Exploring Shared-Use Mobility through Hubway Bikeshare

Photos courtesy of Hubway

Prepared by the Central Transportation Planning Staff for the Massachusetts Department of Transportation

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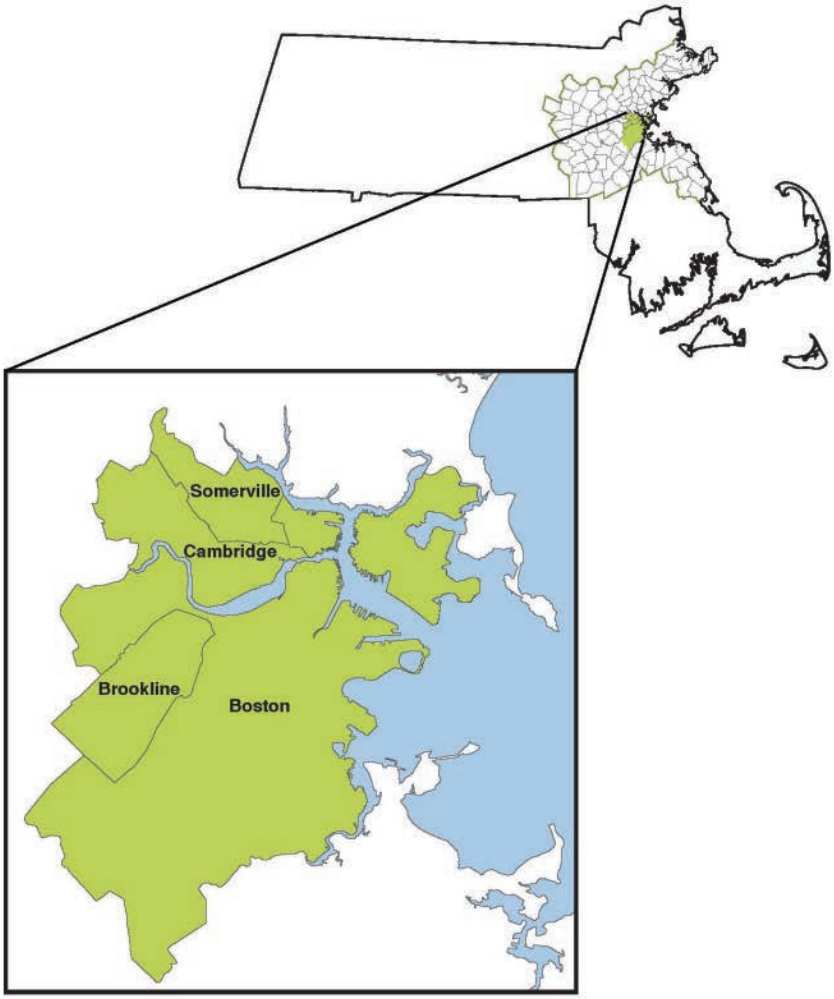

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ABSTRACT

Bikesharing is an example of a shared-use mobility service, which involves sharing vehicles, bicycles, or other modes of travel, and provides users with short-term access to transportation. This report on Hubway, the bikesharing system that serves Boston, Brookline, Cambridge, and Somerville, includes three components:

1. **An analysis of Hubway member characteristics and travel behaviors, using survey data collected in February 2016.** This information sheds light on how members use the system, including in conjunction with other modes. It explores not only member responses to individual questions, but also the relationships between different member characteristics and behaviors using cross-tabulations and a regression model. Survey results of members' most recent trips show that many members used Hubway to meet essential transportation needs, such as commuting, and that many members selected Hubway because it was the fastest way to their destination. Top alternative modes for these most-recent trips include public transit (36 percent) and walking (33 percent).

   Staff also used a statistical model to explore factors that might encourage Hubway members to replace motor vehicle trips with Hubway trips going forward. The model showed that respondents who had been Hubway members for longer periods, continuously or intermittently, had a greater propensity to replace motor vehicle trips with Hubway trips. The results of this survey analysis could be used to inform outreach to current or prospective users or enrollment campaigns.

2. **A discussion of general Hubway usage trends during 2015, according to season, user group, day of the week, time of day, and geographic location.** This information provides a recent and multidimensional view of system usage, including variations in how Hubway members use the system compared to short-term, or casual, users.

3. **An analysis of Hubway's potential to complement or compete with MBTA fixed-route transit service for particular origin-destination (O-D) pairs.** Staff used an open-source trip-planning tool to generate alternative transit itineraries for Hubway trips, and calculated a ratio for each trip to compare Hubway and transit travel times. Staff used this ratio, along with information about transit modes and transfers, to compare transit and bikesharing options for trips and O-D pairs. The tool

recommended walking as an alternative for 31 percent of Hubway member trips, and bus as an alternative for another 36 percent of trips. Only 11 percent of the Hubway member trips analyzed would have been faster, or comparable in travel time, via transit. Staff also examined O-D pairs to identify where travel by Hubway may complement or compete with the MBTA fixed-route transit system.

This information could be used to inform policies, information campaigns, or investments with potential to enhance Hubway's ability to support first-and-last-mile connections to transit, or otherwise offer a non-single-occupant vehicle alternative. This information also could help identify locations where transit could be improved to make it a more competitive option. The analytic techniques used in this report could be applied to analyses of other shared-use mobility datasets.

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1 HUBWAY BIKESHARING RESEARCH OVERVIEW

This analysis of Hubway bikesharing user and trip characteristics is a component of a broader research initiative concerning shared-use mobility services operating in Greater Boston. Shared-use mobility services involve sharing vehicles, bicycles, and other travel modes so that users have short-term access to transportation on an as-needed basis.[1] In particular, bikesharing services enable users to access bicycles on demand from bike docking stations or free-floating fleets around the service area.[2] Shared-use mobility services such as bikesharing provide flexibility on an individual-trip level and may affect longer-term mode-share and car-ownership decisions. It is important to understand the role of shared-use mobility options in the region's transportation system for short- and long-term transportation planning.

In 2016, the Central Transportation Planning Staff (CTPS) of the Metropolitan Planning Staff (MPO) began work on a Massachusetts Department of Transportation (MassDOT)-funded study of shared-use mobility services in Greater Boston. The objectives of this study were to obtain data and provide analytical insights into

- Synergies between shared-use mobility services and more traditional modes, such as Massachusetts Bay Transportation Authority (MBTA) fixed-route transit
- Logistics of how, when, where people use these services to replace private-vehicle or MBTA fixed-route transit trips, or to enable new trips
- Factors that influence a person's decision to switch to these modes
- Potential of shared-use mobility services to allow people to live a less car-dependent lifestyle

In addition to the Hubway analysis described in this report, CTPS conducted a literature review of shared-use mobility services, characteristics of their users, and impacts of these services on the transportation system.[3] Because of limited available data on shared-use mobility services, CTPS focused on bikesharing when researching the study objectives.

[1] Shaheen, S., et al, *Shared Mobility: Definitions, Industry Developments, and Early Understanding*, 2015, http://innovativemobility.org/wp-content/uploads/2015/11/SharedMobility_WhitePaper_FINAL.pdf, accessed April 19, 2016, p. 4.

[2] *Ibid,* p. 20.

[3] See CTPS, *Shared Use Mobility Services: Literature Review*, 2017.

Hubway began operating in Boston in 2011 and expanded to Cambridge, Brookline, and Somerville in 2012.[4] Financial support for the system has included grants from the Federal Transit Administration's Bus Livability grant program and the Federal Highway Administration's Congestion Mitigation and Air Quality CMAQ program. Funding also came from the Centers for Disease Control and Prevention, the Massachusetts Executive Office of Housing and Economic Development, the Boston Public Health Commission, the Barr Foundation, and corporate sponsorships from New Balance and other local private institutions.

The system is owned by the municipal governments of Boston, Brookline, Cambridge, and Somerville. Municipal funds have provided support for the Hubway system. The Metropolitan Area Planning Council (MAPC) oversees interaction and use of the system between municipalities. Motivate, formerly Alta Bicycle Share, is the contractor that designs, deploys, operates, and manages the Hubway system. As of the end of 2015, Hubway's system footprint covered approximately 25 square miles and included 155 stations and 1,500 bikes.[5] The Hubway system features dedicated docking stations for its bicycles and automated credit card payment. Users can sign up for either an annual or a monthly membership or purchase a 24- or 72-hour pass.

The Hubway system presents a valuable case study for exploring the characteristics of shared-use mobility. Because the service has existed for several years, people living in Greater Boston have had an opportunity to integrate Hubway into their overall travel patterns, and potentially change their behaviors in response to its availability. Motivate publishes comprehensive Hubway trip logs on its website, which grants planners and researchers easy access to detailed data on individual trips from one Hubway station to another. Using trip data, along with Hubway member survey data obtained from Motivate via MAPC, staff conducted a three-part analysis:

1. **Analysis of 2015 Hubway member survey data, to gain insight into Hubway user characteristics and how and why they use bikesharing.** This section describes what motivates members to use bikesharing, what kind of trips they make using bikesharing, and how bikesharing may fit into their overall travel behavior, including use of other modes. The analyses go beyond summary statistics of individual variables, and explore relationships between variables using cross-tabulations and a regression analysis. These results could be used to inform outreach or enrollment

[4] Hubway. "Hubway Media Kit." http://www.thehubway.com/mediakit. Accessed October 14, 2016.

[5] Hubway. "Hubway Media Kit." http://www.thehubway.com/mediakit. Accessed October 14, 2016.

campaigns to help users (or potential users) to obtain or maintain their memberships.

2. **General analysis of Hubway trips taken during 2015.** This section examines recent use of the Hubway system and describes when and where the system is being used, and how different customer segments (members or casual users) use the system differently.

3. **Analysis that compares Hubway trips with transit alternatives, and identifies cases where Hubway may complement or compete with the fixed-route transit system.** Staff tested a technique using Open Trip Planner (OTP) that generated alternative transit and walking itineraries for Hubway origin and destination (O-D) pairs, and examined how these transit options would compare to Hubway trips in terms of travel time. This method could potentially be replicated with data from other transportation modes, particularly other shared-use mobility services. These results build upon the general analysis of Hubway trips and cite O-D pairs where OTP generally recommended a transit alternative that was faster or comparable in travel time to Hubway or much slower than Hubway. They also identified O-D pairs where OTP generally recommended that people walk. This information could be used to inform policies, information campaigns, or investments—such as integrated fare payment—that enhance Hubway's ability to support first-and-last mile connections to transit or offer a non-single-occupant vehicle (SOV) option where it might not be feasible or desirable to enhance transit service, or where service could be crowded. This information could also be used to identify locations where transit could be improved to make it a more competitive option.

2 HUBWAY MEMBER SURVEY RESEARCH

2.1 Member Survey Data Overview

As of the end of 2015, Hubway had 13,248 annual members.[6] In February 2016, Hubway issued a 2015 year-end survey to members who had an active annual membership at the end of 2015, to which 1,460 members responded. The survey asked questions on topics that included

- Respondents' demographic and socio-economic characteristics
- Details on respondents' most recent trip
- Members' satisfaction with Hubway service
- Their safety and spending habits while using Hubway

[6] Hubway. "Hubway Media Kit." http://www.thehubway.com/mediakit. Accessed October 14, 2016.

- How they use Hubway in concert with other modes to meet their travel needs

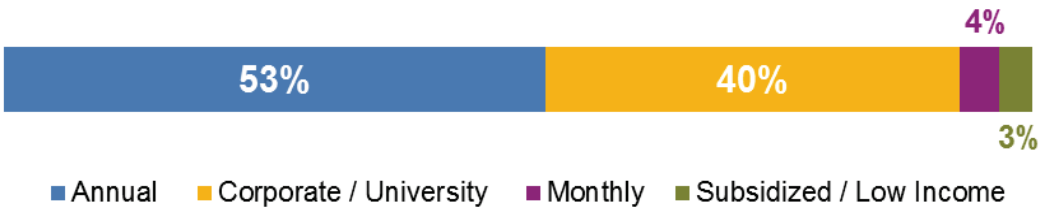
This analysis focuses on the subset of survey questions that pertain most directly to the research objectives discussed in Part 1. Because this survey is specific to Hubway members, it does not provide insight into the characteristics and preferences of short-term-pass-purchasers. As discussed in the sections to follow, casual users took approximately 22 percent of Hubway trips in 2015; and differ from Hubway members in terms of when and where they make trips.

The survey form was distributed by email and data was collected during the winter of 2016, when people likely would modify their bicycling usage in response to the weather. Not all respondents answered all questions. In addition, responses reflect only those members who elected to respond; hence, these results may not be representative of all Hubway members. In spite of these limitations, this information still provides valuable insights into the travel behaviors of bikeshare users in greater Boston.

2.2 Member Characteristics

Figures 2-1 through 2-8 summarize the membership, demographic, and socioeconomic characteristics of Hubway survey respondents.

FIGURE 2-1
2015 Survey Respondents by Recent Membership Type

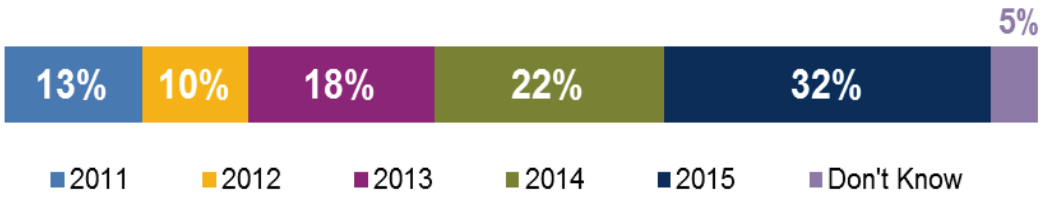


Data source: 2015 Hubway member survey. Sample size = 1,315.

Annual memberships and corporate or university-supported memberships are most common among the sample group, together comprising 93 percent of all reported memberships. Corporate or university-supported memberships are those where an organization collaborates with Hubway and covers some or all of members' costs.[7]

[7] Hubway. "Corporate Partners." 2016. https://www.thehubway.com/pricing/corporate-membership/corporate-partners, accessed February 25, 2017.

FIGURE 2-2
2015 Survey Respondents by Initial Membership Year



Data source: 2015 Hubway member survey (sample size = 1,315).

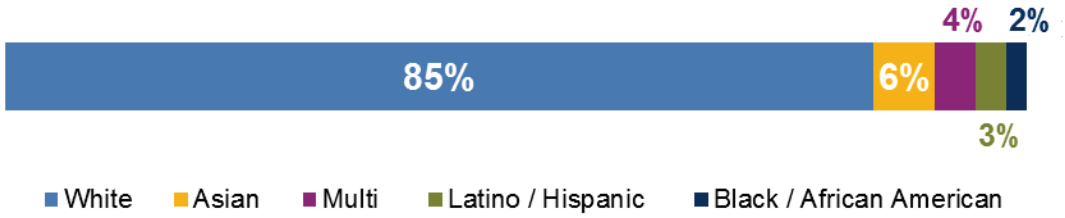
Many respondents became Hubway members relatively recently; approximately half report joining in 2014 or 2015.

As shown in Figures 2-3 and 2-4, approximately two-thirds of respondents identified themselves as male, and 85 percent of respondents identified as white.

FIGURE 2-3
2015 Survey Respondents by Gender

Data source: 2015 Hubway member survey (sample size = 1,252).
Note: Those who identified as Other comprised less than one percent of respondents and are not shown above.

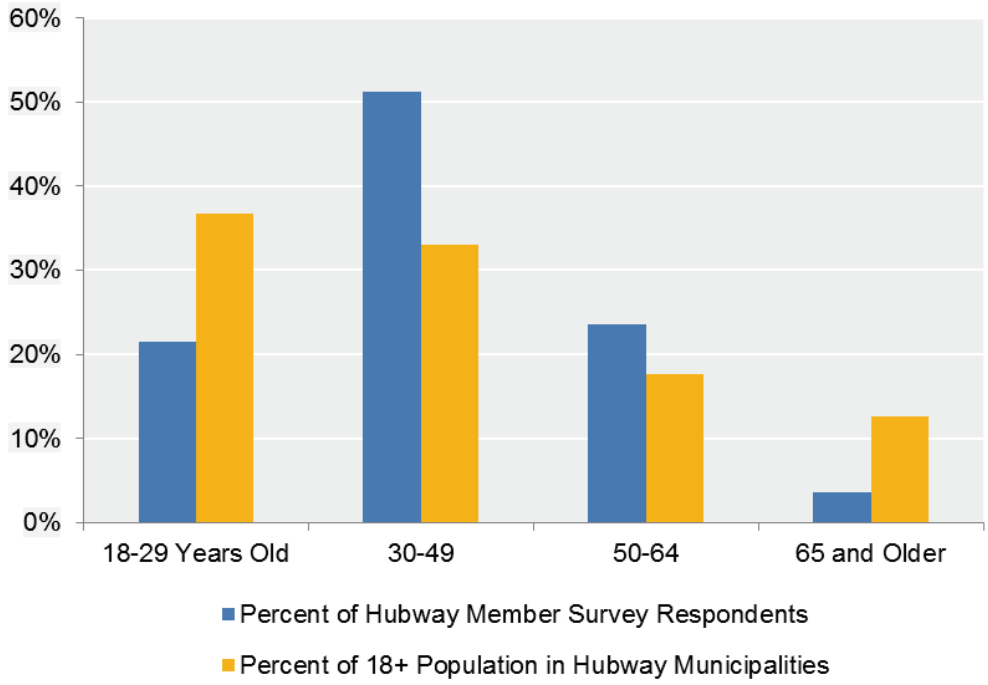
FIGURE 2-4
2015 Survey Respondents by Race/Ethnicity



Data source: 2015 Hubway member survey (sample size = 1,190).
Notes: 1) The Multi category reflects those who selected more than one response option. 2) Other responses (not shown) includes American Indian and Alaskan Native (one person), Native Hawaiian and Pacific Islander (one person), and Other (three people). 3) The Other category includes those identifying as being of Middle Eastern ethnicity.

Figures 2-5, 2-6, and 2-7 describe respondents' age, household income, and education level. Staff aggregated responses to these questions in ways that made it possible to compare this information to US Census data on age, income, and education level for the Hubway service area population.

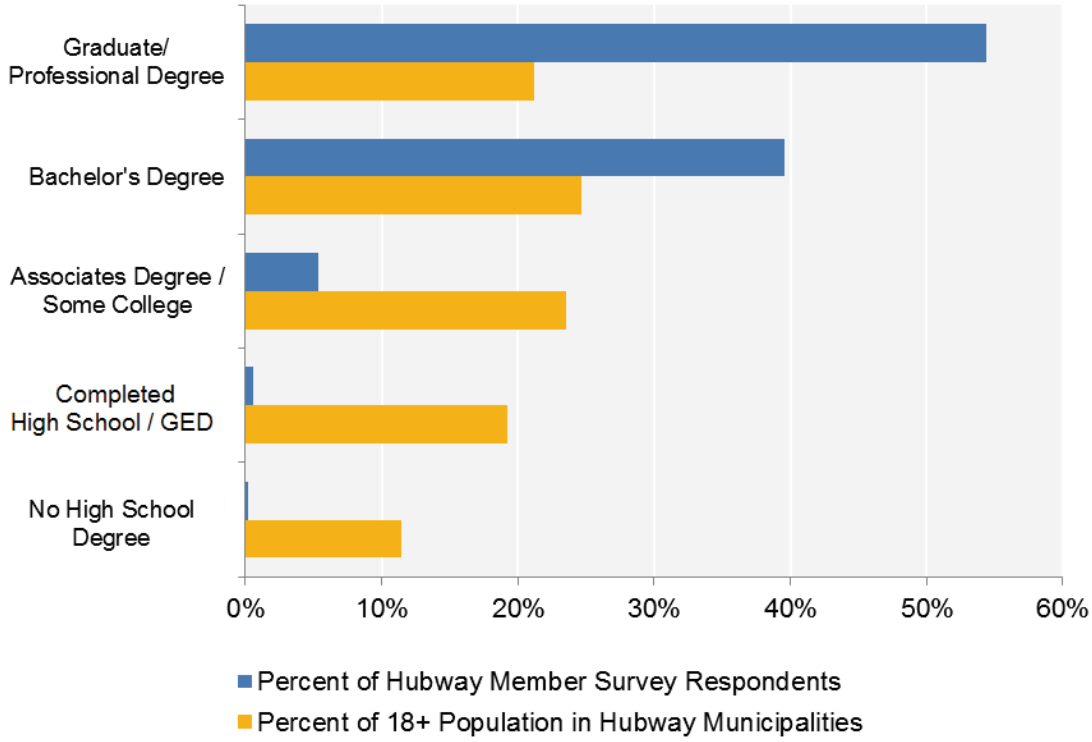
FIGURE 2-5
2015 Survey Respondents and
Population of Hubway Municipalities by Age



Data sources: 2015 Hubway Member Survey (sample size = 1,234), and 2010-14 American Community Survey (ACS) data for Boston, Brookline, Cambridge, and Somerville.
Note: A person must be at least 16 years of age to become a Hubway member.

Of the respondents who answered this question, most were between 30 and 49 years old. The shares of respondents in the 18-to-29-year-old and 50-to-64-year-old categories are similar. As shown above, the largest share of survey respondents falls into the 30-to-49-year-old category, while the largest share of the 18-year-or-older population of the municipalities that have Hubway stations—Boston, Brookline, Cambridge, and Somerville—falls into the 18-to-29-year-old category.

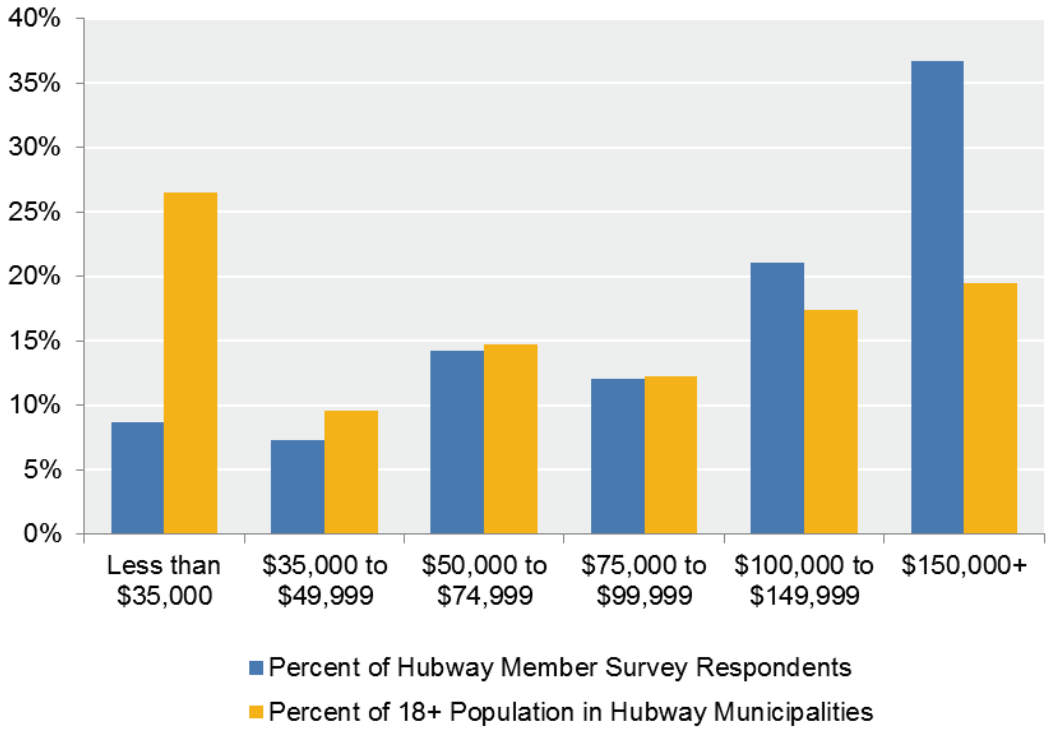
FIGURE 2-6
2015 Survey Respondents and Population of Hubway Municipalities by Education Level



Data sources: 2015 Hubway Member Survey (sample size = 1,263), and 2010-14 ACS data.
GED = general education development (high school equivalency).

The survey respondent group also has higher educational levels compared to the 18-year-or-older population in the Hubway service area municipalities. As shown above, 94 percent of survey respondents earned a bachelor's degree or higher, compared to 46 percent of the service area population.

FIGURE 2-7
2015 Survey Respondents and
Population of Hubway Municipalities by Household Income



Data sources: 2015 Hubway Member Survey (sample size = 1,086) and the 2010-14 ACS Survey Public Use Microsample (PUMS).[8]

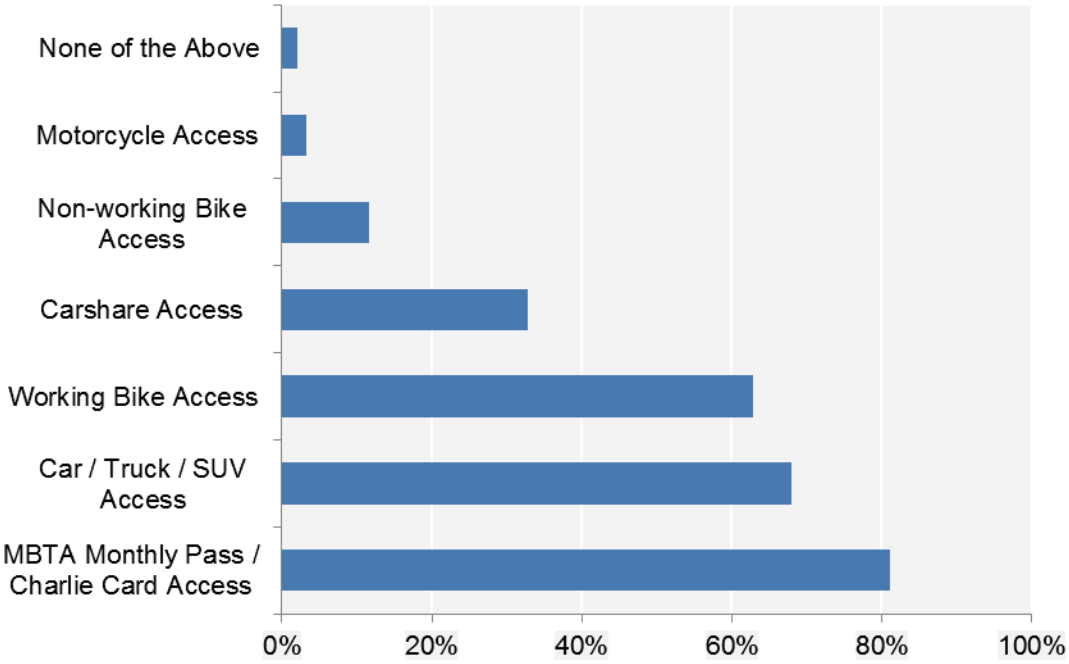
The survey respondent group skews toward higher household incomes than the 18-year-or-older population in the Hubway service area municipalities. The two groups are similar in terms of their shares of people with incomes between $50,000 and $74,999 and between $75,000 and $99,999.

The characteristics of the 2015 Hubway member survey respondents generally correspond to findings about the characteristics of bikeshare users. Fishman's 2016 review of bikesharing literature reports that bikeshare users are more likely

[8] The income distribution by city of the population 18 years of age and older was derived from 2010–2014 ACS Public Use Microdata Sample (PUMS) statistics. The smallest unit of geography for PUMS data is the Public Use Microdata Area (PUMA). Each PUMA has a population of at least 100,000. Boston is comprised of five PUMAs, a single PUMA covers Cambridge; Brookline shares a PUMA with Newton; and Somerville shares a PUMA with Everett. This income distribution was then applied to 2010–2014 ACS Summary File age 18 and older population counts in households for each city. ACS income data is tabulated only for household populations, excluding residents of group quarters facilities such as college dormitories.

to be white (in the US and London), and male, and to have higher-than-average incomes and levels of education.[9]

FIGURE 2-8
2015 Survey Respondents by Reported Access to Select Transportation Resources



Data source: 2015 Hubway member survey (sample size = 1,327).
Notes: 1) 133 respondents who did not identify any transportation resources, and who did not answer subsequent questions, were excluded. 2) One person did not select "None of the Above" but did not identify any transportation resources.
SUV = sport utility vehicle.

When asked about the transportation resources available to them, approximately 81 percent of respondents reported that they had access to a MBTA "Monthly Pass/Charlie Card, as shown in Figure 2-8."[10] Sixty-eight percent said they had access to a personal vehicle, while 63 percent reported access to a working bike.[11] This information, combined with information about Hubway member incomes and education level, suggests that Hubway members generally are aware of, and have access to, a variety of transportation options; which enhances their ability to select the optimal mode for a given trip.

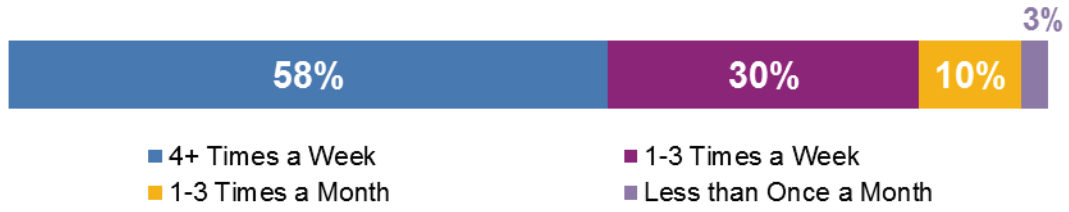
[9] Fishman, E. "Bikeshare: A Review of Recent Literature," *Transport Reviews, 36:1* (2016), 92-113, doi: 10.1080/01441647.2015.1033036, accessed April 19, 2016, p. 109.
[10] Four people did not select the MBTA Monthly Pass/Charlie Card Access option, but reported having "pay-as-you-go" Charlie Cards. These people are not reflected in Figure 2-8.
[11] Eighty-six people who reported having access to a non-working bike also reported having access to a working bike. These people are reflected in Figure 2-8.

2.3 Members' Hubway Use

General Trip Information

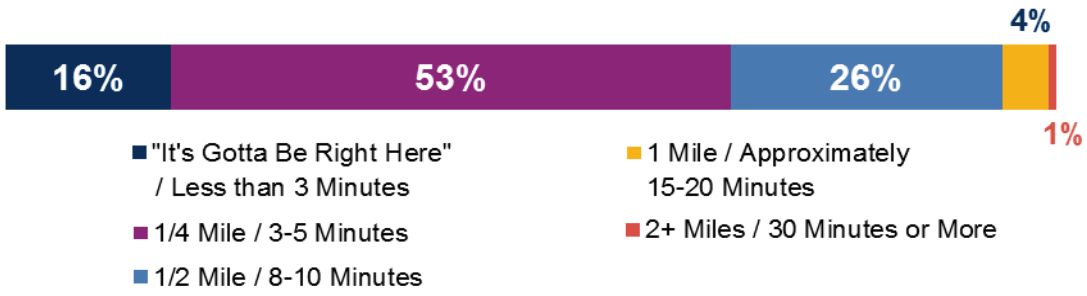
Figures 2-9 and 2-10 provide information about members' biking frequency during periods of good weather and the distance they are willing to walk to access a Hubway station.

FIGURE 2-9
2015 Survey Respondents by Biking Frequency



Data source: 2015 Hubway member survey (sample size = 1,397).
Note: Values sum to greater than 100 percent because of rounding.

FIGURE 2-10
2015 Survey Respondents by Distance They Are Willing to Walk to a Hubway Station



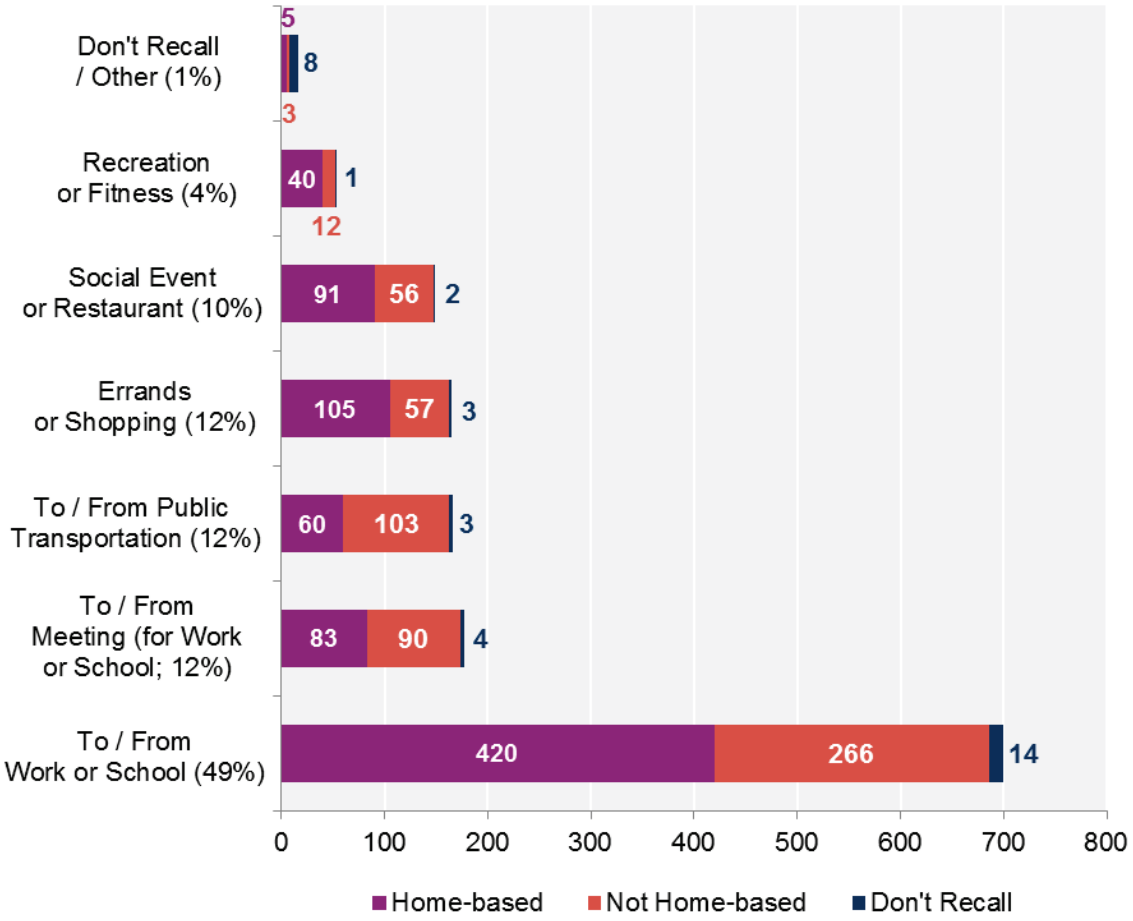
Data source: 2015 Hubway member survey (sample size = 1,309).

The majority of survey respondents (88 percent) reported using Hubway or their personal bike during periods of good weather at least once a week, as shown in Figure 2-9. Figure 2-10 shows that 53 percent of respondents reported that they would be willing to walk as much as one-quarter mile to reach a Hubway station, although 16 percent said that the station would need to be "right here," or within a three-minute walk.

Most Recent Trip Information

The member survey includes questions about respondents' most recent Hubway trip. Figures 2-11 through 2-17 display the results of a subset of these questions.

FIGURE 2-11
2015 Survey Respondents by Purpose and Starting Location of Their Most Recent Hubway Trip



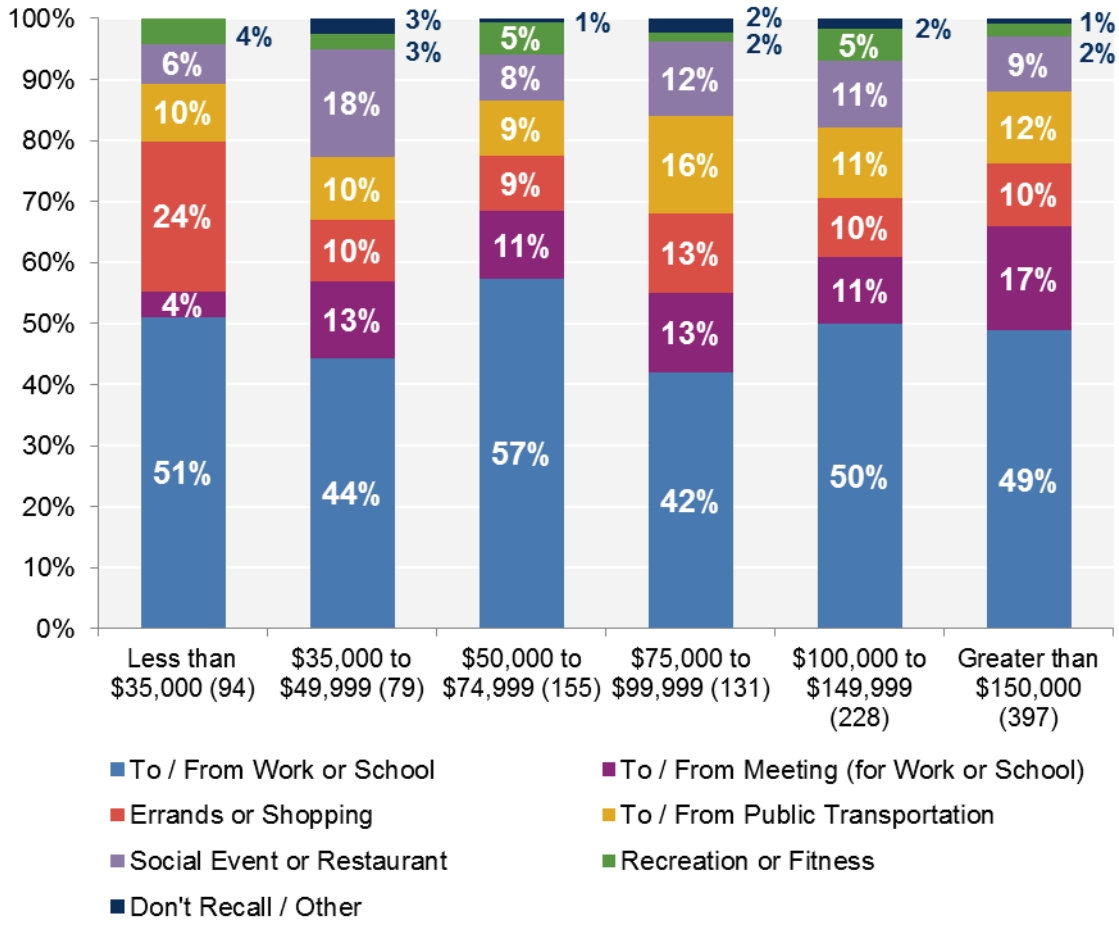
Data source: 2015 Hubway member survey (sample size = 1,426).
Note: Percent values in data labels reflect each trip purposes's share of total responses.

The top Hubway trip purpose identified by survey respondents was commuting to or from work or school (49 percent of all responses), followed by traveling to or from work-related meetings or public transportation or for errands. In his review of bikesharing systems in the US and internationally, Fishman found that commuting was a top trip purpose among bikesharing members.[12] Fifty-five percent of respondents' most recent trips were home-based. Figure 2-11 shows that less than half of trips to or from work-related meetings (12 percent of all trips) or public transit (12 percent of all trips) began from respondents' homes.

[12] Fishman, E., "Bikeshare: A Review of Recent Literature," p. 98.

Figure 2-12 examines Hubway trip purposes with respect to respondents' household income.

FIGURE 2-12
2015 Survey Respondents by Purpose of Most Recent Hubway Trip and Household Income

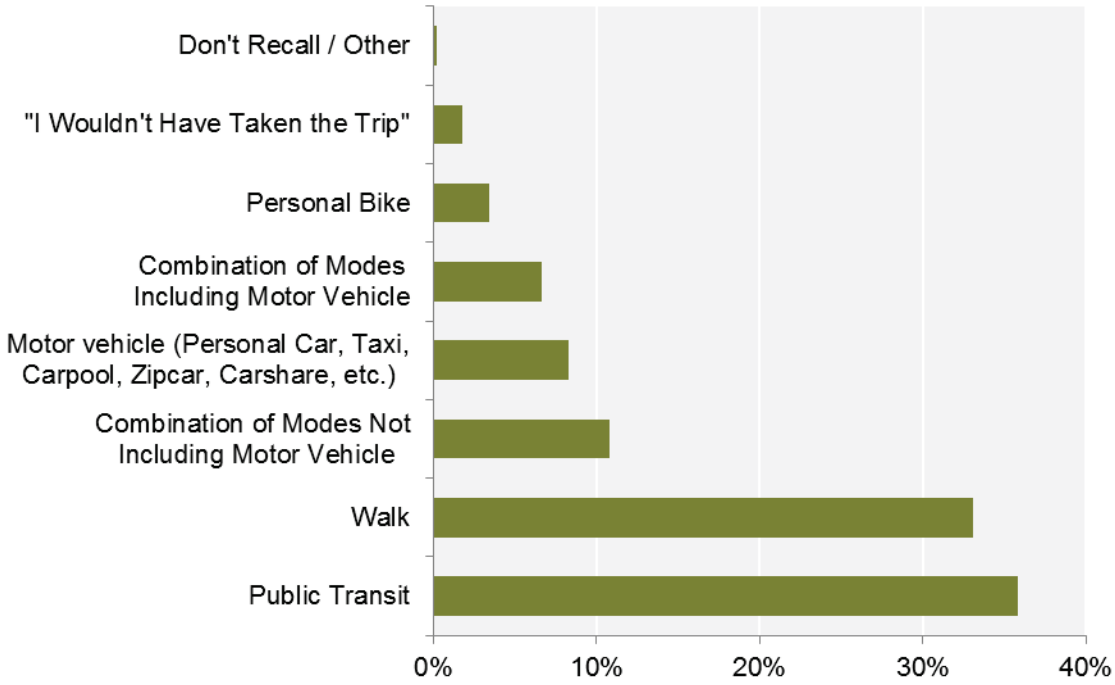


Data source: 2015 Hubway member survey (sample size = 1,084 respondents).
Notes: 1) The sample size for each income category is included in its data label. 2) The percent values in each column may not sum to 100 percent because of rounding.

More than 50 percent of the people in each income group reported making their most recent trip for work or school purposes (including meetings). Those who earned less than $35,000 made a larger share of Hubway trips for errands or shopping than other groups, while those with incomes in the $75,000–$99,999 range made a larger share of trips to connect with public transportation.

Figure 2-13 shows survey respondents' most-preferred alternative travel modes had Hubway not been available for their most recent trip.

FIGURE 2-13
2015 Survey Respondents by Most-Preferred Alternative Travel Mode for Their Most Recent Hubway Trip



Data source: 2015 Hubway member survey (sample size = 1,430).

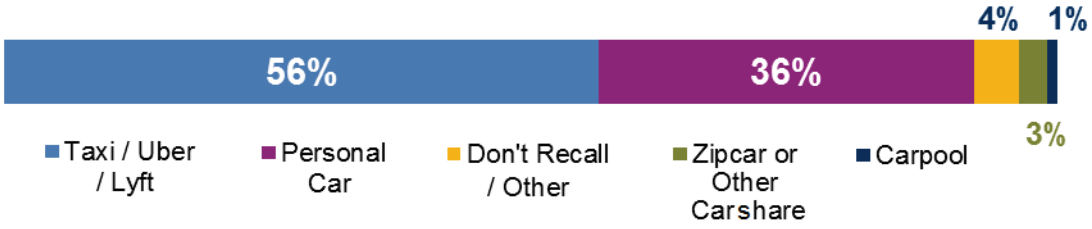
Thirty-six percent of respondents identified public transit as their most-preferred alternative for their recent trip, while 33 percent selected walking. Again, these results might have been affected by the survey being distributed in winter. However, these results do reflect findings from other bikeshare surveys across the country.[13] In particular, the Shared Use Mobility Center (SUMC) found that respondents to their 2015 multi-city survey tended to cluster into active-transportation or motor vehicle-oriented groups when selecting alternatives to

[13] Fishman, E. Bikeshare: A Review of Recent Literature, p. 103-4; Shaheen, S. et al., Mineta Transportation Institute Report 12-29: Public Bikesharing in North America during a Period of Rapid Expansion: Understanding Business Models, Industry Trends, and User Impacts, 2014, http://transweb.sjsu.edu/PDFs/research/1131-public-bikesharing-business-models-trends-impacts.pdf, accessed April 19, 2016, p. 71-79; Shaheen, S. et al. Shared Mobility: Definitions, Industry Developments, and Early Understanding, p. 10.

their preferred shared-use mode.[14] Those who are inclined to use bikesharing might be most inclined to use transit or walking as a next-best alternative.

Figure 2-14 provides additional detail on the subset of respondents who selected "motor vehicle," or "combination of modes including motor vehicle," as their preferred alternate mode to Hubway for their most recent trip.

FIGURE 2-14
2015 Survey Respondents by Preferred Alternate Motor-Vehicle Mode for Their Most Recent Hubway Trip



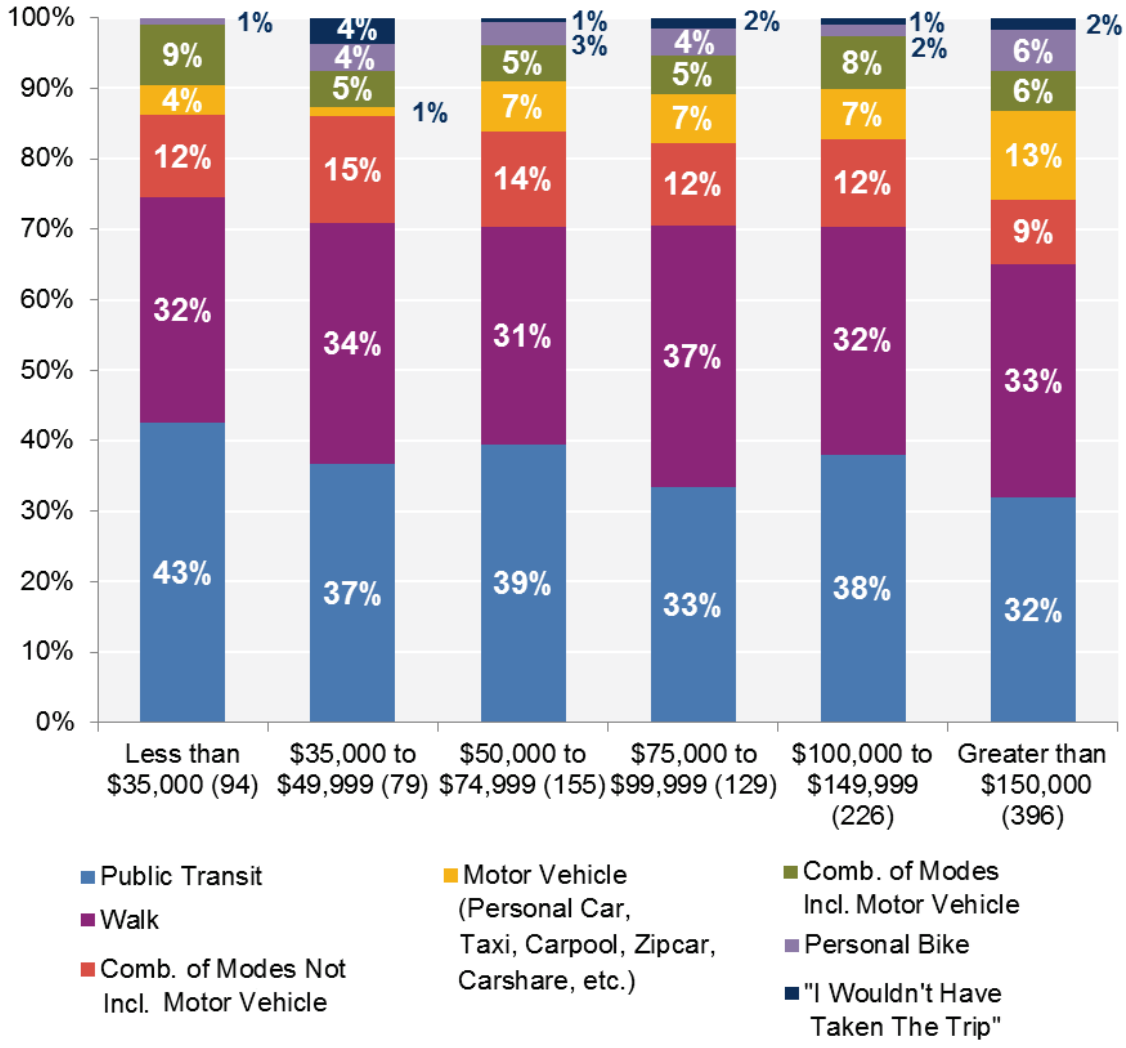
Data source: 2015 Hubway member survey (sample size = 214).
Note: The sample for this chart only includes respondents who selected "motor vehicle" or "combination of modes including motor vehicle" as their preferred alternative to Hubway.

Respondents in this subset more frequently selected taxis or ridesourcing (56 percent) compared to personal vehicles (36 percent). This seems reasonable given that many respondents' (41 percent) most recent trips started somewhere other than home.

[14] Shared-Use Mobility Center, Shared Mobility and the Transformation of Public Transit, 2016, http://sharedusemobilitycenter.org/wp-content/uploads/2016/04/Final_TOPT_DigitalPagesNL.pdf, accessed April 19, 2016, p. 16.

Figure 2-15 examines respondents' preferred alternate mode for their most recent Hubway trip with respect to their household income.

FIGURE 2-15
2015 Survey Respondents by Preferred Alternate Mode for Their Most Recent Hubway Trip, and Household Income

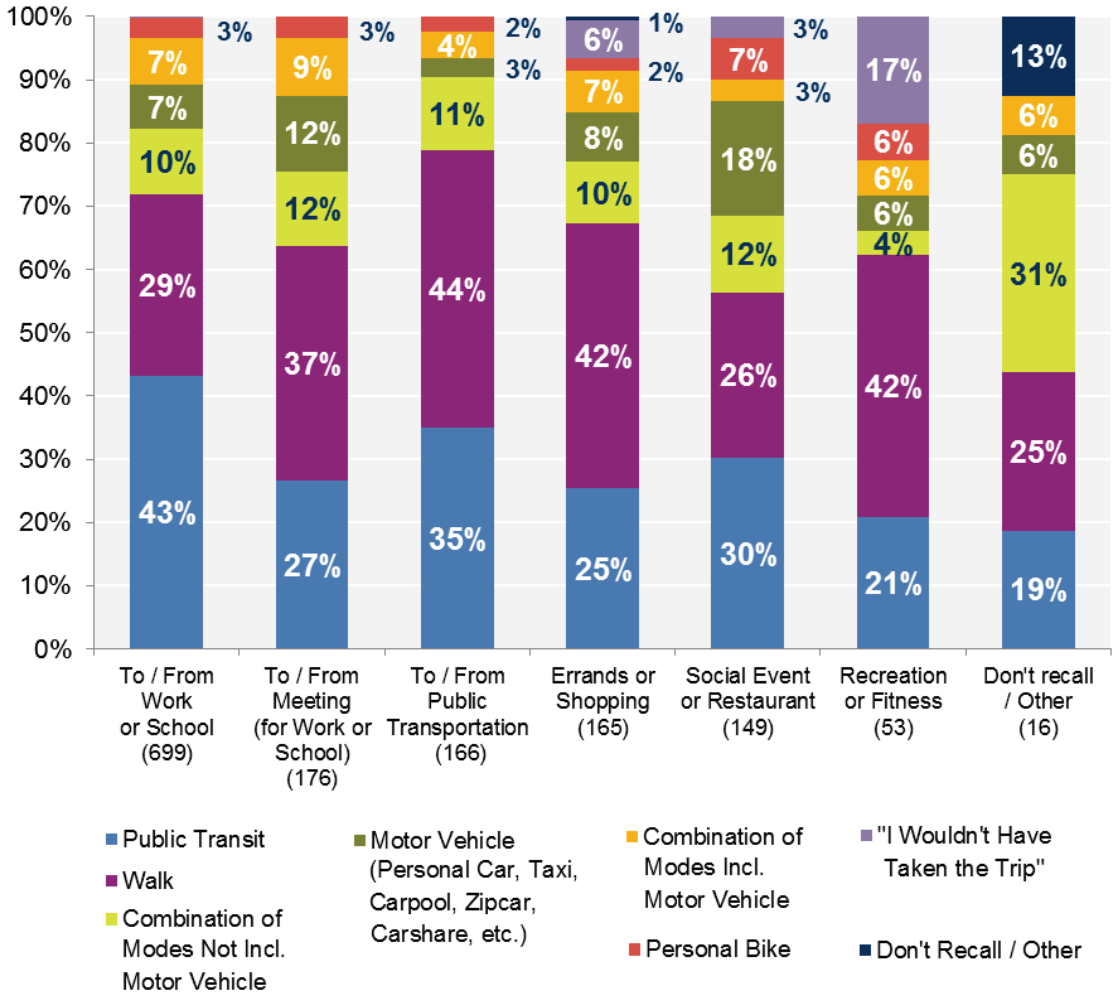


Data source: 2015 Hubway member survey (sample size = 1).
Notes: 1) The sample size for each income category is included in its data label. 2) The percent values in each column may not sum to 100 percent because of rounding.

Across all income groups, walk and public transit make up the largest shares in terms of the modes respondents would have used if Hubway were not available. Those with household incomes greater than $150,000 had the highest share of those who selected motor vehicle as their alternate travel mode (13 percent).

Figure 2-16 shows the percent of respondents who selected each alternate mode for a given trip purpose.

FIGURE 2-16
2015 Survey Respondents by Most Recent Trip by Purpose and Preferred Alternate Mode

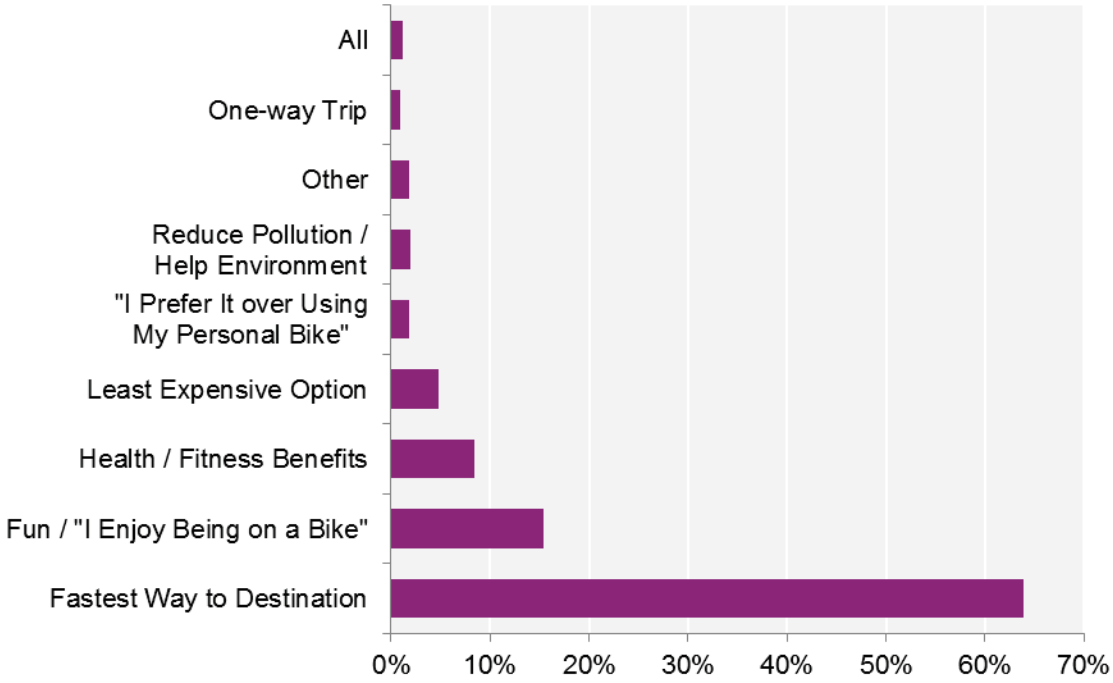


Data source: 2015 Hubway member survey (sample size = 1,424).
Notes: 1) The sample size for each trip purpose category is included in its data label. 2) The percent values in each column may not sum to 100 percent because of rounding.

Public transit and walking are generally the travel alternatives respondents chose, although the rank of these alternatives (in terms of preference) varies depending on the trip purpose. Motor vehicles are a more popular alternative for social trips. Recreation or fitness trips had the highest share of respondents who said they would not have taken the trip if Hubway had not been available.

Respondents were asked about their primary reason for using Hubway for their most recent trip; their responses are shown in in Figure 2-17.

FIGURE 2-17
2015 Survey Respondents by Their Primary Reason for Using Hubway for Their Most Recent Trip



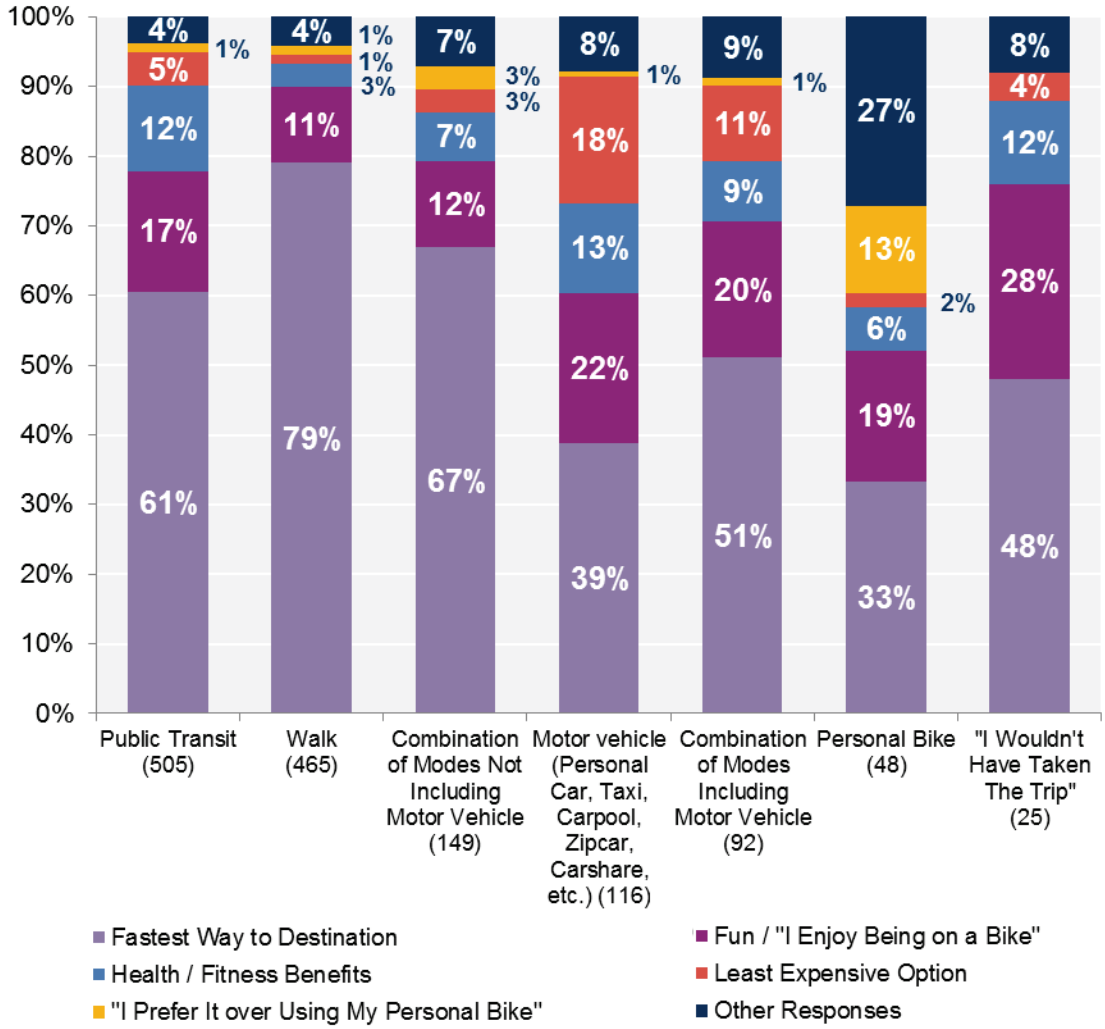
Data source: 2015 Hubway member survey (sample size = 1,412).
Note: The "One-Way Trip" category includes "One-Way T" responses.

Approximately two-thirds of respondents selected "fastest way to [their] destination" as their primary reason for using Hubway for their most recent trip, which is consistent with findings in bikesharing literature.[15] However, other choices may have been more prominent had the survey been issued during a warmer season.

[15] Capital Bikeshare. *2013 Capital Bikeshare Member Survey Report*. http://www.capitalbikeshare.com/assets/pdf/CABI-2013SurveyReport.pdf, accessed April 19, 2016, p. iv, 14-15.

Figure 2-18 compares the primary reason that members used Hubway for their most recent trip with the alternate mode they would have chosen for that trip.

FIGURE 2-18
2015 Survey Respondents by Primary Reason for Choosing Hubway for Their Most Recent Trip and Preferred Alternate Mode



Data source: 2015 Hubway member survey (sample size = 1,407).
Notes: 1) The sample size for each alternate mode category is included in its data label. 2) "Other" reasons for using Hubway include "reduce pollution/help the environment;" "Other;" "All;" "One-way Trip." 3) The percent values in each column may not sum to 100 percent because of rounding.

The majority of respondents who otherwise would have taken public transit, taken a combination of modes, or walked said that their primary reason for using Hubway was that it was the “fastest way to [their] destination.” Approximately 18 percent of members who otherwise would have taken a motor vehicle said that they chose Hubway because it was the “least expensive option.”

2.4 General Travel Characteristics of Members

Commute and Non-Commute Trips by Mode

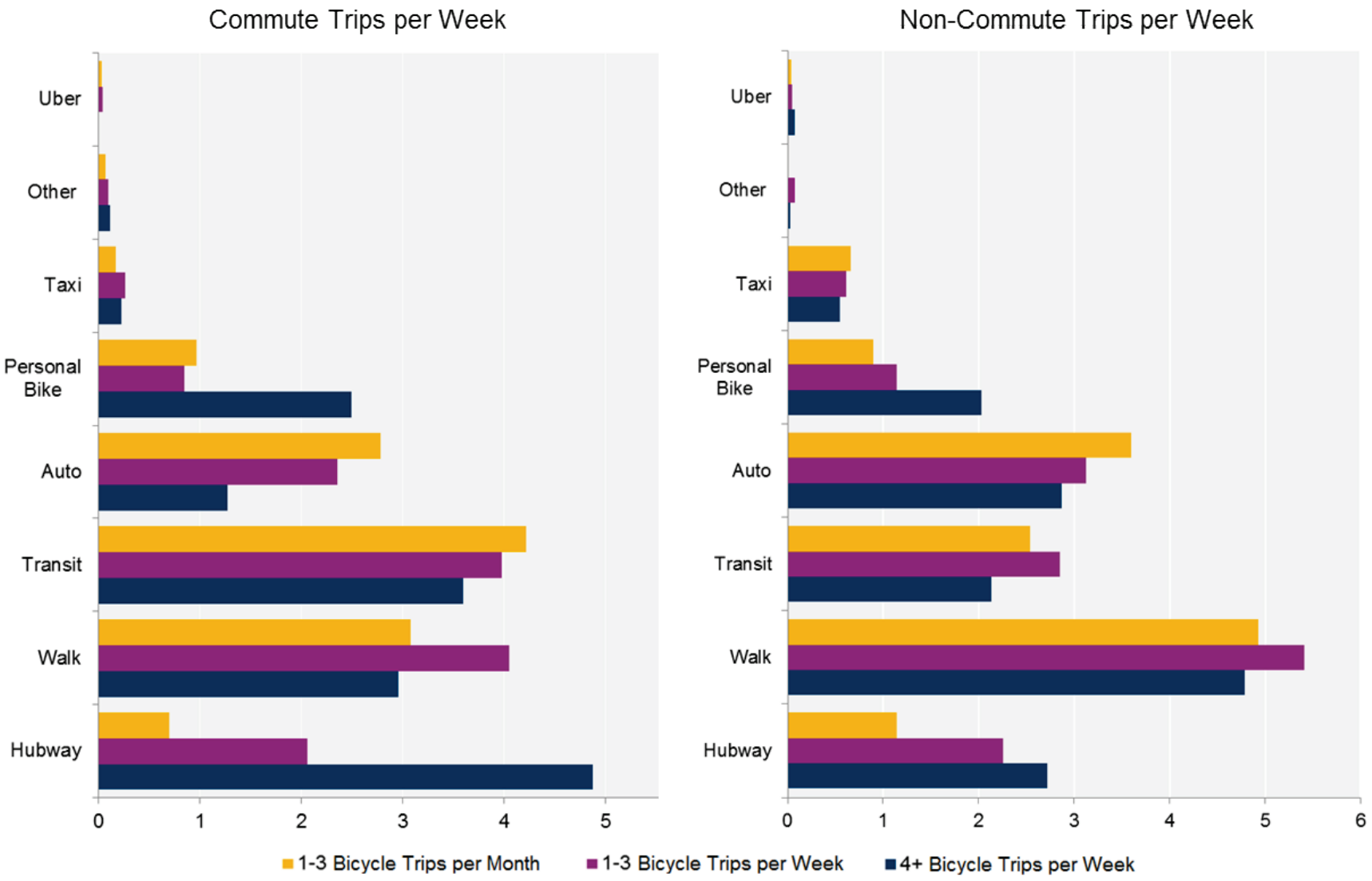
The Hubway member survey also offered insights into how Hubway fits into respondents' overall travel habits. The survey asked respondents to report the number of one-way commuting trips and non-commuting trips they make during a typical week using various forms of transportation.[16] CTPS used responses to these questions to calculate a weighted average number of commuting and non-commuting trips per week for each mode.[17] Figure 2-19 shows these average numbers of trips for three groups of respondents: those who made four or more bicycle (Hubway or personal bike) trips per week, those who made between one-and-three bicycle trips per week, and those who made between one-and-three bicycle trips per month.

Figure 2-19 shows that those who reported biking four or more times a week made a much larger average number of Hubway commuting trips per week, compared to those who reported biking less frequently. Respondents in the "one-to-three trips per week" group made about one additional walking trip compared to the other two groups. Meanwhile, the "one-to-three trips per week" and "one-to-three trips per month" groups made at least one additional commute trip per week by auto compared to those who used Hubway or their personal bicycle more frequently. Those in the "one-to-three bicycle trips per month" group made slightly more transit commute trips per week, on average, than the other two groups, though there is not a large difference in the average number of transit-based commute trips across the three groups. The evidence that transit commute trips are relatively consistent across respondent groups while Hubway trips vary may suggest that some members in the "four or more bicycle trips per week" group use Hubway to connect to transit.

For non-commute trips. walking and transit trip making across groups was fairly similar, although the "one-to-three bicycle trips per week" group made slightly more walking and transit trips, on average, than the "four or more bicycle trips per week" or the "one-to-three bicycle trips per month" groups. Overall, Hubway and transit appear to be prominent options for Hubway member commute trips, while auto is a more prominent option for non-commuting purposes. Walking is a prominent option for both types of trips.

[16] The questions were worded as "During a typical week, how many commute (or non-commute) trips do you take to / from work or school using each of these forms of transportation? Count each one way trip (example: if you biked to work but walked home, that's 1 for each)."

[17] CTPS only included information from respondents who had made at least one commute or non-commute trip (by any mode) during a typical week.



Data source: 2015 Hubway member survey. Sample size (4+ bicycle trips per week) = 735. Sample size (1-3 bicycle trips per month) = 362. Sample size (1-3 bicycle trips per month) = 119.

CTPS

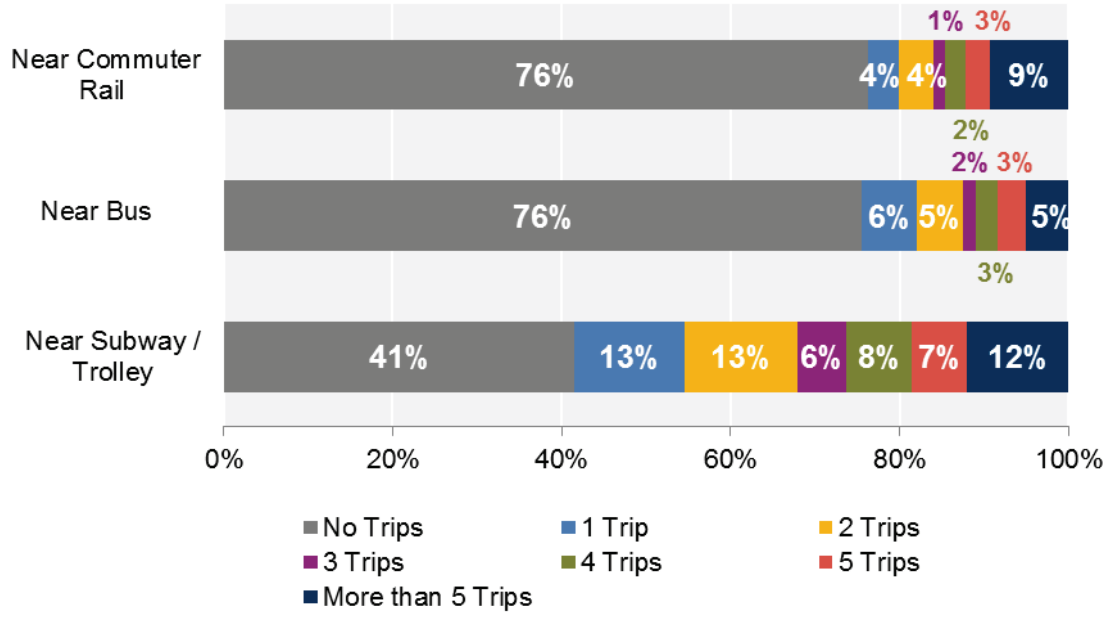
FIGURE 2-19
Average Commute and Non-Commute Trips per Week by Mode and Bicycling Frequency Group

Exploring Shared-Use Mobility through Hubway Bikeshare

Potential Connections to Transit

As mentioned in section 2.3, approximately 12 percent of Hubway respondents reported that they made their most recent trip to connect to transit. Later in the survey, respondents were asked to report how many of their Hubway trips started or ended near various public transit locations during a typical week. Figure 2-20 shows these results for subway/trolley, bus, and commuter rail.

FIGURE 2-20
2015 Survey Respondents by Number of Hubway Trips per Week Starting or Ending at Various Transit Locations



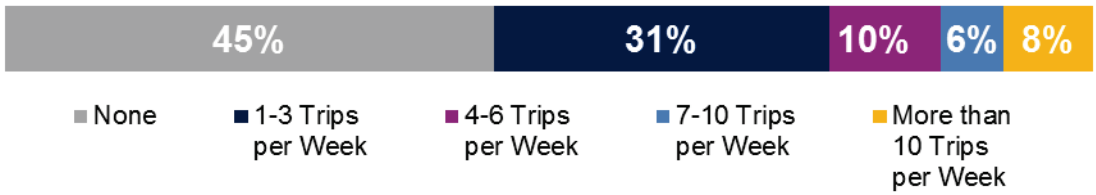
Data source: 2015 Hubway member survey (sample size (subway / trolley) = 1,166).
Notes: 1) Sample size (bus) = 970. Sample size (commuter rail) = 1,035. 2) Respondents who did not provide an answer for a specific mode were left out of that mode's sample.3) Percent values in each bar may not sum to 100 percent because of rounding.

As Figure 2-20 shows, more respondents reported making at least one trip per week that started or ended near a subway/trolley connection (59 percent), compared to trips that started or ended near bus or commuter rail (24 percent each). However, the wording of this question imposes some limitations on the information CTPS could glean about how frequently Hubway members may connect to transit stations, and what modes they use. The Hubway system is located in a relatively transit-dense area, so the likelihood of a Hubway station being near at least one transit option is high. While this question asks about the number of trips that started or ended near transit, it does not ask whether respondents used transit prior to or after making their Hubway trips, which would provide more information on how Hubway is used in multimodal trip making.

Auto Trips Replaced by Hubway Trips

The survey also asked respondents "If you have access to a motor vehicle, how many trips in a typical week in 2015 did you use Hubway instead of your motor vehicle?" This question could shed light on a great potential benefit of Hubway: encouraging users to shift away from single-occupant motor vehicle travel. Responses to this question are shown in Figure 2-21.

FIGURE 2-21
2015 Survey Respondents by Number of Trips for which They Used Hubway Instead of Their Motor Vehicle



Data source: 2015 Hubway member survey (sample size = 1,152).

Approximately 55 percent of respondents reduced their motor vehicle travel by at least one trip per week. Research using bikesharing data from other cities, including Minneapolis/St. Paul (the Twin Cities), Montreal, and Washington DC similarly found reductions in driving among bikeshare members.[18]

To explore this topic in more detail CTPS created an ordinary-least-squares (OLS) linear regression model to explore the factors that may influence respondents to replace motor vehicle trips with Hubway trips.[19] This model estimated an individual's tendency to replace vehicle trips with Hubway trips using this replacement ratio:

$$Replacement\ Ratio = Number\ of\ Vehicle\ Trips\ Replaced\ by\ Hubway\ in\ a\ Typical\ Week / Number\ of\ Hubway\ Trips\ in\ a\ Typical\ Week$$

[18] Shaheen, S., et al. *Mineta Transportation Institute Report 12-29: Public Bikesharing in North America during a Period of Rapid Expansion: Understanding Business Models, Industry Trends, and User Impacts,* p. 80; Capital Bikeshare. *2013 Capital Bikeshare Member Survey Report*, p. ii, 56-59.

[19] Ordinary least squares (OLS) regression is a linear modelling technique that may be used to model a single response, or dependent variable. See Hutcheson, G. D. "Ordinary Least-Squares Regression," 2011, https://datajobs.com/data-science-repo/OLS-Regression-[GD-Hutcheson].pdf, p 1.

For this model, CTPS selected 600 respondents from the overall sample who reported

- Owning a car, sport-utility vehicle or truck
- Making at least one Hubway trip during a typical week
- Taking fewer motor vehicle trips replaced by Hubway than total Hubway trips

CTPS calculated the total number of Hubway trips that a respondent made each week by summing the Hubway commute and non-commute trips that the respondent reported, as discussed earlier in this section (see Figure 2-19). CTPS then examined the category the respondent selected for the number of motor vehicle trips she typically replaced with Hubway each week (see Figure 2-21). Because respondents did not provide raw values for the motor vehicle trips that they replaced each week, CTPS used the midpoint value as the representative value for the "1-3 trips", "4-6 trips", and "7-10 trips" categories, as shown in Table 2-1. For the "More than 10 trips" category, CTPS assumed a left-skewed distribution and therefore selected 11.5 trips as the representative value.

TABLE 2-1
Numeric Values Assigned to Motor Vehicle Trip-Reduction Categories

Motor Vehicle Trip-Reduction Category	Assigned Numerical Value
0 trips	0 trips
1-3 trips	2 trips
4-6 trips	5 trips
7-10 trips	8.5 trips
More than 10 trips	11.5 trips

CTPS examined different groups of variables from the survey that might influence an individual's inclination to replace Hubway trips with motor vehicle trips, including but not limited to

- Demographic, socio-economic, and membership information
- Information about a respondent's most recent Hubway trip
- Number of commute and non-commute trips by mode
- Number of trips that started or ended near transit stops or stations

CTPS removed survey responses that contained at least one missing value for these explanatory variables and ultimately used 462 Hubway member survey responses in the final model estimation. Table 2-2 describes the seven explanatory variables (including the model intercept[20]) that were ultimately included in the final model. All of these variables are statistically significant,

[20] The intercept value is the expected value of the replacement ratio when the values of the predictor variables are set to zero.

meaning that it is highly probable that there is a relationship between each variable and the replacement ratio is not random.[21]

The model includes two explanatory variables that are difficult to explain directly: the home-based trip indicator and the Asian-respondent indicator. CTPS kept these statistically significant variables in the model because they might serve as proxies for a "true" factor that contributes to variations in the vehicle-trip replacement ratio. Meanwhile, the "years since first becoming a Hubway member" variable provides valuable information from a policy standpoint. If people can maintain their Hubway memberships over time—perhaps through financial support—they may be able to maintain the behaviors that would help them transition away from single-occupant motor vehicle use for some of their trips.

[21] These variables are statistically significant at a 95 percent confidence level (t value of 1.8).

TABLE 2-2
OLS Regression Results Measuring Hubway Members' Propensity to Replace Auto Vehicle Trips with Hubway Trips

Variable Description	Estimated Parameter	t-Statistic	Coefficient Interpretation	Description and Possible Explanation
Intercept	0.31	4.5	N/A	N/A
The share of automobile and taxi trips of all (commute and non-commute) trips in a typical week	0.37	3.4	A 10 percent increase in motor vehicle trip share results in a 3.7 percent average increase in a respondent's motor vehicle trip replacement ratio.	Hubway members that rely primarily on motor vehicles are more likely to replace motor vehicle trips with Hubway trips (as opposed to those who may rely more on transit).
Home-based trip indicator (1 if the respondent's most recent Hubway trip was home-based, 0 if otherwise)	0.13	3.4	If a respondent's most recent Hubway trip was home-based, her replacement ratio increases by 13 percent, on average.	If a respondent's most recent Hubway trip was home-based, we assume that she may be more likely to start her Hubway trips from home generally than would a member who reported that his most recent trip was not based at home. Using this assumption, members who typically make home-based Hubway trips may be more likely to replace motor-vehicle trips than if they were not typically making home-based trips. This makes sense if a member's motor vehicle is parked near her home.
Commute trips by transit in a typical week	-0.01	-3.0	Each additional transit commute trip a respondent makes per week decreases his replacement ratio by one percent on average.	As members increase the number of commute trips they make by transit each week, they become less likely to replace motor vehicle trips with Hubway trips. This is probably because their Hubway trips would replace transit trips more often (as opposed to motor vehicle trips).
Asian respondent indicator (1 if the respondent is Asian, 0 if otherwise)	0.24	2.7	If a respondent is Asian, his replacement ratio increases by 24 percent on average.	This variable might be a proxy for where Hubway trips are being made. For example, Asian members may take Hubway trips in neighborhoods where taking trips by Hubway might be easier than taking trips by motor vehicle.
Years of Hubway membership	0.03	2.3	For each additional year that has passed since a respondent first became a Hubway member, her replacement ratio increases by three percent on average.	The more years that have passed since a person first became a Hubway member, the more likely she is to replace motor vehicle trips with Hubway trips.
Willingness to walk more than five minutes to a Hubway station (1 if yes, 0 if otherwise)	0.07	1.8	If a respondent is willing to walk longer than five minutes to access a Hubway station, his replacement ratio increases by seven percent on average.	Members that are willing to walk longer to reach a Hubway station might be more likely to make behavior changes that support a mode shift from motor vehicle to Hubway use.

Note: The "Descriptions and Possible Explanations" column suggests possible reasons behind the relationships between each explanatory variable and the response variable. However, this model can only highlight correlations between variables and not definitively explain why the relationship exists.
N/A = Not available or applicable. OLS = ordinary-least-squares.

Table 2-3 shows the number of observations included in the final model, along with statistics that describe how well the model fits the data.

TABLE 2-3
Motor-Vehicle Trip Replacement OLS Regression Model Statistics

Model Parameter	Value
Number of observations	462
F-statistic	10.75
R-squared	0.124
Adjusted R-squared	0.113

Note: The p-value associated with the F-statistic is 0.000 or $3.396e^{-11}$
OLS = ordinary-least-squares.

The F-statistic for this model indicates that this model predicts changes in the response variable (motor-vehicle-trip replacement ratio) better than a model that included only the intercept, or the mean motor-vehicle replacement ratio value. In terms of the overall model fit, an r-square value of 0.124 means that the model explains 12 percent of the variability in the data. The model may have this relatively low R-squared value for the following reasons:

- Behavioral data, such as the kind collected through this survey, can be difficult to predict. Survey data can be difficult to work with because all responses are subject to an individual's interpretation of the survey questions. There is some ambiguity in the wording of the survey questions, which may affect how members respond and whether their responses accurately reflect their travel behavior.

- This survey was administered in February, when members likely would use Hubway less often. The responses might have been influenced by the time of year that the survey was issued.

- Finally, CTPS's transformation of the categorical variables—describing the number of motor vehicles trips per week that respondents replaced with Hubway trips (see Table 2-1)—might not have reflected the true distribution of motor vehicle trips that were replaced by Hubway trips. This would make it more difficult to uncover true relationships between the explanatory variables and the motor vehicle trip replacement ratio.

Though this model has a low R-squared value, which limits its ability to make precise predictions, it still provides valuable insights into the relationship between the variables, and the factors that may influence the extent to which a person might replace motor-vehicle trips with Hubway trips. The high t-statistics

associated with the explanatory variables (see Table 2-2) indicate that these variables reveal significant trends in otherwise noisy and highly variable data.

2.5 Summary of Findings from the 2015 Hubway Member Survey

Of the research objectives mentioned in Section 1, the results of Hubway's 2015 member survey provide insights into

- Factors that influence a person's decisions to choose bikesharing, including as an alternative to other modes for particular trips
- Bikesharing's potential to allow people to live a less car-dependent lifestyle

Choosing Bikesharing as a Travel Option

In the 2015 Hubway member survey, the majority of respondents reported that their top reason for using Hubway for their most recent trip was that it was the fastest way to their destination. Figure 2-13 shows that this response far surpassed other reasons, including cost, health, or environmental benefits. Moreover, Figure 2-18 shows that this reason continued to be prominent regardless of the alternative mode the member might have taken for their trip. While not surprising, this finding speaks to the role that Hubway can play as part of an integrated transportation system. Figures 2-14 and 2-17 suggest that members may be making very small numbers of bikeshare trips that they would not otherwise have made, and that these trips were primarily for recreational, fitness, errands, or shopping purposes. It is important to note that because this research used member survey data, these results are biased towards individuals who have chosen to use Hubway. To conduct an unbiased study that examines people's decisions to switch to bikesharing, one would need data from a broader population—including people who did not use Hubway—and comprised of individuals with the ability to choose from multiple modes for particular trips. This data then would describe how respondents would choose from various transportation modes to make particular trips.

The survey also provides information about who is taking advantage of the Hubway system to meet their travel needs. The results indicate that Hubway survey respondents tend to be better educated and have higher household incomes than the overall population of municipalities with Hubway service (Figures 2-3 and 2-7), suggesting that knowledge and resources may enable people to make the choice to use bikesharing. The City of Boston and the Boston Public Health Commission have collaborated to make subsidized memberships available to low-income individuals, and Hubway offers monthly memberships, which can increase access for those who might not be able to afford an annual

membership.[22] To the degree that these initiatives, along with public education campaigns, can be sustained and expanded, more people of various incomes and education levels may be able take advantage of the service. Hubway has also made new stations available in East Boston, Dorchester, Roxbury, and other areas during 2016. Therefore, the 2016 member survey possibly may reflect more diversity in respondent characteristics than it might have prior to this geographic expansion.

Reducing Motor Vehicle Dependence

Survey data on respondents' most recent Hubway trips reveals mixed findings with respect to bike sharing's ability to help individuals live a less car-dependent lifestyle. Many members made their most recent Hubway trip to commute, attend work or school meetings, access public transportation, or do errands, which suggests that people use Hubway to meet essential transportation needs (see Figure 2-11); thus, offering the potential for people to become less dependent on automobiles for regular or essential travel. Meanwhile, the majority of survey respondents reported that they otherwise would have walked or taken public transit for their most recent trip; and in cases where they would have used a vehicle, they more likely would have used a taxi or ridesourcing service (such as Uber or Lyft) than a personal vehicle.

Bikesharing's potential to reduce motor vehicle dependent lifestyles may be more apparent when one examines broader trip-making patterns. Figure 2-11 shows that more than half of respondents made their last Hubway trip for work or school, while Figure 2-19 shows that those who bicycle most frequently make a larger average number of commuting trips (an essential transportation purpose) using Hubway during a typical week. The survey results also show that 55 percent of respondents reported replacing at least one motor vehicle trip with a Hubway trip each week. The results of the regression model show that respondents who had been Hubway members for longer periods, continuously or intermittently, had higher propensities to replace motor vehicle trips with Hubway trips. This is a positive indicator that Hubway might help people to live a more car-free lifestyle. Future surveys could supplement these findings by adding questions about whether Hubway members have sold cars or postponed new car purchases because they had access to Hubway, or how they have changed their use of different modes since joining Hubway. Future research also could explore how members use Hubway differently based on their reported home zip codes.

[22] City of Boston. "$5 Hubway Memberships," https://www.boston.gov/departments/boston-bikes/5-hubway-memberships, accessed January 23, 2017.

3 HUBWAY TRIP DATA RESEARCH

While Hubway's member survey data provide information about user characteristics, preferences, and self-reported behaviors, Hubway trip logs reveal when and where users actually make bikeshare trips. This makes it possible to look at trip-making behavior across all users and explore whether they are using the Hubway system in ways that potentially complement, or compete with, transit.

3.1 Trip Data Source

CTPS obtained trip logs for the years 2011 through 2015 from Motivate in February 2016, although Motivate also now provides trip logs on the Hubway website.[23] These logs include trip duration (length of time), the start and stop dates and times of the trip, the start and end stations, and the bicycle identification number. The logs that CTPS obtained also list whether the person who made the trip was a Hubway member or casual user (that is, a short-term pass purchaser). If the person was a member, the data includes the member's home zip code and gender. While this data is a rich resource for exploring shared-use mobility, it lacks several details that prevent it from telling the full story about a person's trip:

- Information about where a person began her trip, before arriving at her origin Hubway station, or where she ended her trip, after leaving her destination Hubway station
- Information about the time the user took, or the modes he used, to access a Hubway station or to travel from a Hubway station to his final destination
- The trip route, including information about intermediate stops the user made between bicycle checkout and bicycle return
- Anonymized identification numbers that could be used to identify all trips made by an individual users within the trip dataset

In the absence of full details, CTPS has defined a Hubway trip as including only the time and activity between when a bicycle is checked out of a Hubway station dock and when it is returned to a station dock. In addition to Hubway trip logs, CTPS used data provided by Motivate about Hubway stations, including stations' identification numbers, names, coordinates, and number of available bike docks.

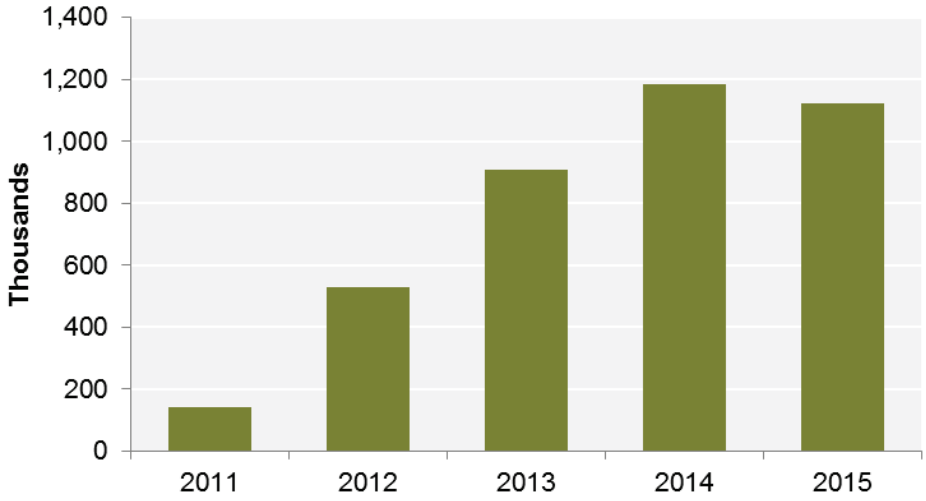
[23] Hubway, "System Data," https://www.thehubway.com/system-data, accessed January 23, 2017. Data available on the Hubway website now complies with General Bikeshare Feed Specification (GBFS) standards, which were not in effect when CTPS received the trip logs in February 2016. This may result in some differences in trip counts between past and current datasets because of variations in data cleaning.

3.2 General Trip Trends

Trips by Year and Season

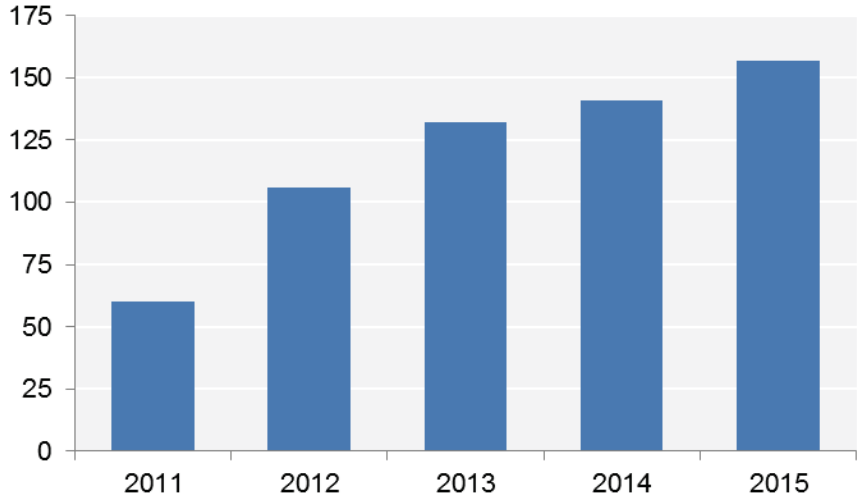
Figures 3-1 and 3-2 below show the number of trips and stations that appeared in each year of Hubway data.[24]

FIGURE 3-1
Hubway Trips per Year



Data source: 2011-2015 Hubway trip logs.

FIGURE 3-2
Available Hubway Stations per Year



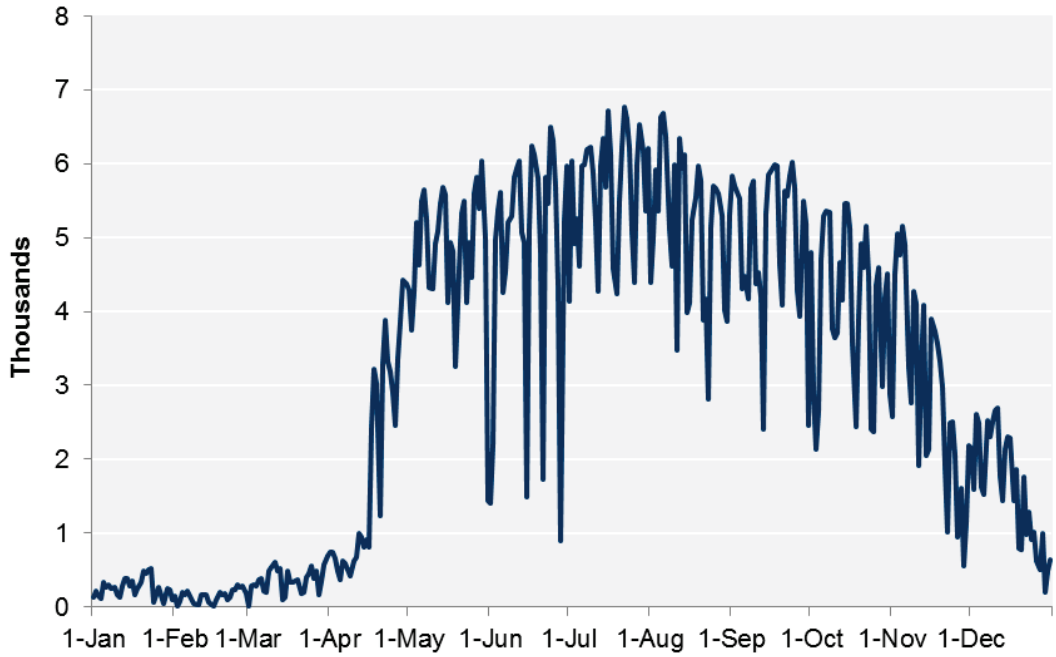
Data source: 2011-2015 Hubway trip logs.

[24] This data does not count trips that lasted less than one minute.

Hubway launched service in Boston in 2011 and expanded into Cambridge, Somerville, and Brookline during summer 2012. During this time, total annual trips increased 276 percent, and total available stations increased by 75 percent.[25] Total annual trips decreased by about five percent between 2014 and 2015, despite the increase in the number of stations. This likely can be explained in part by the heavy snowfall and extended periods of inclement weather during early 2015.

Subsequent components of this analysis focus on trips made during 2015. Figure 3-3 shows the distribution of Hubway trips over the course of 2015.

FIGURE 3-3
Hubway Daily Trip Volumes in 2015



Data source: 2015 Hubway trip logs.

Depending on the time of year, Hubway may have only a limited number of stations in operation, which contributes to the variations in Hubway usage over the course of the year. According to Motivate, 32 stations were open in Cambridge during winter and early spring 2015, during which the number of trips per day remained consistently below 1,000 until the full season opening on April 17, 2015.[26] In the summer and fall months, the number of trips on the system generally remained between 4,000 and 6,000 per day and then began to decline in mid-November. Starting on November 25, system stations began to close;

[25] Hubway, "Media Kit", https://www.thehubway.com/about, Accessed October 24, 2016.
[26] *Ibid.*

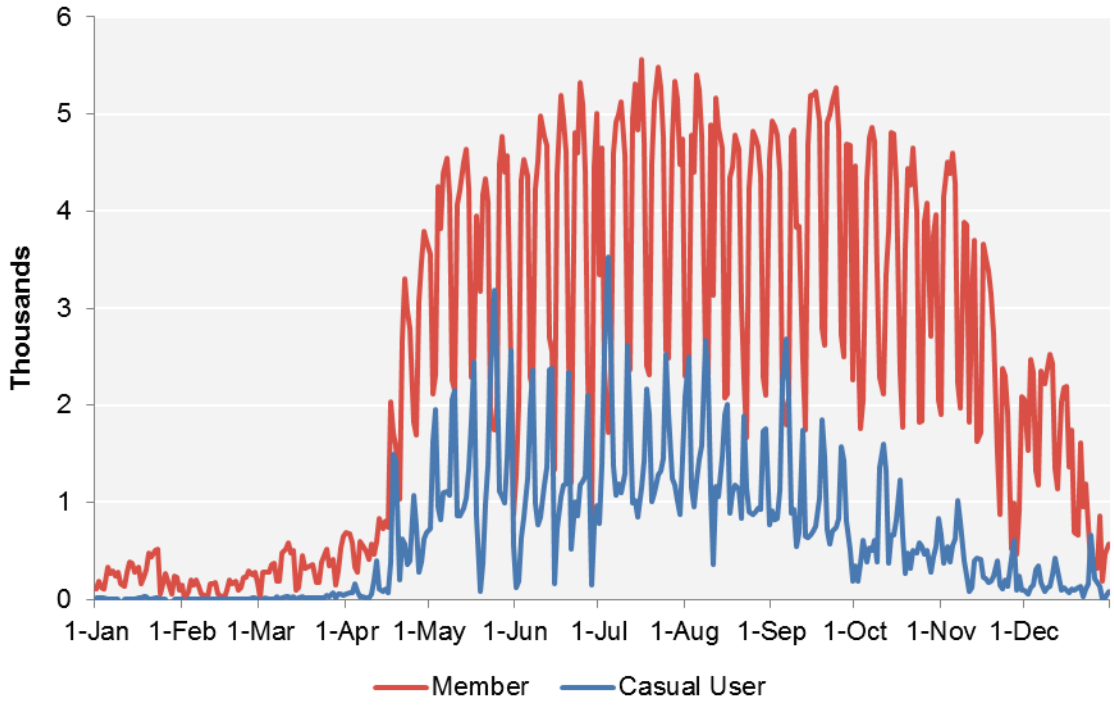
according to Motivate 111 stations were open through December 7, and 108 stations were open through the end of the year.[27] After December 18, the number of trips per day trips generally remained below 1,000, similar to wintertime levels exhibited in the early parts of the year.

Trip Data by User Type

The Hubway 2015 trip data reflects trip made by both Hubway members and casual users of the Hubway system. According to Motivate, Hubway had 13,248 members and sold 102,445 24-or-72 hour casual passes during 2015; and system volumes reflect trips made by about 60,000 unique users.[28] In 2015, casual users accounted for approximately 22 percent of the trips made on the system, while members accounted for the other 78 percent.

Figure 3-4 shows how the trips made by members and casual users are distributed throughout the year.

FIGURE 3-4
Hubway Daily Trip Volumes by User Type in 2015



Data source: 2015 Hubway trip logs.

[27] *Ibid.*
[28] *Ibid.*

In general, the number of Hubway trips made by casual users per day is lower than the number of trips made by members, except during holidays and holiday weekends, when the number of casual user trips tends to exceed those made by members. This likely reflects that members are not making their typical commuting trips, while casual users are biking more for recreational purposes.

For the subsequent sections of this report, CTPS analyzed only Hubway trips within a "high-activity season," the period between April 17, 2015 and December 18, 2015. CTPS analyzed this subset of trips to focus on the part of the year when the Hubway system was most widely available and most heavily used and to avoid data outliers that the wintertime trips may introduce, such as longer-than-typical durations because of inclement weather. To create this subset, CTPS removed approximately 45,000 of 1,222,000 trips or three percent of all 2015 trips, from the dataset, and retained approximately 1,077,000 trips for the next stage of analysis. CTPS excluded other subsets of trips to meet the needs of subsequent analyses, as we discuss later in this section and in Section 4. Appendix A includes a diagram that identifies each stage in the analysis when trips were excluded from the 2015 dataset.

Trip Data by Day of Week and Time of Day

Table 3-1 shows the typical daily volume of trips made by members and casual users during the previously defined "high-activity" season (4/17/2015–12/18/2015).

TABLE 3-1
Average Hubway Trips per Day by User Type and Day of Week (High-Activity Season)

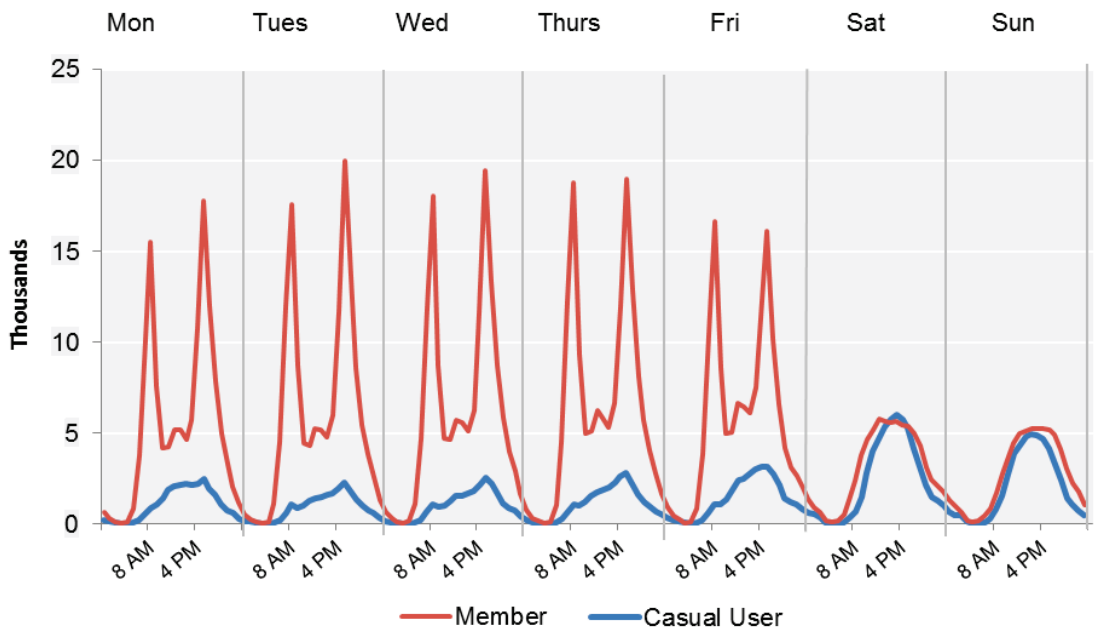
User Type	Number of Weekday Trips	Number of Weekend Trips
Casual User	844	1,296
Member	3,593	2,996
Overall Users	**4,438**	**4,292**

Data source: 2015 Hubway trip logs (4/17/2015–12/18/2015).

Members tend to make more trips per day than casual users on both weekdays and weekend days. Unlike members, casual users tend to make more trips on weekend days than on weekdays.

Figure 3-5 shows the distribution of member- and casual-user trips made during the 2015 high-activity season according to the day of the week and time they were made.

FIGURE 3-5
Hubway Trip Volumes by User Type, Day of Week, and Time of Day (High-Activity Season)



Data source: 2015 Hubway trip logs (4/17/2015–12/18/2015).

During weekdays, member trips exhibit clear peaks in usage: around 8:00 AM and 5:00 PM (commuting periods), while the number of casual-user trips gradually increases during the day to a peak at around 5:00 PM. On weekend days, members and casual users are similar in terms of the number and timing of trips they make, which are distributed gradually throughout the day and peak in the afternoon. These weekday and weekend trip distributions generally reflect usage patterns identified in previous analyses of Hubway trip making[29], and in similar research of bikeshare systems around the country.[30]

3.3 Station-level Data Trends

Analyses at the station and origin-destination-pair (O-D pair) level place Hubway trip data in a geospatial context. The 2015 Hubway trip log referenced 156 stations. CTPS combined two stations near the Old State House into one record and two stations near TD Garden into one record because these stations were very close together, and established a set of 154 stations for the purposes of

[29] Ofsevit, A. "Hubway Data Visualization: Overview", http://ariofsevit.com/hubway/, accessed November 30, 2016.
[30] Fishman, E., "Bikeshare: A Review of Recent Literature," p. 95.

analysis.[31] For this report, CTPS assigned aliases to replace the station names assigned by Hubway, which can be long. Hubway station names and their aliases are listed in Appendix B.

Figure 3-6 displays these stations, which have been classified by their total station visits between April 17, 2015 and December 18, 2015. Station visits include trips originating or arriving at a given Hubway station, according to the trip logs. In general, stations with a large volume of visits are close to MBTA transit facilities—particularly along the Orange and Green Line subway lines in the northern part of Boston, and along the northern portion of the Red Line, extending from South Station north into Cambridge and Somerville. High-volume stations also are often near or within college and university campuses, such as Harvard, MIT, and Boston University.

Table 3-2 shows the top-10 Hubway stations by the number of station visits made during the high-activity season. These stations account for 20 percent of station visits. The top-four stations—TD Garden, South Station, MIT at Massachusetts Ave. and Amherst Street, and Harvard Square at Massachusetts Ave. and Dunster Street—account for 10 percent of all station visits, while 37 stations (24 percent of all stations) account for 50 percent of all station visits.

TABLE 3-2
Top-Ten Stations by 2015 Station-Visit Volume (High-Activity Season)

Station Name	Municipality	Station Visits in 2015[a]
TD Garden	Boston	65,070
South Station	Boston	61,372
MIT: Mass Ave	Cambridge	53,141
Harvard Square: Mass Ave @ Dunster St.	Cambridge	42,394
Boston Public Library	Boston	38,389
Central Square	Cambridge	37,614
Lafayette Square	Cambridge	35,395
MIT: Stata Center	Cambridge	34,545
Charles Circle	Boston	34,108
Back Bay / South End Station	Boston	32,110
Total Visits		**434,287**
Average of all 154 Stations[b]		**13,987**

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015).
[a] The number of bicycle docks varies by station. [b] This average excluded visits made to the Hubway Warehouse at 18 Dorrance Street, Boston (149 visits).

[31] One of the combined stations near the Old State House reflects a temporary station relocation. This final list of stations excludes Hubway's warehouse at 18 Dorrance Street in Charlestown.

Figure 3-6 ranks stations by visit volumes and according to user type (member or casual user), day of the week (weekday or weekend day), and time of day. The top-10 stations in each category are shown on the chart, which also shows the stations that are prominent across multiple categories.

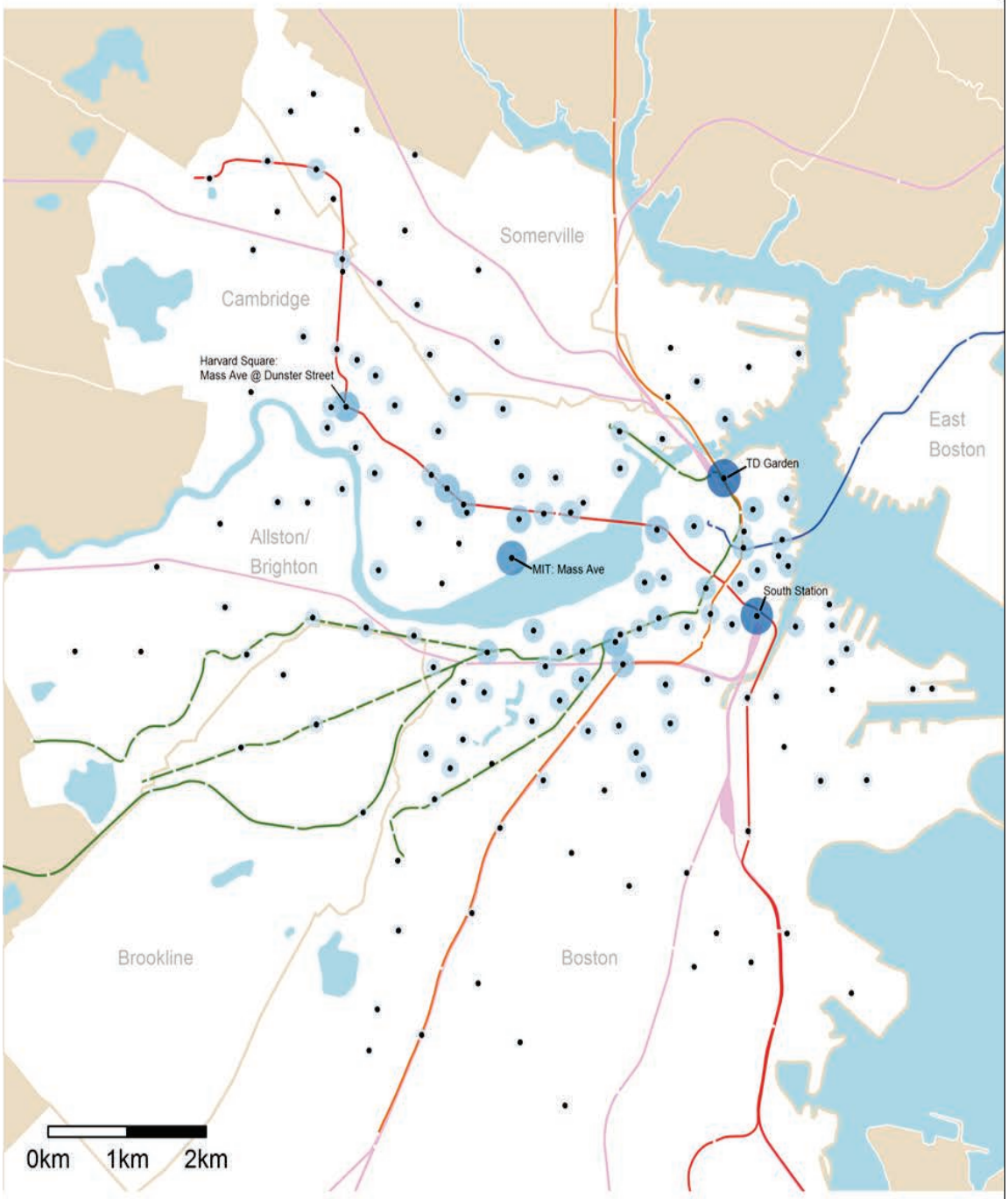


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FIGURE 3-6
Hubway Station Locations and Visit Volumes

Exploring Shared-Use Mobility through Hubway Bikeshare

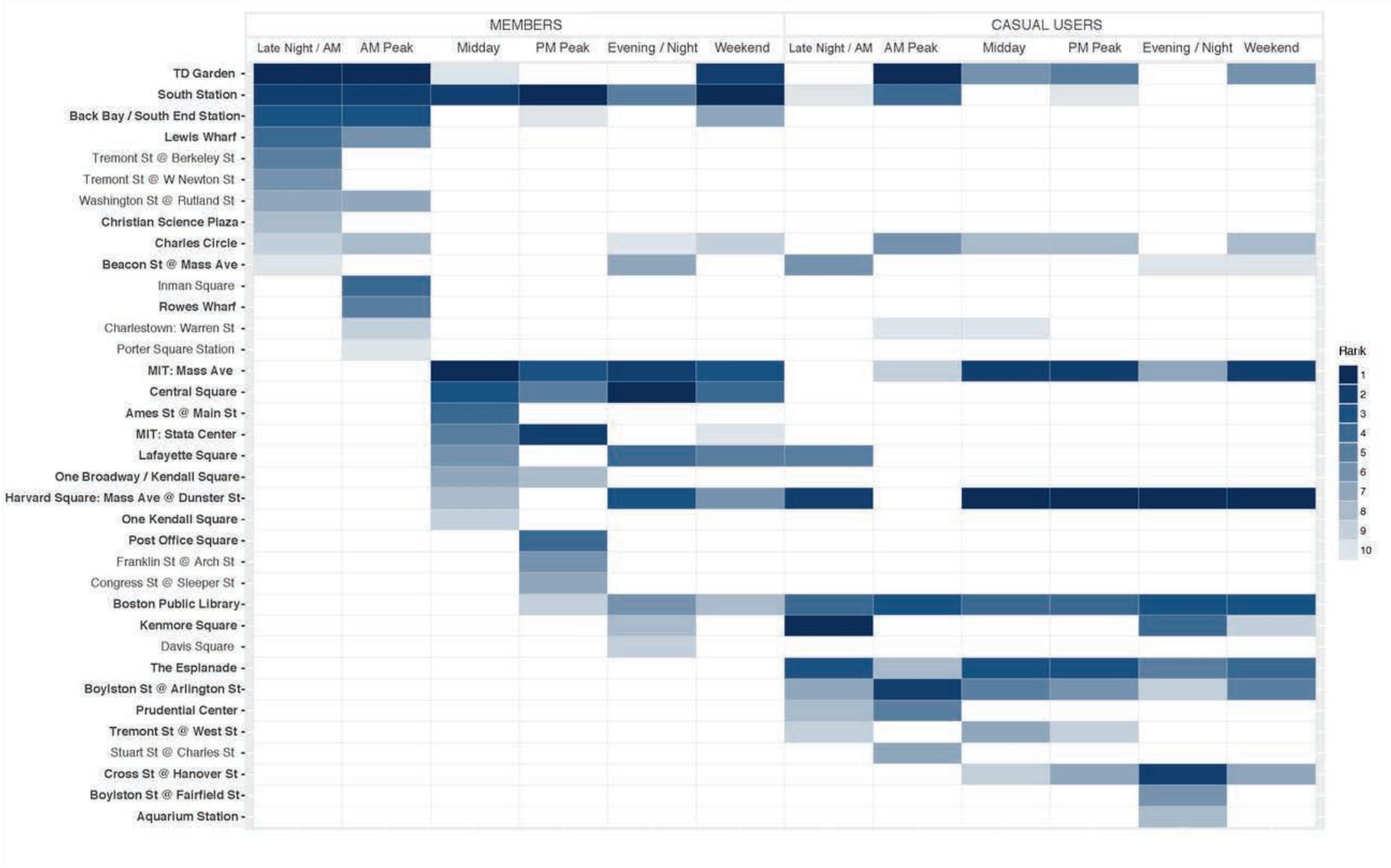
Table 3-3 describes the hours covered by each weekday time period; the weekend category includes all hours on Saturdays and Sundays.

TABLE 3-3
Weekday Time Periods

Time Period	Relevant Hours
Late Night / Early Morning	12:00 AM–6:59 AM
AM Peak	7:00 AM–10:00 AM
Midday	10:01 AM-3:59 PM
PM Peak	4:00 PM–7:00 PM
Evening / Night	7:01 PM–11:59 AM

Source: Central Transportation Planning Staff.
Note: These time periods are based on distribution of Hubway member trips over the course of a weekday.

Twenty-six of the 36 stations in Figure 3-7, below, fall within the top-30 stations, as ranked by overall station visit volumes between April 17 and December 18, 2015; these stations are shown in bold. However, these stations vary somewhat in terms of when they are used and by whom. Several stations rank high across all, or nearly all categories, such as TD Garden, Harvard Square, and MIT: Massachusetts Avenue at Amherst Street. Some stations—such as Boylston Street at Arlington Street, the Boston Public Library (Boylston Street), and the Esplanade—rank high in terms of casual user visits across all day and time categories, but do not rank as high in terms of member visits. Other stations, such as those at Back Bay and Central Square, experience more visits by members, particularly during commuting hours.



Data source: 2015 Hubway trip logs (4/17/2015 – 12/18/2015).

Note: Stations shown in bold are among the top-30 stations by visit volumes.

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FIGURE 3-7
Top-Ten Stations by User Type and Day-and-Time Period

Exploring Shared-Use Mobility through Hubway Bikeshare

3.4 Origin-Destination (O-D) Pair Data Trends

General O-D Pair Trends

CTPS organized the trip data into origin-destination flows to explore where people have used Hubway to make connections. According to the 2015 Hubway trip logs, of the 1,077,000 trips during the high-activity period, 97 percent have different origin and destination stations. Seventy-nine percent of these trips were made by Hubway members, while the remaining 21 percent were made by casual users. These trips have been classified into 17,615 O-D pairs, which account for the direction of the trip.[32] Table 3-4 classifies these O-D pairs by their trip volumes during the high-activity season.

TABLE 3-4
O-D Pairs Categorized by Trip Volume

Trip Volume per O-D Pair	Number of O-D Pairs	Percent of All O-D Pairs	Cumulative Percent of All O-D Pairs	Number of Trips	Percent of All Trips	Cumulative Percent of All Trips
1,000 or more	36	0.2%	0.2%	55,537	5.3%	5.3%
500 to 999	201	1.1%	1.3%	134,708	12.9%	18.2%
200 to 499	1,033	5.9%	7.2%	306,067	29.3%	47.6%
100 to 199	1,684	9.6%	16.8%	232,809	22.3%	69.9%
Less than 100	14,661	83.2%	100.0%	314,166	30.1%	100.0%
Total	**17,615**	**100.0%**	**100.0%**	**1,043,287**	**100.0%**	**100.0%**

Data source: 2015 Hubway trip logs (4/17/2015–12/18/2015).
O-D = Origin-destination.

Table 3-5 shows that a relatively small share of O-D pairs covers a large share of Hubway trips. For example, 1.5 percent of O-D pairs had 500 or more trips, and these comprised 18.2 percent of trips on the system. Meanwhile, 83.2 percent of O-D pairs had less than 100 trips, but these pairs accounted for only slightly more than 30 percent of trips during the high-activity season.

Figure 3-8 displays the O-D pairs with 500 or more trips or more during the high-activity season.

[32] For example, a trip from the Hubway station @ South Station to the Hubway station at MIT: Massachusetts Avenue at Amherst Street falls into a different pair than a trip with the same stations, but flowing in reverse.

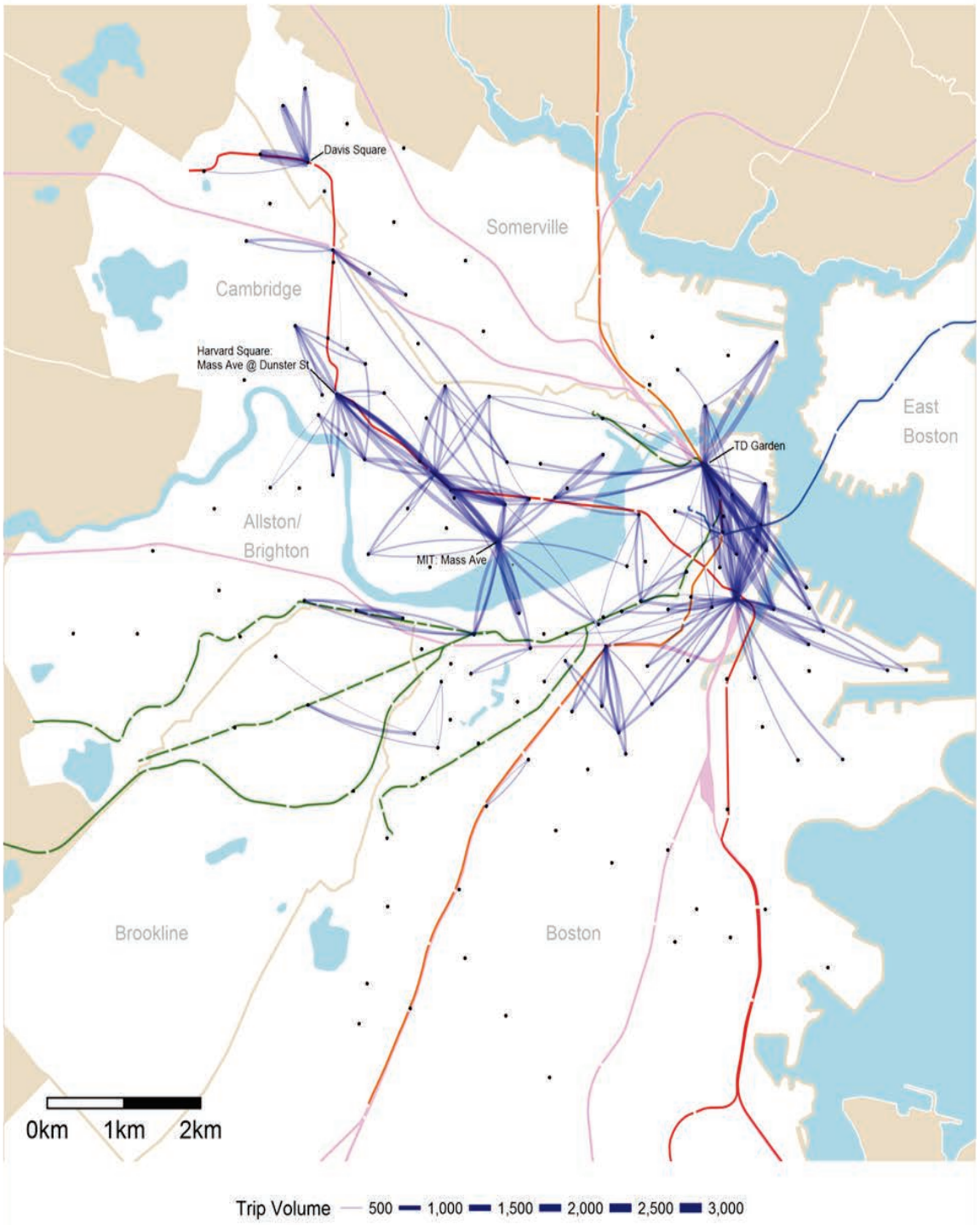

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FIGURE 3-8
Trip Volumes by Hubway O-D Pair

Exploring Shared-Use Mobility through Hubway Bikeshare

High-volume flows exist between Hubway stations at Teele Square and the northern end of Linear Park and Davis Square, between and within Harvard and MIT, and on the link over the Charles River at the Harvard Bridge. Other high-volume flows exist between North Station (TD Garden) and South Station, between North Station and Congress/Sleeper Streets, between South Station and the Boston Waterfront, and between TD Garden and points in Charlestown. Woodruff identified similar high-volume flows in his analysis of Hubway trips between July 2011 and October 2012.[33] These findings also correspond to a Hubway trip flow analysis conducted for the GoBoston 2030 Vision Framework, which highlights high-volume flows between North and South Stations and over the Mass Ave. (Harvard) bridge.[34]

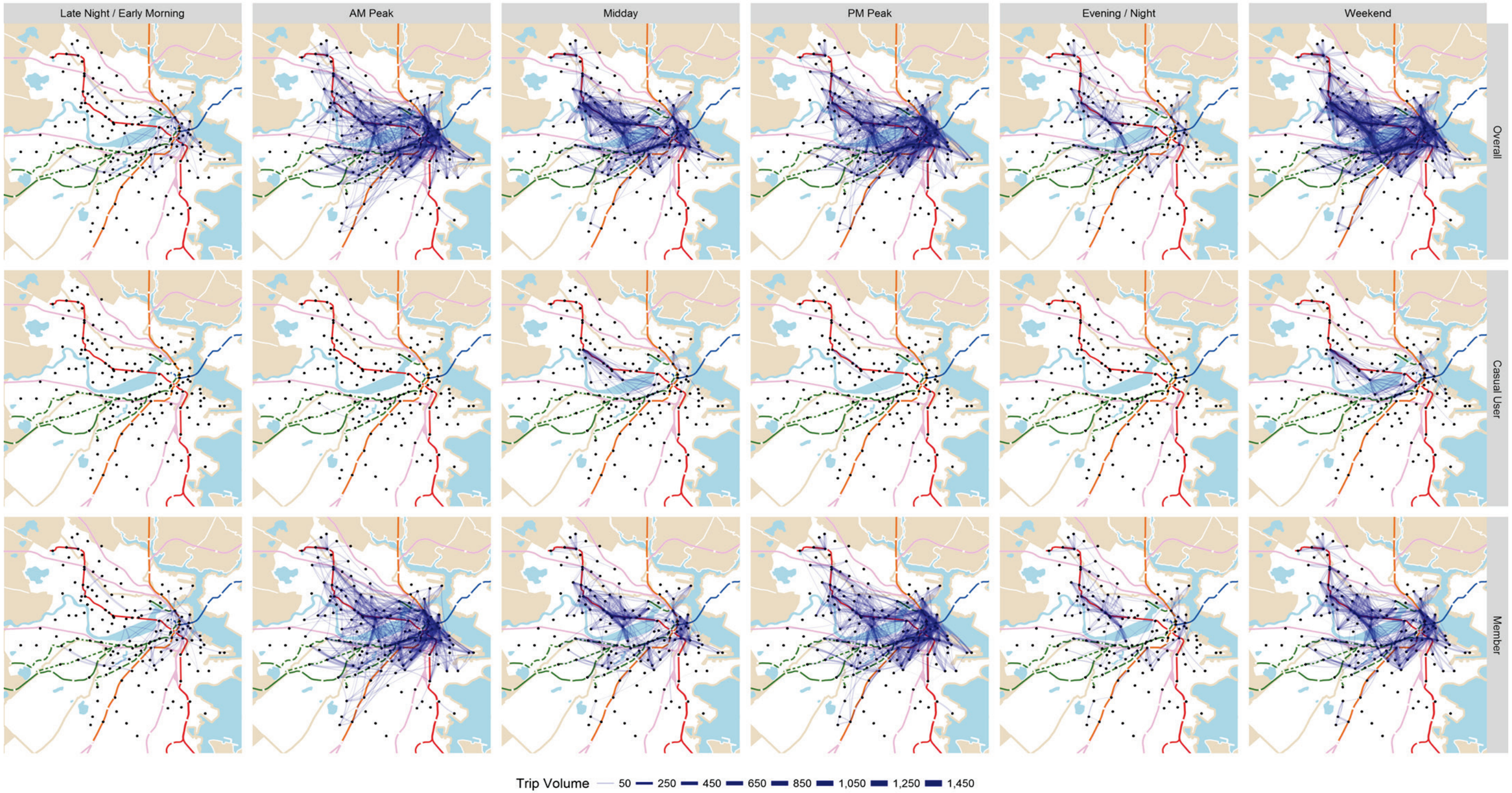
O-D Pairs by User Type, Day of the Week, and Time Period

Figure 3-9 shows the geographic distribution of O-D pairs by time period, and by the type of user. The "Weekend" maps show system use for the full day on weekend days.

The variations in trip activity shown in Figure 3-9 correspond to CTPS's earlier findings on the extent to which members influence overall trip patterns. They also highlight the presence of morning and evening peaks in system use. Casual user activity appears to be the most concentrated in Cambridge on weekdays, though casual user activity in downtown Boston increases on the weekends. Member trips comprise most of the trip activity in northern parts of Cambridge, in Somerville, and in Brookline. Travel near universities—including but not limited to Harvard, MIT, Northeastern, Tufts, and Boston University—comprises a considerable portion of trip activity during the midday and evening/night periods.

[33] Woodruff, A. " Hubway Snapshots," http://hubwaydatachallenge.org/media/submission/entries/hubway_snapshots.pdf, accessed November 30, 2016, p. 2.

[34] Boston Transportation Department. *Go Boston 2030 Vision Framework (draft for public review),* 2015, http://goboston2030.org/flipbook/files/00_Entire-report-for-download.pdf, accessed November 30, 2016, p. 20.



Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and station locations.
Note: The O-D line symbols flow counterclockwise to indicate the O-D pair direction.

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FIGURE 3-9
High-Volume O-D Pairs by User Type and Day-and-Time Period

Exploring Shared-Use Mobility through Hubway Bikeshare

The remaining three percent of trips during the high-activity season have a common origin and destination point. Of these, 57 percent were made by casual users and 43 percent were made by members. Table 3-5 shows the top stations in terms of overall trip volumes during the high-activity season.

TABLE 3-5
Stations with High Volumes of "One-Station" Trips

Station	Number of Trips (Common O-D)
The Esplanade	1,296
MIT: Mass Ave	912
Harvard Square: Mass Ave @ Dunster St	848
Old State House	768
Boston Public Library	684
Charles Circle	665
TD Garden	636
Charlestown: Warren St	634
Total Common Origin and Destination Trips	**6,443**

Data source: 2015 Hubway trip logs (4/17/2015–12/18/2015).
O-D = Origin and destination.

Many of these stations are in areas with recreational and tourist activity, suggesting that many trips made from these locations may be for recreation, rather than strictly for transportation from one point to another. Many of these trips also could be made by people who are not familiar with the area. These eight stations account for nearly 20 percent of all trips with a common origin and destination.

4 HUBWAY'S POTENTIAL TO COMPLEMENT OR COMPETE WITH TRANSIT

4.1 Comparing Hubway and Transit Trip Characteristics

Section 3 provided an overview of the Hubway system, and where, when, and how many riders used it in 2015. This section explores instances when trips on the Hubway system may complement activity on the transit network or when Hubway trips may be competing with adequate transit service. Existing research has examined the ways that Hubway bikeshare service, when integrated with the MBTA system, can reduce travel time and transfers for trips throughout a combined network.[35] Chiraphadhanakul modeled optimal travel on all links on the MBTA system, both with Hubway service (as it existed in 2011 and 2012) and without it, and found that the availability of Hubway improved travel time savings and reduced transfers between transit nodes, or connection points, across the combined system.[36] His research highlights the overall value of strategically placed one-way links to extend the transit system or close gaps in the network.

This analysis uses trip data to look more closely at where and when large volumes of Hubway trips are being made, and explores the MBTA fixed-route transit alternatives that are available for those high-volume O-D pairs. In some cases, Hubway may complement transit by:

- Supporting first- and last-mile connections to transit stations, thereby extending the effective reach of the transit system
- Providing an all-hours travel alternative when transit services are not operating
- Providing an alternative for transit trips with very long travel times, or those that involve one or more transfers
- Providing a "release valve" for transit service that is uncomfortable because of crowding
- Supporting mobility between locations that may not be served by, or may not connect to, fixed-route transit

However, in other cases, people may be using Hubway as a substitute for trips that might be as direct and as fast—or faster—on transit, and on links where travel on transit vehicles may be comfortable (relatively uncrowded). In these

[35] Chiraphadhanakul, V. *Large-Scale Analytics and Optimization in Urban Transportation: Improving Public Transit and Its Integration with Vehicle-Sharing Services*, 2013, https://dspace.mit.edu/bitstream/handle/1721.1/82190/863064079-MIT.pdf?sequence=2, accessed January 24, 2017, p. 57-92.

[36] *Ibid,* p. 85-86.

cases, it might be worth gathering more data to learn why people might use Hubway for these O-D pairs.

4.2 Tools for Comparing Travel Times

To learn more about how transit service may compare to Hubway service for various O-D pairs, CTPS used a trip planning tool to generate alternative transit or walk itineraries for 2015 Hubway bikesharing trips. The goal of this exercise was to model how riders might otherwise have traveled on transit or by foot to complete the trips they made using Hubway, so as to compare travel times and other trip characteristics across modes. Staff used a methodology initially implemented by James Wong to compare bicycling travel time to transit travel time for trips between Capital Bikeshare stations in the Washington DC region.[37] Following his approach, CTPS used Open Trip Planner (OTP), an open-source journey-planning tool, to generate transit or walk itineraries for individual Hubway trips from the 2015 trip dataset.[38]

- **Step 1:** CTPS set up an Open Trip Planner for the Hubway service area using 1) map data for Boston and neighboring municipalities from a MapZen Metro Extract of Open Street Map, and 2) MBTA General Transit Feed Specification (GTFS) files to reflect available transit service.[39]

- **Step 2:** CTPS organized approximately 1,043,000 Hubway trips that a) had different origins and destinations, and b) were made during the high-activity season in 2015 (4/17/2015–12/18/2015) into batches based on their date-and-time stamp. Trip data in these input files included 1) the coordinates of the origin Hubway station, 2) the coordinates of the destination Hubway station, 3) and the date-and-time stamp for individual 2015 Hubway trips.

- **Step 3:** CTPS modified Wong's open-source Python script and used it to batch query OTP, which would use the Hubway trip input data and its algorithm to generate alternate transit or walk-only trip itineraries for Hubway trips. For each batch of trips, CTPS would update the GTFS file

[37] Wong, J. "When is bikeshare faster than transit?" 2012. *Greater Greater Washington,* http://greatergreaterwashington.org/post/15168/when-is-bikeshare-faster-than-transit/, accessed January 24, 2017.

[38] For more information on this methodology, see Wong, J. "Batch Analysis of Bikeshare Trip Data using OpenTrip Planner," 2012, https://github.com/opentripplanner/otp-batch-analysis/blob/master/OTPMethodology.pdf, accessed January 24, 2017.

[39] For more information about Open Trip Planner, see Open Trip Planner, "Multimodal Planning and Analysis," http://www.opentripplanner.org, accessed January 27, 2017. MBTA GTFS files are available at http://www.mbta.com/rider_tools/developers/default.asp?id=21895. MapZen Metro Extracts are available at https://mapzen.com/data/metro-extracts/.

used in OTP, so that the transit schedules in OTP would match the timeframe during which the Hubway trips were made.[40] CTPS calibrated OTP so that it would generate itineraries that would 1) minimize overall travel time between the origin and destination, and 2) limit the distance that a person would walk for a given trip to two kilometers (1.2 miles).[41]

Output information for these itineraries included the following:

- If a transit alternative was recommended for the trip, the itinerary included travel time associated with each step of the transit trip—walking time between the origin point and the transit pick-up point (access), waiting time, in-vehicle time, and walking time between the transit drop-off point and the destination point (egress). The itinerary also included the transit modes recommended for the trip—bus, rapid transit, commuter rail, and/or ferry—and the number of transfers between transit vehicles.

- If OTP recommended walking to minimize travel time, the itinerary only included walking time.

- OTP also provided bicycling travel time and distance for an optimal bicycling trip itinerary.

CTPS used the Hubway trip travel time from the data logs and the alternate transit trip travel time from OTP's output to calculate a travel-time ratio using the following formula:

$$Travel\ Time\ Ratio = Transit\ Travel\ Time(excluding\ walk\ access\ and\ egress\ time)\ /\ Hubway\ Travel\ Time$$

As mentioned in Section 3.1, the Hubway trip data used in this analysis only included the portion of each Hubway trip from when a rider picked up a bicycle at the origin Hubway station to when she dropped it off at the destination Hubway station. The rider's true origin (for example, her home), her true destination (for example, her workplace), and the distance she traveled between these locations and Hubway stations are all unknown. The Hubway station coordinates were the

[40] CTPS used eight 2015 MBTA GTFS files that covered the period from 4/17/2015 to 12/18/2015.

[41] For a very small percentage of Hubway trips (approximately 1,000 trips, or 0.01 percent of all trips entered into OTP), OTP did not return any transit or walk itinerary. If OTP's algorithm would require a person to walk more than two kilometers between the origin and destination—including as part of a transit itinerary—OTP did not return an itinerary for that Hubway trip.

only data that CTPS could use to identify the locations associated with a Hubway trip and to model an alternative transit trip. However, using the Hubway stations as trip start-and-end points systematically underestimates the total time of the Hubway trip. Using these stations as start-and-end points for an alternative transit trip also may overestimate or underestimate travel time by transit, depending on the locations of the rider's true origin and destination. To mitigate this bias, and better compare Hubway trips and their estimated transit alternatives, CTPS excluded walk access and walk egress times from the estimates of transit travel time that were used to calculate trip travel-time ratios. For more information about this adjustment, see Appendix C.

At this stage, CTPS removed several other groups of trips from the 2015 sample before conducting further analysis. (See the diagram in Appendix A for impacts on the overall trip sample.) These trips include the following:

- Causal user trips: Members may be more likely to use the service for commuting or point-to-point trips, which are more appropriate for comparing Hubway and transit travel times. Member trips may provide a better understanding of where people are using the Hubway system as part of their daily travel behavior and how they might use bikesharing to complement or replace other modes. CTPS assumes that member trips likely would be more direct than casual user trips, which may make them better candidates for comparisons with transit trips.

- Trips with transit waiting times in excess of one hour.

- Trips with estimated Hubway travel speeds of less than two or more than 20 miles per hour. CTPS expects that trips with speeds above or below these thresholds likely would be outliers.[42]

[42] CTPS examined the distribution of estimated bicycling travel speeds to select the thresholds for excluding trips. Average pedestrian speeds have been estimated at three miles per hour in most conditions (see Fehr and Peers, "Multimodal Level of Service Toolkit: HCM 2010 – Pedestrian LOS," http://asap.fehrandpeers.com/wp-content/uploads/2012/05/MMLOS-Tool-HCM-2010-Pedestrian.pdf, accessed February 27, 2017, p. 1).

This analysis assumes that in some cases, a bicyclist may need to travel slightly less than three miles per hour given congestion and road hazards at places where they are biking, so the lower threshold was set at two miles per hour. CTPS estimated biking speeds by dividing the bicycle trip distance for the optimal trip generated by OTP by the Hubway trip duration from the trip logs. It is important to note that in general, the Hubway/transit travel time ratio is based in part on bicycle trip duration, which in turn is based on an individual's biking speed, and that there can be considerable variations in biking speeds across individuals.

4.3 Results for Individual Trips

CTPS used the scheme described in Table 4-1 to classify the travel time ratios that were calculated using the formula cited in Section 4.2.

TABLE 4-1
Travel-Time-Ratio Categories

Travel Mode	Travel-Time-Ratio Range
Transit Faster than Hubway	$0 < x < 0.9$
Transit Comparable to Hubway	$0.9 \leq x \leq 1.1$
Transit Slower than Hubway	$1.1 < x \leq 2$
Transit Much Slower than Hubway	$x > 2$

Source: Central Transportation Planning Staff.

Figure 4-1 summarizes how the transit alternatives for approximately 814,200 Hubway member trips were distributed across the travel-time-ratio categories listed in Table 4-1.

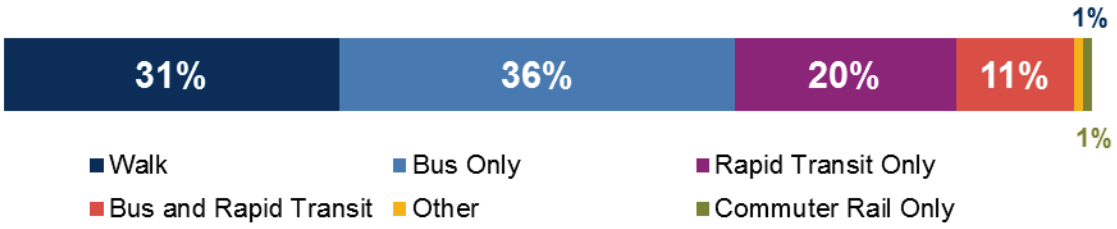
FIGURE 4-1
Alternatives to Hubway Trips by Travel-Time-Ratio Category

Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample = 814,225).
Note: The Walk category includes some trips without itineraries.

In only 11 percent of cases would Hubway trips have been faster or comparable via transit. A larger share of trips (18 percent) would have taken more than twice as long by transit.

Figure 4-2 summarizes the modes included in the alternative transit itineraries for these Hubway trips, which were recommended by OTP to minimize travel time. Figure 4-3 provides similar information but excludes trips with walk-only itineraries.

FIGURE 4-2
Alternatives to Hubway Trips by Mode



Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample = 814,225).
Notes: 1) The "Rapid Transit Only" and "Bus Only" categories include trips with transit itineraries that would have involved transfers between rapid transit lines or bus routes, respectively. 2) The Walk category includes some trips without itineraries.

FIGURE 4-3
Transit Alternatives to Hubway Trips by Mode (Walk Trips Excluded)

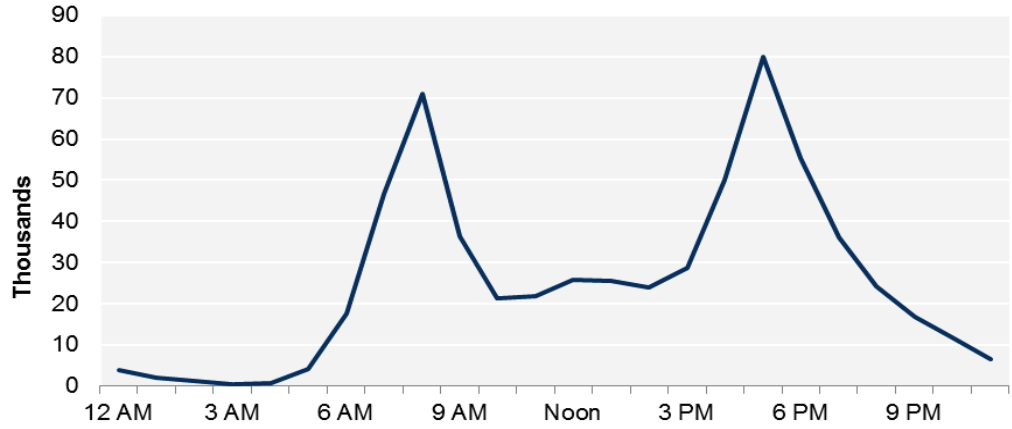
Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample (excluding walk trips) = 562,831).
Note: The "Rapid Transit Only" and "Bus Only" categories include trips with transit itineraries that would have involved transfers between rapid transit lines or bus routes, respectively.

Figure 4-2 shows that OTP recommended a bus trip alternative for 36 percent of member Hubway trips. For 11 percent of trips, OTP recommended a transit alternative that included both bus and rapid transit; this was the largest group of trips that would have involved multiple transit modes. Figures 4-1 and 4-2 both show that walk-only alternatives were suggested for 31 percent of Hubway trips.[43] Figure 4-3 shows that slightly more than half of trips for which OTP recommended a transit alternative only involved bus service.

The next series of graphs show how shares of Hubway member trips vary throughout the day with respect to travel-time-ratio categories and OTP-recommended alternative modes. Figure 4-4 provides some context by showing the distribution of Hubway member trips over the course of a weekday.

[43] There were 631 Hubway member trips for which OTP did not produce an alternative transit or walking itinerary were included in the "Walk Only" category. See footnote 41 for more details about these trips.

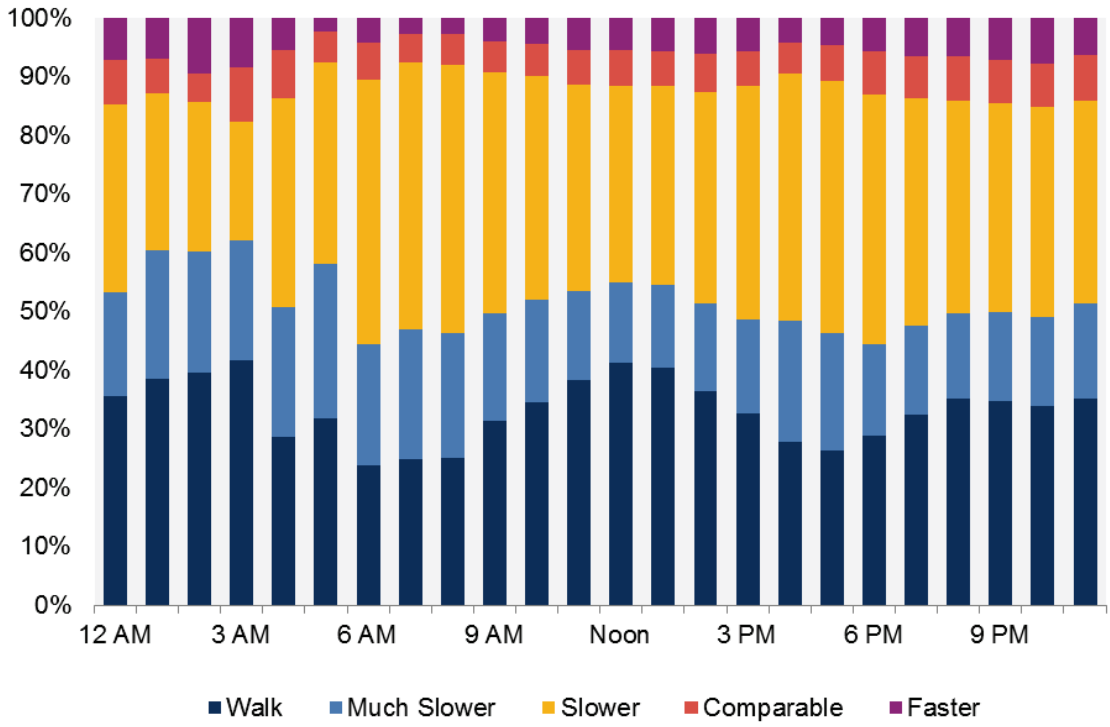
FIGURE 4-4
Hubway Member Trips by Weekday Hour



Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample (weekday trips) = 612,917).

Figure 4-5 shows how member trips that took place during each weekday hour fall into the various travel-time-ratio categories.

FIGURE 4-5
Transit Alternatives to Hubway Trips
by Travel-Time Ratio Category and Weekday Hour

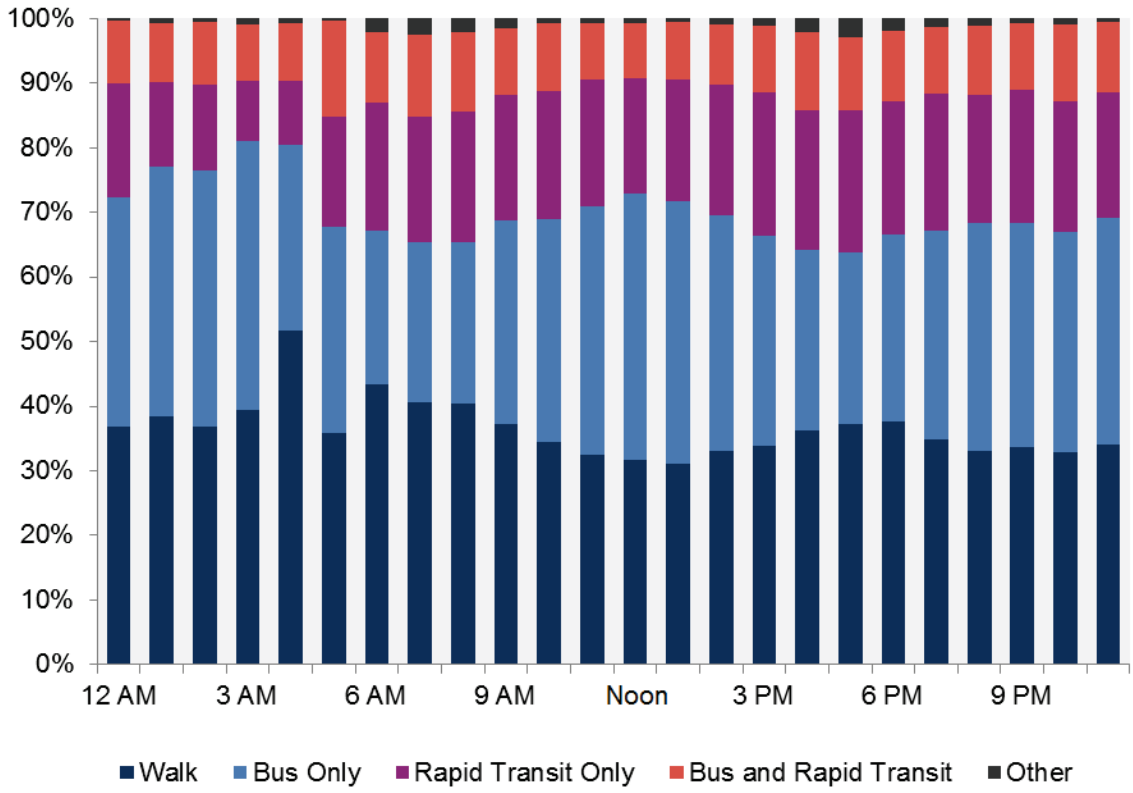


Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample (weekday trips) = 612,917).

Figure 4-5 shows that even though the level of trip activity varies over the course of the day, the share of trips that would be faster or comparable in travel time by transit stays relatively consistent, though this share is largest in the late night or early morning hours. Meanwhile, the share of Hubway trips for which OTP recommended a walk alternative decreases during the morning and afternoon peak periods. This may be because transit service is operating at higher frequencies, and may be a more readily available alternative for certain trips.

Figure 4-6 shows the share of trips by recommended alternate mode, by weekday hour.

FIGURE 4-6
Hubway Trips by Alternative Recommended Modes by Weekday Hour



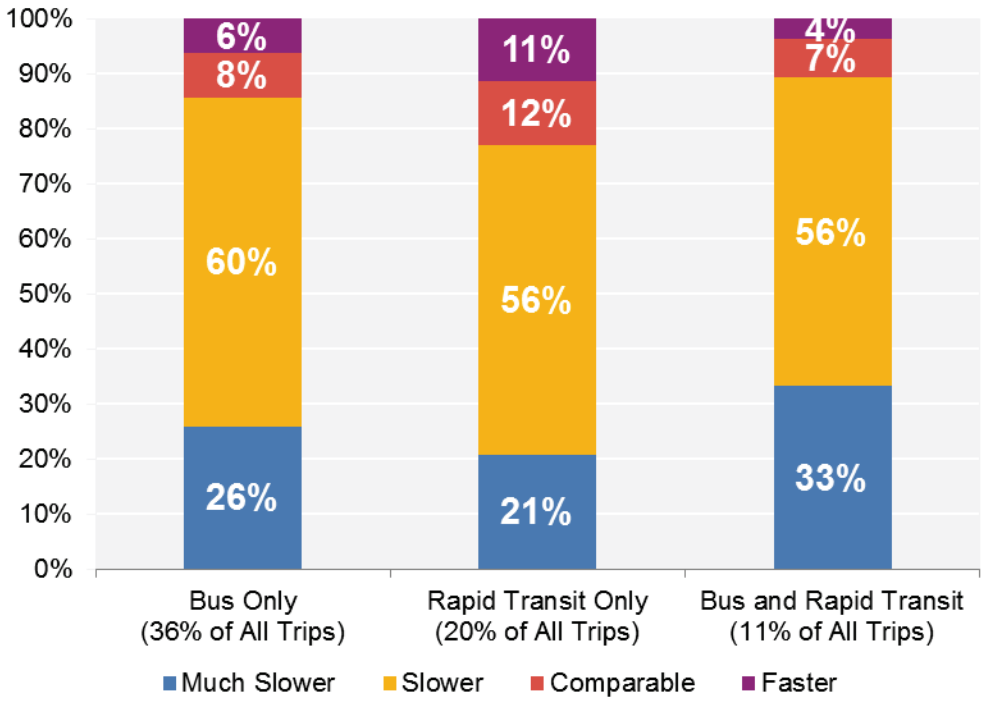
Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015, (trip sample (weekday trips) = 612,917).
Note: The "Rapid Transit Only" and "Bus Only" categories include trips with transit itineraries that would have involved transfers between rapid transit lines or bus routes, respectively.

The share of trips for which OTP recommended a "bus-only" alternative fluctuates more dramatically over the course of the day than shares of trips with "rapid transit-only" or "bus and rapid transit" alternatives. This may be because

bus service frequencies change more dramatically than do rapid transit service frequencies.

Figure 4-7 shows how trips for which OTP recommended a bus-only, rapid-transit-only, or bus-and-rapid-transit alternative fell into the various travel-time-ratio categories.

FIGURE 4-7
Hubway Trips by Alternative Recommended Modes and Travel-Time-Ratio Category



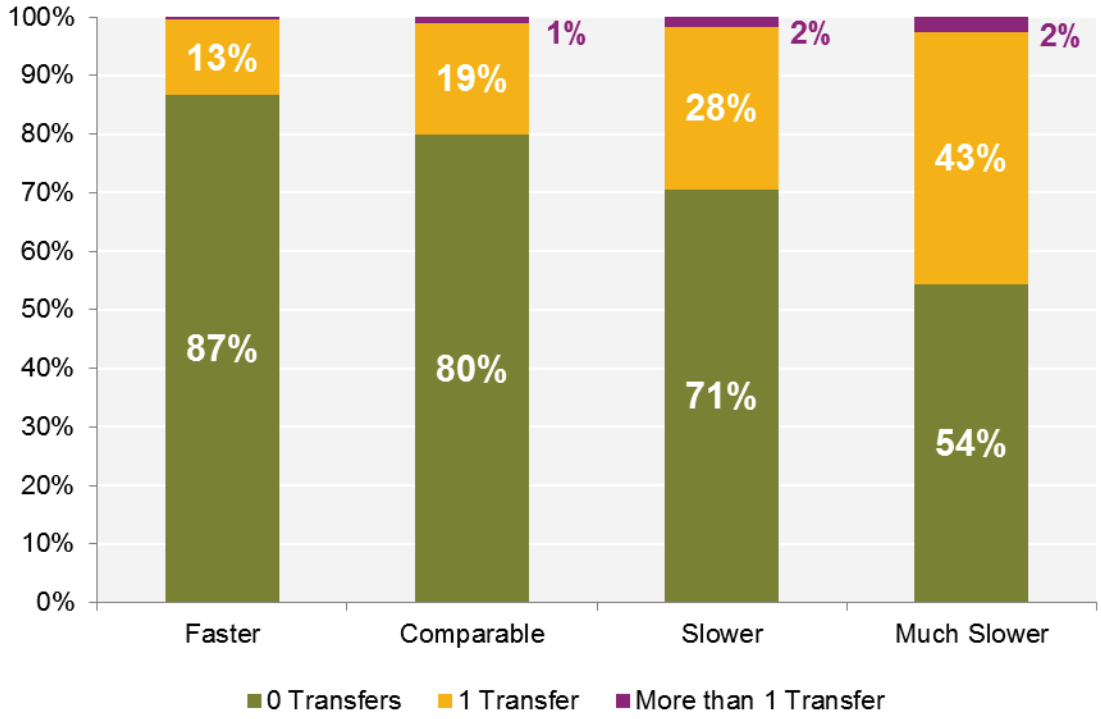
Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015.
Notes: 1) Data reflect both weekdays and weekends. All trips = 814,225 trips. 2) Walk trips (31 percent of trips) or trips involving other modes or combinations of modes (two percent of trips) are not shown. 3) The "Rapid Transit Only" and "Bus Only" categories include trips with transit itineraries that would have involved transfers between rapid transit lines or bus routes, respectively.

Of trips that had a "rapid-transit-only" alternative, 11 percent would have been faster and 12 percent would have been comparable in travel time if made by transit. These percentages are higher than in the "bus only" or "bus-and-rapid transit" categories.

Alternative transit itineraries from OTP included the number of transfers between transit vehicles. Of the trips with transit itineraries, which make up 69 percent of all trips discussed in this section, 69 percent did not include any transfers, and

another 30 percent involved one transfer. Figure 4-8 shows the number of trips in each travel-time-ratio category that have zero, one, or more than one transfers.

FIGURE 4-8
Hubway Trips by Number of Transfers and Travel-Time-Ratio Category

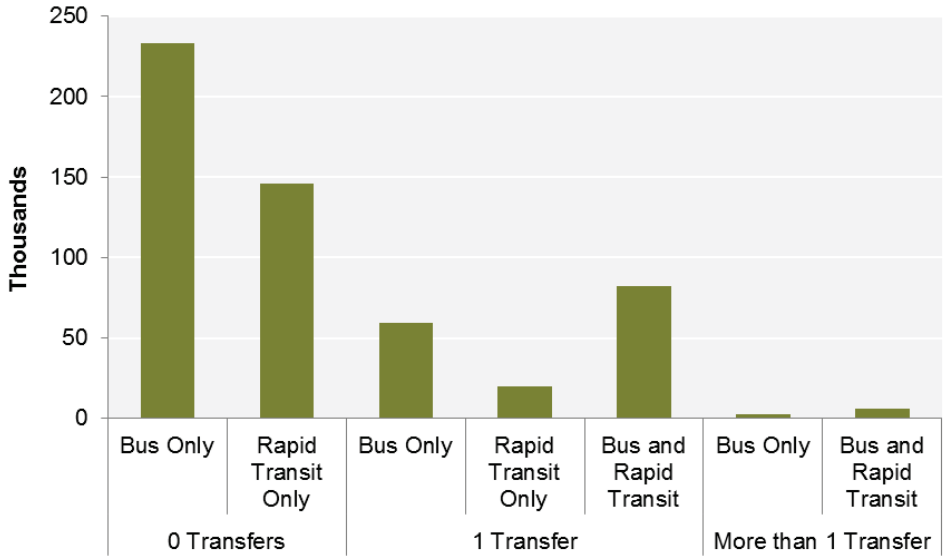


Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample = 562,831 trips with transit itineraries).
Note: Values are rounded to the nearest whole percent; not all columns sum to 100 percent.

The itineraries for Hubway trips that would have been faster or comparable in travel time by transit almost always involved zero transfers or one transfer.

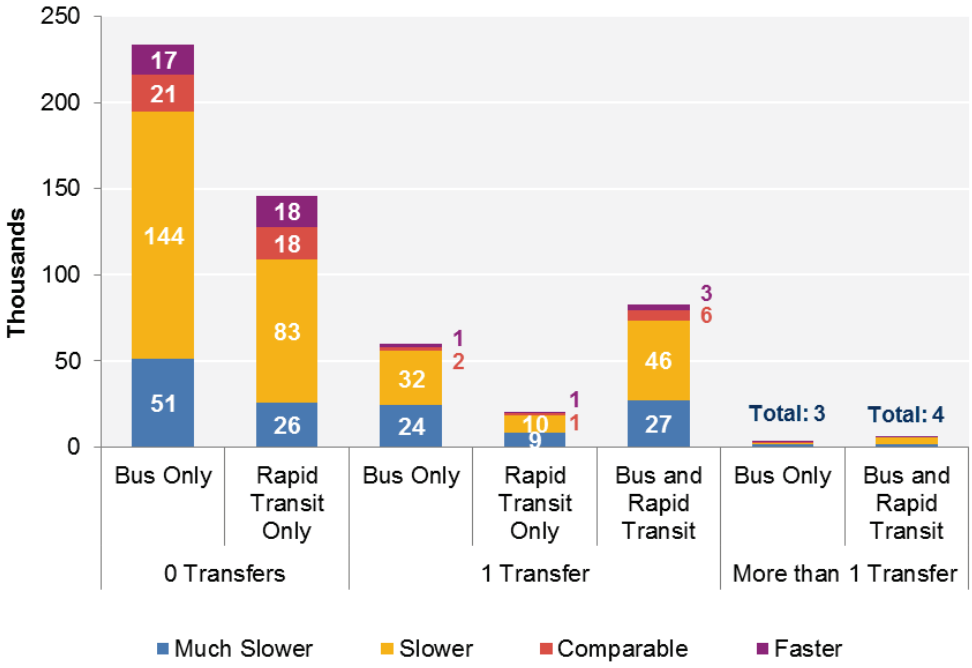
Figure 4-9 shows Hubway trips with transit itineraries by their mode and number of transfers. Figure 4-10 incorporates information about how the alternate transit itineraries for these trips fell into the various travel-time-ratio categories.

FIGURE 4-9
Trips with Transit Itineraries by Mode and Number of Transfers



Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample = 549,811 trips (of 562,831 trips with transit itineraries).
Note: Trips in other modal categories (two percent of trips with transit itineraries) are not shown.

FIGURE 4-10
Trips with Transit Itineraries by Mode, Number of Transfers, and Travel-Time-Ratio Category



Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015 (trip sample = 549,811 trips (of 562,831 trips with transit itineraries).
Notes: 1) Trips in other modal categories (two percent of trips with transit itineraries) are not shown. 2) Total trips in each category have been rounded to the nearest thousand.

There is a slightly larger share of Hubway trips with bus-and-rapid-transit alternative itineraries involving one transfer that are faster or comparable by transit (11 percent) than Hubway trips with “bus only” or “rapid transit only” itineraries involving one transfer (6 percent and 7 percent). For these trips, transit may be more competitive in terms of travel time because the alternative itineraries effectively combine the frequency and speed of rapid transit with the geographic coverage of the bus system.

4.4 Results for Origin-Destination Pairs

Sections 4.4 through 4.8 discuss Hubway trips that have been clustered into O-D pairs. O-D pairs can be categorized and analyzed using the metrics that CTPS used to analyze individual Hubway trips in section 4.3. The significant difference is that an O-D pair is essentially a bundle of Hubway trips taking place between a unique set of points. Hubway trips within each O-D bundle were taken at various times of day or on different days of the week, and OTP may have recommended different transit alternatives depending on when the trip took place. As a result, the alternate itineraries for these trips may fall into a range of travel-time-ratio categories, or involve a variety of modes. However, by examining trips according to their origin and destination, it is possible to see patterns in a geospatial context.

As described in Section 4.2, CTPS used OTP to generate alternative transit itineraries for approximately 1,043,000 Hubway trips.[44] Approximately 814,000 of these trips were made by Hubway members. These member trips can be classified into 16,696 O-D pairs. CTPS analyzed O-D pairs that included 200 or more trips to ensure sufficient samples for analysis, and 873 O-D pairs met this criterion.

CTPS focused specifically on O-D pairs with large shares of Hubway trips that 1) would have been faster or comparable in travel time by transit; 2) would have been much slower by transit; or 3) would have had walk-only itineraries. Tables 4-2, 4-3, and 4-4 categorize the 873 O-D pairs with respect to the shares of their alternative itineraries that fall into these categories.

Table 4-2 shows that for 90 percent of the analyzed O-D pairs, less than 25 percent of trips would have been faster or comparable in travel time by transit. These results correspond to those in Figure 4-1, which shows that of all Hubway trips—and not just O-D pairs—only 11 percent would have been faster or comparable in travel time by transit.

[44] As discussed above, OTP did not produce itineraries for approximately 1,000 of these trips.

TABLE 4-2
O-D Pairs by Percentage of Trips that Would Have Been Faster or Comparable by Transit

Share of Faster or Comparable Trips	Number of O-D Pairs	Percent of O-D Pairs
100%	0	0%
75% to 99%	13	1%
50% to 74%	28	3%
25% to 49%	55	6%
1% to 24%	442	51%
0%	335	38%
Total O-D Pairs	**873**	**100%**

Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015.
Note: Table shows data for 873 pairs, each of which includes 200 or more trips.

Table 4-3 shows that for 77 percent of O-D pairs, less than 25 percent of trips would have been much slower—more than twice as long—by transit. Only 12 percent of O-D pairs had more than 50 percent of trips that would have been much slower by transit than they would have been by Hubway.

TABLE 4-3
O-D Pairs by Percentage of Trips that Would Have Been Much Slower by Transit

Share of Much Slower Trips	Number of O-D Pairs	Percent of O-D Pairs
100%	1	0%
75% to 99%	40	5%
50% to 74%	57	7%
25% to 49%	101	12%
1% to 24%	313	36%
0%	361	41%
Total O-D Pairs	**873**	**100%**

Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015.
Note: Table shows data for 873 pairs, each of which includes 200 or more trips.

Table 4-4 shows that most O-D pairs either 1) only included trips that would have had walk-only itineraries; or 2) did not include any trips that would have had walk-only itineraries. In 30 percent of O-D pairs, all Hubway trips would have had walk-only itineraries. Only one-third of O-D pairs include a mix of trips that would have had walk-only itineraries and those that would have had transit itineraries.

TABLE 4-4
O-D Pairs by Percentage of Trips that Would Have Had Walk-Only Itineraries

Share of Walk Only Trips	Number of O-D Pairs	Percent of O-D Pairs
100%	263	30%
75% to 99%	88	10%
50% to 74%	48	5%
25% to 49%	54	6%
1% to 24%	93	11%
0%	327	37%
Total O-D Pairs	**873**	**100%**

Data source: 2015 Hubway trip logs and Open Trip Planner output, 4/17/2015–12/18/2015.
Note Table shows data for 873 pairs, each of which includes 200 or more trips.

Table 4-5 displays details for O-D pairs that include more than 1,000 member trips. These pairs comprise approximately five percent of all trips in the analysis sample (approximately 814,000 member trips in total). Many of these O-D pairs have very large shares of trips that would have had walk-only itineraries or much slower transit itineraries, although a few O-D pairs include trips from a variety of categories. Figure 4-11 shows these pairs on a map of the Hubway service area.

TABLE 4-5
High Volume O-D Pairs with Trips Classified by Travel-Time-Ratio Category

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Number of Trips	Percent of Total Trips					
			Faster by Transit	Comparable by Transit	Slower by Transit	Much Slower by Transit	Walk-Only	Grand Total
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Square	2,800	0%	0%	0%	0%	100%	100%
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	2,542	0%	0%	0%	0%	100%	100%
A32010 to D32022	South Station to TD Garden	2,445	2%	2%	64%	32%	0%	100%
S32011 to S32006	Teele Square to Davis Square	1,962	1%	1%	1%	0%	96%	100%
D32022 to A32010	TD Garden to South Station	1,876	4%	10%	73%	14%	0%	100%
D32022 to C32010	TD Garden to Congress St @ Sleeper St	1,826	1%	1%	68%	30%	0%	100%
D32006 to A32010	Lewis Wharf to South Station	1,792	4%	5%	21%	5%	65%	100%
M32006 to B32016	MIT: Mass Ave to Beacon St @ Mass Ave	1,758	3%	4%	33%	6%	53%	100%
C32010 to D32022	Congress St @ Sleeper St to TD Garden	1,689	0%	1%	23%	76%	0%	100%
D32008 to D32022	Rowes Wharf to TD Garden	1,656	0%	0%	4%	3%	93%	100%
B32016 to M32006	Beacon St @ Mass Ave to MIT: Mass Ave	1,597	4%	10%	38%	2%	46%	100%
A32010 to D32006	South Station to Lewis Wharf	1,580	0%	2%	28%	4%	65%	100%
D32012 to D32022	Post Office Square to TD Garden	1,545	1%	2%	53%	26%	18%	100%
B32004 to A32010	Aquarium Station to South Station	1,340	0%	0%	4%	0%	96%	100%
M32006 to M32011	MIT: Mass Ave to Central Square	1,315	2%	4%	57%	15%	23%	100%
A32010 to B32004	South Station to Aquarium Station	1,266	0%	0%	5%	0%	95%	100%
D32021 to D32022	Charlestown: Warren St to TD Garden	1,246	0%	0%	0%	0%	100%	100%
D32023 to D32022	Spaulding Hospital: Charlestown Navy Yard to TD Garden	1,221	2%	3%	67%	23%	5%	100%
D32022 to A32013	TD Garden to John F Fitzgerald - Surface Rd	1,210	0%	0%	0%	0%	100%	100%
M32011 to M32006	Central Square to MIT: Mass Ave	1,175	8%	17%	64%	1%	10%	100%
D32022 to D32023	TD Garden to Spaulding Hospital: Charlestown Navy Yard	1,175	7%	8%	54%	25%	6%	100%
A32010 to D32008	South Station to Rowes Wharf	1,109	0%	0%	0%	0%	100%	100%
M32003 to M32019	One Broadway / Kendall Square to CambridgeSide Galleria	1,079	0%	0%	0%	0%	100%	100%
S32006 to S32011	Davis Square to Teele Square	1,052	0%	1%	5%	0%	94%	100%
D32022 to D32021	TD Garden to Charlestown: Warren St	1,017	0%	0%	0%	0%	100%	100%
M32011 to M32014	Central Square to Harvard Housing: Putnam Ave	1,003	0%	0%	2%	1%	97%	100%

Data source: 2015 Hubway Trip Logs and OTP output, 4/17/2015–12/18/2015.
O-D = Origin-Destination. OTP = Open Trip Planner.
Note: Hubway trips within each O-D bundle were taken at various times of day or on different days of the week, and OTP may have recommended different transit alternatives depending on when the trip took place. As a result, the alternate itineraries for these trips may fall into a range of travel-time-ratio categories, or involve a variety of modes.

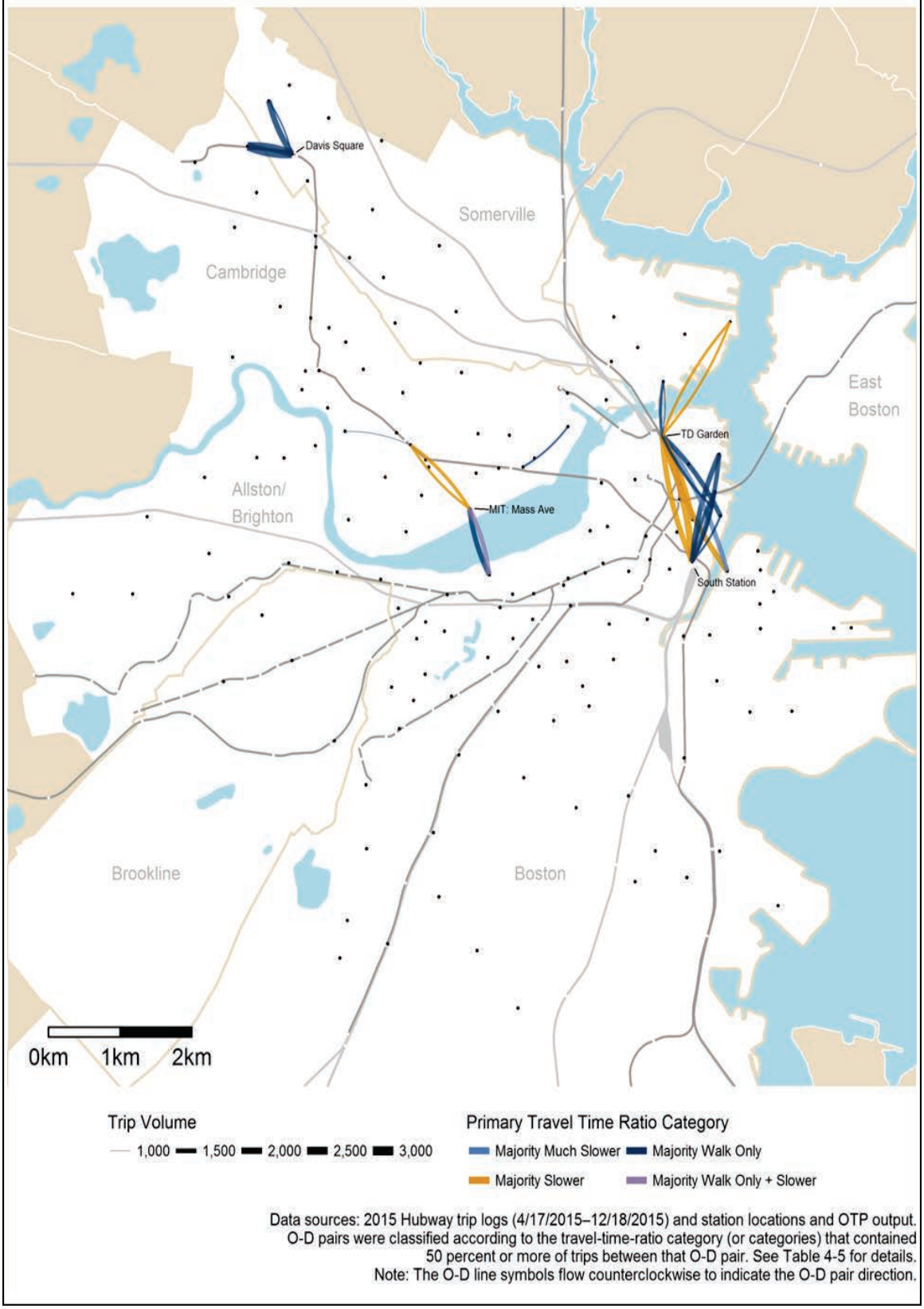


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FIGURE 4-11
O-D Pairs with 1,000 or More Hubway Trips by Primary Travel-Time-Ratio Category

Exploring Shared-Use Mobility through Hubway Bikeshare

4.5 Identifying O-D Pairs that May Complement or Compete with Transit

To understand how Hubway O-D pairs may complement or compete with transit service, CTPS began by examining how the alternate transit itineraries for the trips in each O-D pair were distributed across the travel-time-ratio categories.

1. If an O-D pair includes a large share of Hubway trips that would have been faster or comparable in travel time by transit, it is possible that Hubway use between that O-D pair may **compete** with the transit system, particularly if these trips would be direct and not crowded. However, Hubway service may play a **complementary** role
    a. if transit alternatives for these trips would involve transfers; or
    b. if Hubway trips were taking place during peak periods, and the transit vehicles serving them likely would be uncomfortable because of high levels of passenger demand.[45]

    Section 4.6 describes CTPS's analysis of these O-D pairs.

2. If most or all trips for a certain O-D pair would be much slower by transit, Hubway service could **complement** transit by giving regular transit riders a quicker, more direct alternative, especially if it would not be cost-effective for the MBTA to improve these links in the transit network. However, should the MBTA make improvements that would make these trips quicker and more direct by transit, Hubway service on these links could become **competitive**. Section 4.7 discusses these cases.

3. If OTP recommended that a person otherwise walk for all (or almost all) Hubway trips for a particular O-D pair, transit likely would not be a suitable mode for making this connection. This could occur because 1) the trip might be relatively short and/or 2) transit service might be limited, involve transfers, or be non-existent for this O-D pair. In these instances, Hubway may **complement** transit. Section 4.8 examines these cases.

4. Hubway may **complement** the MBTA transit network in cases where OTP recommended that a walk-only alternative for all (or almost all) Hubway trips between a particular O-D pair and one of the Hubway stations is located near a transit station. Using Hubway between these O-D pairs could help people gain access to the transit network. Section 4.8 also examines these cases.

[45] Transfers not only add to travel time but also inconvenience travelers. The former is captured in the travel time ratio but the latter is not.

4.6 Results for O-D Pairs with Large Shares of Trips that are Faster or Comparable in Travel Time by Transit

CTPS first examined Hubway trips and O-D pairs using the day-and-time periods shown in Table 4-6.

TABLE 4-6
Day-and-Time Periods

Time Period	Relevant Hours
Weekday - Late Night / Early Morning	12:00 AM–6:59 AM
Weekday AM Peak	7:00 AM–10:00 AM
Weekday - Midday	10:01 AM–3:59 PM
Weekday - PM Peak	4:00 PM–7:00 PM
Weekday - Evening / Night	7:01 PM–11:59 AM
Weekend	All day

Source: Central Transportation Planning Staff.

For each day-and-time period, CTPS selected a subset of pairs that met the following two criteria:

1. The O-D pair had 100 or more trips during that particular day-and-time period
2. Fifty percent or more of the trips in that O-D pair during that time period would have been faster or comparable in travel time via transit

Trips between these O-D pairs may compete with transit during off-peak periods. They may also compete with transit during peak periods unless there is evidence of uncomfortable conditions or a need to make transfers on the transit modes that might otherwise serve the trip.

As discussed in Sections 4.2 and 4.3, the OTP output data provides information on the modes and transfers included in each transit itinerary. Using this information, CTPS reviewed the O-D pairs that met the trip volume and travel-time-ratio criteria during the different day-and-time periods and identified the combinations of transit modes and transfers that would have provided alternatives to Hubway trips for each O-D pair. CTPS documented the transit mode and transfer combinations that accounted for the majority of Hubway trips that would have been faster or comparable in travel time by transit. For more information about the results for these O-D pairs, see tables E-1 to E-4 in Appendix E.

CTPS considered Hubway activity on prominent O-D pairs during off-peak periods to be competing with transit. In general, the transit alternatives for these trips did not involve any transfers (for more information, see tables E-3 and E-4 in

Appendix E). For O-D pairs that were prominent during the AM and PM peak periods, CTPS followed several additional steps:

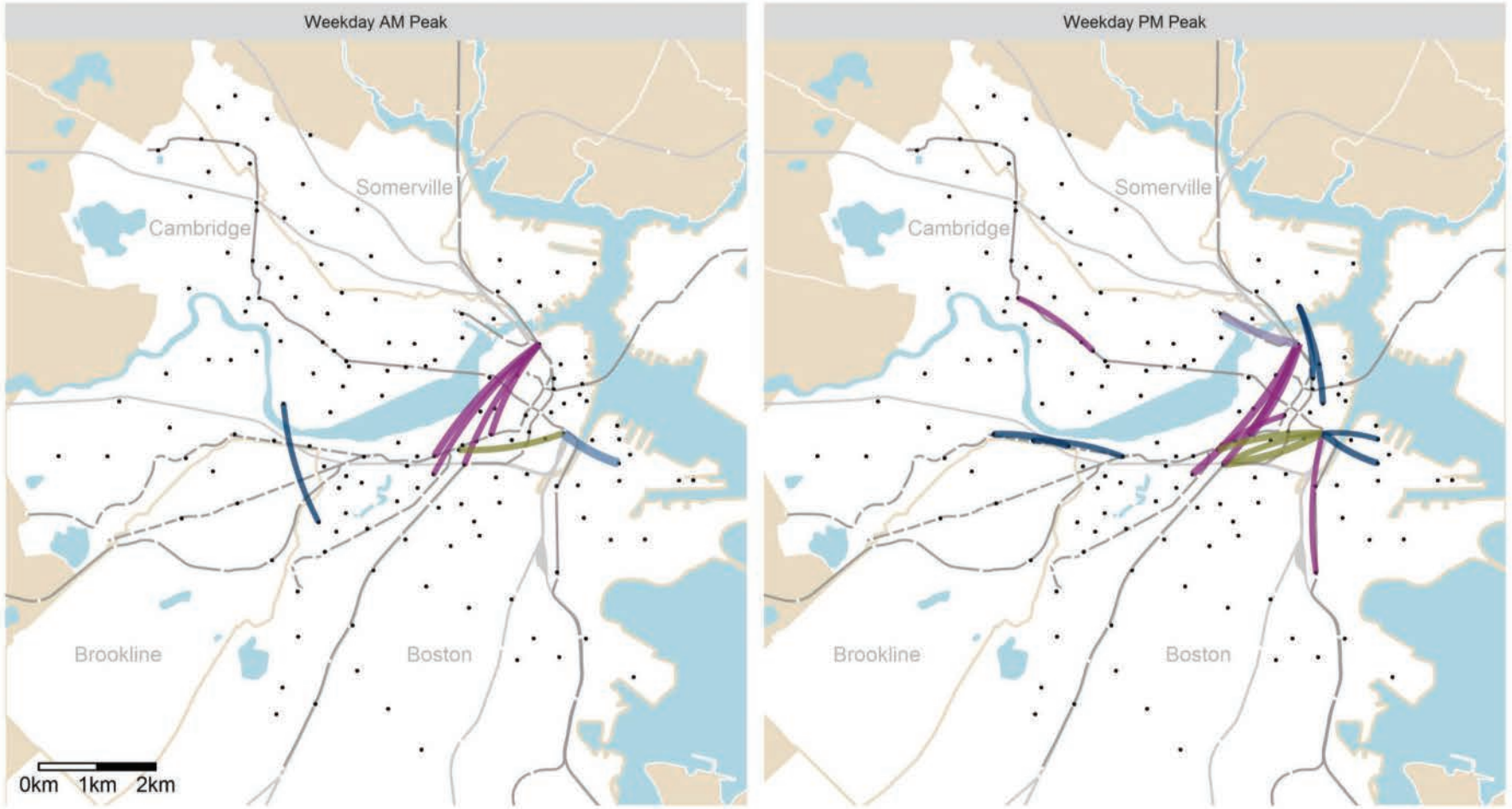
1. Gathered details on relevant routes and stops for more alternate trip itineraries for these prominent O-D pairs using OTP and Google Maps. In some cases, multiple rapid transit lines or bus routes would provide service for a particular link.

2. Examined MBTA bus point-check data, proposed MBTA measures and data about bus passenger comfort, and rapid transit system passenger flow data for evidence that relevant segments of these transit routes or lines might be uncomfortable because of high levels of passenger demand. Appendix D describes the methodologies used to carry out this step.

3. Identified an O-D pair as a potential complement to transit if Hubway trips between this pair had at least one alternative transit route or line for which there was some evidence of uncomfortable conditions, using the methods described in Appendix D. Hubway travel on these O-D pairs could complement transit to a greater degree if Hubway members using bikesharing to travel on these links have MBTA monthly passes. In these cases, the MBTA would not lose revenue if these people took Hubway as an alternative to a crowded bus or train.

4. Considered O-D pairs that did not meet these time and demand criteria, or those that could not be evaluated, still to be potential competitors.

Figure 4-12 shows the results of this four-step analysis for Hubway trips that took place in the AM and PM peak periods. The O-D pairs shown in Figure 4-12 are classified by the transit mode that served the majority of trips that would be faster or comparable in travel time by transit. Tables E-1 and E-2 in Appendix E contain more detailed information for the OD pairs in these time periods.



Data sources: 2015 Hubway trip logs (4/17/2015-12/18/2015) and station locations and OTP output.
See Appendix E for more information on these O-D pairs.
Note: The O-D line symbols flow counterclockwise to indicate the O-D pair direction.

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FIGURE 4-12
O-D Pairs That May Complement or Compete with Transit (AM and PM Peak Periods)

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Many of the transit alternatives for the O-D pairs in the weekday AM peak period involve rapid transit, while a wider variety of transit modes could serve the pairs in the weekday PM peak period. When these two periods are compared, it is possible to see how the flow of travel changes over the course of the day. Three pairs that flow away from TD Garden during the AM peak period flow toward TD Garden during the PM peak period.

Most O-D pairs in both periods could be complements to transit, because some evidence suggests that transit travel on these segments could be uncomfortable during peak periods. Transit alternatives for these O-D pairs did not involve transfers. In both periods, many alternative transit trips would have relied upon the Green Line subway and the portion of the Orange Line between Back Bay and North Station. Commuter rail would have supported transit trips between several O-D pairs that may compete with transit; there is no evidence of uncomfortable conditions for these commuter rail segments. However, commuter rail is not necessarily designed to help people make these short-distance connections in urban cores. In particular, commuter rail service is less frequent than other modes, such as rapid transit; as a result, riders need to be aware of schedules, and their trips would need to coincide with these schedules. People might also avoid commuter rail for this O-D pair because they might assume that it is more expensive and less convenient to travel by commuter rail, even if the trip would be quick and presumably comfortable.

Figure 4-13 shows O-D pairs that met the trip volume and travel-time-ratio criteria during the weekday off-peak periods and the weekend period. Tables E-3 and E-4 in Appendix E contain more detailed information for the OD pairs in these time periods, including the shares of faster or comparable trips that could be served by different transit modes. The O-D pairs shown in Figure 4-13 are classified by the transit mode that served the majority of these trips. CTPS did not investigate whether conditions would be uncomfortable on relevant transit modes during these off-peak periods; these O-D pairs could be considered potential competitors to transit until more detailed transit itinerary and passenger demand information is analyzed. The maps in Figure 4-13 provide information about the transit mode combinations that would otherwise serve these O-D pairs. Figure 4-13 shows that Hubway O-D pairs near Harvard, MIT, Tufts, and Boston University are prominent during the weekday midday and evening periods and during the weekend. During the early-morning and midday periods, several O-D pairs that have many trips with transit alternatives that would be faster or comparable in travel time to Hubway would be served by rapid transit. In the evening and on the weekend, more of these O-D pairs would be served by buses.

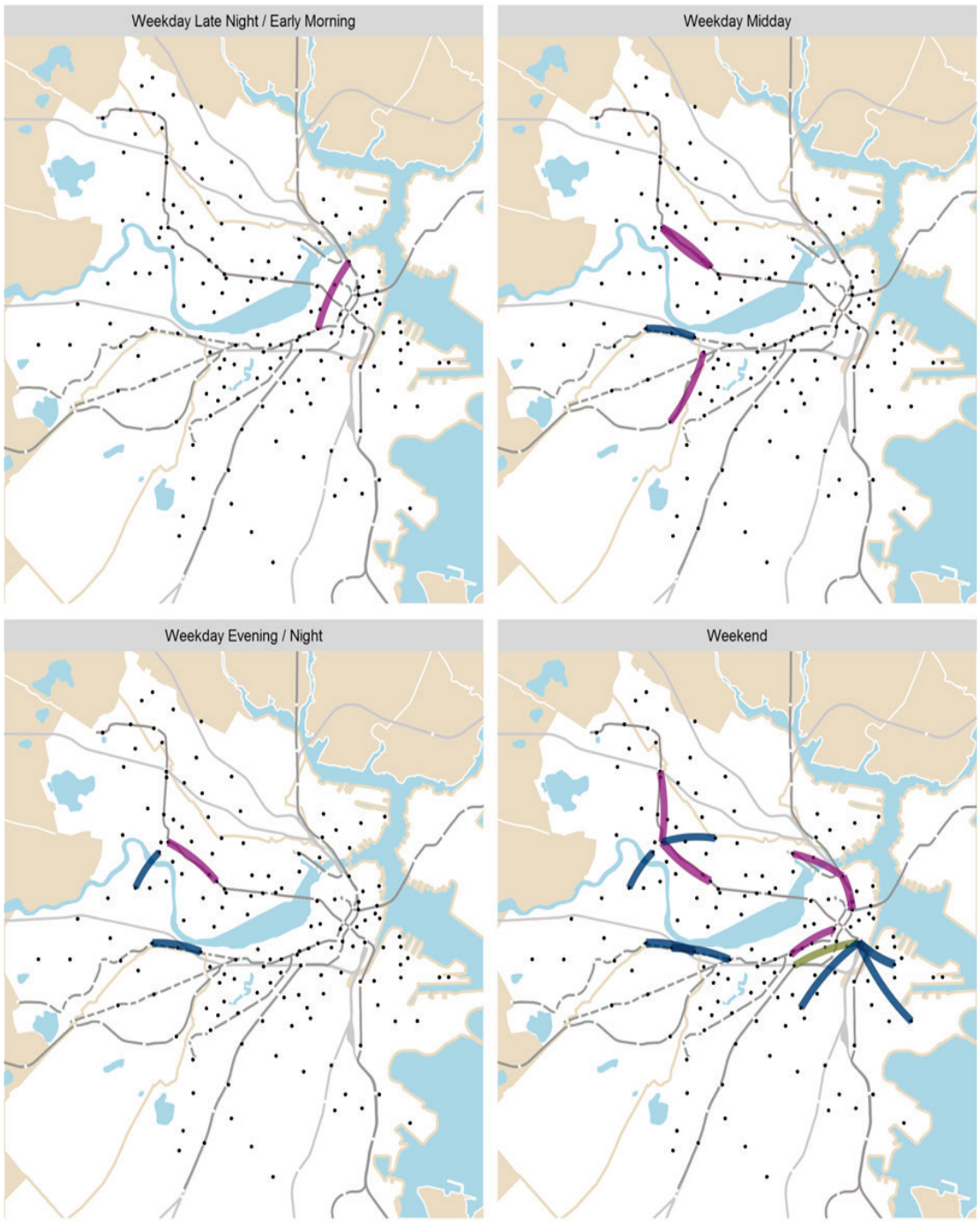

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FIGURE 4-13
O-D Pairs that May Compete with Transit (Weekday Off-Peak and Weekend Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare

4.7 Results for O-D Pairs with Large Shares of Trips that are Much Slower by Transit

As shown in Table 4-1, Hubway trips that would have been much slower by transit are those for which OTP recommended an alternative transit itinerary with a travel time that was more than twice as long as the Hubway travel time. Given this difference in travel time, O-D pairs that include a large share of these trips may complement transit because it might be difficult for the MBTA to provide a quick or direct transit option for this link. This is particularly the case if Hubway riders also have MBTA monthly passes, which would mean that the MBTA would receive the same revenues even if these people were using Hubway to make these trips. However, if the MBTA can apply a relatively low-cost fix to improve transit service that would otherwise serve these links, Hubway could eventually compete with transit. In either case, it is important to understand where O-D pairs with large volumes of "much slower" trips are located, so that the MBTA can choose whether to improve transit service in these locations.

To identify relevant O-D pairs for analysis, CTPS examined each day-and-time period listed in Table 4-3 and selected a subset of O-D pairs that met the following two criteria:

1. The O-D pair had 100 or more trips during that particular day-and-time period
2. Seventy-five percent or more trips in that O-D pair during that time period would have been faster or comparable in travel time by transit

Figures 4-14 and 4-15 show these O-D pairs by time of day. These individual O-D pairs have been classified by the transit mode that would have served 50 percent or more of trips that would have been much slower by transit. Tables F-1 to F-5 in Appendix F describe these O-D pairs. These tables show that for each O-D pair, one transit mode-and-transfer combination tends to account for most trips that would have been slower or much slower by transit. For example, the alternative option for 85 percent of "much slower" trips between Inman Square and the MIT Stata Center during the AM peak period would be a bus trip with no transfers. However, although one option tends to dominate, the transit options for "much slower" trips on many O-D pairs are spread across multiple mode-and-transfer categories.

Figure 4-14 shows that during the weekday AM peak period, many O-D pairs meet the trip volume and travel-time-ratio criteria, though no pair stands out in terms of trip volume. In the PM peak period, there are fewer O-D pairs that meet these criteria, but the qualifying O-D pairs vary more by volume. The highest volume O-D pairs generally connect TD Garden (North Station) to points in Cambridge or South Boston. During the PM peak period, several O-D pairs

represent trips flowing in the opposite direction of O-D pairs during the AM peak period, although different combinations of transit modes might have served these trips during the PM peak period.

Figures 4-14 and 4-15 both show that OTP recommended bus options for many O-D pairs that would have been much slower by transit. Tables F-1 to F-5 in Appendix F show that transit itineraries for these OD pairs involve more transfers and multi-modal combinations than do the itineraries for O-D pairs with 50 percent or more trips that would be faster or comparable by transit.

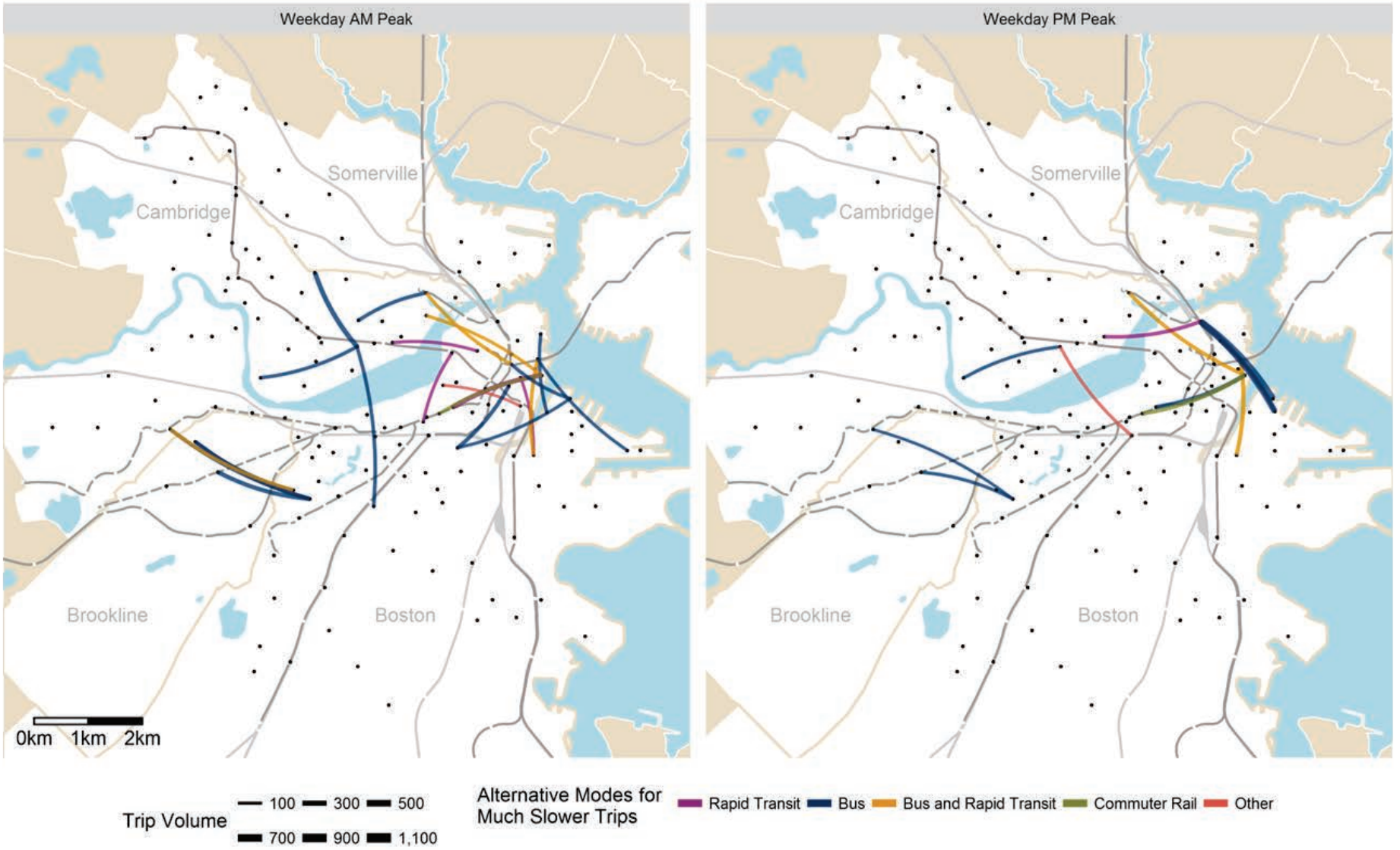

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FIGURE 4-14
O-D Pairs with 75 Percent or More Trips Much Slower by Transit (Weekday AM and PM Peak Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare

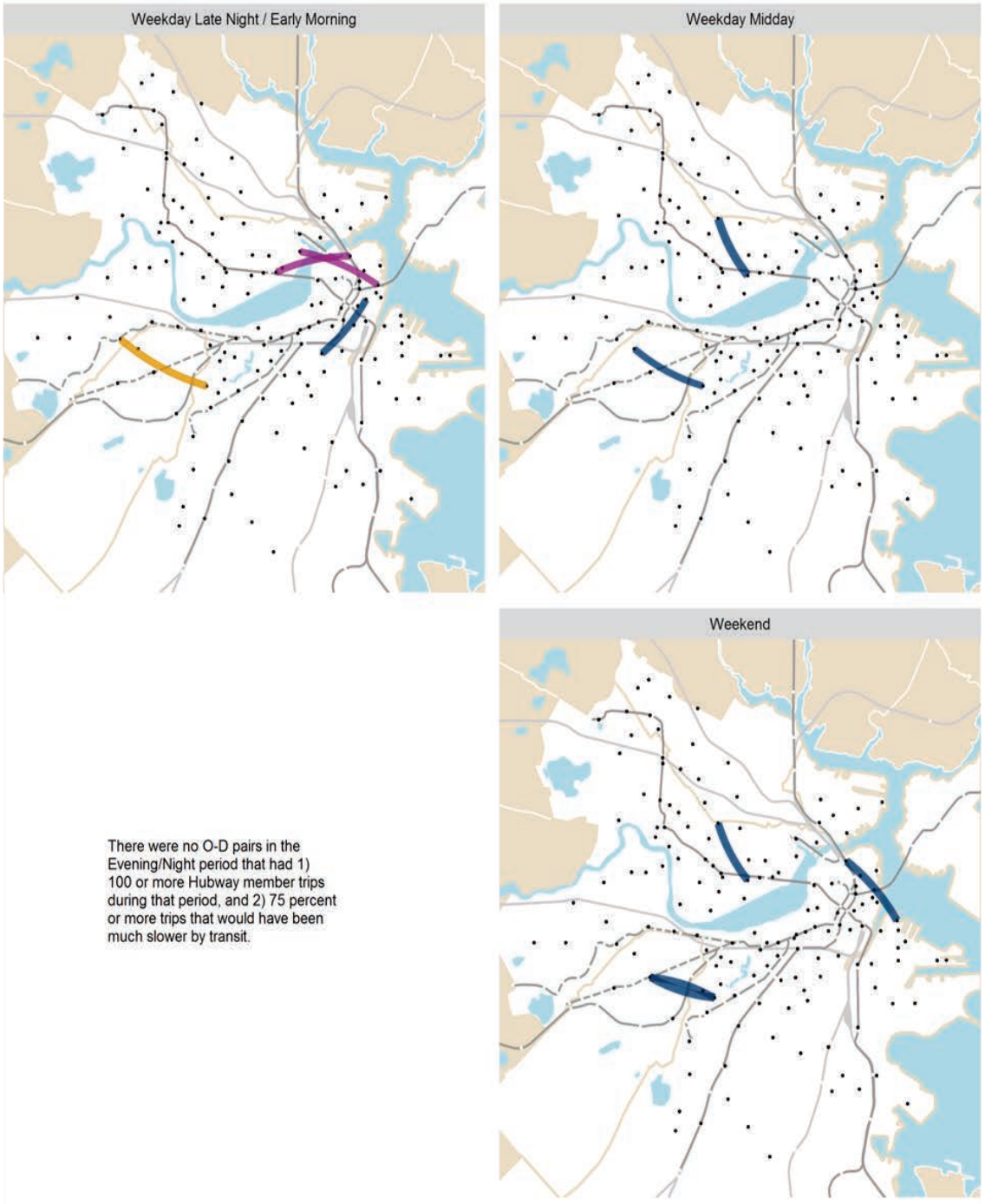

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FIGURE 4-15
O-D Pairs with 75 Percent or More Trips Much Slower by Transit (Weekday Off-Peak and Weekend Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare

4.8 Results for O-D Pairs with Large Shares of Walk-Only Trips

For some connections, Hubway may complement the existing transit system by providing a way for people to make trips on links where transit service is limited, complicated, nonexistent, or otherwise not a sensible alternative (especially if the distance between the origin and destination is relatively short). CTPS used OTP outputs that recommended a walk-only alternative (as opposed to a transit alternative) for many trips between a particular O-D pair as a way to identify these cases. As part of this analysis, CTPS examined O-D pairs during each day-and-time period listed in Table 4-3 and identified a subset of O-D pairs that met the following two criteria:

1. The O-D pair had 100 or more trips during that particular day-and-time period
2. For ninety-five percent or more trips in that O-D pair, OTP recommended that travelers walk, as opposed to taking transit

CTPS also classified Hubway stations according to the transit modes available near each station, using a geographic information systems (GIS) analysis of the bus stops and modes available at transit stations within 200 meters (approximately one-eighth mile) of each Hubway station. Figure 4-16 classifies Hubway stations by the transit modes that are nearby. Appendix B also lists the transit modes that are near each Hubway station.

Figure 4-17 shows the high-volume O-D pairs with 95 percent or more walk-only trips during the weekday AM and PM peak periods and Figure 4-18 shows these pairs for the weekday off-peak and weekend periods. Tables G-1 to G-6 in Appendix G list the prominent O-D pairs during each time period.

As Figures 4-17 and 4-18 show, many of these O-D pairs exist along the Rose Kennedy Greenway in Boston, near MIT and Harvard, and near stations further north on the Red Line, including Porter and Davis Squares.

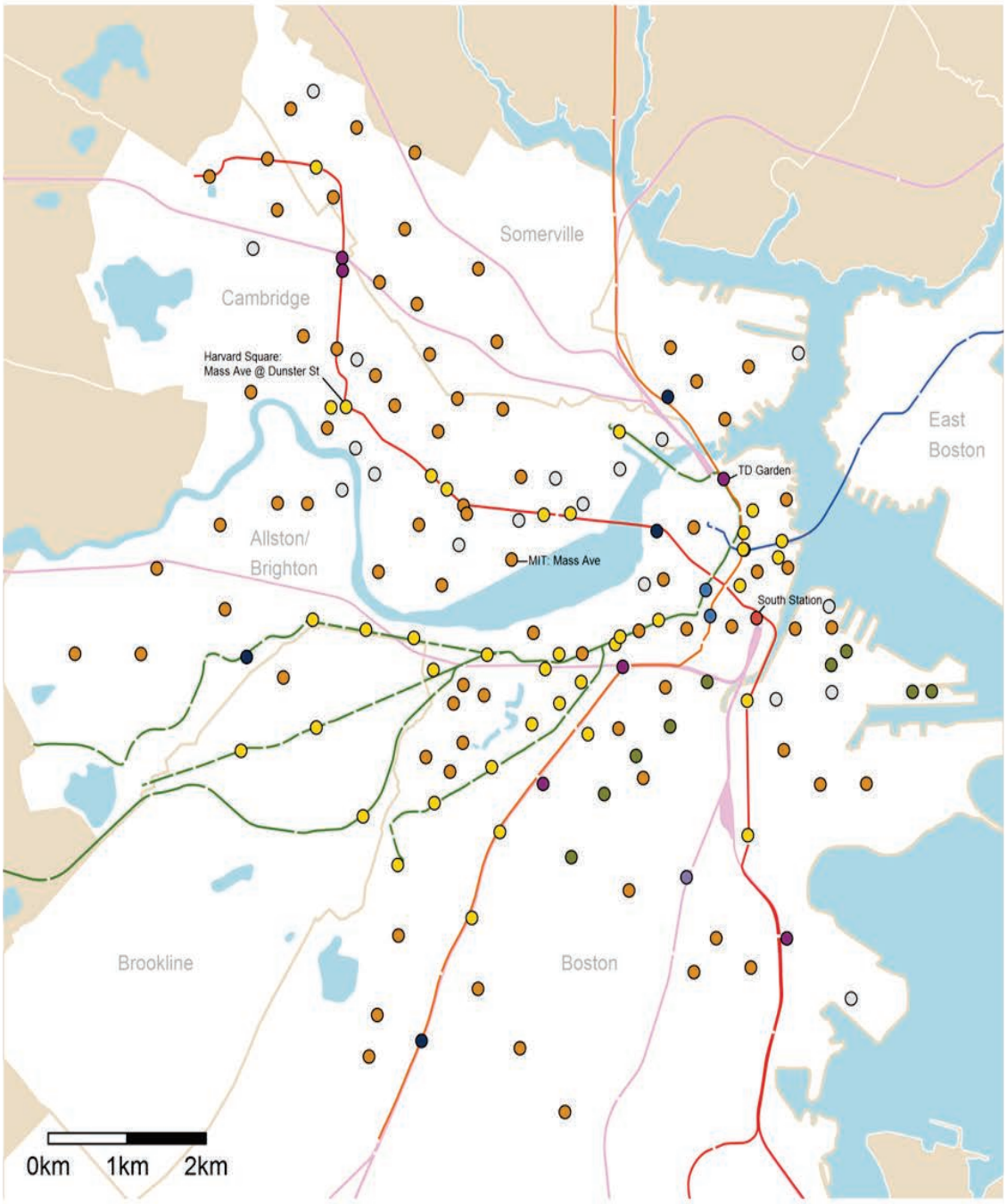

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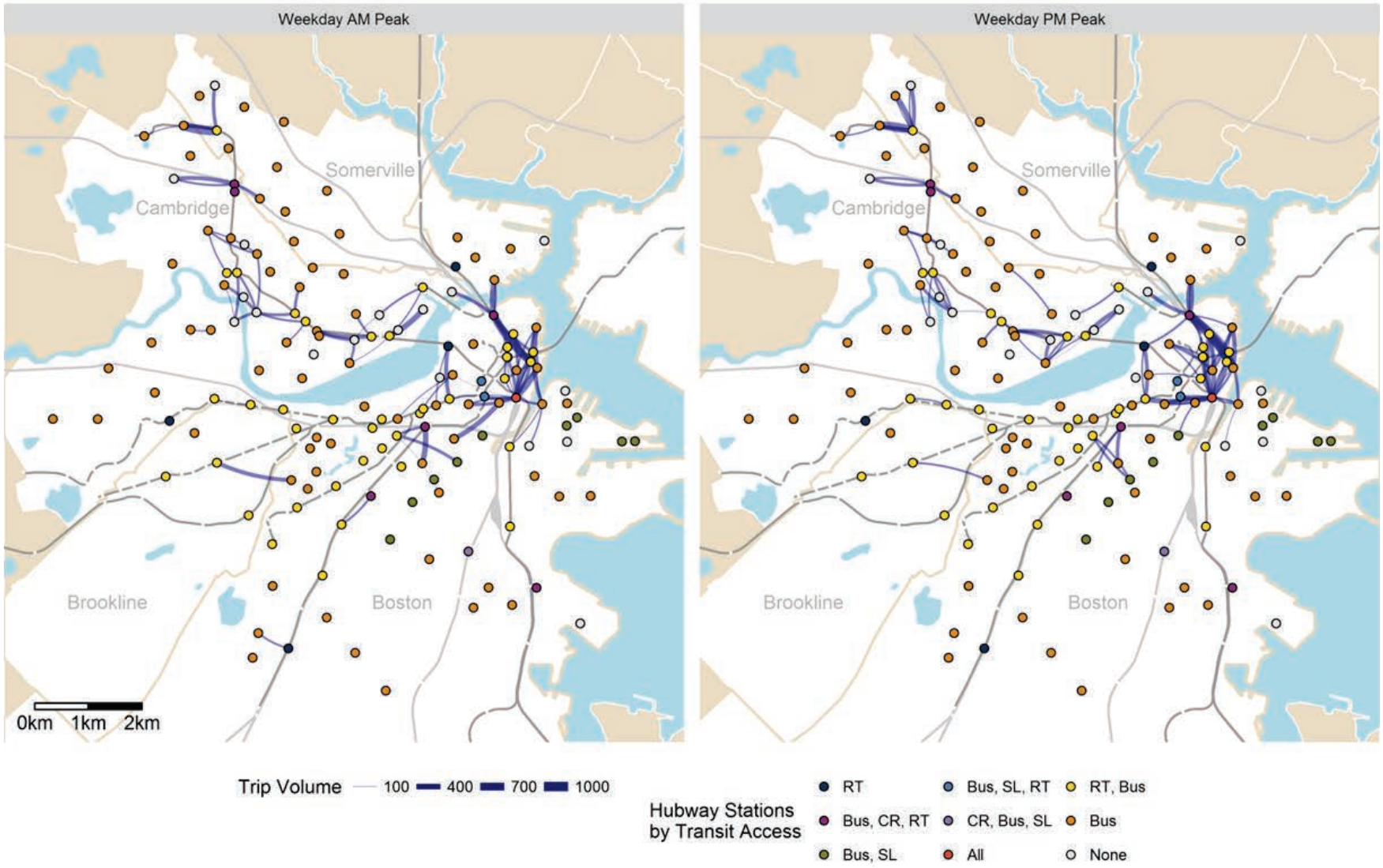
FIGURE 4-16
Hubway Stations by Transit Modes Available within 200 Meters

Exploring Shared-Use Mobility through Hubway Bikeshare



Data sources: 2015 Hubway trip logs and station locations (4/17/2015–12/18/2015), OTP output, and CTPS GIS analysis.
See Appendix B for information on station classifications.
See Appendix G for more information on O-D pairs.
Note: The O-D line symbols flow counterclockwise to indicate the O-D pair direction.

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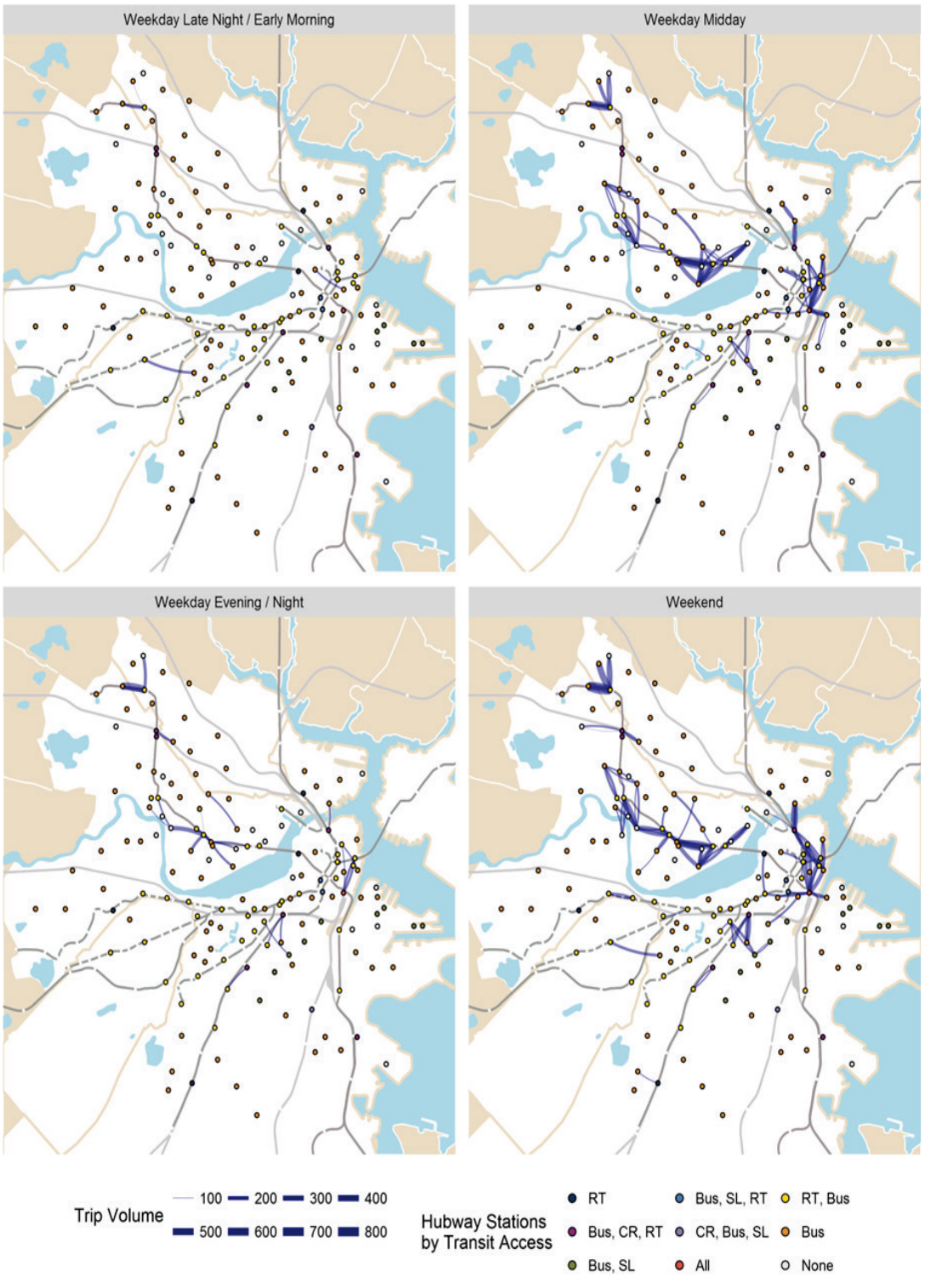
FIGURE 4-17
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday AM and PM Peak Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare



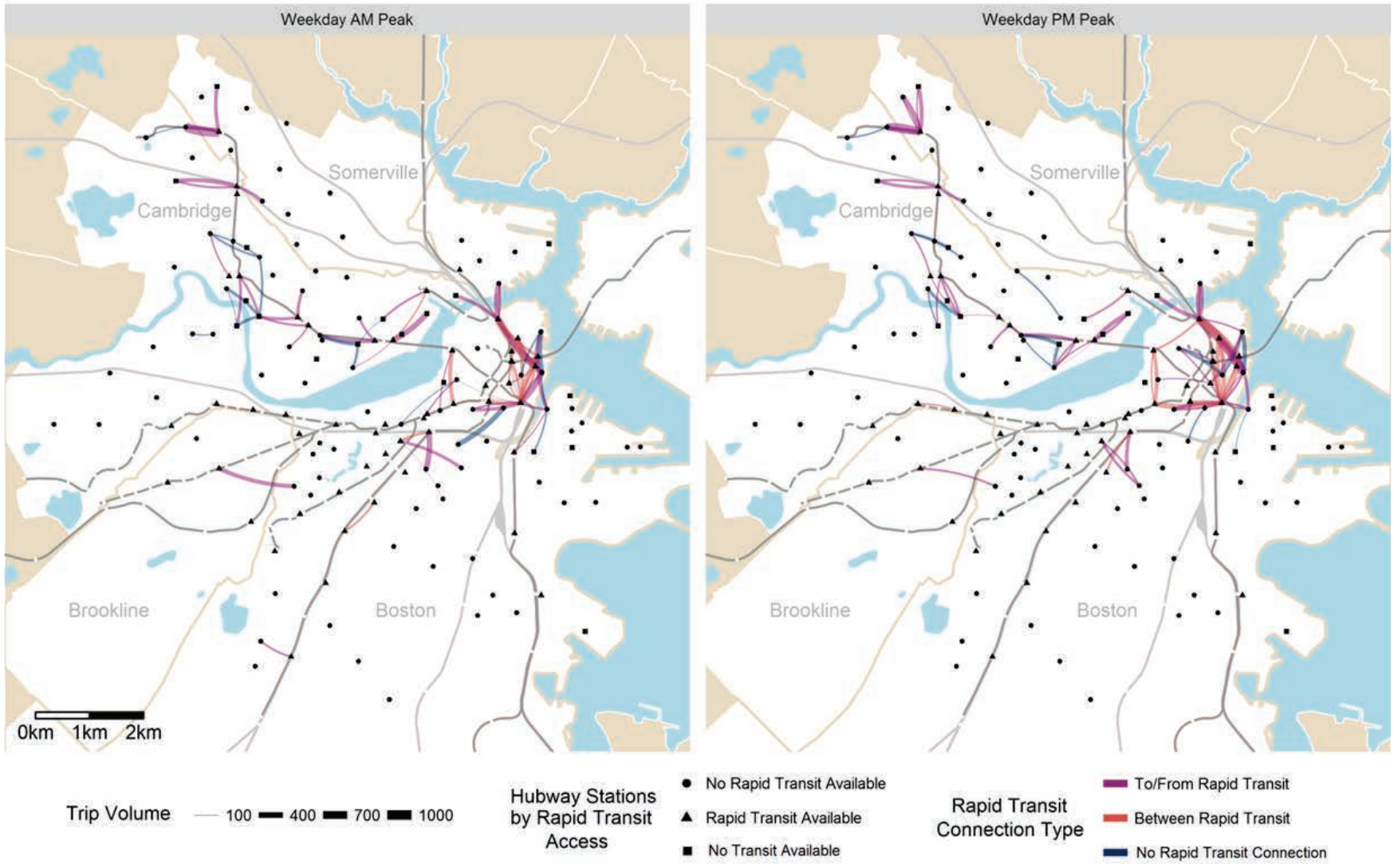
Data sources: 2015 Hubway trip logs and station locations (4/17/2015–12/18/2015), OTP output, and CTPS GIS analysis.
See Appendix B for information on station classifications.
See Appendix G for more information on O-D pairs.
Note: The O-D line symbols flow counterclockwise to indicate the O-D pair direction.

CTPS N

FIGURE 4-18
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Off-Peak and Weekend Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare

CTPS analyzed which O-D pairs with large shares of walk-only trips might complement transit by helping riders connect to stations, specifically those serving rapid transit. As shown in Figure 2-21, more than half of Hubway member survey respondents reported making at least one trip that ended near a rapid transit station during a typical week. To identify this subset of O-D pairs, CTPS examined the transit modes that were near the origin and destination stations of each O-D pair. Figures 4-19 and 4-20 take the O-D pairs shown in Figures 4-17 and 4-18 and classify them by whether they include zero, one, or two trip ends at a rapid transit station.



Data sources: 2015 Hubway trip logs and station locations (4/17/2015–12/18/2015), OTP output, and CTPS GIS analysis.
See Appendix B for information on station classifications.
See Appendix G for more information on O-D pairs.
Note: The O-D line symbols flow counterclockwise to indicate the O-D pair direction.

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FIGURE 4-19
O-D Pairs with 95 Percent or More Walk-Only Trips by Connections to Rapid Transit (Weekday AM and PM Peak Periods)

Exploring Shared-Use Mobility through Hubway Bikeshare

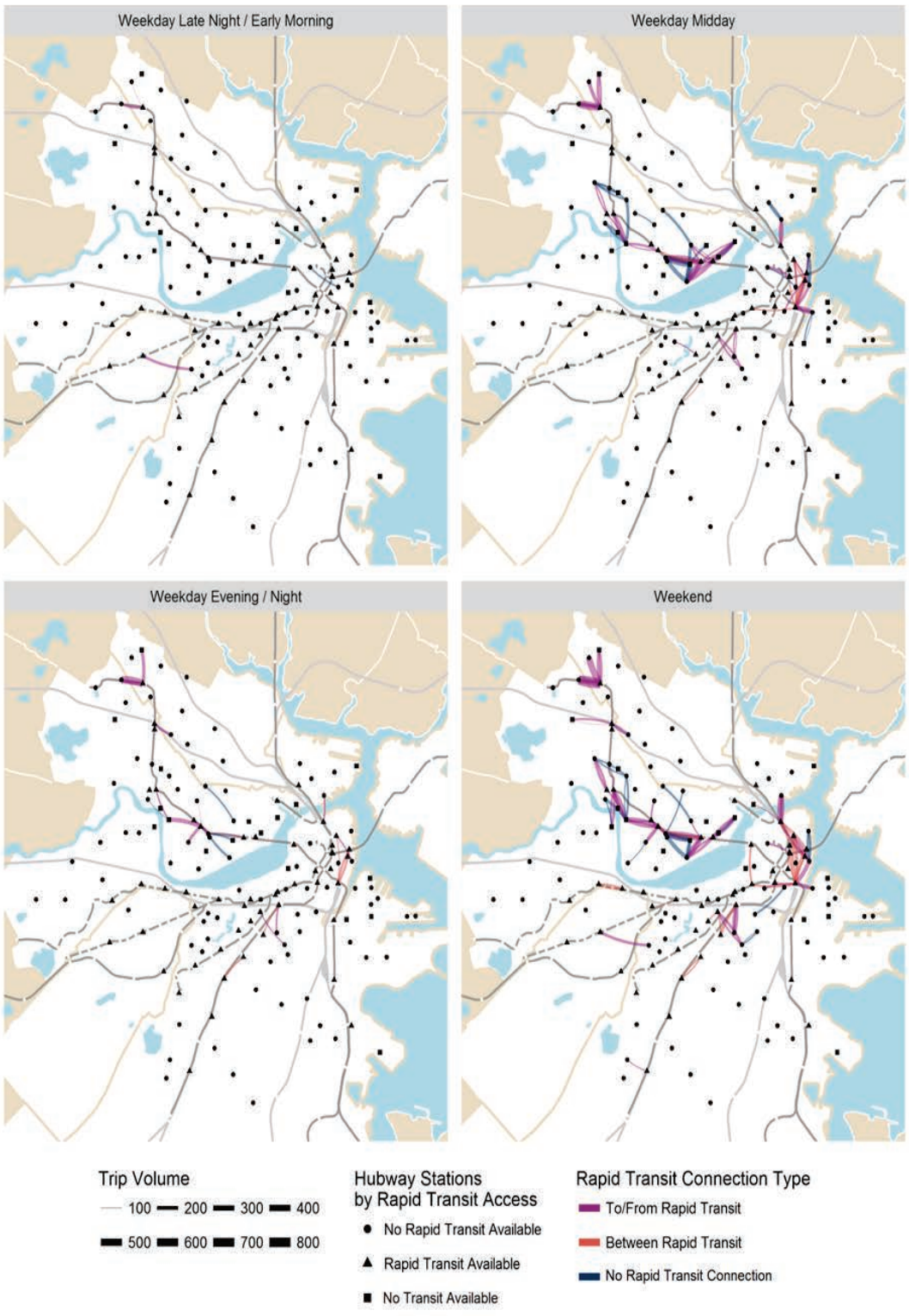


FIGURE 4-20

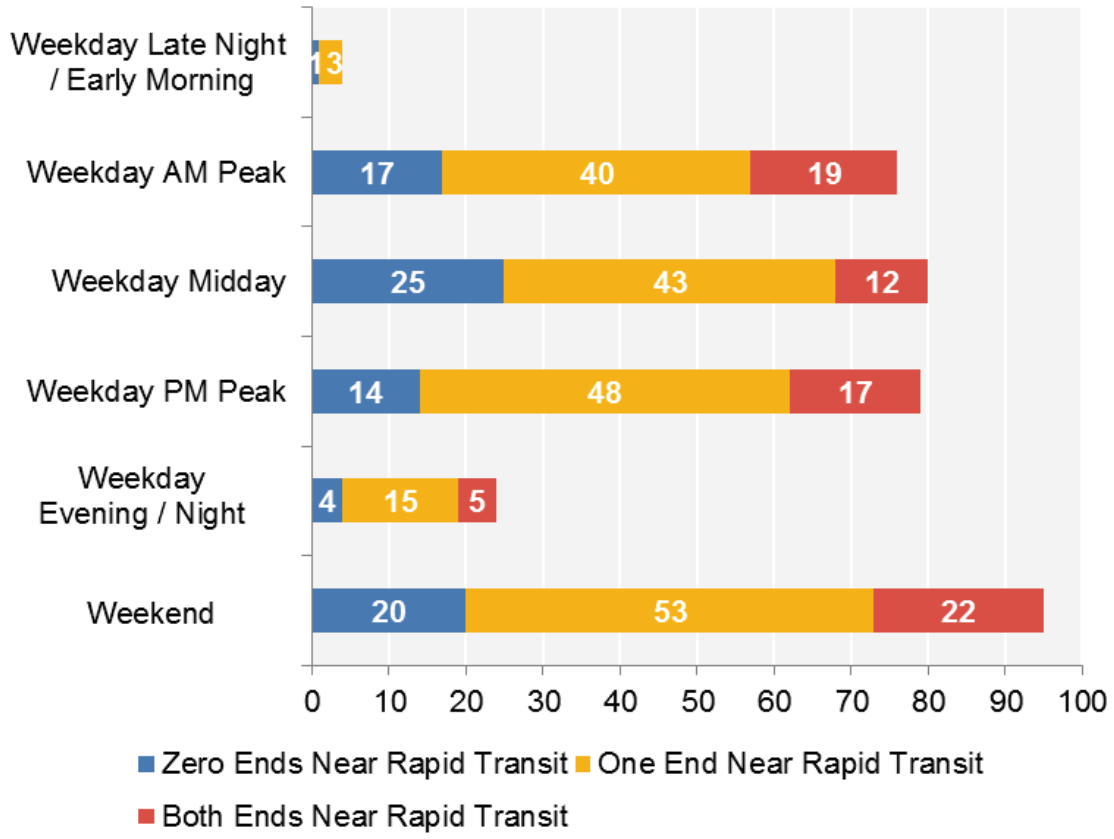
O-D Pairs with 95 Percent or More Walk-Only Trips by Connections to Rapid Transit (Weekday Off-Peak and Weekend Periods)

CTPS N

Exploring Shared-Use Mobility through Hubway Bikeshare

Figure 4-21 shows the number of O-D pairs in each day-or-time period that have zero, one, or both ends near a rapid transit station. High-volume O-D pairs that 1) are almost exclusively made up of walk alternative trips, and 2) have one trip end at a rapid transit station may support first-or-last-mile connections to rapid transit. Trips between O-D pairs with no ends near rapid transit may close gaps in the transportation network by providing service where transit service does not exist and/or where it may not make sense to provide fixed-route transit service. More analysis of trips between origins and destinations that each are near rapid transit would be needed to determine whether these trips might complement or compete with transit. If the origin and destination Hubway stations each are near different rapid transit lines, Hubway trips between these points could help travelers avoid transit trips with transfers.

FIGURE 4-21
O-D Pairs with 95 Percent or More Walk-Only Trips
by Number of Ends within 200 Meters of Rapid Transit Stations



Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), OTP output, CTPS GIS analysis.
Note: O-D pairs may appear in multiple day/time periods.

It is important to note that OTP's algorithm determined whether to recommend a walk or transit alternative for a particular O-D pair using MBTA GTFS files that had been incorporated into the OTP implementation. This implementation does not include data for other transit services that may be operating in the Hubway service area—including Transportation Management Area, university, or other shuttles. If available data from these other services had been incorporated into OTP, it is possible that some of these O-D pairs would have had lower shares of walk alternative trips. That said, the fact that people are using Hubway to make these connections raises questions about whether people are aware of these other transit services or perceive them as being a preferable alternative to Hubway.

4.9 Summary of Findings

Section 3 describes when and where Hubway riders are making their trips, in terms of visits to stations or between O-D pairs. This information creates a context for the analysis in Section 4, which examines potential synergies and areas of competition between the Hubway system and the MBTA fixed-route transit system. CTPS used the ratio of Hubway travel time to the travel time from OTP's alternative itinerary for each trip as a basis for comparing the two modes in different circumstances.

Some of these synergies and potential areas of competition between Hubway and transit appear at the trip level (see Section 4.3).

- **Travel-time ratio:** Figure 4-1 showed that Open Trip Planner recommended a transit alternative that would have been a slower alternative than Hubway—accounting for waiting, in vehicle time, and time to transfer between vehicles—for about 40 percent of member trips, and a much slower (twice as long or longer) alternative for another 18 percent of trips. OTP recommended a walk-only alternative for another 31 percent of member trips. Hubway potentially provides a beneficial option for trips with much-slower and walk-only alternatives by helping people to make faster trips where it may not be cost effective or straightforward to improve transit alternatives. Meanwhile, for trips with slower transit alternatives (a travel-time ratio between 1.1 and 2), Hubway might offer travelers a way to get to their destinations faster, but it is less clear whether to encourage people to use Hubway instead of transit.

- **Alternative transit modes and itineraries with transfers.** When it suggested transit alternatives for Hubway trips, OTP recommended a bus-only alternative for about 53 percent of trips, and recommended alternatives that combined bus with rapid transit for another 16 percent of

trips (see Figure 4-3). While these OTP itineraries suggest that Hubway may be primarily replacing bus trips, as shown in Figures 4-2 and 4-3, a variety of mode combinations were included in OTP's alternatives for Hubway trips. Figure 4-7 showed that there were some, but not major, differences between the three top alternative mode combinations—bus, rapid transit, and bus and rapid transit—in terms of trips that were faster, comparable, or slower by transit. For 70 percent of member trips for which OTP recommended a transit alternative, the alternative itinerary did not include any transfers. This suggests for many Hubway trips, other factors besides trip complexity may motivate people to use Hubway instead of transit.

Sections 4.4 through 4.8 described how CTPS clustered trips into O-D pairs to explore trip flows based on time and geographic location. CTPS examined O-D pairs with larger-than-typical shares of trips with walk-only alternatives or transit alternatives that would have been faster, comparable to, slower, or much slower than the Hubway trips. The findings discussed in these sections generally highlight potentially complementary relationships between Hubway and MBTA fixed-route transit because Hubway might provide an alternative for

- Transit trips that may be uncomfortable because of passenger demand during peak periods
- Trips that otherwise would best be made by walking

However, Hubway O-D pairs with large shares of trips in the slower range (travel time ratio between 1 and 2) or much slower range (travel time ratio greater than 2), merit further exploration. Hubway trips that would have much slower transit alternatives may be able to complement transit if it would not make sense for the MBTA to improve transit service or provide other options on these links. More nuanced analyses would be needed to identify the potential for synergies or competition for O-D pairs where OTP generally identified slower or much slower transit alternatives.

This study provides one analytical perspective on how bike sharing and the fixed-route transit system interrelate by using evidence of when and where people have used the Hubway system to meet their travel needs. However, Hubway trip data by itself cannot provide complete information about how and why people chose to use Hubway instead of transit or other modes in specific circumstances. This study is limited in that it is inherently biased toward Hubway by only analyzing Hubway trips, which likely happen in places where Hubway is convenient and transit is not. The data do not make it possible to analyze cases when people might have chosen to use transit instead of Hubway. Moreover, CTPS's ability to identify possible alternatives to Hubway trips was limited by

having data only on the portions of trips between the Hubway stations, as discussed in Section 4.2. Without knowing the true origins and destinations of riders' full trips, or the purposes of their trips, it is not possible to identify an optimal itinerary definitively.

Future research could include a more detailed examination of the O-D pairs in Sections 4.6 to 4.8, in order to determine whether Hubway use on these links should be encouraged, or if transit service in these areas should be improved to make it more competitive. Other options include exploring the travel patterns of casual bikesharing users, including their potential to interact with other parts of the transportation system, particularly fixed-route transit. The methodology used in this report also could be adapted to compare the travel times of other point-to-point shared-use mobility services to transit.

APPENDIX A:
DATA USED IN ANALYSIS STAGES


Hubway Trips Used in Analysis Steps
All 2015 Trip Data: 1,122,000 trips
Used in: General 2015 trip trends (Sections 3.1, 3.2)
• Removed 45,000 trips before 4/17/2015 and after 12/18/2015
High Activity Season Trip Data: 1,077,000 trips
Used in: 2015 trip trends by user type and time period, and station data (Sections 3.2, 3.3)
• Removed 34,000 trips that have the same origin and destination
Active Period Trips with Different Origins and Destinations: 1,043,000 trips
Used in: General OD Pair analysis (Section 3.4)
Trips Processed through Open Trip Planner:
1,042,000 trips with itineraries
1,000 trips without itineraries
• Removed 219,000 casual user trips
• Removed 10,000 member trips identified as invalid, based on transit wait time or biking speed)
Trips Analyzed to Compare Hubway and Transit: 814,000 trips
Used in: Trip and OD Pair analysis and comparison with transit (Sections 4.3 – 4.8)
Note: Trip volumes have been rounded to the nearest 1,000 trips.

APPENDIX B:
STATION NAMES, ALIASES, AND VISIT DATA

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
Boston Stations:						
D32022	TD Garden - Causeway @ Portal Park #1 [a]	TD Garden	30,117	34,953	65,070	Bus, Commuter Rail, and Rapid Transit
A32010	South Station - 700 Atlantic Ave.	South Station	30,434	30,938	61,372	All
D32005	Boston Public Library - 700 Boylston St.	Boston Public Library	18,944	19,445	38,389	Bus and Rapid Transit
D32016	Charles Circle - Charles St. @ Cambridge St.	Charles Circle	17,285	16,823	34,108	Rapid Transit Only
C32003	Back Bay / South End Station	Back Bay / South End	16,473	15,637	32,110	Bus, Commuter Rail, and Rapid Transit
B32010	Kenmore Sq / Comm Ave	Kenmore Square	14,330	14,461	28,791	Bus and Rapid Transit
D32010	Cross St. @ Hanover St.	Cross St @ Hanover St	14,497	13,551	28,048	Bus and Rapid Transit
B32008	Old State House [b]	Old State House	14,217	13,364	27,581	Bus and Rapid Transit
B32016	Beacon St / Mass Ave	Beacon St @ Mass Ave	13,861	13,345	27,206	Bus Only
D32007	Boylston St. @ Arlington St.	Boylston St @ Arlington St	13,119	14,044	27,163	Bus and Rapid Transit
D32017	The Esplanade - Beacon St. @ Arlington St.	The Esplanade	13,204	12,914	26,118	None
C32008	Boylston @ Fairfield	Boylston St @ Fairfield St	12,646	12,664	25,310	Bus Only
D32000	Cambridge St. @ Joy St.	Cambridge St @ Joy St	12,826	12,436	25,262	Bus Only
C32007	Prudential Center / Belvidere	Prudential Center	12,404	12,697	25,101	Bus and Rapid Transit
D32008	Rowes Wharf - Atlantic Ave	Rowes Wharf	12,452	12,376	24,828	Bus Only
D32014	Tremont St / West St	Tremont St @ West St	12,226	12,218	24,444	Bus, Rapid Transit, and Silver Line
B32004	Aquarium Station - 200 Atlantic Ave.	Aquarium Station	12,206	11,733	23,939	Bus and Rapid Transit
B32005	Christian Science Plaza	Christian Science Plaza	11,729	11,500	23,229	Bus and Rapid Transit
B32018	Boylston / Mass Ave	Boylston St @ Mass Ave	11,328	11,235	22,563	Bus and Rapid Transit
D32012	Post Office Square	Post Office Square	10,841	11,171	22,012	Bus Only
D32006	Lewis Wharf - Atlantic Ave.	Lewis Wharf	11,101	10,663	21,764	Bus Only
D32021	Charlestown - Warren St @ Chelsea St	Charlestown: Warren St	11,227	10,531	21,758	Bus Only
B32000	Newbury St / Hereford St	Newbury St @ Hereford St	10,396	10,220	20,616	Bus and Rapid Transit
D32019	Boylston St / Washington	Boylston St @	10,165	10,342	20,507	Bus, Rapid Transit,

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
	St	Washington St				and Silver Line
D32004	Franklin St. / Arch St.	Franklin St @ Arch St	10,301	10,176	20,477	Bus and Rapid Transit
C32010	Congress / Sleeper	Congress St @ Sleeper St	9,617	10,732	20,349	Bus Only
B32011	Yawkey Way @ Boylston St.	Yawkey Way @ Boylston St	9,786	9,760	19,546	Bus Only
C32006	Washington St. @ Rutland St.	Washington St @ Rutland St	9,373	9,592	18,965	Bus and Silver Line
B32003	HMS / HSPH - Ave. Louis Pasteur @ Longwood Ave.	Harvard: HMS/HSPH	9,425	9,279	18,704	Bus Only
D32013	Boylston St / Berkeley St	Boylston St @ Berkeley St	8,866	9,388	18,254	Bus Only
C32000	Tremont St. @ Berkeley St.	Tremont St @ Berkeley St	9,395	8,857	18,252	Bus Only
D32024	Charles St @ Beacon St	Charles St @ Beacon St	9,353	8,863	18,216	Bus Only
D32002	Washington St. @ Waltham St.	Washington St @ Waltham St	9,103	9,077	18,180	Bus and Silver Line
C32002	Boston Medical Center - East Concord @ Harrison Ave	Boston Medical Center	8,913	9,037	17,950	Bus Only
A32002	Agganis Arena - 925 Comm Ave.	Agganis Arena	8,423	8,688	17,111	Bus and Rapid Transit
D32015	Chinatown Gate Plaza - Surface Rd. @ Beach St.	Chinatown Gate Plaza	8,240	8,717	16,957	Bus Only
A32004	Longwood Ave / Binney St	Longwood Ave @ Binney St	7,783	8,798	16,581	Bus Only
C32004	Columbus Ave. @ Mass. Ave.	Columbus Ave @ Mass Ave	8,551	7,688	16,239	Bus and Rapid Transit
B32015	Landmark Centre	Landmark Center	7,662	7,870	15,532	Bus Only
D32011	Stuart St. @ Charles St.	Stuart St @ Charles St	7,606	7,708	15,314	Bus Only
A32012	Packard's Corner - Comm. Ave. @ Brighton Ave.	Packard's Corner	7,730	7,512	15,242	Bus and Rapid Transit
A32009	Tremont St / W Newton St	Tremont St @ W Newton St	7,950	7,177	15,127	Bus Only
A32003	B.U. Central - 725 Comm. Ave.	BU Central	7,172	7,544	14,716	Bus and Rapid Transit
B32014	Seaport Hotel	Seaport Hotel	7,345	7,047	14,392	Bus and Silver Line
A32013	John F Fitzgerald - Surface Road @ India Street	John F Fitzgerald - Surface Rd	7,021	7,263	14,284	Bus and Rapid Transit
D32009	Faneuil Hall - Union St. @ North St.	Faneuil Hall	7,257	7,016	14,273	Bus and Rapid Transit
A32008	Buswell St. @ Park Dr.	Buswell St @	6,777	7,028	13,805	Bus and Rapid

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
		Park Dr				Transit
A32006	Harvard University Housing - 111 Western Ave. @ Soldiers Field Park	Harvard Housing: Western Ave	6,502	6,308	12,810	None
B32002	Ruggles Station / Columbus Ave.	Ruggles Station	6,313	6,397	12,710	Bus, Commuter Rail, and Rapid Transit
B32007	Seaport Square - Seaport Blvd. @ Boston Wharf	Seaport Square	6,528	6,112	12,640	Bus Only
B32012	Northeastern U / North Parking Lot	Northeastern	6,121	6,239	12,360	Bus and Rapid Transit
D32027	New Balance Store - Boylston @ Dartmouth	New Balance: Boylston St	5,764	5,849	11,613	Bus and Rapid Transit
D32020	Charlestown - Main St @ Austin St	Charlestown: Main St	5,954	5,500	11,454	Bus Only
C32025	Ink Block	Ink Block	5,677	5,736	11,413	Bus and Silver Line
B32013	Brigham Cir / Huntington Ave	Brigham Circle	5,291	5,118	10,409	Bus and Rapid Transit
C32024	State Street @ Channel Center	State Street	5,133	5,178	10,311	None
B32006	Colleges of the Fenway	Colleges of the Fenway	5,017	5,004	10,021	Bus Only
A32019	Harvard University Transportation Services - 175 North Harvard St	Harvard: Transportation Services	5,066	4,843	9,909	Bus Only
D32023	Spaulding Rehabilitation Hospital - Charlestown Navy Yard	Spaulding Hospital: Charlestown Navy Yard	4,894	5,009	9,903	None
A32000	Fan Pier	Fan Pier	4,668	5,231	9,899	None
A32017	Allston Green District - Commonwealth Ave & Griggs St	Allston Green District	5,123	4,529	9,652	Rapid Transit Only
D32018	Boston Convention & Exhibition Center	BCEC	4,756	4,632	9,388	Bus and Silver Line
C32016	West Broadway @ Dorchester St	W Broadway @ Dorchester St	4,846	4,363	9,209	Bus Only
C32017	South Boston Library - 646 East Broadway	South Boston Library	4,352	4,562	8,914	Bus Only
C32001	Roxbury Crossing Station	Roxbury Crossing Station	4,244	4,015	8,259	Bus and Rapid Transit
C32021	ID Building West	ID Building W	3,844	3,957	7,801	Bus and Silver Line
A32001	Union Square - Brighton Ave. @ Cambridge St.	Union Square: Brighton Ave	3,662	3,723	7,385	Bus Only
C32009	Dorchester Ave. @ Gillette Park	Dorchester Ave @ Gillette Park	3,542	3,554	7,096	Bus and Rapid Transit
E32003	Hyde Square @ Barbara St	Hyde Square	3,458	3,131	6,589	Bus Only

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
C32020	ID Building East	ID Building E	3,221	3,341	6,562	Bus and Silver Line
E32005	Green St T	Green Street Station	3,133	3,270	6,403	Rapid Transit Only
A32011	Innovation Lab - 125 Western Ave. @ Batten Way	Innovation Lab: Western Ave	3,065	3,174	6,239	Bus Only
E32006	Jackson Square T @ Centre St	Jackson Square Station	3,142	2,932	6,074	Bus and Rapid Transit
B32020	BIDMC - Brookline @ Burlington St	BIDMC - Brookline	2,888	3,105	5,993	Bus Only
C32005	Washington St. @ Lenox St.	Washington St Lenox Street	2,748	2,826	5,574	Bus and Silver Line
C32012	Andrew Station - Dorchester Ave @ Humboldt Pl	Andrew Station	2,689	2,533	5,222	Bus and Rapid Transit
D32026	Hayes Square @ Vine St.	Hayes Square	2,445	2,612	5,057	Bus Only
E32002	JP Center - Centre Street @ Myrtle Street	JP Center	2,094	2,288	4,382	Bus Only
A32005	Harvard Real Estate - Brighton Mills - 370 Western Ave	Harvard Real Estate - Brighton Mills - 370 Western Ave	2,012	2,136	4,148	Bus Only
E32001	JP Monument - South St @ Centre St	JP Monument	2,053	2,059	4,112	Bus Only
B32017	Dudley Square	Dudley Square	1,601	1,602	3,203	Bus and Silver Line
C32013	JFK / UMASS Station	JFK / UMASS Station	1,431	1,610	3,041	Bus, Commuter Rail, and Rapid Transit
D32001	New Balance - 20 Guest St.	New Balance: Guest St	1,235	1,297	2,532	Bus Only
C32022	Newmarket Square	Newmarket Square	1,183	1,308	2,491	Commuter Rail, Bus, and Silver Line
E32004	Egleston Square @ Columbus Ave	Egleston Square	1,128	881	2,009	Bus Only
C32018	E. Cottage St @ Columbia Rd	E Cottage St @ Columbia Road	703	776	1,479	Bus Only
B32021	Wentworth Institute of Technology	Wentworth IT	711	705	1,416	Bus and Rapid Transit
C32019	Upham's Corner - Ramsey St @ Dudley St	Upham's Corner	761	609	1,370	Bus Only
C32029	West Broadway @ D Street	W Broadway @ D St	670	690	1,360	Bus Only
C32014	UMass Boston Integrated Sciences Complex	UMass Boston ISC	648	650	1,298	None
C32015	Mt Pleasant Ave / Dudley Town Common	Dudley Town Common	625	566	1,191	Bus Only
A32022	Main Street @ Eden Street Park	Main St @ Eden St Park	614	552	1,166	Bus Only
C32028	Lawn on D	Lawn on D	535	493	1,028	None

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Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
A32023	Bunker Hill Community College	Bunker Hill CC	252	226	478	Rapid Transit Only
D32028	Brighton Center	Brighton Center	202	197	399	Bus Only
E32007	Heath St @ South Huntington	Heath St @ S Huntington Ave	191	142	333	Bus and Rapid Transit
D32029	Washington St @ Brock St	Washington St @ Brock St	116	127	243	Bus Only
C32031	Ryan Playground - Dorchester Avenue Station	Ryan Playground	88	100	188	Bus Only
X32999	Dorrance Warehouse	Dorrance Warehouse	45	104	149	No Data
C32027	Franklin Park - Seaver Street @ Humbolt Ave	Franklin Park	65	39	104	Bus Only
C32030	Franklin Park Zoo	Franklin Park Zoo	42	35	77	Bus Only
Brookline Stations:						
K32001	Coolidge Corner - Beacon St @ Centre St	Coolidge Corner	6,213	6,197	12,410	Bus and Rapid Transit
K32003	Brookline Village - Station Street @ MBTA	Brookline Village	4,017	4,217	8,234	Bus and Rapid Transit
K32004	JFK Crossing @ Harvard St. / Thorndike St.	JFK Crossing	3,348	2,860	6,208	Bus Only
K32002	Washington Square @ Washington St. / Beacon St.	Washington Square	3,193	2,584	5,777	Bus and Rapid Transit
Cambridge Stations:						
M32006	MIT @ Mass Ave / Amherst St	MIT: Mass Ave	26,511	26,630	53,141	Bus Only
M32018	Harvard Square @ Mass Ave/ Dunster	Harvard Square: Mass Ave @ Dunster St	20,856	21,538	42,394	Bus and Rapid Transit
M32011	Central Square @ Mass Ave / Essex St	Central Square	19,011	18,603	37,614	Bus and Rapid Transit
M32009	Lafayette Square @ Mass Ave / Main St / Columbia St	Lafayette Square	17,832	17,563	35,395	Bus Only
M32005	MIT Stata Center @ Vassar St / Main St	MIT: Stata Center	14,919	19,626	34,545	None
M32003	One Broadway / Kendall Sq @ Main St / 3rd St	One Broadway / Kendall Square	13,419	12,928	26,347	Bus and Rapid Transit
M32037	Ames St @ Main St	Ames St @ Main St	12,267	12,666	24,933	Bus and Rapid Transit
M32012	Central Sq Post Office / Cambridge City Hall @ Mass Ave / Pleasant St	Cambridge City Hall	12,414	11,964	24,378	Bus and Rapid Transit
M32002	One Kendall Square @ Hampshire St / Portland	One Kendall Square	12,312	11,818	24,130	Bus Only

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
	St					
M32010	Inman Square @ Vellucci Plaza / Hampshire St	Inman Square	11,250	10,308	21,558	Bus Only
M32001	Lechmere Station @ Cambridge St / First St	Lechmere Station	9,969	10,087	20,056	Bus and Rapid Transit
M32022	Lower Cambridgeport @ Magazine St/Riverside Rd	Lower Cambridgeport	9,962	9,905	19,867	Bus Only
M32017	Harvard Square @ Brattle St / Eliot St	Harvard Square: Brattle St	9,698	9,907	19,605	Bus and Rapid Transit
M32029	Porter Square Station	Porter Square Station	9,636	9,239	18,875	Bus, Commuter Rail, and Rapid Transit
M32019	CambridgeSide Galleria - CambridgeSide PL @ Land Blvd	CambridgeSide Galleria	9,085	9,548	18,633	None
M32007	Cambridge St - @ Columbia St / Webster Ave	Cambridge St @ Columbia St	8,958	8,371	17,329	Bus Only
M32021	Harvard University Gund Hall @ Quincy St / Kirkland S	Harvard: Gund Hall	8,457	8,539	16,996	Bus Only
M32014	Harvard University Housing - 115 Putnam Ave @ Peabody Terrace	Harvard Housing: Putnam Ave	8,695	7,870	16,565	None
M32013	Cambridge Main Library @ Broadway / Trowbridge St	Cambridge Main Library	8,301	8,241	16,542	Bus Only
M32016	Harvard Kennedy School @ Bennett St / Eliot St	Harvard Kennedy School	7,210	7,697	14,907	Bus Only
M32026	359 Broadway - Broadway @ Fayette Street	359 Broadway	7,751	6,764	14,515	Bus Only
M32023	Harvard University / SEAS Cruft-Pierce Halls @ 29 Oxford St	Harvard: SEAS Cruft-Pierce Halls	6,939	6,957	13,896	None
M32027	Binney St / Sixth St	Binney St @ Sixth St	6,472	6,428	12,900	None
M32032	Kendall Street	Kendall Street	6,041	6,066	12,107	None
M32038	Harvard University River Houses @ DeWolfe St / Cowperthwaite St	Harvard: River Houses	5,853	5,819	11,672	None
M32030	Dana Park	Dana Park	5,893	5,402	11,295	Bus Only
M32020	Harvard Law School @ Mass Ave / Jarvis St	Harvard Law School	5,683	5,575	11,258	Bus Only
M32024	Harvard University Radcliffe Quadrangle @ Shepard St / Garden St	Harvard: Radcliffe Quadrangle	5,571	5,488	11,059	Bus Only
M32034	EF - North Point Park	EF - North Point Park	5,359	5,271	10,630	None

TABLE B-1
Hubway Station Details

Hubway Station Number	Original Hubway Station Name	Hubway Station Alias	4/17/2015 to 12/18/2015 Trip Origins from Station	Trip Destinations at Station	Total Station Visits	Transit Options within 200 Meters
M32025	Linear Park - Mass. Ave. @ Cameron Ave.	Linear Park: Mass Ave @ Cameron Ave	5,185	5,003	10,188	Bus Only
M32033	Alewife Station @ Russell Field	Alewife Station	3,194	3,322	6,516	Bus Only
M32031	Danehy Park	Danehy Park	2,564	2,517	5,081	None
M32036	Rindge Avenue - O'Neill Library	Rindge Ave	1,289	1,349	2,638	Bus Only
M32041	MIT Pacific St @ Purrington St	MIT: Pacific St	1,029	943	1,972	None
M32042	MIT Vassar St	MIT: Vassar St	766	709	1,475	Bus Only
M32040	University Park	University Park	748	667	1,415	Bus Only
M32039	Lesley University	Lesley Univ	236	264	500	Bus, Commuter Rail, and Rapid Transit
M32043	Mt Auburn	Mt Auburn	207	196	403	Bus Only
Somerville Stations:						
S32006	Davis Square	Davis Square	10,027	11,662	21,689	Bus and Rapid Transit
S32002	Union Square - Somerville	Union Square: Somerville	6,122	6,460	12,582	Bus Only
S32004	Conway Park - Somerville Avenue	Conway Park	5,321	5,242	10,563	Bus Only
S32003	Beacon St @ Washington / Kirkland	Beacon St @ Washington St	4,617	4,375	8,992	Bus Only
S32005	Wilson Square	Wilson Square	3,756	3,521	7,277	Bus Only
S32011	Teele Square @ 239 Holland St	Teele Square	3,258	2,108	5,366	Bus Only
S32010	Somerville Hospital @ Highland Ave / Crocker St	Somerville Hospital	2,387	1,670	4,057	Bus Only
S32001	Somerville City Hall	Somerville City Hall	2,051	1,781	3,832	Bus Only
S32009	Packard Ave / Powderhouse Blvd	Packard Ave @ Powderhouse Blvd	1,861	1,780	3,641	None
S32012	Summer St @ Cutter St	Summer St @ Cutter St	1,563	1,773	3,336	Bus Only
S32008	Powder House Circle - Nathan Tufts Park	Powder House Circle	1,699	1,589	3,288	Bus Only
S32013	Magoun Square @ Trum Field	Magoun Square	1,266	1,349	2,615	Bus Only

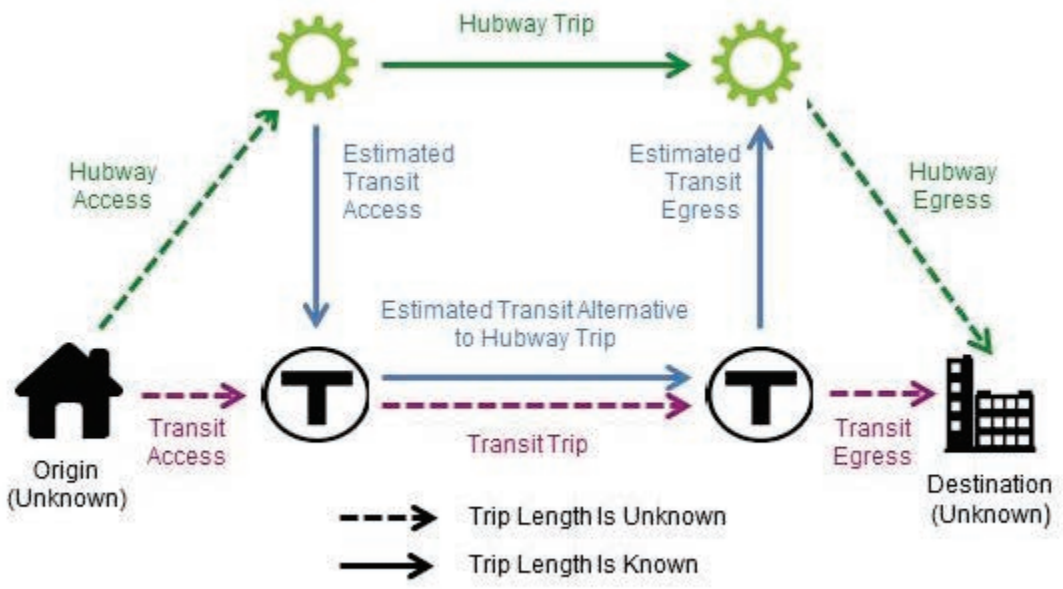
Data Source: 2015 Hubway trip logs (4/17/2015-12/18/2015) and CTPS GIS analysis.
[a] Data for TD Garden - Causeway at Portal Park #1 reflects data for both the TD Garden - Causeway at Portal Park #1 and the TD Garden and the TD Garden - Causeway at Portal Park #2 stations. These stations were combined given their close proximity. [b] Data for Old State House reflects data for both the Old State House and the Mayor Martin J Walsh - 28 State St. stations. These stations were combined given their close proximity.
CTPS = Central Transportation Planning Staff. O-D = Origin-Destination.

APPENDIX C:
ADJUSTING TRANSIT TRAVEL TIME ESTIMATES TO MITIGATE BIAS

As discussed in Section 4.1, CTPS sought a strategy to mitigate the biases that arise when modeling and calculating the travel time of alternative transit trips so that they can be compared to Hubway trips. The Hubway trip data used in this analysis only included the portion of each Hubway trip from when a rider picked up a bicycle at the origin Hubway station to when she dropped it off at the destination Hubway station. The rider's true origin (for example, her home), her true destination (for example, her workplace), and the distance she traveled between these locations and Hubway stations are all unknown. The Hubway station coordinates were the only data that CTPS could use to identify the locations associated with a Hubway trip and to model an alternative transit trip. However, using the Hubway stations as trip start-and-end points systematically underestimates the total time of the Hubway trip. Also, using these stations as start-and-end points for an alternative transit trip may overestimate or underestimate travel time by transit, depending on the locations of the rider's true origin and destination.

Figure C-1 illustrates a scenario where setting Hubway trip origins and destinations at Hubway stations overestimates the travel time of the alternative transit trip.

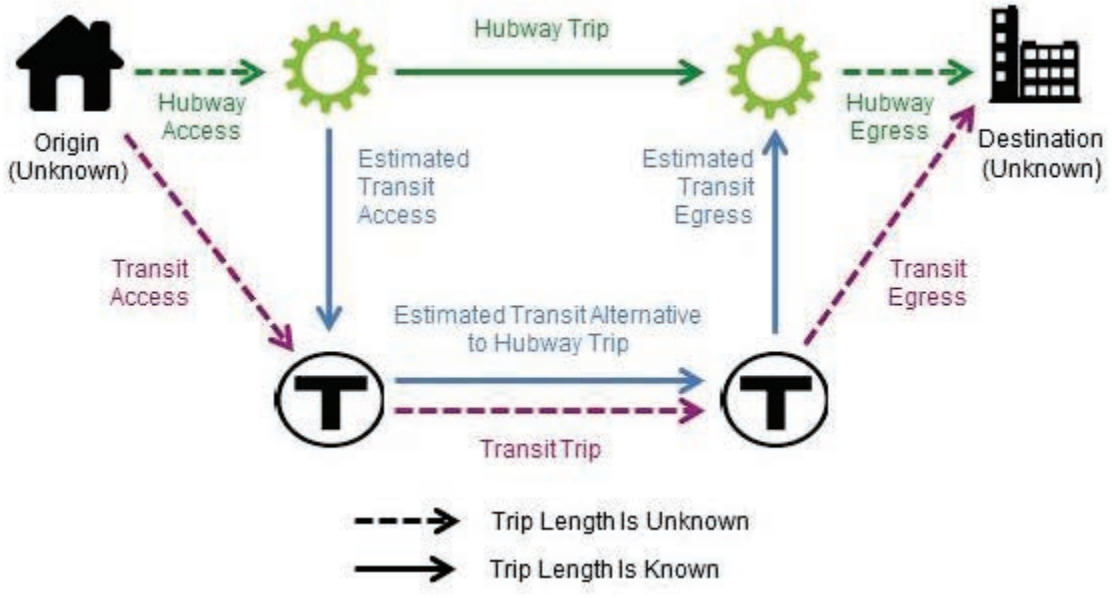
FIGURE C-1
Scenario 1: Underestimating Hubway Travel Time and Overestimating Transit Travel Time



In scenario shown in Figure C-1, the true origin and true destination locations are closer to transit stations than to Hubway stations. In the diagram, the solid green arrow corresponds to the recorded Hubway trip between the two stations, while the dashed green arrows represent the trips of unknown distance that the rider would need to make from her origin to the first Hubway station and from the second Hubway station to her true destination. The blue arrows represent an estimated alternative transit trip that starts and ends at the Hubway stations, and includes walk trips between the Hubway stations and transit stations. The dashed purple arrows represent a transit alternative for making the complete trip that does not involve stopping at Hubway stations. In this hypothetical situation, by using Hubway stations as proxies for the true origin and destination, CTPS underestimated the total Hubway trip time—because the trips to and from Hubway stations are not included—and overestimated the amount of time needed to access and egress transit, thereby overestimating total transit travel time.

Figure C-2 illustrates a scenario where setting Hubway trip origins and destinations at Hubway stations underestimates the travel time of the alternative transit trip.

FIGURE C-2
Scenario 2: Underestimating Hubway Travel Time and Underestimating Transit Travel Time

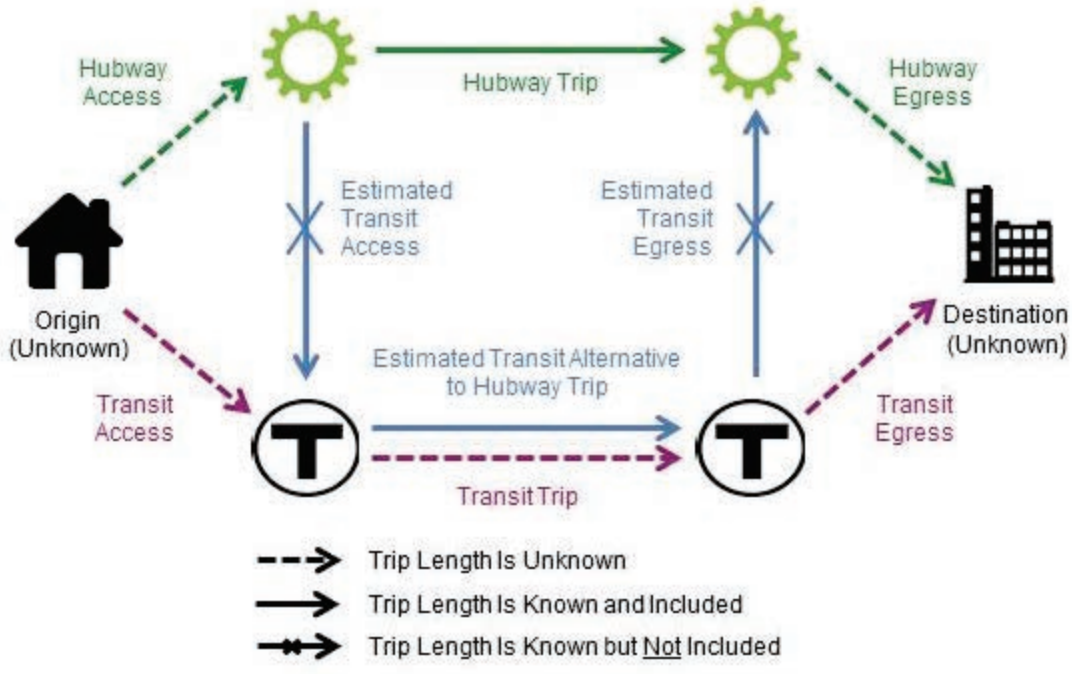


In this hypothetical case, the rider's true origin and true destination are closer to Hubway stations than to transit stations. Using Hubway stations to represent the origin and destination underestimates the amount of time needed to access and

egress transit stations, and thereby underestimates total transit travel time. Also, as in the first scenario, the Hubway trip does not account for the walk access and walk egress trips between the true origin and destination and Hubway stations, which would lead to underestimating total Hubway travel time.

For this analysis described in Section 4, CTPS assumed that the actual start and end points of Hubway trips have a random geographic distribution with respect to Hubway stations and transit stations. If the trips represented by the Hubway data are considered in aggregate, the sums of the variations in walking time to and from Hubway stations (dashed green arrows) would be cancelled out by the sums of the variations in walking time to and from transit stations (dashed purple arrows). Using this assumption, CTPS removed walk access and walk egress time from OTP's transit travel time estimates, in order to compare a Hubway trip's travel time with the travel time of OTP's transit alternative more fairly. Figure C-3 illustrates the effect of CTPS's approach.

FIGURE C-3
Results of CTPS Approach



This approach has a noticeable quantitative impact on estimates of transit travel time, as walk access and egress time make up about 38 percent of all transit travel time for OTP's recommended transit alternatives to Hubway trips, on average. However, in the absence of more detailed trip information, CTPS believes this is the best option to correct for the systematic bias introduced by using Hubway stations as proxies for actual trip origins and destinations.

APPENDIX D:
METHODS USED TO ESTIMATE UNCOMFORTABLE CONDITIONS

CTPS used the following resources to identify evidence of uncomfortable conditions on alternative transit routes identified in Section 4.6, "Results for Origin Destination Pairs with Large Shares of Trips that are Faster or Comparable by Transit":

Point-Checks for MBTA Bus Routes

Data tabulators count bus passengers at the maximum load point for bus trips traveling either inbound or outbound during peak periods. These data-collection activities are referred to as point checks. If the passenger load at the point check falls between 100 and 140 percent of seated bus capacity, the trip is considered overburdened. If the load at the point check is greater than 140 percent of seated capacity, the trip is considered overcrowded. CTPS reviewed fall 2015 point-check data for bus routes that could provide substitute service for a Hubway O-D pair. If the point-check location fell within the bus route segment that would serve as a transit alternative for a particular Hubway O-D pair, CTPS counted the number and share of overcrowded or overburdened bus trips during the relevant peak period. If the point-check data showed that more than 50 percent of trips for a given route were overcrowded or overburdened during the peak period (AM or PM), then CTPS considered this information to be evidence of uncomfortable conditions on that route.

Percentage of Passenger Time in Comfortable Conditions on MBTA Bus Routes

To understand passenger comfort levels on MBTA bus routes better, the MBTA has calculated the ratio of comfortable passenger time to total passenger time for each route during the course of the day using data for average weekdays in fall 2015 from its busload dataset.[46] This data—which is in active development and is considered experimental—combines average trip loads from on-bus automated passenger counter (APC) data and information on boarding and alighting locations from the MBTA's ODX model. During high-volume periods, whenever passenger loads exceeded 140 percent of seated capacity, then all passengers were considered as being uncomfortable.[47]

[46] A version of this measure was initially proposed by Christopher Southwick (see Southwick, C. *Understanding Bus Passenger Crowding through Origin Destination Inference.* 2016. file:///C:/Users/mscott/Downloads/958279515-MIT%20(2).pdf, accessed January 27, 2017, p. 101-103.) The MBTA has since changed the definition and modeling of this measure.

[47] Outside of 6:00-8:59 AM and 1:30-6:29 PM, standees that experienced less severe crowding were also counted as being uncomfortable.

In its current Service Delivery Policy, the MBTA set a minimum threshold of 92 percent of passenger minutes in comfortable conditions for its bus routes.[48] CTPS queried bus crowding data from fall 2015 for the MBTA's relevant bus routes and directions (inbound or outbound) during the peak periods (when information was available), and documented the percentage for the overall routes, as this ratio is the most meaningful at the route level. When a relevant bus route failed to meet the minimum threshold (92 percent) during the relevant peak period, CTPS noted this as possible evidence of uncomfortable conditions on that bus route. CTPS also gathered information for relevant route segments that that would support transit alternatives for Hubway O-D pairs during the AM and PM peak periods. When a bus route failed to meet the minimum threshold during these periods on at least one part of these segments, then CTPS noted this as possible evidence of uncomfortable conditions on that segment.

Rapid Transit System Flow Data

CTPS reviewed MBTA disaggregate automated fare collection data from May 10–12, 2016.[49] This data had been processed through CTPS's CCARD2OD model, which infers origins and destinations on the rapid transit system. This data showed the average passenger load on trains departing from rapid transit stations, by line, for each hour of the day.

To determine whether loads at specific rapid transit stations might indicate uncomfortable conditions, CTPS estimated the passenger capacity per hour for specific rapid transit lines. The passenger capacity per train was estimated using standards for total passenger vehicle loads on rapid transit during peak periods, which are listed in the MBTA's Service Delivery Policy. These vehicle loads were multiplied by an estimated number of cars per train, as shown in Table D-1.

[48] MBTA. *MBTA Service Delivery Policy,* 2017, http://www.mbta.com/uploadedfiles/About_the_T/Board_Meetings/MBTA%20Service%20Delivery%20Policy%202017%20FINAL.pdf, accessed January 26, 2017, p. 26-27.

[49] One limitation of this data is that it reflects 2016 fare system use, while the Hubway trips for this study were made during 2015. Government Center station was closed when the Hubway trips were made in 2015, but was open when the AFC data was collected in 2016.

TABLE D-1
Estimated Passenger Capacity for Rapid Transit Trains during Peak Periods

Line	Total Passenger Load Capacity per Vehicle	Estimated Cars per Train	Estimated Total Passenger Load Capacity per Train
Red	165	6	990
Orange	141	6	846
Blue	86	6	516
Green	100	2	200

Data source for passengers per vehicle: MBTA, *MBTA Service Delivery Policy*, p. 45.

CTPS then multiplied these values by an estimated number of trains per hour on different lines (accounting for direction) of the rapid transit system, as shown in Table D-2.

TABLE D-2
Estimated Passenger Capacity per Hour on Rapid Transit

Line	Segment	Trains Per Hour (All Relevant Lines)	Estimated Total Passenger Load Capacity per Train	Estimated Passenger Load Capacity Per Hour
Red	Alewife to JFK U-Mass (Ashmont, Braintree)	13	990	13,200
Red	JFK U-Mass to Braintree	7	990	6,600
Red	JFK U-Mass to Ashmont	7	990	6,600
Red	Braintree to JFK/U-Mass	7	990	6,600
Red	Ashmont to JFK/U-Mass	7	990	6,600
Red	JFK/UMass to Alewife (Ashmont, Braintree)	13	990	13,200
Orange	Oak Grove to Forest Hills	10	846	8,460
Orange	Forest Hills to Oak Grove	10	846	8,460
Green	Lechmere to North Station (E)	10	200	2,000
Green	North Station to Park St (C, E)	20	200	4,000
Green	Park Station to Copley (B, C, D, E)	40	200	8,000
Green	Copley to Kenmore (B, C, D)	30	200	6,000
Green	Copley to Symphony (E)	10	200	2,000
Green	Surface B Line to Boston College	10	200	2,000
Green	Surface C Line to	10	200	2,000

TABLE D-2
Estimated Passenger Capacity per Hour on Rapid Transit

Line	Segment	Trains Per Hour (All Relevant Lines)	Estimated Total Passenger Load Capacity per Train	Estimated Passenger Load Capacity Per Hour
	Cleveland Circle			
Green	Surface D Line to Riverside	10	200	2,000
Green	Surface E Line to Heath Street	10	200	2,000
Green	North Station to Lechmere (E)	10	200	2,000
Green	Park to North Station (C, E)	20	200	4,000
Green	Copley to Park (B, C, D, E)	40	200	8,000
Green	Kenmore to Copley (B, C, D)	30	200	6,000
Green	Symphony to Copley (E)	10	200	2,000
Green	Surface B Line to Kenmore	10	200	2,000
Green	Surface C Line to Kenmore	10	200	2,000
Green	Surface D Line to Kenmore	10	200	2,000
Green	Surface E Line to Copley	10	200	2,000

Data source for rapid transit service frequencies by line: MBTA Rapid Transit schedule: December 31, 2017 to March 24, 2017, http://www.mbta.com/uploadedFiles/Documents/Schedules_and_Maps/Subway/frequency-schedule.pdf, accessed January 26, 2017, p. 2.
Note: These frequencies were used to calculate the trains per hour, which have been rounded to the nearest whole number of trains in this table.

CTPS noted that there could be uncomfortable conditions on trains departing from a particular station at a particular hour if the ratio between the average load at that station and the total passenger capacity of the relevant rapid transit line was greater than 0.6 for that hour.[50] This threshold was selected because at this level, the passenger loads would be at least 125 percent of seated capacity on all transit lines. It also allows for some variations in passenger loads on individual trains that may pass through a station during a one-hour period. CTPS noted that there could be uncomfortable conditions on a rapid transit segment that would provide an alternative for a Hubway O-D pair if that segment included at least one station meeting the 0.6 ratio threshold during at least one hour of the AM or PM peak period.

Commuter Rail Data

In 2012, CTPS conducted passenger counts for the MBTA commuter rail system, which were used to determine line volumes. The commuter rail segment between South Station and Back Bay Station—served by the Framingham/Worcester, Franklin, Needham, and Providence/Stoughton Lines—is the only option that emerged as an alternative for the Hubway O-D pairs analyzed in Section 4.6. Based on 2012 passenger count data, on these rail lines, the maximum loads occur at some point prior to Back Bay inbound and after Back Bay outbound. By comparison, the commuter rail traffic between Back Bay and South Station is low. For the purposes of this analysis, CTPS assumed that crowding did not take place on this segment, although crowding could theoretically occur because of non-uniform distribution of passengers between cars on a train.

APPENDIX E:
DETAILS ON O-D PAIRS WITH LARGE SHARES OF TRIPS FASTER OR COMPARABLE BY TRANSIT

TABLE E-1
O-D Pairs With Large Shares of Trips Faster or Comparable by Transit (AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Weekday AM Peak Period Trips	Percent Trips Faster or Comparable by Transit	Main Alternative Transit Mode for Trips Faster or Comparable by Transit	Transit Mode Share of All O-D Pair Trips	Transit Mode Share of Trips Faster or Comparable by Transit	Hubway: Potential Complement or Potential Competitor?	Transit Lines and Segments	Evidence of Uncomfortable Conditions [a]			
									Bus Point Checks	Bus Route Comfort Fraction Data	Bus Segment Comfort Fraction Data	Loads at Rapid Transit Stations
D32022 to C32007	TD Garden to Prudential Center	109	98%	Rapid Transit (0 Transfers)	100%	100%	Complement	1. Green Line (North Station to Prudential) 2. Orange Line (No Stan to Massachusetts Avenue)				X X
D32022 to C32003	TD Garden to Back Bay / South End	128	86%	Rapid Transit (0 Transfers)	100%	100%	Complement	1. Orange Line (No Sta to Back Bay) 2. Green Line (No Sta to Copley)				X X
D32022 to D32007	TD Garden to Boylston St @ Arlington St	139	83%	Rapid Transit 0 Transfers)	100%	100%	Complement	1. Orange Line (No Sta to Back Bay) 2. Green Line (No Sta to Arlington)				X X
D32005 to A32010	Boston Public Library to South Station	146	63%	Commuter Rail (0 Transfers)	100%	100%	Competitor	1. Multiple Lines (Back Bay to So Sta)				
D32022 to C32008	TD Garden to Boylston St @ Fairfield St	178	61%	Rapid Transit (0 Transfers)	100%	100%	Complement	2. Green Line (No Sta to Copley)				X
M32022 to A32004	Lower Cambridgeport to Longwood Ave @ Binney St	111	58%	Bus (0 Transfers)	100%	100%	Complement	1. Route 47 (Magazine St @ Riverside Rd to Brookline Ave @ Longwood Ave)		X	X	
A32010 to D32018	So Sta to BCEC	305	54%	Bus (0 Transfers)	100%	100%	Competitor	1.Route 7 bus (So Sta to Summer St Op WTC Avenue)[b] 2.Route 4 (So Sta to Summer St Op WTC Ave)[c]				

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner and Google Maps output, MBTA fall 2015 bus point-check data, MBTA fall 2015 bus crowding data, MBTA AFC data (May 10-12, 2016),

[a] An "X" in the Evidence of Uncomfortable Conditions columns indicates that CTPS identified evidence in this category, according to the methods described in Appendix D. [b] Point-check data was not available for Route 7 buses traveling outbound during the AM Peak period. [c] Point-check data and bus route comfort fraction data were not available for Route 4 buses traveling outbound during the AM Peak period.

AFC = automated fare collection. BCEC = Boston Convention and Exhibition Center. CTPS = Central Transportation Planning Staff. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE E-2
O-D Pairs With Large Shares of Trips Faster or Comparable by Transit (PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Weekday PM Peak Period Trips	Percent of Trips Faster or Comparable by Transit	Main Alternative Transit Mode for Trips Faster or Comparable by Transit	Transit Mode Share of All O-D Pair Trips	Transit Mode Share of Trips Faster or Comparable by Transit	Hubway: Potential Complement or Potential Competitor?	Transit Lines and Segments	Evidence of Uncomfortable Conditions [a]			
									Bus Point Checks	Bus Route Comfort Fraction Data	Bus Segment Comfort Fraction Data	Loads at Rapid Transit Stations
C32007 to D32022	Prudential Center to TD Garden	194	98%	Rapid Transit (0 transfers)	100%	100%	Complement	1. Green Line (Prudential to North Station) 2. Orange Line (Massachusetts Avenue to No Sta)				X X
A32010 to C32003	South Station to Back Bay/South End	128	96%	Commuter Rail Only (0 transfers)	98%	100%	Competitor	1. Commuter Rail (Multiple Lines, So Sta to Back Bay)				
A32010 to C32012	So Sta to Andrew Sta	104	91%	Rapid Transit (0 transfers)	100%	100%	Complement	1. Red Line (So Sta to Andrew)				X
C32003 to A32010	Back Bay /So End to So Sta	204	91%	Commuter Rail (0 transfers)	95%	100%	Competitor	1. Commuter Rail (Multiple Lines, Back Bay to So Sta)				
D32014 to D32005	Tremont St @ West St to Boston Public Library	110	81%	Rapid Transit (0 transfers)	98%	100%	Complement	1. Green Line (Park St to Copley) 2. Orange Line (Chinatown to Back Bay Sta)				X X
D32009 to D32021	Faneuil Hall to Charlestown: Warren St	102	78%	Bus (0 transfers)	100%	100%	Complement	1. Route 93 (Congress St @ North St to Chelsea St @ Warren St) 2. Route 92 (Congress St @ North St to Warren St @ Winthrop St)[b]		X	X	
C32003 to D32022	Back Bay/ So End to TD Garden	141	75%	Rapid Transit (0 transfers)	100%	100%	Complement	1. Orange Line (Back Bay to No Sta)				X
A32010 to D32005	So Sta to Boston Public Library	167	61%	Commuter Rail Only (0 transfers)	98%	100%	Competitor	1. Commuter Rail (Multiple Lines, So Sta to Back Bay)				
D32007 to D32022	Boylston St @ Arlington St to TD Garden	333	58%	Rapid Transit (0 transfers)	100%	100%	Complement	1. Green Line (Arlington to No Sta)				X
A32003 to A32012	BU Central to Packard's Corner	168	55%	Bus (0 transfers)	90%	100%	Complement	1. Route 57 (Commonwealth Ave @ University Rd to 1079 Comm Ave) 2. Route 57A (Comm Ave @ University Rd to 1079 Comm Ave)	X X	X X	X X	

TABLE E-2
O-D Pairs With Large Shares of Trips Faster or Comparable by Transit (PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Weekday PM Peak Period Trips	Percent of Trips Faster or Comparable by Transit	Main Alternative Transit Mode for Trips Faster or Comparable by Transit	Transit Mode Share of All O-D Pair Trips	Transit Mode Share of Trips Faster or Comparable by Transit	Hubway: Potential Complement or Potential Competitor?	Transit Lines and Segments	Evidence of Uncomfortable Conditions [a]			
									Bus Point Checks	Bus Route Comfort Fraction Data	Bus Segment Comfort Fraction Data	Loads at Rapid Transit Stations
A32010 to D32018	So Sta to BCEC	156	55%	Bus (0 transfers)	100%	100%	Complement	1. Route 7 bus (So Sta to Summer St op WTC Ave) 2. Route 4 bus (So Sta to Summer St op World Trade Center Ave)[c]		X	X	
M32011 to M32018	Central Square to Harvard Sq: Mass Ave @ Dunster St	119	54%	Rapid Transit (0 transfers)	86%	94%	Complement	1. Red Line (Central to Harvard)				X
B32007 to A32010	Seaport Sq to So Sta	105	53%	Bus (0 transfers)	100%	100%	Complement	1.SL1 (Courthouse to So Sta)[d] 2. SL2 (Courthouse to So Sta) 3. SL Waterfront (Courthouse to So Sta)[e]	X X	X		
B32010 to A32002	Kenmore Sq to Agganis Arena	124	53%	Bus (0 transfers)	92%	98%	Complement	1. 57 (Kenmore to Comm Ave @ Buick St) 2. 57/57A (Kenmore to Comm Ave @ Buick St)	X X	X X	X X	
D32012 to D32021	Post Office Sq to Charlestown: Warren St	138	51%	Bus (0 transfers)	100%	100%	Complement	1. Route 93 (Pearl St @ Congress St to Chelsea St @ Warren St) 2. Route 92 (Pearl St @ Congress St to Warren St @ Winthrop St)[b]		X	X	
M32001 to D32022	Lechmere Sta to TD Garden	255	51%	Rapid Transit (0 transfers)	59%	100%	Competitor	1. Green Line (Lechmere to No Sta)				

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner and Google Maps output, MBTA fall 2015 bus point-check data, MBTA fall 2015 bus crowding data, MBTA AFC data (May 10-12, 2016),

[a] An "X" in the Evidence of Uncomfortable Conditions columns indicates that CTPS identified evidence in this category, according to the methods described in Appendix D. [b] Comfort fraction data was not available for Route 92 buses traveling outbound during the AM Peak period. [c] Point-check data and bus route comfort fraction data were not available for Route 4 buses traveling outbound during the PM Peak period. [d] Comfort fraction data was not available for SL 1 buses traveling inbound during the PM peak period. [e] Comfort fraction data was not available for SL Waterfront buses traveling inbound during the PM peak period.

AFC = automated fare collection. BCEC = Boston Convention and Exhibition Center. BU = Boston University. CTPS = Central Transportation Planning Staff. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE E-3
O-D Pairs With Large Shares of Trips Faster or Comparable by Transit (Weekday Off-Peak Periods)

						Alternative Transit Modes and Transfers for Trips Faster or Comparable by Transit				
						Bus		Rapid Transit		Commuter Rail
O-D Pair: Station Numbers	O-D Pair: Station Names	Weekday Time Period	Total Trips	Number of Trips Faster or Comparable by Transit	Percent of Trips Faster or Comparable by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	Zero Transfers
D32022 to D32007	TD Garden to Boylston St @ Arlington St	Late Night / Early Morning	113	106	94%	0%	0%	100%	0%	0%
A32003 to A32012	BU Central to Packard's Corner	Midday	113	72	64%	97%	0%	3%	0%	0%
M32018 to M32011	Harvard Square: Mass Ave @ Dunster St to Central Sq	Midday	110	86	78%	1%	0%	99%	0%	0%
M32011 to M32018	Central Square to Harvard Sq: Mass Ave @ Dunster St	Midday	109	61	56%	10%	0%	90%	0%	0%
K32003 to A32008	Brookline Village to Buswell St @ Park Dr	Midday	100	89	89%	0%	0%	100%	0%	0%
A32003 to A32012	BU Central to Packard's Corner	Evening / Night	125	72	58%	97%	0%	3%	0%	0%
M32011 to M32018	Central Square to Harvard Sq: Mass Ave @ Dunster St	Evening / Night	121	63	52%	32%	0%	68%	0%	0%
M32016 to A32019	Harvard Kennedy School to Harvard: Transportation Services	Evening / Night	101	77	76%	100%	0%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
BU = Boston University. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE E-4
O-D Pairs With Large Shares of Trips Faster or Comparable by Transit (Weekend)

					Alternative Transit Modes and Transfers for Trips Faster or Comparable by Transit				
					Bus		Rapid Transit		Commuter Rail
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Number of Trips Faster or Comparable by Transit	Percent of Trips Faster or Comparable by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	Zero Transfers
D32014 to D32005	Tremont St @ West St to Boston Public Library	105	93	89%	0%	0%	100%	0%	0%
M32018 to M32011	Harvard Square: Mass Ave @ Dunster St to Central Square	151	118	78%	3%	0%	97%	0%	0%
A32010 to C32003	South Station to Back Bay / South End	110	72	65%	0%	0%	7%	0%	93%
A32010 to C32017	South Station to South Boston Library	117	75	64%	96%	4%	0%	0%	0%
M32011 to M32018	Central Square to Harvard Square: Mass Ave @ Dunster St	176	108	61%	16%	0%	84%	0%	0%
A32003 to A32012	BU Central to Packard's Corner	151	87	58%	95%	0%	5%	0%	0%
M32018 to M32029	Harvard Square: Mass Ave @ Dunster St to Porter Square Station	122	70	57%	43%	0%	57%	0%	0%
D32022 to M32001	TD Garden to Lechmere Station	102	58	57%	0%	0%	100%	0%	0%
M32016 to A32019	Harvard Kennedy School to Harvard: Transportation Services	107	56	52%	100%	0%	0%	0%	0%
B32010 to A32002	Kenmore Square to Agganis Arena	119	61	51%	98%	0%	2%	0%	0%
A32010 to C32006	South Station to Washington St @ Rutland St	119	60	50%	100%	0%	0%	0%	0%
B32008 to D32022	Old State House to TD Garden	152	76	50%	0%	0%	100%	0%	0%
A32010 to D32018	South Station to BCEC	151	75	50%	100%	0%	0%	0%	0%
M32010 to M32018	Inman Square to Harvard Square: Mass Ave @ Dunster St	105	52	50%	100%	0%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
BCEC = Boston Convention and Exhibition Center. BU = Boston University. O-D = Origin-Destination. OTP = Open Trip Planner.

APPENDIX F:
DETAILS ON O-D PAIRS WITH LARGE SHARES OF TRIPS MUCH SLOWER BY TRANSIT[51]

[51] Notes: There were no O-D pairs in the Evening/Night period that had 1) 100 or more Hubway member trips during that period; and 2) 75 percent or more trips that would have been much slower by transit.

TABLE F-1
O-D Pairs with 75 Percent or More Trips Much Slower by Transit
(Weekday AM Peak Period)

					Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Commuter Rail	Other	
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Number of Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
D32006 to C32010	Lewis Wharf to Congress St @ Sleeper St	135	135	100%	84%	1%	0%	2%	13%	0%	0%	0%	0%
C32024 to D32012	State Street to Post Office Square	106	105	99%	0%	0%	100%	0%	0%	0%	0%	0%	0%
B32004 to C32024	Aquarium Station to State Street	161	158	98%	0%	4%	0%	1%	95%	0%	0%	0%	0%
K32001 to B32003	Coolidge Corner to Harvard: HMS/HSPH	216	209	97%	99%	0%	0%	0%	1%	0%	0%	0%	0%
A32010 to D32017 [a]	South Station to The Esplanade	101	95	94%	6%	0%	0%	24%	0%	0%	0%	69%	0%
K32004 to A32004	JFK Crossing to Longwood Ave @ Binney St	102	95	93%	63%	37%	0%	0%	0%	0%	0%	0%	0%
A32017 to B32003	Allston Green District to Harvard: HMS/HSPH	179	166	93%	78%	0%	0%	0%	22%	0%	0%	0%	0%
C32000 to A32000 [b]	Tremont St @ Berkeley St to Fan Pier	113	104	92%	0%	78%	0%	0%	0%	0%	0%	21%	1%
K32004 to B32003	JFK Crossing to Harvard: HMS/HSPH	197	181	92%	100%	0%	0%	0%	0%	0%	0%	0%	0%
D32000 to M32003	Cambridge St @ Joy St to One Broadway / Kendall Square	115	100	87%	0%	0%	100%	0%	0%	0%	0%	0%	0%
C32000 to D32004	Tremont St @ Berkeley St to Franklin St @ Arch St	177	153	86%	100%	0%	0%	0%	0%	0%	0%	0%	0%
A32017 to A32004	Allston Green District to Longwood Ave @ Binney St	140	121	86%	47%	5%	0%	0%	47%	1%	0%	0%	0%
D32016 to D32005	Charles Circle to Boston Public Library	121	104	86%	16%	0%	0%	60%	21%	0%	0%	3%	0%
D32008 to M32019	Rowes Wharf to CambridgeSide Galleria	126	108	86%	0%	0%	0%	4%	96%	0%	0%	0%	0%
M32001 to M32002	Lechmere Station to One Kendall Square	160	137	86%	45%	55%	0%	0%	0%	0%	0%	0%	0%
D32008 to D32007	Rowes Wharf to Boylston St @ Arlington St	264	222	84%	22%	0%	72%	0%	7%	0%	0%	0%	0%
M32001 to B32008	Lechmere Station to Old State House	135	113	84%	0%	1%	0%	0%	98%	1%	0%	0%	0%
M32022 to	Lower Cambridgeport to MIT:	144	119	83%	74%	26%	0%	0%	0%	0%	0%	0%	0%

TABLE F-1
O-D Pairs with 75 Percent or More Trips Much Slower by Transit
(Weekday AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Number of Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Commuter Rail	Other	
					Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
M32005	Stata Center												
M32010 to M32005	Inman Square to MIT: Stata Center	284	234	82%	85%	14%	0%	0%	1%	0%	0%	0%	0%
B32002 to M32005	Ruggles Station to MIT: Stata Center	152	125	82%	51%	49%	0%	0%	0%	0%	0%	0%	0%
D32008 to D32013	Rowes Wharf to Boylston St @ Berkeley St	141	114	81%	8%	0%	13%	0%	16%	0%	63%	0%	0%
B32004 to C32021	Aquarium Station to ID Building W	114	91	80%	96%	1%	0%	0%	3%	0%	0%	0%	0%
B32008 to A32000	Old State House to Fan Pier	135	105	78%	95%	1%	0%	0%	4%	0%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.

[a] For pair A32010 to D32017, 62 percent of trips involved a combination of bus and commuter rail 1 transfer, while 5 percent of trips involved a combination of rapid transit and commuter rail (1 transfer).

[b] For pair C32000 to A32000, 21 percent of trips involved a combination of bus and commuter rail (1 transfer), while 1 percent of trips involved a combination of bus and commuter rail (2 transfers).

HMS/HSPH = Harvard Medical School / Harvard School of Public Health. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE F-2
O-D Pairs with 75 Percent or More Trips Much Slower by Transit (Weekday PM Peak Period)

					Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Commuter Rail	Other	
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
M32001 to D32008	Lechmere Station to Rowes Wharf	168	168	100%	0%	36%	0%	0%	63%	2%	0%	0%	0%
C32024 to B32004	State Street to Aquarium Station	202	198	98%	0%	0%	0%	2%	98%	0%	0%	0%	0%
B32003 to K32001	Harvard: HMS/HSPH to Coolidge Corner	128	119	93%	76%	4%	0%	0%	20%	0%	0%	0%	0%
A32000 to D32022	Fan Pier to TD Garden	523	483	92%	95%	0%	0%	0%	5%	0%	0%	0%	0%
B32007 to D32010	Seaport Square to Cross St @ Hanover St	124	114	92%	76%	1%	0%	0%	23%	0%	0%	0%	0%
M32032 to D32022	Kendall Street to TD Garden	164	142	87%	0%	0%	0%	99%	0%	0%	0%	1%	0%
D32007 to D32008 [a]	Boylston St @ Arlington St to Rowes Wharf	220	190	86%	48%	0%	21%	10%	15%	0%	0%	7%	0%
B32007 to D32022	Seaport Square to TD Garden	456	373	82%	94%	0%	0%	0%	6%	0%	0%	0%	0%
M32005 to M32022	MIT: Stata Center to Lower Cambridgeport	130	104	80%	0%	58%	0%	0%	42%	0%	0%	0%	0%
C32010 to D32022	Congress St @ Sleeper St to TD Garden	1129	884	78%	86%	5%	0%	0%	9%	0%	0%	0%	0%
M32005 to C32003 [b]	MIT: Stata Center to Back Bay / South End	122	94	77%	0%	1%	0%	5%	16%	0%	0%	78%	0%
B32003 to A32017	Harvard: HMS/HSPH to Allston Green District	100	77	77%	52%	3%	0%	0%	45%	0%	0%	0%	0%
D32013 to D32008	Boylston St @ Berkeley St to Rowes Wharf	212	159	75%	0%	3%	30%	0%	6%	0%	59%	2%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
[a] For pair D32007-D32008, 62 percent of trips involved a combination of rapid transit and commuter rail (1 transfer). [b] For pair M32005-C32003, 78 percent of trips involved a combination of rapid transit and commuter rail (1 transfer).
HMS/HSPH = Harvard Medical School / Harvard School of Public Health. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE F-3
O-D Pairs with 75 Percent or More Trips that Would Be Much Slower by Transit
(Weekday Late Night / Early Morning Period)

					Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Other (not including Rail)		
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
C32000 to D32012	Tremont St @ Berkeley St to Post Office Square	132	115	87%	100%	0%	0%	0%	0%	0%	0%	0%	0%
D32022 to M32003	TD Garden to One Broadway / Kendall Square	114	99	87%	0%	0%	0%	100%	0%	0%	0%	0%	0%
B32004 to M32019	Aquarium Station to CambridgeSide Galleria	109	91	83%	0%	0%	100%	0%	0%	0%	0%	0%	0%
A32017 to A32004	Allston Green District to Longwood Ave @ Binney St	136	105	77%	40%	7%	0%	0%	51%	2%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE F-4
O-D Pairs with 75 Percent or More Trips that Would Be Much Slower by Transit
(Weekday Midday Period)

					Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Other (not including Rail)		
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
K32004 to A32004	JFK Crossing to Longwood Ave @ Binney St	115	104	90%	68%	32%	0%	0%	0%	0%	0%	0%	0%
M32010 to M32005	Inman Square to MIT: Stata Center	190	144	76%	58%	36%	0%	0%	6%	0%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
MIT = Massachusetts Institute of Technology. O-D = Origin-Destination. OTP = Open Trip Planner.

TABLE F-5
O-D Pairs with 75 Percent or More Trips that Would Be Much Slower by Transit (Weekend)

					Alternative Transit Modes and Transfers for Trips Much Slower by Transit								
					Bus		Rapid Transit		Bus and Rapid Transit		Other (not including Rail)		
O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Number of Trips Much Slower by Transit	Percent of Trips Much Slower by Transit	Zero Transfers	One Transfer	Zero Transfers	One Transfer	One Transfer	Two Transfers	Zero Transfers	One Transfer	Two Transfers
K32001 to B32003	Coolidge Corner to Harvard: HMS/HSPH	141	132	94%	97%	0%	0%	0%	3%	0%	0%	0%	0%
A32000 to D32022	Fan Pier to TD Garden	161	137	85%	77%	1%	0%	0%	22%	0%	0%	0%	0%
B32003 to K32001	Harvard: HMS/HSPH to Coolidge Corner	112	94	84%	91%	3%	0%	0%	5%	0%	0%	0%	0%
M32010 to M32005	Inman Square to MIT: Stata Center	163	134	82%	64%	36%	0%	0%	0%	0%	0%	0%	0%

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015) and OTP output.
HMS/HSPH = Harvard Medical School / Harvard School of Public Health. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination. OTP = Open Trip Planner.

APPENDIX G:
DETAILS FOR O-D PAIRS WITH LARGE SHARES OF WALK-ONLY TRIPS

TABLE G-1
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Square	968	968	100%	One
D32022 to A32013	TD Garden to John F Fitzgerald - Surface Rd	761	761	100%	Both
M32003 to M32019	One Broadway / Kendall Square to CambridgeSide Galleria	412	412	100%	One
A32009 to C32003	Tremont St @ W Newton St to Back Bay / South End	410	410	100%	One
D32022 to D32008	TD Garden to Rowes Wharf	381	371	97%	One
D32006 to D32008	Lewis Wharf to Rowes Wharf	376	376	100%	None
D32021 to D32022	Charlestown: Warren St to TD Garden	373	373	100%	One
A32010 to D32008	South Station to Rowes Wharf	356	356	100%	One
B32004 to A32010	Aquarium Station to South Sta	342	342	100%	Both
C32000 to D32015	Tremont St @ Berkeley St to Chinatown Gate Plaza	337	337	100%	None
K32001 to A32004	Coolidge Corner to Longwood Ave @ Binney St	264	264	100%	One
D32016 to D32007	Charles Circle to Boylston St @ Arlington St	255	255	100%	Both
M32029 to M32031	Porter Square Sta to Danehy Park	251	251	100%	One
M32009 to M32037	Lafayette Sq to Ames St @ Main St	230	230	100%	One
B32004 to C32010	Aquarium Sta to Congress St @ Sleeper St	227	227	100%	One
S32009 to S32006	Packard Ave @ Powderhouse Blvd to Davis Sq	222	222	100%	One
D32022 to M32034	TD Garden to EF - North Point Park	213	213	100%	One
D32019 to A32010	Boylston St @ Washington St to South Sta	205	205	100%	Both
D32011 to A32010	Stuart St @ Charles St to South Sta	204	204	100%	One
M32009 to M32005	Lafayette Square to MIT: Stata Ctr	199	199	100%	None
A32010 to B32008	South Station to Old State House	198	198	100%	Both
D32002 to C32007	Washington St @ Waltham St to Prudential Ctr	192	183	95%	One
D32006 to A32013	Lewis Wharf to John F Fitzgerald - Surface Rd	191	191	100%	One
D32010 to D32008	Cross St @ Hanover St to Rowes Wharf	190	190	100%	One

TABLE G-1
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32014 to M32016	Harvard Housing: Putnam Ave to Harvard Kennedy School	185	185	100%	None
S32005 to M32029	Wilson Square to Porter Sq Sta	185	185	100%	One
M32014 to A32006	Harvard Housing: Putnam Ave to Harvard Housing: Western Ave	184	184	100%	None
M32026 to M32012	359 Broadway to Cambridge City Hall	184	184	100%	One
A32010 to A32013	South Station to John F Fitzgerald - Surface Rd	183	183	100%	Both
M32014 to M32012	Harvard Housing: Putnam Ave to Cambridge City Hall	182	182	100%	One
D32022 to B32004	TD Garden to Aquarium Station	179	179	100%	Both
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	176	176	100%	One
A32010 to D32010	South Sta to Cross St @ Hanover St	176	176	100%	Both
A32006 to M32018	Harvard Housing: Western Ave to Harvard Sq: Mass Ave @ Dunster St	170	170	100%	One
C32003 to C32007	Back Bay / South End to Prudential Ctr	168	168	100%	Both
M32006 to M32005	MIT: Mass Ave to MIT: Stata Ctr	161	161	100%	None
M32014 to M32018	Harvard Housing: Putnam Ave to Harvard Sq: Mass Ave @ Dunster St	153	153	100%	One
D32008 to A32010	Rowes Wharf to South Station	153	153	100%	One
A32010 to C32010	South Sta to Congress St @ Sleeper St	152	151	99%	One
M32014 to M32011	Harvard Housing: Putnam Ave to Central Square	145	145	100%	One
D32010 to A32013	Cross St @ Hanover St to John F Fitzgerald - Surface Rd	145	145	100%	Both
M32031 to M32029	Danehy Park to Porter Square Sta	144	144	100%	One
M32002 to M32037	One Kendall Sq to Ames St @ Main St	143	143	100%	One
M32001 to M32027	Lechmere Sta to Binney St @ Sixth St	142	142	100%	One
C32001 to B32002	Roxbury Crossing Station to Ruggles Sta	142	142	100%	Both
M32024 to M32021	Harvard: Radcliffe Quadrangle to Harvard: Gund Hall	137	137	100%	None
M32014 to M32021	Harvard Housing: Putnam Ave to Harvard: Gund Hall	136	136	100%	None
D32010 to D32004	Cross St @ Hanover St to Franklin St @ Arch St	135	135	100%	Both

TABLE G-1
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
E32002 to E32005	JP Center to Green St Station	134	134	100%	One
D32022 to D32021	TD Garden to Charlestown: Warren St	133	133	100%	One
A32010 to D32011	South Sta to Stuart St @ Charles St	132	132	100%	One
D32004 to A32013	Franklin St @ Arch St to John F Fitzgerald - Surface Rd	131	131	100%	Both
D32006 to D32012	Lewis Wharf to Post Office Sq	125	125	100%	None
A32013 to A32010	John F Fitzgerald - Surface Rd to South Sta	125	125	100%	Both
M32024 to M32017	Harvard: Radcliffe Quadrangle to Harvard Square: Brattle St	122	122	100%	One
C32024 to C32010	State Street to Congress St @ Sleeper St	122	122	100%	None
M32021 to M32024	Harvard: Gund Hall to Harvard: Radcliffe Quadrangle	121	121	100%	None
M32030 to M32011	Dana Park to Central Square	120	120	100%	One
M32003 to M32001	One Broadway / Kendall Square to Lechmere Sta	120	120	100%	Both
D32024 to D32005	Charles St @ Beacon St to Boston Public Library	117	116	99%	One
D32004 to A32010	Franklin St @ Arch St to South Sta	117	117	100%	Both
D32016 to D32013	Charles Circle to Boylston St @ Berkeley St	113	113	100%	One
A32019 to A32011	Harvard: Transportation Services to Innovation Lab: Western Ave	113	113	100%	None
D32008 to C32010	Rowes Wharf to Congress St @ Sleeper St	111	111	100%	None
C32009 to C32010	Dorchester Ave @ Gillette Park to Congress St @ Sleeper St	110	110	100%	One
M32025 to M32033	Linear Park: Mass Ave @ Cameron Ave to Alewife Sta	107	107	100%	None
D32024 to C32008	Charles St @ Beacon St to Boylston St @ Fairfield St	107	105	98%	None
A32010 to D32007	South Sta to Boylston St @ Arlington St	105	105	100%	Both
B32008 to A32010	Old State House to South Station	104	103	99%	Both
M32006 to M32003	MIT: Mass Ave to One Broadway / Kendall Sq	103	103	100%	One
A32006 to M32016	Harvard Housing: Western Ave to Harvard Kennedy School	103	103	100%	None
A32012 to A32002	Packard's Corner to Agganis Arena	102	102	100%	Both

TABLE G-1
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday AM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32027 to M32005	Binney St @ Sixth St to MIT: Stata Ctr	101	101	100%	None
B32004 to D32006	Aquarium Station to Lewis Wharf	101	101	100%	One
D32024 to A32010	Charles St @ Beacon St to South Sta	100	100	100%	One
C32002 to C32007	Boston Medical Center to Prudential Ctr	100	100	100%	One

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner output, and CTPS GIS analysis. CTPS = Central Transportation Planning Staff. JP = Jamaica Plain. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination.

TABLE G-2
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
D32008 to D32022	Rowes Wharf to TD Garden	992	966	97%	One
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	712	712	100%	One
B32004 to D32022	Aquarium Station to TD Garden	405	405	100%	Both
A32010 to B32004	South Station to Aquarium Station	395	395	100%	Both
S32006 to S32011	Davis Square to Teele Square	384	371	97%	One
D32007 to A32010	Boylston St @ Arlington St to South Station	380	380	100%	Both
A32013 to D32022	John F Fitzgerald - Surface Rd to TD Garden	321	321	100%	Both
D32010 to A32010	Cross St @ Hanover St to South Station	309	308	100%	Both
D32022 to D32021	TD Garden to Charlestown: Warren St	307	307	100%	One
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Square	305	305	100%	One
A32010 to D32010	South Station to Cross St @ Hanover St	299	299	100%	Both
D32008 to D32010	Rowes Wharf to Cross St @ Hanover St	292	292	100%	One
D32008 to D32006	Rowes Wharf to Lewis Wharf	277	277	100%	None
M32019 to M32003	CambridgeSide Galleria to One Broadway / Kendall Square	273	273	100%	One
S32006 to	Davis Square to Packard Ave @ Powderhouse	249	249	100%	One

TABLE G-2
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
S32009	Blvd				
D32021 to D32022	Charlestown: Warren St to TD Garden	245	245	100%	One
M32034 to D32022	EF-North Point Park to TD Garden	242	242	100%	One
A32010 to D32011	South Station to Stuart St @ Charles St	240	240	100%	One
D32007 to D32016	Boylston St @ Arlington St to Charles Circle	238	238	100%	Both
B32008 to A32010	Old State House to South Station	228	228	100%	Both
C32003 to A32009	Back Bay / South End to Tremont St @ W Newton St	222	211	95%	One
M32005 to M32009	MIT: Stata Center to Lafayette Square	220	220	100%	None
M32005 to M32006	MIT: Stata Center to MIT: Mass Ave	207	207	100%	None
D32019 to A32010	Boylston St @ Washington St to South Station	207	207	100%	Both
D32012 to D32000	Post Office Square to Cambridge St @ Joy St	205	205	100%	None
M32031 to M32029	Danehy Park to Porter Square Station	192	192	100%	One
M32016 to M32014	Harvard Kennedy School to Harvard Housing: Putnam Ave	189	189	100%	None
C32010 to B32004	Congress St @ Sleeper St to Aquarium Station	185	185	100%	One
M32037 to M32009	Ames St @ Main St to Lafayette Square	181	181	100%	One
D32012 to D32006	Post Office Square to Lewis Wharf	173	173	100%	None
M32029 to S32005	Porter Square Station to Wilson Square	170	170	100%	One
C32007 to C32006	Prudential Center to Washington St @ Rutland St	160	160	100%	One
D32004 to D32006	Franklin St @ Arch St to Lewis Wharf	159	152	96%	One
M32018 to M32014	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Putnam Ave	158	158	100%	One
C32010 to A32010	Congress St @ Sleeper St to South Station	154	154	100%	One
M32029 to M32031	Porter Square Station to Danehy Park	153	153	100%	One
A32010 to D32008	South Station to Rowes Wharf	152	152	100%	One
M32003 to M32019	One Broadway / Kendall Square to CambridgeSide Galleria	150	150	100%	One

TABLE G-2
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32023 to M32024	Harvard: SEAS Cruft-Pierce Halls to Harvard: Radcliffe Quadrangle	148	148	100%	None
M32011 to M32030	Central Square to Dana Park	148	148	100%	One
D32016 to D32022	Charles Circle to TD Garden	146	146	100%	Both
M32014 to M32018	Harvard Housing: Putnam Ave to Harvard Square: Mass Ave @ Dunster St	142	142	100%	One
D32009 to D32022	Faneuil Hall to TD Garden	140	133	95%	Both
M32037 to M32006	Ames St @ Main St to MIT: Mass Ave	139	139	100%	One
A32004 to K32001	Longwood Ave @ Binney St to Coolidge Corner	139	139	100%	One
C32006 to C32007	Washington St @ Rutland St to Prudential Center	138	138	100%	One
B32008 to D32000	Old State House to Cambridge St @ Joy St	137	137	100%	One
C32003 to C32004	Back Bay / South End to Columbus Ave @ Mass Ave	136	136	100%	Both
M32027 to M32001	Binney St @ Sixth St to Lechmere Station	134	134	100%	One
M32021 to M32024	Harvard: Gund Hall to Harvard: Radcliffe Quadrangle	129	129	100%	None
M32002 to M32010	One Kendall Square to Inman Square	129	129	100%	None
A32013 to A32010	John F Fitzgerald - Surface Rd to South Station	129	129	100%	Both
M32006 to M32037	MIT: Mass Ave to Ames St @ Main St	127	127	100%	One
D32006 to D32022	Lewis Wharf to TD Garden	127	127	100%	One
D32015 to C32025	Chinatown Gate Plaza to Ink Block	126	126	100%	None
D32016 to D32007	Charles Circle to Boylston St @ Arlington St	125	125	100%	Both
D32009 to A32010	Faneuil Hall to South Station	125	125	100%	Both
M32017 to M32024	Harvard Square: Brattle St to Harvard: Radcliffe Quadrangle	124	124	100%	One
M32018 to A32006	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Western Ave	124	124	100%	One
M32009 to M32011	Lafayette Square to Central Square	124	124	100%	One
M32033 to M32025	Alewife Station to Linear Park: Mass Ave @ Cameron Ave	123	123	100%	None
A32002 to A32012	Agganis Arena to Packard's Corner	122	122	100%	Both

TABLE G-2
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday PM Peak Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
A32010 to D32000	South Station to Cambridge St @ Joy St	120	120	100%	One
S32009 to S32006	Packard Ave @ Powderhouse Blvd to Davis Sq	118	118	100%	One
M32009 to M32006	Lafayette Square to MIT: Mass Ave	118	118	100%	None
D32011 to A32010	Stuart St @ Charles St to South Station	118	118	100%	One
M32016 to A32006	Harvard Kennedy School to Harvard Housing: Western Ave	117	117	100%	None
M32003 to M32006	One Broadway / Kendall Square to MIT: Mass Ave	115	115	100%	One
A32010 to C32010	South Station to Congress St @ Sleeper St	109	106	97%	One
D32004 to D32024	Franklin St @ Arch St to Charles St @ Beacon St	108	108	100%	One
A32010 to D32019	South Station to Boylston St @ Washington St	108	108	100%	Both
M32017 to M32014	Harvard Square: Brattle St to Harvard Housing: Putnam Ave	107	107	100%	One
S32011 to S32006	Teele Square to Davis Square	107	107	100%	One
D32008 to A32010	Rowes Wharf to South Station	104	104	100%	One
C32010 to C32024	Congress St @ Sleeper St to State Street	103	103	100%	None
D32012 to D32010	Post Office Square to Cross St @ Hanover St	102	102	100%	One
D32006 to B32004	Lewis Wharf to Aquarium Station	102	102	100%	One
M32012 to M32014	Cambridge City Hall to Harvard Housing: Putnam Ave	101	101	100%	One
M32006 to M32003	MIT: Mass Ave to One Broadway / Kendall Sq	100	100	100%	One

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner output, and CTPS GIS analysis.
CTPS = Central Transportation Planning Staff. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination.

TABLE G-3
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Late Night / Early Morning Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
K32001 to A32004	Coolidge Corner to Longwood Ave @ Binney St	157	157	100%	One
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Square	152	152	100%	One
D32000 to D32012	Cambridge St @ Joy St to Post Office Square	126	126	100%	None
S32011 to S32006	Teele Square to Davis Square	100	96	96%	One

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner output, and CTPS GIS analysis.
CTPS = Central Transportation Planning Staff. O-D = Origin-Destination.

TABLE G-4
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Midday Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Square	407	407	100%	One
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	362	362	100%	One
M32009 to M32005	Lafayette Square to MIT: Stata Center	348	348	100%	None
M32006 to M32005	MIT: Mass Ave to MIT: Stata Center	345	345	100%	None
M32037 to M32006	Ames St @ Main St to MIT: Mass Ave	292	292	100%	One
M32006 to M32037	MIT: Mass Ave to Ames St @ Main St	292	292	100%	One
M32009 to M32006	Lafayette Square to MIT: Mass Ave	258	258	100%	None
M32037 to M32009	Ames St @ Main St to Lafayette Square	243	243	100%	One
M32005 to M32006	MIT: Stata Center to MIT: Mass Ave	242	242	100%	None
M32009 to M32037	Lafayette Square to Ames St @ Main St	242	242	100%	One
M32005 to M32009	MIT: Stata Center to Lafayette Square	232	232	100%	None
C32010 to A32010	Congress St @ Sleeper St to South Station	232	232	100%	One
S32011 to S32006	Teele Square to Davis Square	226	223	99%	One
M32003 to M32019	One Broadway / Kendall Square to CambridgeSide Galleria	221	221	100%	One
A32010 to B32004	South Station to Aquarium Station	214	214	100%	Both

TABLE G-4
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Midday Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
S32009 to S32006	Packard Ave @ Powderhouse Blvd to Davis Square	210	210	100%	One
M32002 to M32005	One Kendall Square to MIT: Stata Center	202	202	100%	None
M32006 to M32003	MIT: Mass Ave to One Broadway / Kendall Square	198	198	100%	One
M32014 to M32018	Harvard Housing: Putnam Ave to Harvard Square: Mass Ave @ Dunster St	190	190	100%	One
A32010 to C32010	South Station to Congress St @ Sleeper St	185	185	100%	One
M32014 to M32021	Harvard Housing: Putnam Ave to Harvard: Gund Hall	182	182	100%	None
B32008 to D32000	Old State House to Cambridge St @ Joy St	179	179	100%	One
B32004 to A32010	Aquarium Station to South Station	173	172	99%	Both
D32022 to D32021	TD Garden to Charlestown: Warren St	172	172	100%	One
M32014 to M32016	Harvard Housing: Putnam Ave to Harvard Kennedy School	170	170	100%	None
A32010 to D32008	South Station to Rowes Wharf	169	169	100%	One
M32003 to M32006	One Broadway / Kendall Square to MIT: Mass Ave	163	158	97%	One
D32008 to D32006	Rowes Wharf to Lewis Wharf	162	162	100%	None
A32013 to A32010	John F Fitzgerald - Surface Rd to South Station	162	162	100%	Both
D32021 to D32022	Charlestown: Warren St to TD Garden	160	160	100%	One
M32002 to M32010	One Kendall Square to Inman Square	160	156	98%	None
D32020 to D32021	Charlestown: Main St to Charlestown: Warren St	154	154	100%	None
M32018 to M32014	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Putnam Ave	152	152	100%	One
M32019 to M32003	CambridgeSide Galleria to One Broadway / Kendall Square	149	149	100%	One
A32010 to D32010	South Station to Cross St @ Hanover St	146	146	100%	Both
M32037 to M32019	Ames St @ Main St to CambridgeSide Galleria	144	144	100%	One
M32011 to M32014	Central Square to Harvard Housing: Putnam Ave	144	144	100%	One
M32027 to M32005	Binney St @ Sixth St to MIT: Stata Center	143	143	100%	None
M32032 to M32019	Kendall Street to CambridgeSide Galleria	137	137	100%	None

TABLE G-4
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Midday Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
D32006 to D32008	Lewis Wharf to Rowes Wharf	137	137	100%	None
C32006 to C32007	Washington St @ Rutland St to Prudential Center	133	133	100%	One
M32011 to M32037	Central Square to Ames St @ Main St	129	129	100%	Both
A32013 to D32010	John F Fitzgerald - Surface Rd to Cross St @ Hanover St	129	129	100%	Both
A32013 to D32015	John F Fitzgerald - Surface Rd to Chinatown Gate Plaza	128	128	100%	One
M32024 to M32021	Harvard: Radcliffe Quadrangle to Harvard: Gund Hall	126	126	100%	None
D32021 to D32020	Charlestown: Warren St to Charlestown: Main St	126	126	100%	None
M32002 to M32003	One Kendall Square to One Broadway / Kendall Square	125	125	100%	One
C32007 to C32006	Prudential Center to Washington St @ Rutland St	124	124	100%	One
M32002 to M32037	One Kendall Square to Ames St @ Main St	123	123	100%	One
A32010 to D32006	South Station to Lewis Wharf	123	121	98%	One
M32016 to M32014	Harvard Kennedy School to Harvard Housing: Putnam Ave	122	122	100%	None
M32009 to M32003	Lafayette Square to One Broadway / Kendall Square	121	121	100%	One
C32010 to C32024	Congress St @ Sleeper St to State Street	120	120	100%	None
M32023 to M32024	Harvard: SEAS Cruft-Pierce Halls to Harvard: Radcliffe Quadrangle	119	119	100%	None
D32007 to A32010	Boylston St @ Arlington St to South Station	119	119	100%	Both
M32024 to M32023	Harvard: Radcliffe Quadrangle to Harvard: SEAS Cruft-Pierce Halls	118	118	100%	None
M32024 to M32017	Harvard: Radcliffe Quadrangle to Harvard Square: Brattle St	118	118	100%	One
S32006 to S32009	Davis Square to Packard Ave @ Powderhouse Blvd	118	118	100%	One
M32017 to M32024	Harvard Square: Brattle St to Harvard: Radcliffe Quadrangle	118	118	100%	One
C32003 to A32009	Back Bay / South End to Tremont St @ W Newton St	118	118	100%	One
B32008 to A32010	Old State House to South Station	118	118	100%	Both
D32010 to A32013	Cross St @ Hanover St to John F Fitzgerald - Surface Rd	115	115	100%	Both
M32026 to M32013	359 Broadway to Cambridge Main Library	114	111	97%	None

TABLE G-4
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Midday Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32019 to M32037	CambridgeSide Galleria to Ames St @ Main St	114	114	100%	One
M32014 to M32017	Harvard Housing: Putnam Ave to Harvard Square: Brattle St	113	113	100%	One
M32021 to M32024	Harvard: Gund Hall to Harvard: Radcliffe Quadrangle	111	111	100%	None
D32012 to D32000	Post Office Square to Cambridge St @ Joy St	111	111	100%	None
B32012 to B32011	Northeastern to Yawkey Way @ Boylston St	110	110	100%	One
D32004 to A32013	Franklin St @ Arch St to John F Fitzgerald - Surface Rd	109	109	100%	Both
D32008 to D32010	Rowes Wharf to Cross St @ Hanover St	109	109	100%	One
M32014 to M32011	Harvard Housing: Putnam Ave to Central Square	108	108	100%	One
D32012 to D32010	Post Office Square to Cross St @ Hanover St	107	107	100%	One
C32001 to B32002	Roxbury Crossing Station to Ruggles Station	106	106	100%	Both
A32009 to C32003	Tremont St @ W Newton St to Back Bay / South End	105	105	100%	One
M32003 to M32002	One Broadway / Kendall Square to One Kendall Square	103	103	100%	One
C32024 to C32010	State Street to Congress St @ Sleeper St	102	102	100%	None
C32003 to C32004	Back Bay / South End to Columbus Ave @ Mass Ave	102	102	100%	Both
A32006 to M32014	Harvard Housing: Western Ave to Harvard Housing: Putnam Ave	101	101	100%	None
M32018 to A32006	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Western Ave	100	100	100%	One
M32017 to M32014	Harvard Square: Brattle St to Harvard Housing: Putnam Ave	100	100	100%	One

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner output, and CTPS GIS analysis.
CTPS = Central Transportation Planning Staff. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination.

TABLE G-5
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekday Evening / Night Period)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	549	549	100%	One
M32011 to M32014	Central Square to Harvard Housing: Putnam Ave	247	244	99%	One
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Sq	200	200	100%	One
S32006 to S32009	Davis Square to Packard Ave @ Powderhouse Blvd	196	196	100%	One
M32011 to M32030	Central Square to Dana Park	174	174	100%	One
M32009 to M32011	Lafayette Square to Central Square	172	172	100%	One
B32004 to A32010	Aquarium Station to South Station	159	159	100%	Both
A32010 to B32004	South Station to Aquarium Station	151	151	100%	Both
M32029 to S32005	Porter Square Station to Wilson Square	149	149	100%	One
M32009 to M32006	Lafayette Square to MIT: Mass Ave	144	144	100%	None
M32009 to M32012	Lafayette Square to Cambridge City Hall	131	131	100%	One
C32003 to A32009	Back Bay / South End to Tremont St @ W Newton St	125	121	97%	One
M32018 to M32014	Harvard Sq: Mass Ave @ Dunster St to Harvard Housing: Putnam Ave	124	124	100%	One
M32002 to M32010	One Kendall Square to Inman Square	124	122	98%	None
M32005 to M32009	MIT: Stata Center to Lafayette Square	124	124	100%	None
B32002 to C32001	Ruggles Station to Roxbury Crossing Station	119	119	100%	Both
D32022 to D32021	TD Garden to Charlestown: Warren St	116	116	100%	One
C32003 to C32004	Back Bay / South End to Columbus Ave @ Mass Ave	115	115	100%	Both
D32008 to D32010	Rowes Wharf to Cross St @ Hanover St	115	115	100%	One
C32007 to C32006	Prudential Center to Washington St @ Rutland St	111	111	100%	One
M32037 to M32009	Ames St @ Main St to Lafayette Square	110	110	100%	One
A32010 to D32010	South Station to Cross St @ Hanover St	105	105	100%	Both
M32016 to M32014	Harvard Kennedy School to Harvard Housing: Putnam Ave	103	103	100%	None
M32011 to M32026	Central Square to 359 Broadway	100	100	100%	One

Data sources: 2015 Hubway trip logs (4/17/2015–12/18/2015), Open Trip Planner output, and CTPS GIS analysis.
CTPS = Central Transportation Planning Staff. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination.

TABLE G-6
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekend)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
M32025 to S32006	Linear Park: Mass Ave @ Cameron Ave to Davis Sq	768	768	100%	One
S32006 to M32025	Davis Square to Linear Park: Mass Ave @ Cameron Ave	661	661	100%	One
S32011 to S32006	Teele Square to Davis Square	513	491	96%	One
D32021 to D32022	Charlestown: Warren St to TD Garden	368	368	100%	One
M32011 to M32014	Central Square to Harvard Housing: Putnam Ave	294	283	96%	One
D32022 to D32021	TD Garden to Charlestown: Warren St	278	278	100%	One
B32004 to A32010	Aquarium Station to South Station	278	268	96%	Both
M32003 to M32019	One Broadway / Kendall Square to CambridgeSide Galleria	269	269	100%	One
D32022 to A32013	TD Garden to John F Fitzgerald - Surface Rd	261	261	100%	Both
M32006 to M32037	MIT: Mass Ave to Ames St @ Main St	261	261	100%	One
A32010 to D32008	South Station to Rowes Wharf	259	259	100%	One
A32009 to C32003	Tremont St @ W Newton St to Back Bay / South End	245	245	100%	One
M32009 to M32006	Lafayette Square to MIT: Mass Ave	244	244	100%	None
M32014 to M32018	Harvard Housing: Putnam Ave to Harvard Square: Mass Ave @ Dunster St	238	238	100%	One
M32009 to M32005	Lafayette Square to MIT: Stata Center	235	235	100%	None
M32009 to M32037	Lafayette Square to Ames St @ Main St	228	228	100%	One
M32018 to M32014	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Putnam Ave	224	224	100%	One
A32010 to D32010	South Station to Cross St @ Hanover St	220	218	99%	Both
M32014 to M32011	Harvard Housing: Putnam Ave to Central Square	216	216	100%	One
M32037 to M32006	Ames St @ Main St to MIT: Mass Ave	210	210	100%	One
M32005 to M32009	MIT: Stata Center to Lafayette Square	204	204	100%	None
C32003 to A32009	Back Bay / South End to Tremont St @ W Newton St	196	189	96%	One
M32037 to M32009	Ames St @ Main St to Lafayette Square	194	194	100%	One
D32010 to A32010	Cross St @ Hanover St to South Station	194	188	97%	Both

TABLE G-6
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekend)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
C32003 to C32004	Back Bay / South End to Columbus Ave @ Mass Ave	187	187	100%	Both
S32009 to S32006	Packard Ave @ Powderhouse Blvd to Davis Square	186	186	100%	One
M32019 to M32003	CambridgeSide Galleria to One Broadway / Kendall Square	179	179	100%	One
M32006 to M32005	MIT: Mass Ave to MIT: Stata Center	178	178	100%	None
S32006 to S32009	Davis Sq to Packard Ave @ Powderhouse Blvd	175	175	100%	One
M32024 to M32017	Harvard: Radcliffe Quadrangle to Harvard Square: Brattle St	170	170	100%	One
M32014 to M32016	Harvard Housing: Putnam Ave to Harvard Kennedy School	169	169	100%	None
K32001 to A32004	Coolidge Corner to Longwood Ave @ Binney St	164	164	100%	One
M32006 to M32003	MIT: Mass Ave to One Broadway / Kendall Sq	162	162	100%	One
C32006 to C32007	Washington St @ Rutland St to Prudential Center	162	162	100%	One
M32005 to M32006	MIT: Stata Center to MIT: Mass Ave	157	157	100%	None
D32019 to A32010	Boylston St @ Washington St to South Station	153	153	100%	Both
M32009 to M32011	Lafayette Square to Central Square	152	152	100%	One
D32008 to D32006	Rowes Wharf to Lewis Wharf	150	148	99%	None
M32017 to M32024	Harvard Square: Brattle St to Harvard: Radcliffe Quadrangle	149	149	100%	One
M32011 to M32030	Central Square to Dana Park	149	149	100%	One
A32006 to M32018	Harvard Housing: Western Ave to Harvard Square: Mass Ave @ Dunster St	148	148	100%	One
D32006 to D32008	Lewis Wharf to Rowes Wharf	146	146	100%	None
M32002 to M32010	One Kendall Square to Inman Square	144	143	99%	None
D32016 to D32007	Charles Circle to Boylston St @ Arlington St	143	143	100%	Both
M32014 to M32021	Harvard Housing: Putnam Ave to Harvard: Gund Hall	141	141	100%	None
D32008 to D32010	Rowes Wharf to Cross St @ Hanover St	140	140	100%	One
D32007 to A32010	Boylston St @ Arlington St to South Station	140	140	100%	Both
C32000 to D32015	Tremont St @ Berkeley St to Chinatown Gate Plaza	136	135	99%	None
A32010 to	South Station to Congress St @ Sleeper St	134	133	99%	One

TABLE G-6
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekend)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
C32010 M32003 to M32006	One Broadway / Kendall Square to MIT: Mass Ave	133	132	99%	One
A32002 to A32012	Agganis Arena to Packard's Corner	133	133	100%	Both
B32008 to D32000	Old State House to Cambridge St @ Joy St	132	132	100%	One
B32004 to D32022	Aquarium Station to TD Garden	130	125	96%	Both
S32005 to M32029	Wilson Square to Porter Square Station	129	129	100%	One
M32018 to A32006	Harvard Square: Mass Ave @ Dunster St to Harvard Housing: Western Ave	129	129	100%	One
M32026 to M32012	359 Broadway to Cambridge City Hall	129	129	100%	One
M32009 to M32012	Lafayette Square to Cambridge City Hall	129	129	100%	One
M32029 to M32031	Porter Square Station to Danehy Park	128	128	100%	One
M32011 to M32037	Central Square to Ames St @ Main St	128	128	100%	Both
D32022 to D32008	TD Garden to Rowes Wharf	128	124	97%	One
B32008 to A32010	Old State House to South Station	128	127	99%	Both
M32029 to S32005	Porter Square Station to Wilson Square	126	126	100%	One
M32030 to M32011	Dana Park to Central Square	125	125	100%	One
C32007 to C32006	Prudential Center to Washington St @ Rutland St	125	125	100%	One
M32021 to M32024	Harvard: Gund Hall to Harvard: Radcliffe Quadrangle	124	124	100%	None
C32004 to C32007	Columbus Ave @ Mass Ave to Prudential Center	124	124	100%	Both
M32014 to M32012	Harvard Housing: Putnam Ave to Cambridge City Hall	122	122	100%	One
C32010 to A32010	Congress St @ Sleeper St to South Station	122	122	100%	One
M32032 to M32019	Kendall Street to CambridgeSide Galleria	120	120	100%	None
M32024 to M32021	Harvard: Radcliffe Quadrangle to Harvard: Gund Hall	118	118	100%	None
M32009 to M32007	Lafayette Square to Cambridge St @ Columbia St	118	118	100%	None
C32001 to B32002	Roxbury Crossing Station to Ruggles Station	117	117	100%	Both
A32012 to A32002	Packard's Corner to Agganis Arena	117	117	100%	Both

TABLE G-6
O-D Pairs with 95 Percent or More Walk-Only Trips (Weekend)

O-D Pair: Station Numbers	O-D Pair: Station Names	Total Trips	Walk-Only Trips	Percent Walk-Only Trips	Trip Ends Near Rapid Transit
C32006 to D32002	Washington St @ Rutland St to Washington St @ Waltham St	115	115	100%	None
A32010 to D32011	South Station to Stuart St @ Charles St	115	113	98%	One
A32013 to D32022	John F Fitzgerald - Surface Rd to TD Garden	115	115	100%	Both
M32002 to M32037	One Kendall Square to Ames St @ Main St	114	114	100%	One
C32007 to B32005	Prudential Center to Christian Science Plaza	114	114	100%	Both
M32014 to M32017	Harvard Housing: Putnam Ave to Harvard Square: Brattle St	113	113	100%	One
D32010 to D32008	Cross St @ Hanover St to Rowes Wharf	113	113	100%	One
A32006 to M32016	Harvard Housing: Western Ave to Harvard Kennedy School	111	111	100%	None
A32013 to A32010	John F Fitzgerald - Surface Rd to South Station	111	111	100%	Both
D32010 to D32004	Cross St @ Hanover St to Franklin St @ Arch St	110	110	100%	Both
M32038 to M32018	Harvard: River Houses to Harvard Square: Mass Ave @ Dunster St	109	109	100%	One
B32002 to C32001	Ruggles Station to Roxbury Crossing Station	109	109	100%	Both
M32012 to M32009	Cambridge City Hall to Lafayette Square	108	108	100%	One
M32021 to M32014	Harvard: Gund Hall to Harvard Housing: Putnam Ave	108	108	100%	None
M32022 to M32030	Lower Cambridgeport to Dana Park	106	106	100%	None
E32002 to E32005	JP Center to Green Street Station	106	106	100%	One
D32002 to C32006	Washington St @ Waltham St to Washington St @ Rutland St	105	105	100%	None
M32018 to M32020	Harvard Square: Mass Ave @ Dunster St to Harvard Law School	104	104	100%	One
A32008 to B32010	Buswell St @ Park Dr to Kenmore Square	104	104	100%	Both
D32022 to M32034	TD Garden to EF - North Point Park	102	102	100%	One
M32031 to M32029	Danehy Park to Porter Square Station	100	100	100%	One
A32010 to B32008	South Station to Old State House	100	100	100%	Both

Data source: 2015 Hubway trip logs (4/17/2015–12/18/2015, Open Trip Planner output, and CTPS GIS Analysis.
CTPS = Central Transportation Planning Staff. JP = Jamaica Plain. MIT = Massachusetts Institute of Technology. O-D = Origin-Destination.