

Bicyclist Safety in Shared Bus Bike Lanes

A before and after analysis of bicyclist crashes in shared-bus/bike lanes in
Greater Boston

A Master's Thesis submitted by
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Abstract

Shared bus-bike lanes (SBBLs) are on-street, dedicated travel lanes for both buses and bicyclists, primarily in dense, urban areas. The goals of these lanes are to improve and enhance sustainable transportation by creating safe, efficient, and enjoyable spaces for people to ride the bus or a bicycle to get to their destinations. Local and regional efforts to install these lanes contribute to enhancing mobility, environmental sustainability, and safety in cities, such as those in the Greater Boston region.

The purpose of this thesis is to understand how the implementation of shared bus-bike lanes in Greater Boston has impacted safety for people biking. A combination of data sources were used to evaluate cyclist safety in SBBLs. Streetlight Data, a platform that provides transportation analytics by using big data such as connected vehicles and location-based services, was used in conjunction with municipal counts to understand cyclist volumes and normalize crash rates along each corridor. MassDOT Crash Portal data was used to determine the number of crashes on each corridor per year.

This thesis included numerous noteworthy findings. Overall, the installation of shared-bus-bike lanes in Greater Boston appears to be associated with a reduction in bicyclist crashes and crash rates. However, there were numerous limitations with this study including impacts of the COVID-19 pandemic, low total crash numbers, inconsistent and poor bike-related data, and a small sample size of projects, leading to variations in outcomes per project.

Additional research is needed to tell a more accurate and comprehensive picture of how shared bus-bike lanes affect bicyclist safety. Future studies should focus on increasing the total number of projects studied, using consistent bike counts and bike crash data (where available) and potentially using camera-based

data to capture non-serious crashes in order to tell a more comprehensive story of cyclist safety in SBBLs.

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Chapter 1: Introduction

In the United States, shared bus-bike lanes (SBBLs) began emerging in the 2000s, with cities experimenting with them as a policy and planning tool to address traffic congestion, improve air quality, and increase reliability of the bus system. Early municipal adopters include San Francisco, New York City, and Seattle, which implemented these lanes in congested transit corridors to increase cyclist safety and bus efficiency.

Shared bus-bike lanes offer a relatively quick and cost-effective strategy for building a more continuous and connected cycling network, especially in dense urban areas where road width is limited, and in historic cities, like Boston, that were not originally designed for cars. For comparison, bus rapid transit (BRT) projects cost roughly between \$25-\$50 million per mile, whereas rail transit projects come with a cost of approximately \$150-\$250 million per mile or more, and take years to plan and implement. Shared bus-bike lanes also contribute to sustainability goals by prioritizing sustainable modes of transportation over cars - increasing reliability, efficiency, and frequency of transit while also creating safer corridors for people biking.

Shared bus/bike lanes can be used on streets where bus priority lanes and protected bicycle facilities cannot both be added due to space limitations, as bus priority lanes have the ability to serve both buses and bikes at low speeds and low to moderate bus headways. These lanes can be against the curb as right-hand lanes (see Figure 1), or positioned in the middle of the roadway as center-running lanes on wide streets. Unlike traditional bike lanes, SBBLs provide wide lanes for people biking, while allowing buses to travel without getting delayed in traffic, leading to multiple transportation and environmental benefits.

Prior to the COVID-19 pandemic, one of the most prominent policy topics in the Boston region was traffic congestion. In early 2019, the transportation data firm INRIX Research released its annual ranking of the most congested cities in the United States, and Boston was rated number one for the second year in a row (Matousek, 2019). Boston's population and job market continued to grow year after year, but its transportation infrastructure remained stagnant. As a historic, unplanned city, Boston was at a tipping point and needed creative and innovative solutions to move more people faster, utilize street space more efficiently, and create more opportunities for mode shift away from single occupancy vehicles.

Beginning in 2018, the Massachusetts Bay Transportation Authority (MBTA) began a planning process called The Better Bus Project to drastically overhaul and update the region's bus system. One of the outcomes of this planning process was the Bus Priority Vision, a map (see figure 2) showing a network of prioritized bus improvements throughout the region. As part of this process, the MBTA, in partnership with metro Boston municipalities, began to experiment with bus priority lanes, which had proved in other cities throughout the country to be a cheap, quick, and relatively simple way to improve transit for thousands of people. Many of the cities and towns that implemented bus priority lanes often allowed (either formally or informally) people riding bikes to use the dedicated bus lanes, helping to fill gaps in the greater bike network without the need for additional expensive and lengthy street reconstruction projects.

Shared bus-bike lanes were installed (both temporarily and permanently) along several key routes in the region, prioritizing areas with high bus ridership, high bus volumes, significant bus delays, and corridors without enough space for separate bus and bike lanes. Some of these projects, such as Everett's Broadway bus lane, began as simple demonstration projects with orange cones to block traffic

and then evolved into permanent projects when planners and policy-makers saw the positive results from the pilots, while other projects were directly implemented as permanent installations.

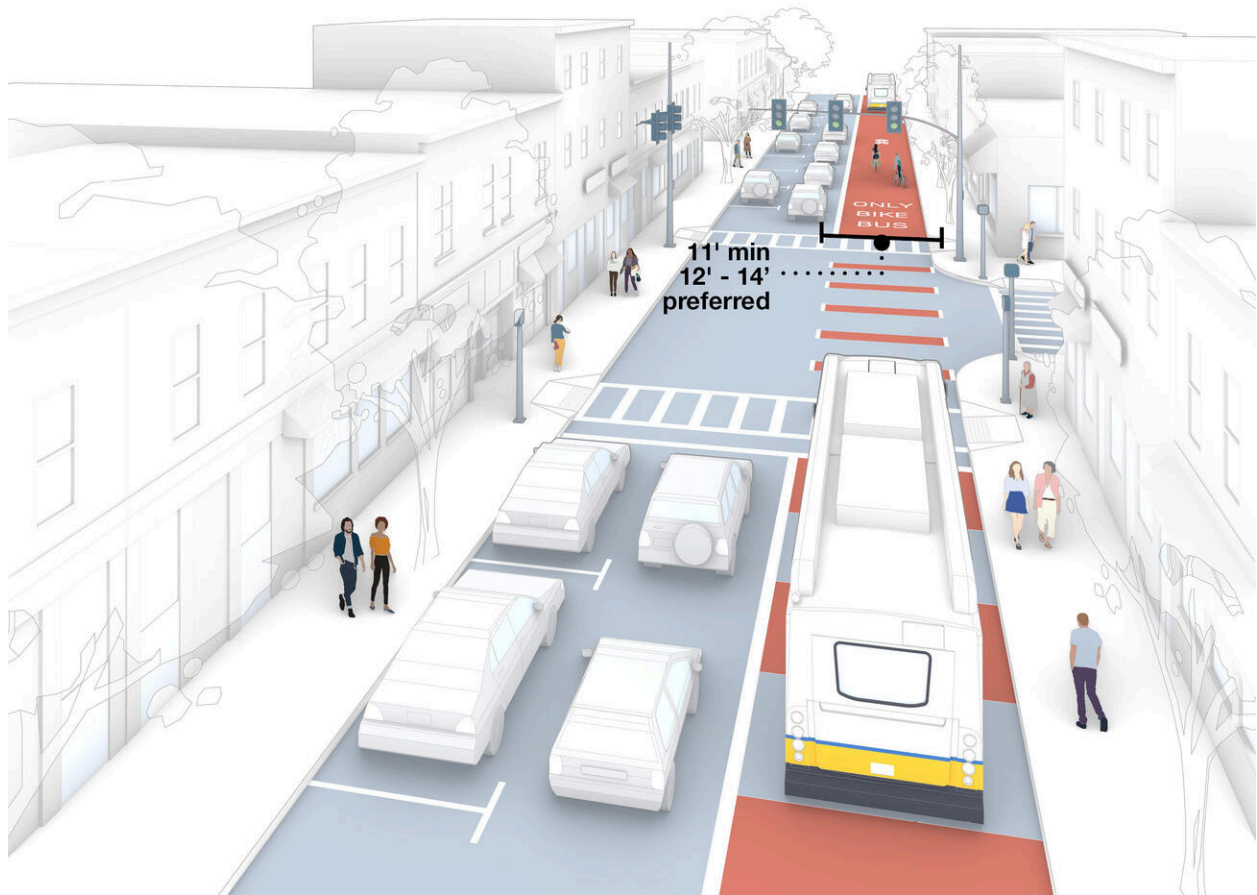


Figure 1: Rendering from MBTA's Transit Priority Strategies (Source: <https://www.mbta.com/projects/transit-priority-strategy>)

In early 2020, the COVID-19 pandemic began having drastic effects on the Boston region, particularly transportation. The traffic that once overwhelmed the region disappeared, almost overnight. Ridership on the whole MBTA system was down by as much as 70%, leaving essential workers and those who could not stay home as the primary riders. Throughout the pandemic, the bus system supported the highest ridership of any other MBTA service, highlighting how essential transit was (and is) for so many people, especially those with no other means of

transportation, as well as the necessity of further bus improvements. Biking also decreased significantly, but still remained an important mode of transportation and recreation for local residents.

A few months after the pandemic hit, the Massachusetts Department of Transportation began a grant program called “Shared Streets and Spaces,” an effort to provide immediate funding to quick build projects to address the pandemic, and bus priority was one of the eligible projects. This grant program played a crucial role in rapidly expanding bus priority throughout Greater Boston, especially on corridors with high bus ridership and significant traffic delays, as well as filling gaps in the region’s bike network.

Considering that SBBLs are fairly new, there is limited research about their safety, design guidelines, policies, implementation practices, and public education strategies. For this thesis project, I explored cyclist safety while using shared bus/bike lanes to better understand how to advance future bus/bike priority lane implementation. This thesis seeks to understand if SBBLs, when executed appropriately, can be an effective tool for improving bicyclist safety and can also be considered a tool for increasing the network for safe biking in urban areas. By moving cyclists out of general purpose travel lanes and into a shared dedicated space with buses, can cities create safer mobility options for more people, especially on corridors with limited roadway width?

I studied six different projects including Summer Street in Boston, Brighton Avenue in Boston, Massachusetts Avenue in Arlington, Broadway in Somerville (both inbound and outbound), and Mount Auburn Street in Cambridge and Watertown. My research question is: How has the implementation of shared bus/bike lanes affected cyclist safety on key transportation corridors in the Greater Boston region?

MBTA Bus Priority Vision

The Vision is a regional network map of bus priority opportunities that support existing service and are aligned with the MBTA Bus Network Redesign.

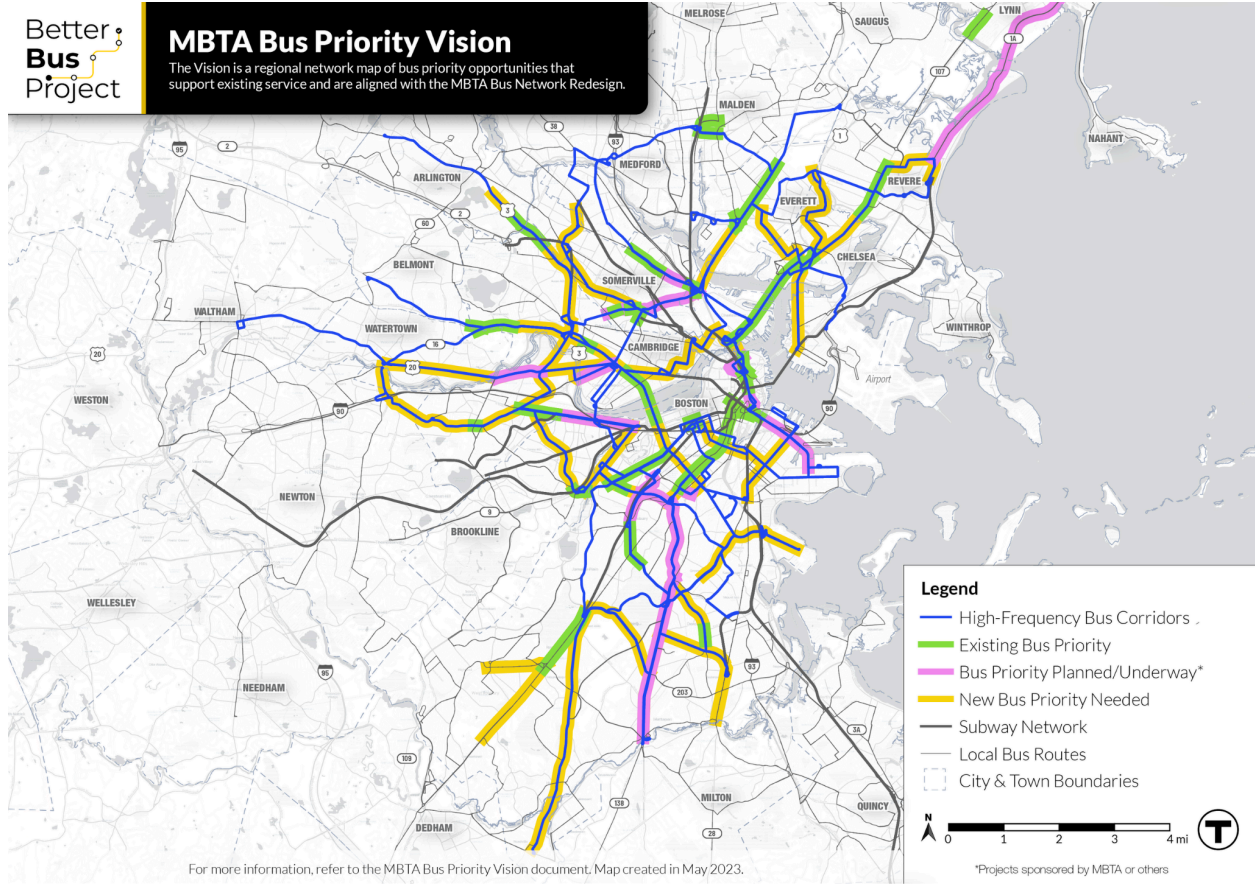


Figure 2: Bus priority corridors from the MBTA Better Bus Project

Chapter 2: Literature Review

Currently, there are multiple aspects of shared bus/bike lanes that are debated in the literature. Since they are relatively new in most cities, the ability to study them, develop best practices, and come to conclusions about their effectiveness has not been widely researched. However, there are a few studies that have attempted to develop some guidance and understanding of how they operate and function. The main topics of debate these articles present are around the design of the lanes, safety for bicyclists, and management and enforcement.

The initial design of shared-use bus bike lanes is crucial to ensure effective and efficient bus operations and bike safety while using the lanes, but the literature suggests multiple different ways to design SBBLs so that they function well. According to Hillsman (2012), the design of SBBLs varies widely depending on the state and the transportation department (Hillsman, 2012). Hillsman (2012) describes three main types of SBBLs, according to their length and location. The first type are SBBLs that serve as connectors to bike lanes, over bridges, highway overpasses, or intersections that are generally shorter than half a mile (Hillsman, 2012). The second type are urban SBBLs, located within or connecting to downtown areas. They are usually shorter than two miles and vary widely in traffic volumes (Hillsman, 2012). The third type are suburban/low density SBBLs, generally implemented on busy arterials or state highways. This type is usually longer than two miles and facilitates buses operating at higher speeds than the first two types of SBBLs (Hillsman, 2012). According to Hillsman, 72 percent of their identified SBBLs have travel lanes that are 13 feet wide or less, with speed limits ranging between 25 and 45 mph.

Cazorla (2017) reinforces that there is no current worldwide standard for the implementation of SBBLs, at least not yet (Cazorla, 2017). In addition, the design recommendations also vary based on the type of road, the incline, the connections, and the positioning of the lane near high or low traffic areas. That being said, Hillsman mentions that the most common arrangement for SBBLs on city streets is along the curb because it minimizes impacts to traffic flow (Hillsman, 2012). However, this puts buses in conflict with vehicles turning, pulling over to pick up passengers, stopping to make deliveries, or parking (Hillsman, 2012). Agrawal (2012) mentions that several cities are taking different approaches to reduce some of these conflicts, including offset lanes that preserve more curb access (New York, San Francisco), physical barriers (Paris), and median bus lanes (Seoul) (Agrawal, 2012).

The methods varied in each of these aforementioned reports. In the Hillsman et al. (2012) study, researchers conducted searches on Transport Research International Documentation (TRID), reviewed periodicals, conference proceedings, webinars, and publications of professional associations (Hillsman, 2012). With such a wide range and diverse mix of research, the findings seem valid and generalizable to many SBBLs worldwide. The Agrawal et al. (2012) paper developed case studies in seven cities that currently have bus lane networks: all of which varied significantly in size, institutional structure, urban form, and relative importance of their bus systems (Agrawal, 2012). Although creating these case studies was the main aspect of that report, the researchers also relied on literature reviews and other valid methods to back up their findings. Finally, the Cazorla et al. (2017) paper based their findings on previous studies, many of which have limited unique research and were challenged on how to generalize their results to a larger scale.

Safety is another crucial aspect of implementing shared-use bus/bike lanes. Since buses and bikes are vastly different in size, speed, and power, whether or not these lanes are safe to share is a hotly contested topic. De Ceunynck (2017) explored the width of bus lanes to determine whether or not a narrow or wide lane was safer for bicyclists (De Ceunynck, 2017). They ultimately concluded that their analysis could not confirm their hypothesis that a sufficiently narrow bus lane is safer than a wider bus lane, but did find a slight increase in close interactions for buses and bikes on narrower lanes (De Ceunynck, 2017). Contrary to the De Ceunynck (2017) paper, Cazorla et al. (2017) found that after a SBBL was installed, bicycling increased and bicycle crashes decreased (Cazorla, 2017). They mention that cyclists also perceive a greater sense of safety due to buses' lower speeds and trained operators (Cazorla, 2017).

The methods in the De Ceunynck (2017) paper and the generalizability of their results are questionable. Over two weeks, the researchers video recorded two sections of bus lanes with bicyclists in Belgium and their interactions were analyzed via the video recordings after the two weeks were over (De Ceunynck, 2017). The generalizability of these results is extremely limited, considering that the researchers only studied two lanes over one two-week period and both lanes were in the same area of one country. In contrast, Cazorla et al. (2017) pulled together their findings from a variety of case studies and reports from cities worldwide, contributing to a greater sense of validity and generalizability for its findings.

Management and enforcement of SBBLs are essential to make sure that they function as they were intended to, moving people quickly and safely without being stuck in congestion. Agrawal discusses the different ways that cities designate the shared lanes. For example, many cities paint their bus lanes one solid color, such as red, to show that it is not a travel lane for cars. Seoul, however, has concerns about

maintenance and how they will sustain their commitment to ongoing painting programs (Agrawal, 2012). According to Cazorla (2017), bus lanes typically experience rapid surface deterioration and bicyclists are more vulnerable to uneven or imperfect surfaces, meaning that cities need to have a regular maintenance plan for SBBLs if they are to remain safe and effective (Cazorla, 2017).

Who and what vehicles get to use the lanes is a frequent topic of debate in the literature. Of all the cities that Agrawal studied, every one of them allowed all vehicles to use curbside SBBLs to make right turns and to enter and exit driveways (Agrawal, 2012). Taxis were frequently allowed to use the lanes to pick up and drop off passengers along the curb, but other vehicles were typically not allowed (Agrawal, 2012). According to Cazorla, allowing additional vehicles beyond buses and bikes to regularly use SBBLs generates congestion inside the lanes, and they effectively become useless as a rapid and safe piece of transit infrastructure (Cazorla, 2012).

Agrawal discusses the various ways the seven cities they studied operate SBBLs, based on their observations. Rather than simply rely on previously identified uses, this report was able to have more valid conclusions based on their observations, which leads to more accurate results for their report. The Cazorla report is ultimately a secondhand report of previous studies. Although their conclusions and recommendations seem more realistic, their methods aren't as strong as those used for the Agrawal report.

Data Validation and Local Reports

StreetLight Data Validation

In addition to SBBL arrangement and design aspects, literature on the accuracy of StreetLight data for transportation analyses was also reviewed for this study. StreetLight is a company that specializes in providing transportation-related data from a variety of smart devices using location-based data. Streetlight uses data from sources such as connected vehicles, GPS, and mobile devices, and then predicts each person's mode of travel through an algorithm that includes an assessment of speed, location, movements, and more.

StreetLight data has increased in popularity as a tool for analyzing transportation behaviors and patterns, as it's able to collect data twenty-four hours a day, seven days a week and count movements across many modes of transportation, unlike conventional strategies that often involve manual counts at a few locations, are very labor intensive, and are only conducted a few times per year.

Multiple research studies have been conducted to understand the reliability of StreetLight's data. Overall, the studies show its accuracy in certain situations, such as in high-volume areas like cities, but also show noteworthy inconsistencies that are important to consider when using this dataset for policy and planning purposes. Several key findings from recent studies highlight strengths and weaknesses of StreetLight Data:

Low error in urban areas, but high error in rural areas: Validation studies show that StreetLight's Annual Average Daily Traffic (AADT) estimates show a strong correlation with data collected by permanent traffic counters in high volume areas, but show higher errors in areas with low traffic volumes. A Minnesota Department

of Transportation study found that Streetlight data improved significantly from 2017 to 2019 (Turner, 2020). The study found that the data error ranged from 8% to 10% for locations greater than 10,000 average daily traffic (AADT) but gradually increased to 42% for areas with less than 1,000 AADT over the two year period (Turner, 2020). In addition, the study found significant errors for low-volume roadways (2,500-5,000 AADT) (Turner, 2020).

A study conducted through Carnegie Mellon University also reported more accurate results in dense, urban settings as compared to rural areas, but recommended combining StreetLight data with manual counts for more accurate planning and data collection efforts (Lindsay, 2024). These findings suggest that StreetLight Data can be an effective tool for studying traffic and mobility patterns in urban areas, but might not be as effective to use in suburban and rural areas, and should continue to be used with traditional transportation data collection methods, especially on lower-volume roads and paths. Dense, urban areas generally provide more data points through location-based devices, but rural regions have less data to use to make accurate conclusions about travel patterns.

Inequity exists in the data collected, some groups are not counted: One noteworthy challenge of StreetLight data is how the data is collected - through devices not people. Streetlight primarily collects its data from mobile devices and GPS sources, which means people who don't use those devices don't get counted. Individuals without access to (or who don't use) smartphones, broadband, or personal vehicles, such as low-income or elderly populations, are likely to be underrepresented, which raises equity concerns if StreetLight data was the primary data source used for decision-making. According to a report by the National Institute for Congestion Reduction, Streetlight data (and other similar data

platforms) can support transportation equity analysis and equity-related decision-making, but can also create inequities, as it's unable to count everyone (Boyd, 2024).

StreetLight Data that counts people walking, biking, and rolling should be validated with other data sources: In addition to vehicle data, StreetLight collects and analyzes data from location-based services on cell phones, allowing for a broader understanding of active transportation patterns, like walking, biking, and rolling. Streetlight's website claims validation efforts for their Active Transportation Monitor show an 0.81 correlation between bicycle volumes predicted by StreetLight and American Community Survey (ACS) data, which exceeds their target threshold of 0.7. A University of Minnesota study found that since Streetlight is based on models, circumstances such as behavior shifts may result in decreased accuracy of those models (Yang, 2024).

Streetlight data is based on proprietary models, which may not capture data accurately: StreetLight relies heavily on proprietary models to interpret raw data, and these models may not always capture rapid shifts in user behavior accurately. For instance, changes in travel patterns due to events like the COVID-19 pandemic or seasonal construction work might not be immediately shown in the data, affecting data reliability. In addition, StreetLight is continuously updating their algorithms to increase accuracy of their data. These changes are not clear, and may affect the ability to accurately analyze travel patterns across different time periods, such as year to year. (Raida, 2024)

As StreetLight Data is a relatively new tool for transportation analysis, it should be used with other conventional data sources like surveys, manual counts, or counters to check accuracy, fill gaps, and more comprehensively count all users.

These data sources, when combined, can provide a more comprehensive picture of travel patterns in a designated area. Combining mobile data with manual data collection efforts can help improve estimates and therefore make more useful and equitable transportation planning decisions.

Municipal and MBTA Project Evaluation

Municipal evaluation data varied widely from project to project. For some projects, no evaluation data was found, while other projects had extensive information available about performance, ridership, usage, and future improvements. The information found is summarized here.

Summer Street, Boston

No project evaluation data was found for this segment of the shared bus-bike lane on Summer Street, however, project extensions have occurred further south on Summer Street in the Seaport. A 0.2 mile dedicated, sidewalk-level bike lane was constructed in 2018 and 2019 that also included wider sidewalks, new street furniture, short crosswalks, and new street trees.

In 2023, the City of Boston piloted a bus and truck lane program on Summer Street between South Station and South Boston. This project also included better bike lanes and improvements to pedestrian infrastructure. At the end of the pilot, the City determined that the bicycle and pedestrian changes would remain, but the bus/truck lane would be removed and reevaluated.

Brighton Avenue, Boston

The City of Boston found that the inbound shared bus-bike lane in Brighton Avenue resulted from an increase in both bus and bike ridership along the corridor.

More than 14,000 MBTA bus passengers and approximately 1,300 bike riders travel along this corridor each day. Results showed a 5.3% growth (from pre-installation) in bus passengers in the morning peak hour, and an 8.1% growth in bus passengers in the evening peak hour (City of Boston, 2024). The City also found that from October 2017 to September 2019, the inbound lane saw a 23% average increase in the peak morning bike ridership, and a 68% average increase in the peak evening bike ridership (City of Boston, 2024). Mode shift also occurred along the corridor, showing an increase in the percentage of people using bikes to travel on this street.

Massachusetts Avenue, Arlington

The Town of Arlington first piloted the Massachusetts Avenue shared bus-bike lane in the fall of 2018. They found that it had both public support and reduced morning commute times for bus riders and improved reliability. Due to these findings, the Town, in partnership with the MBTA, made the pilot permanent in 2019.

In May 2024, the Town of Arlington and the MBTA announced an extension of the Massachusetts Ave bus-bike lane, which includes an outbound lane from Alewife Brook Parkway to the opposite side of Lafayette Street (MBTA and the Town of Arlington, 2024). In addition, the City of Cambridge installed dedicated bus lanes and separated bike lanes on North Massachusetts Avenue, just south of the Arlington SBBL, creating a more cohesive and comprehensive network for both buses and bikes on this corridor. This additional project consisted of 0.4 miles of new dedicated bus lane and separated bike lanes in both directions between Dudley Street and Alewife Brook Parkway, the terminus of the Arlington SBBL. The analysis for this project showed the street changes decreased travel times by 6% during the weekday morning peak hour (MBTA and the Town of Arlington, 2024).

Broadway, Somerville

The City of Somerville installed both the inbound and outbound shared bus-bike lanes on Broadway between Main Street and McGrath Highway (Route 28) in 2019. After the lanes were completed, the city saw an average increase in bus ridership of 30% over pre-installation ridership numbers, including an increase in people taking the bus on the weekends (City of Somerville, October 2019).

At the time the SBBLs were installed, the Broadway corridor was one of Somerville's High Crash Corridors. In addition to installing SBBLs, the city had a multi-pronged approach to addressing these safety issues. They employed strategies such as restricting parking, daylighting at intersections, increasing the safety of non-driving options, improving and increasing crosswalks, and more.

Mt Auburn Street, Cambridge/Watertown

The Mt Auburn shared bus-bike lane spanning Watertown and Cambridge was installed in 2019. The City of Cambridge and the City of Watertown conducted an evaluation of the pilot and found that there was an overall higher level of satisfaction with the new function of the corridor. Prior to the installation of the SBBL and other corridor improvements, less than 19% of the corridor's users were satisfied with the way Mt Auburn Street functioned (City of Cambridge, April 2023). Conversely, after the installation of the SBBLs, nearly 57% of corridor users were satisfied with the way the street functioned (City of Cambridge, April 2023). In addition, people using every mode felt more comfortable traveling on the street. The evaluation also found that bus riders saved 4-5 minutes on an average trip, leading to a total savings of 3,600 hours of travel time on Mount Auburn Street in one year (City of Cambridge, April 2023).

People feel more comfortable to travel on Mount Auburn Street, especially people biking.

Most survey respondents said that comfort improved post-pilot, in particular people biking rated the street as much more comfortable.

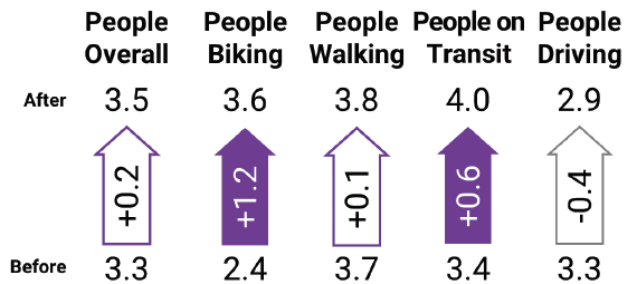


Figure 3: Evaluation results from the City of Cambridge and the City of Watertown's evaluation of the pilot

Impact of COVID-19 on Travel Patterns in Greater Boston

The COVID-19 pandemic significantly disrupted travel patterns in the Greater Boston region, leading to noticeable changes in traffic, crashes, and overall mobility across all modes. While the region saw a reduction in vehicle volumes compared to previous years, the region simultaneously saw an increase in crashes and roadway fatalities, including increased fatalities for people walking, biking, and rolling. Increased speeding on mostly empty roadways as well as reduced police enforcement appeared to be a consistent theme leading to the increase in fatalities despite fewer vehicles on the roads.

Before the COVID-19 pandemic, the greater Boston area was seeing a continuous annual growth in bicycle ridership as bike infrastructure increased, especially in the inner core. In Cambridge, for instance, bicycle counts rose from 5,287 in 2003 to nearly 20,000 in 2019, marking a significant growth in bicycling activity. (City of Cambridge, October 2023) However, the start of the pandemic in 2020 led to a disruption in the annual growth of bicycle ridership. Boston's 2020

bike counts revealed a 35% decrease in June compared to previous years, with over 10,000 bicyclists counted at 23 locations. (Boston Transportation Department, March 2021) This decrease was mainly during peak commuting hours, aligning with reduced work commutes seen across all travel modes in the region. However, off-peak and weekend cycling saw an increase, with weekend trips in areas like Kendall Square (normally a high commuting location) increasing by up to 37% in October 2020, suggesting a surge in recreational biking by local residents (City of Cambridge, October 2023). By 2022, as the effects of the pandemic declined, Cambridge reported a rebound in bicyclist ridership, though counts were still below peak 2019 levels (City of Cambridge, October 2023). Overall, while commuting-related bicycling declined during the pandemic, recreational biking appeared to increase, leading to a shift in bicycling patterns and numbers in the Boston region.

Chapter 3: Methods and Data

The primary methods for this thesis included reviewing bike crash data on corridors before and after bus priority projects were implemented and normalizing that data with average ridership counts using StreetLight data, supplemented with local and regional bike count data. Streetlight is a transportation mobility platform that collects cell phone data and GPS data to analyze for transportation planning purposes. A free student account was used for this review, and the accuracy of Streetlight's data was assessed as well.

Streetlight did not have bike counts available prior to January 2019, so alternative data sources were used for 2018. Multiple sources were reviewed to fill in the gaps from Streetlight's data. The first source that was reviewed was

MassDOT's Bicycle and Pedestrian Counter Dashboard (Commonwealth of Massachusetts, August 2025). This source contains designated counts throughout the state with similar methods from year to year, but only contained data from 2020-2024. In addition, the count locations were almost exclusively on shared use paths, trails, and bridges rather than on-street. The second source reviewed was the Boston Region MPO's Bicycle and Pedestrian Count Database (Boston Region Metropolitan Planning Organization, June 2025). This source included counts at many of the studied locations, but the year of the data was inconsistent and often didn't align with the timeframe needed for this study.

For bike counts within Boston, including on Brighton Ave and Summer St, the City of Boston bike count data was used (Boston Bike Counts, July 2020). This data does not represent annual average counts, like Streetlight, but rather a single day of total bike activity. These counts were captured in the fall (September, October), which likely represents higher than average bike activity on these segments due to weather, students returning to college, and additional commutes to work after summer vacations.

The City of Cambridge also collects bike counts and maintains Citywide Bicycle Count Data (City of Cambridge, September 2024). Two locations along Mt Auburn Street were available for 2018, and those counts were averaged together for the count included in the analysis for Mt Auburn Street.

The City of Somerville has a volunteer bike count program each fall that helps the city understand bike activity in the city. The program has been in place since 2010. Somerville's Bicycle and Pedestrian Counts Database contains data for numerous years and locations (City of Somerville, February 2025). Counts are collected Tuesday, Wednesday, or Thursday for one hour in the morning and evening using a "screen line" method, whereby cyclists and pedestrians are counted

as they pass by an imaginary line across the street and sidewalks. Morning count sessions begin between 7:15 and 7:45 am, and evening count sessions begin between 4:45 and 5:15 pm (City of Somerville, February 2025). Bikes that have multiple people on them, such as cargo bikes, are counted as multiple people biking (City of Somerville, February 2025). Somerville notes that there are several external factors that may influence the counts, such as construction and weather, and that this data should be used to observe high-level trends rather than detailed changes in activity. Two locations in the counts were within and near the SBBLs on Broadway, including Broadway and McGrath Highway (at the southern end of the corridor) and Broadway and Temple Street, directly in the middle of the corridor. There were two counts for Broadway and Temple, and a morning and afternoon counts. These counts were averaged together and multiplied by 12 hours to get a rough average daily bicyclist count for 2018. This same number was used for inbound and outbound counts.

The Town of Arlington does not conduct bike counts, which made finding specific data challenging. The Boston MPO conducts counts on an annual basis at different locations throughout the region, but their locations vary from year to year (Boston Region Metropolitan Planning Organization, September 2016). In 2016, the MPO conducted bike counts along Massachusetts Avenue at Teel Street and Thorndike Street, which is within the segment of roadway that was part of this analysis. The 2016 counts were conducted on a sunny, warm day in September, but only captured people biking during peak times, between 7:00am-9:00am, and 4:30pm-6:30pm (Boston Region Metropolitan Planning Organization, September 2016). These counts captured on average 24 people biking every 15 minutes during the morning peak times, and on average 30 people biking during the afternoon peak times (Boston Region Metropolitan Planning Organization, September 2016).

These counts were averaged together and multiplied by 12 hours to get a rough average daily bicyclist count for 2018.

Projects in Boston, Cambridge, Watertown, Somerville, and Arlington were reviewed to understand how shared bus bike lanes affect cyclist safety throughout the region. The following projects were assessed:

- Summer Street Bus/Bike Lane, Downtown (Boston)
 - Inbound lane installed in October 2019
- Brighton Avenue Bus/Bike Lane, Allston, (Boston)
 - Inbound lane installed June 2019
- Massachusetts Avenue, Arlington
 - Inbound lane installed October 2019
- Broadway, Somerville
 - Inbound lane installed August 2019
 - Outbound lane installed August 2019
- Mt Auburn Street, Cambridge/Watertown
 - Inbound lane installed August 2019

Each of the above projects were installed pre-pandemic, are within the greater Boston region, and provide connectivity along major corridors to connect residential areas to key destinations. Some of these corridors have corresponding outbound shared bus/bike lanes that were not included in this analysis (with the exception of Somerville's Broadway outbound lane). In addition, many of these projects had additional elements added, including lane extensions, transit signal priority that were outside the bounds of this analysis.

Crash data was acquired from MassDOT's Crash Data Portal, and supplemented when needed with municipal crash data. For example, the Boston Police Department does not send most crash reports to the Registry of Motor

Vehicles. The crash data represented in the MassDOT Crash Data Portal for Boston only represents crashes from state police crash reports.

Only crash data for bicycles was included in this analysis, meaning crash data for other modes were not evaluated. The data was normalized using StreetLight Data (and local bike counts for 2018) along the specific corridors where the bus/bike lanes projects were implemented so that an accurate assessment could be made about percent change in crashes based on how many people were biking along the route before and after the bus lanes were added.

Total crashes along the corridor were reviewed two years (24 months) prior to installation versus two and a third years (28 months) after installation. This range helps to account for weather-based changes throughout the year, as well as other changes such as construction. This data was normalized with average daily bike ridership along these corridors throughout the roughly five 1-year time periods using StreetLight data.

In addition to the design of the SBBLs, the National Walkability Index was used to evaluate the surrounding land uses, to better understand if there was a correlation between surrounding land use and safety in shared bus-bike lanes (United States Environmental Protection Agency, May 2025). The National Walkability Index is a nationwide data resource maintained by the United States Environmental Protection Agency (EPA) that ranks block groups according to their relative walkability (United States Environmental Protection Agency, May 2025). It provides walkability scores based on a formula that ranks selected indicators from the Smart Location Database that have been shown to increase walkability in an area, such as density, diversity of land uses, and proximity to transit (United States Environmental Protection Agency, May 2025).

After analyzing the data, literature review findings helped to determine what elements may have contributed to safer shared bus/bike lanes. This was used to propose design and policy solutions for the design and operation of future shared bus/bike lanes in the future.

Analysis of previously collected data

Previously collected data exists in the Boston region about user satisfaction, project performance, ridership changes, as well as some questions regarding level of comfort. Municipalities, the MBTA, non-profits, and private entities all played varying roles in data collection and project evaluation, and these results were included as part of the literature review, as well as the discussion and evaluation of the results.

Chapter 4: Design, Operation, and Surrounding Context of Greater Boston Shared Bus Bike Lanes

The five different shared bus/bike lanes studied for this thesis varied in their design, operation and surrounding context. Some projects only operate at peak times, meaning the times of the day when travel is typically highest, while others operate twenty-four hours a day, seven days per week (also known as all-day bus lanes).

According to the MBTA's Bus Priority Toolkit, released in May 2023, shared bus-bike lanes should consider current and future bicycle volumes along the corridor where the treatment is being planned (Massachusetts Bay Transportation Authority, September 2024). It is recommended to provide separated bike and bus facilities where space allows, as well as grade changes, such as prioritizing

separated facilities on uphill segments where bike riders will likely be significantly slower than a bus. The toolkit also mentions that SBBLs improve speed and reliability, but should not be used on corridors with high transit (under 4 minutes) or bike volumes, or fast moving vehicles (Massachusetts Bay Transportation Authority, September 2024).

All projects included in this thesis include pavement markings and signage to indicate bus-only lanes and allow emergency vehicles and school buses to use the lanes. Many projects also include red paint to reinforce the bus-only lane, signal improvements to allow for transit signal priority, shared bus/bike lane designation, dedicated bike facilities, and pedestrian safety and accessibility improvements.

Summer Street

Summer Street is a major connector route between Downtown Boston and the Seaport, an area with limited rapid transit options. The shared bus-bike lane on Summer Street was installed in 2019 and runs inbound from Dorchester Avenue to Atlantic Avenue in Boston's financial district. The lane is one of the shortest in the region, stretching merely 0.2 miles up to Boston's South Station, one of the busiest transit stops in the region. The SBBL runs adjacent to the curb, and replaced a travel lane for general purpose traffic. This corridor serves bus routes 4 and 7 (Massachusetts Bay Transportation Authority, June 2025).

In addition to the shared bus-bike lane, the City of Boston built separated, sidewalk-level bike lanes on Summer Street just south of the SBBL, creating a network for people biking from the Seaport. These concurrent projects were part of a first phase of completed work on Summer Street, which was later followed by an extension of the bus lane into the Seaport district and towards South Boston.



Figures 4-5: Summer Street (August 2018 vs. August 2024), Google Street View

The area surrounding this segment of Summer Street is considered “Above Average Walkable” according to the National Walkability Index (United States Environmental Protection Agency, May 2025). On the north side of this street segment is the Federal Reserve Plaza, an employment area with many employees, but not necessarily a high walkability area, considering the lack of storefronts and other amenities for the public. It’s likely that employees of the Federal Reserve walk in and around this area, but it probably sees low foot traffic from the general public. To the south of this street segment is an office building and South Station, the busiest transit hub in New England. Again, the office building likely sees many employees entering this building, but not as many people from the general public walking to this area. However, as South Station is the busiest transit hub in New England, there is a substantial amount of foot traffic (and bike traffic) around this corner, which is on the north/west end of the Summer Street SBBL. There is also a Bluebike station with approximately 45 docks, one of the largest bikeshare stations in the region due to the high demand to bike to the station.



Figure 6: Summer Street walkability ranking, National Walkability Index

Brighton Avenue

Brighton Avenue is a key connector route into Downtown Boston from the Allston Brighton neighborhood and beyond. A shared bus-bike lane was installed on the eastbound side of Brighton Avenue between Union Square and Packards corner for peak morning service in the summer of 2019 (Massachusetts Bay Transportation Authority, June 2025). The 0.6 mile parking off-set bus-bike lane is adjacent to curb-side parking, with a vehicle travel lane to its left. The previous condition of the inbound Brighton Ave was a green painted bike lane that cars could drive over, if traffic was heavy, providing little protection for those biking. The SBBL connects to protected bike lanes on Commonwealth Ave east of Packard’s Corner, creating an enhanced network effect for cyclists. According to the MBTA,

this corridor serves more than 1,300 daily bike riders (Massachusetts Bay Transportation Authority, June 2025).



Figures 7-8: Brighton Avenue (Oct 2018 vs. Oct 2022), Google Street View

The area surrounding this segment of Brighton Avenue is primarily considered “Most Walkable,” but has a small area considered “Above Average Walkable” according to the National Walkability Index (United States Environmental Protection Agency, May 2025). This segment of Brighton Avenue has a mix of land uses along the roadway including residential, commercial, and surface parking lots. Many of the businesses along the route are take out restaurants, grocery stores, convenience stores, liquor stores, and other stores that the general public can walk into from the sidewalk. Other amenities included in this area include benches, pedestrian-level lighting, and bike parking. The mix of businesses, available amenities and residential units make this segment highly walkable, bikeable, and very busy most of the day.

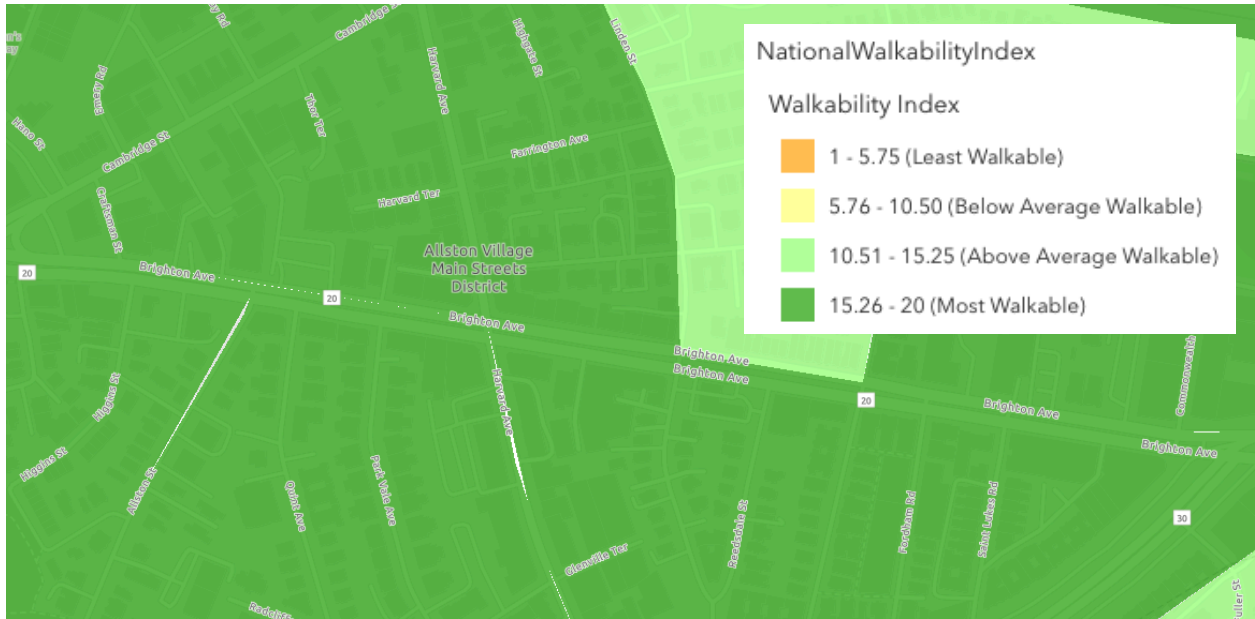
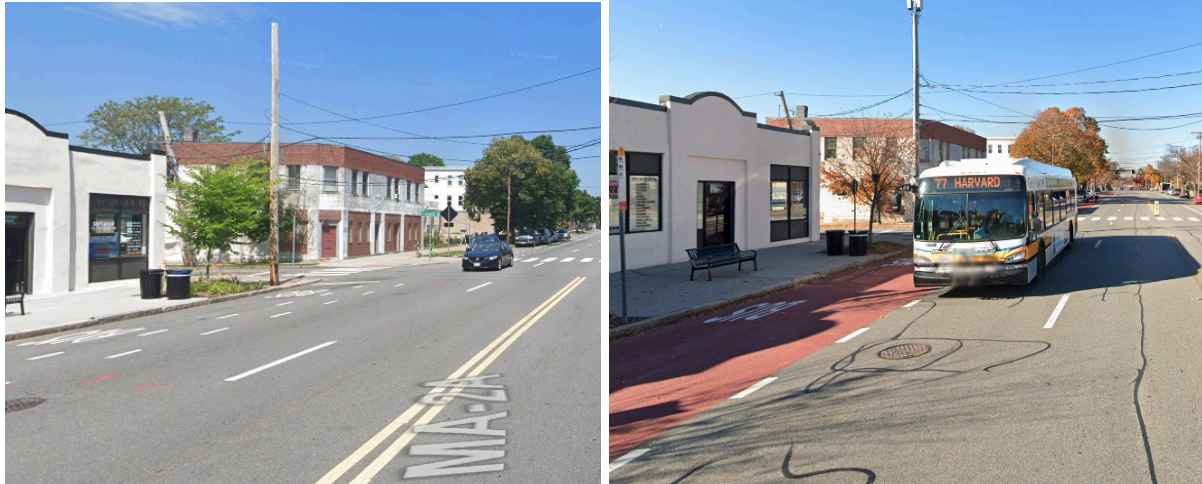


Figure 9: Brighton Avenue walkability ranking, National Walkability Index

Massachusetts Avenue

Arlington repurposed parking along the eastbound section of Massachusetts Avenue from Lake Street to Alewife Brook Parkway to make space for a shared-bus-bike lane. Initially piloted in October 2018, the project underwent multiple changes before it was installed that shortened its original length and layout. The implemented lane runs adjacent to the curb and only operates during peak hours in the morning from 6:00am-9:00am, allowing vehicle parking and dedicated bike lanes during other times of the day (Massachusetts Bay Transportation Authority, June 2025). Vehicles allowed to use the dedicated lane include MBTA buses, emergency vehicles, school buses, and bikes.



Figures 10-11: Massachusetts Avenue (July 2018 vs. March 2022), Google Street View

The area surrounding this segment of Massachusetts Avenue is considered a mix of “Most Walkable” and “Above Average Walkable” according to the National Walkability Index (United States Environmental Protection Agency, May 2025). This segment of Massachusetts Avenue has a variety of land uses along the route, including residential, commercial, surface parking lots, and park spaces. Many of the businesses along the route are take out restaurants, small retail businesses, convenience stores, and other stores that the general public can walk into from the sidewalk. In addition, there are many side streets that intersect with Massachusetts Avenue, allowing residents from those locations increased access to the commercial corridor, and allowing for increased foot and bike traffic in the area. Other amenities included in this area include benches, pedestrian-level lighting, bike parking, and green spaces. The mix of businesses, available amenities and residential units make this segment highly walkable, bikeable, and an important destination for Arlington residents and visitors.

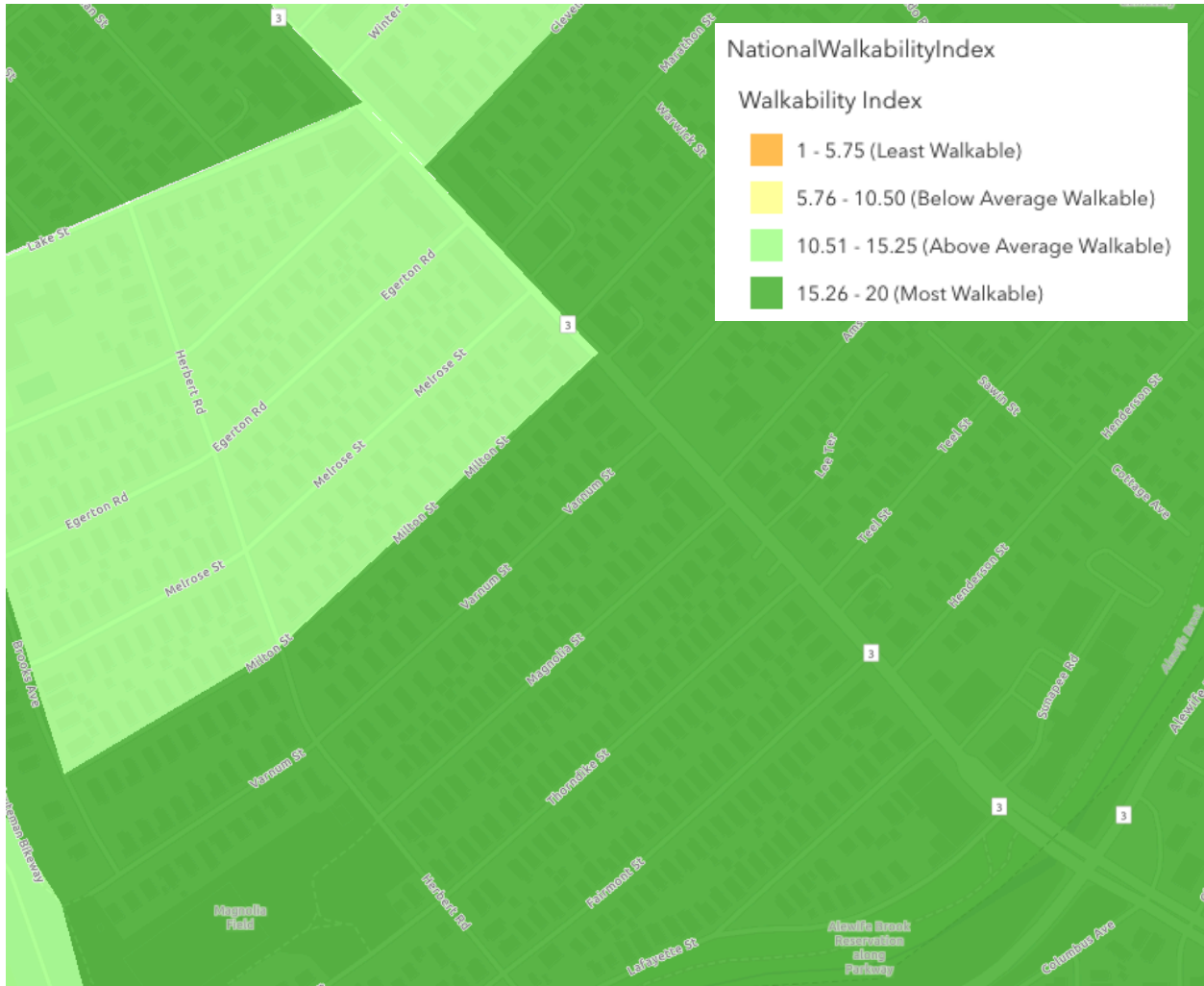


Figure 12: Massachusetts Avenue walkability ranking, National Walkability Index

Mt Auburn Street

The inbound shared bus-bike lane on Mt Auburn Street extends through both Watertown and Cambridge. This project included a dedicated shared bus-bike lane, queue jumps, and re-timed traffic signals and transit signal priority (Massachusetts Bay Transportation Authority, June 2025). The SBBL operates all day and can be used by MBTA buses, bikes, and other shuttles. Cambridge, Watertown, and the Department of Conservation and Recreation (DCR) upgraded signal equipment on Mount Auburn Street, including one queue jump signal at DCR's

Coolidge Ave intersection, and two queue jump lanes in Watertown at School and Walnut Streets (Massachusetts Bay Transportation Authority, June 2025). These queue jumps gave buses and shuttles priority in intersections on Mount Auburn Street and Belmont Street. Re-timed traffic signals and transit signal priority gave buses more green light time and improved traffic flow along the corridor. Bike lanes were also installed in Cambridge westbound (toward Watertown/Belmont).



Figures 13-14: Mt Auburn Street (July 2018 vs. Oct 2023), Google Street View

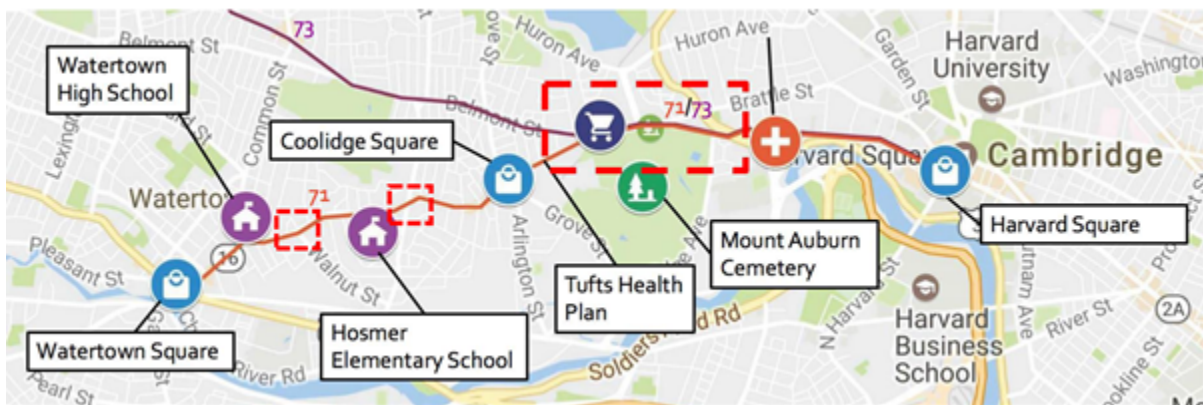


Figure 15: Project Area Map from City of Cambridge - Mt. Auburn Street Bus Priority Pilot

Most of the area surrounding this segment of Mt Auburn Street is considered “Above Average Walkable,” with a few areas considered “Most Walkable” according

to the National Walkability Index (United States Environmental Protection Agency, May 2025). The section of Belmont Street, which includes the first part of this project’s SBBL, is considered “Above Average Walkable” through this same index. The Belmont Street segment is almost entirely residential, with a school and a few small businesses along the route as it approaches the intersection with Mt Auburn Street. The street has sidewalks lining both sides of the street with street trees, benches, and bike parking, increasing the walkability and bikeability along this area. Once the SBBL transitions onto Mt Auburn Street, the walkability changes considerably. To the south of the SBBL is a fenced off cemetery, and to the north are a number of stripmall-type businesses. Concurrently, the roadway transitions to a much higher volume roadway type with multiple lanes of traffic, making it more difficult to cross, and less enjoyable for walking and biking.

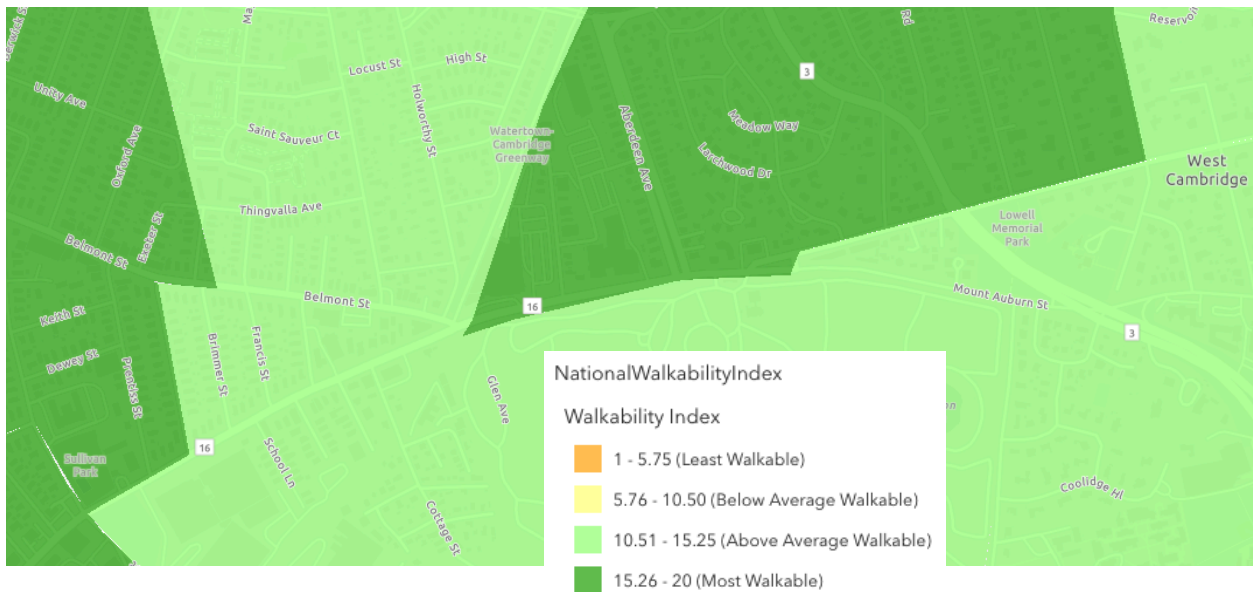


Figure 16: Mt Auburn Street walkability ranking, National Walkability Index

Broadway

Two shared bus-bike lanes (inbound and outbound) were installed on Broadway in Somerville in August 2019. The final design included a half-mile long,

bi-directional, all-day shared bus-bike lane between McGrath Highway (State Route 28) and Main Street. Broadway serves two major bus routes including the 101 and the 89 (Massachusetts Bay Transportation Authority, June 2025). Together these two routes carry approximately 7,700 riders over a typical weekday, a few of the highest bus ridership routes in the city (Massachusetts Bay Transportation Authority, June 2025). Both of these lanes operate twenty four hours a day, seven days a week and never allow cars to use them. MBTA buses, emergency vehicles, school buses, and bikes are allowed to use the dedicated lanes.

There are portions of the corridor that have separated bike lanes, where space allows, but the majority of the corridor has shared bus-bike lanes adjacent to curbside parking. Based on community feedback, the City created separated lanes for buses and bikes between Temple Street and Main Street westbound due to safety concerns about the speed difference between buses and bikes when climbing uphill in this area. Due to this necessary separation, curbside parking was converted along this stretch of the corridor to accommodate both mobility lanes.

These two projects included bus stop consolidations, better signage, and bike and pedestrian improvements throughout the corridor (Massachusetts Bay Transportation Authority, June 2025). The traffic signal upgrades and retiming was considered a key strategy to maximize the benefit of the bus-bike lanes, and simultaneously mitigate potential queuing in the general purpose lanes.



Figures 17-18: Broadway, Inbound (Sept 2018 vs. Aug 2024), Google Street View



Figures 19-20: Broadway, Outbound (Sept 2018 vs. Aug 2024), Google Street View

The area surrounding these two segments on Broadway is considered “Most Walkable,” with a few areas considered “Above Average Walkable” according to the National Walkability Index (United States Environmental Protection Agency, May 2025). Broadway is a key connector route between Somerville, and more northern communities, into downtown Boston, and therefore facilitates the movement of many people in various travel modes, especially during commuting times. There are many multi-unit residential buildings, as well as small businesses accessible from the sidewalks, office buildings, banks, restaurants, medical centers, grocery stores,

a fire station, and surface parking lots. There are many crosswalks in this segment of Broadway, and a center running media that allows a refuge for people crossing the street. Between Broadway's role as a key connection route, and its many amenities along the route, the area sees a significant amount of walk, bike, and roll activity along the roadway.

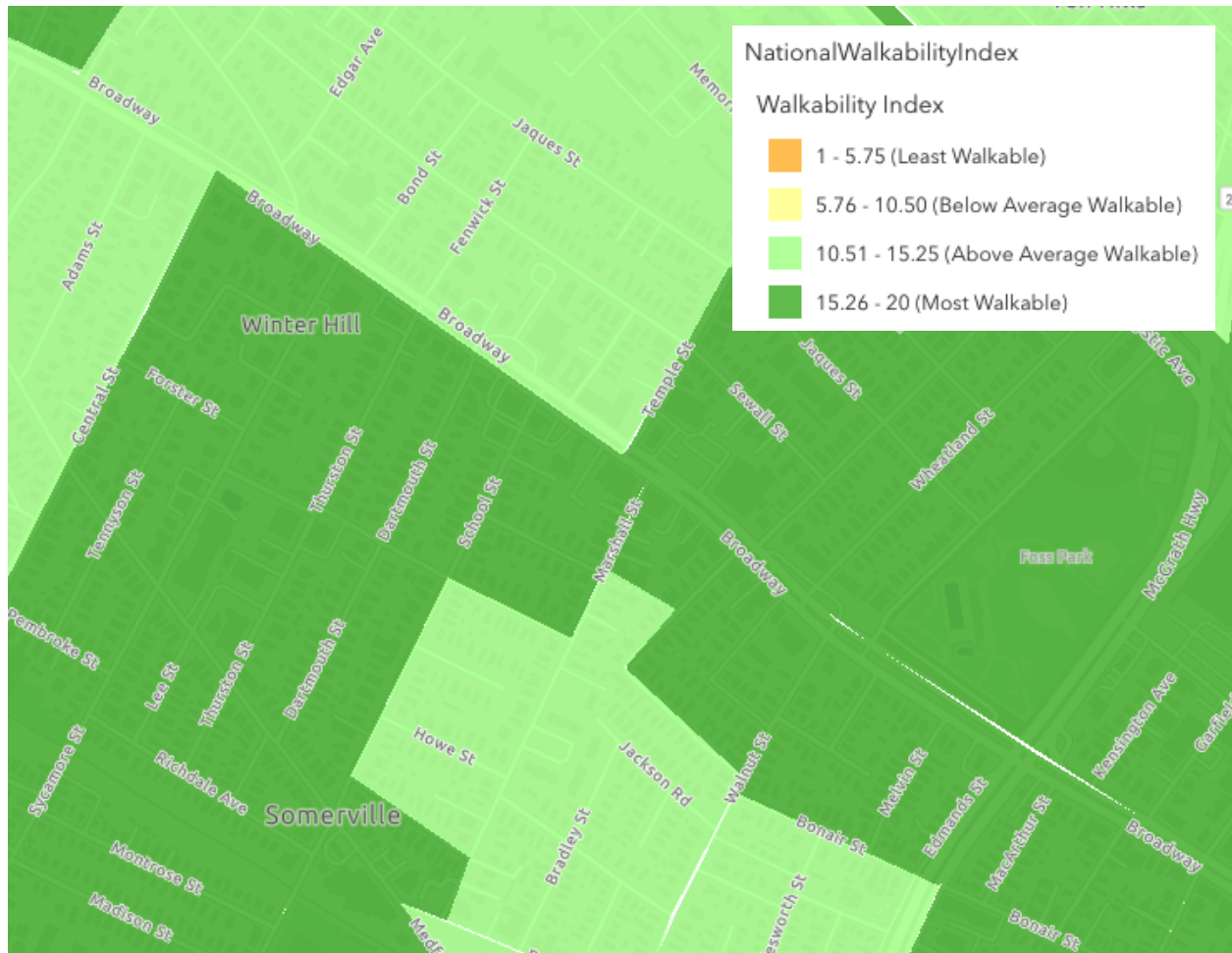


Figure 21: Broadway walkability ranking, National Walkability Index

| Table 1: Basic Project Facts | | | | | |
|------------------------------|----------------------|------------------------|----------------------|-------------------------|-----------------|
| | Summer Street | Brighton Avenue | Massachusetts | Mt Auburn Street | Broadway |

| | | | Avenue | | |
|--------------------------|--|--|---|--|--|
| Municipality | Boston | Boston | Arlington | Cambridge & Watertown | Somerville |
| Bus Routes | 7 | 57/57A and 66 | 77 and 350 | 71 and 73 | 89 and 101 |
| Installation Date | October 2019 | June 2019 | October 2019 | August 2019 | August 2019 |
| Exact Location | Inbound from Dorchester Ave to Atlantic Ave (Financial District) | Inbound from Union Square to Packards Corner | Inbound from Lake St to Alewife Brook Parkway | Inbound from Belmont Street to Aberdeen Avenue; Eastbound on Belmont Street from Sullivan Road to Mount Auburn Street; East- and westbound on Mount Auburn Street from Cottage to Belmont Street | Inbound and Outbound between Main Street and McGrath Highway |
| Peak Headways | 10 min (Route 7) | 10 min (Route 57); 10 min (Route 66) | 10 min (Route 77); 20 min (Route 350) | 10 min (Route 71); 10 min (Route 73) | 10 min (Route 89); 20 min (Route 101) |

| | | | | | |
|--------------------------|------------------------|--------------------------------------|---------------------------------------|--------------------------------------|---------------------------------------|
| Off-Peak Headways | 30 min (Route 7) | 15 min (Route 57); 15 min (Route 66) | 15 min (Route 77); 60 min (Route 350) | 30 min (Route 71); 20 min (Route 73) | 45 min (Route 89); 50 min (Route 101) |
| Total Mileage | 0.1 Miles | 0.6 Miles | 0.2 Miles | 0.8 Miles | 0.6 Miles (each way) |
| Operations | All Day | All Day | Morning Peak; M-F 6:00am-9:00 am | All Day | All Day |
| Walkability Score | Above Average Walkable | Most Walkable/Above Average Walkable | Most Walkable/Above Average Walkable | Most Walkable/Above Average Walkable | Most Walkable/Above Average Walkable |

Chapter 5: Results

Prior to installation of dedicated bus-bike lanes, most of the SBBLs experienced cyclist crashes on the corridors where the lanes would soon be installed. All of these corridors are key connectors for biking access into downtown Boston during commuting times, and experience high volumes of people traveling on these corridors, including those riding the bus, driving, biking, walking, and more. Overall total crash numbers were low across all the studied projects (see Figure 22 below and Table 5 in appendix).

Bicyclist Crashes in Shared Bus-Bike Lanes 2018-2022

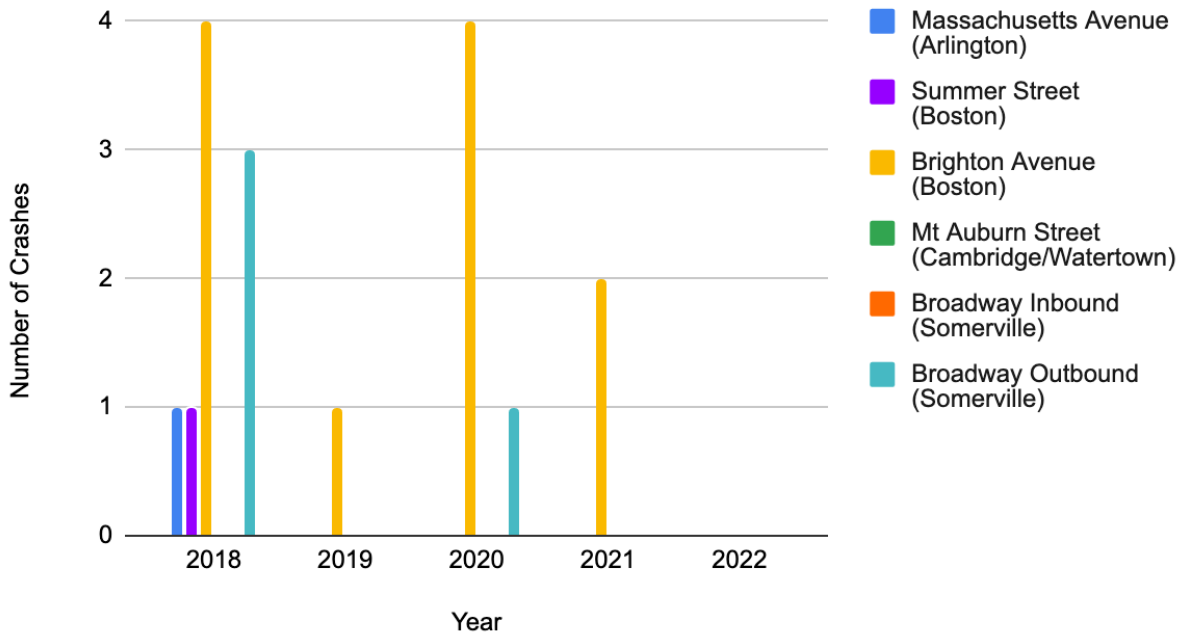


Figure 22: Bicyclist Crashes in Shared Bus-Bike Lanes, 2018-2022 (*Note: 2022 only includes data from January-April 2022, as that was the available data from StreetLight at the time of data review)

Brighton Avenue in Boston had the most total crashes before improvements were made, with four crashes in 2018 and one in 2019. However, once crashes were normalized with total bicyclist activity on the corridor, Brighton Ave had the second highest crash rate pre-installation with 0.03 crashes per 1000 bicyclists (see Figure 23 and Table 2). Brighton Ave also had the second and third highest single year crash rates with 0.01 crashes per 1000 bicyclists in 2018, and 0.02 crashes per 1000 bicyclists in 2019. In 2018, Brighton Avenue had the highest average daily cyclists of all the corridors in this study, likely due to the fact that it's a key connection into downtown Boston from dense residential areas including Allston, Brighton, Newton, and northern Brookline.

The outbound route on Broadway in Somerville also experienced a comparatively high number of crashes pre-installation, with three crashes in 2018

and no crashes in 2019, but experienced the single year crash rate at 0.03 crashes per 1000 bicyclists in 2018, and the highest pre-installation crash rate at 0.03 crashes per 1000 bicyclists (see Figure 23 below and Table 8 in appendix). Broadway also had the second highest average daily bicyclist volume throughout the study period, with an average of 288 cyclists traveling outbound, and an average of 198 cyclists traveling inbound on a daily basis (see Table 7 in appendix).

Summer Street in Boston experienced one crash in 2018 and no crashes in 2019, with a pre-installation crash rate of 0.004 crashes per 1000 bicyclists. Summer Street also had the highest average daily bicyclist volume throughout the study period, with an average of 459 cyclists traveling along the corridor per day (see Table 7 in appendix).

Neither Mt Auburn Street in Watertown and Cambridge nor Broadway (inbound) in Somerville experienced any bicyclist crashes before the installation of shared bus-bike lanes along those corridors. Mount Auburn also had the lowest average daily bicyclist volumes of all the corridors studied throughout the study period, followed by Broadway (inbound).

Bicyclist Crashes per 1000 Bike Trips

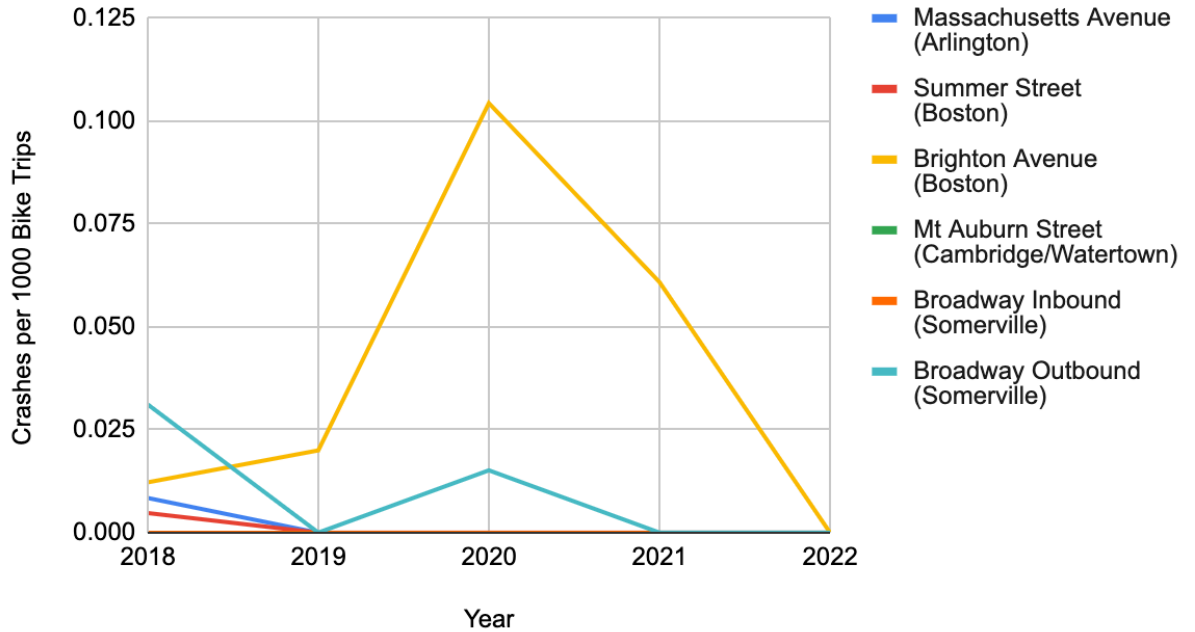


Figure 23: Bicyclist Crashes per 1000 Bike Trips by Year

| Table 2: Crash Totals and Rates by Project (Pre-Installation) | | | |
|--|--|--|---|
| SBBL | 2018 Crashes (Crash rate per 1000 bicyclists) | 2019 Crashes (Crash rate per 1000 bicyclists) | Total Crashes (Avg Crash Rate) |
| Massachusetts Avenue (Arlington) | 1 (0.0085) | 0 (0) | 1 (0.0099) |
| Summer Street (Boston) | 1 (0.0048) | 0 (0) | 1 (0.0035) |
| Brighton Avenue (Boston) | 4 (0.0122) | 1 (0.1757) | 5 (0.0265) |
| Mt Auburn Street (Cambridge/Wat) | 0 (0) | 0 (0) | 0 (0) |

| | | | |
|--------------------------------------|---------------|----------|-----------------------|
| ertown) | | | |
| Broadway Inbound (Somerville) | 0 (0) | 0 (0) | 0 (0) |
| Broadway Outbound (Somerville) | 3 (0.0311) | 0 (0) | 3 (0.0324) |
| Total Crashes | 9 | 1 | 10 |

After installation of shared bus-bike lanes on all five corridors, there was an overall reduction in crashes (see Table 3). Both Mt Auburn Street and Broadway (inbound) maintained zero crashes from pre-installation to post-installation, and therefore experienced no change in safety for people biking. According to StreetLight Data, the average daily cyclists on both Mt Auburn Street and Broadway (inbound) briefly decreased in 2020 after the installation of a shared bus-bike lane, but saw a steady rise in cyclist trips post-installation.

Both Massachusetts Avenue and Summer Street experienced zero crashes post-installation, decreasing their total crashes and crash rates after the installation of SBBLs. The average daily cyclist volumes on Massachusetts Avenue saw a steady decline throughout the study period, while the average cyclist volumes fluctuated on Summer Street in the same timeframe.

Broadway (outbound) experienced a decrease in crashes and a decrease in crash rates, including single years and overall post-installation. Broadway (outbound) saw a significant increase in average daily cyclist volumes post-installation. The crash rate decreased from 0.032 crashes per 1000 bicyclists pre-installation to 0.01 crashes per 1000 bicyclists post-installation. Broadway

(outbound) was the location with the most significant improvement in safety from pre-installation to post-installation conditions.

Brighton Avenue stands out in this analysis as it experienced both higher crashes and a higher overall crash rate post-installation. After the SBBL was installed, Brighton Ave experienced six bicyclist crashes, and a crash rate of 0.176 crashes per 1000 bicyclists. This represents an increase of one crash and a difference in crash rate of 0.15 crashes per 1000 bicyclists.

| Table 3: Crash Totals and Rates by Project (Post-Installation) | | | | |
|---|--|--|---|---|
| SBBL | 2020 Crashes (Crash rate per 1000 bicyclists) | 2021 Crashes (Crash rate per 1000 bicyclists) | 2022* Crashes (Crash rate per 1000 bicyclists) | Total Crashes (Avg Crash Rate) |
| Massachusetts Avenue (Arlington) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Summer Street (Boston) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Brighton Avenue (Boston) | 4 (0.1044) | 2 (0.0609) | 0 (0) | 6 (0.1757) |
| Mt Auburn Street (Cambridge/Watertown) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Broadway Inbound (Somerville) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |

| | | | | |
|--------------------------------------|---------------|----------|----------|-----------------------------|
| Broadway Outbound (Somerville) | 1 (0.0151) | 0 (0) | 0 (0) | 1 (0.0099) |
| Total Crashes | 5 | 2 | 0 | 7 |

**Note: 2022 only includes data from January-April 2022, as that was the available data from StreetLight at the time of data review.*

Impact of COVID-19 on Bicyclist Volumes and Crash Trends

As previously noted in the literature review, the COVID-19 pandemic had a big impact on traffic volumes, total crashes and crash rates in Massachusetts, as well as the Greater Boston area. Prior to the COVID-19 pandemic, bicycling in the Greater Boston region was seeing a steady rise, including in the areas studied in this analysis. Of the six corridors studied, the total bicyclist volumes in 2018 were approximately 152,022 and dropped slightly to 119,598 in 2019. Pre-COVID, Summer Street and Brighton Avenue in Boston experienced the highest average daily bicyclist trips of the areas studied with 1,544 and 1,033 bicyclist trips respectively. The other four corridors experienced a significantly lower bicyclist volume, all roughly averaging 350-550 bicyclists per day per year.

Starting in March of 2020, a stay-at-home order was issued, beginning the drastic reduction of travel in the region. However, not all the areas studied showed a significant decline in average daily bicyclists. Both Summer Street and Brighton Avenue in Boston saw a significant decrease in bicyclist volumes (see Figure 24). Massachusetts Avenue in Arlington and Mt Auburn Street in Cambridge and Watertown both saw steady declines, even after COVID restrictions eased. Conversely, both segments of Broadway in Somerville actually saw a steady

increase in daily bicyclist volumes, even after a slight decline when the pandemic began.

Annual Bike Volumes 2018-2022

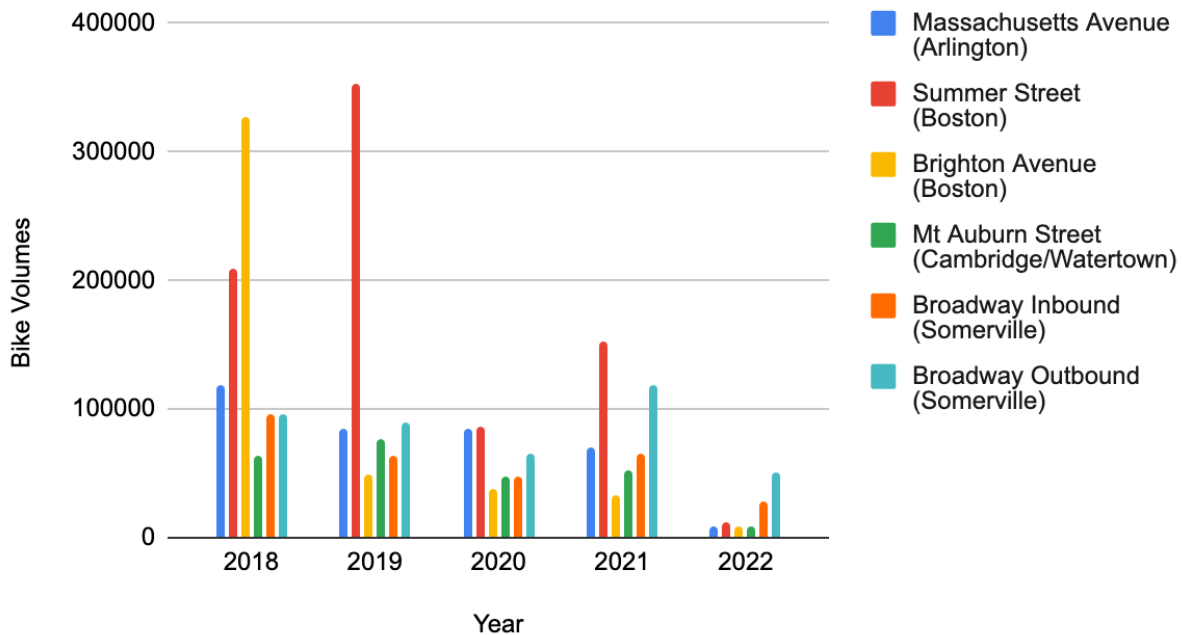


Figure 24: Total Annual Bicyclist Volumes by corridor, noting that 2022 data is projected from average daily bicyclist volumes January-April 2022, and is therefore likely a significant undercount of true bike volumes

Bicyclist crash trends followed a similar pattern, with a few exceptions. Pre-COVID, the normalized crash trends looked fairly similar across many of the areas studied, with roughly 0.006 crashes per 1000 bicyclists. (See figure 23) After the pandemic began, overall crashes decreased, as well as normalized crashes, except on Brighton Avenue. Although Brighton Avenue experienced a significant decrease in bicyclist volumes, the corridor experienced a noteworthy increase in the crash rate, changing from 0.0265 crashes per 1000 bicyclists pre-installation to 0.1757 crashes per 1000 bicyclists post-installation.

Although overall total crashes decreased during COVID, so did total bicyclist volumes (see Figure 25). Due to this, the overall normalized crash rate across all six projects studied actually increased slightly post-installation from 0.006 to 0.007 crashes per 1000 bicyclists. This was likely due to the severe decrease in bicyclist volumes during and directly after COVID, meaning that each crash that occurred had more of an impact on the overall normalized rate.

Average Daily Bicyclist Volumes

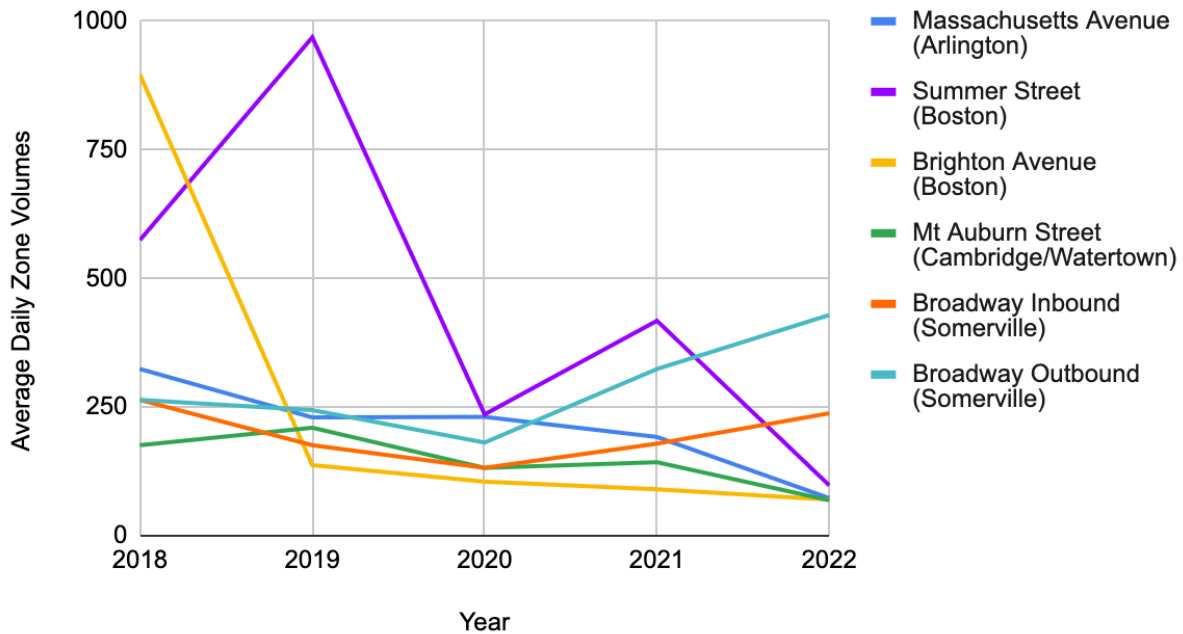


Figure 25: Average Daily Bicyclist Volumes per Year

| Table 4: Change in Bicyclist Activity Pre- and Post-Installation | | | | |
|--|--------------|--|---|--------------------------------------|
| Corridor | Municipality | Average Number of Bicyclists per day pre-COVID | Average Number of Bicyclists per day post-COVID | Percent Change in Bicyclist Activity |
| | | | | |

| | | | | |
|-----------------------------|-----------------------|----------------------------------|----------------------------------|---------------------------------|
| Summer Street | Boston | 772 | 323 | -139% |
| Brighton Avenue | Boston | 516 | 114 | -354% |
| Massachusetts Avenue | Arlington | 277 | 213 | -30% |
| Mt Auburn Street | Cambridge & Watertown | 193 | 147 | -31% |
| Broadway | Somerville | 220 (Inbound); 254 (Outbound) | 236 (Inbound); 401 (Outbound) | 6% (Inbound); 36% (Outbound) |

Chapter 6: Discussion and Conclusions

Summary of Findings

Shared bus-bike lanes, when executed appropriately, appear to be an effective tool for improving bicyclist safety and increasing the larger network for biking in Greater Boston. By moving cyclists out of general purpose travel lanes and into a shared dedicated space with buses, this research shows that cities can create safer mobility options for more people, especially on tight urban corridors.

The installation of shared bus-bike lanes in the Greater Boston area appears to be associated with a reduction in bicyclist crashes and crash rates along each of the corridors studied. Overall, both crash rates and total crashes decreased on nearly all the corridors studied. These findings suggest that the implementation of shared bus-bike lanes on various corridors in Greater Boston has positively contributed to bicyclist safety, even amid the challenges to roadway safety presented by the COVID-19 pandemic.

However, low total crash numbers present a challenge for this conclusion to be considered valid and generalizable. Across all corridors, there were only 17 crashes over the 4.3 years studied (see Table 5 in appendix). When these crash numbers were normalized against thousands of bicyclist trips over each year, the normalization rate is quite small (see Table 9 in appendix). In contrast, 17 crashes could be seen as significant geographically, as each of these segments were less than a mile in length, with Mount Auburn Street being the longest at 0.8 miles in length and Summer Street being the shortest, at only 0.1 miles long. The total mileage studied was 2.9 miles of shared bus-bike lanes.

It's also noteworthy that when all crashes were aggregated against total annual bike volumes across all six projects both pre- and post-installation of SBBLs, the normalized crash rate increased slightly after the installation of SBBLs (see Table 9 in appendix). This is likely due to the fact that crashes continued post-installation, while the total bicyclist volume significantly decreased, especially during 2020 and 2021, which were the years most significantly disrupted by the COVID-19 pandemic.

In addition, while this thesis intended to understand how the installation of shared bus-bike lanes affect bicyclist safety, a major finding from this research also included the inadequacy of bike travel data, including bike volumes and bike crashes.

Influence of COVID-19 on Crash Data and Bike Counts

The COVID-19 pandemic likely had a significant impact on state and municipal crash data, which created challenges in understanding the full picture of bicyclist safety, and understanding the role of new street changes, such as SBBLs, in

increasing safety and decreasing crash rates. With significant changes in travel patterns due to lockdowns, work-from-home orders, and shifts in commuting patterns, crash data from this period may not accurately reflect the trends that would have occurred in normal (non-pandemic) years, and may also contain increased errors.

Reduced vehicle traffic, especially in the early weeks and months of the lockdown period, could have led to less crashes with cyclists, but also may have contributed to more crashes, as less traffic also meant an increase in vehicle speeds on many roadways. It is also possible that many crashes, regardless of their severity, weren't reported, as that would have required interacting with more people, either on-street or at the police station.

One of the challenges of analyzing the data over the COVID-19 pandemic was distinguishing between temporary versus long-term changes in people biking as well as bicyclist safety. This study looked at crashes and bicyclist volumes over a 52 month (4.3 years) period, of which at least two years (24 months) were significantly impacted by the pandemic. During the pandemic, many people started cycling for recreation and to spend time outdoors. This increase in ridership may have increased crashes, either by increasing overall opportunities for crashes or by creating a safety-in-numbers effect. It's also possible that because people may have been cycling for recreation, their patterns and locations they chose to bike were different than the routes they may take when commuting. However, as more workplaces started opening and travel patterns shifted back towards pre-pandemic normal, some of the bike ridership decreased. Understanding whether the safety benefits or risks with the installation of SBBLs continued after the pandemic would

require a more long-term study that could more effectively evaluate the before and after effects on SBBL installation.

In addition, many municipal bike count programs, typically executed by local volunteers, stopped during 2020 and 2021. The data gathered through these programs helps to inform trends related to mobility in the region, as well as specific corridors, and was also used in this analysis to check the accuracy of StreetLight data counts. However, because these programs were paused during the pandemic, gaps exist in these local data sets. Graphs showing StreetLight's accuracy compared to local municipal bike counts can be found in the appendix.

Effectiveness of Existing Bike Crash & Count Data

One of the consistent challenges noted in this study was the consistency of bicycle volume and crash data. In Massachusetts, and in particular the Greater Boston region, there exists a notable disparity between the availability of data on motor vehicle trips and trips by bicycle. Automobile-related data, including the number of trips, crash rates, and traffic patterns, are extensively documented, providing a wealth of information to help planners and policy makers understand resident and visitor driving patterns.

In contrast, data on bicyclist trips and crashes are considerably limited. While local or region initiatives like Boston's annual bicyclist count program, initiated in 2016, or CTPS' annual count program, aim to collect data at specific locations using automated counters or volunteers, these efforts offer only a small sample of data at a snapshot in time, rather than a comprehensive dataset region-wide. In addition, because this is such a small sample size, often one or two days per year,

the data could shift significantly due to a variety of factors including weather, construction, local events, a nearby crash, and more.

Many municipalities, including Boston, Cambridge, and Somerville, have existing programs to collect municipal data on bicyclist trips in their municipalities. However, these counts are conducted differently between municipalities. For example, Boston's bike count program began in 2016 and collects data annually using automated technology at specific locations throughout the city, and only a few times per year. In contrast, both the City of Cambridge and the City of Somerville collect bicyclist counts through volunteer programs over a few select days in September. Cambridge and Somerville train their volunteers, but it's likely that human error exists in their counts, causing a lack of consistency from year to year. (See table 11 and figure 26-30 in appendix for a full comparison of municipal and StreetLight bike volume data).

In Cambridge, the city began collecting data annually in 2002, then every two years starting in 2008 and have consistently conducted counts at the same sixteen intersections. Cambridge's counts are typically done mid-week, and may be repeated if there is bad weather. Cambridge also notes that their 2018 count data (used in this analysis) should be used in a limited way as it was collected under different weather conditions and of different dates than previously collected data.

In Somerville, the city began collecting bicycle and pedestrian count data annually in 2010 through a volunteer program. Like Cambridge, Somerville collects count data mid-week. Somerville counts people walking and biking for one hour in the morning and one hour in the afternoon, roughly aligning with typical commute hours. Somerville also notes that their bike counts will count multiple people biking if there are multiple people on one bike (such as a parent with a child), even if there

is only one bike. This data is helpful to see long-term trends within the city, but not as useful to see seasonal or annual trends, or to understand cyclist activities throughout the city.

Moreover, bicyclist crash data is often underreported. Incidents involving bicyclists, including near-misses, sideswipes, “dooring,” general driver aggressiveness, or crashes are typically documented only when they result in significant injury or property damage. Reporting requires the individuals involved to either call the police to the scene, and/or go to a police station to file a crash report. These steps have both time and equity implications that create barriers for this data to be collected, documented, and assessed. Therefore, less severe crashes, which likely still impact cyclist safety and willingness to continue biking, frequently go unreported, leading to an incomplete picture of cycling safety in the region. The lack of comprehensive data on all types of bicyclist safety incidents, including those less-severe, hampers the development of effective planning and policy initiatives to target safety improvements as well as encourage more people to choose cycling as a mode of transportation.

Variations in Crash Trends Across Locations

The area with the most crashes throughout the study, as well as the highest crash rate post-installation of an SBBL was Brighton Avenue in Boston. This corridor previously had an inbound bike lane that was positioned in a general purpose travel lane, effectively sharing space with cars and other private vehicles. The installation of the SBBL created a dedicated space for cyclists away from vehicles, but sharing space with buses. Brighton Ave is one of just two SBBLs studied that are adjacent to curbside parking, meaning that vehicles will be moving across the SBBL from the general purpose travel lane to the curbside parking and vice versa. This

added vehicle presence and movement in the SBBL likely decreases the level of safety for cyclists on Brighton Avenue.

In addition, Brighton Avenue was the most walkable corridor studied according to data from the National Walkability Index. This likely leads to more activity across all modes along this corridor, as well as more movements including street crossing, parking, boarding and alighting the bus, and more, leading to more possibilities for crashes and near misses. Many college students live in the area surrounding Brighton Avenue, likely meaning there is more consistent activity throughout the day, in place of more traditional morning and afternoon commuting traffic.

Conversely, Broadway (outbound) was the corridor with the most improved crash rating post-installation. Broadway's previous condition consisted of a wide, multi-lane, unmarked roadway with curbside parking. This area was essentially a free-for-all - anyone could move in any direction. Broadway was also one of Somerville's highest crash corridors. The installation of the outbound SBBL on Broadway helped to define the corridor, and the separated uphill bike lane also added an additional level of safety for people biking in an area where a bus would be moving significantly faster than a person biking.

The outbound section of Broadway was one of the most walkable corridors studied, with roughly 60% of the corridor listed as "most walkable" and 40% of the corridor listed as "above average walkable." Considering this segment's walkability, the amount of key destinations directly on the route, as well as the density of residential buildings likely makes this corridor a high mobility area. The changes to move effectively designate space, daylight intersections, and shorten crosswalks all

likely contributed to increased safety for everyone along the corridor, including people biking.

Although the scope of this research can't effectively determine the exact design elements that contribute to safety in SBBLs, some important trends have emerged from this analysis. Creating clear designated spaces for different modes, traffic calming, and reducing movements in and out of designated spaces like SBBLs likely contribute to an increased level of safety for bicyclists along these corridors.

Limitations of the Analysis

One key challenge was with the use of StreetLight data and estimating bike volumes on the roadway segments studied. While the data provided useful estimates for average daily bike volumes over a year's time, it likely included sampling biases and inaccuracies in identifying cyclists, especially on small segments of roadway. In previous studies (described in the literature review), StreetLight showed growing inaccuracies in small areas and lower traffic volume roadways. Since not everyone biking using devices with GPS, such as a smartphone, it's likely that their count is an underestimate or even misrepresenting actual bike counts, especially for populations that may not use smartphones. There were also many ways of analyzing corridor usage, including if a user passed through a start and end point, if they entered the segment at any time, if they started or ended their trip within the segment, and more. All of these variabilities produce challenges for data accuracy.

In addition, another limitation to the Streetlight data was that bike counts were only available from January 2019 to April 2022. This gave a limited window of time to be able to understand bike movements on each corridor, and normalize bike crash data. Ideally, a future study would be able to look at bicyclist volumes

and crash rates for upwards of five years before and after to be able to make a more definitive conclusion regarding the SBBL's role in decreasing crashes. With such a limited data window, other factors could have played a role in decreasing crashes, such as traffic volume changes, work from home orders, decreases in urban population, and more.

Alternative bike counts were sought through municipal and state-level bike data to fill the gap in bike count data for 2018, as well as validate StreetLight's bicycle volumes (see figures 26-30 in the appendix). The local bike counts were inconsistent between municipalities, as not every municipality conducts regular counts, and each municipality conducts their counts in different ways. In addition, some municipalities paused collecting data on bicyclist volumes during the pandemic, as most programs are volunteer-driven and it was not always safe to do so during the pandemic. These discrepancies make it difficult to confirm the accuracy of the estimated bicycle volumes on the studied roadway segments, potentially affecting conclusions about ridership trends and safety impacts.

Another limitation was the use of MassDOT crash data. Most bicyclist crashes are not reported, unless they result in significant injury or property damage. In order to have a bicyclist crash reported, the individual would have to call the police to the scene of the crash, and/or go to the police station to file a report. This has significant equity implications, as not everyone feels safe engaging with the police, or going to a police station. Because only more severe crashes are typically reported, more minor crashes and near-misses, which are important to understanding overall safety risks, are not included in the dataset. Without a more complete view of all bicyclist-related crashes, the study may not fully capture the extent of safety changes that have occurred pre- and post-installation of shared bus/bike lanes.

This study was also constrained by its limited scope, which only studied six roadway segments over five years. While this time frame allows for some understanding of changes before and after SBBL installation, the relatively small number of total reported crashes in these locations limits the ability to draw valid and generalizable conclusions about the safety impacts of SBBLs. A larger sample size with more project locations and a longer study period, potentially ten years, would provide a more comprehensive dataset for evaluating trends and identifying safety changes based on the street design change.

Finally, an additional challenge was isolating the effect of the COVID-19 pandemic on ridership and crash data. The pandemic significantly altered travel behavior, with fluctuations in bicycle ridership and changes in traffic patterns due to lockdowns, work-from-home orders, and shifting commuter patterns. These disruptions make it difficult to determine whether the changes observed in ridership and crashes were due to the implementation of SBBLs or the broader social and traffic changes due to the pandemic. Without a clear method for distinguishing these effects, the findings of this thesis related to ridership trends, crashes, and safety improvements may not be seen as rigorous enough to use them as a basis for policy or infrastructure changes.

Future Research

While this research suggests that shared bus-bike lanes can improve bicyclist safety over general purpose travel lanes, there is further research needed to understand their long-term and broader safety impacts. A longer-term study, such as one conducted over a ten year period, may show more stable trends and account for variables, such as COVID-19. A future study should evaluate not only the number of crashes, but also crash severity, changes in bicyclist behavior, bus

driver interactions, near misses of bicyclists, and possibly driver education. Understanding how these lanes impact safety for all users will be essential to fine-tune their design, implementation, and use.

Beyond the six projects studied in this analysis, it will also be important to expand the geographic reach of this research. As of the writing of this report, there are at least twenty-six existing bus priority corridors (see Figure 2) in the Greater Boston region that differ in their usage, width, allowable vehicles, transit frequency, traffic volumes, land use context, and more (Massachusetts Bay Transportation Authority, April 2025). A broader study could evaluate these additional variables, help identify best practices, and highlight design and operational features that consistently show possible positive and negative correlations with bicyclist safety. This larger study could provide urban planners and policy makers with a stronger evidence base to make informed decisions about how and where to prioritize shared bus-bike lane projects.

Importantly, future studies should also take a more holistic view of safety and comfort on these key roadways, looking beyond just interactions between buses and bikes. It will be important to look at all modes of transportation and their impacts, including car speeds, car volumes, frequency and severity of car crashes, pedestrian safety and volumes, and general roadway level of stress for all users. It would be useful to understand whether shared bus-bike lanes contribute to creating calmer, safer, and more enjoyable streets for everyone using the corridor, inclusive of all modes.

Additionally, future studies should explore the impact of these lanes on other vulnerable road users such as pedestrians, scooter riders, moped users, and people using wheelchairs or other mobility devices. These groups increasingly

share the same spaces in urban environments, and their safety outcomes are vitally important for urban planners and policy-makers to understand and address in future decisions. A more inclusive and holistic approach to studying shared lanes, as well as street changes in general, will ensure that they contribute to creating streets that are truly safe, enjoyable, and accessible for everyone.

Conclusion

Shared bus-bike lanes, when planned and implemented appropriately, appear to be an effective tool for improving bicyclist safety and increasing the larger network for safe biking in Greater Boston. By creating more opportunities for mode shift away from single occupancy vehicles, cities can create safer mobility options for more people, especially in areas that have limited roadway space while simultaneously contributing to local and regional sustainability goals.

For urban planners, shared bus-bike lanes offer a relatively quick and cost-effective strategy for building a safer and more complete cycling network, especially in dense urban areas where road width is limited, and in historic cities, like Boston, that were not originally designed for cars. These lanes help fill in gaps between off-street and/or protected on-street bike lanes without the need for expensive and lengthy street reconstruction processes. Integrating these lanes into a broader network of bike-friendly streets can significantly enhance local bikeability, contributing to healthier, more resilient, and more accessible cities in the Greater Boston region.

Appendix I - Streetlight Bicyclist Volumes and MassDOT Crash Data Evaluation

| Table 5: Total Crashes | | | | | | |
|--|-------------|-------------|-------------|-------------|-------------|---------------|
| SBBL | 2018 | 2019 | 2020 | 2021 | 2022 | Totals |
| Massachusetts Avenue (Arlington) | 1 | 0 | 0 | 0 | 0 | 1 |
| Summer Street (Boston) | 1 | 0 | 0 | 0 | 0 | 1 |
| Brighton Avenue (Boston) | 4 | 1 | 4 | 2 | 0 | 11 |
| Mt Auburn Street (Cambridge/Watertown) | 0 | 0 | 0 | 0 | 0 | 0 |
| Broadway Inbound (Somerville) | 0 | 0 | 0 | 0 | 0 | 0 |
| Broadway Outbound (Somerville) | 3 | 0 | 1 | 0 | 0 | 4 |
| Totals | 9 | 1 | 5 | 2 | 0 | 17 |

| Table 6: StreetLight Average Daily Zone Traffic | | | | | | |
|--|--------------|--------------|--------------|--------------|--------------|-----------------------------------|
| SBBL | 2018 | 2019 | 2020 | 2021 | 2022 | Average Daily Bike Volumes |
| Massachusetts Avenue (Arlington) | 324 | 230 | 231 | 192 | 73 | 210 |
| Summer Street (Boston) | 575 | 969 | 236 | 418 | 98 | 459.2 |
| Brighton Avenue (Boston) | 896 | 137 | 105 | 90 | 70 | 259.6 |
| Mt Auburn Street (Cambridge/Watertown) | 176 | 210 | 132 | 143 | 69 | 146 |
| Broadway Inbound (Somerville) | 264 | 176 | 132 | 179 | 238 | 197.8 |
| Broadway Outbound (Somerville) | 264 | 244 | 181 | 324 | 429 | 288.4 |
| Averages | 416.5 | 327.7 | 169.5 | 224.3 | 162.8 | |

| Table 7: StreetLight Annual Bike Volumes (Avg Daily*365) | | | | | | |
|---|-----------------|-----------------|----------------|----------------|---------------|------------------------------------|
| SBBL | 2018 | 2019 | 2020 | 2021 | 2022 | Average Annual Bike Volumes |
| Massachusetts Avenue (Arlington) | 118260 | 83950 | 84315 | 70080 | 8760 | 73073 |
| Summer Street (Boston) | 209875 | 353685 | 86140 | 152570 | 11760 | 162806 |
| Brighton Avenue (Boston) | 327040 | 50005 | 38325 | 32850 | 8400 | 91324 |
| Mt Auburn Street (Cambridge/Watertown) | 64240 | 76650 | 48180 | 52195 | 8280 | 49909 |
| Broadway Inbound (Somerville) | 96360 | 64240 | 48180 | 65335 | 28560 | 60535 |
| Broadway Outbound (Somerville) | 96360 | 89060 | 66065 | 118260 | 51480 | 84245 |
| Averages | 152022.5 | 119598.3 | 61867.5 | 81881.7 | 19540 | |
| Totals | 912135 | 717590 | 371205 | 491290 | 117240 | |

| Table 8: Crashes per 1000 Bike Trips | | | | | |
|---|-------------|-------------|-------------|-------------|-------------|
| SBBL | 2018 | 2019 | 2020 | 2021 | 2022 |
| Massachusetts Avenue (Arlington) | 0.0085 | 0 | 0 | 0 | 0 |
| Summer Street (Boston) | 0.0048 | 0 | 0 | 0 | 0 |
| Brighton Avenue (Boston) | 0.0122 | 0.0199 | 0.1044 | 0.0609 | 0 |
| Mt Auburn Street (Cambridge/Watertown) | 0 | 0 | 0 | 0 | 0 |
| Broadway Inbound (Somerville) | 0 | 0 | 0 | 0 | 0 |
| Broadway Outbound (Somerville) | 0.0311 | 0 | 0.0151 | 0 | 0 |

| Table 9: Average Crash Rates | | | |
|---|-------------------------|--------------------------|-------------------|
| SBBL | Pre-Installation | Post-Installation | Difference |
| Massachusetts Avenue (Arlington) | 0.0099 | 0 | 0.0099 |
| Summer Street (Boston) | 0.0035 | 0 | 0.0035 |
| Brighton Avenue (Boston) | 0.0265 | 0.1757 | -0.1492 |
| Mt Auburn Street (Cambridge/Watertown) | 0 | 0 | 0 |
| Broadway Inbound (Somerville) | 0 | 0 | 0 |
| Broadway Outbound (Somerville) | 0.0323 | 0.0099 | 0.0258 |
| Average Crash Rates | 0.0061 | 0.0071 | |

| Table 10: Average Daily Cyclist Volumes | | | |
|--|-------------------------|--------------------------|-----------------------|
| SBBL | Pre-Installation | Post-Installation | Percent Change |
| Massachusetts Avenue (Arlington) | 277 | 212.88 | -30.12% |
| Summer Street (Boston) | 772 | 322.75 | -139.20% |
| Brighton Avenue (Boston) | 516.5 | 113.73 | -354.13% |
| Mt Auburn Street (Cambridge/Watertown) | 193 | 147.64 | -30.72% |
| Broadway Inbound (Somerville) | 220 | 235.62 | 6.63% |
| Broadway Outbound (Somerville) | 254 | 400.86 | 36.64% |

Table 11: Cyclist Volumes - StreetLight Vs. Municipal Data

| | | (Sept 2019) | | (Sept 2020) | | (Sept 2021) | *Jan-Apr 2022 | (Sept 2021) |
|--|--------------------------|-----------------------|--------------------------|-----------------------|--------------------------|-----------------------|--------------------------|-----------------------|
| SBBL | 2019 Street Light | 2019 Municipal | 2020 Street Light | 2020 Municipal | 2021 Street Light | 2021 Municipal | 2022 Street Light | 2022 Municipal |
| Massachusetts Avenue* (Arlington) | 230 | 1279 | 231 | No Data | 192 | No Data | 73 | 1282 |
| Summer Street (Boston) | 969 | 1113 | 236 | 618 | 418 | 721 | 98 | 274 |
| Brighton Avenue (Boston) | 137 | 1365 | 105 | 958 | 90 | 1350 | 70 | 1349 |
| Mt Auburn Street (Cambridge/Watertown) | 210 | No Data | 132 | No Data | 143 | No Data | 69 | No Data |
| Broadway Inbound** (Somerville) | 176 | 77 | 132 | 89 | 179 | 101 | 238 | 96 |
| Broadway Outbound (Somerville) | 244 | 77 | 181 | 89 | 324 | 101 | 429 | 96 |

**Massachusetts Avenue municipal counts taken from Cambridge data on north Massachusetts Avenue*

***Broadway (Inbound) municipal counts taken two times during the day, not all day*

Appendix II - Streetlight Validation Against Local Bike Counts

Massachusetts Avenue, Arlington

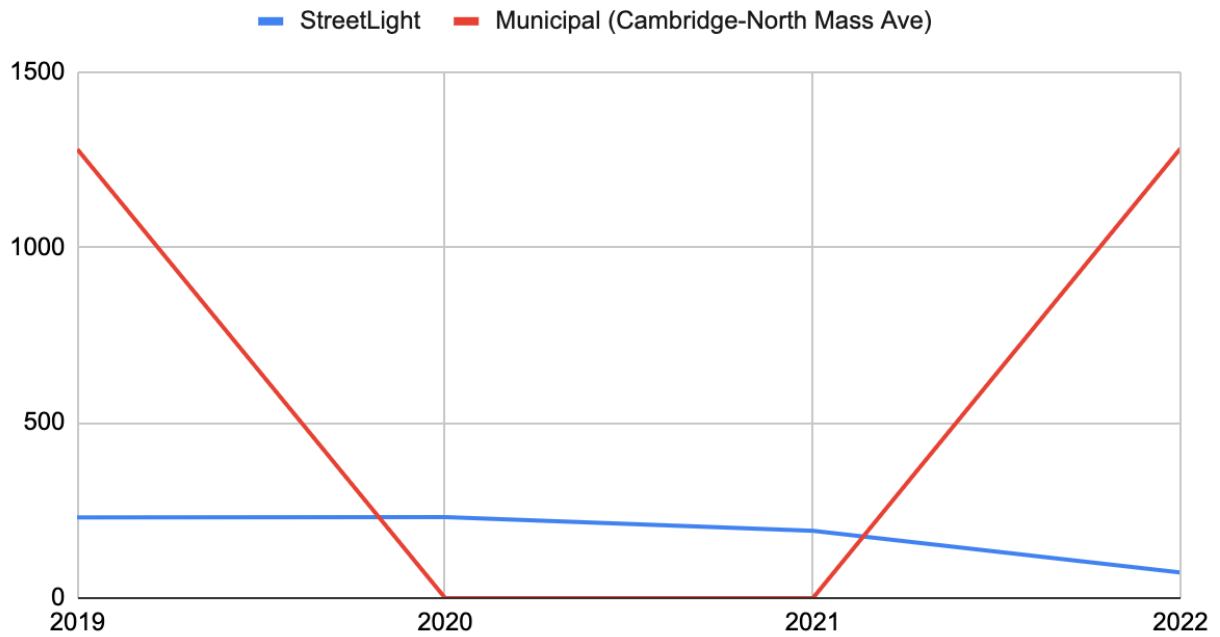


Figure 26: StreetLight bike volume data compared to municipal (City of Cambridge) bike volume data

Summer Street

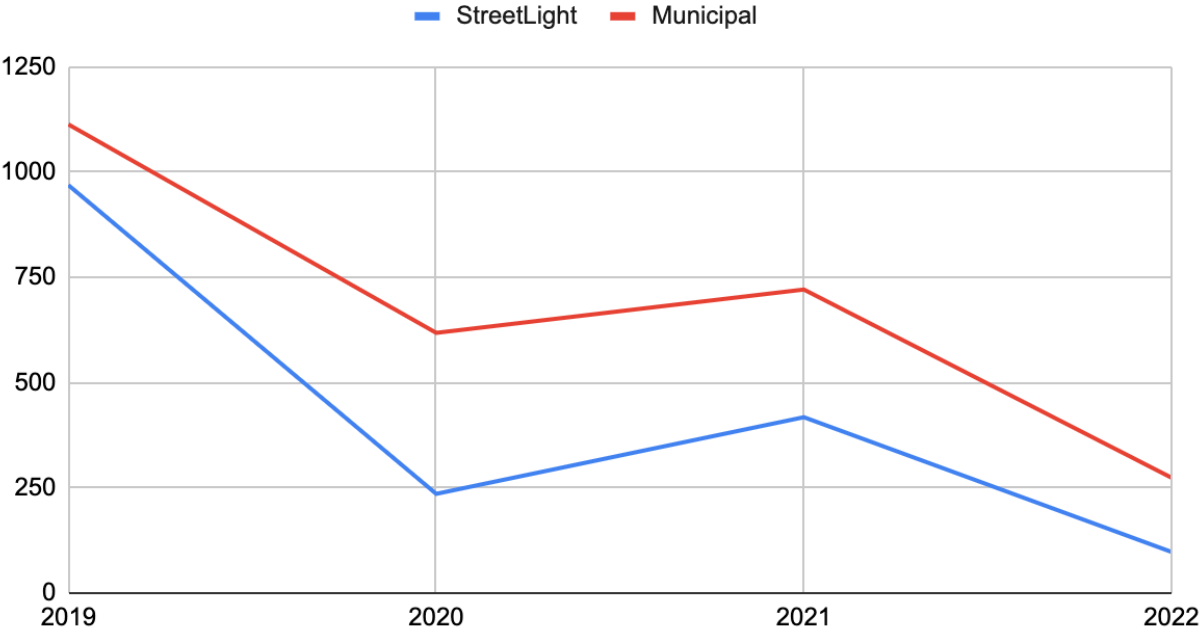


Figure 27: StreetLight bike volume data compared to municipal (City of Boston) bike volume data

Brighton Ave

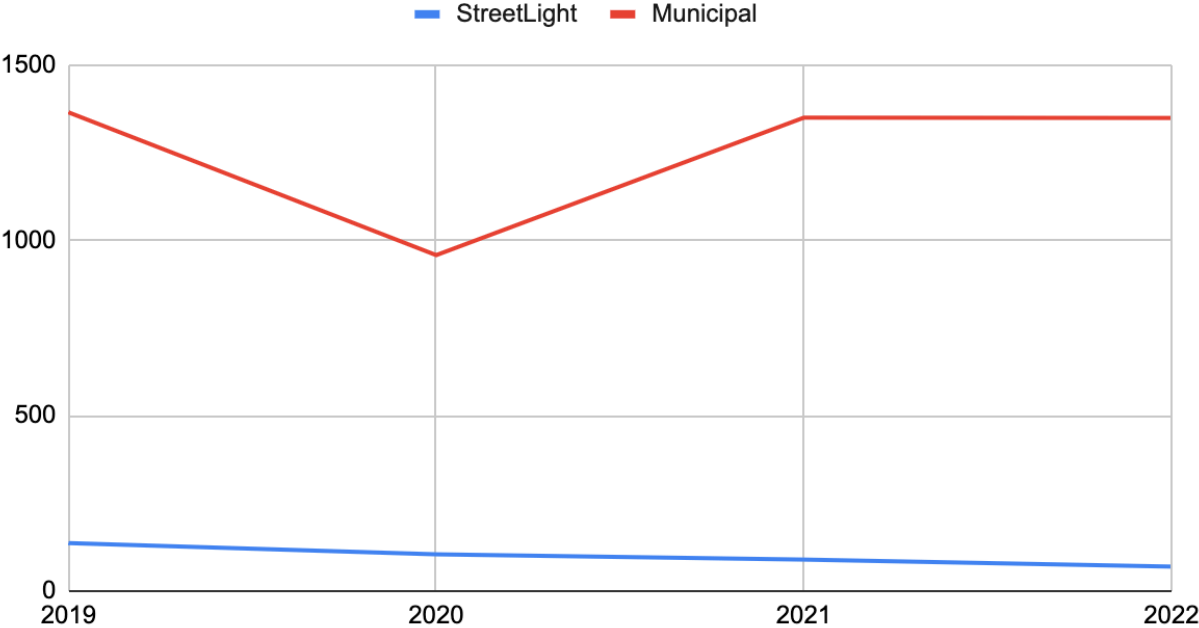


Figure 28: StreetLight bike volume data compared to municipal (City of Boston) bike volume data

Broadway (Inbound)

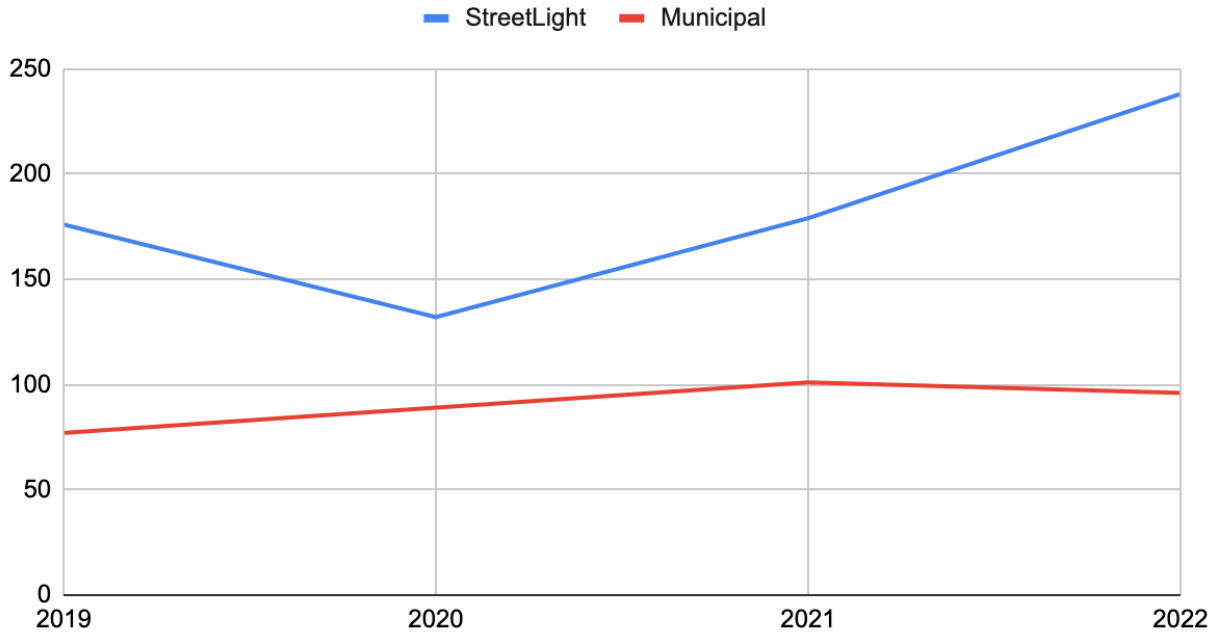


Figure 29: StreetLight bike volume data compared to municipal (City of Somerville) bike volume data

Broadway (Outbound)

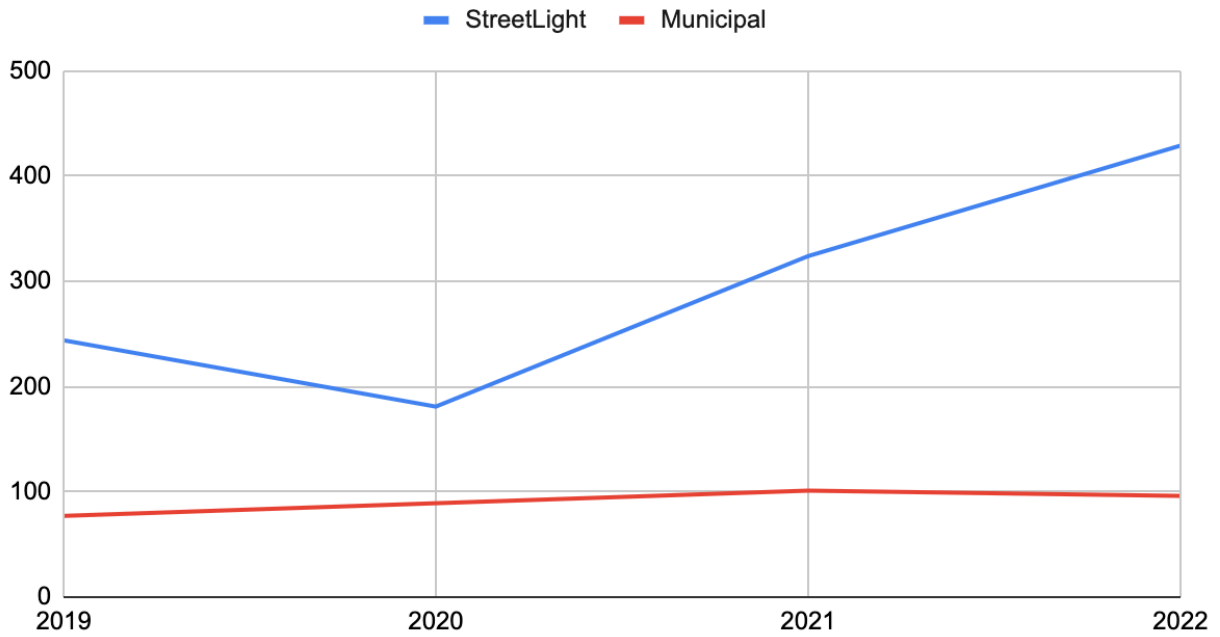


Figure 30: StreetLight bike volume data compared to municipal (City of Somerville) bike volume data

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