



BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Jamey Tesler, Acting MassDOT Secretary and CEO and MPO Chair
Tegin L. Teich, Executive Director, MPO Staff

TECHNICAL MEMORANDUM

DATE: March 4, 2021
TO: Anna Sangree, Andy Stuntz, and Anthony Thomas,
Massachusetts Bay Transportation Authority
FROM: Steven Andrews, Emily Domanico, and Bradley Putnam,
Central Transportation Planning Staff
RE: Fare Transformation Proposed Sales Network Analysis

As part of its Fare Transformation initiative, the Massachusetts Bay Transportation Authority (MBTA) is proposing a new network of fare sales locations. The new network would greatly expand the number of sales terminals, but riders would no longer be able to pay cash onboard buses, light rail vehicles, or commuter rail trains. The Central Transportation Planning Staff (CTPS) analyzed the equity implications of these proposed changes and found no disparate impact on minority populations and no disproportionate burden on low-income populations.

1 BACKGROUND

Under the current fare system on the MBTA's bus and rapid transit network, riders can use a fare card to board buses at any stop, to board light rail vehicles at surface stops, or to enter gated rapid transit stations. Customers can also pay cash to board a bus or light rail vehicle at surface stops. Customers can reload fare cards at fareboxes onboard buses or light rail vehicles (cash only), at fare vending machines, at retail sales terminals, or on the MBTA's website. Most fare vending machines are located at entrances to rapid transit stations, and most retail sales terminals are located at convenience stores. Fare cards are not accepted on commuter rail trains or ferries, so riders on those modes must either buy a ticket or pass before riding, pay using a smartphone app, or pay cash onboard.

As part of its Fare Transformation initiative, the MBTA aims to allow riders to pay by smartphone, by contactless credit and debit card, and with a fare card on all modes while removing the option of paying cash onboard vehicles. These changes will make paying fares more convenient for many riders. However, paying fares may become less convenient for riders who only pay with cash, and so the MBTA proposes to add new fare sales terminals throughout its service

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area. The MBTA 2015–17 systemwide passenger survey indicated that low-income riders are more likely to pay with cash than non-low-income riders, and that minority riders are more likely to pay with cash than nonminority riders; removing the option of paying cash onboard could have a greater impact on minority or low-income riders than on nonminority or non-low-income riders.¹

This memorandum presents an analysis of whether the proposed elimination of the option to pay a fare with cash onboard vehicles together with the proposed changes to the network of fare sales locations might result in a potential disparate impact on minority populations in the MBTA service area or a potential disproportionate burden on low-income populations. According to the MBTA's Disparate Impact and Disproportionate Burden policy, a fare change that results in a ratio of low-income to non-low-income burden or minority to nonminority burden greater than 1.1 would suggest a potential disparate impact or a potential disproportionate burden.²

2 METHODOLOGY

First, CTPS assembled a list of locations where riders can currently pay fares by cash. This list includes

- fare vending machines, including all gated rapid transit stations;
- retail sales terminals, which are mostly located in convenience stores;
- all bus stops using the farebox onboard the vehicle;
- all surface light rail stations using the farebox onboard the vehicle; and
- all commuter rail stations, purchasing from the conductor.

Second, the MBTA provided a list of the proposed fare sales locations where riders would be able to pay cash to reload fare cards as part of the Fare Transformation initiative. This list includes

- all current fare vending machine locations;
- all current retail sales terminals;
- over 900 bus stops;
- over 100 commuter rail stations;
- over 40 surface light rail stations; and
- all ferry docks.

At this stage of planning, the MBTA has not determined whether the proposed fare sales locations at bus stops, commuter rail stations, surface light rail stations, and ferry docks will be fare vending machines or nearby retail sales

¹ Detailed results of the MBTA 2015–17 systemwide passenger survey can be found at <https://www.ctps.org/apps/mbtasurvey2018/index.html#>.

² The MBTA's Disparate Impact and Disproportionate Burden policy can be found at <https://www.mbta.com/policies/fair-service-fair-fares>.

terminals. For the purpose of this analysis, these locations are all treated the same.

Third, CTPS calculated the number of people classified as minority, nonminority, low-income, and non-low-income within the MBTA's service area living within a quarter mile of a location where cash can be used to pay fares either currently or under the proposed fare sales network. CTPS used Geographic Information System software to calculate quarter-mile buffers around each location and then used demographic proportion data from the 2015–19 American Community Survey (ACS) applied to population totals from the 2010 decennial census to calculate the population numbers by demographic category.

CTPS used census data instead of MBTA ridership data in order to capture the geographic dimensions of the proposed fare sales network. Ridership demographic data does not have sufficient precision at the stop level to analyze sales locations.

2.1 Definitions of Minority and Low-Income Populations

CTPS applied demographic proportions from the ACS estimates to population totals from the 2010 decennial census to find the minority and nonminority population size in each census tract. CTPS used the 2015–19 ACS Table B03002 (Hispanic or Latino Origin by Race) to find the percent of minority and nonminority residents within a census tract. Residents who were classified as “white alone, not Hispanic or Latino” were classified as nonminority residents; all others were classified as minority residents. CTPS used the 2010 decennial census Table P001001 (Total Population) to find the total population by census tract. The total population for each census tract was multiplied by the ACS minority percentage to find the minority population and the ACS nonminority percentage to find the nonminority population.

Similarly, CTPS applied demographic proportions from the ACS estimates to population totals from the 2010 decennial census to find the number of low-income and non-low-income households in each census tract. CTPS used the 2015–19 ACS Table B19001 (Household Income in the Past 12 Months) to find the percentage of households within a census tract that are low income. Households were classified as low-income if the household earned less than 60 percent of the median household income for the MBTA service area (a threshold

of \$53,382).^{3, 4} Household counts by income status were found by multiplying the total occupied housing units for each census tract from the 2010 decennial census Table H002002 (Total Occupied Housing Units) by the percentage of low-income households to find the number of low-income households and by the percentage of non-low-income households to find the number of non-low-income households.

2.2 Assigning Census Demographics to the Service Area

CTPS used the following methodology to estimate the demographics of populations within the MBTA service area:

Determine the geographic area

- 1) Create a quarter-mile buffer around all fare sales point locations
- 2) Dissolve the buffer so that overlapping regions are not double-counted

Calculate proportions of each census tract in the buffer

- 3) For each census tract that is included in the buffer, calculate the length of roads within the buffer
- 4) For each census tract that is included in the buffer, calculate the total length of roads in the census tract
- 5) Calculate the percentage of total road length within the buffer in each census tract

Calculate demographics within the buffer

- 6) For each census tract, multiply the percentage of road length within the buffer by the number of people or households in each population group (minority, nonminority, low-income, and non-low-income)
- 7) Sum the number of people in each population group for all census tracts within the service area

³ The median household income was derived from 2015–19 ACS household income distribution data by (1) finding the number of households in each census-based income category for the entire MBTA service area, (2) finding which income category for the service area contained at least 50 percent of households, and (3) calculating how far into that category the median is, assuming that incomes are evenly distributed along each category. Following this approach, CTPS found the median household income in the MBTA service area to be \$88,970. The low-income threshold is 60 percent of the median household income, which is \$53,382.

⁴ All households earning less than \$50,000 were classified as low income, and all households earning \$60,000 or more were classified as non-low income. Households in the census category “\$50,000 to \$59,999” were separated into each population group by multiplying the number of households in that category by 0.34, a value derived by the following equation: $(\$53,382 - 50,000) / (59,999 - 50,000) = 34\%$. The equation distributes the households in the category based on how far the threshold extends into the category. The equation assumes household incomes are distributed equally within the category.

CTPS used road lengths instead of land area because road lengths are a proxy for population density within a census tract, whereas calculating by land area would assume uniform population density across a tract. When calculating the length of roads in a census tract or buffer, CTPS used road geometries from the 2019 US Census TIGER/Line Shapefiles.

3 RESULTS

Table 1 shows that eliminating the ability to pay fares with cash onboard buses, surface light rail vehicles, and commuter rail trains and switching from the current sales network to the proposed sales network would cause 66,022 low-income households in the MBTA service area to lose quarter-mile proximity to sales locations, while 159,482 non-low-income households would lose quarter-mile proximity. Likewise, 172,693 minority residents would lose quarter-mile proximity, as would 391,137 nonminority residents.

**Table 1
Households and Populations Living within
One-quarter Mile of a Fare Sales Location**

	Low-income households	Non-low-income households	Minority population	Nonminority population
Current sales network	257,585	478,046	758,840	1,054,353
Proposed sales network	191,564	318,564	586,147	663,216
Change	-66,022	-159,482	-172,693	-391,137
Percent change	-25.6%	-33.4%	-22.8%	-37.1%
Ratio		0.77 ^a		0.61 ^b

Note: Values displayed in this table are rounded; calculations were performed using unrounded values.

^aThis value is the ratio of the percentage change in low-income households to the percentage change in non-low-income households.

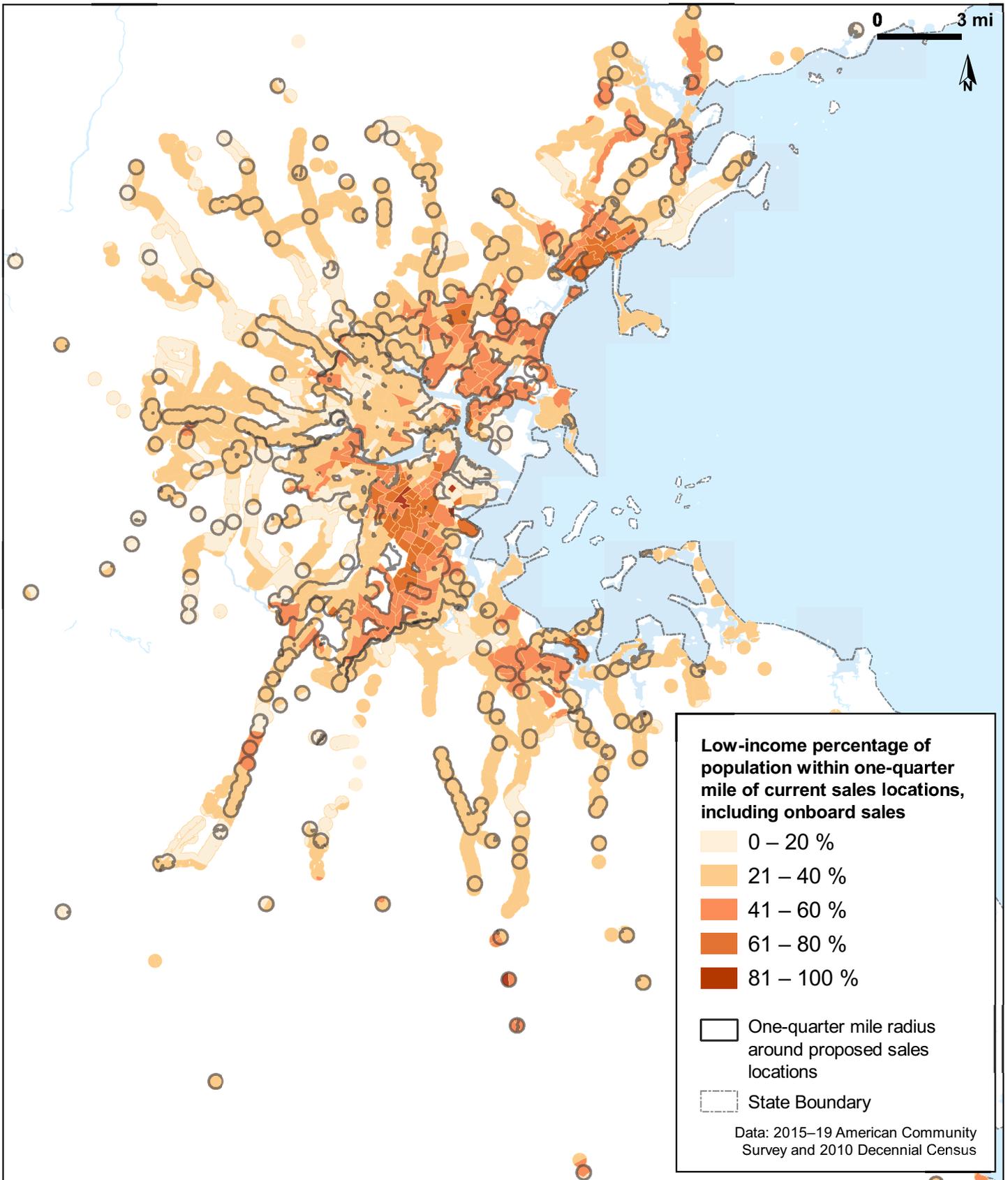
^bThis value is the ratio of the percentage change in minority population to the percentage change in nonminority population.

Source: Central Transportation Planning Staff and the Massachusetts Bay Transportation Authority.

Table 1 also shows that the ratio of the percentage loss to low-income households (25.6 percent) to the percentage loss to non-low-income households (33.4 percent) is 0.77, and that the ratio of the percentage loss to minority residents (22.8 percent) to the percentage loss to nonminority residents (37.1 percent) is 0.61. According to the MBTA’s Disparate Impact and Disproportionate Burden policy, a fare change that results in a ratio of low-income to non-low-income loss or minority to nonminority loss greater than 1.1 would suggest a potential disparate impact or a potential disproportionate burden. Since both ratios are less than 1.1, no disparate impact or disproportionate burden is found.

Figures 1a and 1b show the percentage of low-income households in areas that would lose quarter-mile proximity to the ability to pay cash. Figure 1a shows the MBTA bus service area and Figure 1b shows the commuter rail service area. Both figures show that areas that would lose quarter-mile proximity have relatively low percentages of low-income households.

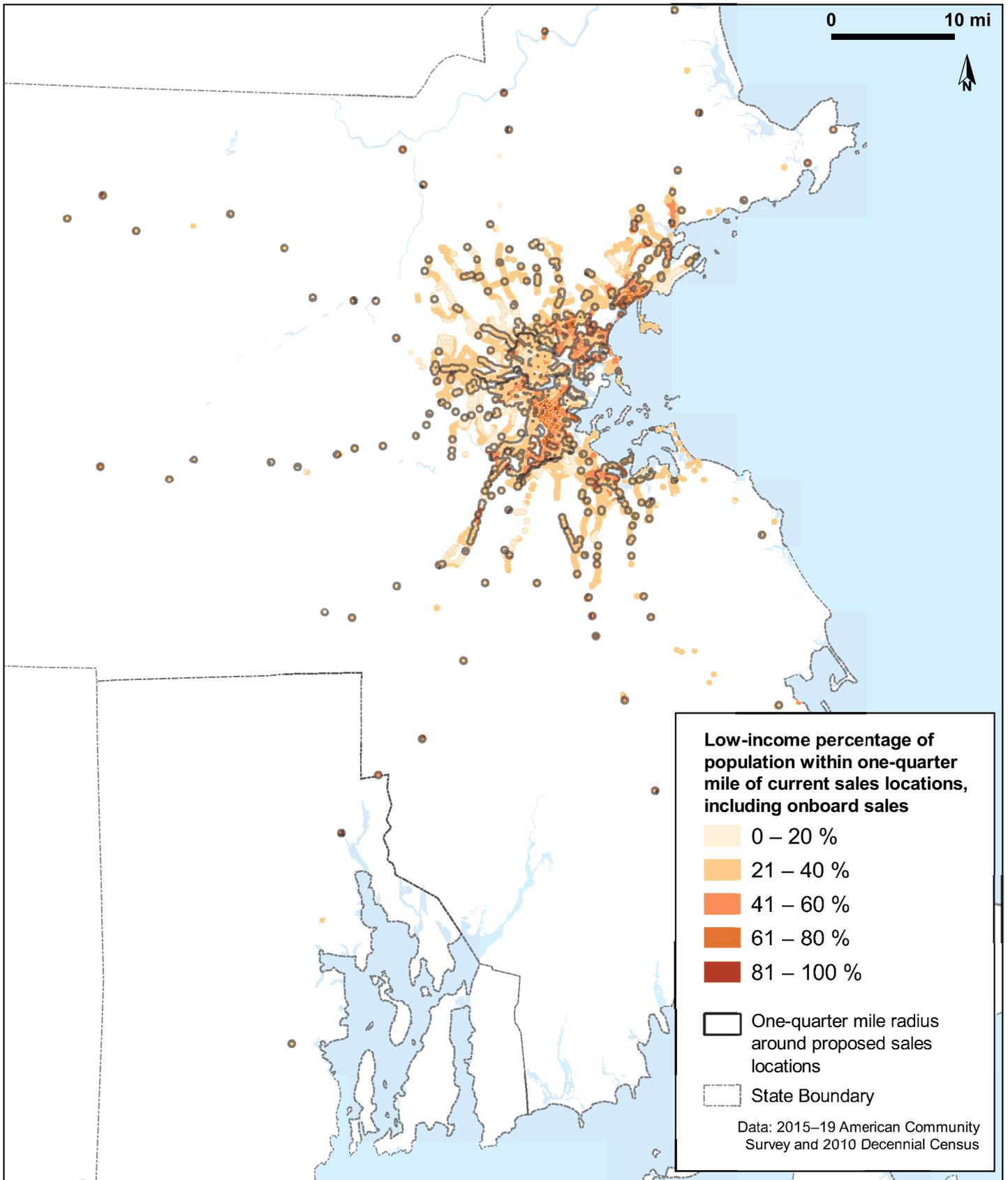
Figures 2a and 2b show the percentage of minority population in areas that would lose quarter-mile proximity to the ability to pay cash. Figure 2a shows the MBTA bus service area and Figure 2b shows the commuter rail service area. Both figures show that areas that would lose quarter-mile proximity have relatively low percentages of minority population.



CTPS

FIGURE 1A
Low-income Populations Living within One-quarter Mile of Fare Sales Locations in the MBTA Bus Service Area

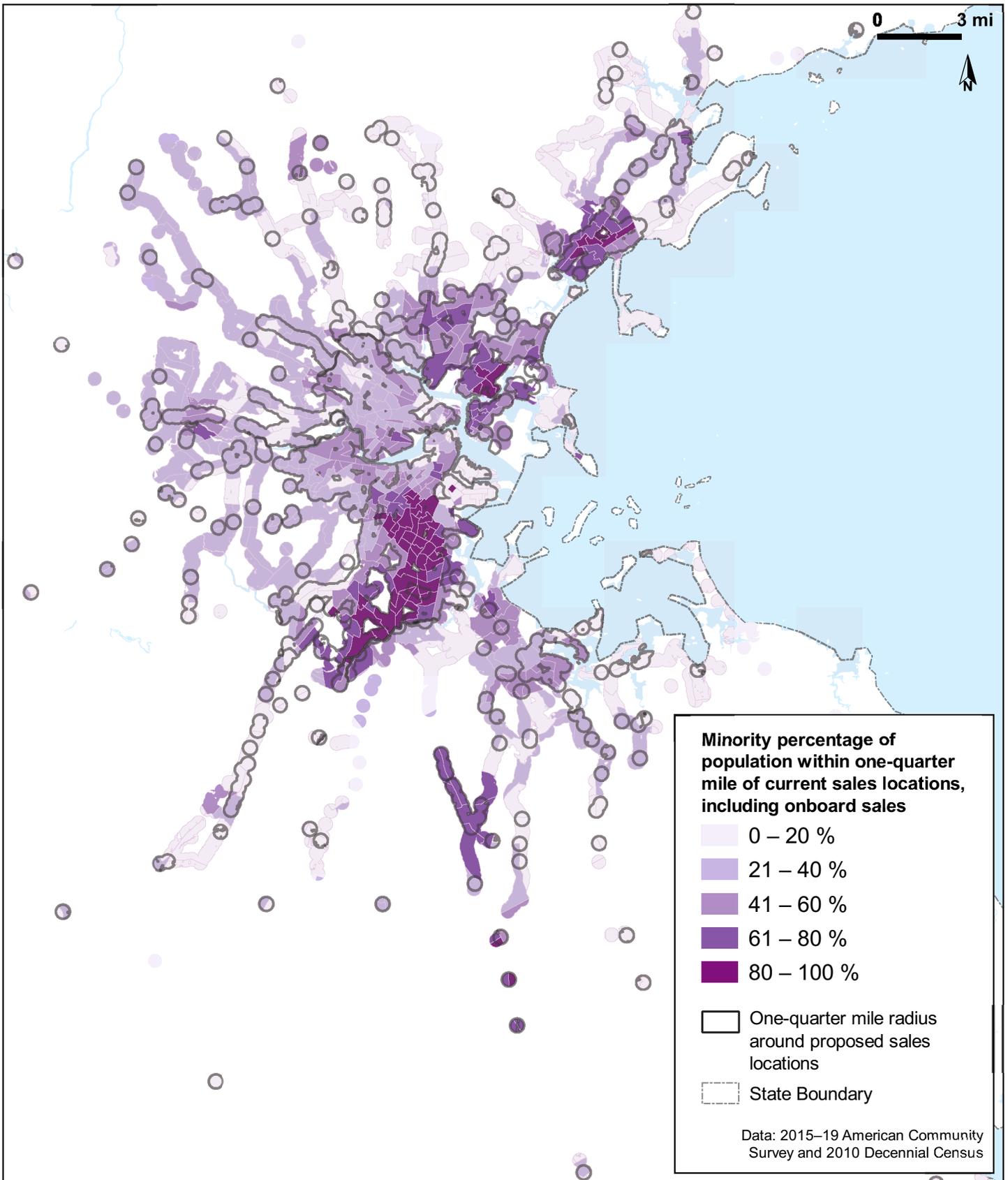
Fare Transformation Sales Network Analysis



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FIGURE 1B
Low-income Populations Living within One-quarter Mile of Fare Sales Locations in the Commuter Rail Service Area

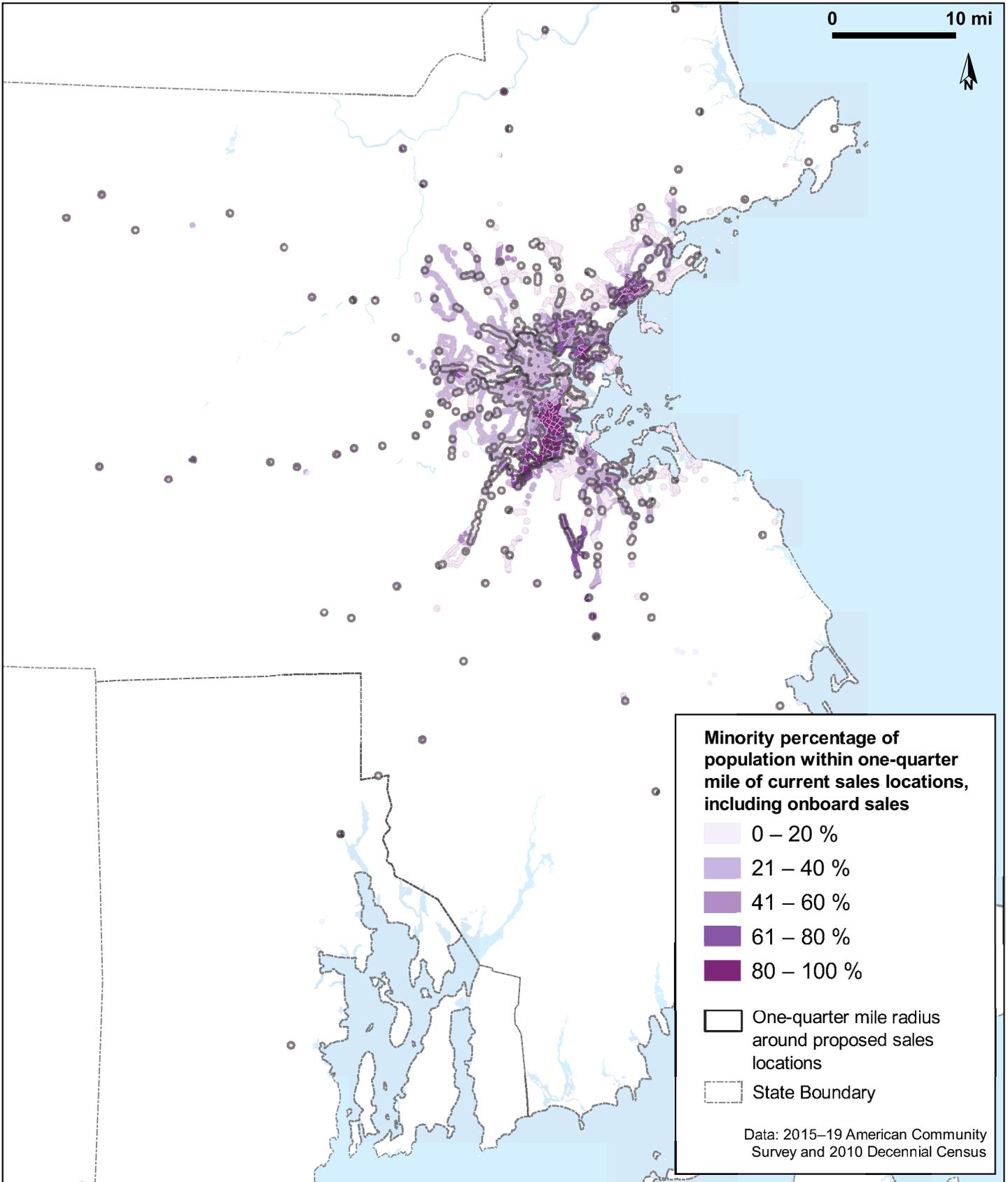
Fare Transformation Sales Network Analysis



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FIGURE 2A
Minority Populations Living within One-quarter Mile of Fare Sales Locations in the MBTA Bus Service Area

Fare Transformation Sales Network Analysis



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FIGURE 2B
Minority Populations Living within One-quarter Mile
of Fare Sales Locations in the Commuter Rail Service Area

*Fare
 Transformation
 Sales Network
 Analysis*

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