Boston

# Cyclist Safety Report

2013

City Of Boston
Thomas M. Menino, Mayor

Draft 5/15/13

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City Of Boston
Thomas M. Menino, Mayor

May 21, 2013

Dear Fellow Bostonians,

During the summer and fall of 2012, our city experienced five fatal bicycle incidents that led to this report. Through detailed analysis of four years of police report data, City officials will have concrete information with which to make the roadways safer for vulnerable users. This document will help us smartly apply our resources to continue improving our streets using the "six E's of bicycle planning": Engineering, Education, Enforcement, Encouragement, Evaluation, and Equity.

Since the City of Boston bicycle program launched in 2007, we have gone from being called one of the worst cities for cycling in the country to one of the best. The addition of nearly 60 miles of on-street bicycle facilities, hundreds of new bike racks, and the overwhelmingly successful New Balance Hubway bike share program has brought cycling into the mainstream here in Boston. Boston is well on its way to becoming a world-class cycling city.

The bicycle has become a critical part of our transportation system. Boston streets are full of people commuting to work and school, families enjoying a weekend ride together, and every type of rider in-between. This spirited resurgence of the bicycle has placed our city streets in a time of transition, from one dependent upon cars, to one embracing more active transportation options. Transitions can be difficult.

The close-knit community among cyclists continues to impress me. When one member of the community suffers from a terrible incident, the degree of separation to all cyclists is not far. We must work tirelessly and collaboratively to continue improving the safety of our streets. This report will help guide the process of continuing to grow Boston's vibrant bicycle community.

Sincerely,

Thomas M. Menino
Mayor, City of Boston

# Introduction

Mayor Thomas M. Menino envisions a vibrant, healthy and safe city that benefits all its citizens. As part of this vision, the Mayor seeks to make Boston a world-class bicycling city by creating safe and inviting conditions for all residents and visitors.

Since launching Boston Bikes in 2007, Mayor Menino has transformed Boston into one of the nation's leading bike friendly cities. The City has installed more than 60 miles of bike lanes and 1,000 bike racks and created a robust event series including bringing the first professional bike race to Boston in nearly 20 years. In 2011, the City unveiled the New Balance Hubway bike share system making Boston one of the first cities in the country with a bike share system. Hubway went on to become the first truly regional system in the country. With support from the Boston Public Health Commission (BPHC), the City implemented one of the nation's most successful community bike programs, donating more than 1,700 bicycles to low-income residents and providing on the bike training to 11,000 youth. The BPHC further initiated an all-City helmet campaign. The Boston Police Department (BPD) has conducted efforts to educate cyclists and drivers, enforcing rules of the road pertaining to cyclist issues, and distributing hundreds of helmets per year.

As a result of this work, in 2011, Boston was rated Boston the safest combined bicycling and walking city in the United States and the 8$^{th}$ safest cycling city[1]. Nonetheless, in 2012, five cyclists lost their lives on Boston streets; many more were injured or hospitalized. The City is committed to doing better.

This report is the first phase in a long-term effort to comprehensively address and improve cyclist safety. This report presents a detailed analysis of crash data, as provided by the BPD, the Boston Emergency Medical Services (EMS) and Boston Bikes.  Future efforts will interpret the data and begin to strategically implement programs and projects based on this report that will most effectively to reduce crashes.

[1] Alliance for Biking and Walking, "Bicycling and Walking in the Unites States, 2011 Benchmarking Report.

Key findings from this report are as follows:

1. Although the number of fatalities spiked in 2012, both BPD and EMS show a minimal increase in total crash incidents between 2010 and 2012. During this same period, cycling trips increased.
2. Injured cyclists were less likely to be wearing a helmet than the average cyclists.
3. A majority of the cyclist crashes that resulted in injury involved motor vehicles.
4. Cyclist crash incidents involving and/or injuring pedestrians are minimal. Pedestrians comprised only 2-3% of incidents and injuries in all cyclist incidents.
5. Key behavioral factors associated with crashes included cyclists not stopping at red lights or stop signs, cyclists riding into oncoming traffic, drivers not seeing the cyclists and drivers opening doors.
6. Roads with the highest numbers of crashes also have high cycling volumes.
7. Young adults, particularly men between 18 and 30 comprise more than half of all injured cyclists.

In 2011, Mayor Menino released "A Climate of Progress, the City of Boston's Climate Action Plan", establishing an overarching goal for the bicycle programs: 10% bike mode share by 2020. Safety, however, is as important as ridership. **A direct result from this report, Mayor Menino pledges to decrease the cyclist crash injury rate by 50% by 2020[2]. By simultaneously pursuing safety and ridership goals, the City of Boston will realize its vision of creating a safe, welcoming city for cyclists of all levels.**

[2] The crash injury rate will be calculated by looking at EMS incidents relative to cycling trips in the City. BPD data will also be evaluated to determine the change in crash rate. The total number of cycling trips is estimated to be 56,644 in 2012. This number is extrapolated using the American Community Survey estimates of ridership growth based on the baseline 2000 estimates for cycling trips in "Access Boston 2000-2010Boston Transportation Fact Book and Neighborhood Profiles". American Community Survey and Boston Bikes Count data will b e used to calculate the change in cycling trips.

# Approach

The 2013 Cyclist Crash Report is comprised of multiple sections. The Findings section consolidates information from the BPD, EMS and Boston Bikes to provide a holistic picture of crashes in Boston. The report then makes recommendations based on the findings. Lastly, the document provides the original crash report prepared by the BPD and EMS. By offering the original information from each department, the reader can most accurately and fully understand the data.

Data for this report comes primarily from two sources: the BPD and EMS. Supplementary data comes from Boston Bikes.

**Boston Police Department** The BPD collects standard variables from Boston Police incident reports related to each collision, such as date and time of occurrence, details on involved parties and their property (i.e., motor vehicles), and an open-ended description of the circumstances surrounding a collision. The majority of these variables are collected into fields that are easily transferred into the CAD database, with the exception of the narrative section, written by the police officers that respond to the scene. As such, in order to extract relevant data for this section of the report, the group reviewed and coded thousands of narrative files originating from these incident reports.

The BPD, in collaboration the Boston Area Research Initiative at Harvard's Radcliffe Institute, the Harvard Injury Control Research Center, and the Boston Cyclists Union reviewed BPD crash data to generate baseline crash estimates and maps for planning purposes.

- BPD's Office of Research and Development provided senior research analysts and interns.
- The Radcliffe Institute and the Rappaport Institute provided funding for a graduate level research consultant to conduct bicycle and pedestrian injury research studies as a part of her PhD dissertation.
- Harvard University's Institute for Quantitative Social Science also provided an in-kind PhD-level computer scientist to assist the student with data manipulation, programming, and advanced modeling.
- Boston Cyclists Union supplied volunteer data coders for the project.

Through this process, the BPD was able to provide a general description of bicycle collisions and their characteristics within the attached Boston Police Department Bicycle Collision Report (BPD Report). It is likely that the BPD report is the first of its kind to conduct a detailed review of a large volume of bicycle collision narrative reports and to use computer science methods to de-identify narratives.

Cycling-related collisions and injuries not reported to the BPD are not included within the BPD Report. In addition, analysis of qualitative data, such bicyclist and vehicle operator behavior, is limited by the available data extracted from open-ended narrative descriptions reported to officers by involved individuals or collision witnesses. A detailed summary of the methods for this study are provided in an appendix to the BPD report, as well as recommendations related to police activities and updates to the bicycle and pedestrian collision database.

**Boston Emergency Medical Services** Boston EMS is committed to compassionately delivering excellent pre-hospital care and to protecting the safety and health of Boston's residents and visitors. The department shares Mayor Thomas M. Menino's vision of promoting safe bicycling as a healthy mode of transportation and recreation in Boston. Boston EMS is an active member of the City of Boston's Bicycling and Pedestrian Working group, which aims to reduce biking and pedestrian-related injuries.

Boston EMS is committed to the continuum of patient care through meaningful application of its data. Each ambulance is equipped with a tablet computer for the documentation of patient care information. The finished record is electronically transferred to a secure database via a cellular connection. The use of an electronic Patient Care Reporting (ePCR) system at Boston EMS allows for comprehensive and near real-time reporting. A department Data Analyst has created a report that searches the records for keyword and dropdown list criteria pertaining to cyclist incidents. These incidents are subsequently reviewed by an experienced Boston EMS paramedic to confirm that each identified incident was in fact associated with an injured cyclist. To ensure that data truly represents relevant road bicycle accidents, other injuries associated with motorcycles, spin exercise equipment and bicycle maintenance have been excluded. Additionally, incidents where the paramedic reviewing the records was able to discern that the cause of the incident was unrelated to the person riding on a bicycle, such as cardiac arrest, have also been

excluded. The vetted data is then stored separately for review and later reporting by department personnel.

While it is not possible to know exactly how many people ride a bicycle on any given day, how long they ride for, or how many in total are involved in an accident (not all accidents are reported), the department has developed a system for identifying all Boston EMS cyclist patient encounters. The data presented in this report is drawn from the Boston EMS cyclist incident database, which is distinct from other crash data sources. **From 2009 through 2012, there were 1,700 confirmed cyclist incidents documented by Boston EMS emergency medical technicians and paramedics.**

It is important to note that, in Boston, the absence of links between datasets about bicycle and pedestrian collisions is a limitation that prevents us from specifying the rate of underreporting for either BPD or EMS data.

**Boston Bikes 2009 Accident Survey** In 2009, Boston Bikes conducted a survey of more than 2,500 cyclists who provided self-reported information on 2,577 crashes taking place between 2005 through 2009. Cyclists were asked to report every crash, including the seemingly insignificant incidents such as falling over alone and getting up uninjured. The survey was an attempt to gather information on the many "unreported" incidents, i.e. those did not see EMS or BPD attention. With respondents reporting that only 10% of the crashes required a hospital visit, it is likely that this survey did succeed in collecting otherwise unreported information. The survey was promoted to cyclists through the Boston Bikes mailing list, email lists from cycling partners, and online via Facebook. Limitations of this survey include population bias (respondents needed to be on a mailing list to learn of the study) and information bias (information from the accidents was self-reported).

**Boston Bikes Annual Counts** In 2007, prior to launching Boston Bikes, the City established benchmark counts of cycling trips, counting 6,629 trips at 24 locations. The City repeats the annually. Overseen by Boston Bikes, volunteers record cyclist trips, typically at morning and afternoon peak rush hour, one day a year, between September 15$^{th}$ and October 15$^{th}$, at 20-40 locations. Counts are useful for a general understanding in ridership trends. The data is limited however. One-day peak hour counts

are known to have significant levels of error[3]. Additionally, the counts do not provide total trips per day in the City, although they can be used to calculate trips per day in conjunction with other data sources.

Other Detail on any additional sources used in this report can be found in the report body or footnote.

Occasionally in this report, one can find apparent inconsistencies between data provided the various sources. It is important to note that while BPD and EMS both report nearly the same numbers of incidents per year, the two data sets are not a perfect match.

1. BPD reports address crashes only on City of Boston property. This does not include state roads within the city's jurisdiction. EMS data includes all locations within the city's jurisdiction, regardless of whether the incident took place on city or other roads.
2. BPD data includes reported crashes that did not require EMS attention, a likely scenario being an incident in which an individual was at fault but there was no injury and/or walk-in reports at stations after the events occurred.
3. EMS data may include crashes with injuries in which BPD was not called, a common example being crashes that did not include a motor-vehicle.
4. By design, the Boston Bikes Accident Report includes predominantly the "unreported "crashes not picked up by BPD and EMS.

[3] Nordback, Marshall, Janson and Stoltz, "Estimating Annual Average Daily Bicyclists" Error and Accuracy"

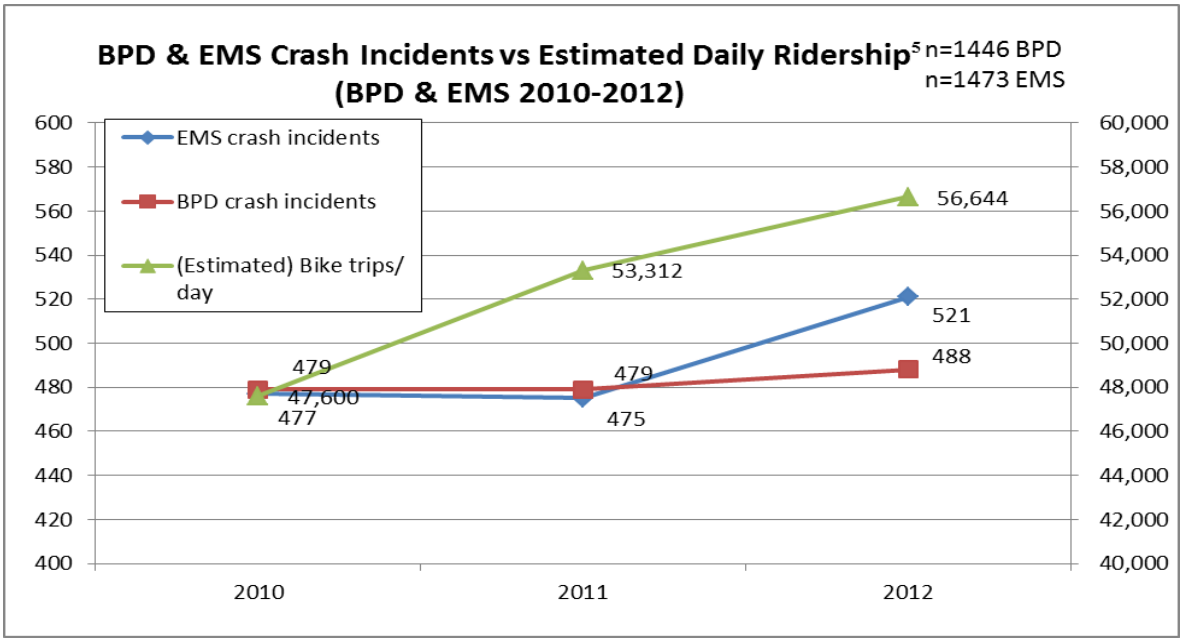
# Findings

## Incident Total

Between 2010 and 2012, BPD records a total of 1,446 incidents. EMS records 1,432 incidents.[4] BPD reports 9 fatalities in this period; EMS reports 8. The difference in fatalities requires explanation. The extra incident recorded by BPD and not EMS represents an incident in which the patient was alive at time of transport, but passed later. The BPD captures such data through follow up investigation. EMS does not.

As noted above, although the total number of incidents reported by BPD and EMS are similar, the data sets are imperfect overlaps. Both data sets underestimate the total number of crashes; under-reporting of crashes is common, such as in cases with injury to persons or property damage.

Between 2010 and 2012 BPD showed a 2% increase in incidents. EMS reveals a 9% increase. During this period, Boston Bikes reports an approximate increase in trips per day of 16-28% with calculated daily trips rising growing to roughly 56,000.[5]

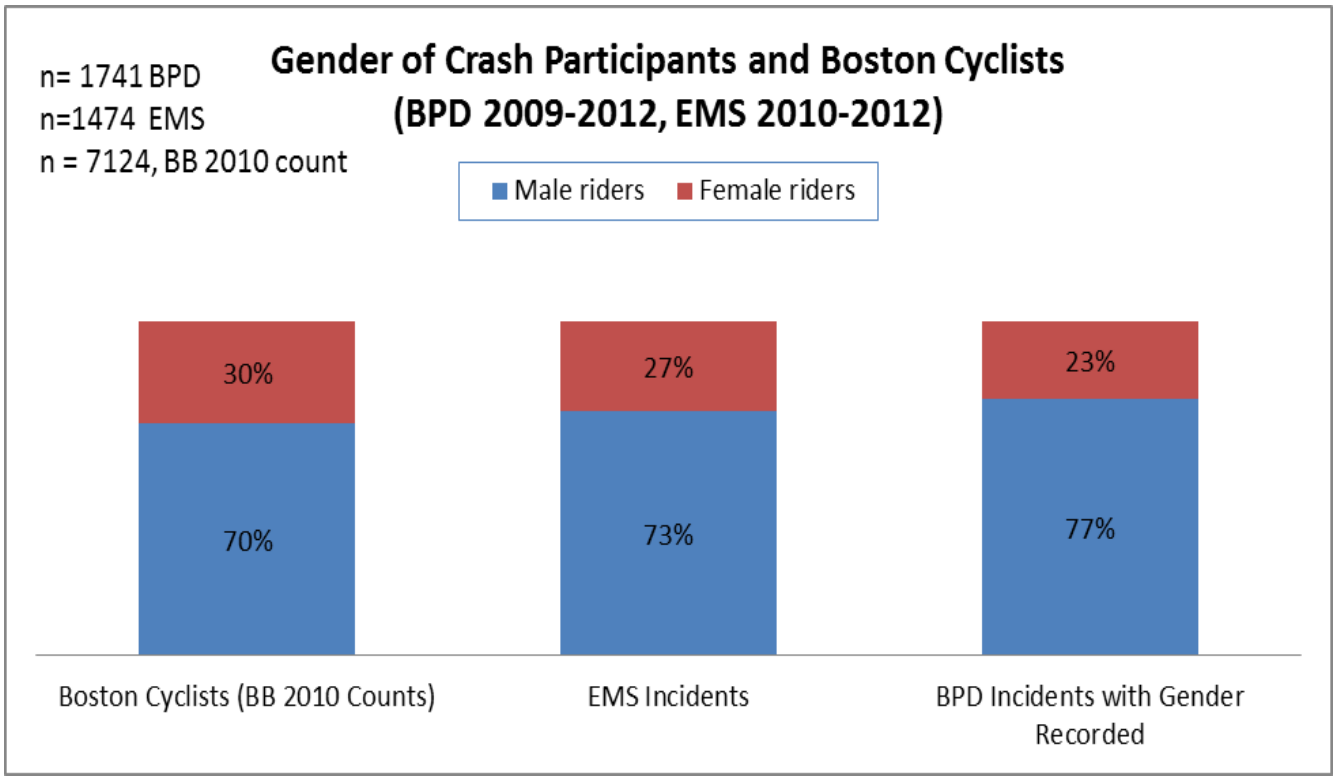



[4] The data collection method used by both EMS and BPD changed after 2009. Incident total before 2010 is not comparable.
[5] Data on increased trips per day is based on Boston Bikes Annual Counts. A 2010 daily ridership baseline is calculated using number of bike trips per day in 2000 from the Boston Transportation Department Access Boston 2000-2010 and extrapolating to 2010 based on the American Community Survey data showing increased trips by year.

Data from more years, and more precise counts, will be required to draw conclusions related to the crash rate [6] relative to cyclist trips[7]. If the emerging trend proves valid in the future, the pattern would be consistent with a national, albeit debatable, trend that has seen the rate of crashes decrease with increased levels of cycling.[8] This has become known as the "Safety in Numbers" effect.

## Gender

Of the cases in which gender was reported, EMS and BPD data indicate that male cyclists account for 76% and 77% respectively of bicyclist involved in crashes. It cannot be concluded, however, that men are "riskier" and/or overrepresented in crashes. Men are known to conduct a majority of cycling trips in Boston. Boston Bikes' 2010 counts, show men comprise 70% of recorded trips.

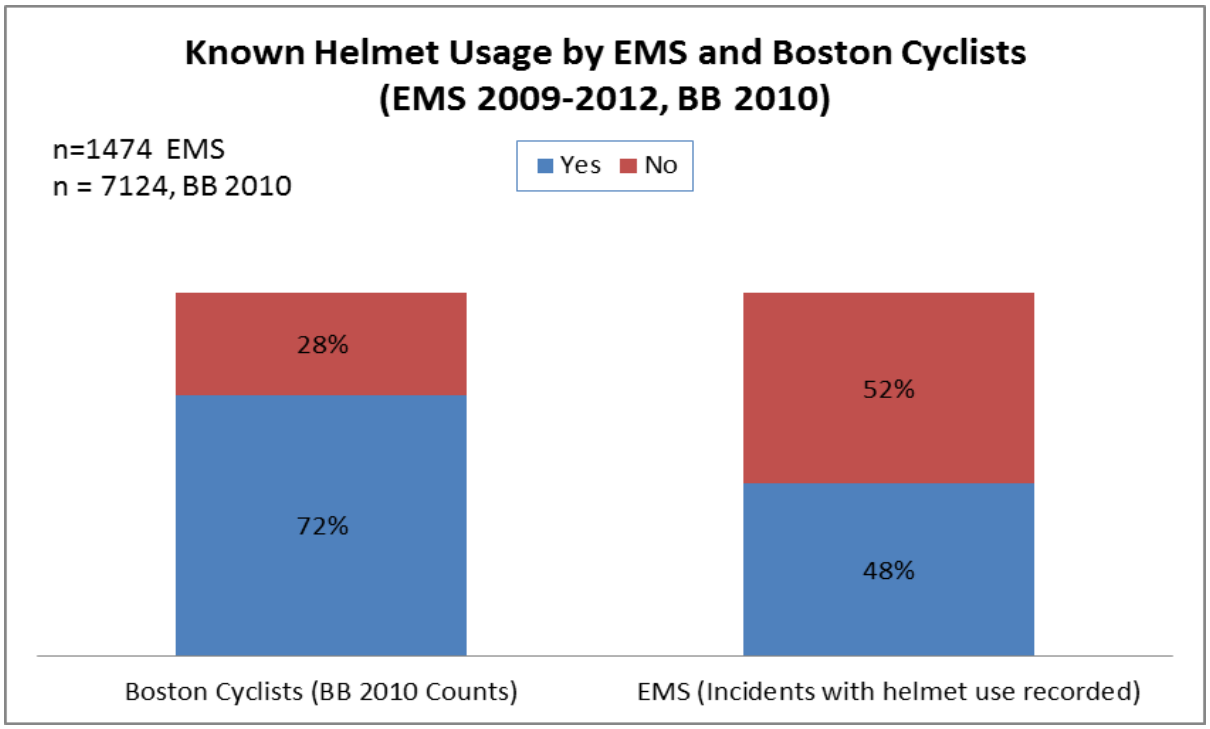



[6] The rate of crashes is typically defined as the number of crashes per 1,000 cycling trips.
[7] As noted in the Approach Section, annual counts can contain significant levels of error in an individual year.
[8] Jacobsen PL. Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Inj Prev 2003; 9: 205-9.

## Helmets

In EMS incidents where helmet usage was recorded, cyclists wore helmets in less than 50% of incidents. Men wore helmets in 43% of incidents, women 60%. This is substantially lower than the citywide helmet usage rate of 72%, which includes variation by neighborhood.[9]

Further investigation is recommended. It has been established that helmets reduce the risk of head injury by 85% and brain injury by 88%.[10] The




difference between helmet usage citywide versus in EMS incidents may imply that those who wear helmets are less likely to require EMS attention. Further, the varying helmet use by neighborhood may lead to disproportionate rates of EMS incidents by neighborhood.

Between 2010 and 2012, the BPD was not reliably recording helmet usage. The BPD does take helmet use seriously, as evidenced, by way of example, by their distribution of hundreds of helmets per year. It is recommended that BPD begin collecting helmet data moving forward.

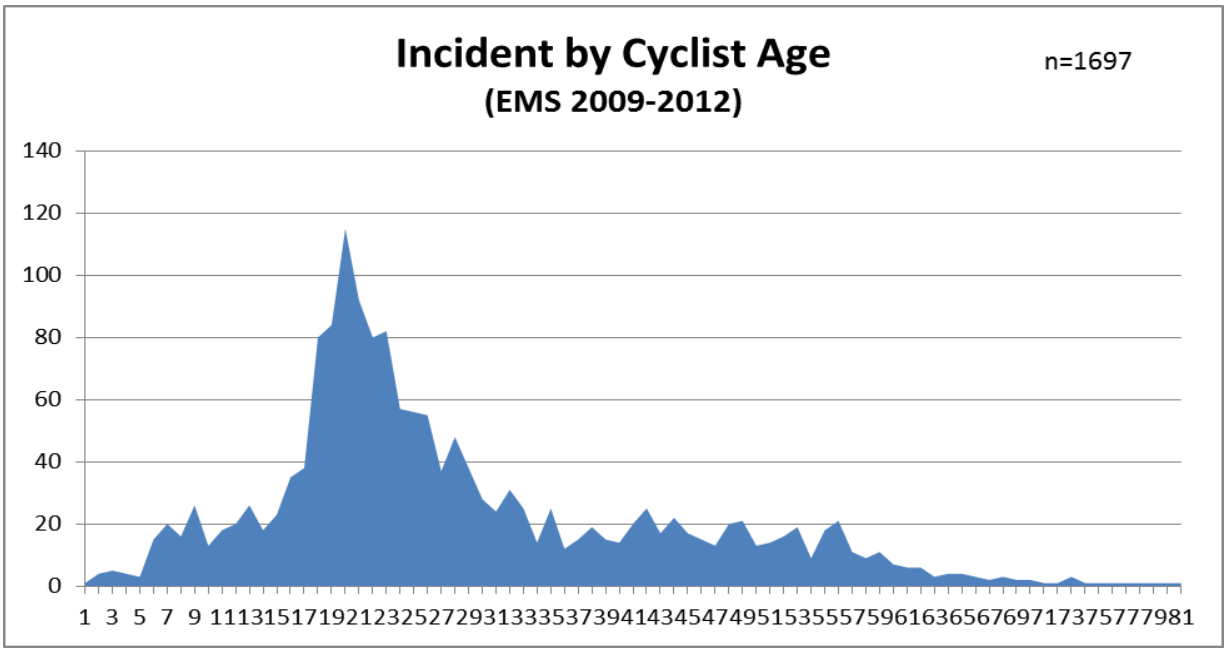
[9] Boston Bikes 2010 annual peak hour counts of 7124 cyclists recorded gender and helmet usage by riders at 42 locations and/or time periods.

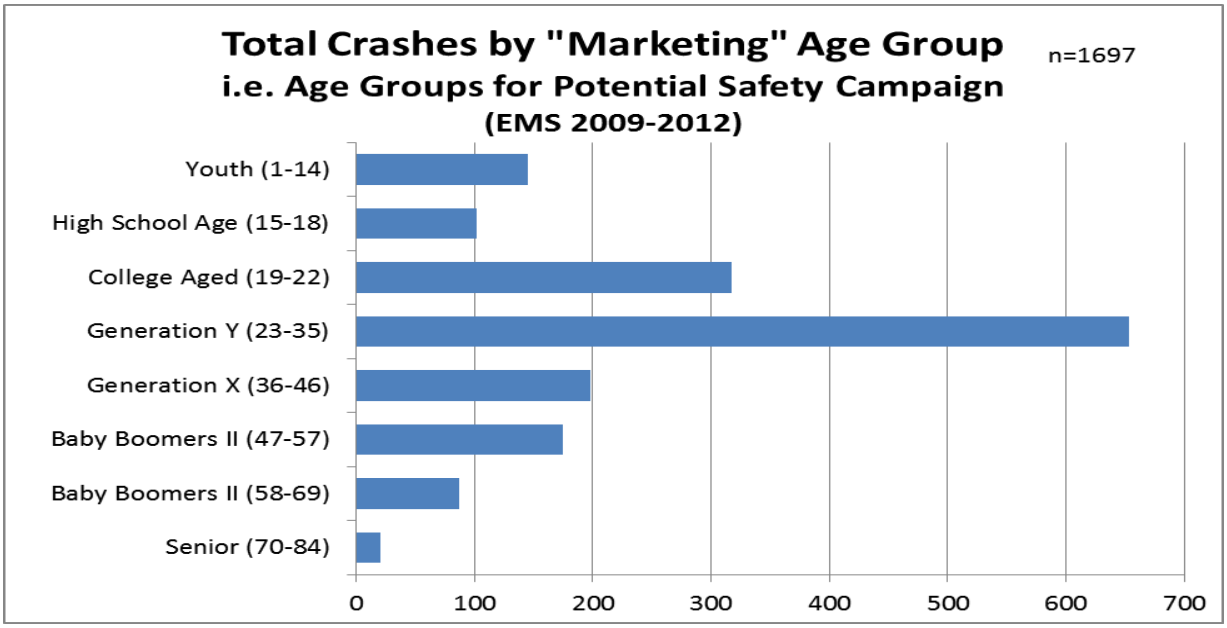
[10] Thompson RS, Rivara FP, Thompson DC. Case-control study of the effectiveness of bicycle safety helmets. *N Engl J Med*, 1989, 320:1361-1367.

## Age

Both EMS and BPD report increased levels of incidents for younger riders. In the absence of age demographic information on Boston cyclists, it is not known if younger cyclists are over-represented in crashes.

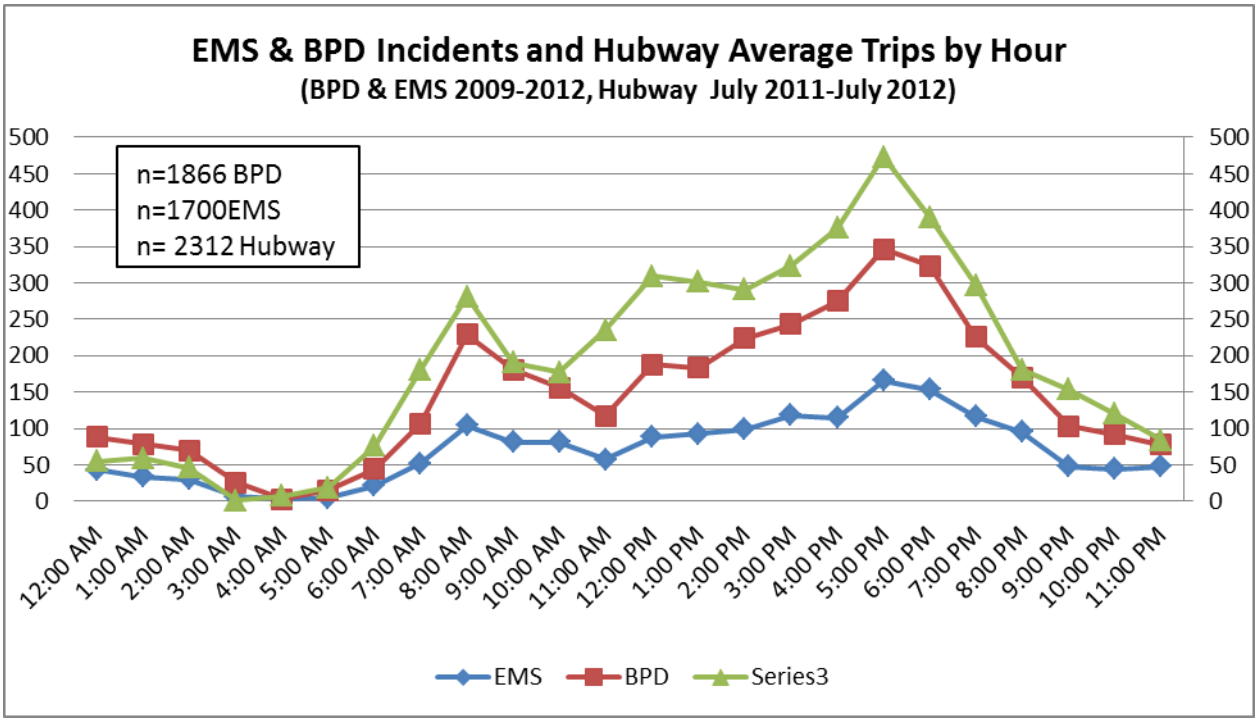
EMS data shows the peak age for incidents is 22; the average age is 31. Young Adults aged 18-30, comprise 50% of the injured cyclists. This data can guide the design of future safety campaigns which would vary dramatically by age group.



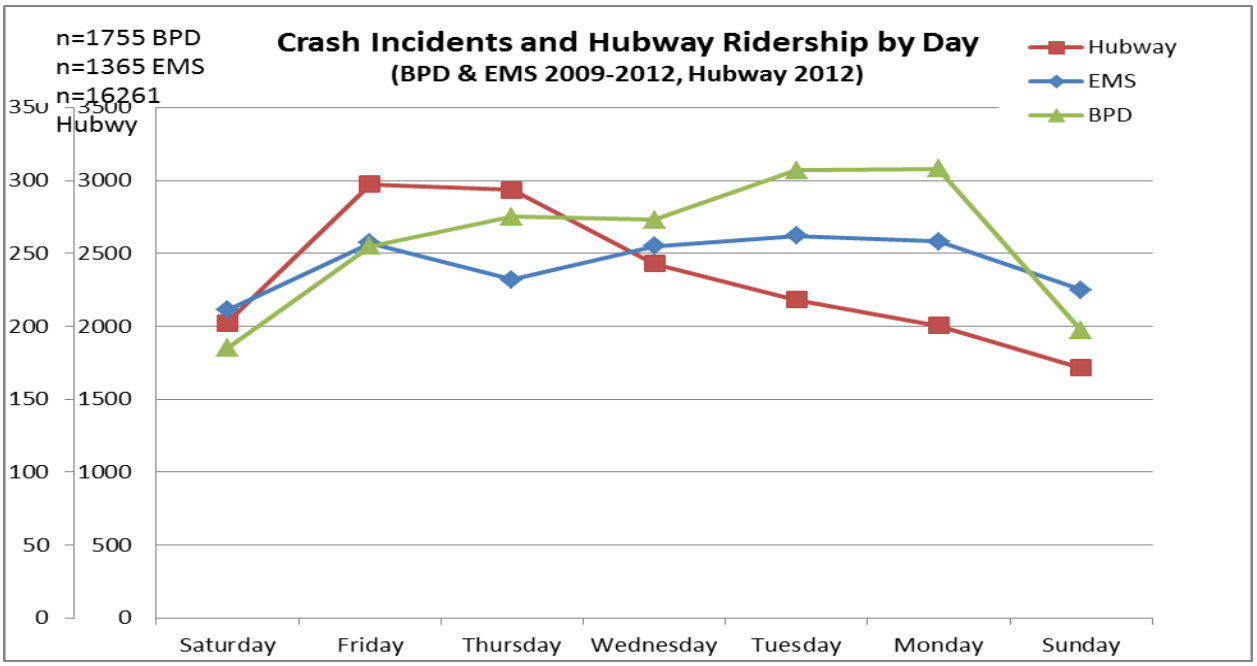
## Day/Time/Season

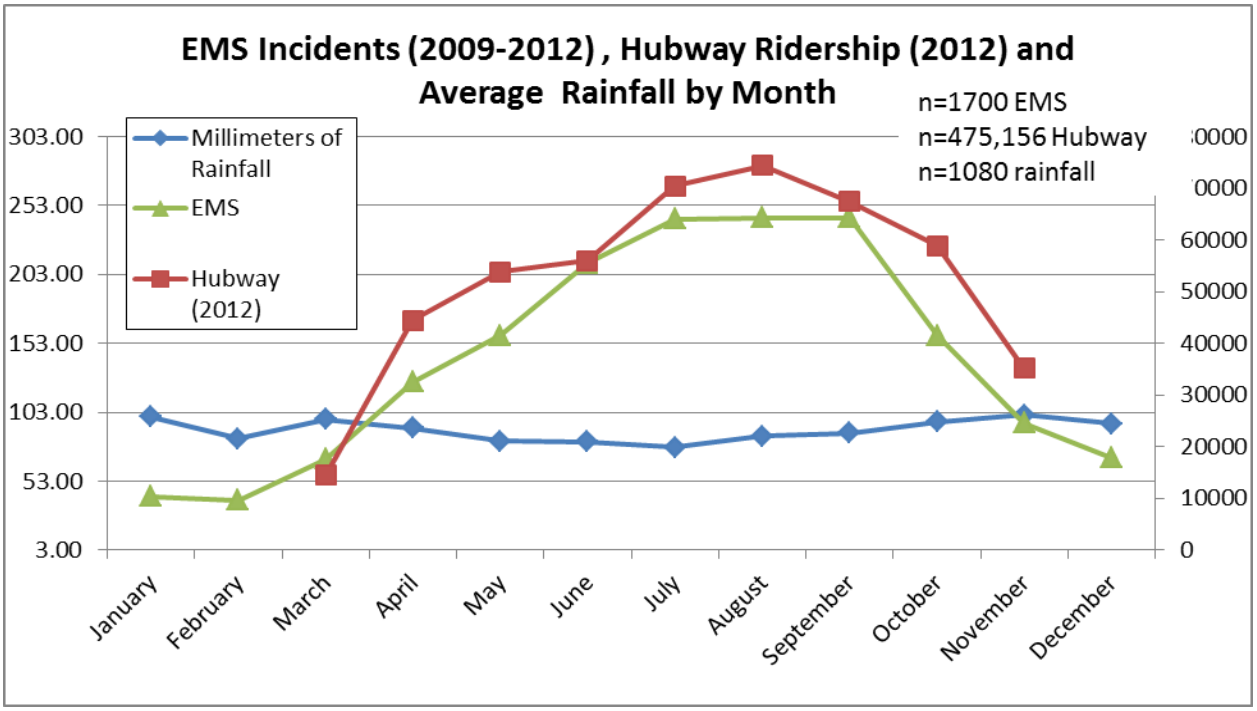
Both BPD and EMS data show an increasing rate of crashes throughout the day with three peaks. The largest peak takes place around 5:00 PM. smaller peaks take place 7:00 AM and 12:00 PM. This is consistent with morning, lunch and evening rush hours. While overall trips by time of day are unknown, we employed Hubway ridership as a proxy overall for ridership trends. EMS and BPD incidents correlate to ridership trends by time of day. Please note this is not a comment on crashes on Hubway bicycles, which remain very low.




The increased number of crashes during peak travel hours underscores the need to for all users to better *share* roads.

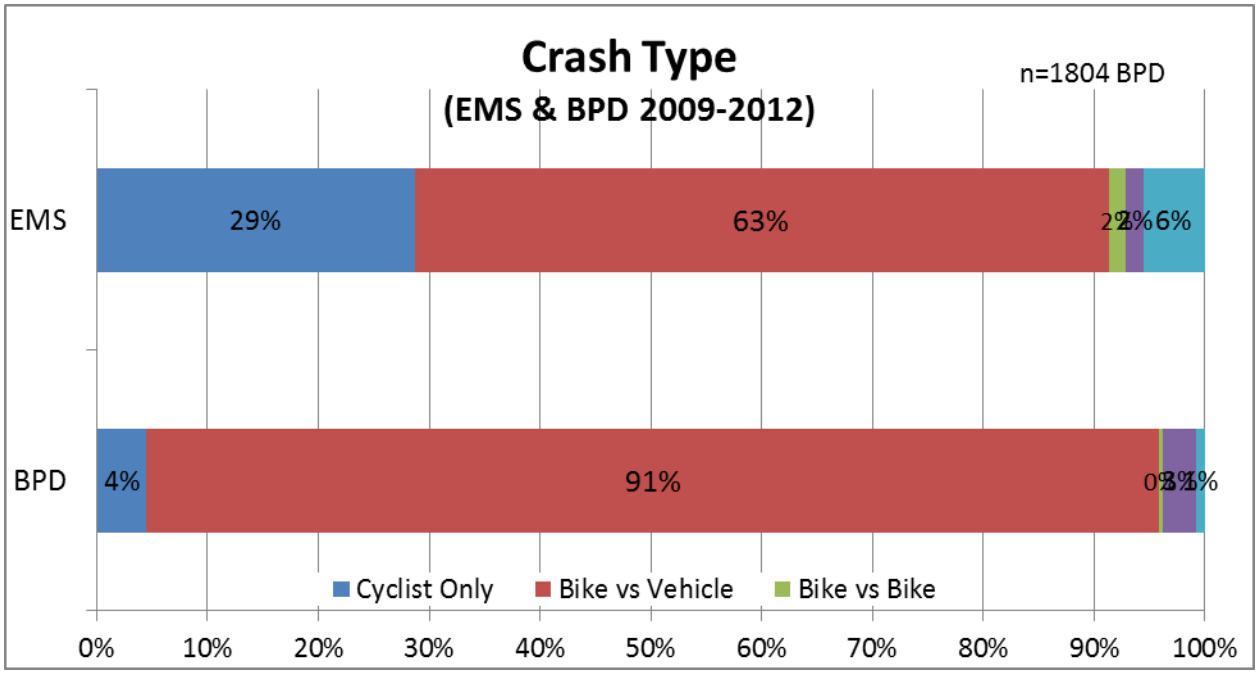
Both BPD and EMS data show crash incidents increasing from January through September, before declining through December. When compared again with Hubway ridership, BPD and EMS incidents by month appear to correlate. Crash incidents do not correlate to inches of rainfall which is lowest in the summer months. Lastly, both BPD and EMS show fewer crash incidents on weekends. Hubway ridership is likewise lower on weekends.


n=1755 BPD
n=1365 EMS
n=16261 Hubwy
Crash Incidents and Hubway Ridership by Day
(BPD & EMS 2009-2012, Hubway 2012)
Hubway
EMS
BPD
350
300
250
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
Saturday
Friday
Thursday
Wednesday
Tuesday
Monday
Sunday


EMS Incidents (2009-2012) , Hubway Ridership (2012) and
Average Rainfall by Month
n=1700 EMS
n=475,156 Hubway
n=1080 rainfall
Millimeters of Rainfall
EMS
Hubway (2012)
303.00
253.00
203.00
153.00
103.00
53.00
3.00
60000
50000
40000
30000
20000
10000
0
January
February
March
April
May
June
July
August
September
October
November
December

## Crash Type

Motor vehicles are involved in a majority of incidents. BPD reports 91% of incidents involve a motor vehicle; EMS reports 63%. We note that this is a substantial difference, but consistent with the different types of calls responded to by the BPD and EMS.




## Behavioral Factors

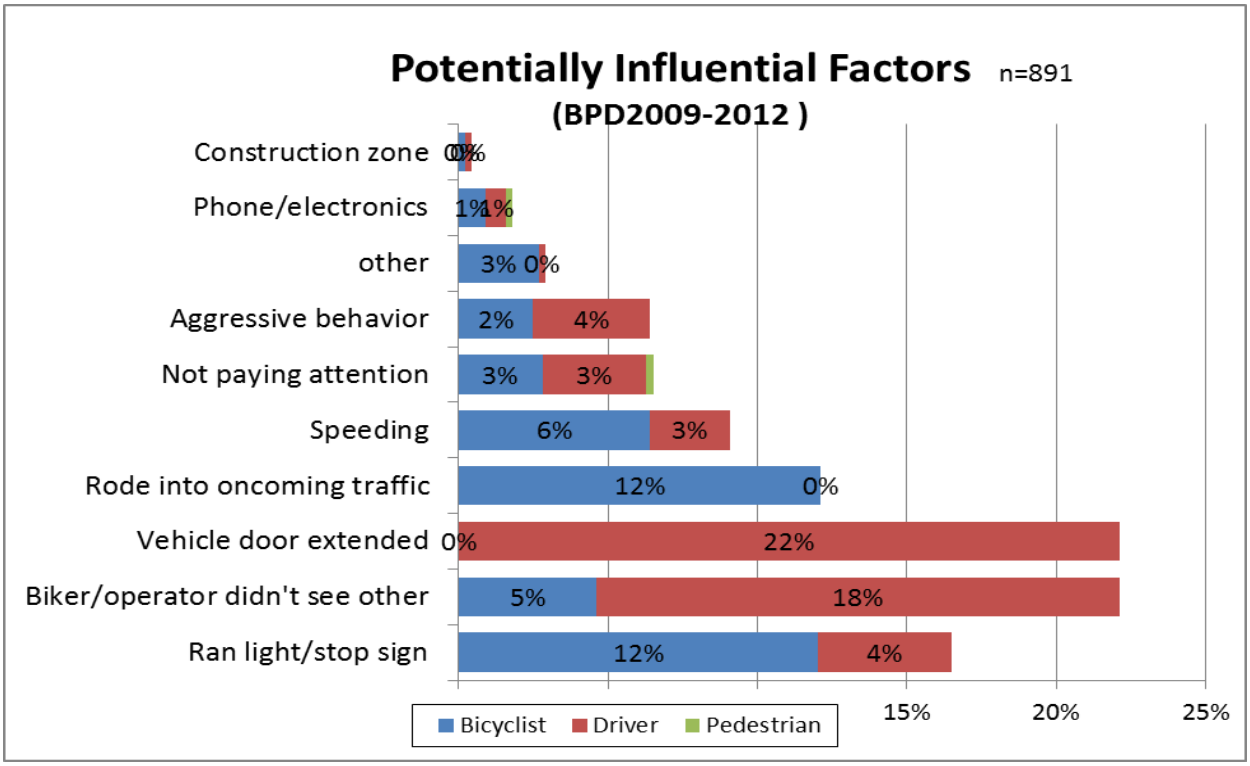
The BPD additionally records behavioral factors of cyclists, pedestrians and drivers that may lead to crashes.[11] Police referenced cyclist behavioral factors in 44% of incidents compared with 55% for drivers and .4% for pedestrians.

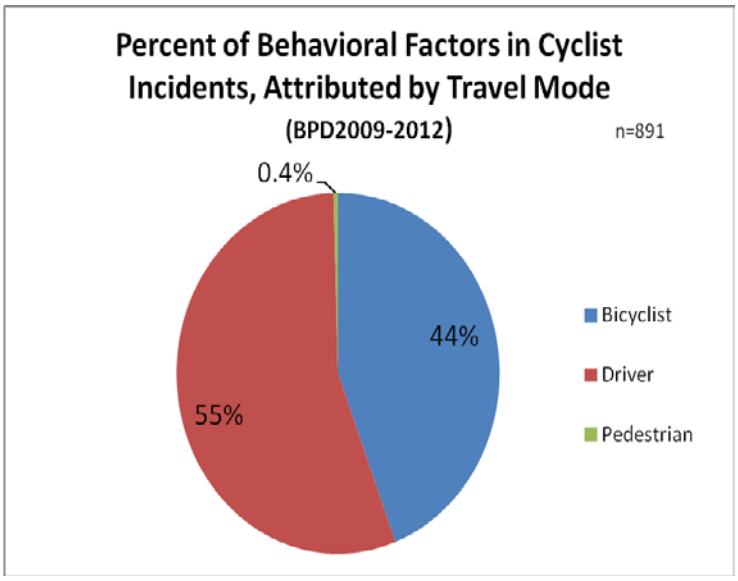
Of the incidents referencing behavioral factors:

- 24% noted the bicyclist either: a) ran a red light, b) ran a stop sign or c) rode into oncoming traffic.
- 22% of the cases involved a driver or passenger opening a car door into an oncoming cyclist. This represents 40% of all cases in which driver behavior is noted.
- 18% noted that the driver did not see the cyclist.

[11] As noted in the BPD report it is not customary nor required for officers to document many of these themes. Therefore these behaviors may have occurred more often than noted below.

**Campaigns targeting "dooring", cyclist compliance with traffic rules (red lights, stop signs, etc.), and cyclist visibility could address factors noted in more than one half of the incidents**[12] This report recommends gaining insight into some of the factors, such as "Biker/operator did not see operator/biker" for intervention purposes.



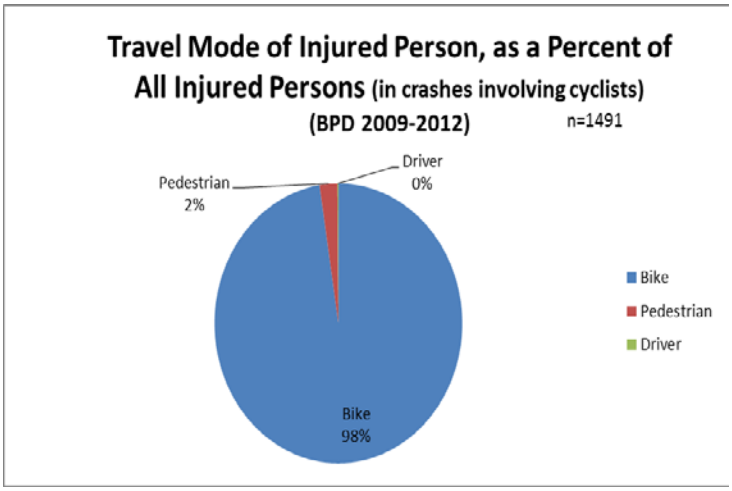



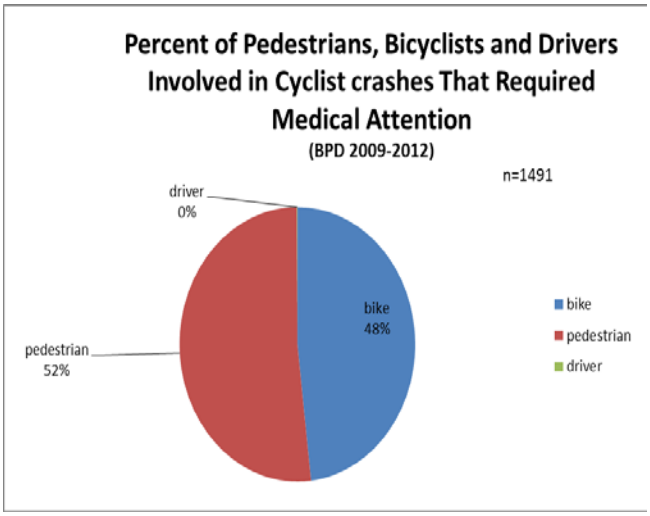

[12] The statement of "nearly three quarters incidents" is derived from summing 38%, 18% and 14% noted in paragraph.

## Injury

The BPD data shows cyclist and pedestrian disproportionately injured in crashes involving cyclists. Cyclists and pedestrians have frequently been called "vulnerable" road users because of their disproportionate injury rate relative to motor vehicles.

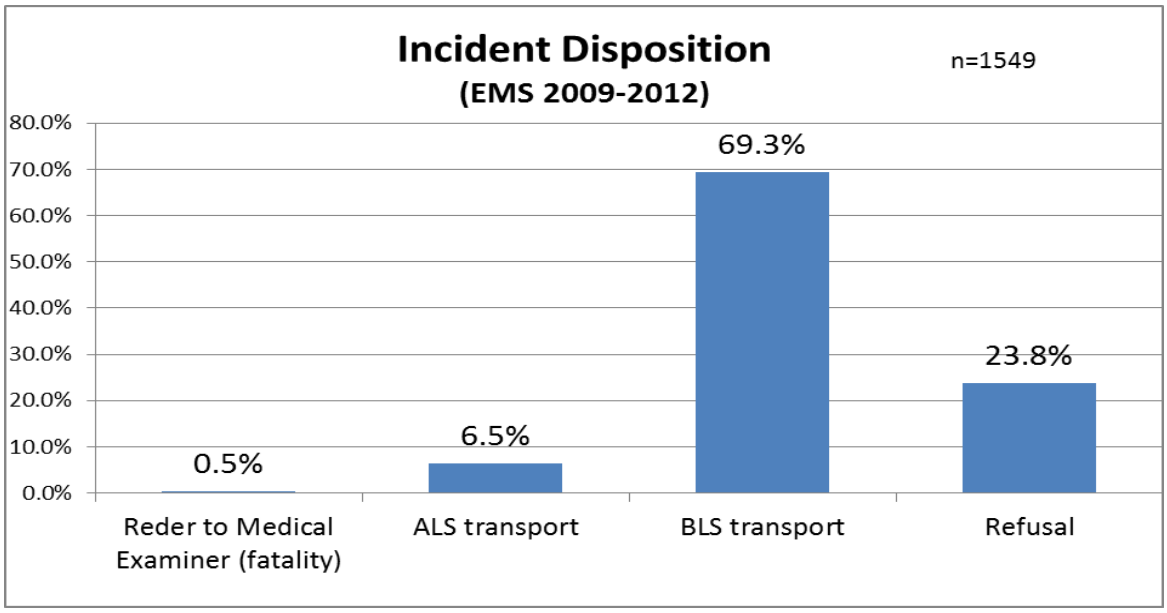
- Cyclists account for 98% of all the injured in cyclist crashes, while comprising 53% of people involved in the crashes.
- Drivers and their passengers account for 2% of the injured, while comprising 46% of people involved in crashes.
- Pedestrians account for 2% of the injured, while comprising 1% of people involved in crashes.

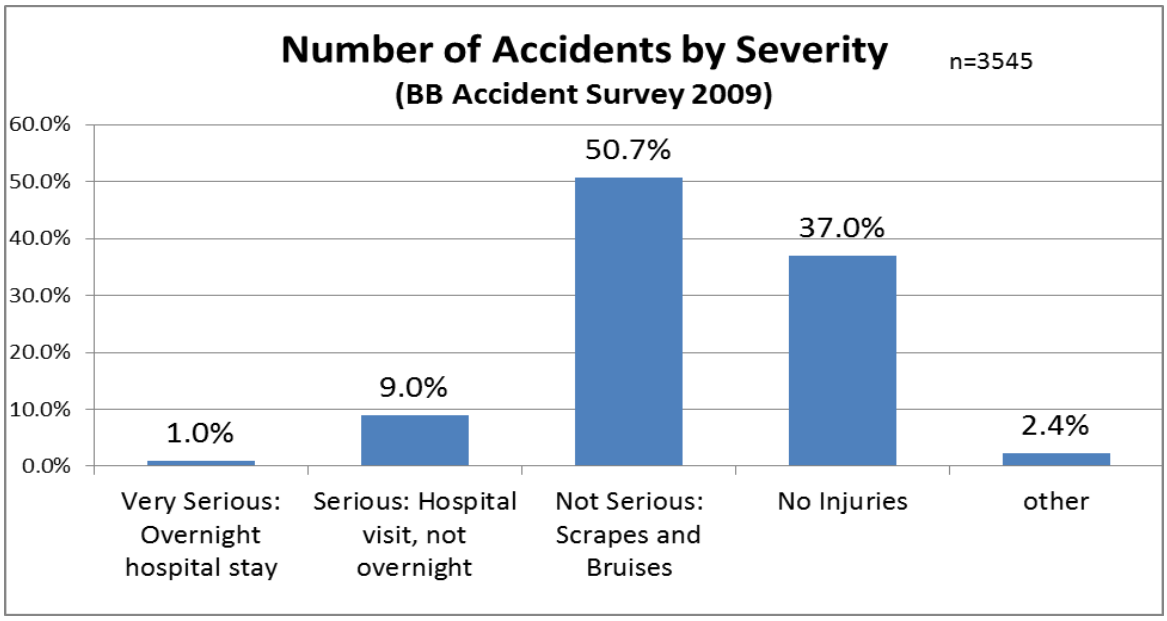



In reviewing data, the EMS was able to provide incident disposition[13] In 93% of the cases, patients either refused care or were transported by Basic Life Support. The remainder were transported by Advanced Life Support or referred to the medical examiner.

[13] Four categories of incident disposition are as follows:1) Patient referred to medical examiner, meaning the patient is no longer alive.2) Patient transported by Advanced Life Support ambulance, usually dispatched for cases deemed more life-threatening.3) Patient transported by Basic Life Support, usually dispatched for cases not deemed life threatening. 4) Patient refuses medical care.




As an approximation of the quantities of crashes that may be going unreported, the Boston Bikes Accident Survey reveals that only 10% of self-reported accidents require some type of visit to a hospital visit. The remainder are self-reported to be not serious or without injury.

## Neighborhood

Both EMS and BPD show similar geographic trends for crashes which are consistent with the Boston Bikes Accident Survey. Key findings include:

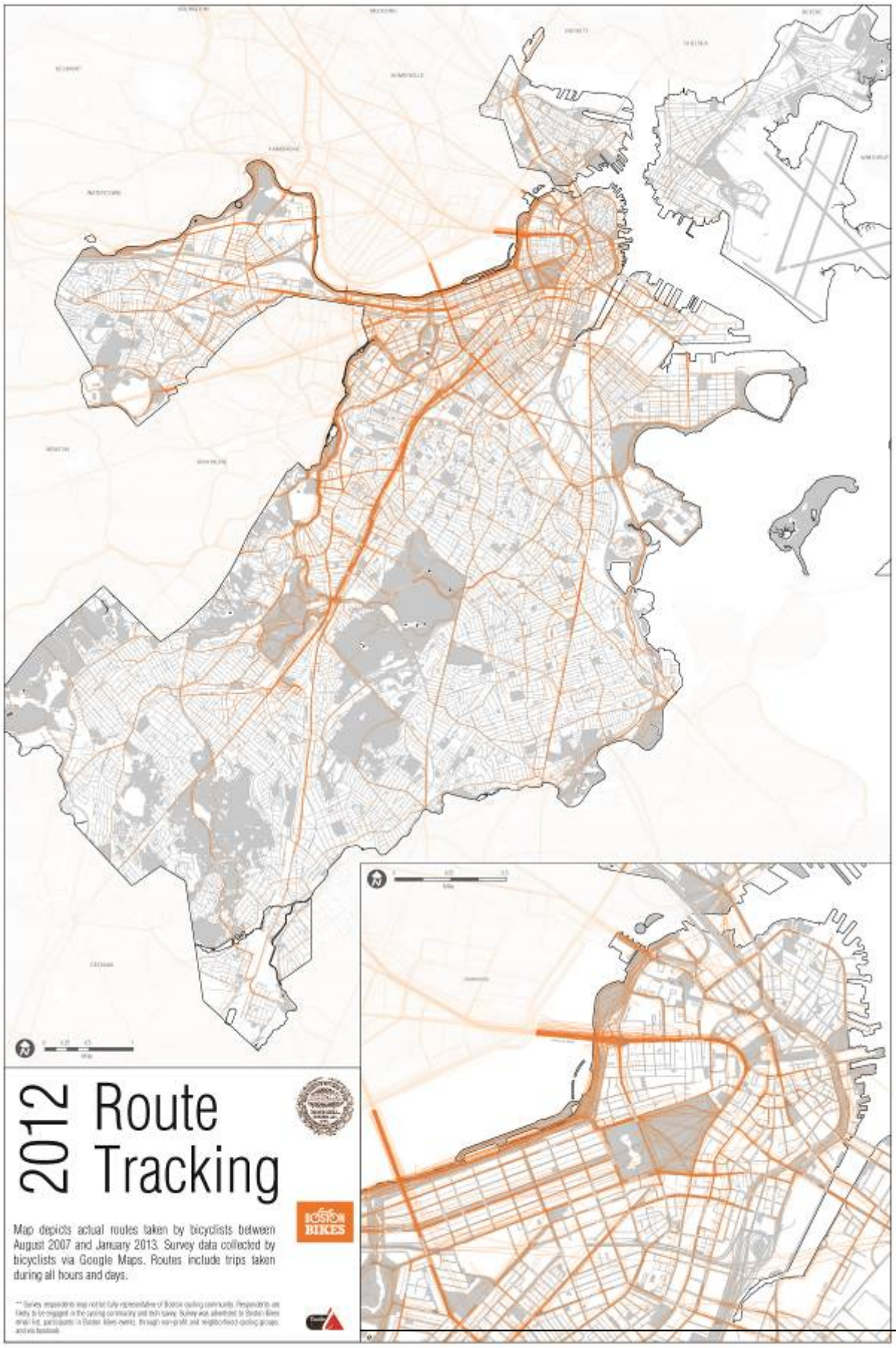
- Boston's central core out through Fenway/Kenmore sees the highest number of crashes.
- BPD and Boston Bikes report the similar roads to have the high numbers of crashes.
    - BPD's top five includes[14]: Commonwealth Avenue, Mass Avenue, Beacon Street, Boylston Street and Dorchester Avenue.
    - Boston Bikes top five respectively includes: Commonwealth Avenue, Mass Avenue, Huntington Avenue, Beacon Street and Boylston Street.
- Allston/Brighton sees the most collisions, followed by Roxbury, Jamaica Plain and Fenway/Kenmore.

Overall, locations highlighted by the report do not necessarily have the highest crash *rate* as ridership in these areas is likewise high. The 2012 Boston Bikes Route Tracking Map on the following pages shows the density of cyclist trips by road[15]. While this data on trips per route is not quantifiable from this map, the trend of crashes and cyclist trips is visible.

From a public health and design safety perspective the numerator, i.e. total crash incidents in a given location, is important.

[14] This is a compilation of the top road segments reporting 2 or more crashes. See BPD report for full list.

[15] More than 300 cyclists responded to a survey asking to map their "most recent route" using google maps. This survey seems the same population bias as other Boston Bikes surveys, in this case reaching cyclists who are more engaged in the community (ie more likely to find out about the survey) and cyclists comfortable with technology.


2012 Route Tracking
Map depicts actual routes taken by bicyclists between August 2007 and January 2013. Survey data collected by bicyclists via Google Maps. Routes include trips taken during all hours and days.
BOSTON BIKES

# Recommendations

A series of recommendations stem from this report. Recommendations tend to fall into one of three categories:

- Short term recommendations can be implanted within the next two years and are intended to reduce the total number of injuries as immediately as possible. These interventions tend to be the quickest to implement and most cost-effective, the "low-hanging fruit". Short term interventions do often target sub-groups, cyclists, taxi drivers, fleet vehicles, etc. as this strategy can often lead rapidly to positive change.
- Long term recommendations implemented over the next five years include more complex and costly interventions and/or interventions that require more time to take effect. For long term recommendations, care is taken to ensure interventions across all modes of travel and all demographics.
- Data recommendations provide suggestions for enhancing information gathering to further refine our knowledge of cyclist crashes and injuries.

## Infrastructure

- New Infrastructure (short and long term) - Prioritize installation of bike facilities on roads and at intersections with high numbers of crashes. *The City currently does this and will continue to do so. The City added bike facilities on many of the roads listed in the top 5 for crashes by BPD and Boston Bikes: Commonwealth Avenue, Massachusetts Avenue, Dorchester Avenue and Huntington Avenue.*
- Infrastructure Upgrades (short and long term) – Implement infrastructure upgrades at hot spot locations. *The City has done this and will continue to do so. In response to multiple crashes on Commonwealth Avenue, the City upgraded the bike lanes to place green color through intersections, add signage and install reflectors. The City previously added pavement markings at trolley tracks at Packard's Corner and the intersection of Huntington Avenue and South Huntington in response to crashes.*

- Integrate Crash Data (short term) – The City should review crash data during the engineering and design process so as to best understand and address location specific safety issues. This can include reviewing specific police reports to identify and address unique challenges.

### Targeted Efforts

The City, particularly in the short term should work with distinct easy to reach sub-groups to maximize the immediate impact.

- Universities (short term) – With a high percentage of crashes involving university aged cyclists, the City should encourage and facilitate bike safety efforts at all universities. The City can bring together representatives from universities to share best practices and potentially support a coordinated, comprehensive safety effort. Longer term, this effort can expand to target other at risk cyclist groups such as messengers, youth, etc. In addition to education efforts, this should include identification and promotion of"low-stress" routes in the vicinity of campuses. *Currently many universities individually plan safety efforts. No fully coordinated effort currently exists.*
- Fleet Vehicles/Drivers (short and long term) – Fleet vehicles and drivers can be addressed through education and physical interventions. Fleet drivers, particularly taxi and MBTA drivers can be educated about how to drive safely in the presence of cyclists. Topics can include: dooring, parking, blocking the bike lanes, right turns, speeding and aggressive driving. Additionally, physical interventions such as wheel guards, side guards, audible external turn signals on vehicles, etc. can be implemented. If the physical and education efforts prove successful, the programs can be expanded to more groups such as delivery drivers, Zipcar drivers, government employees, etc. *The City is actively addressing fleet issues:*
    - *Currently 1,825 taxis are being outfitted in Boston with window stickers warning passengers to not open their door into passing cyclists. The City hopes to add an in-cab PSA as well.*
    - *The City is adding side guards on 19 large Public Works vehicles this June in the largest pilot to date in the United States. The City hopes to inspire other truck owners to do*

*the same. The City likewise is adding "If you can't see me, I can't see you" signs on Public Works vehicles by June.*
    - *Mass Bike has worked extensively with the MBTA to train all drivers on cyclist issues.*
- Work-Place Training (short term) – Given the volume of rush hour crashes, this report suggests partnering with employers to provide on-site education on commuter cycling.

### Helmets

The City of Boston should encourage all riders to wear helmets. As noted earlier, and consistent with national data, helmet use reduces the risk of injury. To encourage helmet use in the short term, the City can focus on making helmets readily available at low cost while mainstreaming helmet use to overcome image issues.

- Low-Cost Helmets (short term) - The City should expand its distribution of low cost and free helmets. Online sales should allow the general public to order helmets to be mailed to their house. Retail locations beyond the Hubway zone should sell low-cost helmets. One-day distribution opportunities should be expanded and sought, particularly in neighborhoods with lower levels of helmet use. *The City currently makes low cost helmets available at more than 32 retail locations, at farmers markets throughout the summer and online for Hubway members.*
- Helmet Machines (short term) - To address access and cost, the City should implement helmet vending machines with as many New Balance Hubway stations as possible. Helmet vending machines should be able to rent and sell inexpensive helmets to Hubway users as well as the general public. ***Plans are currently underway to install helmet vending machines in 2013.*** *At the time of this writing, the City has recognized HelmetHub as the preferred vendor for Boston and is working to finalize a contract for helmet vending machines.*
- Geographic Equity (long term)– Preliminary data from Boston Bikes counts suggests that the rate of helmet use may vary substantially by neighborhood in Boston. More data should be collected and specific efforts should be made to correct an imbalance.
- Helmet Law (long term) The City should consider implementing a mandatory all-ages helmet law. Studies showing that helmet laws

reduce ridership are far from conclusive. *Helmets are currently required for youth 16 years and younger and Hubway users.*

## Education

- Outreach Campaign (short term) - Implement a large-scale outreach effort to educate cyclists on key safety issues shown in this report to be connected with injury. These include wearing helmets, avoiding car doors, not running red lights/ riding into oncoming traffic and staying visible (using lights, wearing bright clothes, staying out of blind spots, etc.). The outreach effort can rely heavily on earned media, social media, emails, etc.
- Youth Cycling (short and long term) – Continue, grow and institutionalize the existing Youth Cycling Program with the goal of reaching 100% of Boston Public School youth. *Boston Bikes currently provides on the bike training for 4,000 youth per year.*
- Skill Classes (long term) – Encourage third party groups to increase opportunities for on the bike training to provide cyclists safe riding skills. *Boston has piloted adult skills classes. These have not gone to scale.*
- Driver/ Pedestrian Education (long term) – The City can expand efforts to better reach the general driving and pedestrian population. Possible methods include a marketing campaign focused on drivers, increasing cycling questions on the driver's test, providing more information at the Registry of Motor Vehicles, working with driver's education programs to incorporate cyclist issues, etc. *Currently all Boston drivers receive a flyer with tips for driving safely among cyclists with the excise bill. The City has had preliminary discussions with the Registry of Motor Vehicles and other potential partners.*

## Enforcement

- Hot Spot Enforcement (short and long term) - Develop specialized enforcement strategies for hotspot areas with heightened police enforcement. *Currently BPD and Boston Bikes conduct enforcement in areas that see the highest rates of crashes, particularly Commonwealth Avenue and Massachusetts Avenue.*
- Tickets (short term) - Enhance police enforcement of cyclists and drivers by increasing days of targeted cycling enforcement (of drivers and cyclists). *Currently BPD conducts weekly and/or bi-*

*weekly seasonal enforcement of cyclists. Warnings, not fines, are distributed. BTD is increasing the number of officers on bicycles.*

- Fines (short term) - Transition to issuing fines, as opposed to warnings, to cyclists for not following rules of the road. *The BPD intends to issue fines in 2013.*
- Police Training (long term) Train and encourage all BPD officers to enforce rules of the road for cyclists so as to institutionalize cyclist enforcement throughout the agency.

## Data Collection, Analysis and Sharing

- Data Sharing (long term) - Share de-identified collision data between BPD, EMS, BTD and/or other City agencies so data can be mined for information on an as-needed basis by professionals in their respective agencies.
- Enhance Database (long term) - Enhance BPD and/or EMS database to collect more detailed information about the circumstances surrounding bicycle and other transportation collisions. Include helmet usage as a required element in the police report. Consider, as possible, collecting information on race/ethnicity, and injury type. Continue collecting self-reported data from cyclists to provide a complete picture of incidents from all perspectives.
- PBCAT (long term)- Standardize police reporting and documentation through the adoption and use of The Pedestrian and Bicycle Crash Analysis Tool (PBCAT).
- Count data (long term) – Enhance and increase cyclist count data particularly at high traffic locations to facilitate better analysis.
- Evaluation (long term) - Establish metrics to evaluate the success of all crash interventions recommended in this section.

## Further Analysis

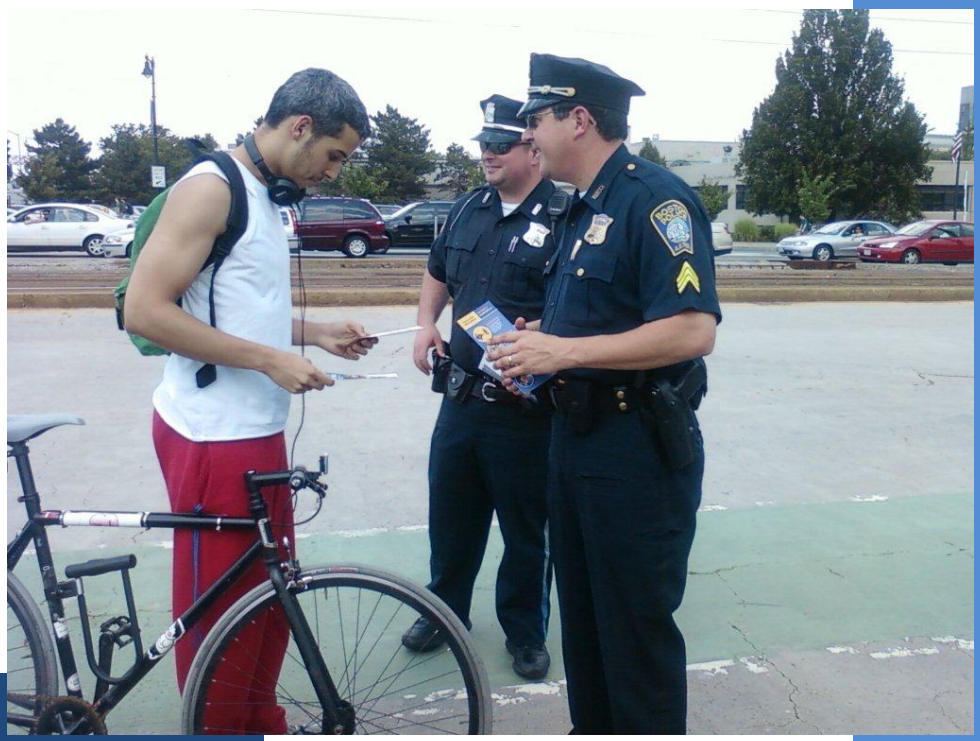
- As discussed in the introduction, this report represents the beginning of an ongoing commitment to identify, analyze and address safety challenges for cyclist. Data can always be analyzed more; data from this report included. This report did not look at the impact adding bike lanes, shared lanes or cycletracks had on cyclist collisions etc. Nor did the report look in detail at the impact of large vehicles, or collision type (left turn, right turn, sideswipe, etc.). It is recommended that future analysis begin to look at some or all of the following issues:

- Incident by road type
- Incident by bike facility type and impact of bike facilities on crashes
- Vehicle type (truck, bus, SUV, taxi…) involved in crash
- Age and gender of vehicle driver in incidents
- More detailed information on activity at time of incident: more behavioral information, direction of travel of cyclist and vehicle, etc.
- Patterns of bike-pedestrian crashes

As data can be analyzed ad infinitum, this report recommends continuing to analyze data strategically, with an eye firmly and always on the ultimate goal:  reducing crashes and saving lives.

# Part II

# Boston Police Department Collision Report



2009-2012

## Executive Summary

Mayor Thomas M. Menino is committed to promoting bicycle safety throughout the city of Boston. In line with this commitment, he has requested that the Boston Police Department (BPD), through the Mayor's Bicycle/Pedestrian Working Group, collaborate with the Boston Area Research Initiative, the Harvard Injury Control Research Center, and the Boston Cyclists Union to thoroughly review our crash data and generate baseline crash estimates and maps for planning purposes. This initial study will provide information about bicycle collisions and help to generate recommendations for improved collision surveillance and prevention, so that the City can—along with partner agencies and members of the community—make cycling even safer for all Bostonians and visitors.

## Key Findings

### Collision Types

Of 1,813 total bicycle collisions that were reported to the BPD over the last four years (2009-2012), we found that most (91.0 %) of the bicycle-related collisions reported to the department involved a vehicle. The other 7.7% of collisions included falls or bicycles versus other bicycles or pedestrians. During the process of hand-coding the narratives, we categorized 15 (1.3%) cases as Bike-Related- Unknown because we were unclear about the circumstances of the collisions (e.g., if a police officer responded to the scene and found a cyclist unconscious with no witnesses).

### Time Trends

We found that the number of reported collisions from 2010 to 2012 did not vary significantly. As expected, the months of June, July, August, and September accounted for over 50% of the total collisions. With regard to weather conditions, 20% of collisions took place during rainy conditions, while 80% took place in favorable weather. In fact we found a correlation between the number of collisions and average temperature per month – collision numbers rose as temperatures rose, and collision numbers dropped as temperature dropped. The highest frequency of collisions occurred on Thursdays and Fridays and then dropped by

approximately 25% on Saturday and Sunday. With regards to the time of day, the majority of the collisions (60%) occurred during daylight hours. In fact, one third of total collisions occurred during the afternoon rush, between 4:00 PM to 7:00 PM.

### Road Users' Injuries and Fatalities

Over the course of three years, 9 bicyclists died as a result of a collision with a motor vehicle. A total number of 3,416 people were directly involved in the 1,813 bicycle collisions in our study. These people included: 1,818 cyclists, 40 pedestrians, and 1,544 automobile drivers, 14 vehicle passengers, and 1 motorcyclist. Approximately 79% of bicyclists and 83% of pedestrians involved in these collisions were injured, while 2 of the 1,583 drivers were injured.

### Potentially Influential Behavioral Factors

After actively looking for particular themes in narrative sections of those police incident reports that included narrative details about bicyclists or driver behavior, the top three out ten frequent behaviors noted were: drivers not seeing bicyclist (156), bicyclist riding into incoming traffic (108), and bicyclist running red lights (85). Table 1A, 1B and 1C within this report will give a fuller picture of other influencing behavioral factors.

### Geographic Analysis: Intersections and Hotspots

We found that nearly 60% of all bicycle collisions occurred at street intersections. Of the 7 locations with 5 or more geographically identical collision locations, the top two intersections with the highest number of crashes were in the Back Bay/Beacon Hill neighborhood, with 14 collisions at Beacon St and Massachusetts Ave and 12 collisions at Massachusetts Avenue and Commonwealth Ave (Westbound). Allston/Brighton was the only neighborhood with 3 intersections in which collisions occurred repeatedly.

## Leadership

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Captain John Danilecki, Bureau of Field Services, Night Command

Maria C. Cheevers, M.Ed., Director, Office of Research and Development

Marjorie Bernadeau, Data Manager, Office of Research and Development

**Boston Area Research Initiative (BARI)****

Daniel O'Brien, PhD, Research Director

**Boston Cyclist Union (BCU)**[^]

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**Harvard Injury Control Research Center (HICRC)**[†]

David Hemenway, PhD, Director

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## Introduction

Bicycling in the City of Boston is growing in popularity both as a recreational activity and as a means of transportation. According to the 2012 Massachusetts Travel Survey, over 56% of households in the Boston region owned one or more bicycles, and 7.9% of people surveyed had used a bicycle for transportation in the previous week. According to the American Community Survey, biking to work in the city of Boston grew by 82% between 2008 (0.94%) and 2011 (1.7%).

Part of the popularity of cycling lies in its health benefits. To maintain good health, The U.S. Surgeon General recommends that adults get at least 30 minutes of physical activity per day for at least five days each week and that children and adolescents get at least 60 minutes of physical activity per day for at least five days each week. To encourage the growth of cycling in the city, Boston's Transportation Department and the Boston Bikes program have added 61 miles of sharrows, bike lanes, and cycle tracks since 2008 and plan on expanding the network in the coming years. The City of Boston also runs a full complement of bike programs, as do several bicycle advocacy and other non-profit organizations. Such a comprehensive approach has been shown to increase bicycle mode share in many other cities (Pucher, Dill, & Handy, 2010) and Boston's large college student population may increase their use of bicycles as the infrastructure for this form of active transportation continues to expand.

The "safety in numbers" (SIN) theory proposes that as more people cycle, the overall rate of collisions and risk of injury to each cyclist decreases (Jacobsen, 2003). However, in reviewing reports generated by agencies in other cities, there is some evidence that contradicts this theory. For example, after analyzing 5 years of collision and bicycle count data, the San Francisco Municipal Transportation Agency reported that SIN did "not appear to be the case so far [for bicyclists] in San Francisco" (pg. 21, SFMTA 2010-2011 Collision Report). As such, as riding continues to increase in popularity in Boston, the City of Boston is especially committed to taking appropriate measures to reduce the likelihood of injury and death to cyclists.

The first step in preventing negative outcomes such as injuries and deaths is to identify and describe the problem and its patterns. In order to begin to address the challenge of improving safety, we aimed to review our collision data and generate baseline collision and injury estimates and maps. What follows is a set of initial findings on bicycle collisions in the City of Boston from 2009 to 2012. **We hope that this initial study can provide information about bicycle collisions and help to generate recommendations for improved collision surveillance and prevention, so that we can—along with our partner agencies and members of the community—make cycling even safer for all Bostonians and visitors.**

Given our commitment to improving our collision surveillance program, the BPD established a formal research protocol with the Boston Area Research Initiative (hosted by the Radcliffe Institute for Advanced Study at Harvard University) and the Harvard Injury Control Research Center (at the Harvard School of Public Health) to conduct ongoing research on bicycle collisions and to improve the effectiveness and efficiency of our bicycle and pedestrian collision surveillance program. The Harvard Committee on the Use of Human Subjects in Research approved the research protocol in January of 2013 and we have taken appropriate measures to ensure the highest level of data sharing security. Although we are in the beginning stages of evaluating the BPD's data collection method, we share at the end of this report our initial findings and recommendations for collecting more detailed bicycle and pedestrian collision data.

## Method

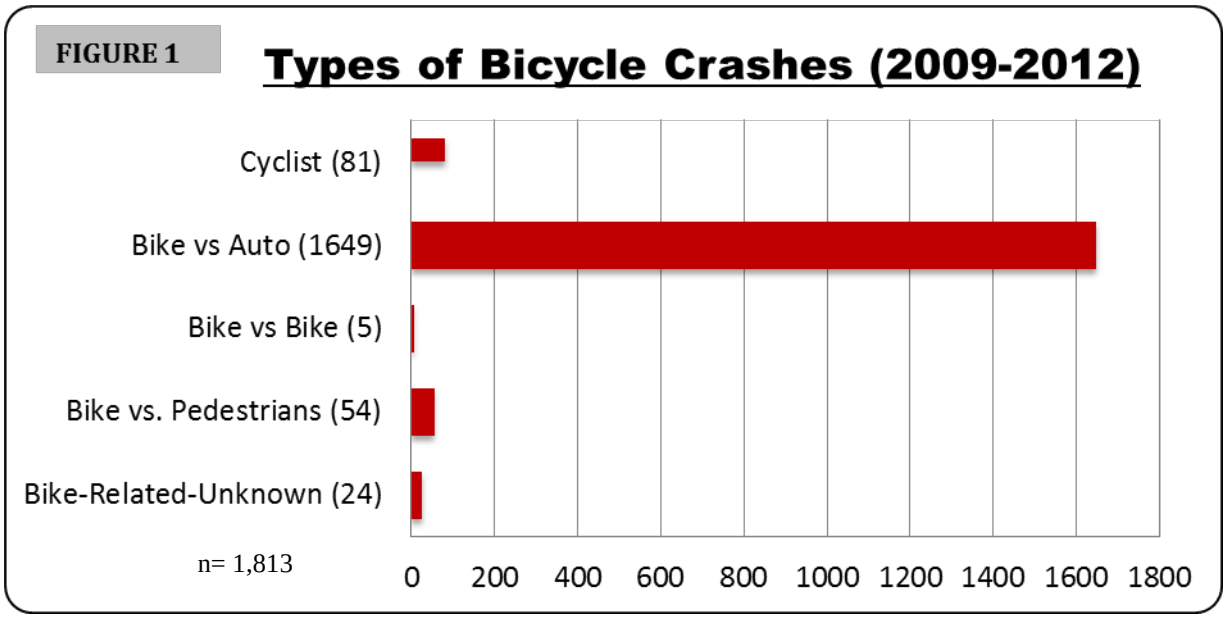
We note that the Boston Police Department (BPD) database is currently not optimized to collect highly specific transportation-related collision information. The BPD collects standard variables related to each collision, such as date and time of occurrence, details on involved parties and their property (i.e., motor vehicles), and an open-ended description of the circumstances surrounding a collision. These descriptions are written by the police officers that respond to the scene. As such, in order to extract relevant data for this report, we reviewed and coded thousands of narrative files with the help of a large team of analysts and research interns currently employed by at least one of the project partners listed above. Please see Appendix A for a detailed summary of the methods for this study.

## Findings

### Collision Types

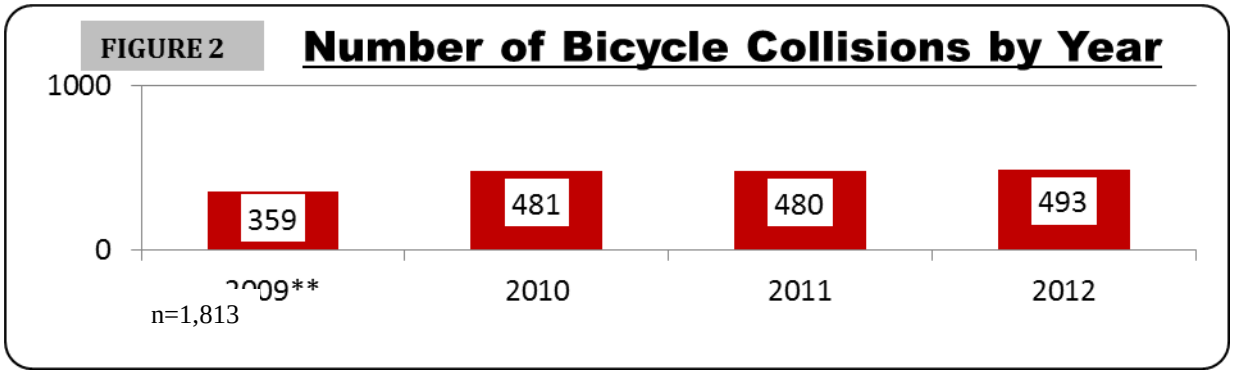
Of all the bicycle collisions[16] that were reported to the BPD over the last four years, we found that most (91.0%) of the bicycle-related collisions reported to the department involved a motor vehicle (n= 1649; see Figure 1). An additional 7.7% of collisions included cyclist only, or bicyclist colliding with other another bicyclist or a pedestrian. During the process of hand-coding the narratives, we categorized 15 (1.3%) cases as Bike-Related-Unknown because we were unclear about the circumstances of the collisions (e.g., if a police officer responded to the scene and found a cyclist unconscious with no witnesses). Studies in various parts of the world have demonstrated that police departments tend to underreport Cyclist Only collisions and that hospital databases can help account for cyclists who fell and subsequently sought medical treatment (Lopez, Sunjaya, Chan, et al, 2012; Langley, 2003). Therefore, the number of Cyclist Only collisions in Boston may be greater than the 81 incidents we have reported. There is no mandated reporting to BPD for a cyclist fall. Cyclists who fall may decide not to contact the police for several possible reasons, such as: if a vehicle was not involved; if they feel that their injuries were not severe enough to require medical treatment; if they seek medical attention without the assistance of the police or other first responders; or if they choose not to document their fall with a police report.

[16] Our raw data included 1,814 narrative reports. However, due to the large number of variables generated or collected from a diverse relational database, the total number of collisions may vary slightly when calculating estimates in this report. For example, we did not have location information for 80 cases when generating maps. This resulted in 1,734 collisions included in the analysis of locations.




## Time Trends

**We found that the number of reported collisions from 2010 to 2012 did not vary significantly.** Although the distribution in Figure 2 appears to show a sharp increase in the number of bicycle collisions between 2009 and 2010, we *cannot* conclude that the number of collisions increased dramatically at that time because we found that a large proportion of data elements were missing in the data from 2009. Therefore, we attribute this spike in collisions to better reporting given that the BPD implemented a bicycle collision indicator in the police incident report/database in 2010. We were unable to calculate a collision rate that accounts for vehicle, bicycle, and pedestrian volumes. These data are not currently available.

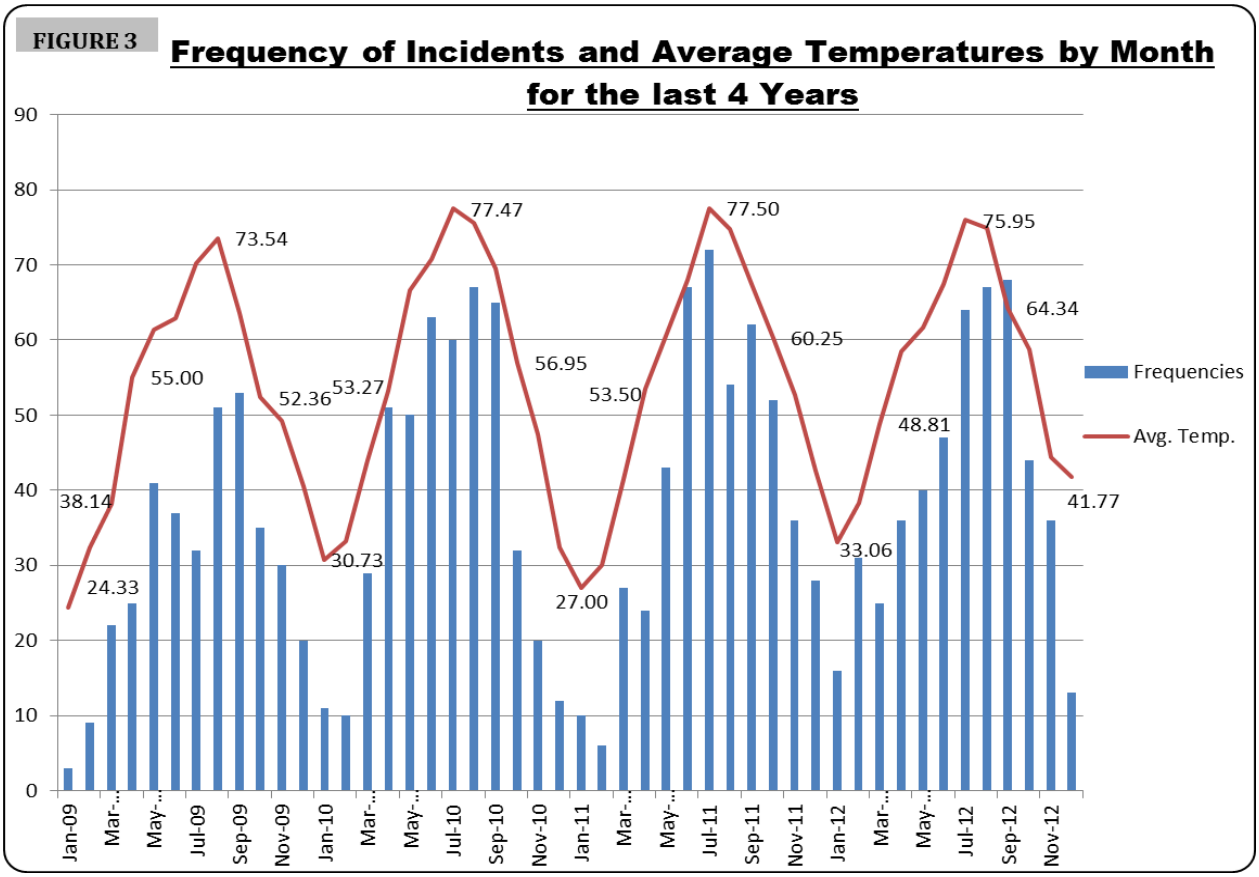



***The Boston Police Department did not code bicycle incidents separate from motor vehicle accidents within their incident reports until May 2009. Therefore the number represented for 2009 does not represent the total number for that year.*

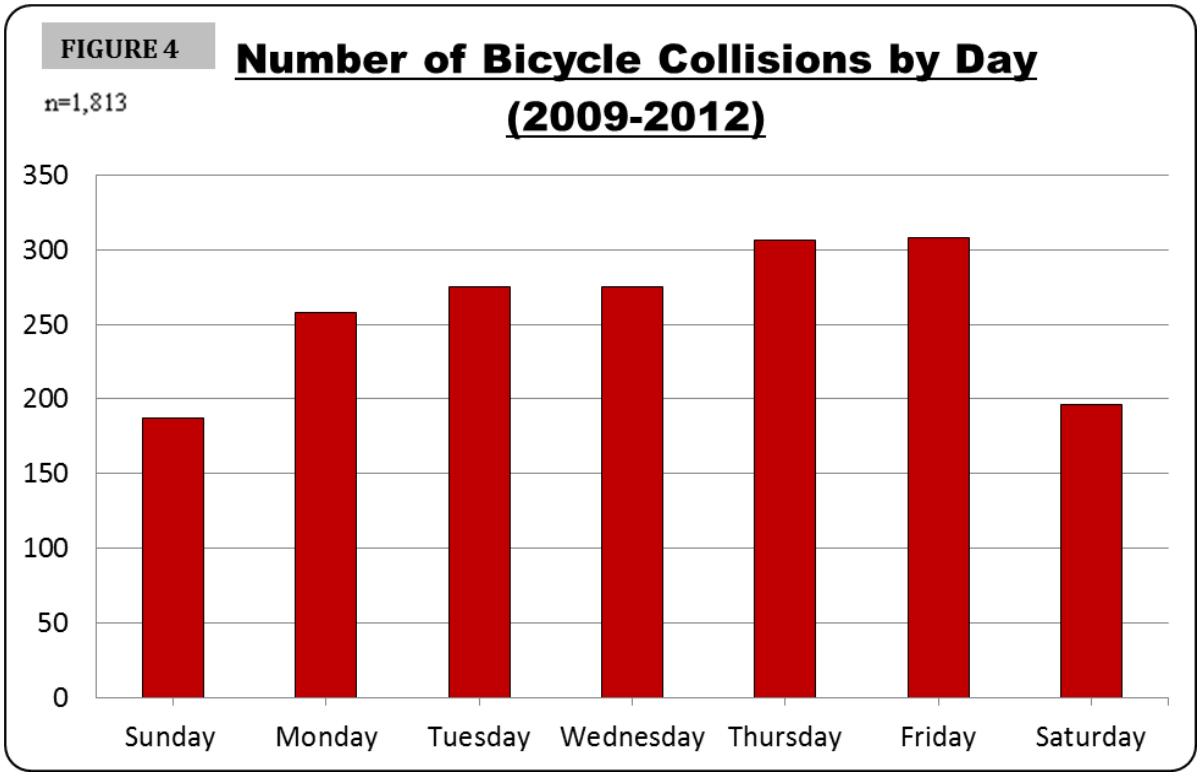
Collision counts by month differed significantly, indicating that the distribution of collisions throughout the year is not random. **As expected, the months of June, July, August, and September accounted for over 50% of the total collisions.** We speculate that the total number of cyclists on the road during these months also increases due to favorable weather conditions and the influx of students into the city at the beginning of the fall semester. With regard to weather conditions, 20% of collisions took place during rainy conditions, while 80% took place in favorable weather. With regard to temperature, 59.9% of collisions took place with temperatures over 60 degrees, while 39.5% of collisions took place during temperatures of 59 degrees or less.

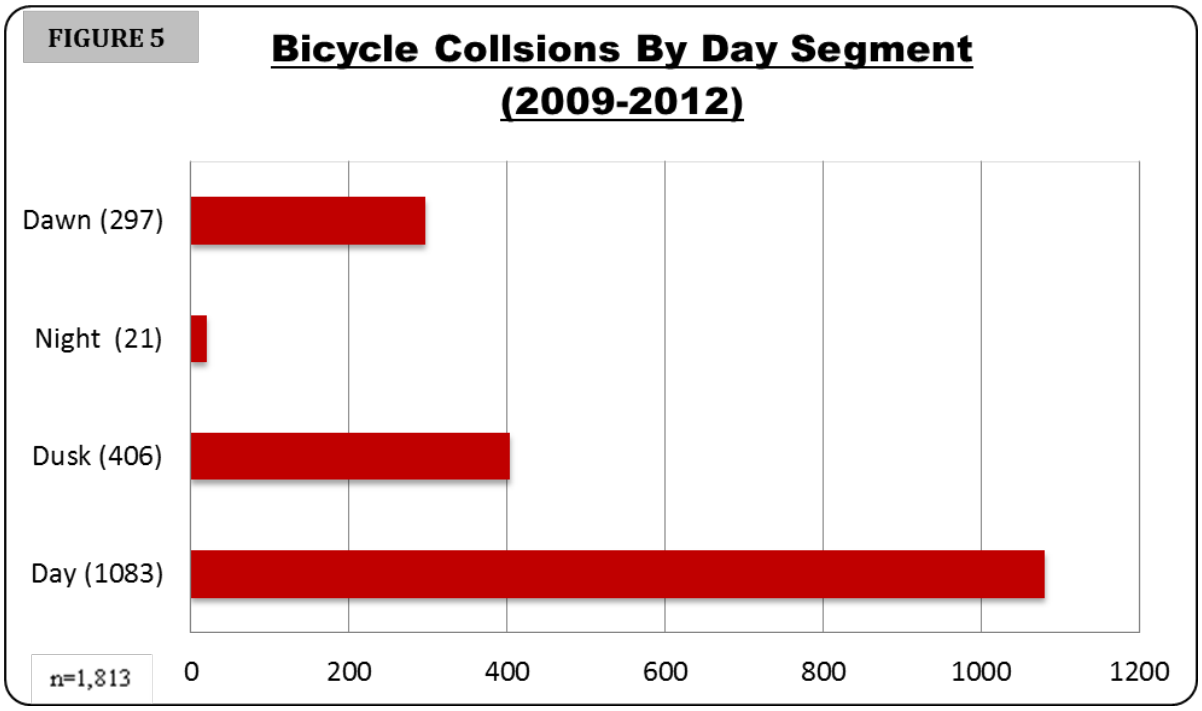
See Figure 3 for bicycle collision counts by month for the four years studied.

FIGURE 3

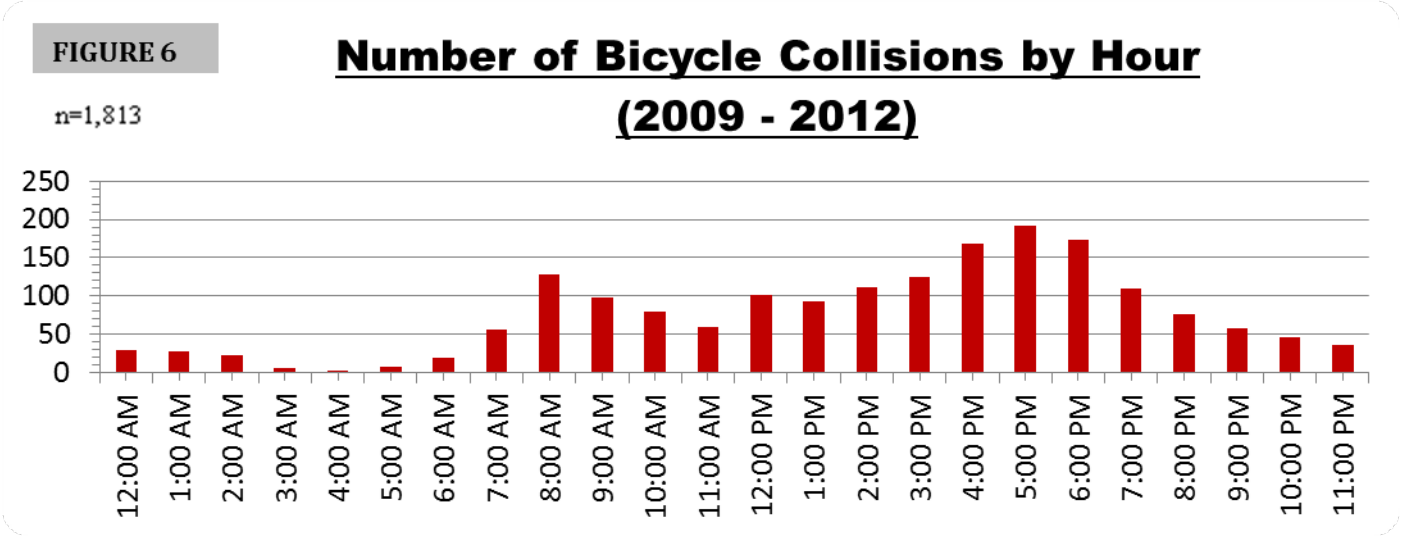


Collision counts by day of the week also differed significantly. See Figure 4. It is possible that counts are higher during the week because there are presumably more riders (and more overall traffic volume) commuting to work during the week. **With regards to the time of day, the majority of the collisions (60%) occurred during daylight hours. In fact, one third of total collisions occurred during the afternoon rush, between 4:00 PM to 7:00 PM.** See Figures 5 and 6.






*Dawn was defined as a period of time 60 minutes before and 60 minutes after the official sunrise times on the day of each collision.
° Dusk was defined similarly with the official sunset data.
**Day and Night was the period of time between the aforementioned dusk and dawn periods.

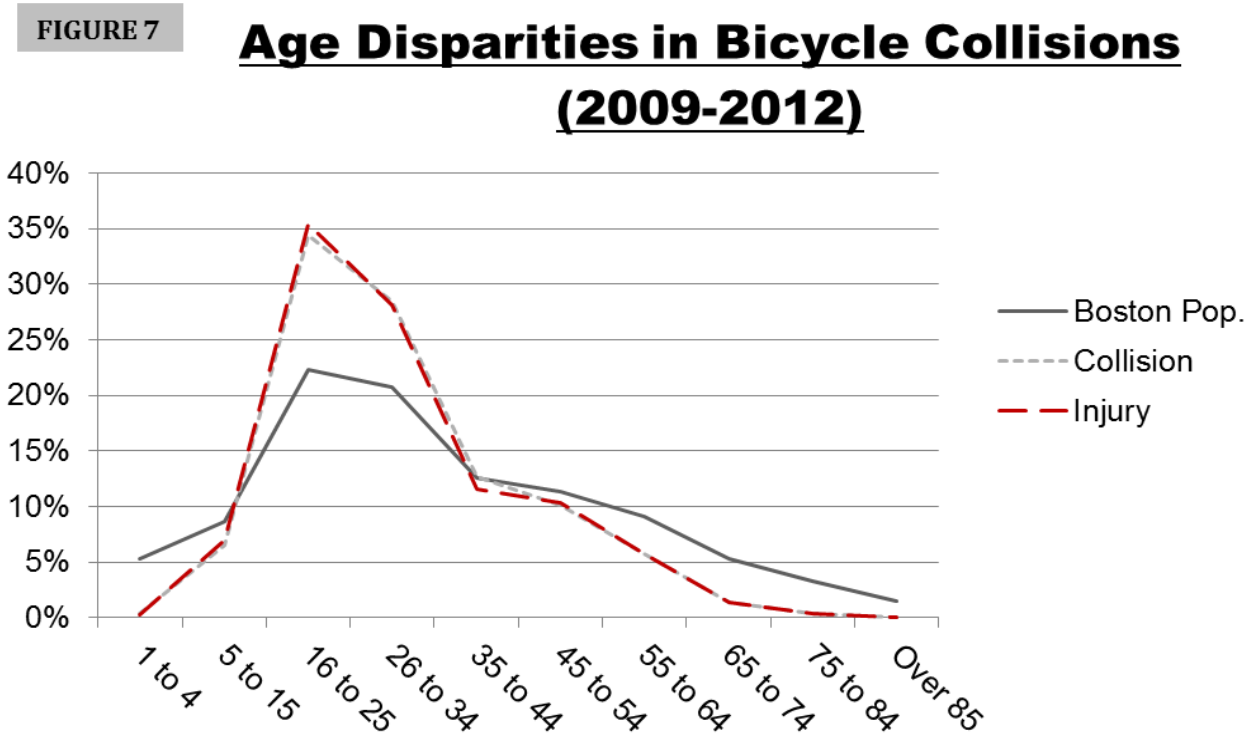



## Demographics of Involved Bicyclists

Gender data were available for 1,741 of the 1,818 bicyclists identified in police reports (note: some reports included more than one bicyclist). Men accounted for 73% (n=1335) and women for 22% (n=406) of all the police-reported bicyclists involved collisions. Five percent of the cases were missing gender data. Bicyclists ranged in age from 1 to 79, with a

mean age of 31 (SD= 14), and median age of 30. The children "bicyclists" under the age of 5 were those who were riding in a bicycle with their parents or learning to use a ride-on toy that resembled a bicycle. **However, as is evident in Figure 7, bicycle collision frequencies are highest for those between the ages of 5 and 34.** Approximately 55% of bicyclists involved in a collision were in this age bracket, yet only 42% of the Boston population falls in that age bracket. We did not find the same disparity among other age brackets.

**FIGURE 7**



Moreover, after adjusting for the distribution of ages using Boston population figures and US Population weights, we found that the rates of bicycle injuries per 100,000 Boston residents were 56, 53, and 49 for 2010, 2011, and 2012, respectively. Data from 2009 is not used due to a different reporting method that makes data incomparable. In other words, in 2010, 56 bicycles related injuries occurred per 100,000 residents. According to the National Highway Traffic Safety Administration (NHTSA), the rate of bicycle related injuries in the US was 16.7 per 100,000 people in 2010 (NHTSA, 2012). This means that the bicycle related injury rate for Boston is approximately 3.5 times higher than the national rate. However, it must be noted that NHTSA's rate calculation adjusted for differences in population density across cities, but not for other factors such as overall urbanization. A better way to interpret the age-adjusted bicycle injury rate might be to compare it to the rate of a city that is similar in size and population, such as San Francisco—a city that is 49 square miles and has a population of 800,000 residents. **When compared to San Francisco's rate of 68 bicycle related injuries per 100,000 residents in 2010, Boston's rate in 2010 is 17% lower**. We were unable to compare Boston to San Francisco for other years because the latest available year of data (in the California Statewide Integrated Traffic Records System) for the San Francisco bicycle injuries was 2010. Although there are differences between these cities for which we have not accounted (e.g., terrain and bicycle volume), these weighted rate comparisons help to place the burden of bicycle injury in Boston into context.

Furthermore, we found that Whites (non-Hispanic) were overrepresented among injured bicyclists. Approximately 65% of bicyclists involved in a collision were White, yet they account for only 56% of the Boston population. We did not find this disparity among any other ethnicity categories[17].

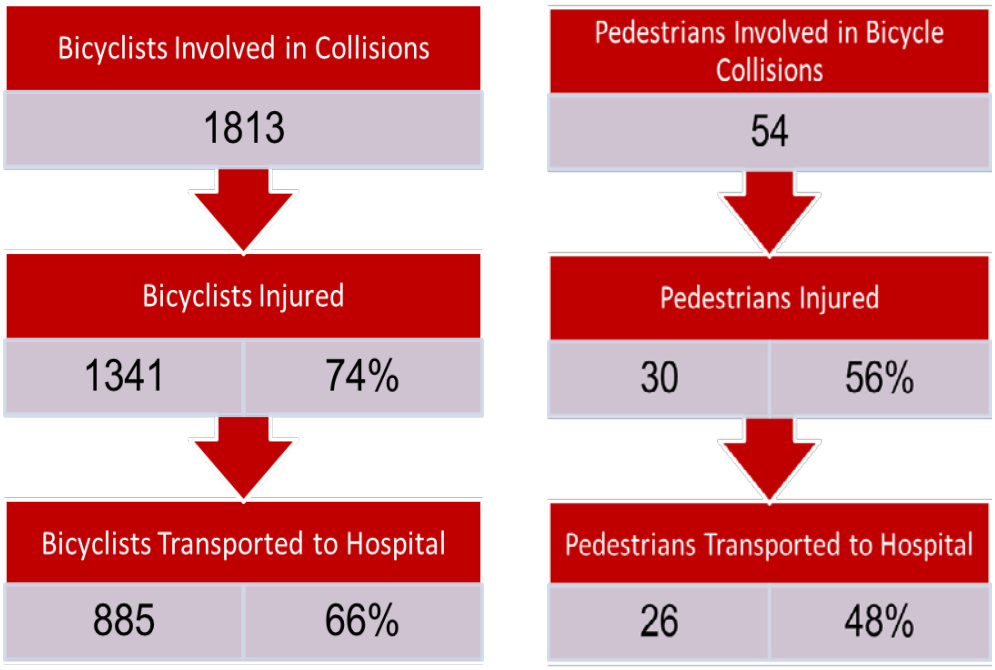
[17] While the reported BPD-ollision rates show higher numbers for Whites, relative risk calculations would require data regarding relative exposure (e.g. miles cycled per person, cycle trips per person) which are currently unavailable. Whites may represent higher total numbers of BPD-reported bike incidents because they account for a much larger share of the total commuting cyclist population and therefore, total cycling risk exposure.

### Road Users' Injuries and Fatalities

A total number of 3,417 people were directly involved in the bicycle collisions in our study. These people included 1,818 cyclists, 40 pedestrians, 1,544 automobile drivers, 14 vehicle passengers, and 1 motorcyclist. Per Figure 8 below, 79% of bicyclists and 83% of pedestrians involved in these collisions were injured. Only 2 of the 1,544 drivers were injured. Among the injured bicyclists and pedestrians, 66% and 86%, respectively were transported to a medical facility for further assessment. An additional 14% of injured bicyclists, who refused to be transported to the hospital, received treatment at the scene and then released home. None of the injured pedestrians were treated at the scene because they were all transported to the hospital. Only one of the injured drivers was treated at the scene and neither of the injured drivers was transported to the hospital. Over the course of three years, 9 bicyclists died as a result of a collision with a motor vehicle. *It must be noted that other agencies, such as the State Police and local area hospitals, may contain additional injuries and deaths not reported to the Boston Police for these years.*

**CHART 1**

## Breakdown of Collisions and Injuries for Bicyclist and Pedestrians



### Potentially Influential Behavioral Factors

After actively looking for particular themes in narrative sections of 1,790 incident reports from 2009-2012, we found the following results. Tables 1A, 1B, and 1C list the number of cases in which police officers mentioned behavioral factors potentially associated with the crash occurrence. It must be noted, however, that it is neither customary nor required for officers to document many of these themes. Therefore, it is possible that some of these behaviors occurred more often than noted below, yet were not documented. However, in performing this exercise, we were able to draw recommendations to improve the BPD's documentation of transportation-related collisions.

**TABLE 1A**

| Behaviors | Frequency |
|---|---|
| Driver Did Not See Bicyclist | 156 |
| Cyclist Rode into Oncoming Traffic | 108 |
| Bicyclist Ran Red Light | 85 |
| Bicyclist Speeding | 57 |
| Bicyclist Did not see the Car | 41 |
| Driver was Speeding | 24 |
| Driver Ran Red Light | 23 |
| Bicyclist Ran Stop Sign | 22 |
| Driver Ran Stop Sign | 17 |
| Bicyclist - Personal Item Caught | 2 |

**TABLE 1B**

| Distraction Type | Frequency |
|---|---|
| Operator - Not Paying Attention | 31 |
| Bicyclist - Not Paying Attention | 25 |
| Bicyclist - Other | 22 |
| Operator - Phone | 5 |
| Bicyclist - Electronics | 5 |
| Bicyclist - Phone | 3 |
| Operator - Construction zone | 2 |
| Operator - Other | 2 |
| Bicyclist - Construction Zone | 2 |
| Pedestrian - Not Paying Attention | 2 |
| Pedestrian - Electronics | 2 |
| Operator - Electronics | 1 |

**TABLE 1C**

| Other Themes | Frequency |
|---|---|
| Vehicle Operator or Occupant – Extended Door | 197 |
| Vehicle Operator – Aggressive Behavior | 35 |
| Bicyclist – Aggressive Behavior | 22 |

### Frequent Road Users: Taxis and Buses

Two hundred and two incidents involved "dooring", in which the bicyclist collided head-on with an open door or was hit sideways by an opening door. Taxis (including regular taxis and livery) were significantly more likely to be involved in "dooring" than non-taxis (19.2% vs. 10.9%, respectively). In other words, the ratio of taxis involved in "dooring" incidents (30/156) was higher than the ratio of non-taxis involved in

"dooring" (172/1,569). By definition, taxis make frequent stops to pick up and drop off passengers, so their higher ratio of "dooring" occurrences was expected. However, the number of non-taxis on the road far outnumbers the number of taxis, so they contributed to 90% of the "dooring" incidents. Overall, "dooring" was responsible for 11% of all bicycle collisions in the city. The occurrence of "doorings" appeared consistent over time. The proportion of "doorings" was 13%, 7%, 13%, and 12%, respectively for 2009 and subsequent years. One feasible way of reducing bicycle collisions by next year is to educate the public and taxi drivers about the dangers of "dooring" and ask them to make a concerted effort to watch for oncoming cyclists when opening a car door.
There were 18 incidents that involved a bus. In 2010 we had 8 buses versus bicycle collisions, accounting for nearly 50% of the total over the past four years. All other years had fewer than 5 bus collisions per year, with no substantial pattern surfacing within in the analysis of the data.

### Estimate of Lifetime Cost Estimates—2010

We estimated that the combined cost of bicycle injuries and deaths that occurred in the city of Boston in 2010 is between $6.2 million and $46.7 million. Using the Cost of Injury Reports (WISQARS, accessed January 2013) on the Centers for Disease Control and Prevention website, we estimated that the total lifetime costs (including medical cost and work loss cost) of bicycle *injuries* for police- reported collisions *in 2010* fell between $1.3 and $41.8 million in 2010 dollars. Using the data from 2010 only, we generated the lower bound for this estimate by making the assumption that all transported bicyclist and pedestrian injuries did not result in hospitalization but were released directly from the emergency department. Furthermore, we generated the upper limit for this estimate by assuming that all transported bicyclist and pedestrian injuries resulted in hospitalization. For the 3 fatalities that occurred in 2010, their estimated medical and work loss cost was $4.9 million. Please see Appendix A for a more detailed description of this calculation. These costs estimates help make the economic case for investing in safety improvements in active transportation modes.

### Geographic Analysis: Intersections and Hotspots

We found that nearly 60% of all bicycle collisions occurred at street intersections. However, collisions that resulted in injuries were no more likely to occur at intersections than at non- intersections. Using mapping program, we also identified hotspot locations for

bicycle collisions. Various maps of bicycle collisions in Boston can be found in Appendix C. Furthermore, Table 2 (and Map for Table 2) shows where collisions occurred 5 or more times *at the same location* over the period of 4 years. Of the 7 locations with 5 or more geographically identical collision locations, the top two intersections with the highest number of crashes were in the Back Bay/Beacon Hill neighborhood, with 14 collisions at Beacon St and Massachusetts Ave and 12 collisions at Massachusetts Avenue and Commonwealth Ave (Westbound). Allston/Brighton was the only neighborhood with 3 intersections in which collisions occurred repeatedly. These two intersections are located in an area of the city with high traffic, bicycling, and pedestrian volumes, as well as large roads and a wide range of bicycle and pedestrian "generators" such as restaurants, shops, and colleges.

***TABLE 2: Intersections with 5 or more crashes at identical location***

| Neighborhood | Intersection | Count |
|---|---|---|
| Back Bay/Beacon Hill | Beacon St/Massachusetts Ave | 14 |
| | Massachusetts Ave /Commonwealth Ave (West) | 12 |
| Roxbury | Cedar St /Columbus Ave (Inbound) | 9 |
| Allston/Brighton | Harvard Ave/Brighton Ave | 9 |
| Allston/Brighton | Harvard Ave/Commonwealth Ave (Outbound) | 7 |
| Fenway/Kenmore | Belvedere St /Huntington Ave | 7 |
| Allston/Brighton | Harvard Ave/ Commonwealth Ave (Inbound) | 5 |

***Corresponding Map for Table 2:***

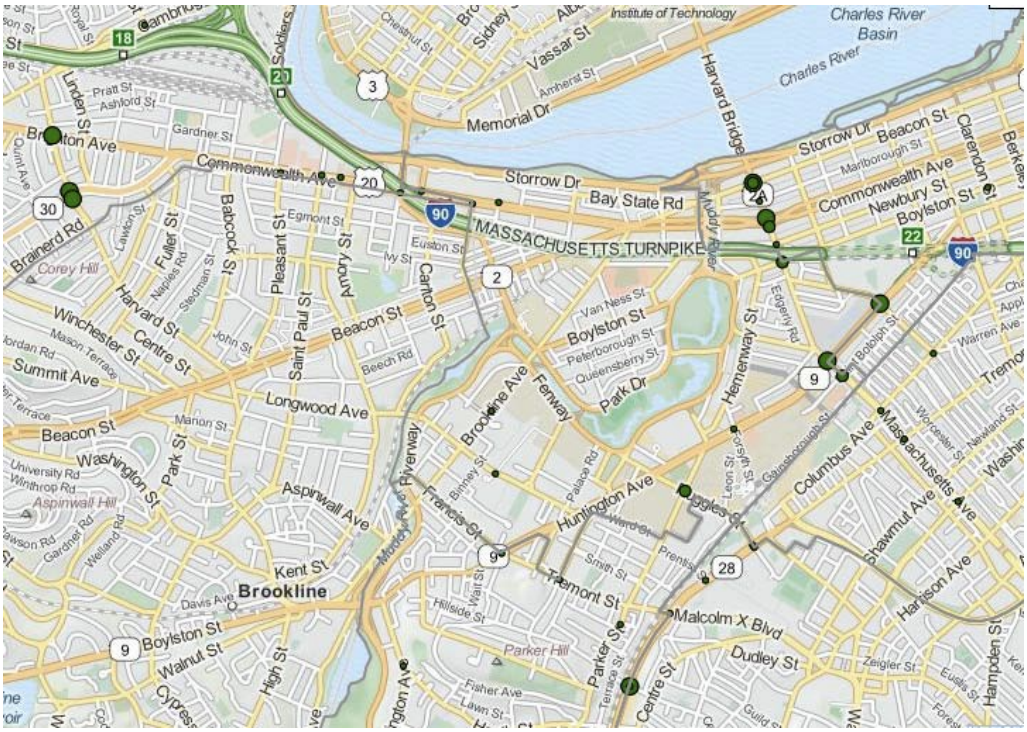


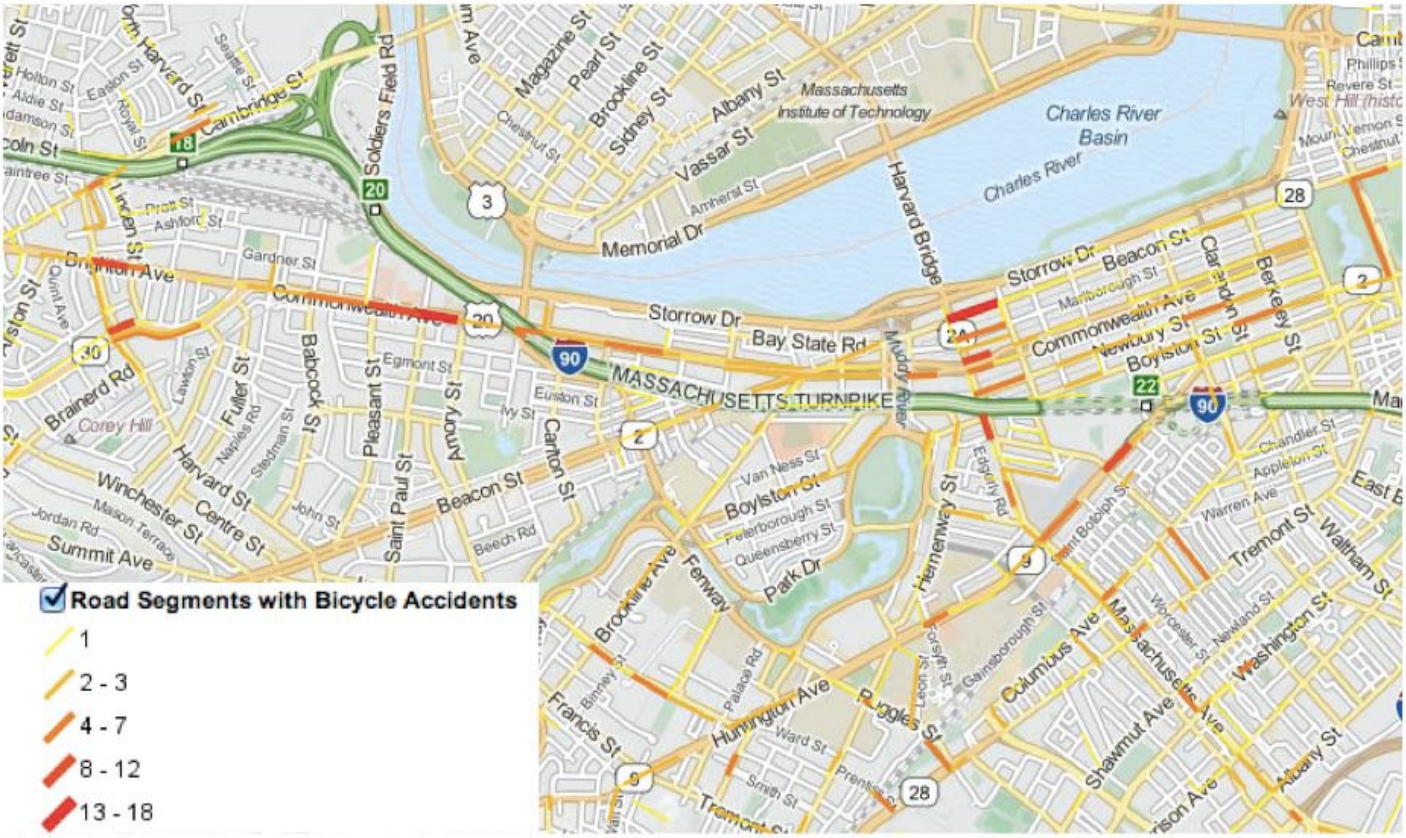

Table 3 shows a list of the top 5 street segments (or intersections, when applicable) for each Boston neighborhood where collisions occurred within 100 feet of that segment. A segment is defined as a stretch of road between two intersections. The list in Table 3 was generated from the density map below ("Map for Table 3"). Again we found that Allston ranked at the top of the list with regards to the number of collisions clustered near a given segment. In line with the City's neighborhood focused approach, we generated this list to inform stakeholders interested in improving safety in their communities.

*TABLE 3: Top 5 street segments with collisions occurring within 100 feet of a segment*

| Neighborhood | Top Segments or Intersections | Count |
|---|---|---|
| Allston | Commonwealth Ave between Saint Paul St and Armory St | 18 |
| | Commonwealth Ave between Saint Paul and Pleasant St | 11 |
| | Brighton Ave between Linden St and Harvard Ave | 11 |
| | Commonwealth Ave (westbound) between Linden St and Harvard Ave | 9 |
| | Western Ave between N. Harvard St and Travis St | 6 |
| Back Bay | Beacon St between Hereford St and Massachusetts Ave | 15 |
| | Commonwealth Ave (westbound) between Hereford St and Massachusetts Ave | 9 |
| | Boylston St between Berkeley St and Clarendon St | 7 |
| | Commonwealth Ave (eastbound) between Hereford Stand Massachusetts Ave | 5 |
| | Newbury St between Hereford St and Mass Ave | 5 |
| Beacon Hill | Cambridge St between Irving St and Garden St | 7 |
| | Beacon St between Charles St and Spruce St | 5 |
| | Charles St between Boylston St and Beacon St | 4 |
| | Irving St between Phillips St and Cambridge St | 2 |
| Brighton | Washington St between Leicester St and Parsons St | 4 |
| | Allston St between Commonwealth Ave and Kelton St | 4 |
| | N. Beacon St between Islington St and Cambridge St | 4 |
| | Sutherland Rd between Selkirk Rd and Strathmore Rd | 3 |
| | Cambridge St between Dustin St and Warren St | 3 |
| Charlestown | 5th St between Chelsea St and 5th Ave | 2 |
| | Alford St between Main St and West St | 2 |
| | Caldwell St between Maffa Way and Brighton St | 2 |
| Chinatown | Kneeland St between Washington St and Harvard St | 6 |
| | Boylston St between Charles St and Tremont St | 5 |
| | Stuart St between Washington St and Tremont St | 4 |
| | Boylston St between Arlington St and Charles St | 4 |
| | Essex St between Harrison St and Washington St | 3 |
| | Summer St between Otis St and Devonshire St | 2 |
| Dorchester | Dorchester Ave between Melville Ave and Gibson St | 8 |

| | | |
|---|---|---|
| | Intersection of Dorchester Ave and Linden St | 6 |
| | Massachusetts Ave between Newmarket Sq and Magazine St | 5 |
| Downtown | JFK Surface Rd between State St and Central St | 3 |
| | Water St between Congress St and Kilby St | 3 |
| | Water St between Batterymarch St and Kilby St | 2 |
| | State St between Congress St and Kilby St | 2 |
| | Summer St between High St and Purchase St | 2 |
| East Boston | Meridian St between Saratoga St and Bennington St | 2 |
| | Porter St between Paris and Chelsea St | 2 |
| | Bremen St between Putnam St and Brooks St | 2 |
| | Saratoga St between Bremen St and Swift St | 2 |
| Fenway | Massachusetts Ave between Cambria St and Belvidere St | 12 |
| | Huntington Ave between Massachusetts Ave and Greenwich Park St | 7 |
| | Massachusetts Ave between Westland Ave and Clearway St | 7 |
| | Commonwealth Ave between Charlesgate West and Kenmore St | 3 |
| | Hemenway St between Boylston St and Haviland St | 3 |

***Corresponding Map for Table 3:***

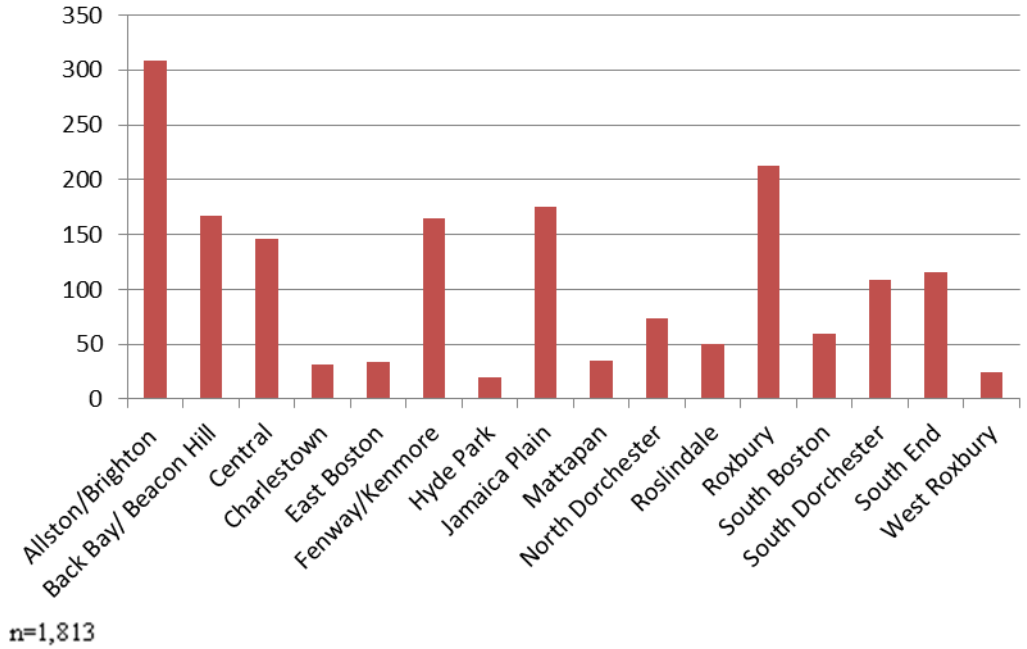


Although it is possible that the "Safety in Numbers" (SIN) theory could lessen these hotspots if we accounted for bicycle, auto, and pedestrian volumes in those areas, the overall burden of injury (numerator) would still remain. In essence, dividing the collision numbers by any large denominator reduces the per-person risk of a *collision* (Bhatia & Wier, 2011). It does not, however, reduce the severity of injury once a collision has occurred nor does it reduce the burden of *injury*.

### Bicycle Collisions in Various District Types

Furthermore, we generated collision frequencies by various district types in order to present the data in a relevant form for various stakeholders. These include counts by police district, by city council district, and Boston Redevelopment Authority (BRA) planning district. Please see Figures 9,
10, and 11.

FIGURE 9 **Bike Collisions by Neighborhood (2009-2012)**




n=1,813

FIGURE 10

## Bicycle Collisons by Police Districts (2009-2012)

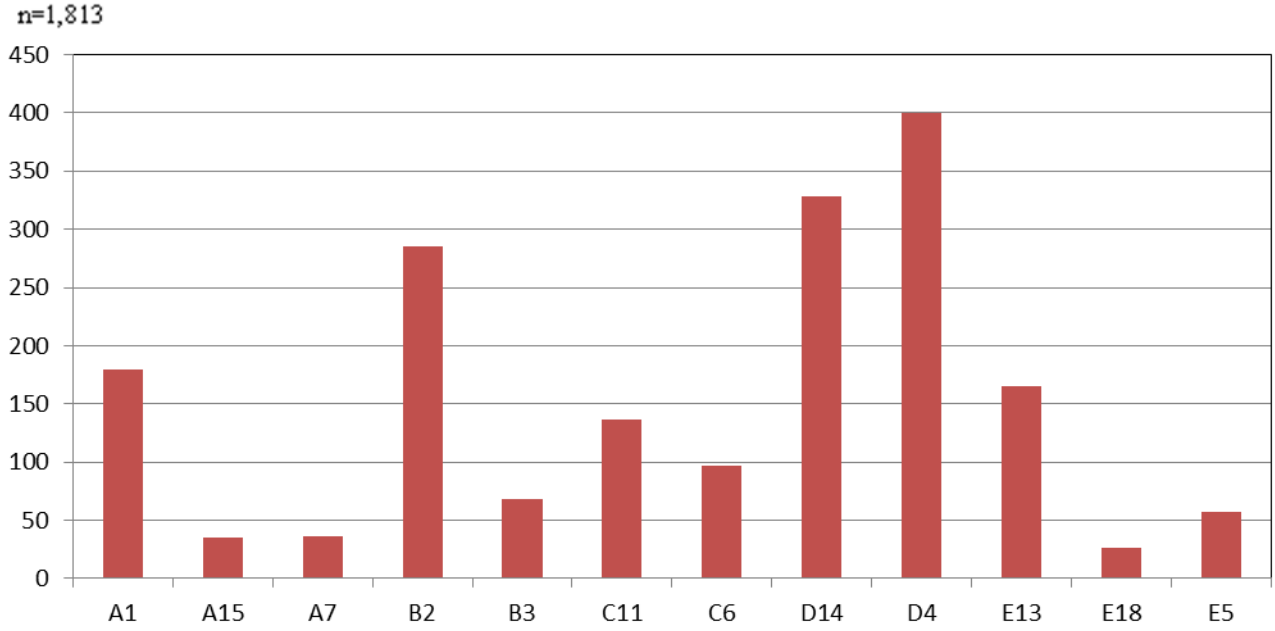
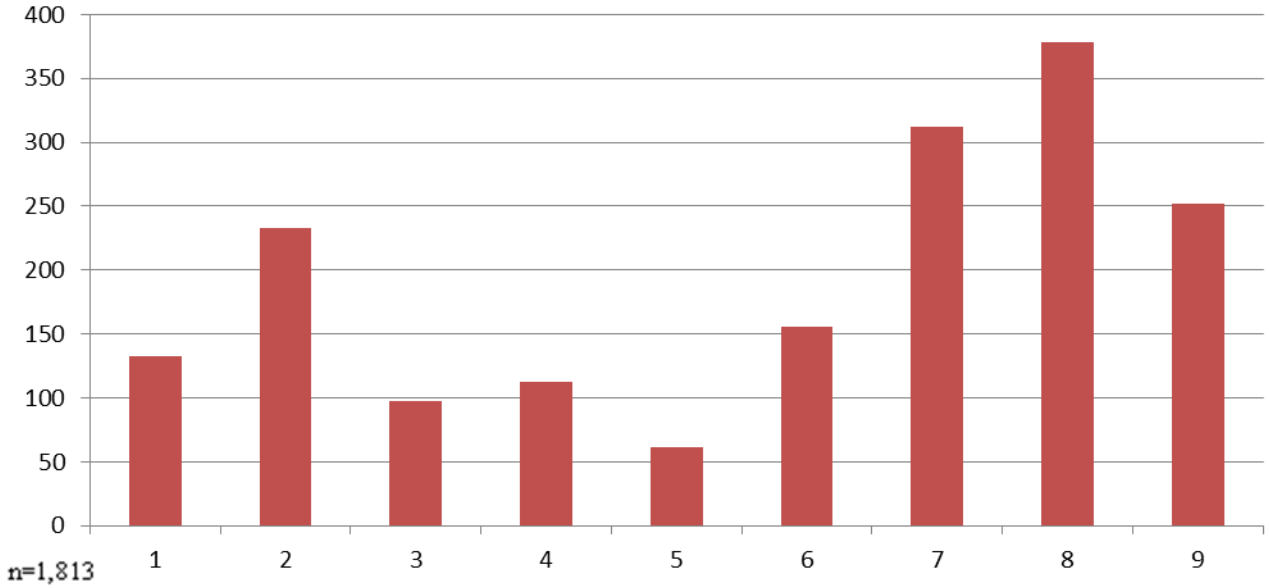



FIGURE 11

## Bicycle Collisions By Planning Districts (2009-2012)

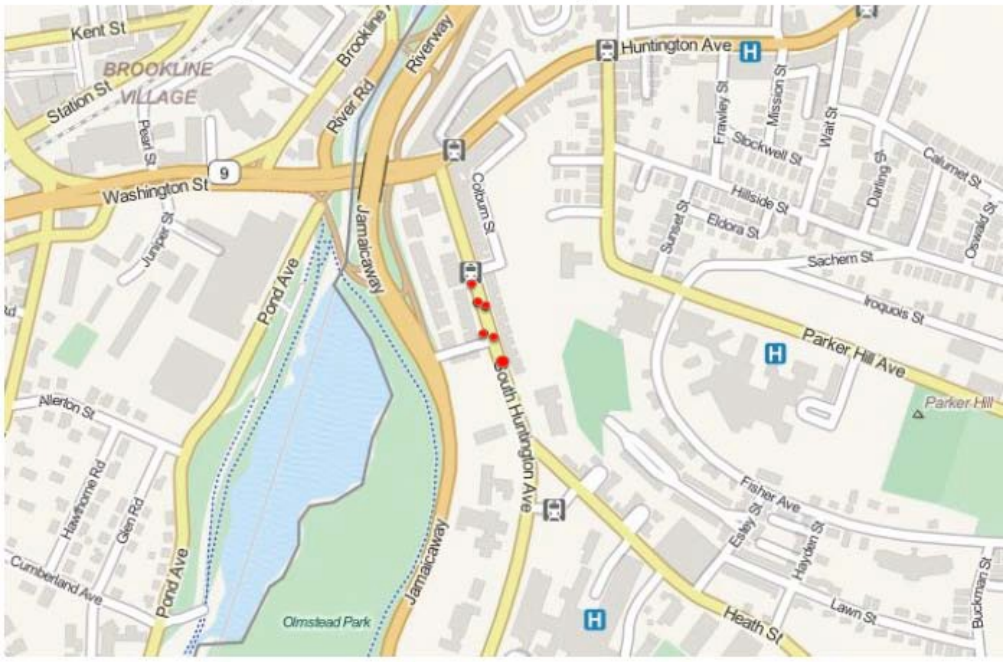


## Maps and Stories: Getting to the Heart of the Matter

In order for the reader to visualize the distribution of the collisions throughout the city, we have included (in Appendix C) several maps of bicycle collisions that occurred in different Boston neighborhoods. After mapping the collisions, we began to find a more profound understanding of the collision circumstances by reading the narrative reports in groups according to how they were geographically clustered. We provide below examples of patterns we found in two hotspots.

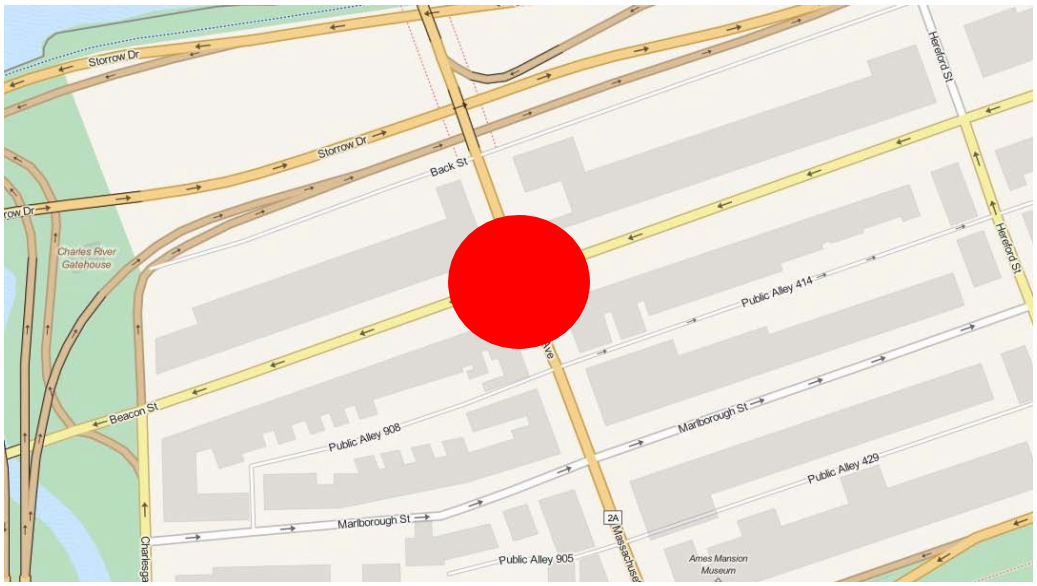
On South Huntington Ave, directly across from the *Back of the Hill* stop of the E line, seven Cyclist Only collisions occurred within 500 feet of each other over a period of 4 years (See Map A). Upon inspection of the narrative reports for those cases, we found that six of the seven were attributable to cyclists getting their tires lodged in the trolley tracks. All cyclists were injured and transported to the hospital for further assessment. This is the only *Cyclist Only* cluster that we observed as all other *Cyclist Only* collisions appeared to be more evenly dispersed throughout the city, but the use of mapping and narrative reports helped to quickly identify a hazard that can be addressed in the near future.

**Map A. Cyclist Only Cluster on S. Huntington Ave. 6 out of 7 collisions attributable to bicycle wheels lodged in trolley tracks.**



A second example of a cluster from which we were able to draw common threads from the narrative reports is the intersection of Beacon St and Massachusetts Ave. As mentioned earlier, it is the intersection with the highest number of collisions occurring at identical coordinates. Six of the 14 collisions at this intersection occurred when cars turned left from Massachusetts Ave to Beacon St (westbound), or right turns onto Beacon Street. Also, taxicab/livery vehicles were involved in six of the 14 collisions. This information may help target our safety interventions at that specific location or at the very least provide us with clues about potential hazards that require mitigation. For instance, planners and engineers at the Boston Transportation Department might examine the turning movements at that intersection and the BPD might consider targeted enforcement of traffic laws at that intersection, especially during peak hour.

**Map B. Auto vs. Bicycle Collisions occurring 14 times at the corner of Massachusetts Ave and Beacon Street**[18]




[18] Over the past three years Boston Bikes has recognized the issues in these areas and implemented various treatments, like bike boxes and sparrow markings in these locations. The City will continue to evaluate these interventions and improve upon them.

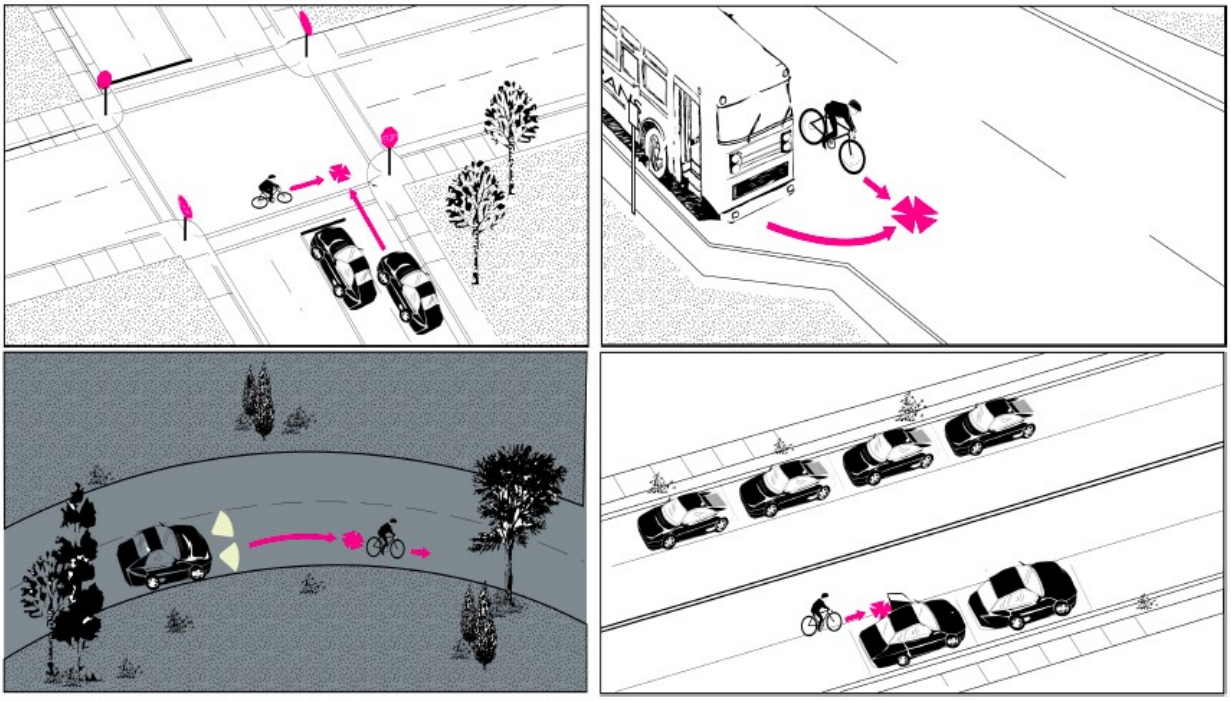
## Surveillance Recommendations

We firmly believe that conducting detailed hotspot analyses with the stories portrayed in the narratives would be incredibly beneficial. We recommend that the police narratives be shared with agencies charged with researching and/or improving safety. Through this study we have identified means to strip personal information from police narratives, allowing us to legally share the data with other interested parties. We recognize that the analysis of bicycle collisions is interdisciplinary in nature. For example, Transportation engineers, public health experts, urban planners, and police officers each come with specialized perspectives, knowledge and skill sets which should continue to be used in a complimentary manner to better understand the available data regarding bike crashes.

Secondly, based on a thorough review of the data collected by the BPD on bicycle collisi**ons**, **we recommend that the current police database undergo significant improvements so that it may collect more detailed information about the circumstances surrounding bicycle and other transportation collisions, such as pedestrian and automobile collisions.** Based on a thorough review of other cities' collision reports (see Appendix B for a review of selected cities' reports), we found that several cities have already begun to use an open-source (i.e., free) and nationally recognized crash analysis tool developed by the National Highway Traffic Safety Administration. Our team was able to download and install the program successfully onto BPD computers at the Research and Development Office, and was able to use the interface immediately due to the intuitive nature of the forms. We predict that this tool would reduce reporting errors and increase efficiency in documenting transportation-related collisions because the "crash typing" module is algorithmic[19]. Figure 12 provides examples of bicycle collision depictions. Ultimately, we recommend that police reporting and documentation on transportation-related collisions become standardized as soon as possible through the adoption and use of The Pedestrian and Bicycle Crash Analysis Tool (PBCAT).

[19] In other words, assuming police officers used the tool to enter collision information directly, a series of pop-up windows would ask them to answer yes/no questions or to select from a list of choices until the crash was appropriately classified. Another very useful feature of PBCAT is that it can help researchers generate categorize and depict nearly 80 different types of common collision occurrences. For more information, please go to: http://www.walkinginfo.org/facts/pbcat/index.cfm

*Figure 12: Collision Depiction Examples from the Pedestrian and Bicycle Crash Analysis Tool*



## Sustainability of Continued Analysis

The Boston Police Department has established a collaborative agreement with the Boston Area Research Initiative (BARI), the Harvard Injury Control Research Center (HICRC), and the Boston Cyclists Union (BCU) to perform ongoing research on transportation-related collisions in the City of Boston. So far, we have approval from the Harvard Committee on the Use of Human Subjects in research to solidify a computer science-based methodology to de-identify police narratives and to perform "topic modeling" on the narratives in order to gain a more comprehensive summary of their content. We also intend to pilot the Pedestrian and Bicycle Crash Analysis Tool (PBCAT) to evaluate the feasibility of implementing it into our police reporting system.

As of mid-February 2013 we have devised the first iteration of a computer science method to de-identify the narrative reports. For a detailed

description of the method, please see Appendix D. The appendix also contains an example of a narrative report stripped completely of personal identifiers with crucial elements of the story still intact. Once the methodology is finalized and approved by governing bodies, it is foreseeable that thousands of narrative reports can be de- identified within a time frame of three days and with very minimal reading or processing by human readers. We would need to conduct a more comprehensive evaluation of a random sample of narratives to ensure that their readability is acceptable and that any potential for error in de-identification is infinitesimal. Once de-identified, the narratives could be linked to their X-Y coordinates and shared on an interactive GIS platform for review by professionals from other City departments.

## Closing Remarks

In order to fully and effectively address the challenge of bike collision in the City of Boston, we must first understand it. This Report represents a first step in an ongoing process to understand our bike collision challenge. The City of Boston and its partners on this project—the Boston Area Research Initiative, the Harvard Injury Control Research Center, and the Boston Cyclists Union—are committed to making Boston one of the safest cycling cities in the country. Our vibrant city is the home of over 60 colleges and universities and we look forward to solving the bicycle collision puzzle with the help of our sister agencies, and through the scientific and creative ingenuity that permeates our city.

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## Appendix A: Detailed Summary of Method

In designing our methodology, we took other cities' reports into consideration and attempted to extract enough data to paint an initial picture of the state of bicycle collisions in the city and more importantly, to lay the foundation for a more comprehensive collision reporting system. Given that the Boston Police Department does not currently maintain a comprehensive database of transportation- related collisions, the data used for this report were based primarily on extractions of raw police narrative reports.

The first step in the study was identifying all reports for bicycle incidents occurring from 2009-

2012. We selected cases that were specifically related to bicycle collisions: Auto-vs.-Bicycle (AVB), Bicycle-vs.-Bicycle (BVB), Bicycle-vs.-Pedestrian (BVP), and Cyclist Only (CO; also known as "cyclist falls"). We excluded false positive cases having to do with larceny (theft) or other criminal activity (e.g., intentionally crashing a bicycle into a pedestrian during an altercation).

We then constructed a coding scheme by holding interviews with members of an advisory team, which was comprised of safety advocates, public health experts, police officers, urban planners, and experienced data managers. These interviews helped us prioritize the list of variables to extract. After agreeing upon the coding scheme, we used a combination of computer-aided coding and hand coding to extract quantitative data from qualitative police narrative reports.

Next, we conducted two phases of narrative report reviews. The first phase encompassed importing all narrative reports into a database and searching for terms that would indicate the presence of a theme of interest, such as "dooring" or intoxication. After indicating these themes, data abstractors reviewed narratives related specifically to those themes to verify the presence of the theme in question. The second phase of the narrative reviews did not make use of the computer- aided "search" feature. Instead, data abstractors read each individual narrative and indicated the presence of themes that would be more difficult for a computer system to interpret. These included, among many, "aggressive driving," various motor vehicle violations, the presence of an injury, transportation to health care facility, and distractions prior to the collision (i.e., cell phone use).

Using other fields contained in our database, we furthermore obtained date and time of occurrence, X-Y coordinates, make and model of the vehicles involved, and demographic information about the bicyclists and drivers involved in each collision. When possible and with regards to environmental variables, we tried to substitute subjective data collected by each police officer with objective data. For example, rather than using our free text weather and lighting variables, we imported historical weather data from the National Oceanic Atmospheric Administration (NOAA) using the date and time that the collision occurred.

Given that we expected to estimate injury and fatality counts for the study period, we also calculated an estimated lifetime cost range for the bicyclists and pedestrians involved in collisions that occurred in 2010. The Centers for Disease Control and Prevention (CDC) provides a tool (WISQARS Cost of Injury Reports, accessed January 2013) for practitioners in injury prevention to calculate such estimates. The tool uses average medical costs and work loss costs based on a sample of thousands of bicycle and pedestrian injury cases that occurred in the United States in 2005. The tool allows the user to enter counts for a specific area and then produces a cost estimate expressed in 2010 dollar to account for inflation. Using the data from 2010 only, we generated the lower bound for this estimate by making the assumption that all transported bicyclist and pedestrian injuries did not result in hospitalization but were released directly from the emergency department.

To generate the upper limit for this estimate, we assumed that all transported bicyclist and pedestrian injuries resulted in hospitalization. The actual data from hospitals in the Boston area on whether injured bicyclists were admitted for their injuries could be beneficial for gauging a more precise estimate of the societal cost of "treating" the injuries versus preventing them. One limitation of this cost estimate is that it does not include costs for property damage, judicial, or litigation costs, among others. We used a wide range of statistical and programming software to manipulate and manage our data. These included SPSS, Access, R, and Python. We also used GIS to assess the overall distribution of collisions throughout the city and to identify collision hotspots.

# Appendix B—Review of Other Cities' Bicycle Collision Reports

The City of Boulder report reviewed 681 cases related to the city's most common types of collisions. The data were abstracted from narrative texts completed by City of Boulder's Police Department accident investigation team. The reports captured demographic and vehicle information for those involved in the collision, collision description information, citations issued as well as descriptive witness statements. The most common behavioral aspects of the collisions were coded using an open-source tool, the Pedestrian and Bicycle Crash Analysis Tool (PBCAT), which was designed by the National Highway Traffic Safety Administration (NHTSA) for "*typing* pedestrian and bicycle crashes to better define the sequence of events and precipitating actions leading to crashes" (Pedestrian and Bicycle Information Center, 2013). The data from the Accident Report forms were mapped using GIS-based spatial and relational database. This is one of the few reports that involved acquiring collision data from narrative police reports. The strengths of the report included the use of GIS-mapping and PBCAT data to characterize the most common locations and behavior collision types, as well as to localize crashes to the specific location on the roadway. The limitations included the omission other collision-related factors such as weather conditions and human/environmental distractions among others.

The Orlando Area Bicyclist Crash Study analyzed 885 crashes between cyclists and motorists in 3 counties in Florida from 2003-2004. The authors considered their analysis "unconventional" in that it grouped the countermeasures for each stakeholder role assumed in the community (cyclist, motorist, traffic engineer, etc.) and assessed each countermeasure for its "mitigation potential" to reduce crashes. The researchers gathered their data from long-form crash reports collected by local police departments and the Florida Department of Highway Safety and Motor Vehicles (DHSMV). Like the City of Boulder, they also used PBCAT software to analyze behavioral aspects of each collision and GIS to identify locations with high crash frequencies. The strength of this report was the analysis of the potential benefit on crash reduction via countermeasures implemented by different stakeholders. The primary limitation was a description of the countermeasures or efforts that had taken place prior to the study period. Similar to the Boulder study, collision-related factors such as weather conditions and human/environmental distractions were not discussed.\

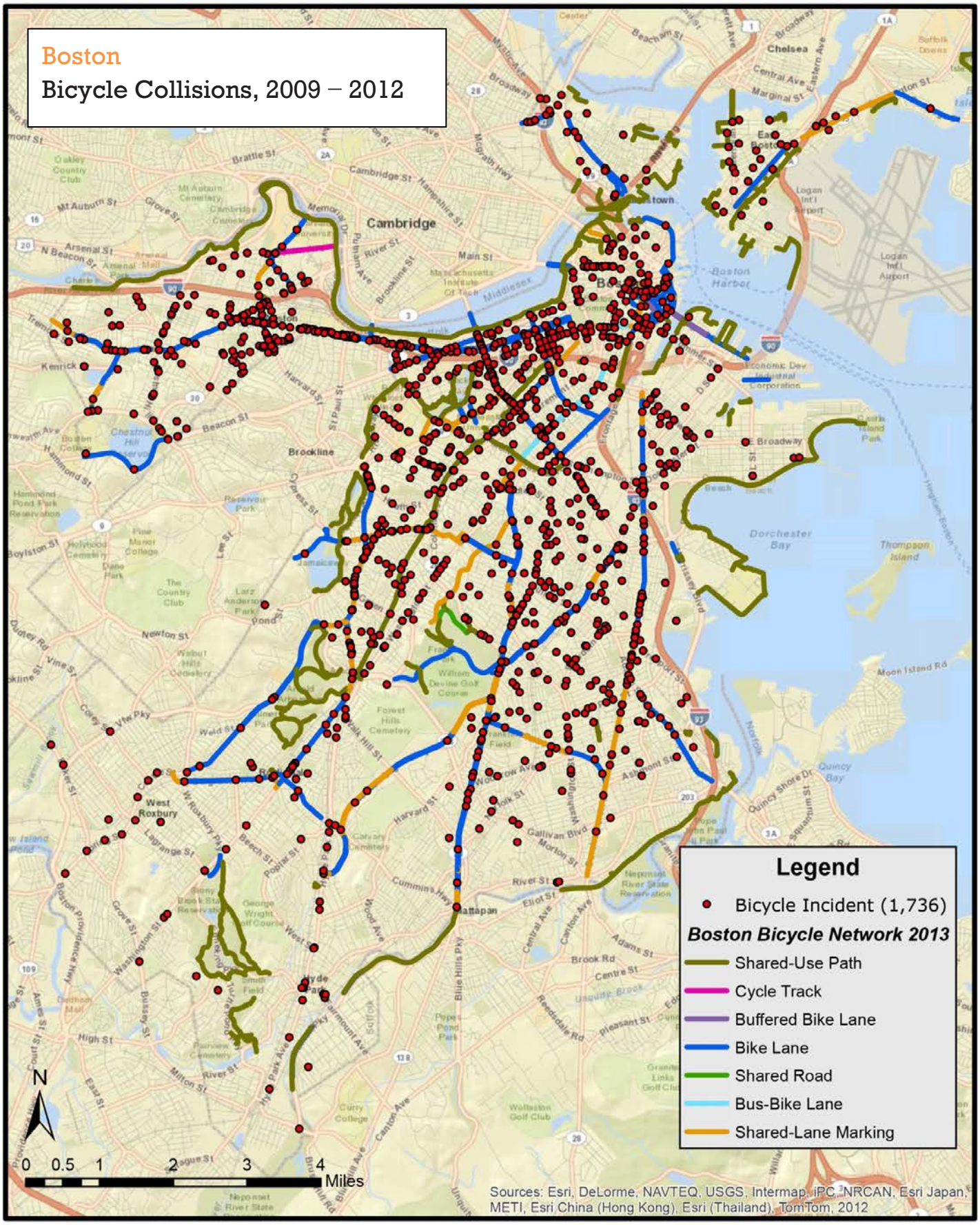
The City of New York report included an analysis of traffic-related bicycle crashes resulting in serious injury and death for 1996-2003 and 1996-2005, respectively. It also included a description of characteristics of the motorists, bicyclists, and their injuries, as well as maps of frequent crash locations. The fatality data were collected from New York City Department of Transportation Fatality Databases, the Accident Investigation Squad (AIS) police reports, and medical examiner files. Serious injury data were comparatively less complete and were compiled from AIS police reports submitted by the New York Police Department to the New

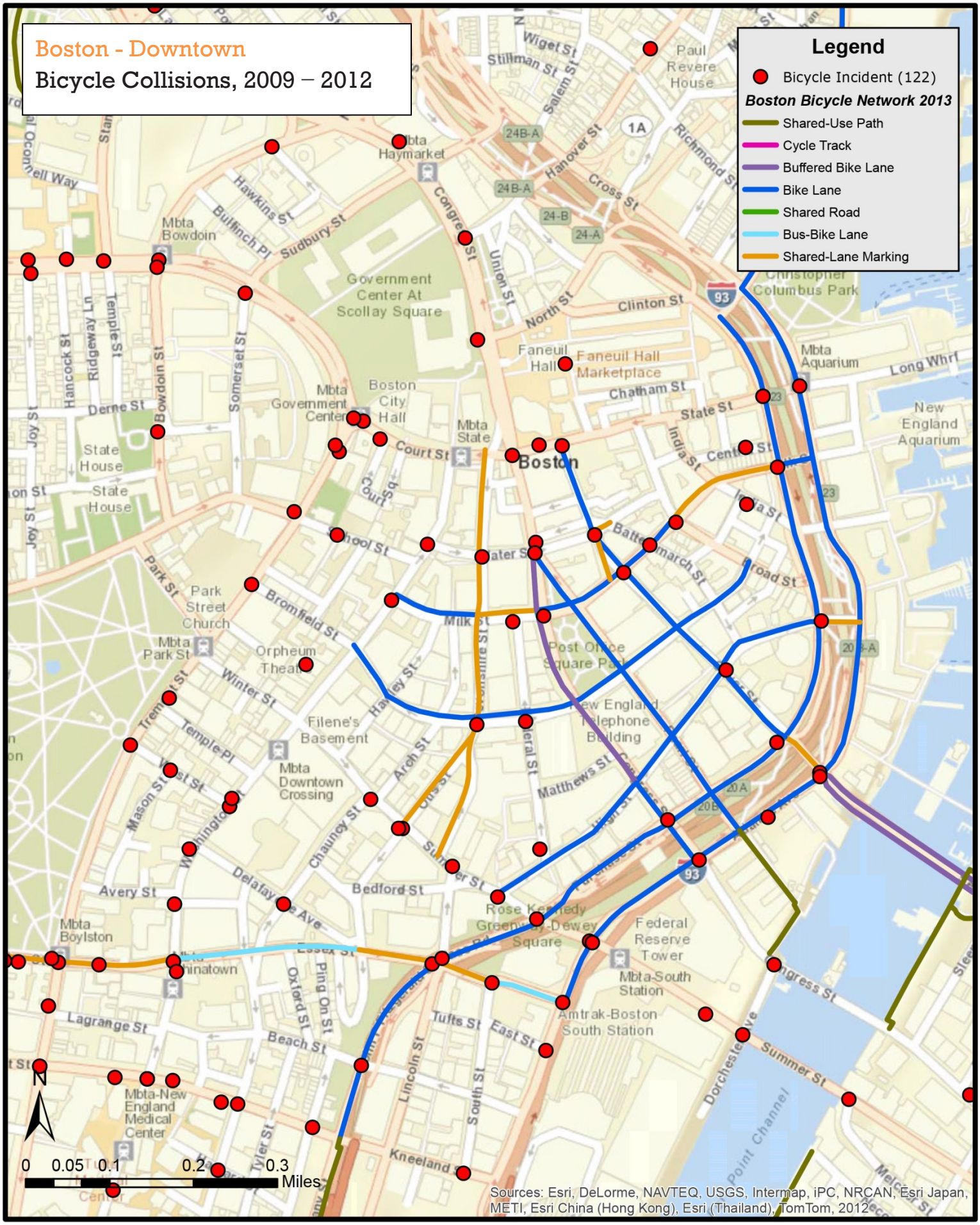
York State Department of Motor Vehicles. This report summarized two outcomes: bicyclist fatalities and serious injuries, with the incidence of each adjusted by bike counts and population figures. Each outcome type was subcategorized into street type (limited access highway, arterial roadway, local street), crash location (intersection vs. mid-block), month, and time of day. Fatality outcomes were also subcategorized into body region

injured (head vs. all others), helmet use, and vehicle type (large vs. small). Crash-related factors for motorists and bicyclists were subcategorized into factor type (human, environment, and vehicular). A subgroup of Pedestrian Deaths due to Collisions with Bicycles (BPV) was also identified and analyzed. GIS mapping was also performed showing individual locations and high-frequency areas for each outcome. In its report, the New York State Department of Motor Vehicles defined serious injury as injuries that required the bicyclist to be transported directly to hospital by EMS personnel. The strength of this report was its comprehensive nature and its use of interagency collaboration to answer circumstantial questions regarding the collisions under study. This report did not make use of PBCAT. Nonetheless, crash-related factors were included with some notable omissions (e.g., intoxication of motorists collected but not of bicyclists).

The San Francisco Municipal Transportation Agency report described long-term collision trends and intersections with the highest citywide collision totals for the years 2010 and 2011. Two main sources of data were used: the Statewide Integrated Traffic Records System Records (SWITRS) for 2010 and the San Francisco Police Department collision data for 2011. The report did not mention data collection or coding methods. Results were presented in two parts: (1) citywide injury and fatal collision trends and (2) collision types and causes. Additional outcomes included red light violation collisions, highest collision intersections, pedestrian and bicycle-related injury collisions over a ten-year period, and a comparison of bike-related injury collisions with bike counts over a similar ten-year period. The strengths of the report were the use of longitudinal data, the prompt reporting of recent crash data, and the reporting of common crash locations by City Supervisor Districts. The report did not make use of PBCAT, but police reports are comprehensive.

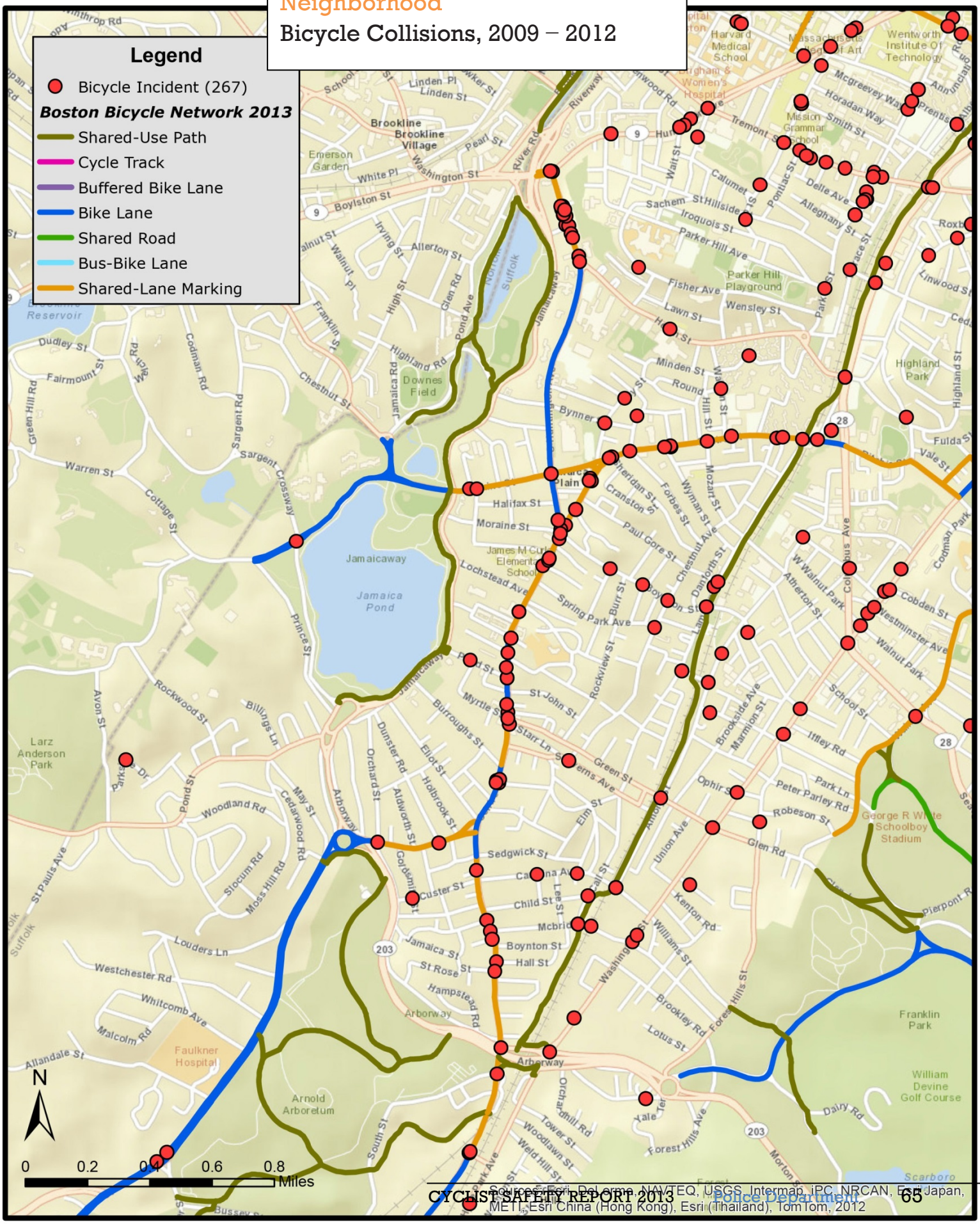
# Appendix C – Selected Maps

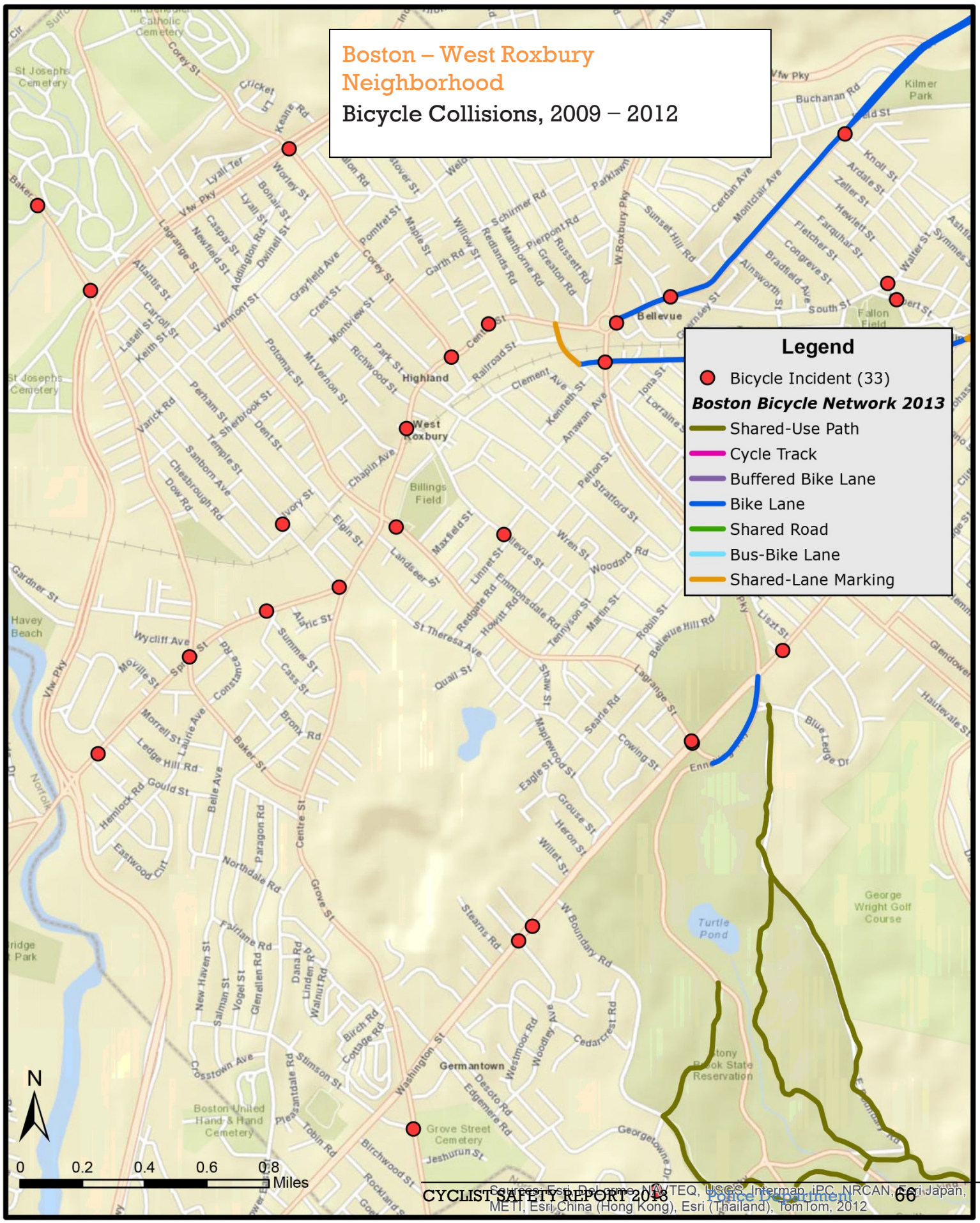


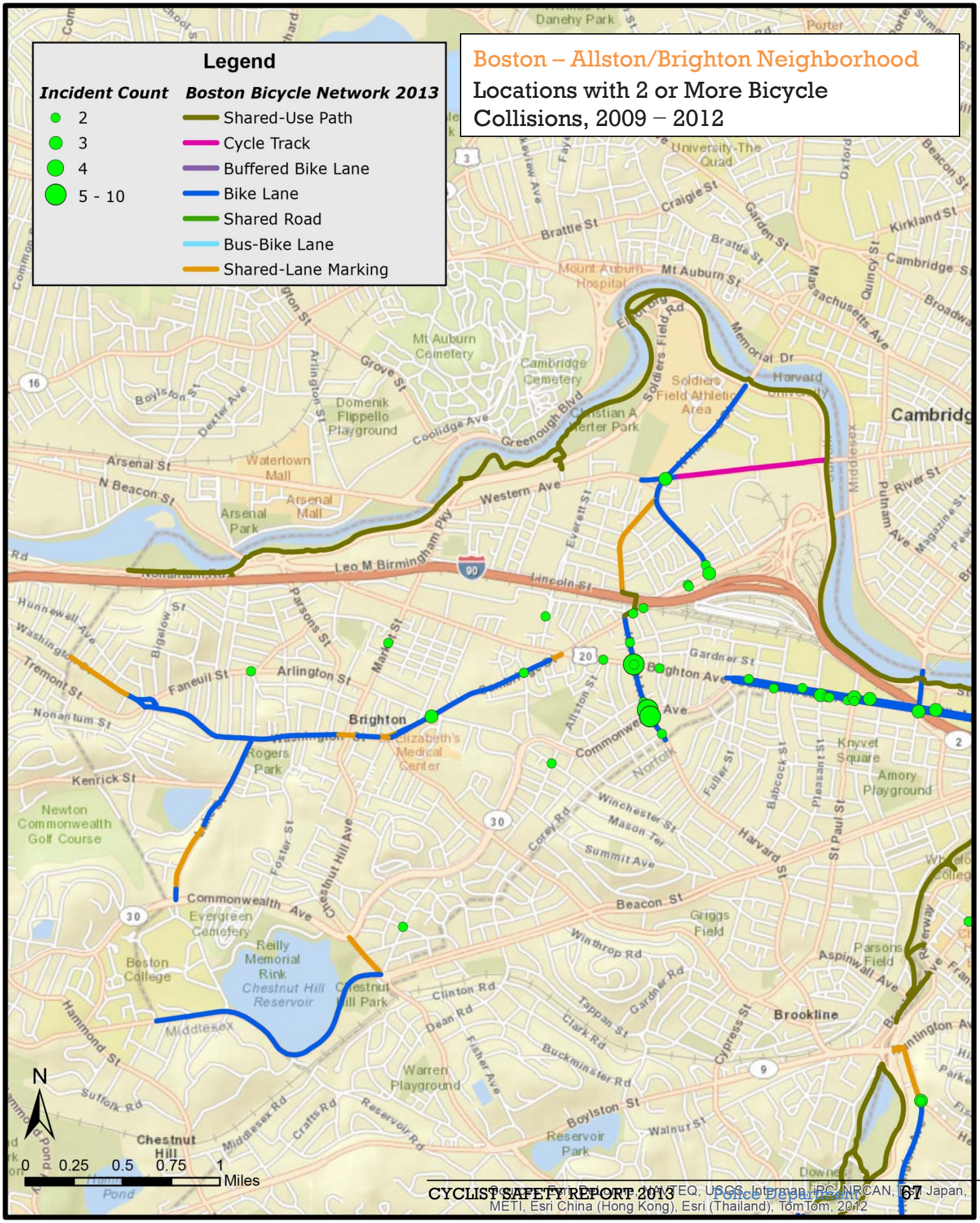

Boston - Downtown
Bicycle Collisions, 2009 – 2012
Legend
Bicycle Incident (122)
Boston Bicycle Network 2013
Shared-Use Path
Cycle Track
Buffered Bike Lane
Bike Lane
Shared Road
Bus-Bike Lane
Shared-Lane Marking
Paul Revere House
Mbta Haymarket
Mbta Bowdoin
Government Center At Scollay Square
Mbta Government Center
Boston City Hall
Mbta State
Boston
State House
Faneuil Hall
Faneuil Hall Marketplace
Mbta Aquarium
New England Aquarium
Christopher Columbus Park
Park Street Church
Mbta Park St
Orpheum Theatre
Filene's Basement
Mbta Downtown Crossing
Post Office Square Park
New England Telephone Building
Rose Kennedy Greenway-Dewey Square
Federal Reserve Tower
Mbta-South Station
Amtrak-Boston South Station
Mbta Boylston
Mbta-New England Medical Center
N
0 0.05 0.1 0.2 0.3 Miles
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

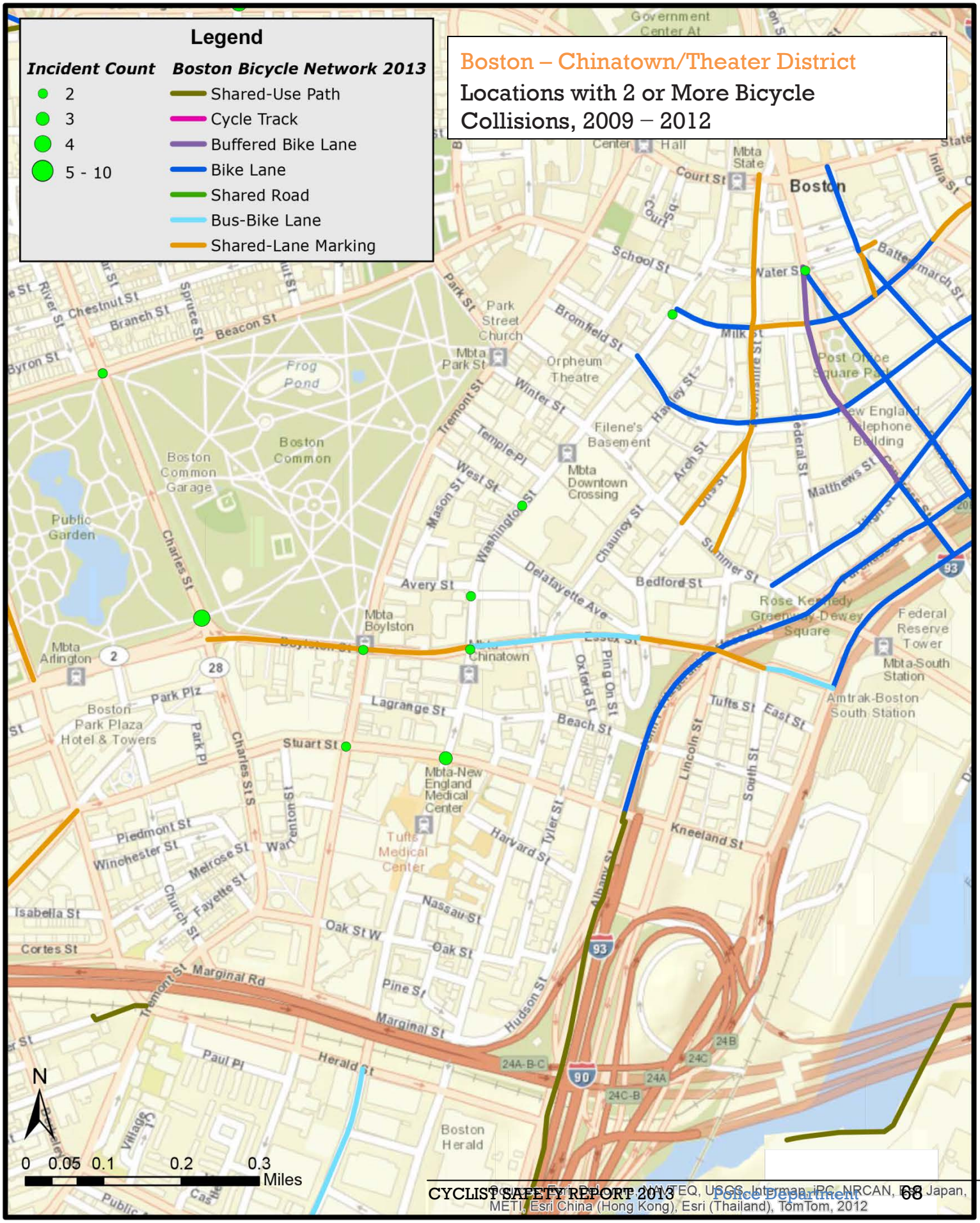
# Boston – Jamaica Plain/ Mission Hill Neighborhood

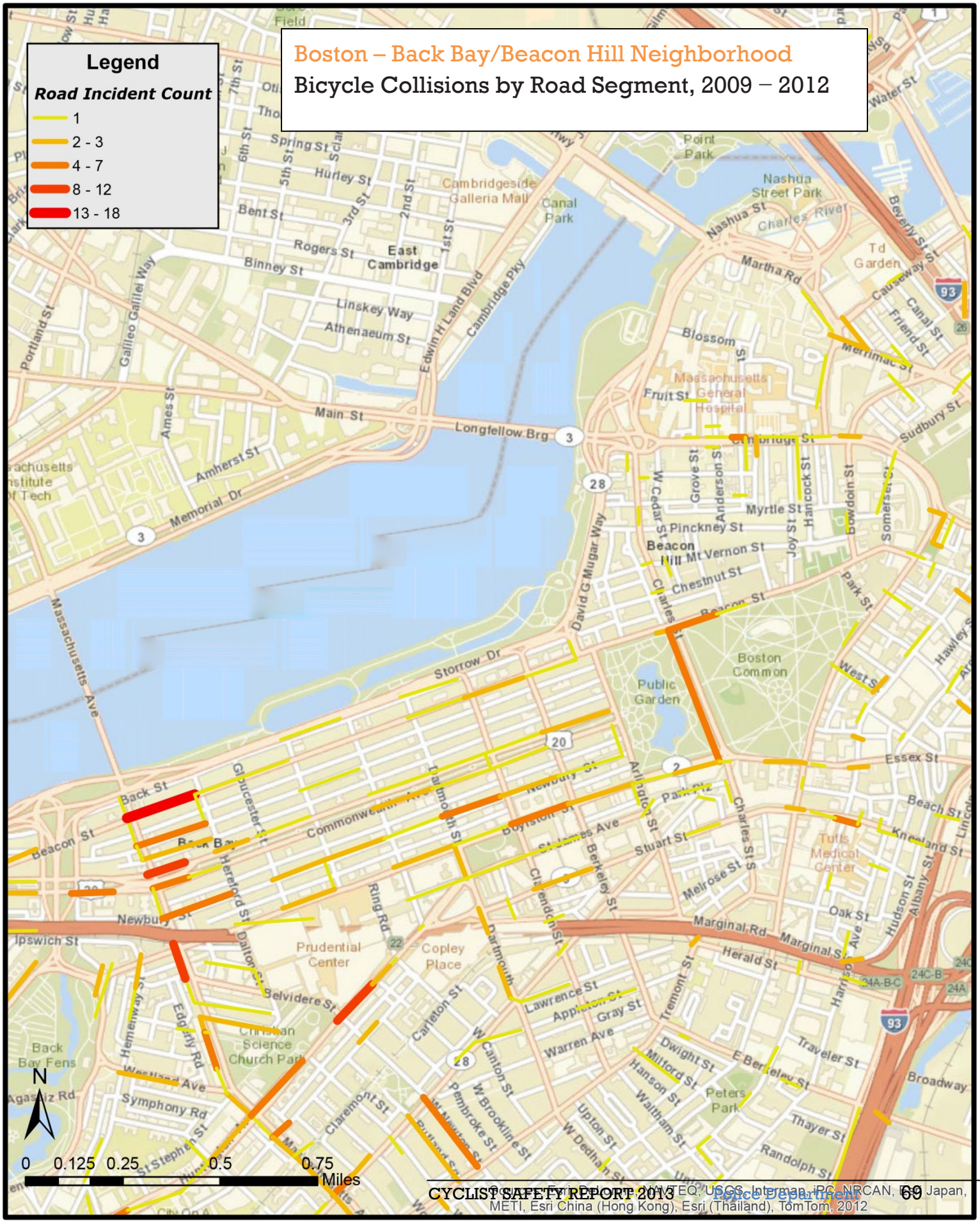
## Bicycle Collisions, 2009 – 2012




Boston – West Roxbury Neighborhood
Bicycle Collisions, 2009 – 2012
Legend
Bicycle Incident (33)
Boston Bicycle Network 2013
Shared-Use Path
Cycle Track
Buffered Bike Lane
Bike Lane
Shared Road
Bus-Bike Lane
Shared-Lane Marking
N
0 0.2 0.4 0.6 0.8 Miles
Source: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012


Legend
Incident Count
2
3
4
5 - 10
Boston Bicycle Network 2013
Shared-Use Path
Cycle Track
Buffered Bike Lane
Bike Lane
Shared Road
Bus-Bike Lane
Shared-Lane Marking
Boston – Allston/Brighton Neighborhood
Locations with 2 or More Bicycle Collisions, 2009 – 2012
Brighton
Allston
Cambridge
Brookline
Chestnut Hill
Boston College
Newton Commonwealth Golf Course
Mt Auburn Cemetery
Cambridge Cemetery
Harvard University
Soldiers Field Athletic Area
Watertown Mall
Arsenal Mall
Arsenal Park
Domenik Flippello Playground
Rogers Park
Chestnut Hill Reservoir
Chestnut Hill Park
Reilly Memorial Rink
Evergreen Cemetery
Griggs Field
Parsons Field
Amory Playground
Knyvet Square
Warren Playground
Reservoir Park
Leo M Birmingham Pky
Mt Auburn St
Memorial Dr
Western Ave
Lincoln St
Commonwealth Ave
Beacon St
Boylston St
Brighton Ave
Harvard St
Cambridge St
Massachusetts Ave
Soldiers Field Rd
Greenough Blvd
Coolidge Ave
Grove St
Arlington St
Mass Pike
N
0 0.25 0.5 0.75 1 Miles
Boston Police Department
NAVTEQ, USGS, Intermap, iPC, NRCAN, METI Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012


Legend
Incident Count
2
3
4
5 - 10
Boston Bicycle Network 2013
Shared-Use Path
Cycle Track
Buffered Bike Lane
Bike Lane
Shared Road
Bus-Bike Lane
Shared-Lane Marking
Boston – Chinatown/Theater District
Locations with 2 or More Bicycle Collisions, 2009 – 2012
Boston
Boston Common
Frog Pond
Public Garden
Park Street Church
Orpheum Theatre
Filene's Basement
Mbta Downtown Crossing
Mbta Boylston
Mbta Chinatown
Mbta-New England Medical Center
Tufts Medical Center
Rose Kennedy Greenway-Dewey Square
Federal Reserve Tower
Mbta-South Station
Amtrak-Boston South Station
Boston Herald
N
0 0.05 0.1 0.2 0.3 Miles


Boston – Back Bay/Beacon Hill Neighborhood
Bicycle Collisions by Road Segment, 2009 – 2012
Legend
Road Incident Count
1
2 - 3
4 - 7
8 - 12
13 - 18
Cambridgeside Galleria Mall
Canal Park
Point Park
Nashua Street Park
Charles River
Td Garden
East Cambridge
Massachusetts General Hospital
Beacon Hill
Boston Common
Public Garden
Tufts Medical Center
Prudential Center
Copley Place
Christian Science Church Park
Back Bay Fens
Peters Park
Longfellow Brg
Memorial Dr
Storrow Dr
Commonwealth Ave
Boylston St
Beacon St
Back St
Newbury St
Ipswich St
Marginal Rd
Marginal St
Herald St
Broadway
Traveler St
Thayer St
Randolph St
Symphony Rd
Massachusetts Ave
Cambridge Pky
Edwin H Land Blvd
Galileo Galilei Way
Portland St
Ames St
Amherst St
Main St
Binney St
Rogers St
Bent St
Hurley St
Spring St
Linskey Way
Athenaeum St
Blossom St
Fruit St
Martha Rd
Merrimac St
Sudbury St
Pinckney St
Mt Vernon St
Chestnut St
Myrtle St
Park St
Essex St
Beach St
Kneeland St
Stuart St
Melrose St
Oak St
Lawrence St
Gray St
Warren Ave
Dwight St
Milford St
Hanson St
Waltham St
Upton St
Pembroke St
W Brookline St
W Canton St
Carleton St
Claremont St
Dartmouth St
Clarendon St
Berkeley St
Arlington St
Charles St S
Tremont St
Hereford St
Gloucester St
Dalton St
Ring Rd
Selvidere St
Hemenway St
Edgerly Rd
Westland Ave
Agassiz Rd
St Stephen St
Hudson St
Albany St
Harrison Ave
Beverly St
Causeway St
Canal St
Friend St
Joy St
Hancock St
Bowdoin St
Somerset St
Grove St
Anderson St
W Cedar St
David G Mugar Way
N
0 0.125 0.25 0.5 0.75 Miles
Source: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, ©OpenStreetMap contributors, and the GIS User Community, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

## Appendix D – Narrative De-Identification

The narratives for 2012 were subjected to a computer science-based data manipulation process by a PhD-level computer scientist from the Institute for Quantitative Social Science on the research team. The goal was to remove all personal identifiers. First, we read the narrative data into Python (Version 2.7.3) and iterated over all words, keeping track of which documents had each word and of how many times that word appeared in total. If the word appeared in less than 3 documents, we asked Python to compile a list of those terms so they may be replaced with "XXXX" in the redacted narratives. This helped to drop any uncommon terms like first and last names. Furthermore, we removed any terms that contained digits, which helped to drop all incident and citation numbers, social security numbers, phone numbers, etc. Next, we had Python check the words against the English Dictionary. If a word was not in the dictionary, we removed it. We added back into the redaction (by inspection) any terms that we deemed necessary for understanding the final version of the redacted narrative (e.g., "on-scene, operator/owner, daylight"). Then, we replaced all words in the documents that were not in the final list of "keep" words with the number of x's corresponding to the length of the word. Finally, we reviewed by hand any narratives that included potentially identifying names. For example, "Harrison" is a major street but also a common name. If it was used as a street name, we added it back in on a case-by-case basis.

An example of a de-identified narrative follows:

About xxxxx hours on Friday, xxxxxxxx xx, xxxx Officer xxxxxxxx ( xxxxx ) along with Sgt. xxxxxx ( xxxx ) responded to a radio call at Abbot St. and Blue Hill Av., Dorchester. On arrival Officers observed that xx Registration xxxxxx ( xxxxxx xxxxx ) and a pedestrian, on a bicycle, were involved in an accident. Officers spoke with the occupants of the above mentioned vehicle ( xxxxxx xxxxxx, xxxxxxxxx xxxxxxxx and xxxxxxx xxxxxx ). They all stated they had stopped at the stop sign at the above-mentioned intersection. The operator ( xxxxxx ) stated she began to slowly move forward when her vehicle was struck by a young, xxx male riding a bicycle. She stated he hit the front windshield and then fell to the ground. At this time Officers observed a cracked windshield and broken passenger side mirror. All occupants of the vehicle were offered medical attention, which they declined. Officers then spoke with the operator of the bicycle, who was being treated by EMS xx. He stated he was riding his bike outbound on Blue Hill Av. He stated when he came to the intersection of Abbot St. he collided with a vehicle. He stated he hit his chin on the front windshield. At this time he was unaware if he had sustained any other injuries. EMS transported him to xxxxxx Medical Center for further treatment. Officers were also able to xxxxxxx is bike and informed him he would be able to pick it up at Area xxx.

# Appendix E – Leadership & Team Member Biographies

## Boston Police Department

***Police Commissioner Edward F. Davis***

Police Commissioner Edward F. Davis is the 40th Police Commissioner of the City of Boston. He was sworn in by Mayor Thomas Menino on December 4, 2006. Commissioner Davis previously served as the Superintendent of Police in Lowell Massachusetts for 12 years and has been in law enforcement for 34 years. The Commissioner oversees police services for over a half million residents along with those visiting and working in the City of Boston. Commissioner Davis has been recognized for his efforts locally and nationally, including through the Police Executive Research Forum, the International Association of Chiefs of Police and the Major Cities Chiefs Association.

***Captain John Danilecki***

Captain John Danilecki is currently assigned to BFS/Night Command. He is a 26-year veteran of the BPD and has held numerous positions in the Department including Bicycle officer, Detective, Sergeant, Lieutenant, and Lieutenant Commander of the Tactical Bicycle Unit and is the former Lieutenant Detective of Area B-2 in Roxbury.

***Maria C. Cheevers***

Maria C. Cheevers, M Ed, has been the Director of the Boston Police Department's (BPD) Office of Research and Development (ORD) since March 2011, and was the previous Assistant Director of ORD from 1992 through 1999. Ms. Cheevers has worked to serve the neighborhoods of Boston for twenty one years, within the governmental, nonprofit and private sectors. The ORD works directly under the Office of the Police Commissioner to support the BPD in its efforts to improve quality of life, and reduce crime within the neighborhoods of Boston.

***Marjorie Bernadeau-Alexandre***

Marjorie Bernadeau-Alexandre holds the position of Senior Research Analyst for the BPD, ORD, and has been with the BPD for eleven years. Ms. Bernadeau-Alexandre is a graduate of Northeastern University with Bachelor of Arts in English and Social Anthropology.

***Carlos Cannon***

Carlos Cannon was born in Miami, Florida, graduated from Boston College in 2012 with degrees in Psychology and Sociology. Carlos joined BPD's ORD in December of 2012 and has been working on the 'bike project'
since its inception.

***Tremayne Youmans***

Tremayne Youmans is currently enrolled in the Masters of Business Administration program with a concentration in Management in the H. Wayne Huizenga School of Business and Entrepreneurship at Nova Southeastern University. Tremayne's work experience has been in market research, public relations consulting, and forming competitive strategies for government, non-profit, and private sector agencies.

## Harvard University

***David Hemenway***
David Hemenway, Ph.D., is Director of the Harvard Injury Control Research Center. Once a year he spends a week at the University of Vermont as a James Marsh Visiting Professor-at-Large. Dr. Hemenway teaches classes on injury and on economics.

***DanO'Brien***
Dan O'Brien is the Research Director for the Boston Area Research Initiative, a Lecturer on Sociology at Harvard University and a Lecturer in the Department of Psychology at the University of Massachusetts Boston. Dan O'Brien's research and teaching is focused on the psychology and sociology of urban neighborhoods.

***Dahianna Lopez***
Dahianna Lopez is a student at Harvard University currently working on a PhD in Health Policy with a concentration in Evaluative Sciences and Statistics. She is interested in the link between transportation inputs and health outcomes (i.e., crashes, injuries, and trauma). Dahianna earned a Bachelor of Arts degree in Psychology from the University of California, Berkeley and Dual Master's degrees in Public Health and Nursing Science (MPH; MSN) from the University of California, Los Angeles.

***Alex Storer***
Alex earned his Ph.D. in Cognitive and Neural Systems from Boston University and has bachelor's degrees in Cognitive Science, and Electrical Engineering and Computer Science (EECS) from UC Berkeley. Prior to joining IQSS, Alex studied computational models of biological vision and used brain signals to predict natural movements.

***Kenneth Frausto***
Kenneth Frausto is an emergency medicine physician at Alta Bates Summit Medical Center in Oakland, CA. He attended medical school at the University of California, Los Angeles, and concurrently earned his MPH degree in health services. He recently finished an Emergency Medicine residency at Alameda County Medical Center – Highland Hospital in Oakland CA.

## Boston Cyclists Union

***Pete Stidman***
Pete Stidman is the Executive Director of the Boston Cyclists Union, which he founded in 2010 to promote the bicycle as an enjoyable, healthy and affordable form of transportation. A former reporter, he has a special interest in uncovering the truth about cycling and all of its aspects, including injury prevention.

***Ira Hubert***
Ira earned a Bachelor of Arts degree in Geography from Hunter College and a Master of Arts in Teaching (MAT) in Secondary Education from the University of Memphis. He has completed graduate level coursework in cartography and geography at the University of Wisconsin/Madison. He has served as a business analyst, systems engineer, and information analyst with Electronic Data Systems (now Hewlett-Packard).

***John Ferrante***

John Ferrante is an Urban Planning Intern for the Boston Cyclists Union. Attending Boston College for his Bachelor's degree, John will receive his Masters of Urban and Regional Policy and Planning from Northeastern University in August 2013.

***Natalia Gayl***

Natalia Gayl is an undergraduate at Boston Architectural College. She is graduating at the end of this year (2012) with a degree in sustainable design. Natalia studied abroad in Scandinavia last fall and became enthralled with the way a city can affect our happiness.

***Rafael Medina***

Rafael moved to Boston in 2007 to work for the US Census Bureau as a Supervisory Geographer for the Boston regional office. He has a Bachelor of Arts degree in Geography from the University of Puerto Rico and a Master of Science in Environmental Management and Planning from the Metropolitan University School of Environmental Affairs.

# Acknowledgements

**Our group would like to thank the following individuals and organizations for their assistance with accessing non-police data or answering general questions related to urban planning and design concepts.**

- City of Boston
- Mayor's Office
- Bicycle Pedestrian Working Group, a collaboration between Boston Police Department, Boston Transportation Department, Boston Bike, Boston Public Health Commission, Boston Cyclist Union and Walk Boston
- Police Officer John A. Conway, Operations Division, Advisor, Moving Violations
- BPD Civilian, Cate O'Rourke, Compositor, Office of Multi-Media
- Toole Design Group for providing Bike Lane GIS data
- Vineet Gupta, Director of Planning, Boston Transportation Department
- Charlotte Fleetwood, Boston Transportation Department

# Part III

# Boston Emergency Medical Services Cyclist Incident Report

## 2009-2012

## Introduction

Boston EMS is the City of Boston's municipal emergency medical services provider. The department maintains twenty-four frontline ambulances dynamically deployed throughout the City, staffed with either two paramedics or two emergency medical technicians (EMTs). There are nineteen frontline EMT-operated basic life support (BLS) ambulances and five frontline paramedic staffed advanced life support (ALS) units. During the three shifts of a twenty-four hour period, the number of ambulances fluctuates. Less are deployed overnight when usual demand decreases and additional spare units are added to the normal complement when the need for EMS increases and/or responses may be delayed, due to various factors such as inclement weather or special events. As a two tiered system, a greater number of BLS units handle the majority of calls and the fewer ALS ambulances cover the less-frequent more acute emergencies.

In addition to covering all areas of Boston, the department provides pre-hospital coverage for state roadways and parks within and abutting the City. When a person makes a 9-1-1 call for a medical emergency in Boston EMS' service zone, the line is routed to a department call taker who is both an experienced EMT and certified emergency medical communications operator (EMCO). Based on the information provided, the call taker enters the appropriate incident details and a department dispatcher (who is also an EMT and EMCO) notifies necessary responding units. Boston EMS receives calls for and responds to an average of 300 medical emergencies per day; over 100,000 per year.

Boston EMS is committed to compassionately delivering excellent pre-hospital care and to protecting the safety and health of Boston's residents and visitors. The department shares Mayor Thomas M. Menino's vision of promoting safe bicycling as a healthy mode of transportation and recreation in Boston. Boston EMS is an active member of the City of Boston's Bicycling and Pedestrian Working group, which aims to reduce biking and pedestrian-related injuries.

While it is not possible to know exactly how many people ride a bicycle on any given day, how long they ride for, or how many in total are involved in an accident (not all accidents are reported), the department has developed a system for identifying all Boston EMS cyclist patient encounters. The data presented in this report is drawn from the Boston

EMS cyclist incident database, which is distinct from other crash data sources. **From 2009 through 2012, there were 1,700 confirmed cyclist incidents documented by Boston EMS emergency medical technicians and paramedics.**

With each encounter, the priority is to provide the best possible care. Any information collected is intended to support this objective, including clinical impressions, symptoms, and a general description of what happened. EMTs and Paramedics are not responsible for determining who is at fault for the accident; such investigations are handled by the Police Department. While Boston EMS may document 'what' caused the incident, this does not imply 'who' caused the accident; no such conclusions should be derived from the data included in this report.

Boston EMS cautions the reader of this report from drawing any other speculative inferences based on the data provided. While risk or rates of injury to any cyclist is unknown, the findings can be used to inform policies, roadway improvements and outreach campaigns; as well as monitor trends.

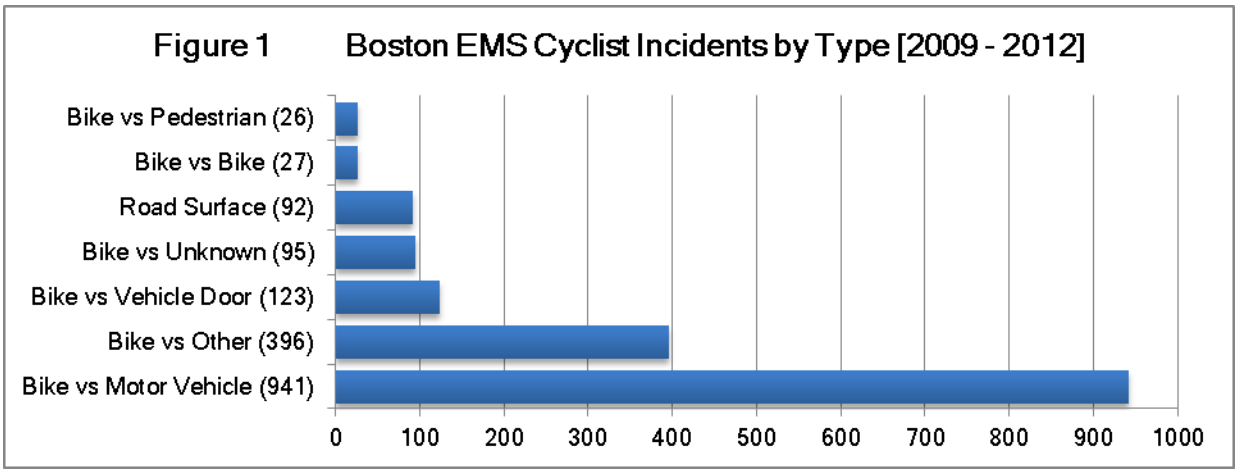
## Method

Boston EMS is committed to the continuum of patient care through meaningful application of its data. Each ambulance is equipped with a tablet computer for the documentation of patient care information. The finished record is electronically transferred to a secure database via a cellular connection. The use of an electronic Patient Care Reporting (ePCR) system at Boston EMS allows for comprehensive and near real-time reporting. A department Data Analyst has created a report that searches the records for keyword and dropdown list criteria pertaining to cyclist incidents. These incidents are subsequently reviewed by an experienced Boston EMS paramedic to confirm that each identified incident was in fact associated with an injured cyclist. To ensure that data truly represents relevant road bicycle accidents, other injuries associated with motorcycles, spin exercise equipment and bicycle maintenance have been excluded. Additionally, incidents where the paramedic reviewing the records was able to discern that the cause of the incident was unrelated to the person riding on a bicycle, such as cardiac arrest, have also been excluded. The vetted data is then stored separately for review and later reporting by department personnel.

Historically, cyclists were grouped with pedestrians for coding and documentation purposes. Beginning in 2010, Boston EMS implemented a revised reporting protocol to enhance identification of cyclist incidents. The drop down list for incident cause was expanded to include 'Bicycle Accident' and a field was added to record whether the cyclist was wearing a helmet. Department EMTs and Paramedics are also updated on the use of these data fields and the importance of documenting this information. These changes increased the number of confirmed cases through the enhanced strategies for recognition. For this reason, Boston EMS assumes that the 2009 counts are an under representation of the true number of cyclist incidents the department encountered that year. As such, any comparisons between 2009 and future years' data is inconclusive.

## Findings

### Incident Types




The most prevalent bike-related incident type with a Boston EMS encounter, from 2009 through 2012, was 'Bike vs. Motor Vehicle', involving a collision between a cyclist and a motor vehicle on a Boston roadway. During this four-year timeframe, there were 941 of such incidents, accounting for 55.4% of EMS cyclist incident encounters (Figure 1). 'Bike vs. Vehicle Door' incidents, in which a bicyclist strikes the open door of a parked vehicle is commonly referred to as 'dooring'. Dooring accounted for 123 incidents (7.2%). Boston EMS distinguishes between these two types of vehicular incidents to inform outreach and/or intervention strategies for improving roadway safety. There were 27 incidents involving 'Bike vs. Bike' (1.6%) and 26 categorized as 'Bike vs. Pedestrian' (1.5%). The 396 (23.3%) 'Bike vs. Other' incidents signify

cyclist-only accidents where the rider came into contact with a stationary object, such as a curb, pole or a stopped/parked vehicle. 'Road Surface' events are defined as cyclist-only incidents in which something on the roadway was noted as a contributor to the accident, such as sand, train tracks or potholes; 92 records were associated with this category (5.4%). The final group, 'Bike vs. Unknown', is incidents where the patient care reports were inconclusive to categorize the incident type; there were 95 of such incidents (5.6%). In addition to the accident type, Boston EMS incidents can also be categorized according to patient disposition.

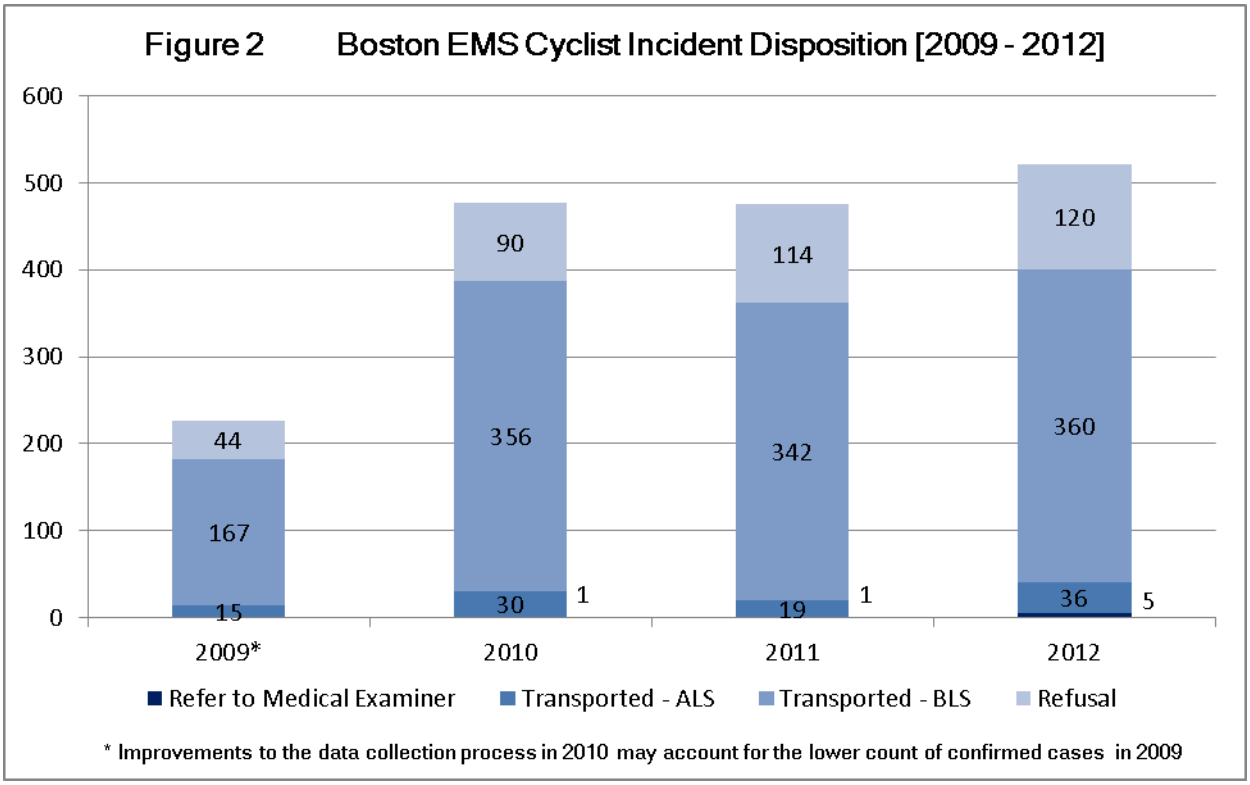
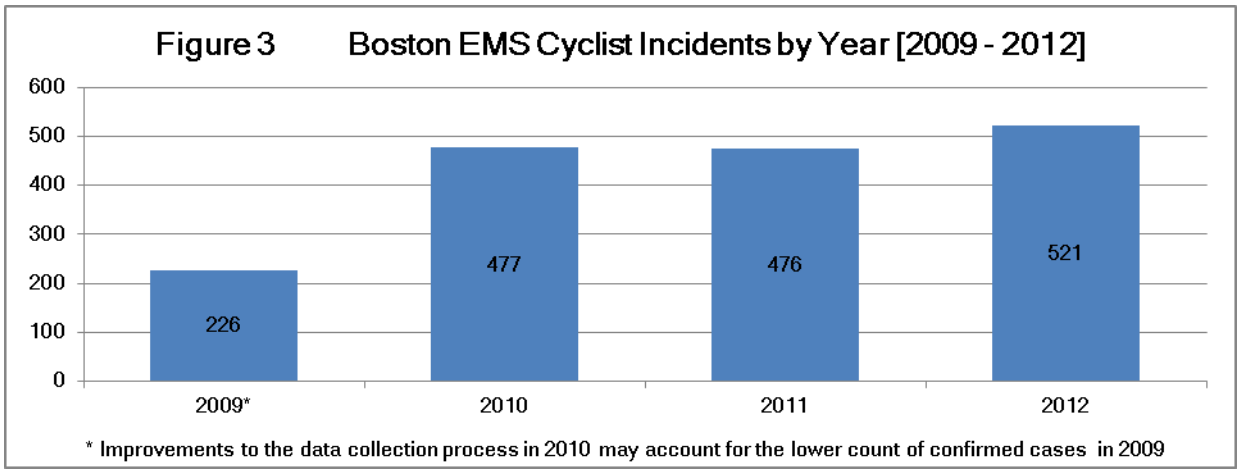



Figure 2 illustrates Boston EMS cyclist incident encounters by final patient disposition. Patient refusals are cases where a patient may have no obvious injury after evaluation or injuries are of such a minor nature that they refuse any transport. Basic Life Support (BLS) transport is the most frequent patient disposition; such incidents are typically minor in nature, not life threatening or may be precautionary, such as sprains, simple fractures, contusions and lacerations , with no loss of conscious. Advanced Life Support (ALS) transport is less frequent; they are generally of higher acuity and might include patients with multiple injuries, loss of consciousness or potential serious head trauma. The determination of whether an ALS or BLS ambulance transports a patient is based on multiple factors, including acuity of injury and unit availability. For this

reason, whether ALS or BLS transports a patient suggests general trends, but is not a precise indicator of severity. Referred to Medical Examiner (RME) represent the rare instances where the patient is found lifeless with injuries so severe that resuscitation is not possible; the number of such incidents is shown at the bottom right-hand side of each bar chart within Figure 2.

## Incident Trends over Time




From 2010 through 2012, Boston EMS Cyclist incident encounter annual totals range from approximately 477 to 521 (Figure 3). As noted in the chart and the Methodology section, 2009 data is assumed to be an under-representation of the true number of injured cyclists who were seen by Boston EMS personnel.

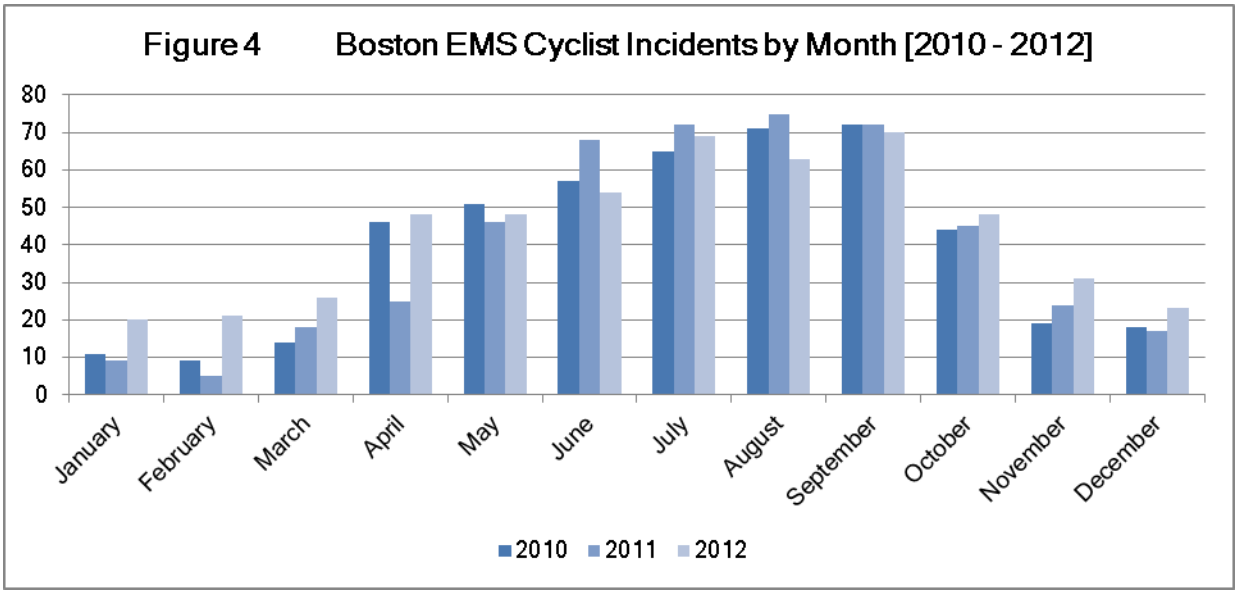


Figure 4 depicts Boston EMS cyclist incidents by month over the last three years. Boston EMS records show the highest rates of incidents in the warmer months of April through October, generally peaking in July, August and September.

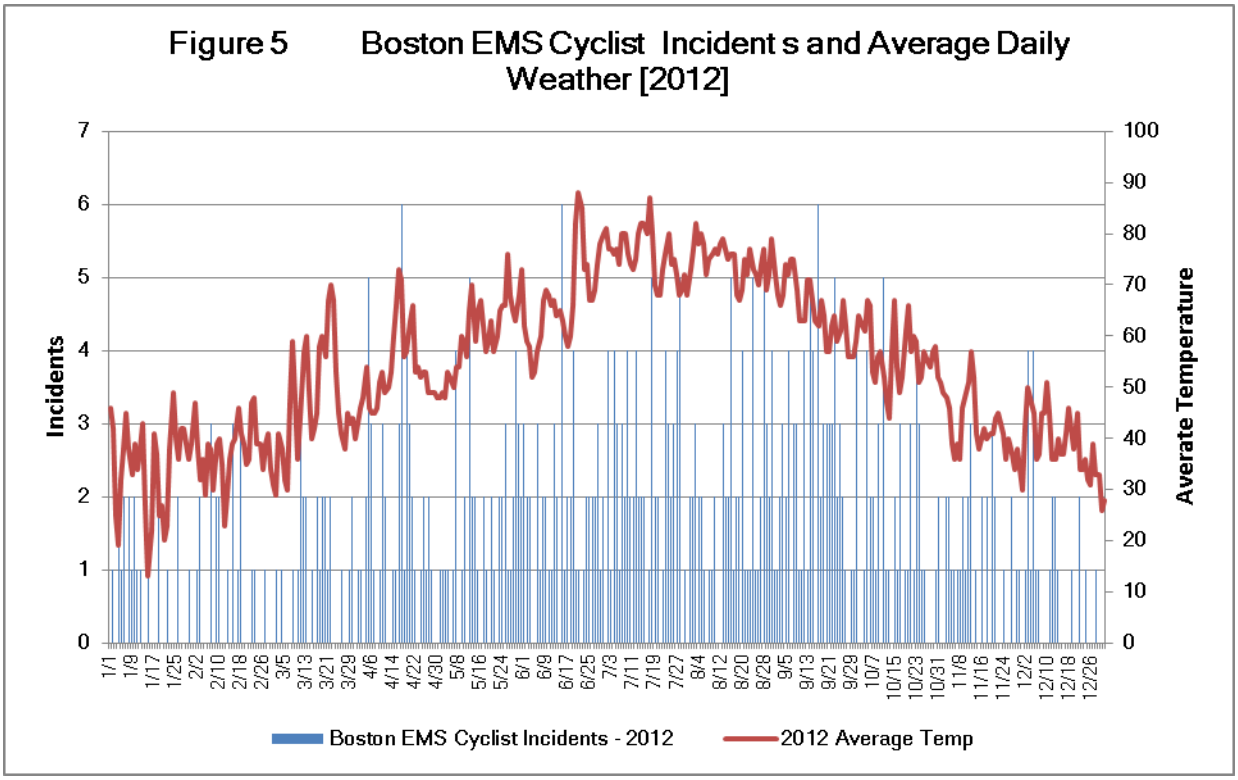



Figure 5 provides Boston EMS daily incident counts for calendar year 2012, with average daily temperature represented on a secondary axis.

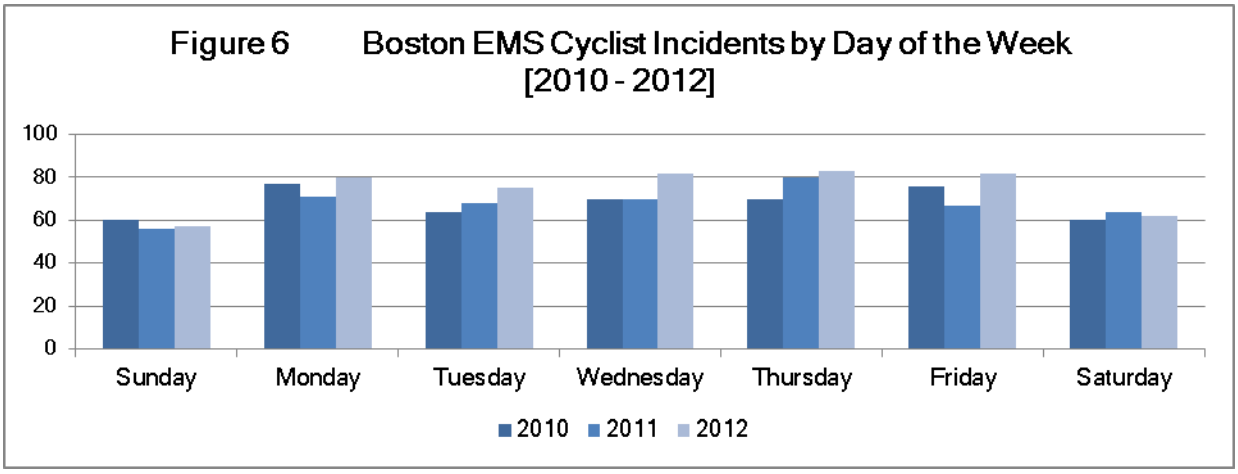



Figure 6 illustrates Boston EMS cyclist incident counts by day of the week from 2010 through 2012. For the three years, there was an average of 60 incidents per day on Saturdays and Sundays. In 2010 and 2011, Boston

EMS saw an average of 71 cyclist incidents per day for Monday through Friday and in 2012 there was an average of 80 incidents per weekday.

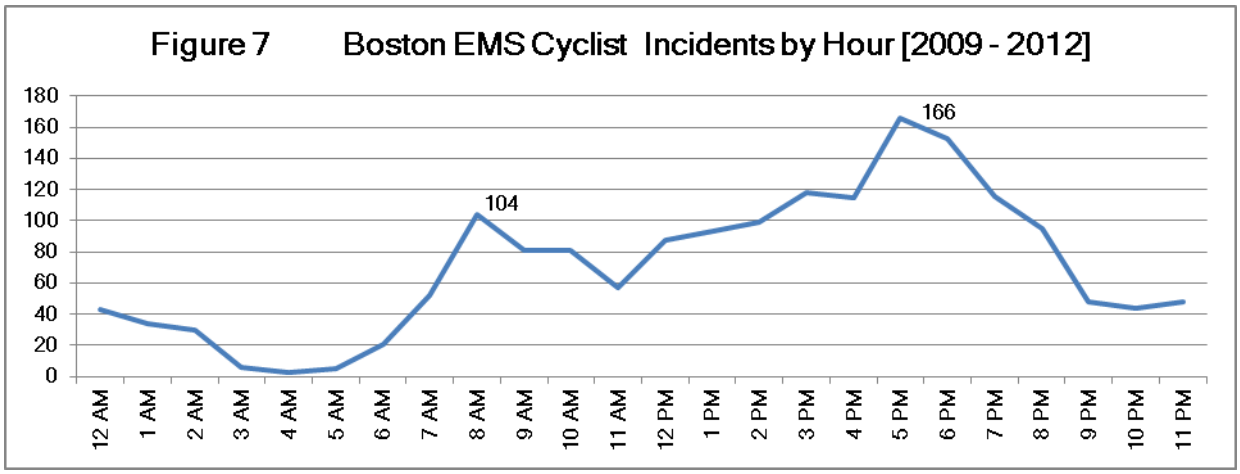
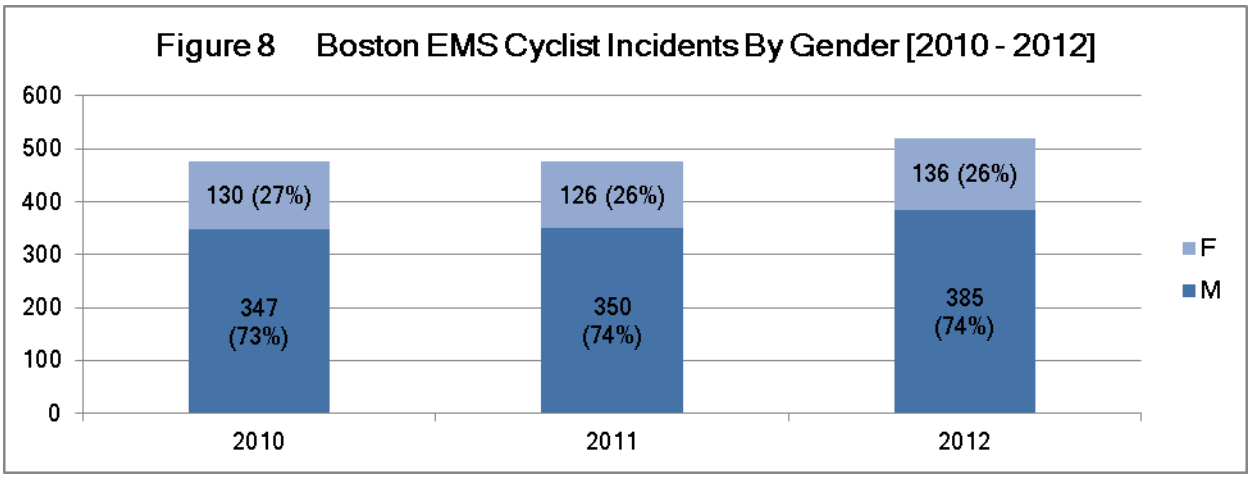


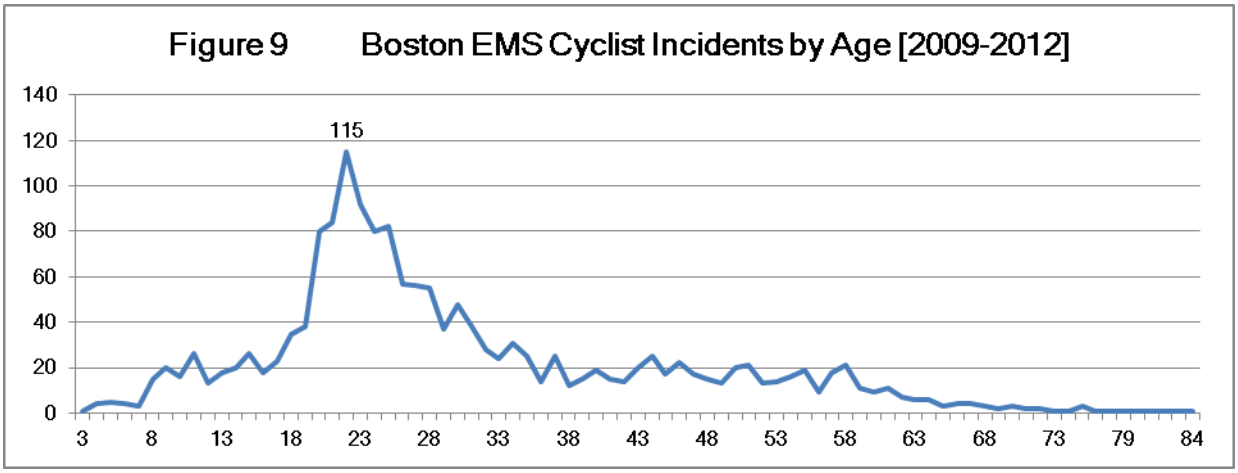

Figure 7 graphically displays Boston EMS confirmed cyclist incident encounters over the past four years by hour of the day. The incident peaks appear to be within the 8AM and 5PM hour blocks, coinciding with typical rush hour time periods.

## Demographics of Cyclists




When Boston EMS cyclist incidents are evaluated by gender, the breakdown of approximately 26% female encounters to 74% male appears to be relatively consistent. The above chart illustrates total counts and percentages over the past three years. Gender-based injury rates and relative risk cannot be calculated without having comprehensive ridership information. Boston Bikes has reported that of cyclists observed, utilizing

a convenience sampling method, at selected Boston intersections over several days in September and October of 2012, approximately 30% were female and 70% were male. If annual ridership in 2012 shares a similar gender ratio as the Boston Bikes count, the higher numbers of males involved in Boston EMS cyclist incidents might be due to the higher numbers of male cyclists on roadways, and not higher injury rates for males versus females.




Boston EMS has identified the highest counts of cyclist incidents among 18 to 35 year olds, who account for 1005 of the confirmed 1700 incidents (59%). The highest number of cyclist-related encounters (115) is for 22 year olds. It is unknown how this compares to the actual age distribution of Boston's ridership, it may be that there are more incidents among 18 to 35 year olds because there are also more cyclists on roadways in this age group.

## Cyclist Incidents by Neighborhood

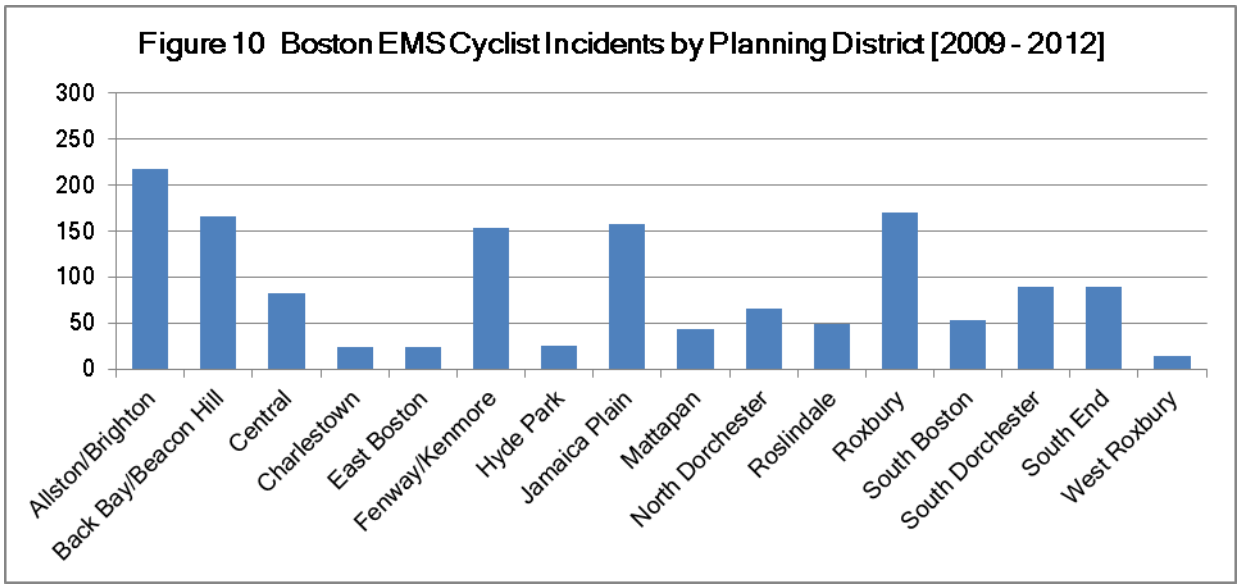
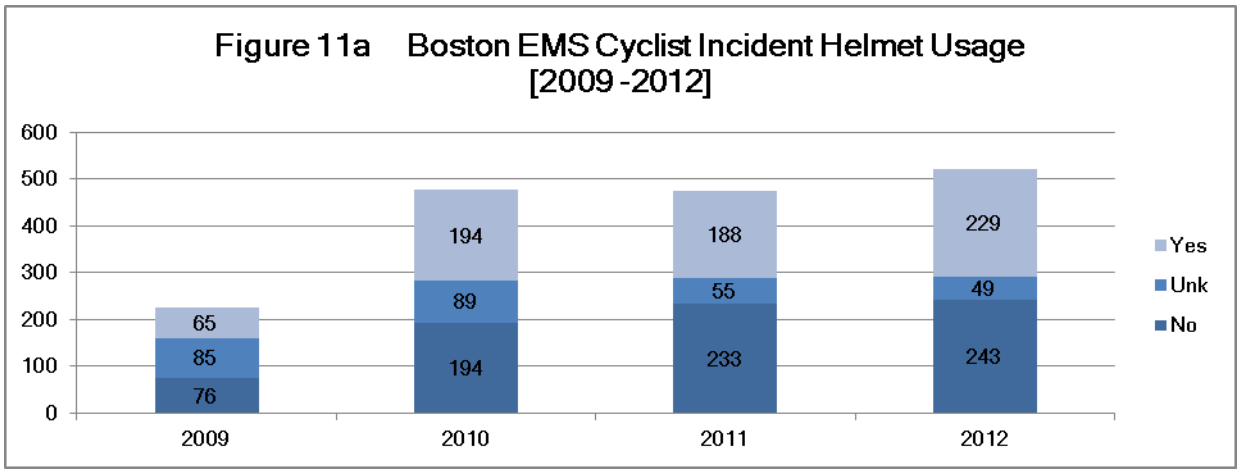
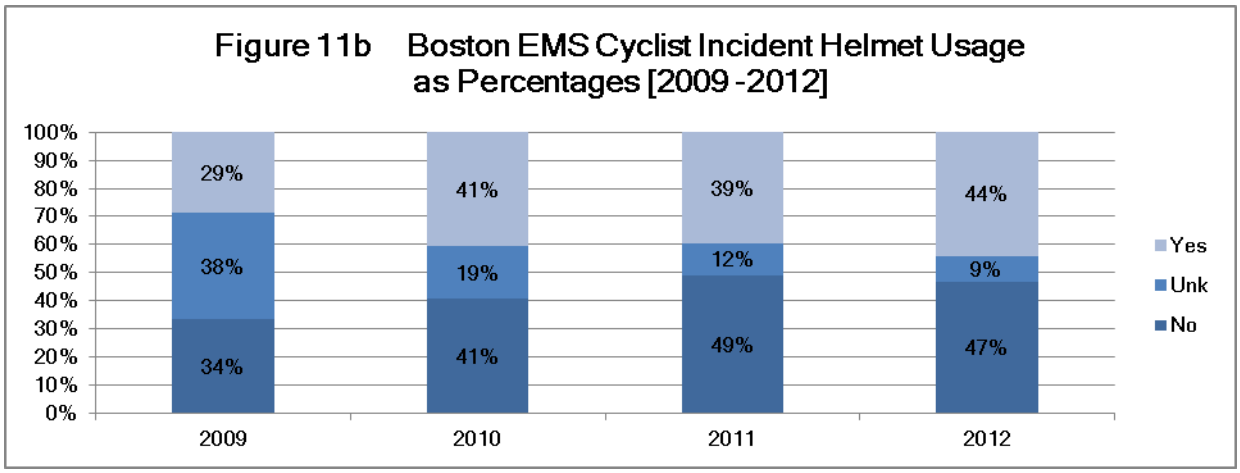
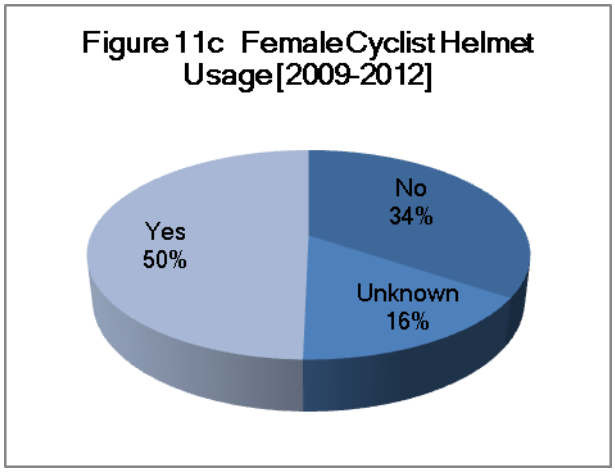


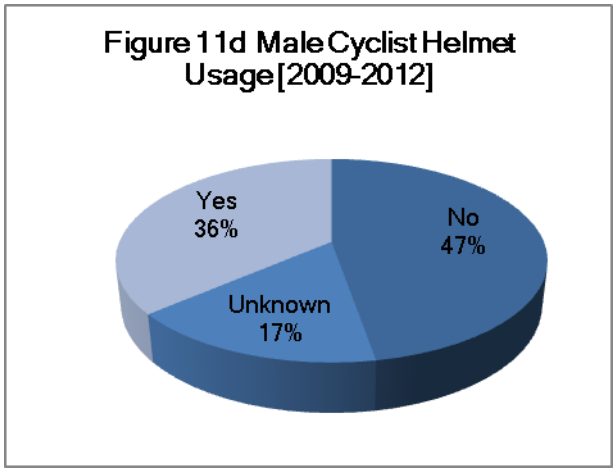

Figure 10 represents the distribution of Boston EMS cyclist injury encounters for 1,426 of the 1,700 incidents during the 2009 through 2012 timeframe. The data was geocoded and assigned to the Boston Redevelopment Authority planning districts to ensure consistent coding by neighborhood.

## Cyclist Helmet Usage






Boston EMS personnel have been documenting helmet usage among bicycle and motorcycle riders for many years, although it was not until 2010 that the patient care report had a designated field for recording this information. While patient care remains the first priority, EMTs and paramedics are trained to record helmet use for patients involved in cycling incidents; information about the mechanism of injury is clinically

relevant and understanding helmet use supports efforts to reduce the risk of cyclist head injury and brain trauma.

It is unknown how the relatively low rates of helmet use among cyclists involved in Boston EMS incidents relates to the overall rate of helmet use in Boston. Convenience sampling of Boston cyclists observed at selected sites throughout the city by Boston Bikes and other researchers has yielded average helmet use rates ranging from 48-72%, although observed rates were significantly lower in some neighborhoods.[20] [21] Helmets have been shown to reduce the risk of head injury by up to 85 percent and the risk of brain injury by up to 88 percent[22], making the promotion of their universal use a priority. Bicycle helmets are effective regardless of the age of the cyclist.[23]

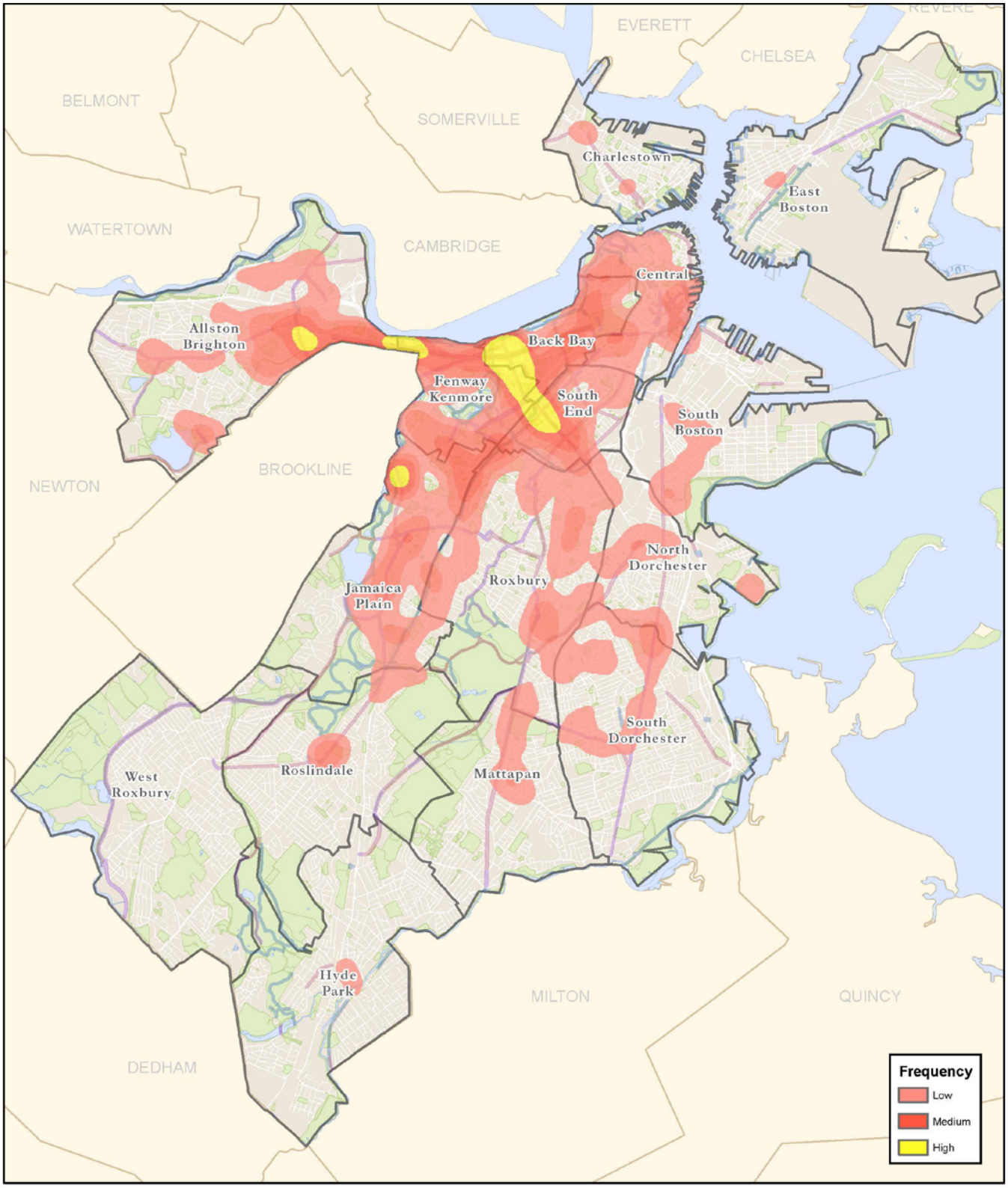
[20] Boston Bikes Observational Helmet Use Study, September, 2012.

[21] Fischer CM, Sanchez CE, Pittman M, Milzman D, Volz KA, Huang H, Gautam S, Sanchez LD. Prevalence of bicycle helmet use by users of public bikeshare programs. *Ann Emerg Med*, 2012;60(2):228-31.

[22] Thompson RS, Rivara FP, Thompson DC. Case-control study of the effectiveness of bicycle safety helmets. *N Engl J Med*, 1989;320:1361-1367.

[23] Thompson DC, Rivara FP, Thompson RS. Effectiveness of bicycle safety helmets in preventing head injuries: a case-control study. *JAMA*, 1996;276(24):1968-1973.

## Cyclist Incident Maps

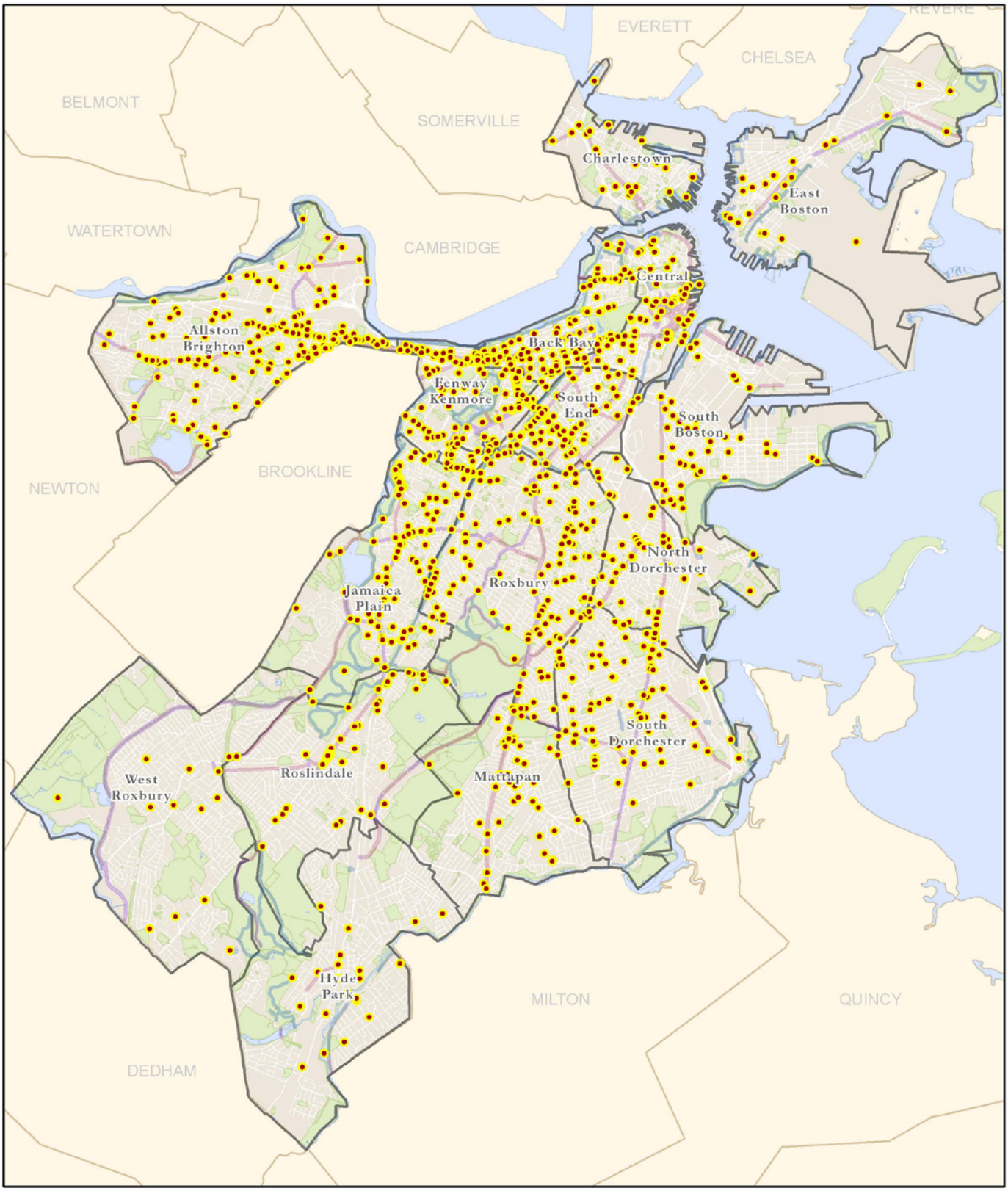



**City of Boston**

EMS Cyclist Incidents [2009 – 2012] - *By Frequency*

N 0 0.5 1 Miles April 2013

City of Boston MAPS




**City of Boston**

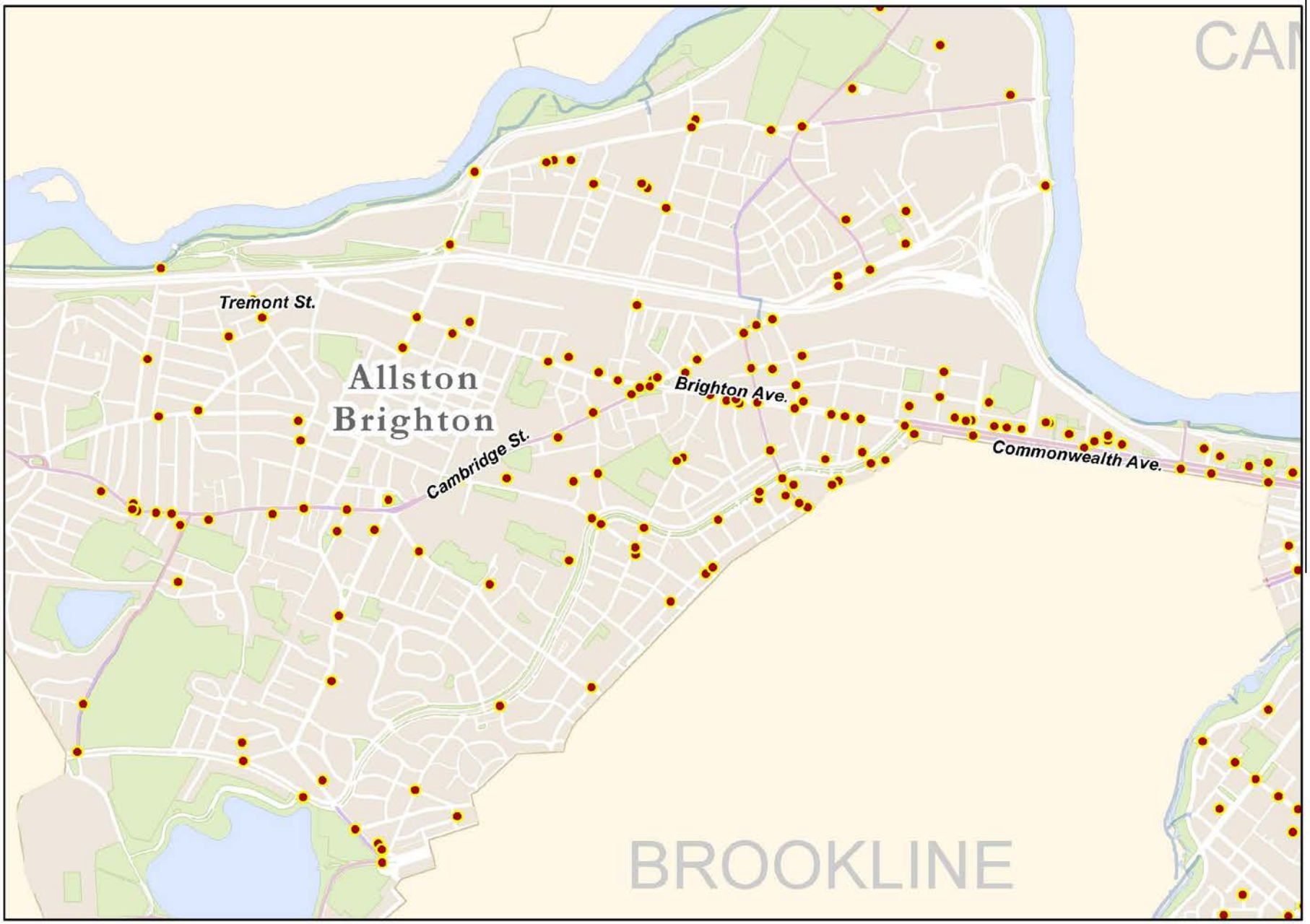
EMS Cyclist Incidents [2009 – 2012]

Incident

N 0 0.5 1 Miles

April 2013

City of Boston MAPS



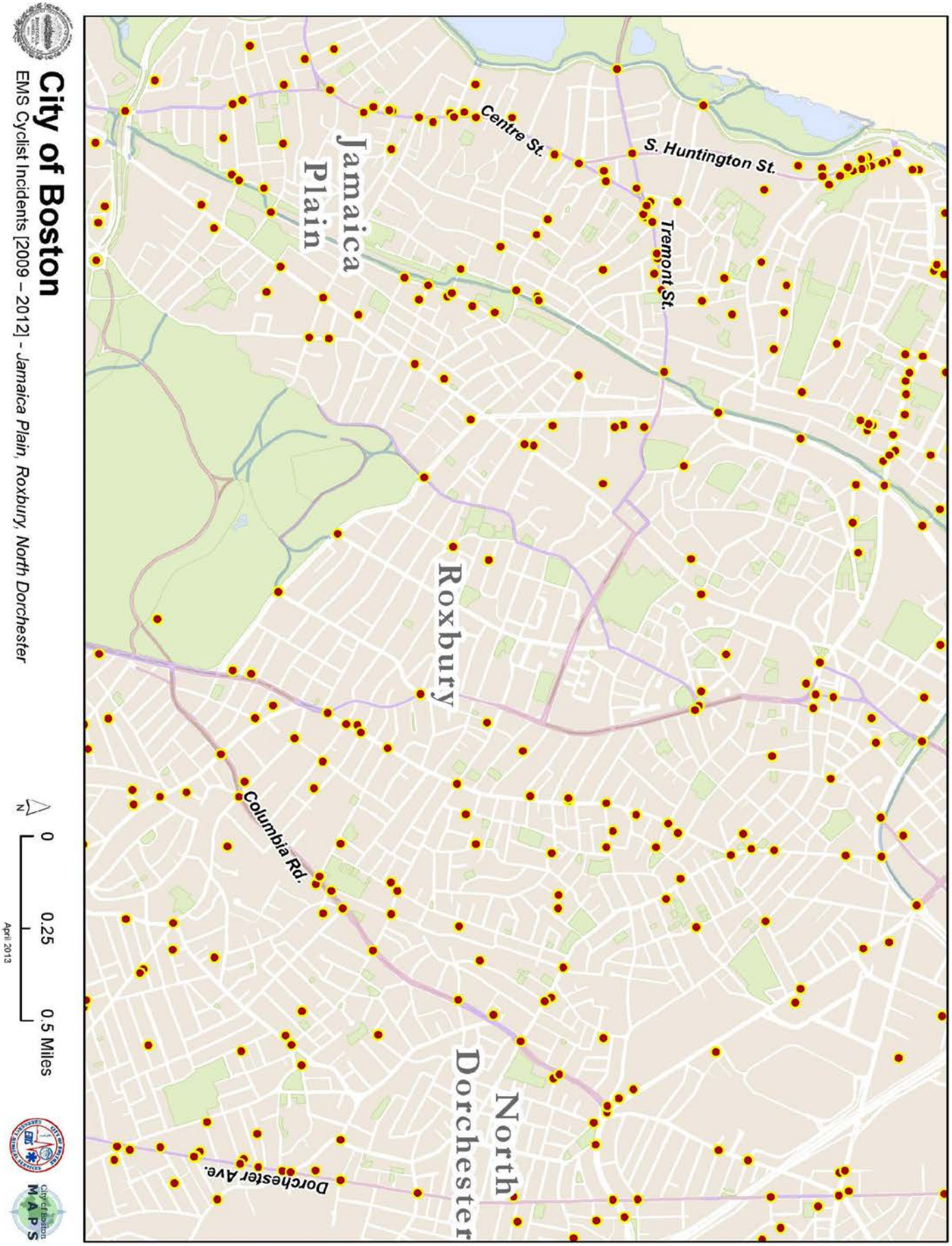

**City of Boston**

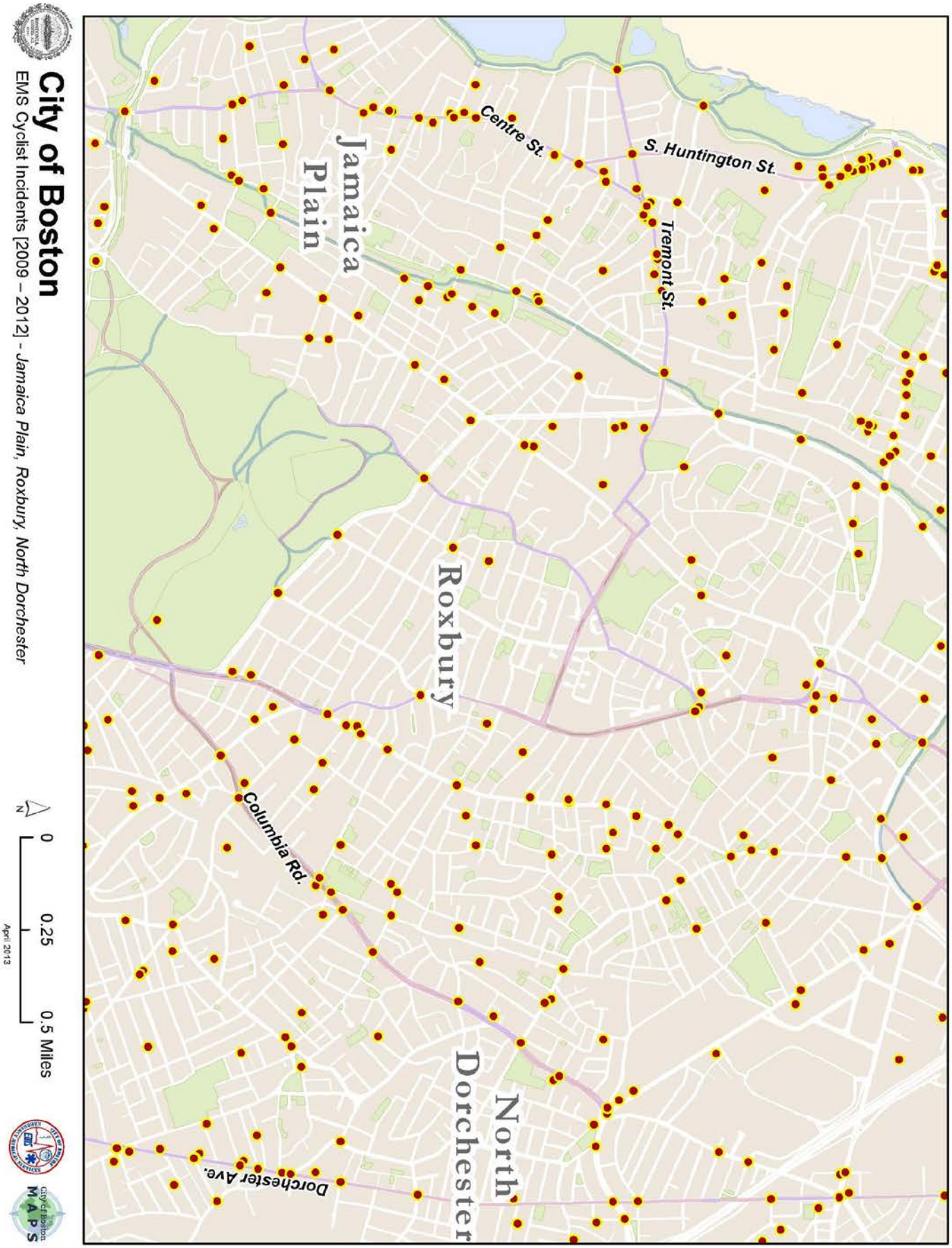
EMS Cyclist Incidents [2009 – 2012] - *Allston / Brighton*

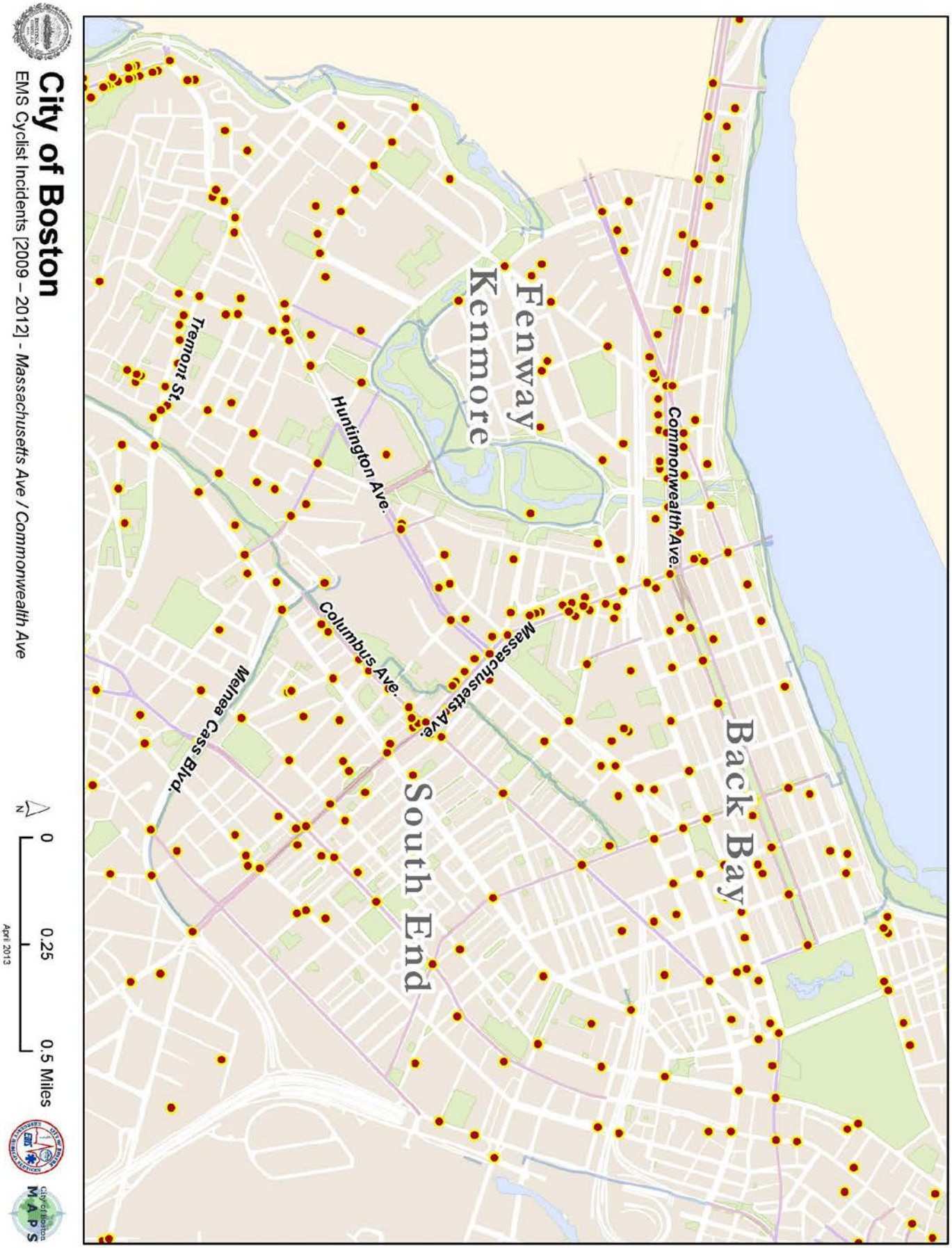
N

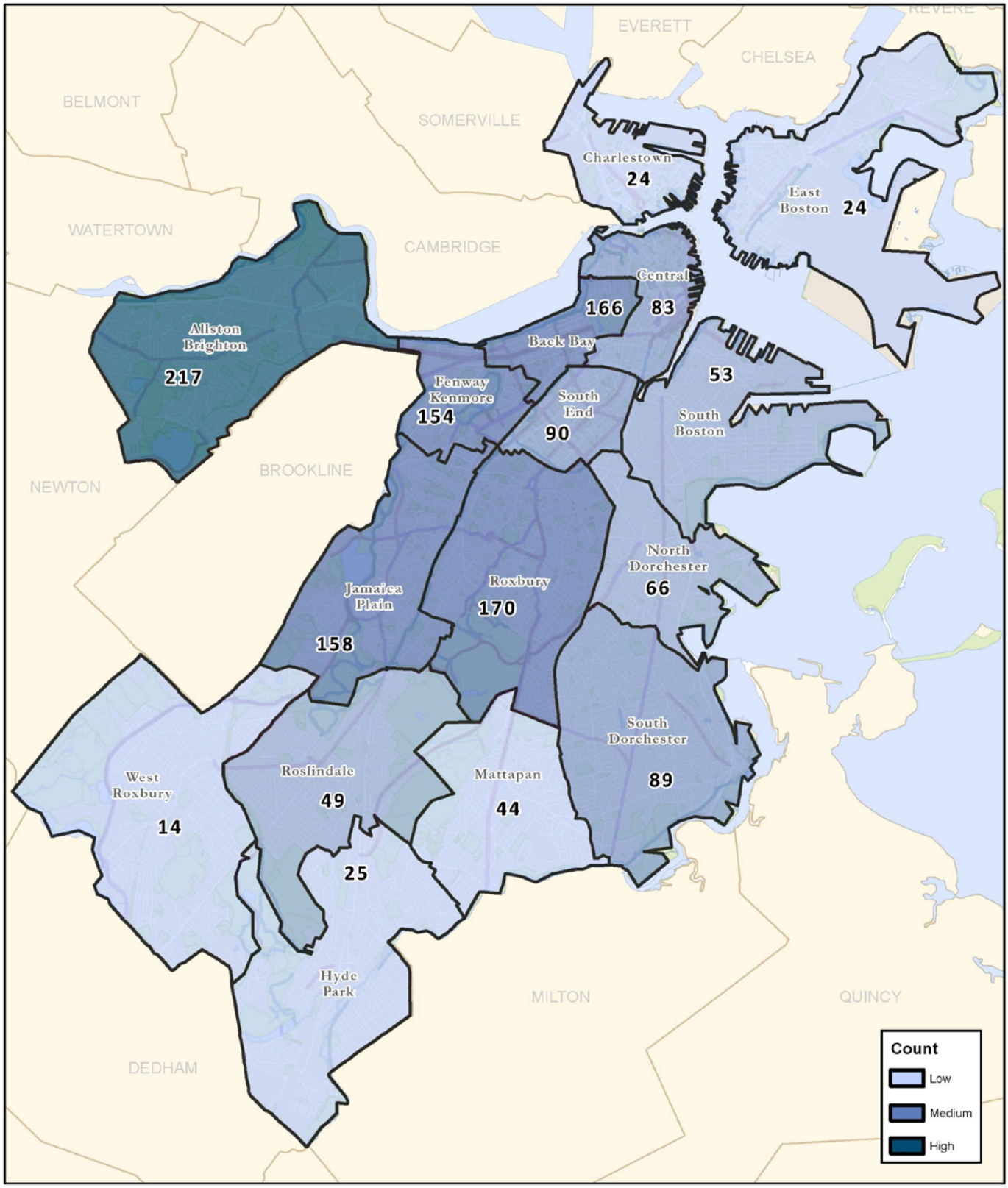
0 0.25 0.5 Miles

April 2013


City of Boston
EMS Cyclist Incidents [2009 – 2012] - Jamaica Plain, Roxbury, North Dorchester
Jamaica Plain
Roxbury
North Dorchester
Centre St.
S. Huntington St.
Tremont St.
Columbia Rd.
Dorchester Ave.
N
0
0.25
0.5 Miles
April 2013
City of Boston
MAPS


City of Boston
EMS Cyclist Incidents [2009 – 2012] - Jamaica Plain, Roxbury, North Dorchester
Jamaica Plain
Roxbury
North Dorchester
Centre St.
S. Huntington St.
Tremont St.
Columbia Rd.
Dorchester Ave.
N
0
0.25
0.5 Miles
April 2013
City of Boston
M A P S


Back Bay
Commonwealth Ave.
Fenway
Kenmore
Massachusetts Ave.
Huntington Ave.
Columbus Ave.
South End
Tremont St.
Melnea Cass Blvd.
City of Boston
EMS Cyclist Incidents [2009 – 2012] - Massachusetts Ave / Commonwealth Ave
N
0
0.25
0.5 Miles
April 2013
City of Boston
MAPS




# City of Boston

EMS Cyclist Incidents [2009 – 2012] - *Neighborhood Count*

N 0 0.5 1 Miles
April 2013

## Contributors to Boston EMS Report

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### Partners

Boston Transportation Division

Highway Safety Division, Executive Office of Public Safety and Security

Boston Police Department

## Partners

This report is the combined effort of many city agencies and partners. We are sincerely grateful for the work of all contributors.

Mayor's Office
Boston Bikes
Boston Police Department
Boston Public Health Commission and Boston Emergency Medical Services
Boston Transportation Department
Department of Innovation & Technology

Boston Area Research Initiative
Boston Cyclists Union
Harvard Injury Control Research Center
Highway Safety Division, Executive Office of public Safety and Security
Mayor's Bike/ Pedestrian Working Group

City Of Boston
Thomas M. Menino, Mayor