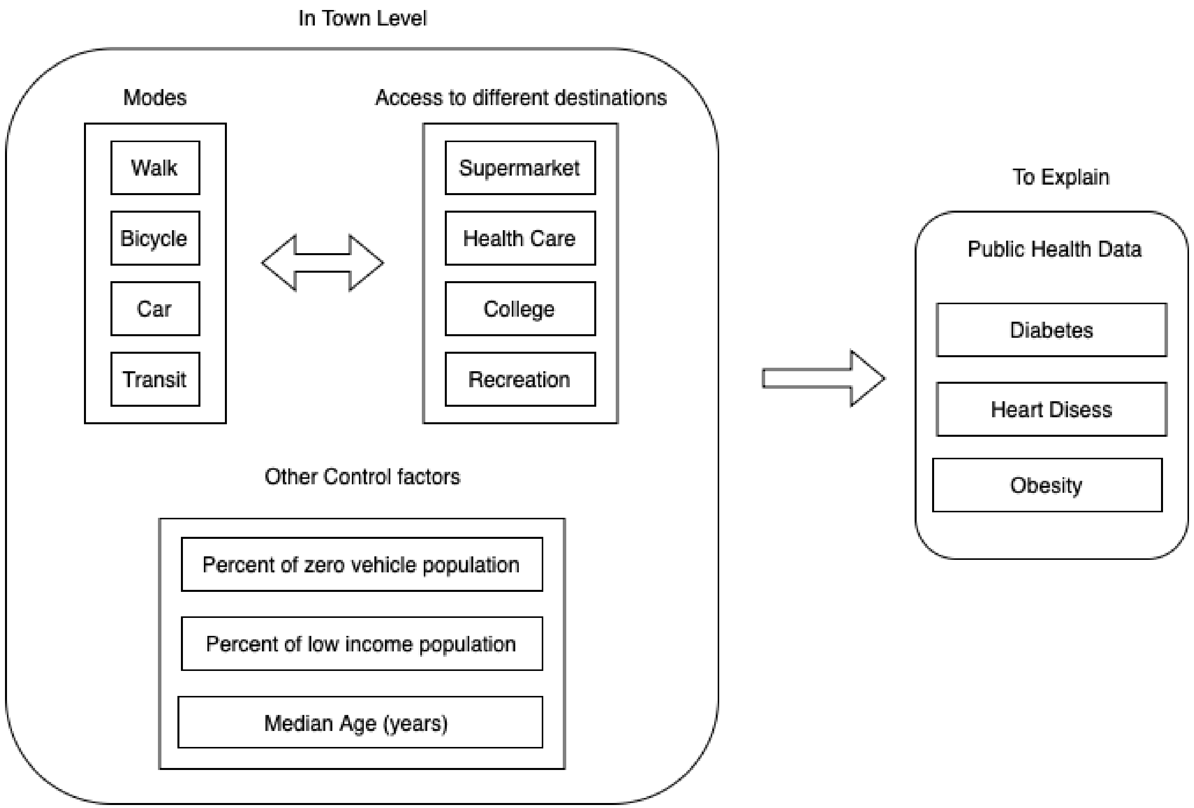
Access metrics are aggregated from fine resolution to the level of municipalities, weighted by the population in each census block group.



Linking Access to Public Health

Models to link access metrics to public health outcomes, controlling for household vehicles, income, and age:

- Ridge Regression, Ordinary Least Squares
- Global Random Forest
- Geographic Random Forest



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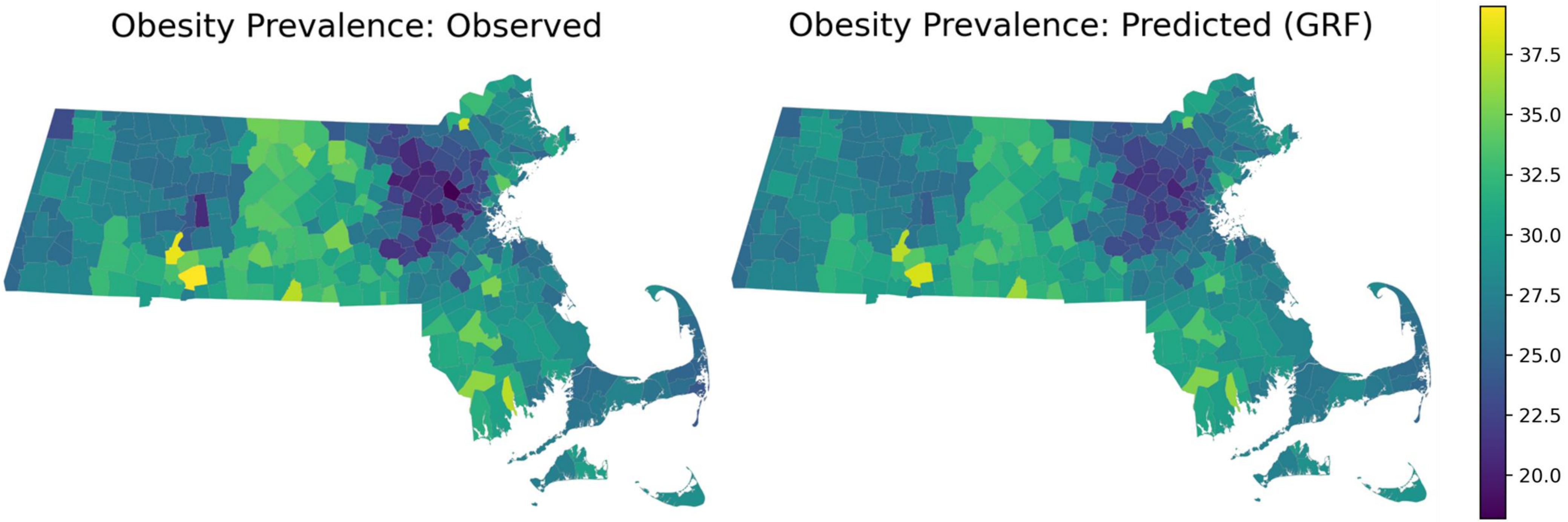
Linking Access to Public Health

Model Performance, Predicting Disease Rate (% of population)

Health Outcome	Moran's I	Model	MSE	RMSE	MAE
Diabetes	0.2550	Ridge	1.0095	1.0047	0.8247
		Global RF	0.1306	0.3613	0.2784
		GRF	0.1083	0.3291	0.2357
Heart Disease	0.2057	Ridge	0.0544	0.2332	0.1769
		Global RF	0.0671	0.2590	0.1978
		GRF	0.0489	0.2212	0.1701
Obesity	0.5125	Ridge	9.7310	3.1195	2.5056
		Global RF	1.3102	1.1447	0.8904
		GRF	1.0138	1.0069	0.7703

Linking Access to Public Health

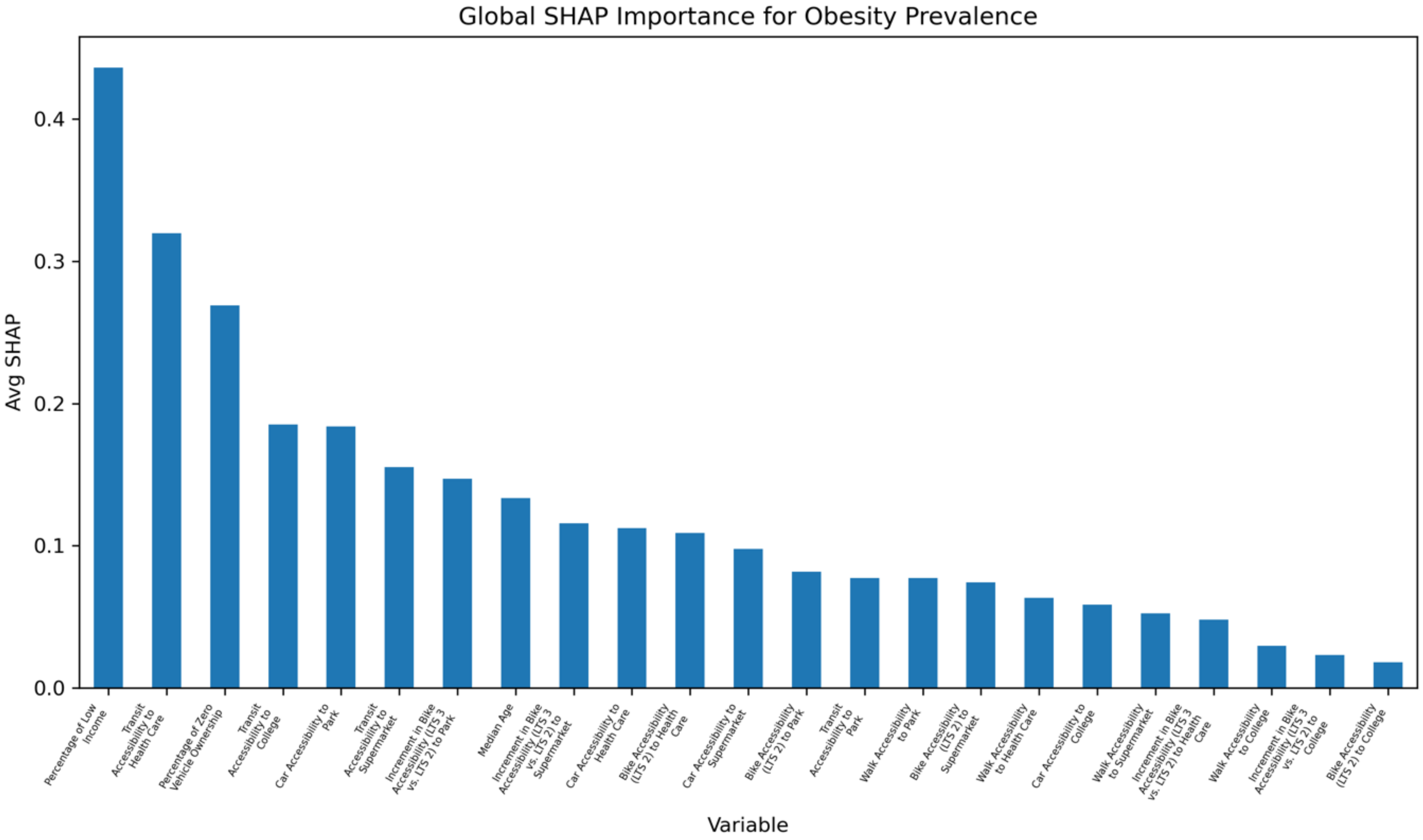
Strongest links between access and public health appear for obesity.



Linking Access to Public Health

SHapley Additive exPlanations (SHAP) Importance Factors indicate the contribution of each explanatory variable.

SHAP varies by location, but the global average shows the relative importance of different types of access.

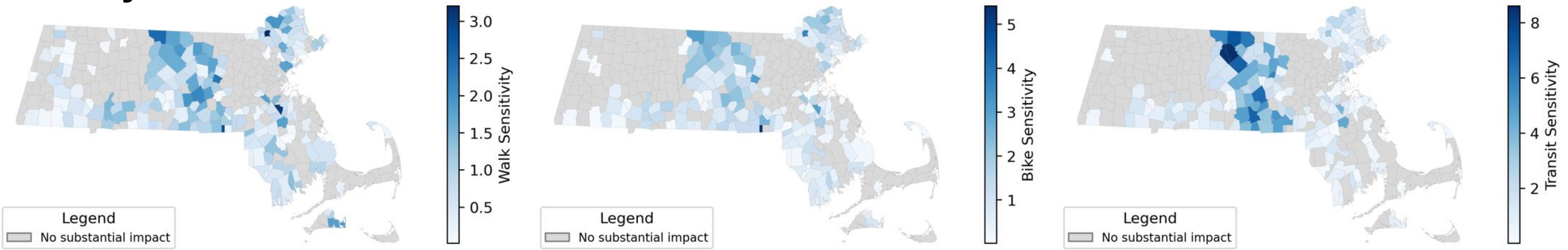


Linking Access to Public Health

The models also allow for a counterfactual analysis:

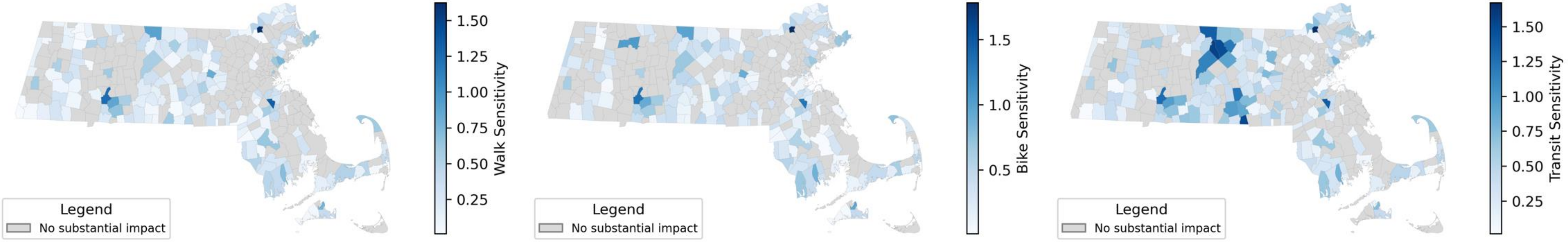
What is the expected effect of improving mode-specific access on public health outcomes?

Obesity

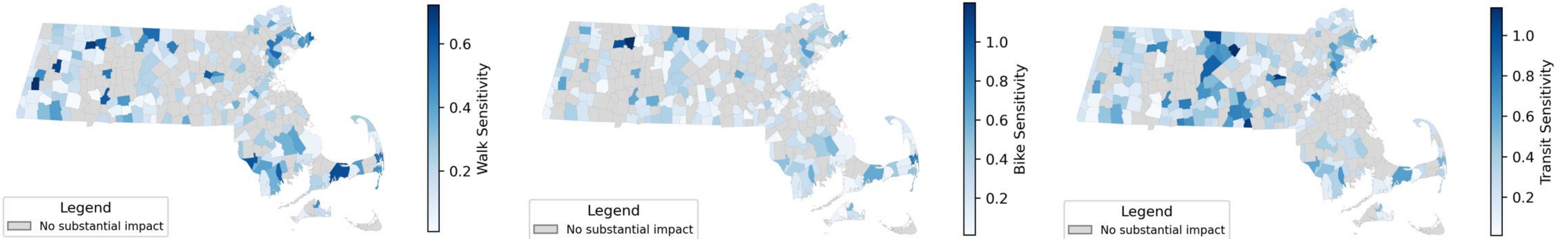


Linking Access to Public Health

Diabetes



Heart Disease



Conclusions

Improved access metrics reflect mode characteristics

- **Walk access accounting for walkability** – Using the NWI as a consistent indicator to adjust the walkable distance

- **Bike access accounting for bikeability** – Using the LTS to measure to identify roads and paths that most people are comfortable using

- **Transit access that includes microtransit** – Measuring the reach of microtransit as if it were a slow, delayed car.

Conclusions

Linking access metrics to demographics

- Access by car is relatively more equitable across Massachusetts than by other modes, so access disparity is worse for people that are not able to drive.

- It is important to quantify the size of potentially vulnerable populations. The REJ+ designation is based on threshold percentages, but there are significant access gaps that affect low income and 0-car households outside of REJ+ communities.

Conclusions

Linking access metrics to public health outcomes

- Access metrics are significant determinants of public health, especially in communities with large populations in low-income or 0-car households.
- The relative importance of access by mode and destination varies geographically. The largest impacts are in communities with the highest rates of chronic disease.
- Modes that provide more access tend to be a stronger determinant of public health. Populations that do not have access to a car are likely to benefit most from improved transit access.

QUESTIONS

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