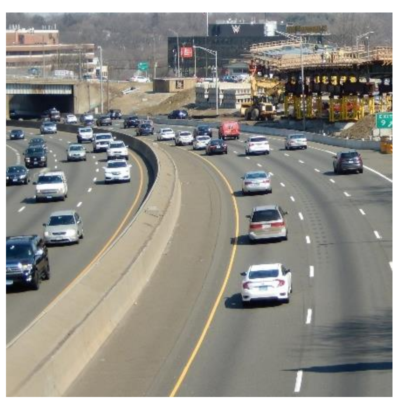
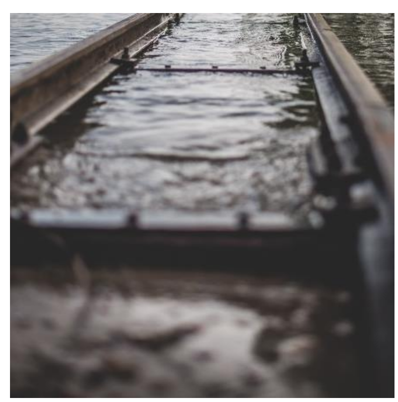
New Haven to Providence Market Study

March 2023

New Haven to Providence Market Study

March 2023

Prepared for:

The National Railroad Passenger Corporation (Amtrak)
1 Massachusetts Avenue NW
Washington, DC 20001

Prepared by:

HNTB Corporation
31 St. James Avenue, Suite 300
Boston, MA 02116

Steer
501 Boylston Street
Boston, MA 02116

FHI Studio
416 Asylum Street
Hartford, CT 06103

Contents

Executive Summary

Background and Purpose

NEC FUTURE is the Federal Railroad Administration's (FRA) long-term vision for the Northeast Corridor (NEC) rail line from Washington D.C. to Boston, MA, and a Tier 1 Environmental Impact Statement (EIS) and Record of Decision (ROD) was completed in July 2017.[1] In developing its Preferred Alternative for the Final Environmental Impact Statement (FEIS), FRA analyzed several potential new alignment options between New Haven, CT and Providence, RI, however, potential design constraints and public comments expressing opposition to specific portions of this proposed new alignment resulted in FRA recommending a Capacity Planning Study be conducted to further evaluate alternatives to grow rail capacity and improve rail performance in an area within Connecticut and Rhode Island, inclusive of the NEC Shoreline corridor between New Haven and Providence.

The NEC Commission's October 2022 five-year Capital Investment Plan[2] and FRA's NEC Project Inventory[3] identify this future Capacity Planning Study and potential funding to conduct the study. *In advance of the initiation of the Capacity Planning Study, Amtrak, in coordination with FRA, the NEC Commission, and the states of Connecticut, Rhode Island, and Massachusetts, have conducted a Market Study to understand potential changes to the NEC travel market between New Haven, CT and Providence, RI.*

The Market Study aims to provide a data-driven, evidenced-based understanding of travel behavior and demand on the corridor. This includes a market analysis of present travel patterns and volumes of individuals currently traveling in the study area, with particular focus on rail travel. The Market Study also includes an evaluation of the potential impacts, challenges, and opportunities for future rail travel in the study area, particularly long-term impacts from COVID-19, the development of new transportation technologies, and planned infrastructure investments in the study area and its broader region.

Corridor Context & Methodology

The New Haven – Providence corridor is home to millions of people and is between two of the country's most populous and economically important metropolitan areas, Boston and New York City ("NYC") as shown in Figure A. It includes numerous urban centers, including Hartford, New Haven, and Providence. In addition to Amtrak's services on the NEC and connected routes, the study area also has multiple commuter rail services, as well as airports and significant highway infrastructure.

The Market Study utilizes a variety of data sources, including economic, demographic, and ridership data. The Market Study also utilizes Location-Based Services ("LBS") cellphone data to inform demand. LBS data utilizes geolocation information from cellphone app users, as well as other locational data, to estimate key flows and travel behaviors between areas. This data was not utilized for prior studies of the corridor.

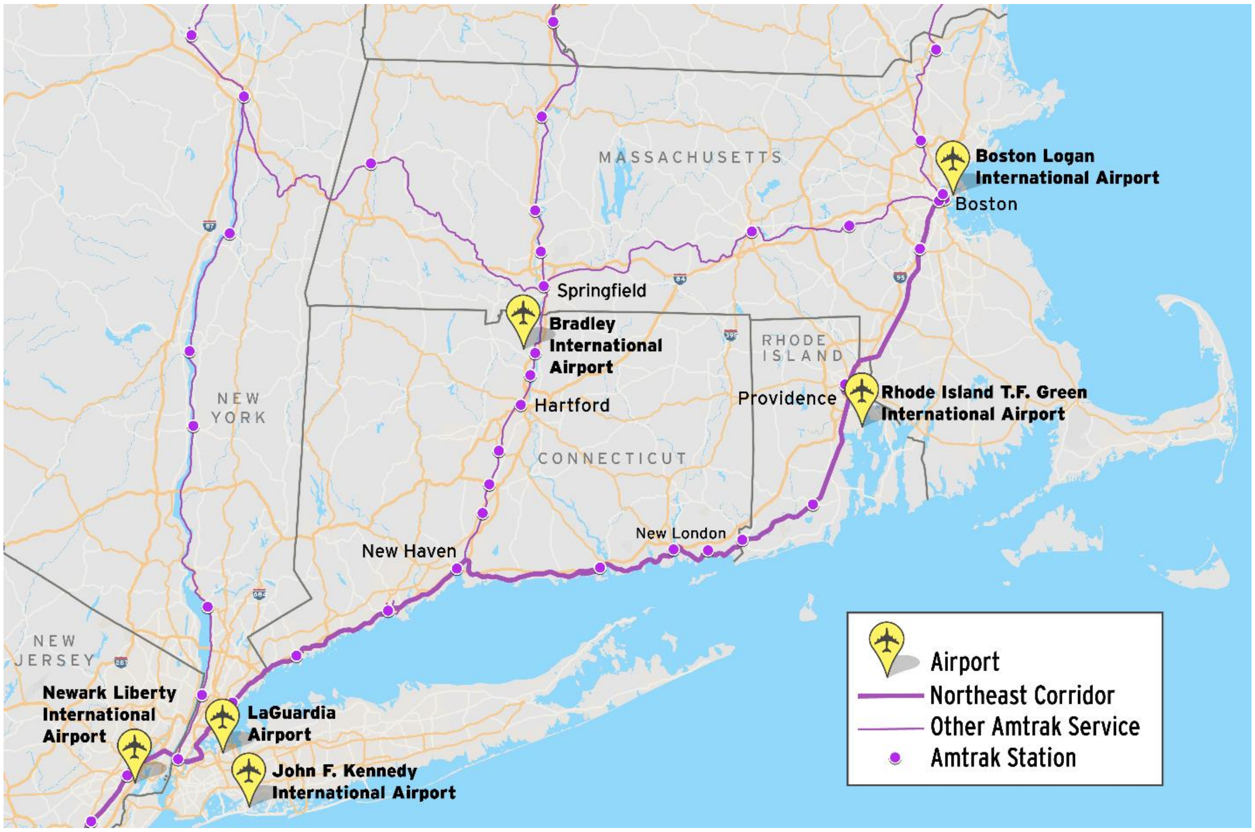
---

[1] https://www.fra.dot.gov/necfuture/project_docs/reports.aspx

[2] https://nec-commission.com/app/uploads/2022/10/FY23-27-Capital-Investment-Plan-01-Body-Oct-22.pdf

[3] https://railroads.dot.gov/sites/fra.dot.gov/files/2022-11/NEC%20Project%20Inventory.pdf

Figure A: The New Haven – Providence corridor as part of a larger interconnected network



Key Findings

The following key conclusions from the analysis of the travel market are set out in this report:

- Amtrak NEC service is dominated by Boston-NYC passengers, with Providence also being an origin or destination for a significant number of passengers.
- Both pre- and post-COVID, population, employment, and intercity travel movements are dominated by two major axes of movement:
  - A West-East axis between NYC-New Haven-Providence-Boston; and
  - A North-South axis between NYC-Fairfield County (CT)-New Haven-Hartford-Springfield.
- Other growing travel markets are most pronounced in the local trips around Boston and the surrounding area and several key Connecticut markets. The trips generated by this growth are ill-suited for intercity rail service because of their short distances.
- West-East travel between Hartford and Providence is relatively small and current forecasts suggest this pattern is unlikely to change significantly going forward.
- Both intercity rail and automotive travel patterns have returned to, or are approaching, pre-COVID levels, with further growth expected. Post-COVID Amtrak ridership reflects more diverse trip purposes, as the amount of leisure travel on *Acela* and *Northeast Regional* services has grown.

The Market Study demonstrates that the key markets for intercity rail in the region will remain along the existing NYC-New Haven-Providence-Boston route and a NYC-Fairfield County-New Haven-Hartford-Springfield axis. Future studies should focus on identifying options for improving overall capacity for service in these markets, whether through new or improved alignments. These options would aim to improve rail travel times between existing stations and position the corridor for greater resilience in the face of future climate trends.

Existing Conditions

This portion of this study is based on an evaluation of data from 2019. It is designed to present a view of the transportation market as it existed prior to the significant disruptions caused by COVID-19. Evaluation of the short- and long- term impacts of the COVID-19 pandemic can be found in the Future Conditions section. A summary of the data sources utilized can be found in Appendix A.

Study Area

The primary study area is defined as the states of Connecticut, Rhode Island, and Massachusetts. Due to its scale, proximity, and interconnectivity with these states, some analysis of the NYC Core Based Statistical Area ("CBSA") is included, particularly with respect to transportation flows. On a similar basis, data for the Boston CBSA does include data for its constituent New Hampshire counties. The study area is home to many local government entities, ranging from some of the nation's largest cities and their commuter suburbs, to historic small towns, reinforcing the complexity of the travel dynamics in the study area.

Figure 1 shows the extent of the study area. Key transportation corridors within the study area include:

- The core corridor between New Haven and Providence, extending on to Boston.
- The North-South corridor between New Haven, Hartford, and Springfield.
- Present and potential corridors between Hartford and Providence.
- The East-West corridor in Massachusetts between Springfield, Worcester, and Boston.

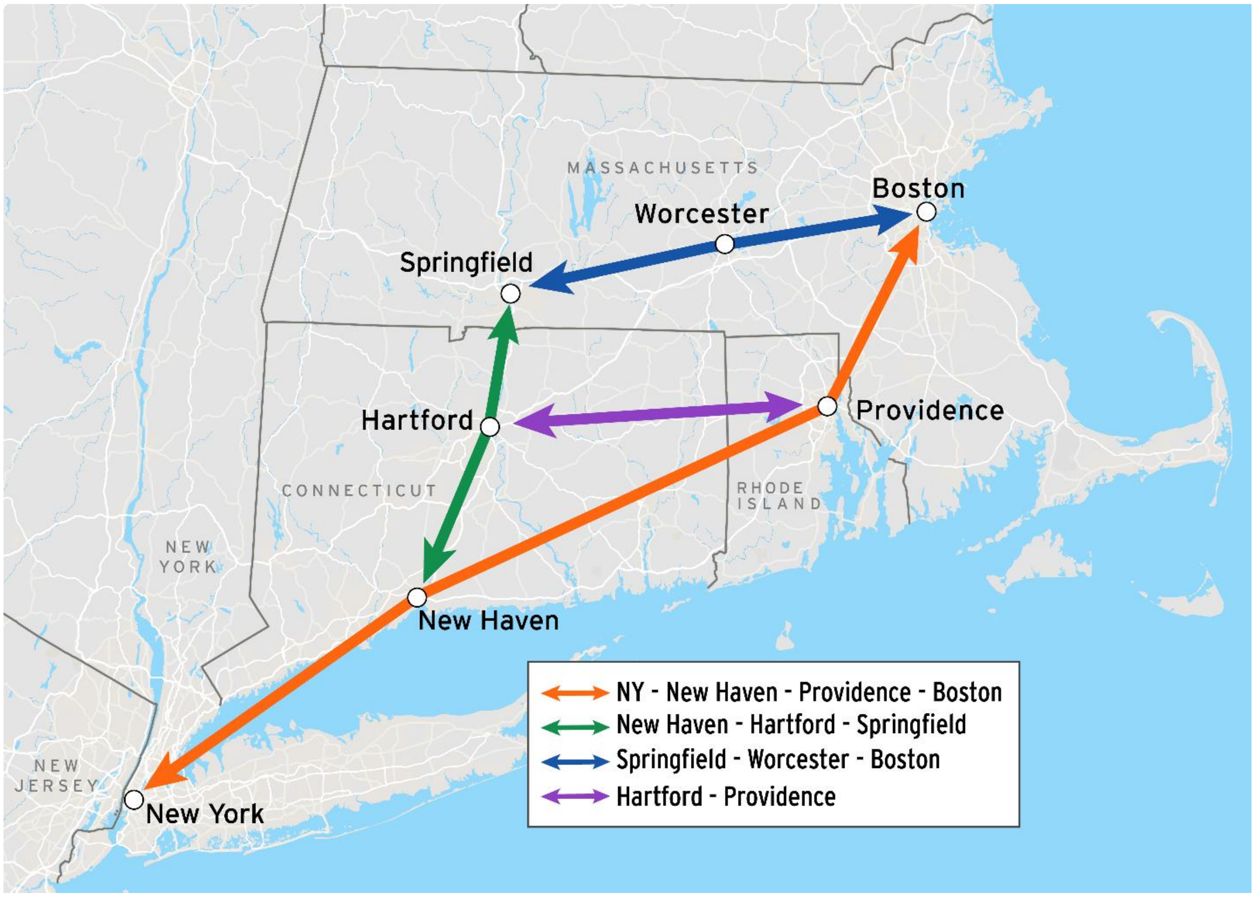
Several levels of geography are utilized to represent the study area in this report, depending on the level of analysis and the data available:

- County Level data is provided for Connecticut, Rhode Island, and Massachusetts.
- CBSA data is provided for all CBSAs in Connecticut, Rhode Island, and Massachusetts, as well as the New York-Newark; NY-NJ-CT-PA CBSA.
- Zone-based Origin-Destination (OD) data is provided from a third-party location-based services ("LBS") data vendor. It uses cellphone and other LBS data to estimate these OD patterns. Each zone for the OD data is a county or aggregation of counties.

Relationship to Potential Capacity Planning Study Area

This study area for the potential New Haven to Providence Capacity Planning Study from the NEC FUTURE ROD is more limited in extent than this Market Study, including only the areas considered for capacity expansion between Branford to Guilford, CT and Old Saybrook, CT to Kenyon, RI. However, the outcomes of that study will likely influence passenger rail services within a study area comparable to the one evaluated here.

Figure 1: Map of Corridor Region, including the key transportation corridors



County Level Socio-Demographics

The following section reviews the population and employment trends in the study area. These factors help identify areas or markets where there is a gap between rail travel demand and existing services; population levels, economic activity, and the location of employment centers inform the distribution and magnitude of commute movements.

Population

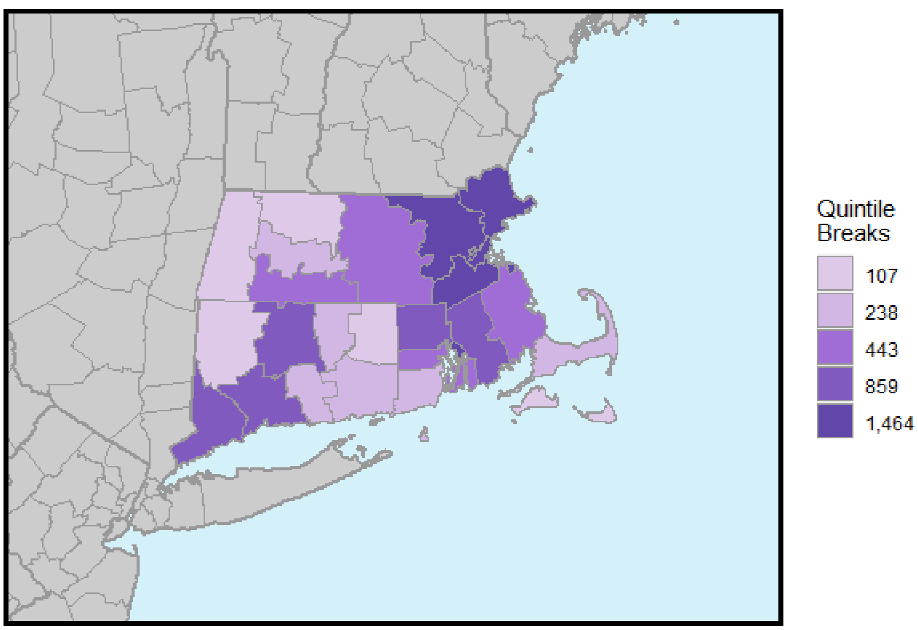
The states of Massachusetts, Rhode Island, and Connecticut have more than 11 million combined residents. Much of the population is concentrated within the Boston region in eastern Massachusetts and several other populous counties located in Connecticut and Rhode Island as seen in Figure 2. The largest counties by population can be seen in Table 1, and include the major metropolitan counties of Middlesex County, MA, Hartford County, CT, and Fairfield County, CT. Notably, while Suffolk County, MA has neither the most jobs nor the most population among study area counties, it has by far the highest density of both, as most of the county is made up of the city of Boston. Boston is a major origin and destination for trips in the study area, which needs to be considered in any future operational and investment decisions.

Table 1: 10 Largest Counties by Population

County	State	Population	Employment	Population per Square Mile	Employment per Square Mile
Middlesex County	MA	1,600,842	940,312	1,889	1,110
Fairfield County	CT	943,926	417,606	1,444	639
Hartford County	CT	893,561	512,042	1,191	682
New Haven County	CT	857,513	368,034	1,381	593
Worcester County	MA	824,772	353,153	522	224
Suffolk County	MA	796,605	703,058	12,014	10,603
Essex County	MA	783,676	327,009	1,472	614
Norfolk County	MA	700,437	354,129	1,697	858
Providence County	RI	635,737	289,328	1,469	669
Bristol County	MA	561,037	228,578	951	387

Source: ACS Data, 5-year Estimates 2015-2019

Figure 2: Population Density by County in CT, RI, and MA (per square mile)



Source: ACS Data, 5-year Estimates 2015-2019

Key Takeaway

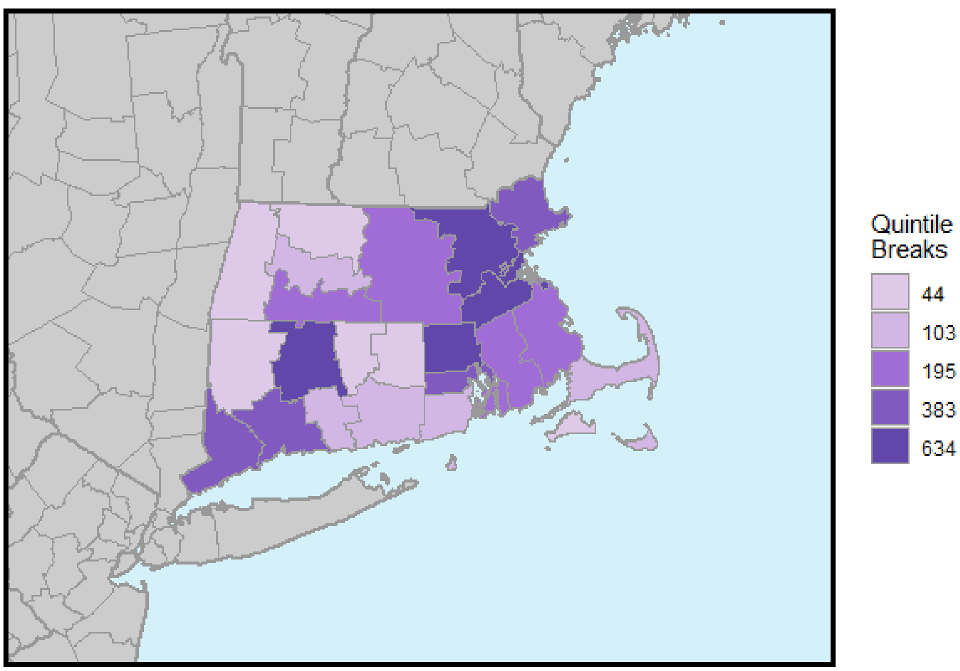
The study area's population is concentrated around the cities of Boston and Providence, and the Fairfield-New Haven-Hartford County axis in Connecticut. This concentration of population suggests the importance of ongoing investments in local and commuter transit services in these areas.

Employment

While the counties with the highest population densities are clustered around Boston, areas of high job densities are distributed across all three states, centered around Boston, Hartford and Providence, as seen in Figure 3. This pattern also reflects suburbanization of jobs in the region, particularly around Boston.

The population to job ratio was used to identify counties that are attracting significant numbers of outside workers, or counties where residents need to commute externally to access jobs.[4] These ratios can be seen in Table 2 and Table 3, and in Figure 4. For example, counties with a lower ratio (such as Suffolk County, MA), have more jobs than residents, which may indicate that there is a higher share of individuals who work in the county but live elsewhere. Improving connectivity between low and high ratio counties can drive rail ridership. However, counties where ratios are close to 1.0, like Berkshire County, MA it can also be representative of a fairly even distribution of jobs and population within the county.

Figure 3: Job Density by County in CT, RI, and MA (per square mile)



Source: ACS Data, 5-year Estimates 2015-2019

[4] Ratio calculated based on population over the age of 16. As not all residents of a county over the age of 16 are workers, a simple above 1 / below 1 relationship for this ratio should not be expected.

Table 2: Top 5 Counties by Population-to-Jobs Ratio

County	State	Population to Job Ratio
Tolland County	CT	1.87
Bristol County	RI	1.78
Litchfield County	CT	1.55
Windham County	CT	1.47
Franklin County	MA	1.34

Source: ACS Data, 5-year Estimates 2015-2019

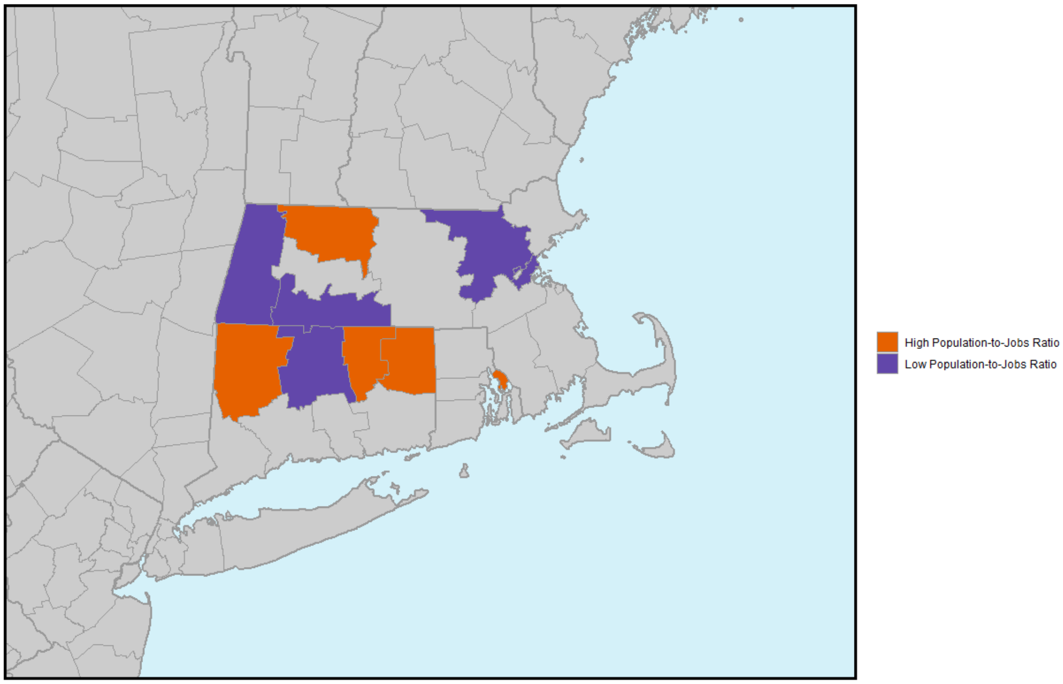
Table 3: Bottom 5 Counties by Population-to-Jobs Ratio[5]

County	State	Population to Job Ratio
Suffolk County	MA	0.62
Hartford County	CT	0.87
Middlesex County	MA	0.93
Hampden	MA	1.01
Berkshire	MA	1.03

Source: ACS Data, 5-year Estimates 2015-2019

[5] The Island counties of Nantucket, MA and Dukes, MA (Martha's Vineyard) are excluded from this analysis.

Figure 4: Top and bottom counties for Population-to-Jobs Ratio



Source: ACS Data, 5-year Estimates 2015-2019

Key Takeaway

The study area's jobs are concentrated in the major urban centers, with many surrounding counties having fewer jobs relative to their population. This distribution further emphasizes the potential importance of commuter and regional rail services in and around some major urban centers.

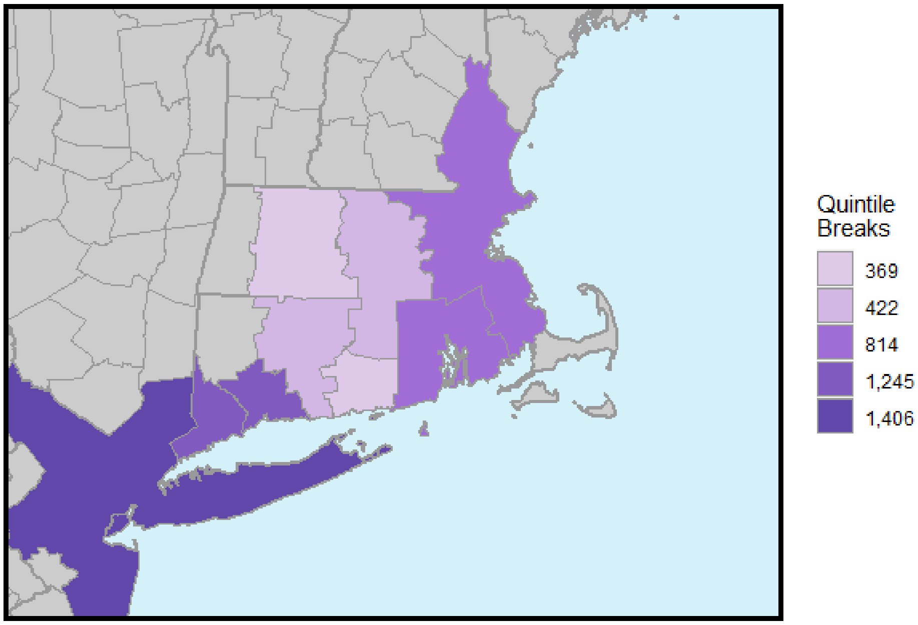
CBSA Level Socio-Demographics

According to the US Census Bureau, a CBSA is a geographic area consisting of one or more counties anchored by an urban center as well as surrounding counties that are socioeconomically tied to the urban center through commuting movements. The CBSA provides a key means by which population-job ratios are equalized, with workers from high ratio counties commuting to low ratio counties. As a standardized, medium scale unit of analysis, CBSAs allow for an aggregated look into longer-distance travel patterns, which often includes rail travel. A map of the nine CBSAs in the study area can be seen in Appendix B.

Population

Figure 5 illustrates the breakdown of population density on the CBSA-level. CBSAs themselves can be aggregated into a Combined Statistical Area ("CSA"), which is reflected in the distribution of population density. The New York City CBSA has the highest population density, followed by the Bridgeport-Stamford and New Haven CBSAs, all three of which form part of the same broader CSA. Similarly, the consistent levels of density between the Boston and Providence CBSAs are reflective of their forming part of the same broader CSA. The concentrations of population density in these two clusters underline the importance of intercity rail travel between New York and Boston, as well as travel by commuter rail and/or intercity rail within each cluster of CBSAs.

Figure 5: Population Density by CBSA (per square mile)



Source: ACS Data, 5-year Estimates 2015-2019

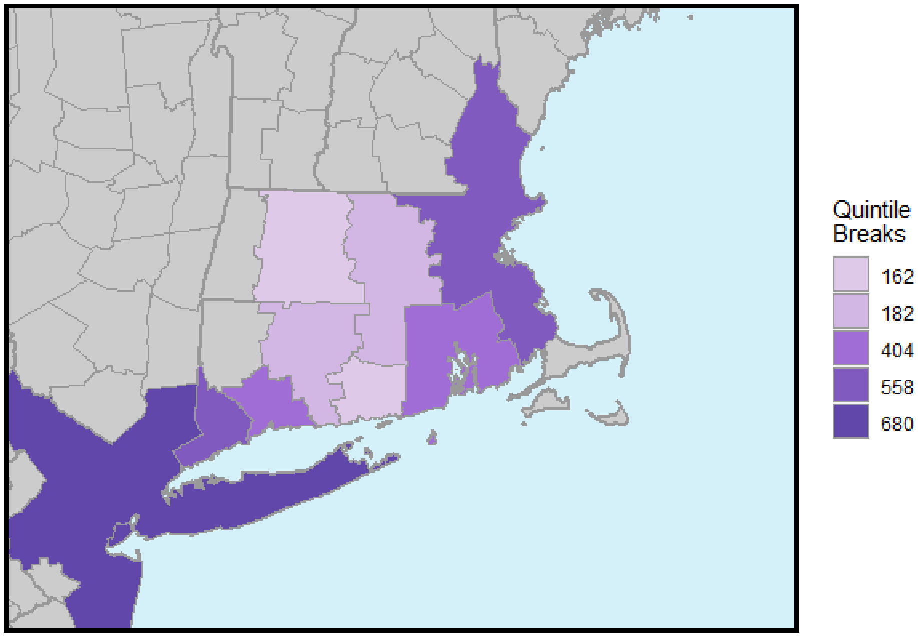
Key Takeaway

The scale of the geography and population density of the New York CBSA emphasizes the importance of connections between it and the study area. Future infrastructure investments in intercity passenger rail may wish to enhance connectivity with New York.

Employment

Job density by CBSA in the NEC follows patterns similar to population density. New York CBSA has the highest concentration of jobs, followed by Bridgeport-Stamford and Boston CBSAs, and then the New Haven and Providence CBSAs. Figure 6 suggests that there are two main economic hubs in the region: The Boston CBSA in the North and NYC CBSA in the South, to which the Providence CBSA, and the Stamford-Bridgeport & New Haven CBSAs are economically linked, respectively. Comparing the distribution of job and population density demonstrates the economic relationships between adjacent CBSAs. For example, While the Boston and Providence CBSAs are both in the same quintile for population density, Boston's CBSA is in a higher quintile for employment. This may reflect commuter flows from the Providence CBSA to the Boston CBSA.

Figure 6: Job Density by CBSA (per square mile)



Source: ACS Data, 5-year Estimates 2015-2019

Key Takeaway

The CBSA-level distribution of employment largely reflects the population distribution.

Amtrak Ridership

In 2019, at least 2.4 million in-study area Amtrak trips had started or ended in either the NYC or Boston CBSAs, as seen in Table 4. This is followed by Providence and New Haven, with relatively high ridership numbers compared to the other four CBSAs with data available. Low ridership numbers in CBSAs adjacent to Boston or New York can be explained by alternative modes of transport available at a lower cost such as commuter rail or personal vehicles.

Table 4: Total Amtrak Boardings and Alightings by CBSA, 2019[6]

CBSA	Annual Amtrak Ridership
New York	2,491,316
Boston	2,403,088
Providence	860,556
New Haven	578,743
Hartford	267,851
Bridgeport-Stamford	262,148
Norwich-New London	154,590
Springfield	101,058

Source: Amtrak 2019 Ridership Data

Key Takeaway

Over two-thirds of Amtrak trips in the study area have at least one endpoint in New York or Boston, which may justify focusing on improvements to these markets as it brings benefits to a larger number of travelers. Given shared track use between Amtrak and multiple commuter railroads, these investments could also benefit the wider area.

Existing Passenger Rail Corridors

Passenger rail has historically played an important role in the study area and continues to do so today. Significant rail trackage exists throughout the study area. A map of all rail track in the study area can be seen in Appendix B. This dense rail infrastructure is utilized by a complex web of freight operators, commuter rail operators, and Amtrak.

Passenger Rail Infrastructure

The condition of the passenger rail infrastructure in the study area varies significantly. Specifically, the trackage used by Amtrak's *Northeast Regional* and *Acela* trains is fully electrified, although some of the trains utilizing that track still operate with diesel-powered equipment. One example is the MBTA Commuter Rail service between Boston and Providence. Other trains, such as Amtrak's *Vermonter* service, may utilize electric locomotives while on the NEC tracks, and then switch to diesel locomotives for the remainder of their trip along unelectrified corridors like the Hartford Line and Connecticut River Line. Any infrastructure investments in the study area must account for the needs of both electric and diesel trains, their separation onto different rights of way, or electrification of the diesel services.

All four major commuter rail services in the study area share track operations with Amtrak. MBTA Commuter Rail and Metro-North run some but not all their services on track shared with Amtrak, while the Shore Line East and Hartford Line services run entirely on rights of way shared with Amtrak. In Massachusetts, east-west Amtrak service on the Lake Shore Limited shares track with freight services and the MBTA. All these operators run significant services in the region, resulting in complex operating patterns and difficult coordination challenges, particularly where intercity, commuter and freight service coexist on the same rail lines.

[6] In Study Area trips only, on the *Northeast Regional*, *Acela*, *Hartford Line*, *Valley Flyer*, and *Vermonter* services

Amtrak

Amtrak operates numerous rail services in the study area, including the higher speed NEC services (i.e., *Acela* and *Northeast Regional*, state-sponsored services like the *Vermonter* & *Valley Flyer*), and Long-Distance trains. Combined, those services had 12.5 million total passengers in FY 2019 across their full routes.[7]

In calendar year 2019, 3.6 million passengers traveled entirely within the study area CBSAs on the *Acela*, *Northeast Regional*, *Vermonter*, and New Haven-Springfield routes, with an average ticket revenue per passenger of approximately $95. Service frequency varied significantly, from regular all-day all-week service on the *Northeast Regional* and *Acela* trains[8], to once-daily service on the Vermonter.

Metro-North Railroad – New Haven Line

Metro-North is a subsidiary entity of the Metropolitan Transportation Authority ("MTA"), whose other public transit operations include the NYC subway and bus systems, as well as the Long Island Rail Road commuter services. Metro-North connects NYC to communities to its north, in both New York State and in Connecticut. The study area is served by Metro-North's New Haven line, which primarily operates from New York's Grand Central Terminal through Fairfield County and continues to a terminus in New Haven, with three branches into the interior of Connecticut. In Connecticut, Metro-North operates on CTDOT owned right of way. The core coastal segment of the route north and west of New Rochelle, NY is track shared with Amtrak.

In 2019, Metro-North recorded over 40 million passengers on the New Haven Line. The New Haven line made up a majority of all commuter rail trips in the study area in 2019, and while the service does not extend beyond New Haven, the operational and infrastructure needs of this service have significant impacts on connected passenger rail in the study area. As of mid-2022, a one-way fare between the New Haven terminus and Manhattan was $24 at Peak/$18 Off Peak, or $500 for a monthly pass.[9] Service was oriented toward peak-hour traditional commuting, with service outside those windows and on weekends operating at longer headways.

CTrail – Shore Line East

Shore Line East is operated by the state of Connecticut and connects New Haven to coastal communities as far east as New London. It shares its right of way with Amtrak's *Northeast Regional* and *Acela* services.

In 2019, Shore Line East recorded over 600,000 trips.[10] Ridership had declined significantly on the service over 2014-2018, from almost 1 million to 600,000. This reflected equipment and track issues that led to frequent service delays and the replacement of many trains with substitute bus service. As of mid-2022, one -way fares between New Haven and New London were $10.25, and $215.25 for a monthly pass.[11] Service was oriented toward peak-hour traditional commuting, with service outside those windows and on weekends operating at longer headways.

---

[7] https://media.amtrak.com/wp-content/uploads/2020/06/Amtrak-Corporate-Profile_FY2019_-FINAL-033120.pdf

[8] *Acela* services have a more significant decrease in frequency on weekends compared to *Northeast Regional* services.

[9] Source: http://web.mta.info/mnr/html/faresApril2019/nhl_nysfares_apr2019.html

[10] https://www.ctinsider.com/shoreline/article/Amtrak-aims-to-honor-Shore-Line-East-tickets-by-16324579.php#:~:text=Ridership%20along%20the%20Shore%20Line,2019%2C%20according%20to%20the%20DOT.

[11] Source: http://web.mta.info/mnr/html/faresApril2019/nhl_nysfares_apr2019.html

Electrified service on Shore Line East began in 2022.[12] Amtrak owns the right of way and dispatches the line. Amtrak crews operate the SLE service.

CTrail – Hartford Line

The CT*rail* Hartford Line regional rail service connects New Haven and Hartford, with some trains providing service north to Springfield, MA along Amtrak's New Haven-Hartford-Springfield Line. The service started operation in 2018, and 2019 data may not be an accurate reflection of underlying demand for the service because it often takes several years for full adoption. CT*rail* complements and expands on existing Amtrak intercity passenger rail services along this corridor.

In 2019, the CT*rail* Hartford Line recorded over 700,000 trips.[13] Ridership performance on the service exceeded forecast expectations of sponsor CTDOT.[14] As of mid-2022, a one-way fare from New Haven was $8.00 to Hartford and $12.75 to Springfield, with monthly passes costing $168 and $267.75 respectively. Service was oriented toward peak-hour traditional commuting, with service outside those windows and on weekends operating at longer headways.

Amtrak owns and maintains the New Haven-Hartford-Springfield Line rail infrastructure and dispatches the line. A third-party contractor provides crews to operate the CT*rail* Hartford Line service for CTDOT.

MBTA Commuter Rail (CR)

The MBTA CR primarily operates radial service, extending from terminal stations in Boston to the north, west, and south. The route most relevant to this study is the Providence Line between Boston South Station and Providence that continues south to TF Green Airport and Wickford Junction stations in Rhode Island. The service shares track with Amtrak *Northeast Regional* and *Acela* service and is operated under contract by Keolis Commuter Services.

In 2019, MBTA CR recorded over 31 million unlinked passenger trips, across all commuter rail routes.[15] 2019 data was not available, but in 2018 the Providence Line made up approximately 25% of MBTA CR ridership. As of mid-2022, a one-way fare between Boston and the outermost zone (where Providence is located) was $13.75 one way, and $426.00 for a monthly pass. Service was oriented towards peak-hour traditional commuting, with service outside those windows and on weekends operating at longer headways.

Key Takeaway

The shared infrastructure between Amtrak, multiple commuter rail operators, and freight operators means that operational and infrastructure changes in the study area will likely involve complex coordination and trade-offs between stakeholders.

---

[12] https://portal.ct.gov/Office-of-the-Governor/News/Press-Releases/2022/05-2022/Governor-Lamont-Announces-That-M8-Electric-Trains-Have-Arrived-on-Shore-Line-East

[13] https://darik.news/massachusetts/ct-ctrails-hartford-line-to-springfield-recovers-in-2021-but-reaching-pre-pandemic-business-will-be-a-challenge/202201485240.html

[14] https://portal.ct.gov/-/media/Office-of-the-Governor/News/20190617-CTrail-Hartford-Line-Year-One-Report.pdf

[15] NTD, 2019 Data

Key Highway Corridors

A map of major interstate highways in the study area can be found in Appendix B. There are also numerous U.S. highways and state highways throughout the study area. Together these comprise a ubiquitous road network that competes with rail travel.

I-95

The principal interstate highway on the U.S. east coast, I-95 stretches from Miami to Maine, reaching the Canadian border. In the study area, it follows a near coastal route through Southern Connecticut, including passing through Bridgeport, Stamford, New Haven, and New London. I-95 then heads northeast towards Providence, RI and continues through Massachusetts.

I-90

I-90 stretches from Seattle, WA to Boston, MA. In the study area, I-90 travels across Massachusetts, connecting Boston to the broader Springfield and Worcester areas and into New York state.

I-91

From the Canadian border, I-91 passes through northern New England, predominantly in Vermont, before crossing into the study area in western Massachusetts, and then into Connecticut. In the study area, I-91 connects its southern terminus in New Haven, CT, to the Hartford and Springfield regions to the north.

I-84

The I-84 interstate in the study area connects Northeast Pennsylvania to Massachusetts via Hartford, CT. It provides an alternative route to I-95 primarily for travelers through Connecticut to connect with I-90 in Massachusetts, or the New York Area.

I-395

A number of interstate highway segments use the I-395 numbering. The segment in the study area diverges from I-95 in eastern Connecticut, between East Lyme and Waterford, and runs north through eastern Connecticut and connects with I-90 south of Worcester, MA.

Non-Interstate Roadways

In addition to these interstate connections, substantial road connectivity is provided by a number of additional limited or partially limited access highways.

Key Takeaway

Robust and generally ubiquitous highway infrastructure throughout the study area ensures driving will be a competitive alternative travel mode to rail travel. The ubiquity of highway infrastructure may limit the feasibility of rail as a competitive mode for serving smaller OD markets.

Air Travel

The study area is home to a significant number of airports. These range from major international airports such as those found in Boston and in the NYC area, to regional airports such as those in Worcester, Hartford, and Providence. Air travel within the study area is dominated by trips centered on Boston and New York, with most passengers starting and/or ending in one of the two. Even between Boston and New York, air travel has a mode share of less than 10%.[16]

Key Takeaway

Like intercity rail, air travel in the study area is dominated by travel to Boston and New York.

2019 (Pre-COVID-19) Travel Patterns

This section examines travel flows in the study area as they were in 2019. This analysis is based on several data-sources, including location-based services (LBS) cellphone data from StreetLight[17], as well as data from the American Community Survey ("ACS"), the National Household Travel Survey ("NHTS"), among other sources.

Travel Market Analysis (All Modes)

Origin-Destination Analysis

This section uses estimated daily flows from LBS cellphone data to assess major trip flows in the study area. OD trips are summarized based on a custom zone framework created for use as part of this analysis, which can be seen in Appendix B. The zone system has 25 zones and is designed to provide more detail within the core study area while still representing longer-distance travel patterns. Each county in Connecticut and Rhode Island is a separate zone, with less detail in Massachusetts, and even less data throughout the broader Northeastern United States. A map of these zones can be seen in Appendix B.

Our analysis considers both urban and intercity trips:

- Short distance urban trips are estimated using the standard Streetlight LBS data platform, which is optimized to estimate shorter distance trips; and
- Long distance intercity trips are estimated using a customed Streetlight LBS data product that combines linked shorter trips into long distance trips to capture long distance travel in the region[18].

---

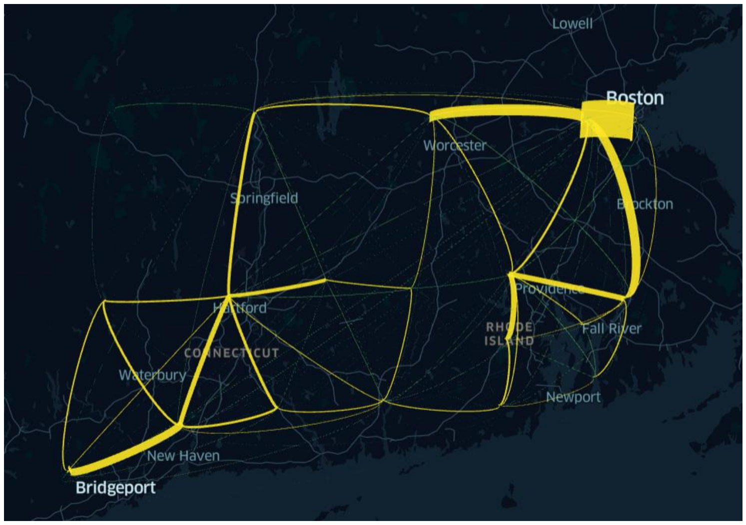
[16] http://nec-commission.com/app/uploads/2018/04/2015-09-14_NEC-Intercity-Travel-Summary-Report_Website.pdf

[17] Streetlight data is primarily used for comparative analysis, and not to produce absolute traffic volume numbers

[18] Covered geography is larger than Study Area to provide broader context for longer distance travel patterns. More details on the LBS data can be found in Appendix A

LBS cellphone data and ACS Journey to Work ("JTW") data allow the study to analyze travel connections between OD pairs. Figure 7 and Figure 8 show short-distance flows within the study area and broader flows throughout the Northeastern United States, using the standard (urban trips) and custom (intercity trips) LBS data respectively. Figure 9 demonstrates the predominance of shorter distance trips over longer distance trips. The data also shows the dominant influence of the Boston and New York areas over travel patterns of the region.

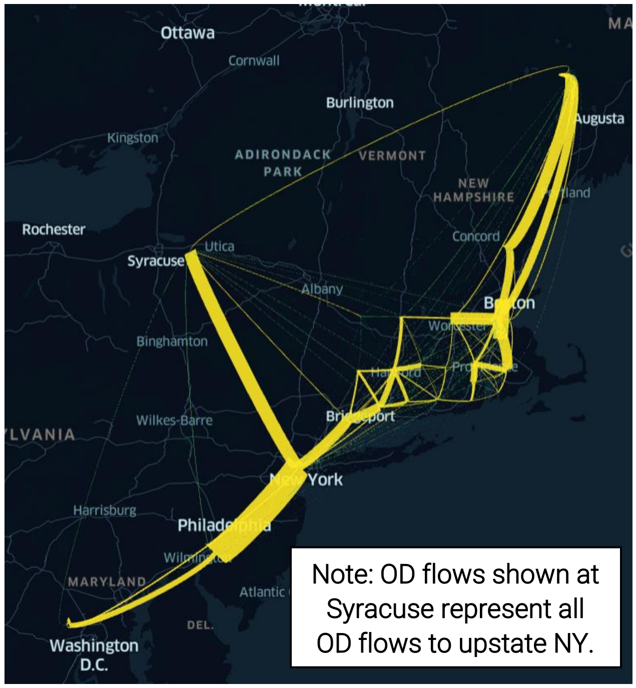
Figure 7: Short Distance OD Flows, Intra-Study Area Flows Only[19]



Source: StreetLight Standard Data, 2019

[19] Flow locations based on Streetlight Zone centroid locations – they do not reflect flows between the exact coordinates depicted.

Figure 8: Long Distance OD Flows, All flows within the Northeastern USA[20]



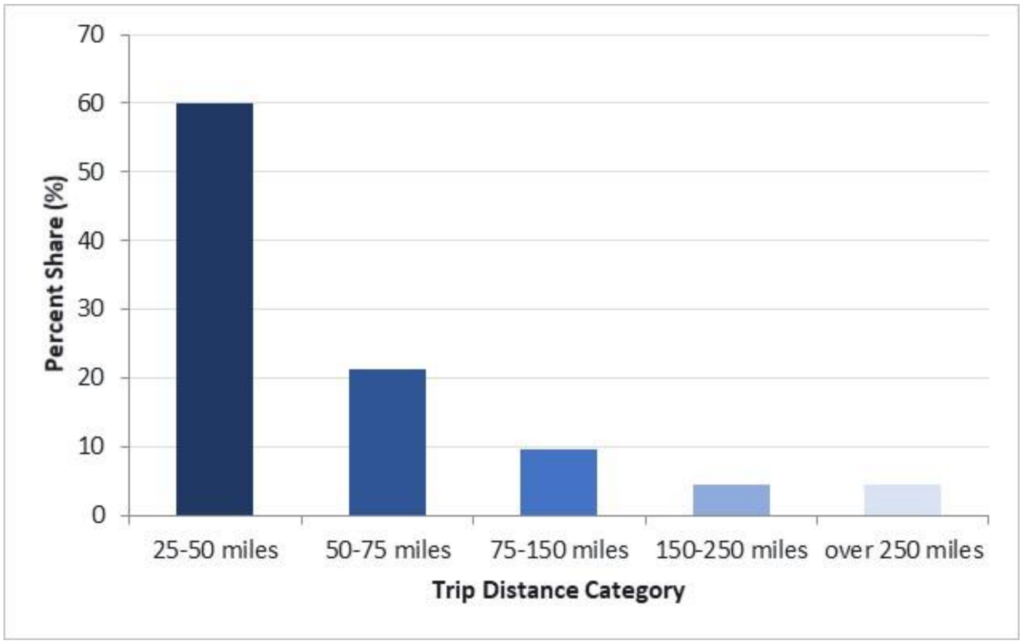
Source: StreetLight Custom Data, 2019

Key Takeaway

The analysis of the cellphone data shows that shorter (commuter trips) dominate travel flows centered on Boston/Providence and Hartford/New Haven, but long-distance demand exists connecting the Boston/Providence area with the Hartford/New Haven and New York City markets. Travel demand is more limited east-west between Providence and Hartford.

[20] Flow locations based on Streetlight Zone centroid locations – they do not reflect flows between the exact coordinates depicted.

Figure 9: Study Area % Share of trips by distance category, (Trips over 25 miles)[21]



Source: 2017 National Household Trip Survey (NHTS) Trip Data

Figure 10 shows short distance flows between CBSA pairs that are less than 75 miles apart while Figure 11 shows intercity trips between CBSA pairs with a minimum distance of 75 miles.[22] This data reflects travel between CBSA pairs, and not just between their core city centers.

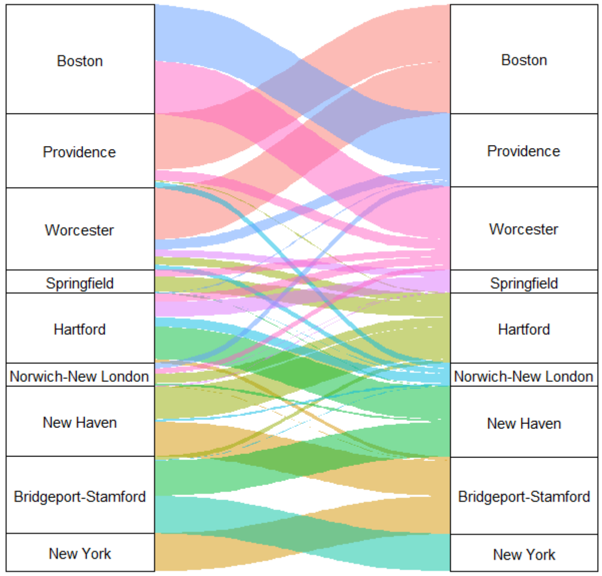
When evaluating these flows, it is also important to keep in mind the relationship between trip flows and distance. As shown in Figure 9, trips over 75 miles in distance are far less common than shorter distance trips.[23]

[21] Trips for MA, CT, & RI only. Trips under 25 miles excluded for legibility.

[22] Distances are calculated based on straight line distance between the centroids of each CBSA.

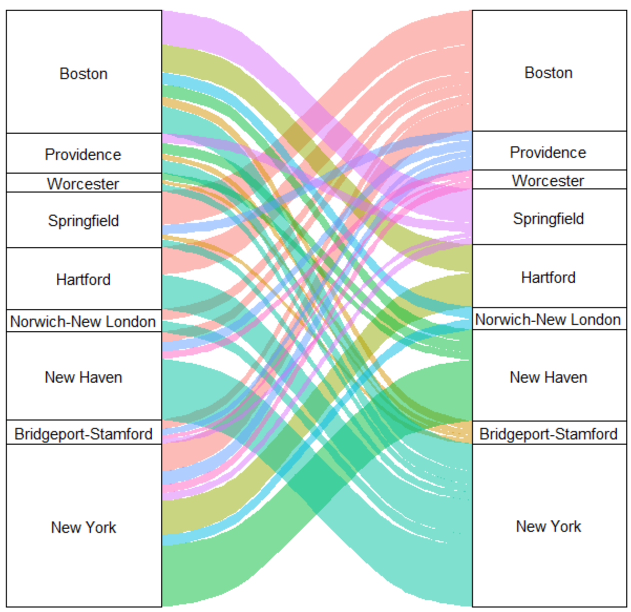
[23] This effect would be magnified at the 0-25 miles category, but almost all of those trips would occur within a single CBSA.

Figure 10: Proportional Short Distance OD Flows by CBSA Pairs (CBSA Pairs less than 75 miles apart)[24]



Source: StreetLight Standard Data, 2019

Figure 11: Proportional Intercity OD Flows by CBSA Pairs (CBSA pairs more than 75 miles apart)

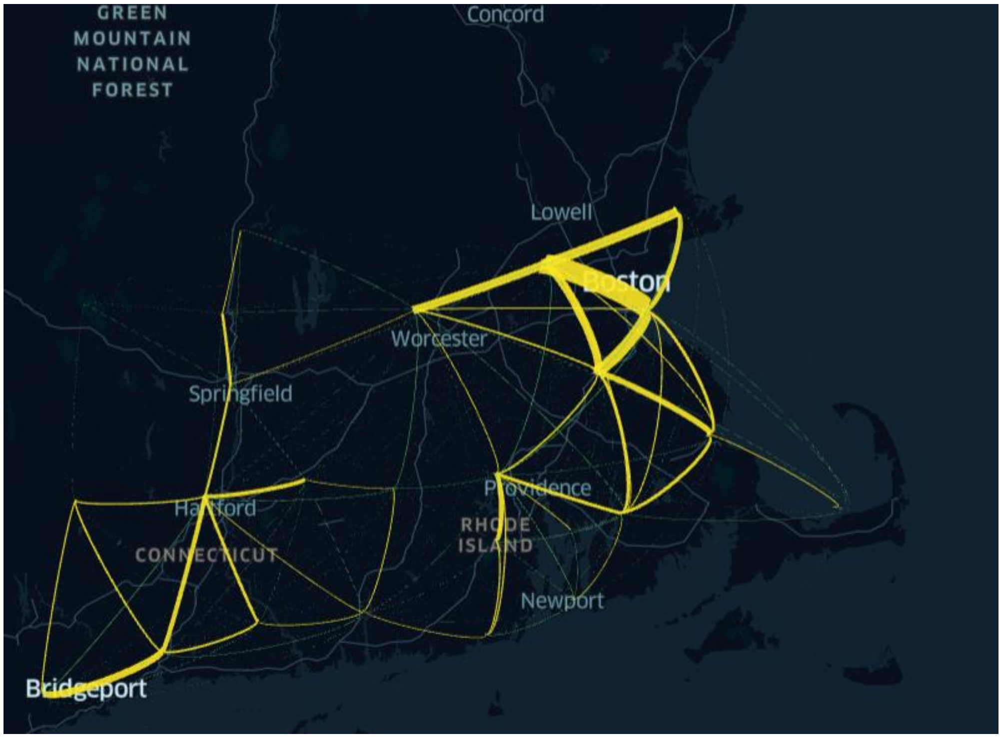


Source: StreetLight Custom Data, 2019

[24] Inter-CBSA trips only

Figure 12 shows commuting flows from the ACS throughout the study area for all modes of travel. It supports the findings from the cellphone data analysis.

Figure 12: All Modes Commuting Flows by County in the Study Area[25]



Source: ACS JTW CTPP Data, 2012-2016 5-year ACS estimates

Key Takeaway

Travel flows throughout the study area are dominated by local rather than longer distance trips. Significant travel takes place in two North-South medium distance pairs, one centered around Boston and the other around a New Haven-Hartford-Springfield axis. East-west travel between Hartford and Providence is more limited.

Trip Purpose Analysis

To assess travel behavior originating in the study area by purpose, trip data from the 2017 NHTS is broken down by primary reason of trip, which are Home-Based Work, Business Travel, Leisure, and Non-Work. Home-Based Work primarily refer to typical commuting behavior, while Business Travel reflects other work-related travel patterns. Leisure trips are trips with shopping, visiting friends or relatives, or other social/recreational activities as the primary purpose, whereas Non-Work trips include all other trip purposes such as medical appointments, school, and personal business.

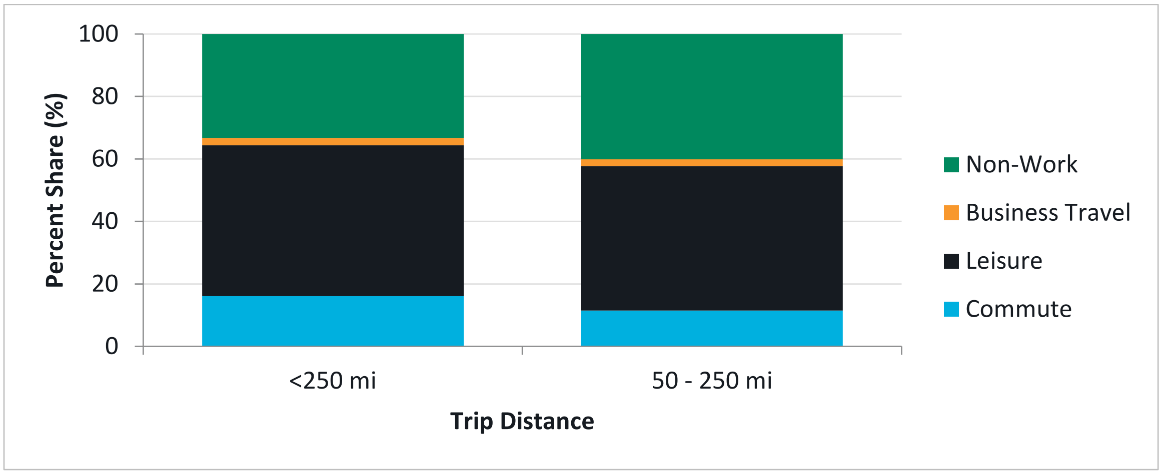
NHTS data only provides the home location of a survey respondent, and not the specific origin and destination addresses for trips. We analyzed two different subsets of trips from the NHTS dataset:

[25] Flow locations based on county centroid locations – they do not reflect flows between the exact coordinates depicted.

- Trips for individual residents in the study area and which were less than 250 miles, to exclude very long-distance trips that would likely exit the study area (such as long-distance air travel).
- Trips for individual residents in the study area and which were between 50-250 miles, to focus on intercity trips while still excluding very long-distance trips.

Maps showing the home county origins of workers for each work county can be seen in Appendix B. Middlesex, Norfolk, and Suffolk Counties in Massachusetts as well as Hartford and Fairfield Counties in Connecticut have the highest number of commuters originating from outside these counties.

Figure 13: Percentage Share of Trip Purposes by Trip Distance



Source: 2017 National Household Trip Survey (NHTS) Trip Data

Figure 13 above illustrates the percentage share of trip purpose for trips less than 250 miles and trips between 50 to 250 miles, with origins in either Connecticut, Massachusetts, or Rhode Island. For both distance cutoffs, the largest share of trips are leisure trips, followed by non-work, commute and finally business travel trips.

Key Takeaway

There is an opportunity to broaden the market for rail travel in the area. Business and commute-oriented travel make up less than 20% of all travel.

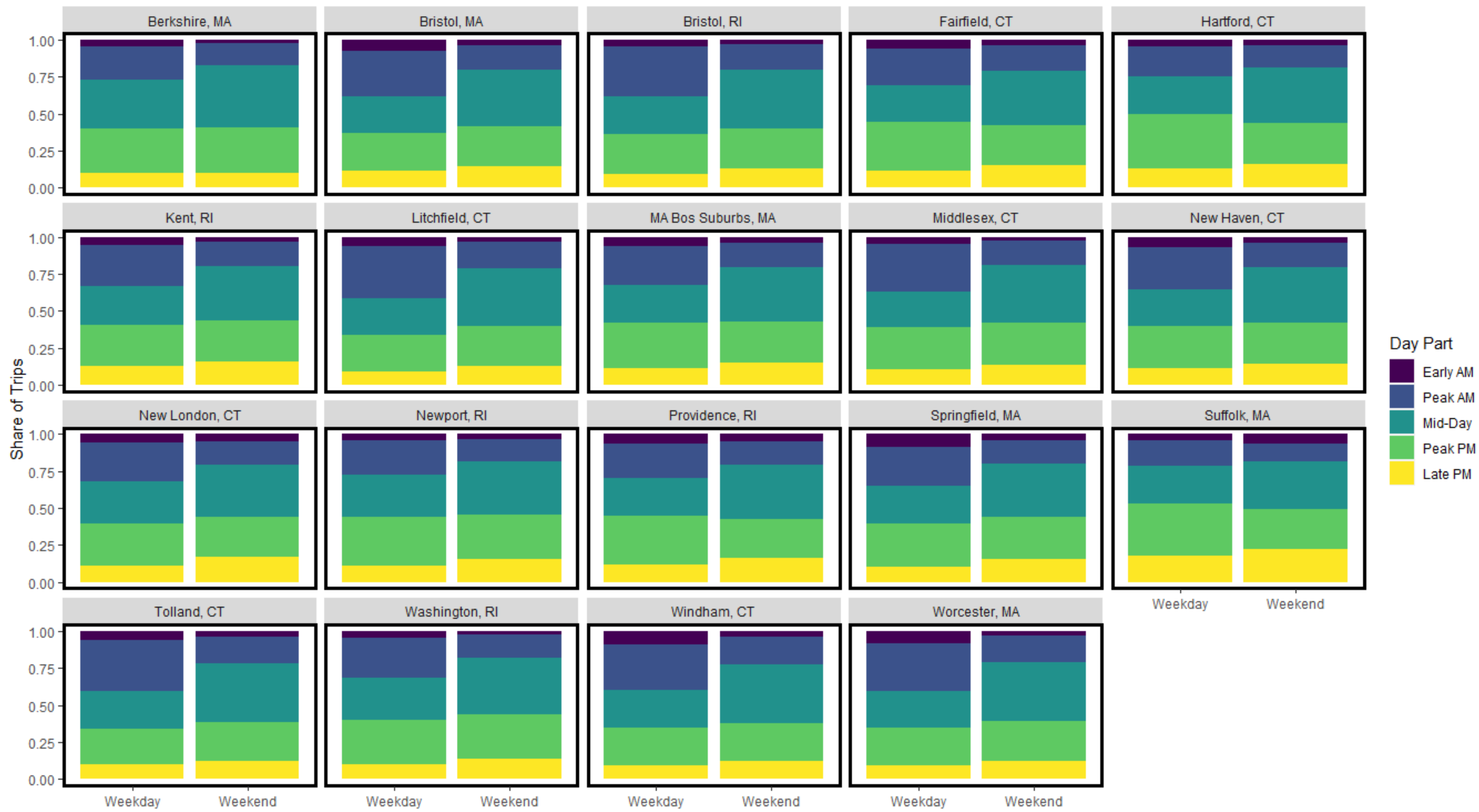
Trip Timing Analysis

We analyzed trip flows by day type (Weekday Vs Weekend) and day part, specifically the following:

- Early AM (12am – 6am)
- Peak AM (6am – 10 am)
- Mid-Day (10am – 3pm)
- Peak PM (3pm – 7pm)
- Late PM (7pm – 12am)

Together, these two time elements can demonstrate key trip patterns, particularly around commuting behavior. For rail operators, these time-based patterns can inform schedule and frequency planning, among other aspects of operations.

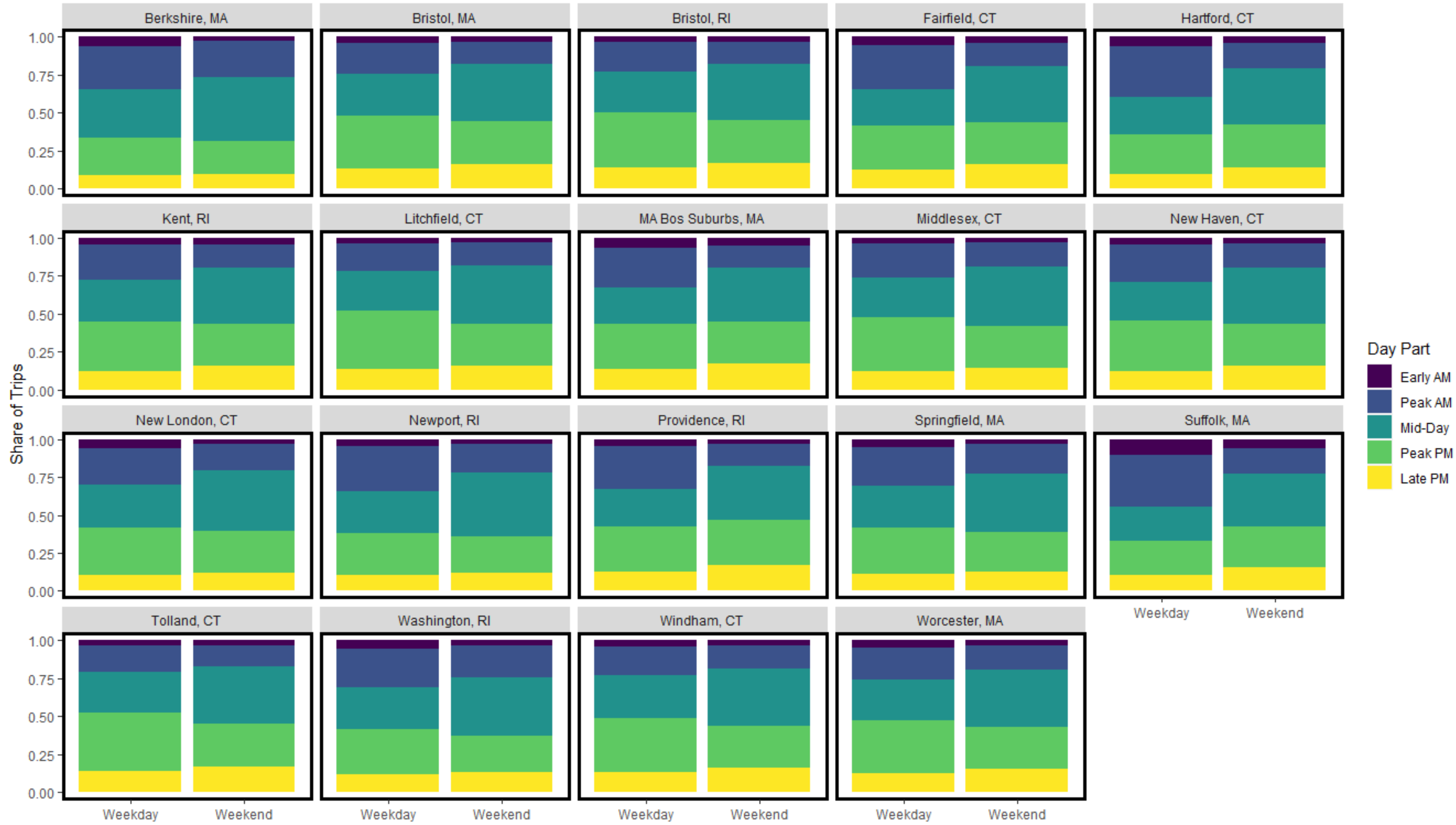
Figure 14: Weekday and Weekend Trip Spread by Time of Day and StreetLight Origin Zone[26]



Source: StreetLight Custom Data

[26] Only Origin Zones in CT, RI, and MA. Trips within a single zone excluded.

Figure 15: Weekday and Weekend Trip Spread by Time of Day and StreetLight Destination Zone[27]



Source: StreetLight Custom Data

[27] Only Destination Zones in CT, RI, and MA. Trips within a single zone excluded.

Figure 14 and Figure 15 show the custom StreetLight data for cross-zone flows by Origin and Destination zone respectively, broken down by day type and day part. Early AM and Peak AM trips are lower on weekend days across all zones, which likely reflects fewer commutes occurring on those days. This difference is largest in counties with a higher number of jobs than population (such as Suffolk County, MA), reflecting relatively few outbound commutes being conducted from Suffolk County to other zones. A similar pattern is seen for Hartford, CT. The reverse pattern is significant for both counties in the Destination zone results, with Peak AM trips to Hartford, CT and Suffolk, MA being much more common on weekdays as compared to weekend days. The data also show that considerable travel also takes place outside the AM and PM peak periods, particularly on weekends.

With the impact of COVID-19 and forecasts about increased acceptance of flexible working (such as hybrid remote/office work or more variable hours) in the future, this could impact rates and concentration of non-daily commuting in the study area. These behaviors were less common before the pandemic; indeed, the 2017 NHTS data suggests a relatively flat distribution of work trips across weekdays in the states of CT, RI, and MA. Table 5 shows that 17-20% of work trips occur on each of the five weekdays. Present data on the impact of COVID-19 on this pattern is limited and may not be reliable. However, daily ridership data is reported by the MTA, which suggests that commuter rail ridership recovery may be slower on Fridays relative to other weekdays.[28]

Table 5: % of Work-trips occurring each Day of Week[29]

Day of Week	% of Work Trips
Sunday	2%
Monday	19%
Tuesday	17%
Wednesday	20%
Thursday	20%
Friday	17%
Saturday	4%

Source: NHTS 2017 Data

Table 6 shows the share of trips on a given day that are commute trips. This distribution is relatively flat across each weekday, with Saturday having a slightly higher commuter share than Sunday.

[28] https://new.mta.info/coronavirus/ridership

[29] Percentages may not add up to 100% due to rounding.

Table 6: Commuter Share of Trips per Day of Week

Day of Week	Commute % of Trips
Sunday	3%
Monday	22%
Tuesday	23%
Wednesday	18%
Thursday	21%
Friday	17%
Saturday	5%

Source: NHTS 2017 Data

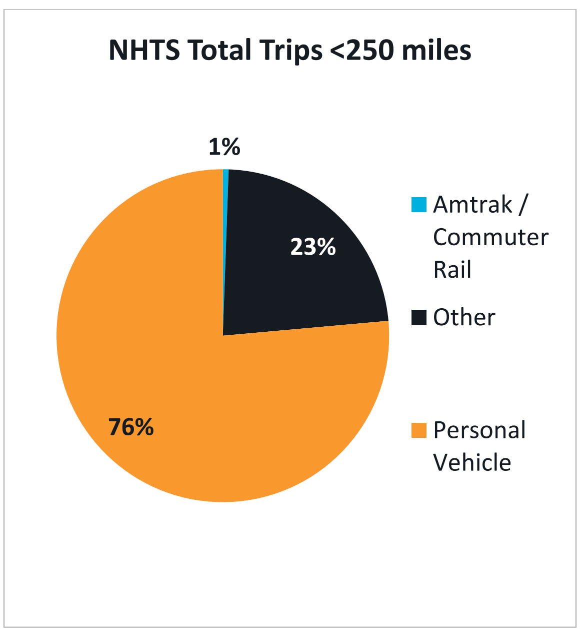
Key Takeaway

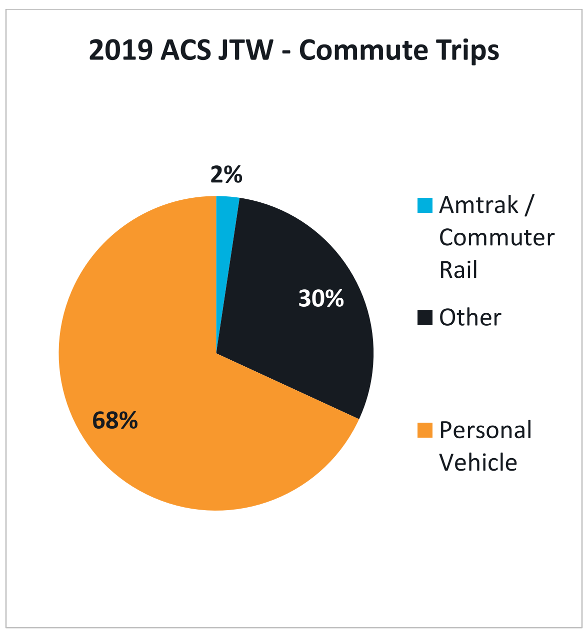
There is both significant non-commuter trip volumes between all counties, and substantial travel generally outside of the typical peak commuting periods.

Modal Split Analysis

This section analyzes NHTS trip data based on the mode of travel: Amtrak/Commuter Rail, Personal Vehicle and Other, which includes all remaining modes of travel such as subway, taxi, and school bus.

Figure 16: Percentage Mode Shares of NHTS Total Trips vs ACS Journey to Work Trips

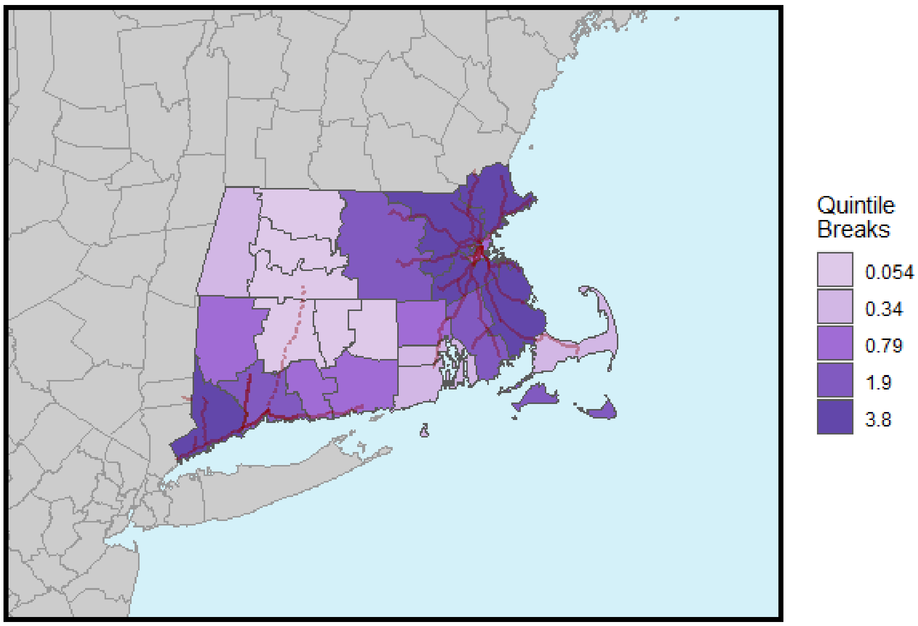




Source: 2017 National Household Trip Survey (NHTS) Trip Data, 2019 ACS JTW CTPP Data

Figure 16 compares mode shares for all trips less than 250 miles and commute trips between NHTS data and ACS Journey to Work data. The share of Amtrak/commuter rail trips is slightly higher for commute-only trips and the share of trips made with personal vehicles are lower for the same type of trips. This suggests that within the study area, there is a higher preference of using Amtrak/Commuter Rail or non-personal vehicle modes (Including non-Commuter Rail transit modes) for commuting in comparison to trips of other purposes.

Figure 17: % of Commuters using Commuter Rail by Home County, with CR lines overlaid[30]

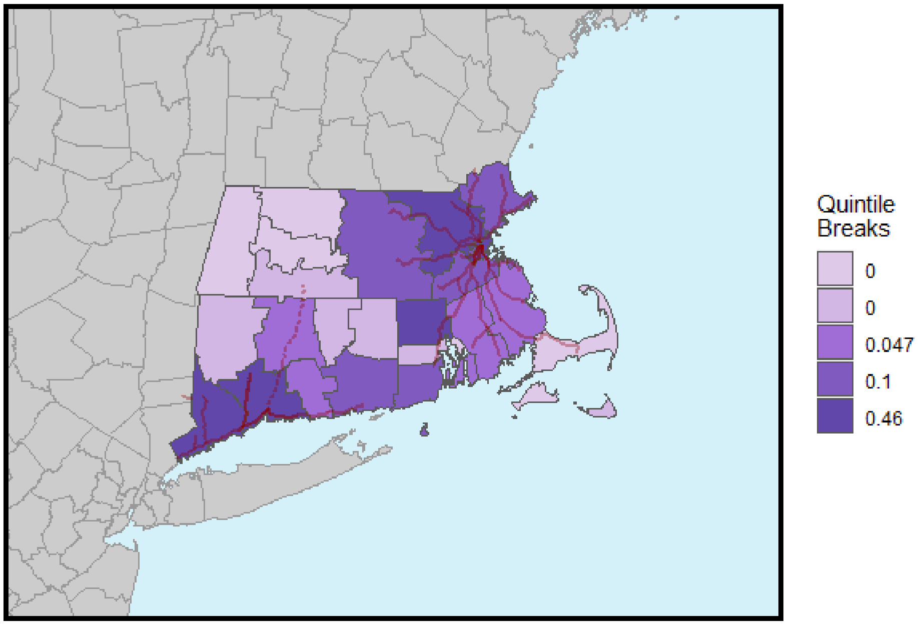


Source: ACS JTW CTPP Data, 5-year Estimates 2012-2016

The home counties with the highest share of commuters using commuter rail are all located within the vicinity of a commuter rail line. As seen in Figure 17 above, the farther away a commuter's home county is from a rail line, the less likely they are to utilize commuter rail. This is consistent with expectations since people will need to first travel to a rail station and then transfer onto the train. Note that this data predates the opening of the Hartford Line, and so does not accurately reflect commuter rail ridership on that corridor.

[30] Quintile breaks expressed in % terms.

Figure 18: % of Commuters using Commuter Rail by Work County, with CR lines overlaid



Source: ACS JTW CTPP Data, 5-year Estimates 2012-2016

Similarly, the share of commuters using commuter rail is also lower for work counties that are not located near a commuter rail line, as seen in Figure 18.

Key Takeaway

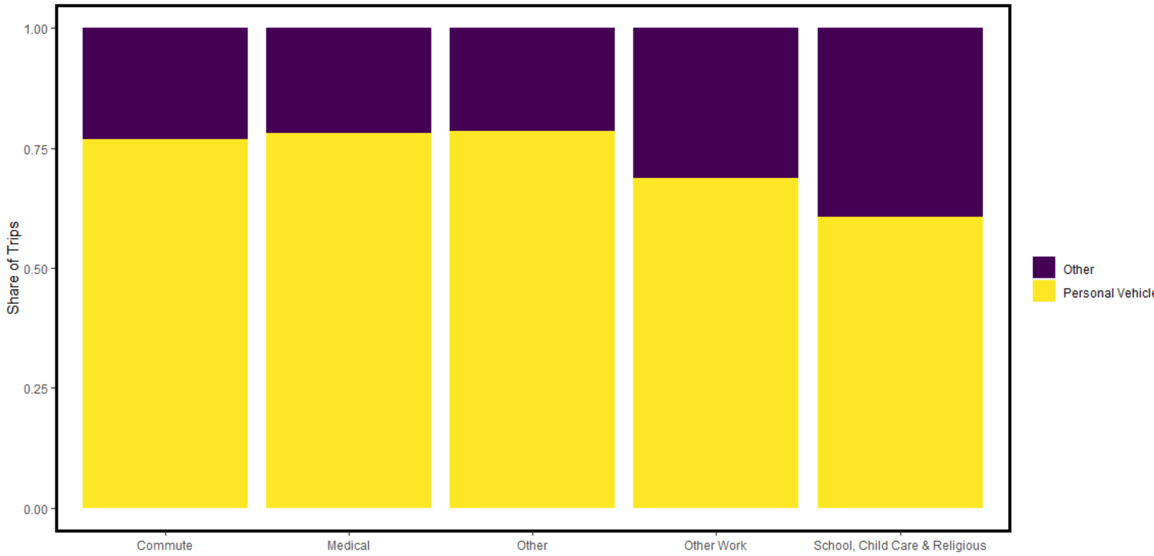
Car use dominates travel in the study area. Rail mode share is limited but can offer an alternative to car travel for certain trips.

Personal Vehicle

Auto travel is the principal mode for travel in the study area. Figure 19 shows the auto share of trips across a broad array of purposes: the mode is used for over 75% of commute, medical, and other trips, and over 50% for Other Work, and School, Childcare & Religious trips. Each of these categories represents the following shares of total trips:

- Commute – 17%
- Medical - 3%
- Other Work - 2%
- School, Childcare & Religion - 10%
- Other - 68%

Figure 19: Personal Vehicle Share of Trips by Purpose for Residents of CT, RI, and MA[31]



Source: NHTS 2017 Data

Although most major commute markets in the study area are connected by rail service, particularly after the launch of the Hartford Line in 2018, smaller commuter markets are not as well served, and even in commuter rail served markets individuals not working a “traditional” schedule, who wish to travel outside of these times, or who are priced out by the commuter rail, may not be able to use this service. Further, individuals whose precise home and work locations lack efficient connectivity to and from commuter rail service may not be able to use the train due to these limitations in first/last-mile connectivity. By contrast the road system is ubiquitous and almost universally accessible to those with access to a vehicle.

Air

According to the FAA’s T-100 dataset, over 3 million people travelled by air within the corridor in 2019.[32] Over 95% of passengers traveling by air within the study area were traveling *between* Boston and one of the three major NYC airports. The focus of air travel in the study area on serving the Boston-NYC submarket is reflected in mode-share, with air representing 8% of this market in 2016.[33] Outside of the Boston-NYC market, rail does not face substantial competition from air services.

Intercity Bus

There is considerable intercity bus service in the study area, with multiple companies operating in the area. Aggregated data on intercity bus services is limited, however in 2019 service was offered under the Greyhound, Megabus, Bolt Bus and Peter Pan brands. While Greyhound provides a variety of service between major study area cities, other intercity bus providers primarily focused on direct service between Boston and NYC. This is reflected in mode share, with intercity bus taking up 13% of the 2016 Boston-NYC market, compared to 15% for rail. Additionally, intercity bus had 9% of the New York City-Hartford

[31] Due to methodological differences and sample size issues, the commute mode shares from NHTS and ACS differ.

[32] FAA, 2019 T-100 Data

[33] http://nec-commission.com/app/uploads/2018/04/2015-09-14_NEC-Intercity-Travel-Summary-Report_Website.pdf, pg 9

submarket, although this may have decreased due to increased rail service on that corridor.[34] Other study area submarkets generally had very low intercity bus mode share.

Key Takeaway

The dominance of the car is consistent across trip purposes, emphasizing the importance of a rail offering that serves multiple different consumer markets. This impacts both commuter and intercity rail.

Travel Decision Making

Individuals and providers make decisions about travel based on a variety of different factors. These factors impact not only whether trips are taken but how, when, and by what mode. These factors include but are not limited to:

- Travel time;
- Monetary cost;
- Frequency of available services for applicable modes, including competing modes;
- Congestion levels for applicable modes; and
- First and Last mile connectivity with ultimate trip origins and destinations.

Additionally, providers of rail services in particular may consider additional factors including but not limited to:

- Balance of operating revenue and costs;
- Availability of non-ticket revenue and funding sources, including subsidy;
- Infrastructure and fleet technical limitations;
- Scheduling limitations;
- Requirements of other users of the same right of way; and
- Connectivity with other services.

Rail Market Analysis (Intercity and Commuter)

The intercity and commuter rail markets play a crucial role for travel in the study area. As discussed above, these services share significant infrastructure with one another, while playing different roles in the broader travel market.

Amtrak NEC

Study area Amtrak ridership, including the NEC as well as the *Vermonter* and the *Valley Flyer* services, is dominated by travel between Boston and NYC, as shown in Figure 20. The data also demonstrates the role of Providence in current service, with significant traffic between it and both Boston and NYC. New Haven is also a sizable destination, potentially reflecting its position on both the NEC and *Hartford Line* services.

[34] http://nec-commission.com/app/uploads/2018/04/2015-09-14_NEC-Intercity-Travel-Summary-Report_Website.pdf

Figure 20: Amtrak bi-directional trip flows by CBSA pair[35]

Source: Amtrak 2019 Ridership Data

Amtrak's mode share in the study area varied significantly by submarkets. According to a 2015 study, Rail had a 15% share of travel between the NYC and Boston regions, likely higher for core-to-core trips.[36] Rail mode share was generally lower for other submarkets in the study area.

Key Takeaway

Amtrak NEC service is dominated by Boston-NYC passengers, with Providence also being an origin or destination for a significant number of passengers. This suggests Amtrak may want to focus primarily on these markets.

Other Amtrak Services (Vermonter, Hartford Line/Valley Flyer)

Ridership on the *Vermonter* and *Hartford Line/Valley Flyer* were significantly lower than for the NEC. In 2019, approximately 375,000 riders utilized the *Hartford Line/Valley Flyer* service, compared to just under 100,000 on the entire *Vermonter* route. The Vermonter service had generally operated at its respective ridership levels over the preceding decade, except during 2015-2017, when ridership was temporarily suppressed by reduced rail service, accommodating the double-tracking of some route segments in Connecticut.

[35] Inter-CBSA trips only. Trips to and from Springfield CBSA omitted due to low volumes.

[36] http://nec-commission.com/app/uploads/2018/04/2015-09-14_NEC-Intercity-Travel-Summary-Report_Website.pdf, pg 9

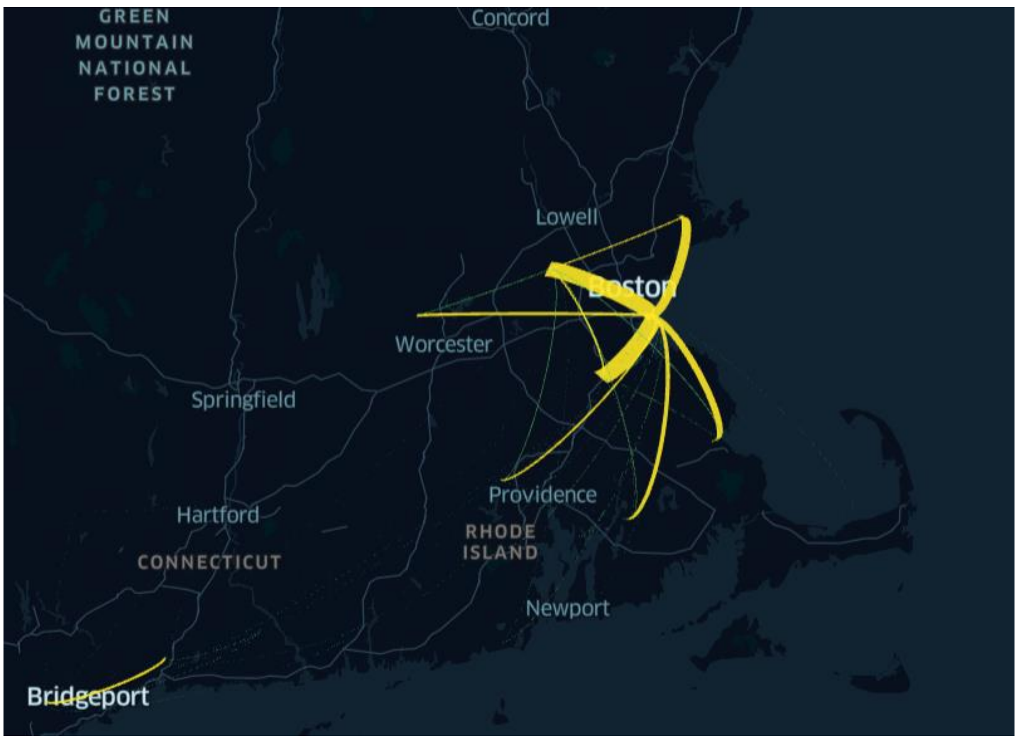
Key Takeaway

Limitations in underlying markets, service, and infrastructure mean the non-NEC services have significantly less ridership than the NEC service and are likely to continue to do so without major investments, and/or changes in economic geography.

Commuter Rail

Figure 21 shows ACS commuting flows for commuter rail. The data clearly show the dominance of radial travel between Boston and its surrounding communities, as well as between Fairfield, CT and New Haven, CT. The latest available data is based on the 2016 5-year ACS survey, and so predates the opening of Hartford Line commuter rail service in 2018. The north-south flows between New Haven, Hartford, and Springfield, MA seen in Figure 21, reflect the rationale for that service. Notably, while there are substantial commuter flows in the Boston area, they flow radially, while the all-modes data shows evidence of flows between the communities surrounding Boston. For example, the all-modes commute data shows substantial flows on a Northeast-Southwest axis from Essex County to Middlesex County to Worcester County. Commutes of this nature are not well served by the existing commuter rail service.

Figure 21: Commuter Rail Only Commuting Flows by County in the Study Area[37]



Note: The ACS JTW CTPP predates the start of operations on the CT*rail* Hartford Line service. As a result, this visualization does not capture the impact of that rail service.

Source: ACS JTW CTPP Data

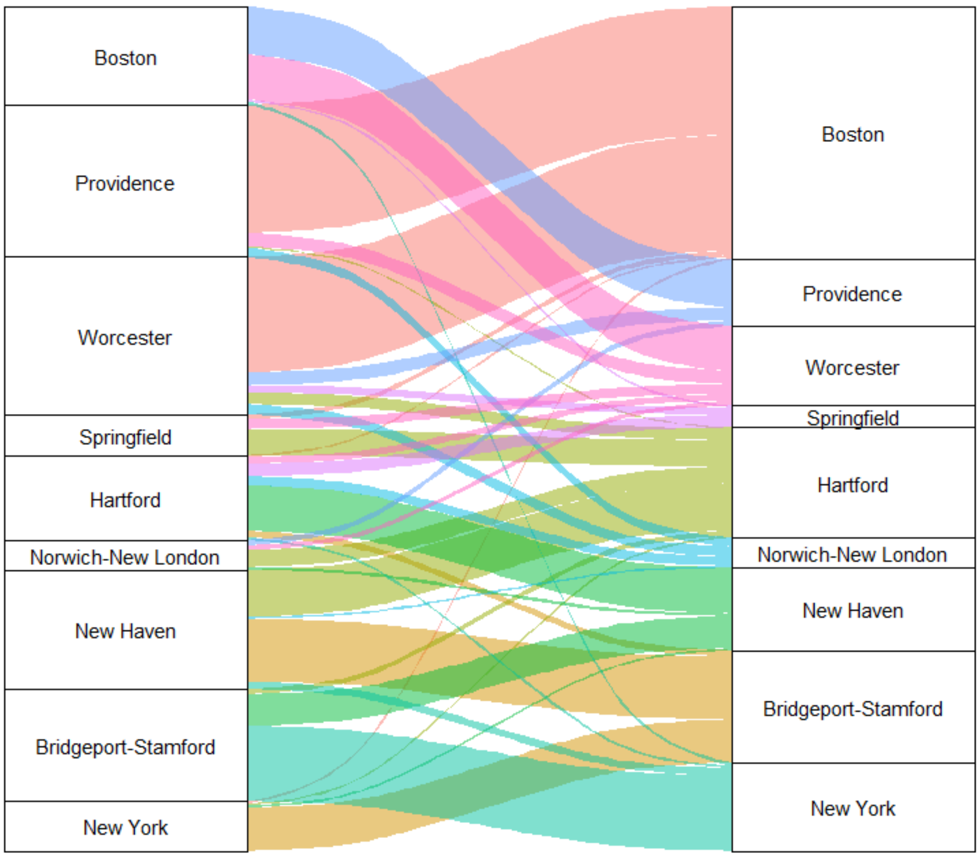
Commute flows are aggregated to the CBSA level in Figure 22. This data reinforces the logical predominance of commuting patterns between adjacent CBSAs. Examples include the flows between Boston and Providence and Boston and Worcester. The data also reinforce the size of the New Haven-

---

[37] Flow locations based on county centroid locations – they do not reflect flows between the exact coordinates depicted.

Hartford and Hartford-Springfield commuting markets, underpinning the Hartford Line commuter service that postdates this data. Hartford Line service connects the last major CBSA commute pairs in the study area with substantial commuter flows, suggesting future improvements in commuter rail may best be focused on improving services and connectivity within existing markets.

Figure 22: Commute Flows by Home CBSA to Work CBSA[38]



Source: ACS JTW CTPP Data, 5-year Estimates 2012-2016

Key Takeaway

There are significant CBSA-to-CBSA commuter flows between New Haven, Hartford, and Springfield. Previously unserved by commuter rail, The Hartford Line commuter rail services, launched in 2018, connect these CBSAs with commuter service - suggesting it addressed a significant gap in the commuter rail offering in the study area. Additional investments may need to focus on improving service and access in existing markets to grow ridership.

Limitations of Analysis

This analysis includes a number of inherent limitations, therefore specific data points should be considered indicative rather than authoritative. Specific potential limitations include but are not limited to the following:

[38] Inter-CBSA trips only. OD pairs with less than 1000 commuters excluded for visual clarity.

- Data compatibility issues due to the use of multiple datasets from multiple sources whose methodologies may involve inconsistent assumptions and approaches.
- This section includes no discussion of the impacts of COVID-19, discussed below in Future Conditions. COVID-19 may have a significant impact on these trends in the future. These impacts cannot be authoritatively predicted or described based on available data.

Future Conditions

This section introduces the future conditions context for the study area out to 2045. Estimating future outcomes in the study area is complicated by the following major factors:

- The uncertain long-term impacts of COVID-19 on transportation and land-use patterns. Most major socio-economic and demographic forecasts have not yet been fully updated to include COVID-19 analysis and the findings of the 2020 U.S. Census. It is possible COVID-19 has significantly impacted the trajectory of pre-COVID-19 population and employment forecasts.
- Any major proposed investments, in rail and other projects, throughout the study area and adjacent regions.

This analysis emphasized evaluation of the contextual environment in which people will be traveling in the future, rather than a single predictive outcome. This analysis is based on two key principles:

- There is limited clarity about the endgame and/or long-term impact of the COVID-19 pandemic and other major future trends, so any single projection is subject to high levels of potential error.
- People, organizations and agencies will not merely experience the future but drive it. The decisions made in the study area and surrounding regions in the coming decades will be a significant determinant of the outcomes that are reached by 2045.

Baseline Forecast Expectations

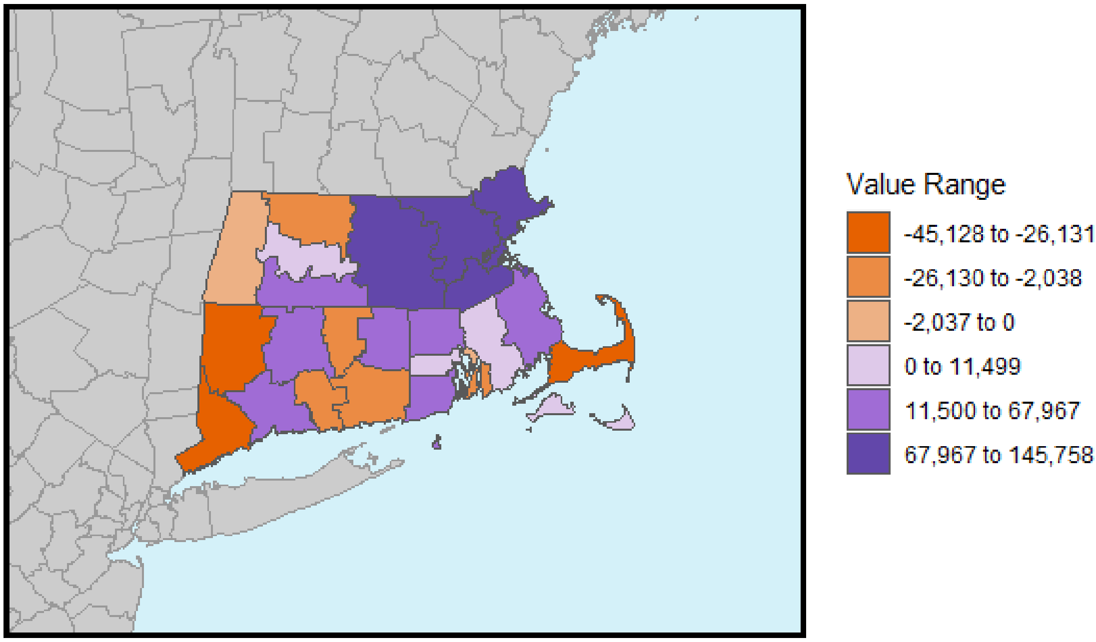
This section examines the population and employment forecasts projected for the study area, up to 2045. Population and employment growth provides an indication of potential changes in travel demand and how the travel market may shift spatially. This section will also address the particular takeaways relevant to rail travel that these projections suggest.

These projections are based on forecasts produced by state governments (for Connecticut and Rhode Island) and a statewide forecast produced by the Boston MPO for Massachusetts. Due to the different sources, underlying forecast assumptions may vary and impact results.

Population Forecasts

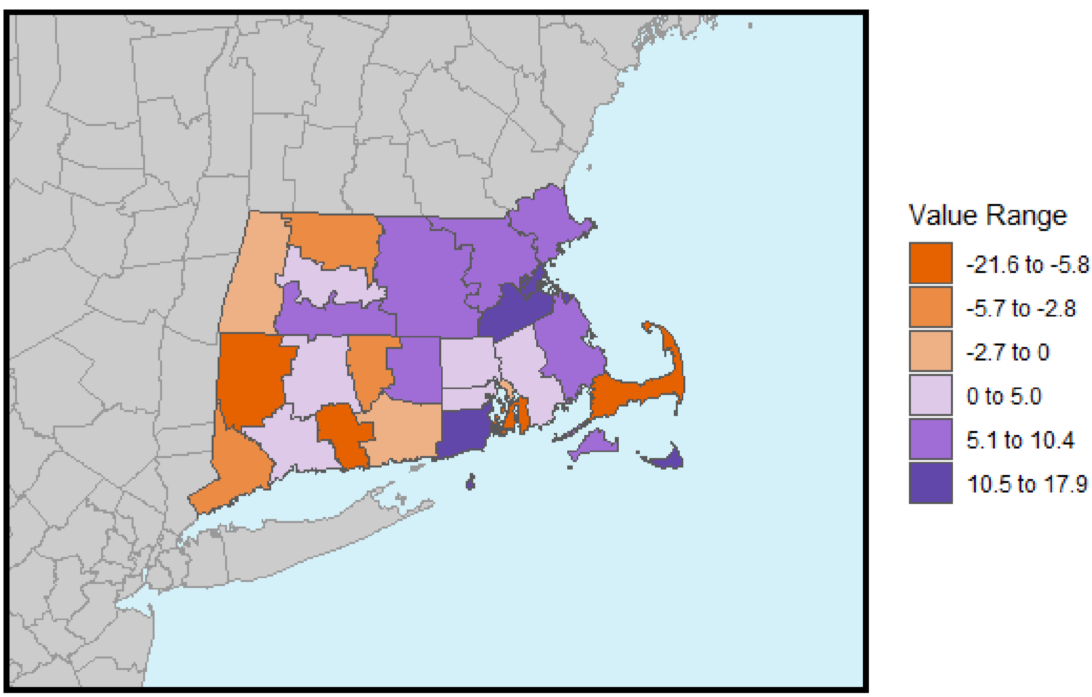
The combined population of Connecticut, Rhode Island, and Massachusetts is expected to grow by close to 540,000 over the period 2019-2045, to approximately 12.1 million. This growth is not evenly spread across the study area, as seen in Figure 23. The greatest growth can be seen in the counties around Boston, including Worcester County, and in a North-South axis between Springfield, MA, Hartford, CT, and New Haven, CT. Middlesex County, MA and Suffolk County, MA are expected to see growth of just under 140,000 and 150,000 over the period, constituting increases of 9% and 17%. The general pattern of percentage growth is also highest around Boston, as seen in Figure 24.

Figure 23: Projected Population Growth by County (2020-2045)



Source: Combined State & MPO forecasts

Figure 24: Projected % Population Growth by County (2020-2045)



Source: Combined State & MPO forecasts

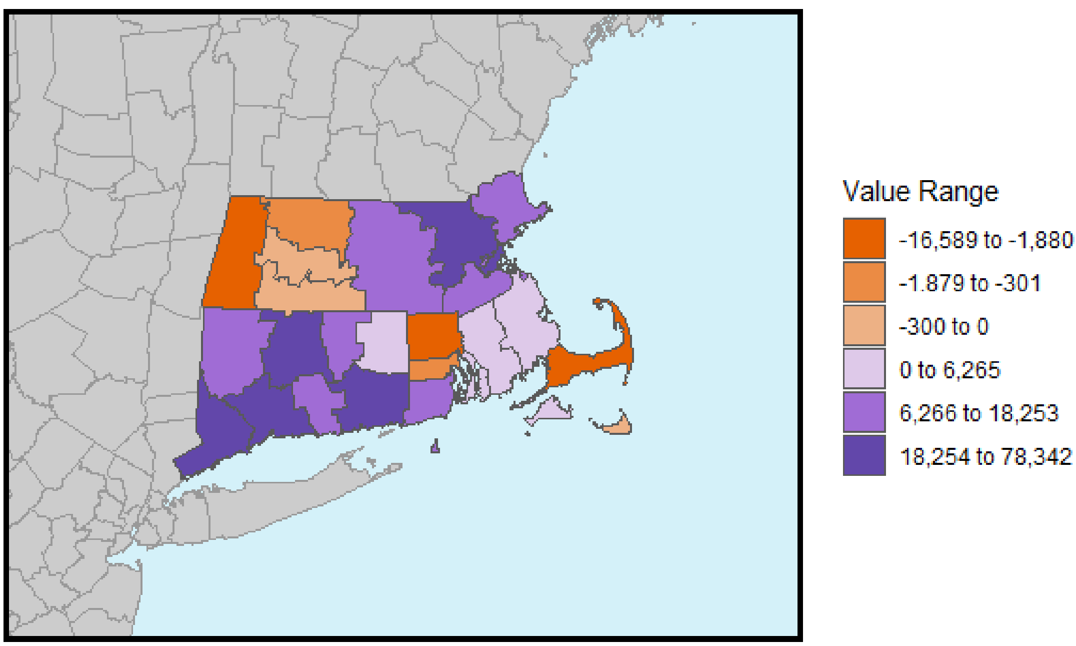
Key Takeaway

Population growth is expected in the study area going forward but is particularly concentrated in the Boston area. This may increase demand for both intercity and commuter rail travel to and from Boston.

Employment Forecasts

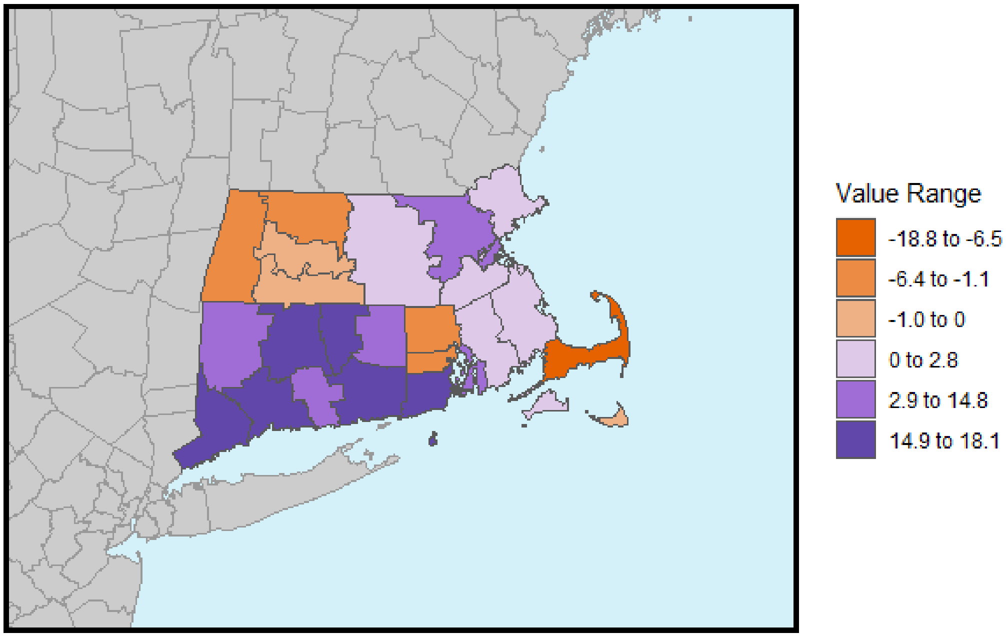
The study area is projected to see substantial job growth, with employment expected to rise by close to 360,000 over the period, a growth rate of 6.4% compared to 4.7% for population. The difference may reflect several factors, including increased commuting into the study area from neighboring states, and changes in the proportion of the population working, among other factors. The absolute and proportional change in employment by county follows a similar pattern to population, with significant growth around Boston and in Fairfield, CT, which can be seen in Figure 25 and Figure 26. However, job growth is significantly higher and more widespread in Connecticut than population growth, with Hartford County, New Haven County, and Fairfield County alone expected to see 200,000 new jobs. This could suggest increased rates of commuting behavior within and into these counties, which could drive demand for improved commuter rail services. Job growth in Connecticut clusters around 15% in all counties, which may reflect differences in methodology relative to the other states.

Figure 25: Projected Job Growth by County (2020-2045)



Source: Combined State & MPO forecasts

Figure 26: Projected % Job Growth by County (2020-2045)



Source: Combined State & MPO forecasts

Key Takeaway

Heavy forecasted employment growth in Connecticut could drive demand for commuter rail service improvements.

Forecasting long-term response to the impacts of the COVID-19 pandemic

Many forecast providers have not yet substantively incorporated COVID-19 and the outputs from the 2020 U.S. Census into their forecasts. This reflects both the fundamental uncertainty associated with COVID-19, and its impact on society, as well as the long processing times associated with generating these kinds of comprehensive forecasts. COVID-19 also had a significant impact on the administration of the 2020 U.S. Census, with indications that the census substantially undercounted non-white communities in particular.[39] This in turn could negatively impact the reliability of future forecast releases incorporating this data.

The three state/MPO forecasts utilized in this study had not yet made substantial adjustments to their data to account for the impact of COVID-19.

Key Impacts & Opportunities for Rail – Baseline Forecasts

Continued but uneven population and job growth in the study area would have significant impacts on rail. The concentration of growth in the counties around Boston and in the New Haven-Hartford-Springfield corridor could result in increased opportunities for ridership growth on Commuter Rail. Commuter Rail Operators would need to ensure those systems had the service capacity and quality to attract and serve that ridership. For example, communities could implement policies to encourage population and job growth concentration in areas already served by current or new Commuter Rail service. By contrast, low or negative growth in other parts of the study area could reduce the demand for intercity services to those areas.

---

[39] https://www.census.gov/newsroom/press-releases/2022/2020-census-estimates-of-undercount-and-overcount.html

COVID-19 Impacts

This section examines the potential impacts of the COVID-19 pandemic on the baseline projections for growth in the study area over the 2019-2045 period. While the ultimate result of these impacts cannot be known at this time, key trends and factors can be identified. Amtrak and the stakeholders will have to manage these trends and factors carefully over the period in order to limit negative impacts and take advantage of opportunities for rail.

This analysis combines several different sources, including short-term impact data from the 2019-2022 period and available research and conclusions on the long-term magnitude of those changes.

2019-2022 COVID-19 Impacts

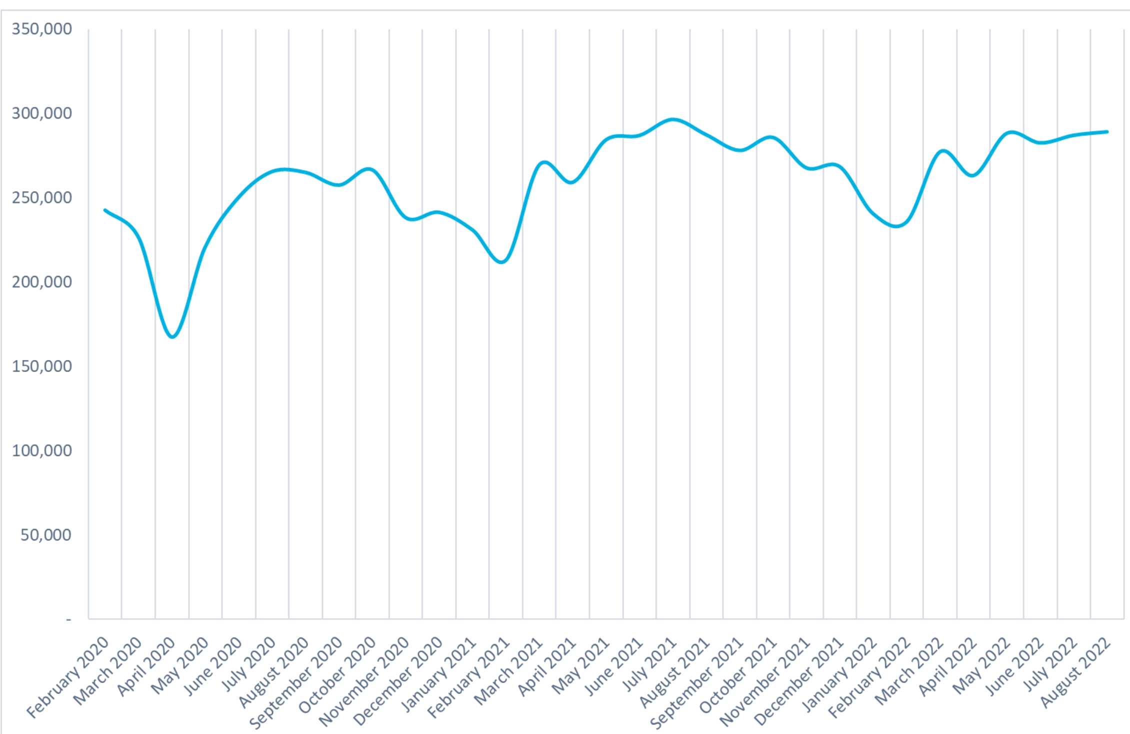
We used 2019-2022 data to analyze the short-term impacts of COVID-19, and the recovery to date. This includes:

- Vehicle Miles Travel ("VMT") data through August 2022.
- Amtrak observed ridership data into 2022.
- Available data from Commuter Rail operators, as well as other transit operators, varies significantly. However, data from the Bureau of Transportation Statistics and other sources allow a general perspective on COVID-19 recovery for those services.

Automotive Travel

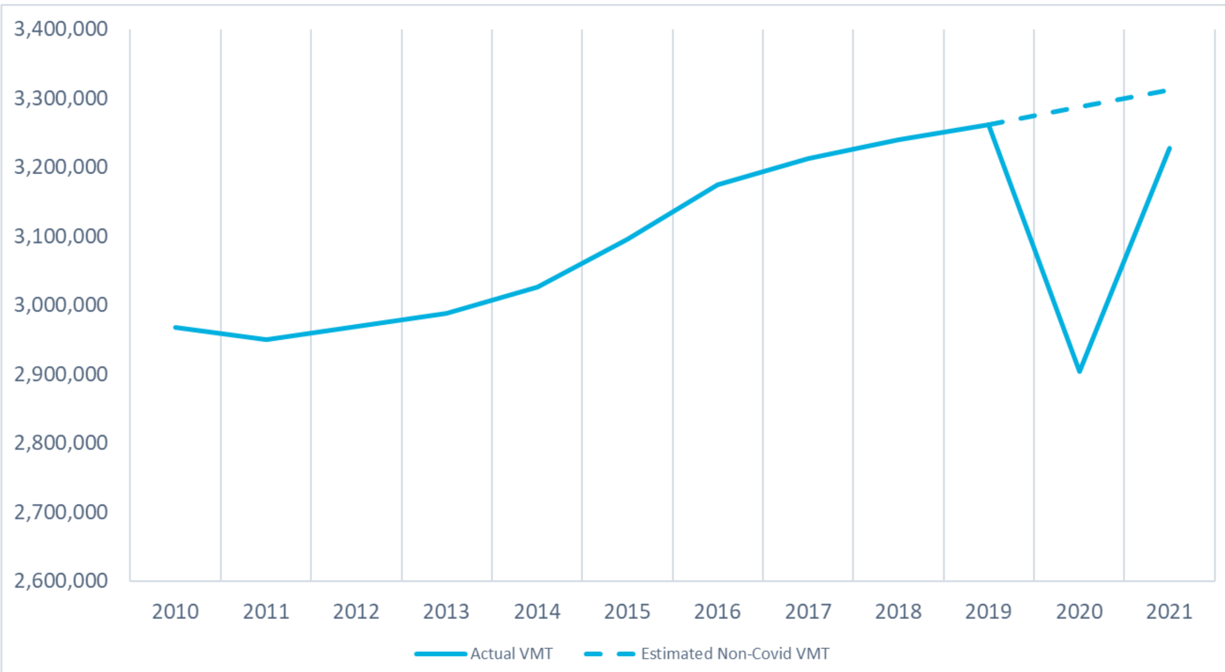
Automotive travel in the US decreased significantly at the onset of the pandemic. This can be seen in Figure 27, which shows US VMT by month from February 2020 to August 2022. VMT rebounded strongly after April 2022 – although the February 2021 level was roughly 12% below that of 2020 and the February 2022 level 3% below 2020. This indicates robust but potentially not entirely complete recovery of travel in the automotive market, at least in terms of VMT.

Figure 27: U.S. monthly VMT 2020-2022 (millions)



However, recovery must also account for lost growth compared to pre-COVID-19 trends. Figure 28 shows annual VMT in the period 2010-2021[40], including alternative estimated data for 2020 and 2021 in a no-COVID-19 scenario. This data indicates that 2021 VMT was approximately 97% of the trend-estimated level. This gap could be larger for non-driving modes, particularly transit, and if individuals have replaced shorter trips with longer ones (such as due to relocation), which would increase VMT per trip. Additionally, travel recovery levels may vary by geography, although the extent of recovery suggests it is likely substantial in most places.

Figure 28: U.S. Vehicle Miles Traveled 2010-2021, with Estimated Non-COVID-19 Trend for 2020-2021 (millions)



Source: FHWA VMT Data, 2010-2021, obtained from FRED

Amtrak

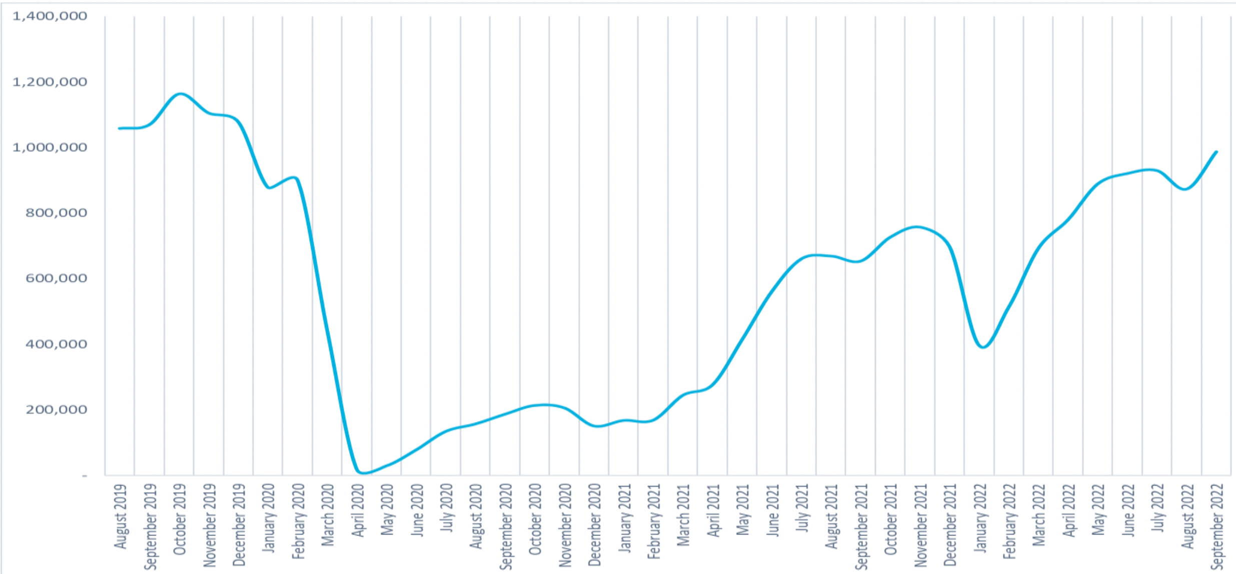
Amtrak ridership has seen both a deeper initial drop and a slower recovery than driving but has still seen significant progress towards the pre-COVID-19 trend. Figure 29 shows that combined ridership on the *Northeast Regional* and *Acela* trains suffered a deep and prolonged collapse in ridership but are now approaching pre-COVID-19 levels even though the service schedules for each have not reached pre-COVID frequencies.[41] This indicates a revival in passenger demand for intercity rail services over time.

---

[40] 2022 not included as year is incomplete as of the writing of this document.

[41] Travel on entire NEC, not just in Study Area.

Figure 29: Amtrak *Northeast Regional* & *Acela* Ridership, 2020-2022

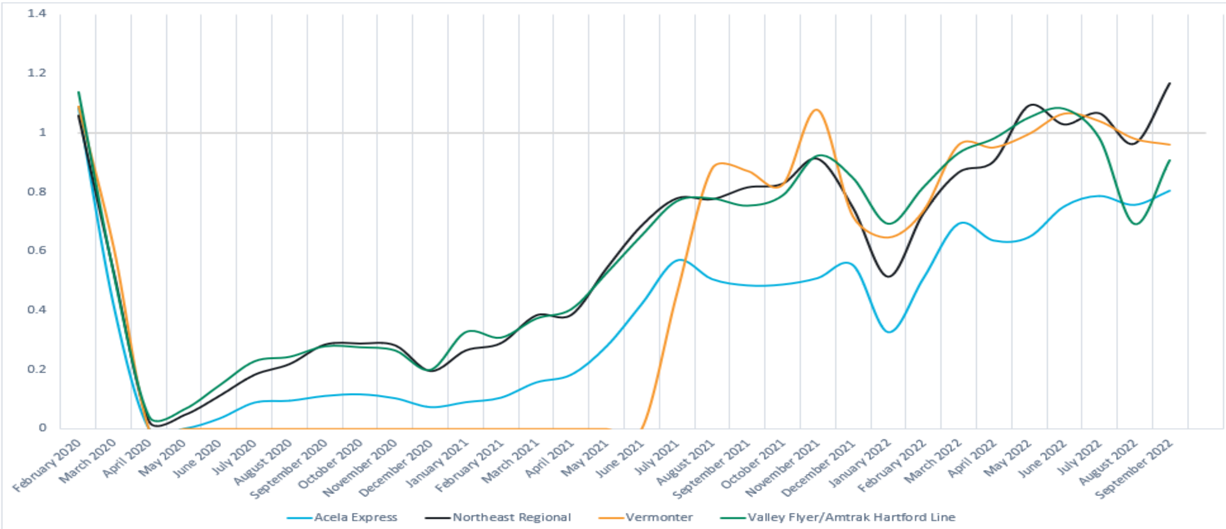


Source: Amtrak Ridership Data

The pattern is similar for Amtrak trips taken entirely within the study area. Figure 30 shows indexed ridership by route within the study area. The *Northeast Regional* and *Valley Flyer/Amtrak Hartford Line* trains show consistent gradual recovery towards pre-COVID-19 levels. The *Vermonter* service was paused for 16 months during the pandemic, but ridership has quickly reached pre-COVID-19 levels on return. The only major service to see less substantial recovery is the *Acela*, which remained below pre-COVID-19 numbers but is still seeing substantial convergence on the pre-COVID-19 levels. This may reflect the greater reliance of this service on business travel, which has recovered the least as many previously in-person business activities are still being held virtually. Geographically, during COVID-19 the share of passengers in the study area traveling between Boston and NYC[42] declined from approximately 52% of traffic in February 2020, to a low of 40% in June 2020, suggesting other OD pairs were relatively more reliable sources of passengers under COVID-19 conditions. The share has since returned to approximately 50%.

[42] *Northeast Regional* and *Acela* routes only. NYC area stations include New York Penn Station & New Rochelle, Boston area stations include Boston South Station, Boston Back Bay, and Route 128 Station.

Figure 30: Indexed Amtrak Ridership for Study-Area Trips, 2020-2022 (February 2020 = 1.00)



Source: Amtrak Ridership Data

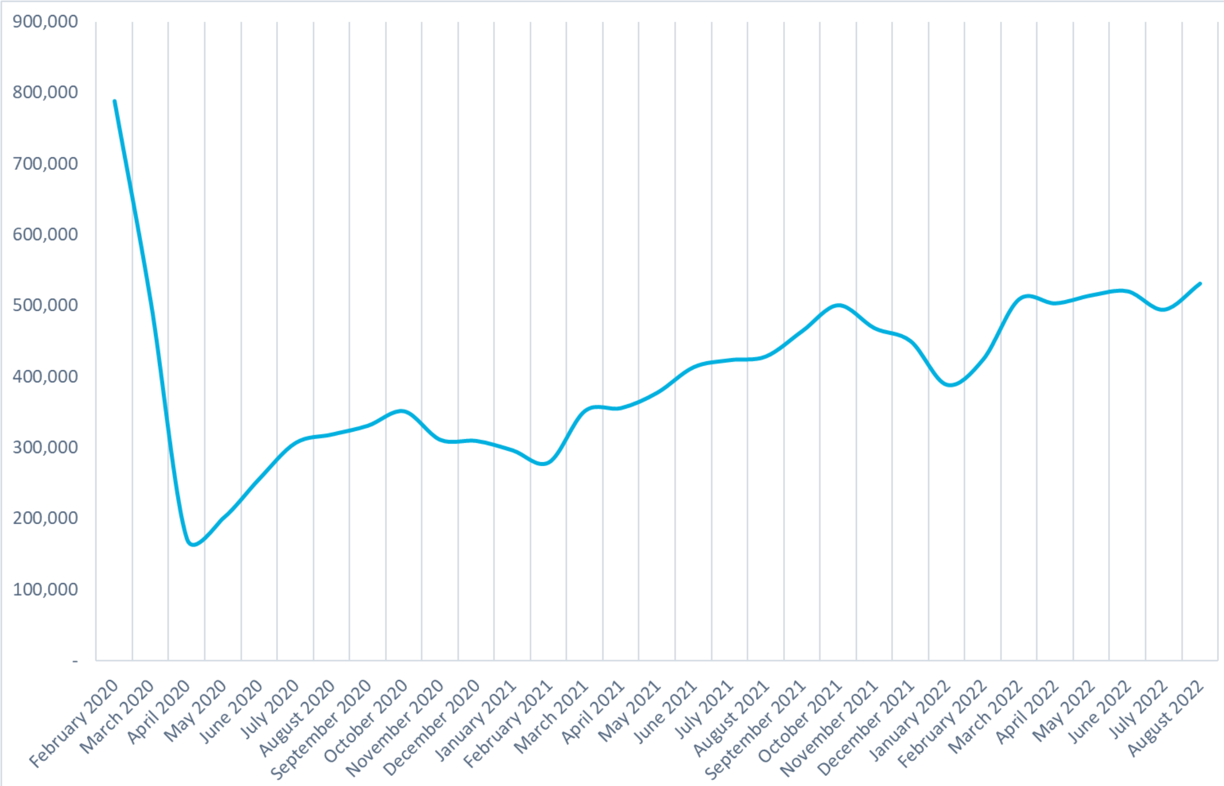
Commuter Rail and Other Transit

Recovery in public transit ridership has lagged significantly behind Amtrak ridership recovery, and recovery in VMT in particular. Figure 31 shows that despite significant recovery, U.S. transit trips remain well below February 2020 levels. This reflects both reduced passenger demand and that many transit agencies may still have lower service levels in response to both lower demand and staffing shortages.

However, aggregate figures mask significant local variation. While detailed ridership recovery data for all systems is not available, some individual operators do publish this information. According to MTA reporting, November 2022 ridership on the New York City Subway, New York City/MTA Buses and the MTA's two commuter rail systems, was generally between 60-75% of pre-COVID-19 levels.[43] Recovery was also stronger on weekend days than weekdays, suggesting non-commuting trip recovery was stronger than commuting trip recovery. By comparison, the MTA's bridges and tunnels were operating at nearly 100% of pre-COVID-19 flows. It is possible other systems may be seeing significantly less recovery. Forecasting when/whether ridership will return to pre-COVID-19 levels is difficult, especially due to these variations in local patterns, particularly if operator responses to COVID-19 result in significant changes in the nature of service relative to the pre-COVID-19 period. Future planning should include scenarios that account for both a prolonged period of catch-up to return to trend values, as well as the potential for transit demand being suppressed by some fraction into the long term.

[43] https://new.mta.info/coronavirus/ridership

Figure 31: U.S. Unlinked Transit Trips by Month 2020-2022



Source: BTS Data, 2020-2021, obtained from FRED

<u>**Key Takeaway**</u>

Travel markets continue their recovery from the impacts of COVID-19. Intercity rail has seen substantial recovery thanks to the attraction of significant leisure travel. This emphasizes the importance of rail serving diverse trip purposes.

Long Term COVID-19 Impacts

There will certainly be long-term impacts from COVID-19. While the nature and extent of those impacts of COVID-19 are impossible to fully predict at this time, a number of key challenges can be identified. These include:

- Changes in the share of jobs being performed from home, at least some of the time.
  - A significant increase in work from home, at least into the medium term, is likely.
  - Public transportation, and particularly commuter rail, are disproportionately dependent on work trips. This could impact as much as 50% of pre-COVID-19 commuter rail ridership in Boston. [44]
  - Demand for monthly passes and other multi-trip fares could be impacted by increased hybrid working.

---

[44] https://41g41s33vxdd2vc05w415s1e-wpengine.netdna-ssl.com/wp-content/uploads/2021/07/FutureOfWorkInMassachusettsReport_july21.pdf, pg 27.

  - Intercity rail and auto traffic may be less impacted due to less reliance on work trips. Provision of remote work could also boost intercity trips as travelers could work while traveling and at their destination.
- Changes in the share of other activities being performed from home.
  - Increased share of home-based activities in other areas like education and healthcare could also impact demand for public transportation, including commuter rail.
- Changes in population settlement patterns.
  - The COVID-19 period has been associated with substantial increases in home buying across the United States. [45]
  - Changes in commuting patterns and other COVID-19 effects could impact population distribution and density.
  - Population may shift in favor of areas not currently well served by rail and where rail service may not be feasible in the future.
- Changes in business travel rates.
  - COVID-19 could also significantly reduce rates of non-commute work travel.
  - An elevated proportion of conferences, meetings, and other business activities may continue to be held remotely. [46]
  - Both intercity rail and air travel could be significantly impacted by these shifts.

If any of these trends persists over the long-term, they could present a significant challenge for rail. Even if these trends gradually return to pre-COVID-19 levels over time, short-term impacts could be substantial for the finances of rail operators and impact the timing and approval of future rail projects.

Recovery trajectories

Rail operators and stakeholders should account for two main kinds of post-COVID-19 trajectories: First, a "long return" scenario, where pre-COVID-19 trends do eventually return, but may take a significant number of years to do so. Second, a "new normal" where some pre-COVID-19 trends are never fully restored, resulting in a long-term gap between pre-COVID-19 demand for rail services as they were previously offered. The ultimate outcome will likely incorporate aspects of both of these trajectories, although the exact timing of recovery, or the size of any long-term demand gap, cannot be projected with meaningful certainty at this time.

Opportunities for Rail – after COVID-19

The impacts of COVID-19 also provide opportunities for rail operators and stakeholders. The disruption of pre-COVID-19 norms could lead to positive change in the rail sector that could drive new growth. One key opportunity is for commuter rail operators to pivot from primarily serving a now reduced suburban commuter flow market. Changes in service patterns and fare policies, among others, could facilitate better serving populations and trips that commuter rail operators may not have been significantly capturing prior to COVID-19. Even before COVID-19, many commuter rail operators were investigating changes to their existing models. The MBTA's 2018-2019 Rail Vision process identified strategies for commuter rail

---

[45] https://www.vox.com/22264268/covid-19-housing-insecurity-housing-prices-mortgage-rates-pandemic-zoning-supply-demand

[46] https://www2.deloitte.com/us/en/insights/focus/transportation/future-of-business-travel-post-covid.html

transformation in the Boston region.[47] Further south, the Philadelphia Transit Plan, released in February 2020, envisaged working with transit operator SEPTA to "provid[e] compelling service for travel at a variety of times, purposes, and locations."[48] While SEPTA is outside the study area, this is an example of how commuter rail operators and stakeholders can redouble such efforts, including infrastructure changes in areas like electrification and platform upgrades, to take advantage of new and changing markets. This kind of integration could provide numerous new opportunities and challenges resulting from the integration of passenger rail services.

If long-term changes in settlement patterns do result from COVID-19, intercity rail could play a role in them, especially in the study area. The density of Amtrak service in the study area could allow new residents in smaller communities to utilize intercity rail service to connect with work, social and other responsibilities in the larger communities they may have relocated from, particularly if that leads to less frequent but longer distance travel needs.

Key Takeaway

Ongoing impacts from COVID-19 are uncertain but will likely involve continued work from home behavior, as well as changes in settlement patterns. Rail operators should continue to proactively adjust to a new travel environment with less commuter/business travel-focused services than the pre-COVID environment.

New Mobility and Other Impacts

This section examines non-COVID impacts, particularly those related to New Mobility technologies and potential major new travel market connections, on the baseline projections for growth in the study area over the 2019-2045 period. As with COVID-19, many of these potential impacts are unknown in their magnitude, timing, and ultimate probability of occurrence. Amtrak and area stakeholders will have to manage these trends and factors carefully over the period in order to limit negative impacts and take advantage of opportunities for rail.

New Mobility Impacts

A variety of potential technological and organizational changes could impact the transportation market in the period 2019-2045. Collectively these potential changes are referred to here as "New Mobility" and include:

- Widespread adoption of electric cars
  - The electric car market was 2.5% of new vehicle sales in 2020 and growing rapidly. [49] Manufacturers expect this to continue.
  - The electric car market is most developed in the West Coast, but also outperforms national trends in the study area, and many of the states have both incentives to purchase electric cars and future mandates to phase out internal combustion engine cars.

[47] https://www.mbta.com/projects/rail-vision

[48] https://www.phila.gov/media/20210222110702/OTIS-Philadelphia-Transit-Plan.pdf, pg 119

[49] https://theicct.org/wp-content/uploads/2021/12/ev-us-market-growth-cities-sept21_0.pdf, pg 1

- Numerous factors including bottlenecks in manufacturing supply chains, technologies challenges, and non-tailpipe pollution issues could potentially slow this adoption in the future.[50]
- Electrification of the vehicle fleet may impact the environmental case for rail travel among consumers.

- Increased railway electrification
  - Railway electrification is expanding globally, with several countries aspiring to totally electrify their systems. [51,52]
  - Several diesel-powered commuter rail services in the United States are also pursuing electrification, such as Caltrain. [53]
  - Electrification could provide improvements in performance, as well as maintaining the environmental case for rail travel among consumers.
- Development of fully autonomous vehicles
  - Significant investment has been made in developing fully autonomous ("Level 4 or 5 Automation") vehicle technology.
  - By removing the need to operate the vehicle, autonomy would enable multitasking during the journey, often cited as a benefit of public transportation.
  - If successful, this technology could lead not just to autonomous personal vehicles, but also the development of autonomous shared ride services, which could compete with public transportation. [54] The impact on commuter and intercity services would likely be less than for local transit.
  - There is significant uncertainty around the future timing of this technology but given remaining technological obstacles and the slow turnover in the vehicle fleet, they may not become a significant factor before 2045. [55]
- Increased use of Ride-hailing services
  - Ride-hailing services performed 65 million trips in Massachusetts in 2017, 85% of them in the Boston region. [56]
  - Although their future growth trajectory is unclear, these services are likely to remain a part of the travel network.
  - Ride-hailing could potentially coordinate with rail services to address first-mile/last-mile issues, but existing studies suggest this complementarity is limited. [57] Studies suggest

---

[50] https://www.reuters.com/technology/world-faces-shortage-lithium-electric-vehicle-batteries-2022-01-21/

[51] https://www.statista.com/statistics/451522/share-of-the-rail-network-which-is-electrified-in-europe/

[52] https://www.financialexpress.com/infrastructure/railways/indian-railways-marching-towards-mission-100-percent-electrification-see-monthly-data-for-2021-22/2441397/

[53] https://www.caltrain.com/about/MediaRelations/news/Caltrain_Electrification_Delayed_to_2024.html

[54] https://www.vtpi.org/avip.pdf, pg 8

[55] https://www.vtpi.org/avip.pdf, pg 30

[56] http://www.mapc.org/wp-content/uploads/2019/03/02Feb-RideHailing.pdf, pg

[57] https://www.sciencedirect.com/science/article/abs/pii/S0966692321002726

many ride-hailing trips would otherwise have been undertaken by a non-car mode or would not have occurred but for the availability of rideshare. [58]

- This impact may be less severe for commuter and intercity rail than for local transit.

Potential progress towards all of these trends is currently underway. However, whether they will reach fruition and the timescale on which that occurs remains unknown and any forecast is subject to substantial uncertainty. All could have potential impacts on rail operators and impact the timing and approval of future rail projects.

Opportunities for Rail – New Mobility

The impacts of New Mobility innovations provide opportunities for rail operators and stakeholders. While the timescales associated with these and other developments may be unclear, and may stretch past 2045, the rail sector will certainly face significant disruption from technological and organization change over the period. Rail operators and stakeholders will have to consider these impacts when planning for 2019-2045. Increasing competition from other modes of transportation will put pressure on rail to improve and develop. Partnerships with ride-hailing companies may or may not prove positive for rail operators, but a solution to the "last mile" challenge is still important. As seen above, even in areas with significant commuter rail infrastructure many commute trips may not be accessible to the existing commuter rail infrastructure without these kinds of solutions. Rail operators and stakeholders will have to identify solutions to this challenge, which could also include improved bike and pedestrian connections, land-use changes, and other solutions. The prospect of technological improvement for private vehicles, and potential competition from other future technologies, also heightens the importance of technological progress in the rail sector. Electrification and other infrastructure investments to deliver faster, more efficient and reliable rail service may help rail remain competitive going forward.

Key Takeaway

Although the impact of specific trends is difficult to forecast, the impact of New Mobility innovations necessitates rail operators improve their own services to continue to compete. As many new mobility operators focus on shorter distance, urban travel, there may be collaborative synergies to help provide 'first-mile/last-mile' connectivity, notably for intercity rail.

Potential New Market Connections

Future rail investments in and around the study area could have a significant impact in the period between 2019-2045. This includes the potential to increase rail connectivity between key submarkets whose current rail connectivity is limited by existing infrastructure levels and service patterns. Two key initiatives in the northern portion of the study area could have particularly important impacts:

- Improved East-West Rail in Massachusetts, including both extending existing Springfield shuttle trains to Boston, to create an Inland Route connection from Boston to New Haven (and potentially farther south), and new service from Albany to Boston.
- Electrification of the Hartford, CT – Springfield, MA corridor.

If implemented, these projects, particularly together, could have significant impacts on the rail market in the study area.

[58] http://www.mapc.org/wp-content/uploads/2019/03/02Feb-RideHailing.pdf

Massachusetts East-West Rail

In January 2021, Massachusetts released the final report for a study on potential East-West passenger rail options connecting Pittsfield, Springfield, Worcester, and Boston, as well as intermediate communities.[59] This project would involve partnering with CSX and utilizing some combination of the company's existing track infrastructure and ROW more generally. The study conducted an alternatives analysis, resulting in the identification of six potential alternatives, differing in service frequency, maximum speeds, travel times, stations served, and infrastructure investments required. Through this improved service offering, the project has the potential to expand rail mode-share between destinations along the corridor. While the trip-flows data analyzed in this study do not indicate East-West travel between the major centers along this corridor as a key opportunity, improved transportation links could drive increased economic and social connectivity, fostering that demand. In August 2022, the Massachusetts legislature passed a bill allocating $275 million for planning, design, engineering, and construction for the project.[60]

Hartford Line Electrification & Other Improvements

The existing commuter rail and intercity rail services between New Haven, CT and Springfield, MA are currently operated with diesel-powered equipment. However, a concept study by the Capital Region Council of Governments ("CRCOG") proposed upgrading this line to run on electric power, as well as making additional infrastructure investments and purchase additional rolling stock. These investments could have a significant impact on the intercity and commuter rail services offered along this line, and potentially on the Hartford region generally. One estimate suggests that insufficient investments in rail connectivity around Hartford may have cost the region 20,000-40,000 jobs.[61] Potential benefits could be particularly valuable in the commuter market. The trip flow analysis in this study indicates significant commuter flows between the Hartford-New Haven and Hartford-Springfield CBSA pairs. Although the current CTPP data predates the opening of the Hartford Line, pre-COVID-19 ridership data suggested the line was outperforming expectations.[62] Projected job and population growth in the New Haven-Hartford-Springfield corridor will make expansion and improvement of the existing service important and add to the need for connecting intercity service along the Inland route.

Implications for the Study Area – Potential New Market Connections

The implementation of these projects has the potential for significant impacts on rail in the study area. They present the potential to realize mode-shift from auto to rail along these corridors, contingent on the ultimate service pattern and quality. Successful implementation of these projects could also impact public support for rail projects and enable further growth of the rail system in the study area.

Key Takeaway

Ongoing investments in the New Haven-Hartford-Springfield corridor reflect a strong underlying travel market. The potential for improved East-West rail in Massachusetts could help generate new travel markets and connectivity in the study area.

---

[59] https://www.mass.gov/doc/chapter-1-executive-summary-0/download

[60] https://www.trains.com/trn/news-reviews/news-wire/massachusetts-legislation-includes-east-west-rail-funding/

[61] https://crcog.org/wp-content/uploads/2021/04/CRCOG_Final-Report_V6_042921.pdf, pg 2

[62] https://portal.ct.gov/Office-of-the-Governor/News/Press-Releases/2020/01-2020/Governor-Lamont-Announces-Hartford-Line-Surpasses-One-Million-Riders

Key Findings and Next Steps

The following key conclusions from the analysis of the travel market are set out in this report:

- Amtrak NEC service is dominated by Boston-NYC passengers, with Providence also being an origin or destination for a significant number of passengers.
- Both pre- and post-COVID, population, employment, and intercity travel movements are dominated by two major axes of movement:
    - A West-East axis between NYC-New Haven-Providence-Boston; and
    - A North-South axis between NYC-Fairfield County (CT)-New Haven-Hartford-Springfield.
- Other growing travel markets are most pronounced in the local trips around Boston and the surrounding area and several key Connecticut markets. The trips generated by this growth are ill-suited for intercity rail service because of their short distances.
- West-East travel between Hartford and Providence is relatively small and current forecasts suggest this pattern is unlikely to change significantly going forward.
- Both intercity rail and automotive travel patterns have returned to, or are approaching, pre-COVID levels, with further growth expected. Post-COVID Amtrak ridership reflects more diverse trip purposes, as the amount of leisure travel on *Acela* and *Northeast Regional* services has grown.

The Market Study demonstrates that the key markets for intercity rail in the region will remain along the existing NYC-New Haven-Providence-Boston route and a NYC-Fairfield County-New Haven-Hartford-Springfield axis. Future studies should focus on identifying options for improving overall capacity for service in these markets, whether through new or improved alignments. These options would aim to improve rail travel times between existing stations and position the corridor for greater resilience in the face of future climate trends.

A Market Study Data Sources

Socio-Demographic Data Sources

ACS

The American Community Survey ("ACS") is a survey product produced by the U.S. Census Bureau to gather and present detailed information on socio-economic and demographic topics. The Main ACS data utilized in this study is population and jobs data by county, utilizing the 2019 5-year ACS estimates.

Please see below for detail on ACS Journey to Work ("JTW") data.

BLS

The Bureau of Labor Statistics ("BLS") provides data on a variety of economic indicators. This study utilizes BLS 2019 jobs estimate data by county.

State and MPO data

A variety of datasets are available from the various state agencies and Metropolitan Planning Organizations ("MPOs") in the study area. This includes a variety of forecast datasets for various economic and demographic variables. These forecasts have largely not been updated to account for COVID-19 as well as the data from the 2020 U.S. Census. Job and population forecasts by county are used in the Future Conditions section of this report. Note that forecast methodologies and assumptions differ between the three states, potentially leading to inconsistencies in the results.

Transportation Demand and Flows Data Sources

Location Based Services Data

Location Based Services ("LBS") providers utilize geolocation data from smartphones and other related data sources to model travel flows between origins and destinations, as well as provide information about those flows.

StreetLight

The LBS provider utilized in this study is StreetLight Data ("StreetLight"). The study utilizes two sets of data from StreetLight. Firstly, a standard dataset that is provided within existing Amtrak licenses allows the study to examine changes in travel patterns over the 2019-2022 period, as well as providing some details about the characteristics of those trips. However, this dataset is not optimized for analysis of longer-distance trips, which are an important component of travel in the study area. As a result, the study also utilizes a custom dataset purchased from StreetLight that is calibrated to better reflect longer-distance trips. However, this dataset covers only 2019, and so does not allow for comparing directly across years. It also does not contain as detailed information about the flows as the standard dataset.

JTW data

The ACS provides JTW data by home location *or* work location, including information about the mode of travel, and other travel features. However the ACS does not directly provide JTW flow data, connecting home location *and* work location.

The American Association of State Highway and Transportation Officials ("AASHTO") provides the Census Transportation Planning products Program ("CTPP"), a special ACS dataset funded by State governments. CTPP provides additional data not available from the standard ACS JTW dataset, including flows connecting home and work location. This flow data also includes features such as the split of travel by mode between each home-work location pair. The latest available CTPP data is for the 2016 5-year ACS.

NHTS data

The Federal Highway Administration ("FHWA") conducts a National Household Travel Survey ("NHTS") at regular intervals. It utilizes data from a national sample to provide information on trip behavior, including modes and purposes of travel, length in time and distance, and many features about the individuals and households performing these trips. The NHTS only provides data on the home location of individuals performing trips. Some information is provided about destinations, such as whether they are urban areas, but destinations themselves are not identified. The latest available NHTS data is for 2017.

Because the NHTS is a national level study, sample sizes in any specific geography are small. As a result, while the NHTS provides a national sample with a standard methodology across geographies, margins of error may be larger than those for more local household travel surveys.

Mode Specific Sources

Amtrak Ridership Data

Amtrak has provided the study with access to actual ridership data. This data provides information on level of ridership, total revenue, and other variables at the station-pair level. The data can be sorted by time period, route number, class of service, and other features. This study primarily utilizes annual data from 2019 for the *Northeast Regional* and *Acela* train routes, although data for other routes and/or time periods is also utilized, such as for the analysis of Amtrak's COVID-19 recovery.

Commuter Rail Data

The study utilizes data from each of the four commuter rail operators present in the region: Metro-North Railroad ("Metro North"), Shoreline East, The Hartford Line, and the Massachusetts Bay Transportation Authority Commuter Rail ("MBTA CR"). The study utilizes the available data from these operators on ridership, schedule, and pricing, at the route level where possible. The study also utilizes data that these operators have provided to the Federal Transit Administration's ("FTA") National Transit Database ("NTD") as well as to the American Public Transit Association ("APTA").

AADT Traffic Data

This study utilizes a number of different sources for Annual Average Daily Traffic ("AADT") data. This includes data from the states of New York, Connecticut, Rhode Island, and Massachusetts. AADT data is only available at particular count locations, and placement of these locations may impact the reliability of conclusions from this data. This study also utilizes AADT data from the FHWA's Highway Performance Monitoring System ("HPMS").

Air Travel Data

This study utilizes two major aviation datasets. First, data submitted by air carriers on Form 41 Schedule T-100 ("T-100"), provides a nearly complete record of variables such as travel volumes. Second, DB1B dataset is based on a sample of air trips, and so does not provide complete volume information. However, it does include relevant data such as fare levels. Combined, the T-100 and DB1B datasets allow for review of air travel within the study area.

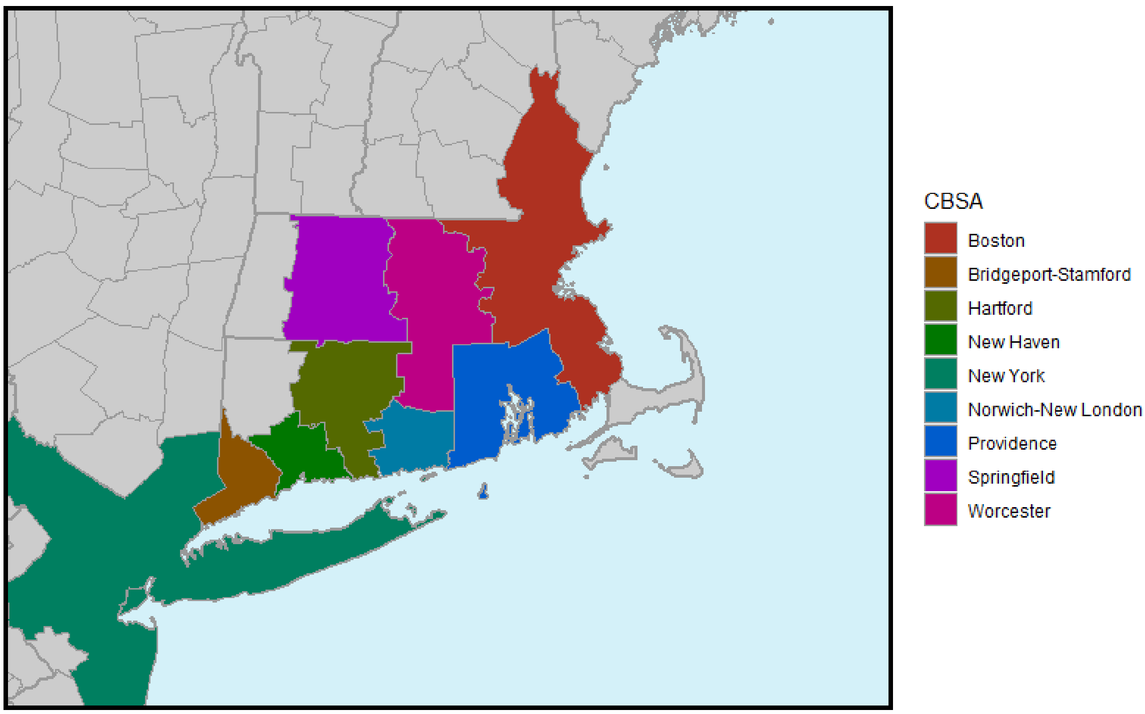
Intercity Coach and Intercity Bus:

The intercity bus market is disaggregated among multiple operators, and standardized data sources are limited. In addition to some data from the Bureau of Transportation Statistics ("BTS") Intercity Bus Atlas database, data was collected from operators themselves. This data is utilized to provide an indicative but not comprehensive view of schedules, pricing, and ridership for intercity bus travel in the study area. Because much of this data is collected from customer facing sources, access to 2019 data was limited in some cases.

B Additional Context

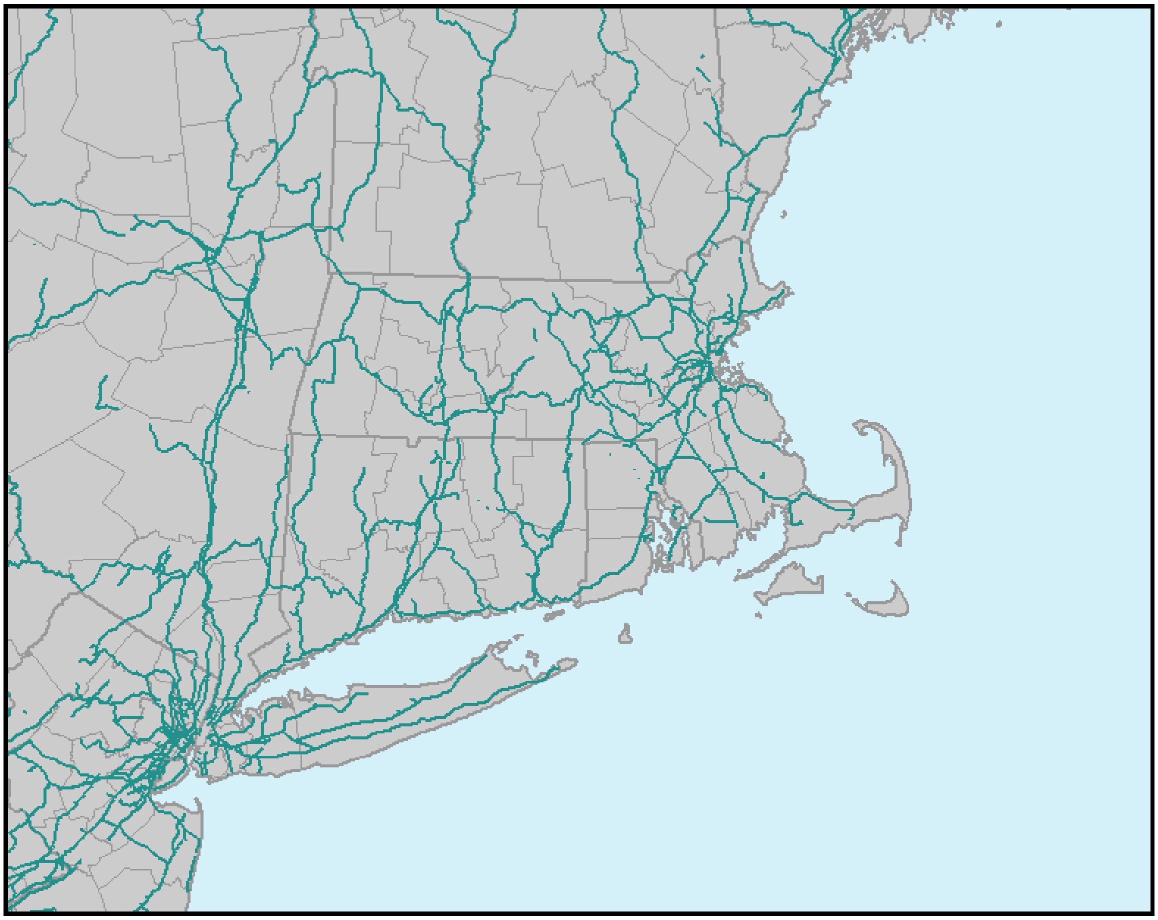
Additional Maps

Figure B-1: Study Area Core Based Statistics Areas



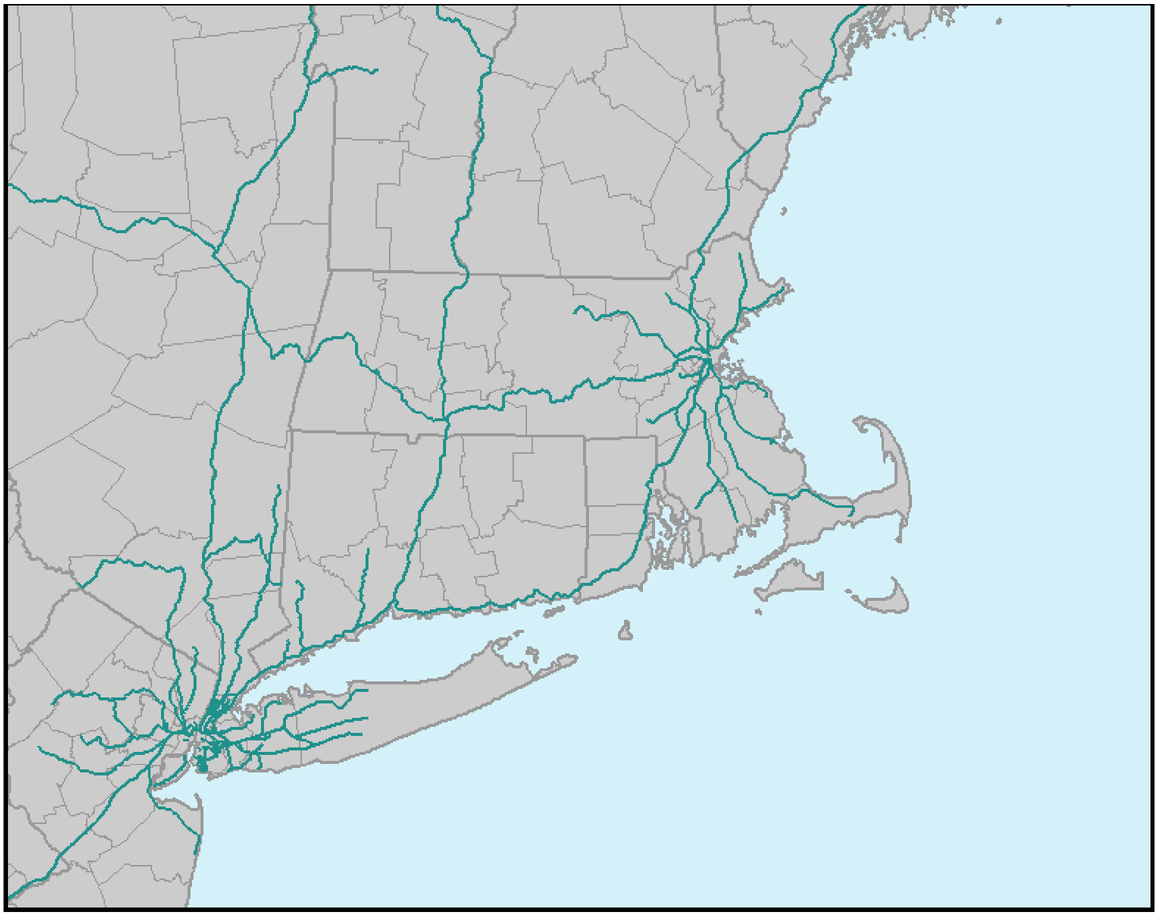
Source: U.S. Census Bureau

Figure B-2: Rail Infrastructure in the Study Area (Freight and Passenger)



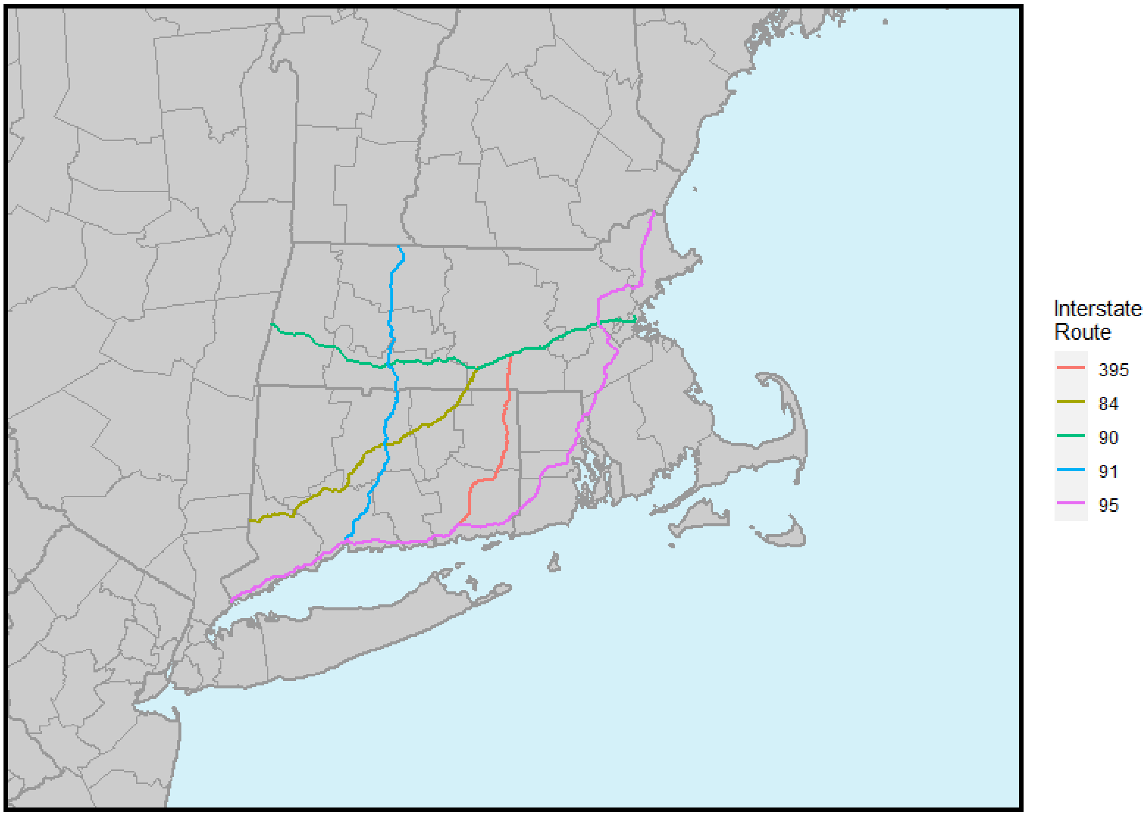
Source: U.S. Census Bureau

Figure B-3: Passenger Rail Infrastructure in the Study Area



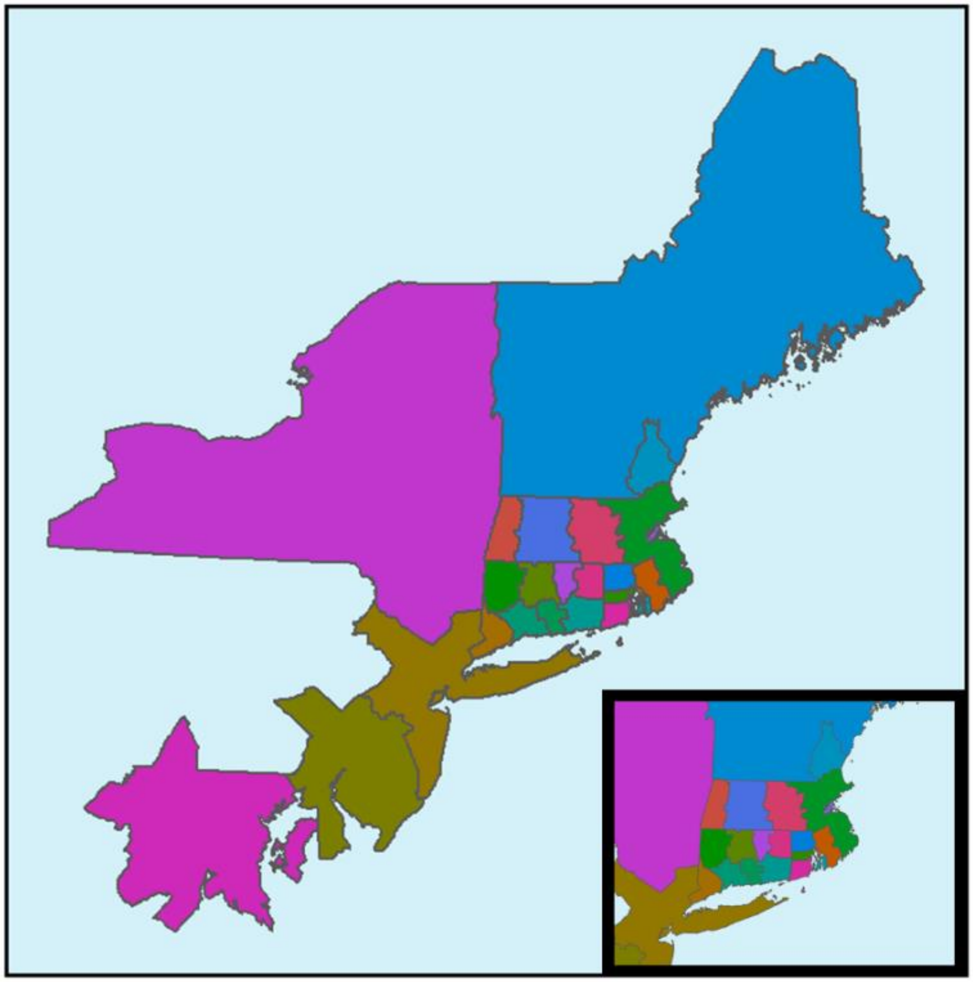
Source: Amtrak, Commuter Rail Operators

Figure B-4: CT, RI, and MA Interstate Highways within the Study Area



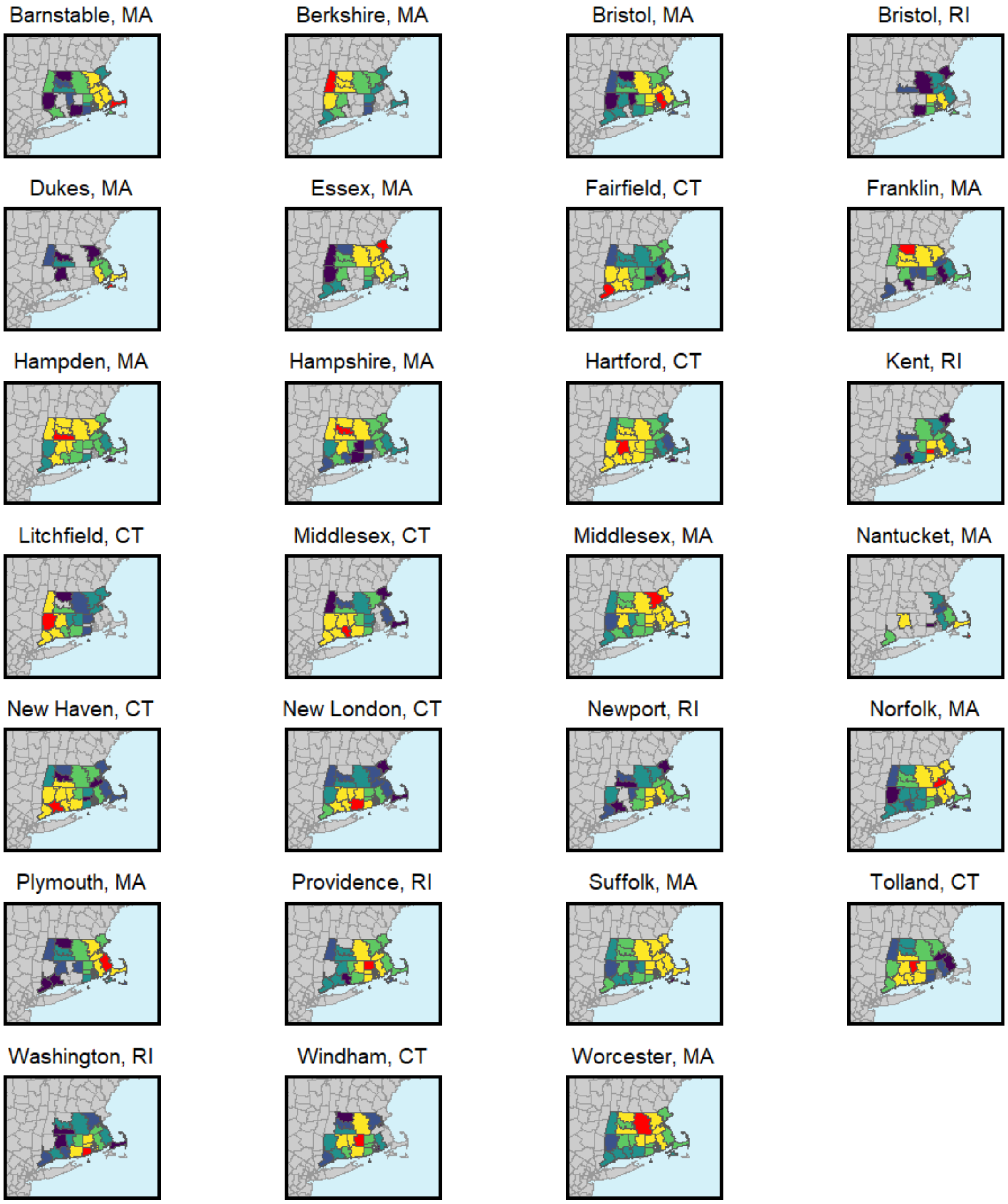
Source: FHWA

Figure B-5: StreetLight Zone System for OD Flows



Source: Steer Analysis

Figure B-6: Home counties By Number of Commuters to Work county (Work County in Red)[63]



Source: ACS JTW CTPP Data, 5-year Estimates 2012-2016

[63] Only includes data on traffic between the colored zones. Note that due to sample limitations in the ACS JTW CTPP dataset, some county-pairs have 0 commuters, especially for smaller work counties.