Bicycling Injuries in Boston

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Introduction
The fear of injury is one of the major obstacles in the way of increased use of bicycling. The City of Boston is interested in reducing bicyclist injuries and deaths, and, indeed, in reducing or eliminating all traffic-related injuries under the “Vision Zero” concept. Understanding how bicyclist injuries occur is a prerequisite to developing and implementing effective countermeasures. While there is an extensive literature on bicycling injuries, many previous studies are insufficient for understanding the urban bicyclist injury situation because they suffer from one or more of the following deficiencies:

- A national sample that disproportionately includes rural and suburban areas not comparable to Boston conditions;
- A reliance on police-reported data, which typically includes only incidents involving motor vehicles.
- The use of standard crash reports only, which generally provide no information about what the bicyclist was doing (entering an intersection, turning, etc) or where the bicyclist was prior to the collision (on the roadway, crosswalk, or sidewalk; facing traffic or riding in the direction of traffic).

This study attempts to remedy these problems by taking advantage of the release of detailed police incident report data on bicycle-related crashes from the City of Boston. The availability of the case narratives meant that it was possible to code the incidents using the bicycle crash typing procedure developed for the National Highway Traffic Safety Administration. More recently, the Boston Police Department has developed a new crash reporting system that will require officers completing reports to systematically code key variables relating to bicycle crashes including not only crash type but bicyclist position (roadway or sidewalk), direction of travel (with or against traffic), and use of nighttime equipment.\(^2\) Data from the new system, when it becomes available, should be more complete and accurate than what is presented in this report because the officer completing the report will be prompted to provide key information.

Hospital and Emergency Department Data
Counts of the number of people with bicycling injuries treated in hospital emergency departments were requested from the Massachusetts Department of Public Health for this report. The Massachusetts DPH maintains databases of hospital and emergency department usage. These include external sources of injury codes (“E-codes”), an international coding system that includes codes for injuries to “pedal cyclists” (as distinct from motorcyclists). Although these data have limited detail about the circumstances of the injuries, they do provide the necessary context about the total numbers of bicyclist injuries (not just those reported by police).

By request, the Mass DPH Injury Surveillance Program prepared tabulations of the data for the same time period as that of the police data used in the main section of this report (except that the last three

\(^2\) Carlos Cannon, Boston Police Department, personal communication, June 1, 2016.
months of data for 2012 were not available). The location of the incident resulting in injury is not available in this database. To approximate a count of bicyclist injuries occurring in Boston, the data was restricted to Boston residents treated in Boston hospitals. This excludes what must be a large number of non-residents injured in Boston. However, considering all bicyclists treated at Boston hospitals would likely not be representative of injuries in Boston, since more severely injured patients may be transported to Boston hospitals from smaller regional hospitals that do not provide specialized care.

The E-code makes it possible to determine whether an incident involved a motor vehicle or not. As shown in Table 1, less than one quarter of the emergency-room visits were motor-vehicle related. The lowest rate, 10%, was for young children (12 and under). The highest rate, 32%, was for young adults age 19 to 24.

Table 1: ED Visits for Pedal Cyclist Injuries, by Age Group and Cause, Boston Residents treated in Boston Hospitals, January 2009-September 2012

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Motor Vehicle-Related</th>
<th>Other</th>
<th>Total</th>
<th>% MV-Related</th>
<th>Age Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12</td>
<td>48</td>
<td>456</td>
<td>504</td>
<td>10%</td>
<td>17%</td>
</tr>
<tr>
<td>13-18</td>
<td>81</td>
<td>223</td>
<td>304</td>
<td>27%</td>
<td>10%</td>
</tr>
<tr>
<td>19-24</td>
<td>197</td>
<td>423</td>
<td>620</td>
<td>32%</td>
<td>21%</td>
</tr>
<tr>
<td>25-44</td>
<td>257</td>
<td>749</td>
<td>1,006</td>
<td>26%</td>
<td>35%</td>
</tr>
<tr>
<td>45+</td>
<td>111</td>
<td>352</td>
<td>463</td>
<td>24%</td>
<td>16%</td>
</tr>
<tr>
<td>Total</td>
<td>694</td>
<td>2,203</td>
<td>2,897</td>
<td>24%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Tabulations prepared by the Mass DPH from the MA Hospital Discharge, Observation Stay, and Emergency Department Discharge databases, MA Center for Health Information and Analysis.

Table 2 shows hospital stays, identifying injuries serious enough such that the injured person was admitted to the hospital overnight. Overall, 40% of bicyclist hospital stays were related to motor vehicles, but the remaining 60% were not. As with emergency-department visits, the 19-24 age group had the highest share that was related to motor vehicles.

Table 2: Hospital Stays for Pedal-Cyclist Injuries, by Age Group and Cause, Boston Residents treated in Boston Hospitals, January 2009-September 2012

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>MV-related</th>
<th>Not MV-related</th>
<th>Total</th>
<th>MV-related</th>
<th>Age Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-18</td>
<td>25</td>
<td>42</td>
<td>67</td>
<td>37%</td>
<td>19%</td>
</tr>
<tr>
<td>19-24</td>
<td>33</td>
<td>42</td>
<td>75</td>
<td>44%</td>
<td>22%</td>
</tr>
<tr>
<td>25-44</td>
<td>47</td>
<td>69</td>
<td>116</td>
<td>41%</td>
<td>34%</td>
</tr>
<tr>
<td>45+</td>
<td>32</td>
<td>56</td>
<td>88</td>
<td>36%</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>209</td>
<td>346</td>
<td>40%</td>
<td>100%</td>
</tr>
</tbody>
</table>

3 The data were provided via personal communication with Jeanne Hathaway, MD, MPH, Epidemiologist, Injury Surveillance Program, MA Dept. of Public Health, July - November 2014.
EMS and Police Data

The [Boston Cyclist Safety Report](City of Boston, May 2013) provides data on bicyclist incidents where the Boston Emergency Medical Services (EMS) responded, as well as separate data on incidents reported by the Boston Police Department (BPD). The table below shows the frequency of incident types based on data from 2009 to 2012 (based on information in the report, both datasets were less complete for 2009). In the EMS data, 63% of incidents involved motor vehicles; in the police data, 91% did.

### Table 3: Bicyclist Incident Type Distribution, EMS and BPD Data, 2009-2012

<table>
<thead>
<tr>
<th>Type of Incident</th>
<th>EMS</th>
<th>Police</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision with motor vehicle</td>
<td>63%</td>
<td>91%</td>
</tr>
<tr>
<td>Collision with pedestrian or bicyclist</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>No other party involved</td>
<td>29%</td>
<td>6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>6%</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Comparing these figures to the hospital data, it is evident that the EMS and BPD data leave out most incidents that result in an emergency department visit and more than half of incidents serious enough to warrant hospital admittance. Using the EMS and BPD data sources alone provides a skewed view of the circumstances that lead to bicyclist injuries, in particular by focusing too much on motor-vehicle related incidents and not enough on those not involving motor vehicles. Unfortunately, the hospital data provides almost no information about the causes of injuries. But given the number of single-bicyclist incidents in the EMS data, it is likely that the large majority of those not involving motor vehicles are falls due to road surface conditions, braking too hard, insufficient brakes, or loss of control due to operator incapacitation or error. Others circumstances not involving motor vehicles include collisions with pedestrians, animals, or other bicyclists. Unlike the hospital data, the BPD data provides several coded fields and a narrative describing the crash circumstances. With this information, it is generally possible to determine how these reported crashes occurred.

Crash-Typing BPD Data

This report analyzes the 1,808 police-reported traffic incidents involving bicyclists that occurred in the City of Boston between January 2009 and December 2012, as collected in the [Boston Cyclist Safety Report](City of Boston, May 2013) and made available in spreadsheet format by the Boston Area Research Initiative (http://www.bostonarearesearchinitiative.net/). The data set includes codes for bicyclist’s age and gender, whether the incident occurred in daylight, dusk, dawn, or night, address, narrative description, and other items.

In order to understand the crash circumstances, the crash narratives were reviewed, and a Crash Type for each one was selected using the categories from the Pedestrian and Bicycle Crash Analysis Tool.
(PBCAT), which was developed for the National Highway Traffic Safety Administration to crash-type bicycle crashes. Several additional codes were added to account for crash types not given a separate code in PBCAT, such as unsafe U-turn or unsafe lane change. In addition, new fields were added to the spreadsheet to indicate whether the bicyclist was operating against traffic and whether the bicyclist was operating on the sidewalk, based on a close reading of the crash narrative and knowledge of the crash location (e.g., which streets are designated as one-way). A complete description of the coding method, including new crash types created, is in Appendix A.

Demographics of Bicyclists

Of the 1,808 records in the BPD data, one was a duplicate and ten did not involve people operating bicycles (see Crashes Excluded in Appendix A), leaving 1,797 available to analyze. The bicyclist’s gender was available in 1,726 of the 1,797 cases; 77% of bicyclists involved were male (see Table 4). This statistic should not be taken as evidence that males are more likely to engage in risky behavior than females: the National Household Travel Survey suggests that men and boys account for approximately 80% of bicycle travel in the country.

<table>
<thead>
<tr>
<th>Table 4: Gender of Bicyclists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>FEMALE</td>
</tr>
<tr>
<td>MALE</td>
</tr>
<tr>
<td>Known</td>
</tr>
<tr>
<td>Unknown Gender</td>
</tr>
<tr>
<td>Grand Total</td>
</tr>
</tbody>
</table>

Table 5 summarizes the ages of the bicyclists. Nearly 90% of the bicyclists injured were adults (18 or older). College-age bicyclists (18 to 24) made up 33% of the total; 40% were between 25 and 44. Only 16% were 45 or older.

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4 A description of the tool and a list of PBCAT codes can be found here: [http://www.pedbikeinfo.org/pbcat_us/](http://www.pedbikeinfo.org/pbcat_us/).
5 Upon review of the data, it was discovered that in some cases the gender listed in the Gender field was not that of the bicyclist but that of another crash participant (e.g. motorist or pedestrian). In those cases the gender was changed to match the narrative, or, if not specified, was changed to “unknown.”
7 The bicyclist’s age was changed to “unknown” in a few cases where the incident report narrative made it clear that the age and gender fields did not match those of the injured bicyclist described in the narrative.
### Table 5: Age of Bicyclists

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 18</td>
<td>184</td>
<td>11%</td>
</tr>
<tr>
<td>18 to 24</td>
<td>547</td>
<td>33%</td>
</tr>
<tr>
<td>25 to 44</td>
<td>669</td>
<td>40%</td>
</tr>
<tr>
<td>45 to 64</td>
<td>240</td>
<td>15%</td>
</tr>
<tr>
<td>65+</td>
<td>20</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total Known</strong></td>
<td><strong>1,660</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td><strong>Unknown Age</strong></td>
<td><strong>137</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>1,797</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### Summary of Crash Types

Appendix B contains a comprehensive discussion of the circumstances of each crash type in detail, with examples illustrating how crashes occur, where there were factors explaining how crashes occur not obvious from the crash type (e.g., lack of bicyclist visibility, drunk motorist, wrong-way bicyclist). After assigning each crash a code, the 95 possible crash types were summarized into 21 groups. In 113 cases (6% of the total), there was not enough information in the police narrative to assign a classification. The total counts for the 21 groups of crash types are shown in Table 3 in descending order of frequency of group size.  

The underlying cause of a crash is not always apparent based on the crash type’s name. For example, Motorist Drive-Out crashes involve a motorist driving out from a side street, driveway, or parking space who strikes an approaching bicyclist. However, in many of these cases, the motorist was looking for and yielding to traffic, but the bicyclist was coming from a place where vehicular traffic is not expected to be (from the sidewalk and/or opposite the flow of traffic). Also, in any situation where a motorist has to yield to a bicyclist, the motorist may not have been able to see the bicyclist if the crash took place in low-light conditions and the bicyclist did not have a headlight, which is a statutory violation.

The most common crash types can be summarized as follows:

1. The single most common crash type in Boston is when a bicyclist hits a suddenly opened car door (“dooring”). Not only are these crashes common, but they can be fatal, especially if the bicyclist is thrown into the path of moving traffic after hitting the door. Bicyclists can avoid these crashes by keeping a door’s width from parked cars.

2. Almost as common as dooring is motorist left turn. Although the turning motorist is required to yield, there are sometimes complicating factors, as when the bicyclist has no headlight after dark, is approaching from the sidewalk or the wrong side of the road, or is overtaking a car on the right and thus screened from the view of the driver of the turning car.

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8 The complete spreadsheet of crashes is available upon request.
Table 6: Summary of Grouped Crash Types

<table>
<thead>
<tr>
<th>Crash Group</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dooring</td>
<td>208</td>
<td>12%</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>197</td>
<td>12%</td>
</tr>
<tr>
<td>Motorist Drive-Out</td>
<td>195</td>
<td>12%</td>
</tr>
<tr>
<td>Motorist Right Turn</td>
<td>163</td>
<td>10%</td>
</tr>
<tr>
<td>Bicyclist Signal Violation</td>
<td>160</td>
<td>10%</td>
</tr>
<tr>
<td>Bicyclist Ride-Out</td>
<td>136</td>
<td>8%</td>
</tr>
<tr>
<td>Bicyclist Lost Control</td>
<td>99</td>
<td>6%</td>
</tr>
<tr>
<td>Other Crossing</td>
<td>97</td>
<td>6%</td>
</tr>
<tr>
<td>Motorist Overtaking</td>
<td>66</td>
<td>4%</td>
</tr>
<tr>
<td>Bicyclist Overtaking</td>
<td>65</td>
<td>4%</td>
</tr>
<tr>
<td>Motorist Merge/Wrong Lane</td>
<td>55</td>
<td>3%</td>
</tr>
<tr>
<td>Pedestrian / Other Bike</td>
<td>53</td>
<td>3%</td>
</tr>
<tr>
<td>Head-On</td>
<td>40</td>
<td>2%</td>
</tr>
<tr>
<td>Bicyclist Turn</td>
<td>37</td>
<td>2%</td>
</tr>
<tr>
<td>Parking</td>
<td>31</td>
<td>2%</td>
</tr>
<tr>
<td>Intentional (Assault)</td>
<td>26</td>
<td>2%</td>
</tr>
<tr>
<td>Bicyclist Merge</td>
<td>16</td>
<td>1%</td>
</tr>
<tr>
<td>Motorist Signal Violation</td>
<td>14</td>
<td>1%</td>
</tr>
<tr>
<td>Backing</td>
<td>13</td>
<td>1%</td>
</tr>
<tr>
<td>Parking Lot</td>
<td>7</td>
<td>0%</td>
</tr>
<tr>
<td>Other Parallel</td>
<td>6</td>
<td>0%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>1684</td>
<td>100%</td>
</tr>
<tr>
<td>Unknown</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1797</td>
<td></td>
</tr>
<tr>
<td>Excluded (not bicycling or duplicate)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Total in Database</td>
<td>1808</td>
<td></td>
</tr>
</tbody>
</table>

3. The third most common type, also representing 12% of the cases, involves a motorist driving out from a stop sign or driveway without yielding. In nearly half of the cases, the bicyclist was approaching from the wrong way – in fact this is so common that the PBCAT authors used a wrong-way bicyclist in their illustration of the crash type.

4. The fourth most common is motorist right turn across the path of a bicyclist. While some occur when the motorist is overtaking the bicyclist, in Boston it is much more likely that the bicyclist is overtaking the car (or riding beside) when the motorist turns right. There were five “bicyclist overtaking” situations identified for each single “motorist overtaking” situation.

5. The fifth most common type was bicyclist signal violation – where the bicyclist fails to stop for a red signal. There were 160 cases of this crash type in the data. By comparison, there were only 14 cases where a motorist failed to stop for a red signal – more than 11 bicyclist violations for each motorist violation.

6. The sixth most common type involved a bicyclist failing to yield when riding out from a stop sign or driveway, or entering the road from between parked cars.
7. The seventh most common type was a fall due to surface conditions, mechanical problems, or alcohol use. None of these crashes involved moving motor vehicles.9

8. “Other crossing” collisions were the next most common type. These are intersection collisions that would probably be included in one of the other categories if more information was available about the exact mechanism of the collision (e.g., who failed to yield).

9. Motorist overtaking was the ninth most common crash type. Being hit by a car approaching from behind is probably the crash that bicyclists fear most, but it accounted for only 4% of crashes. Nearly half, 43%, happened in the dark. Of the daylight cases, 11 involved bicyclists swerving to avoid an object ahead. Of the remaining cases, all but one involved a sideswipe—suggesting that motorists see bicyclists in daylight, and when there is an overtaking collision it is because they misjudge the passing space needed. The single daylight rear-end collision involved a motorist who was driving so recklessly and erratically before hitting the bicyclist that a witness had been watching him.

10. The tenth most common type, with almost exactly the same number of cases as the previous one, was bicyclist overtaking.

Together these 10 crash types account for 82% of the incidents. Except for door and the overtaking collisions, all involve intersections or driveways.

Risk Factors for Crashes
What can bicyclists do to avoid these crashes? Since bicycles have no seat belts, air bags or other crash protection, one might think that bicyclists generally take all precautions to reduce the risk of crashes, such as following the rules of the road. However, there may be a disconnect between what bicyclists believe to be risky and what actually is risky. Because crashes are relatively rare, personal experience may not be an adequate guide to determining the safest behavior. Therefore, changes to bicyclist behavior—guided by an analysis of crash data—could potentially reduce many crashes.

Wrong Way Bicycling
Some bicyclists believe that it is safer to operate facing traffic so they can see motor vehicles approaching. However, where drivers must yield (e.g., at a stop sign, or when turning right on red), they generally look in the direction of approaching traffic, not in the direction of the wrong-way bicyclist. Despite this straightforward explanation as to why wrong-way riding is dangerous, there have been few efforts to quantify the risk compared to operating with the flow. In the landmark Cross and Fisher study of 919 police-reported bicyclist injuries in the U.S. in 1975, the authors noted that wrong-way riding appeared to be a significant risk factor, given that it occurred in 52% of motorist drive-out collisions. Wachtel and Lewiston (1994) found that the risk ratio for riding against traffic compared to with traffic was 10.

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9 The PBCAT system assumes that the data reported are from standard crash reports which according to standard NHTSA practice include only crashes involving motor vehicles. However, a “bicycle only” crash category was added to the most recent version of PBCAT. In this study, the “bicyclist lost control” crash type and its various subtypes were used instead because it provides some detail about the circumstance of the injury.

was 3.6. For bicyclists on the road, the risk ratio was 2.0, and for bicyclists on the sidewalk it was 4.5.\textsuperscript{11}

Several European studies of two-way bicycle sidepaths have found an elevated risk for bicyclists using the path in the direction facing traffic.\textsuperscript{12} In a study of bicyclists seeking treatment in hospital emergency departments in Toronto and Vancouver in 2008-09, the authors found the bicyclists had an eight times greater crash risk at intersections when operating against traffic comparing to riding with the flow of traffic.\textsuperscript{13}

Table 7 shows the percent of bicyclists who were facing traffic by crash type. Overall, 13% were facing traffic, either on the roadway or on the sidewalk (in the latter case, generally entering an intersection or driveway crossing). However, the proportion is not equal by crash type. There were nine crash groups (Class 1) where the percent riding facing traffic was 7% or more, with an overall average of 21%. The remaining 10 crash groups, shown in italics, (Class 2) had an overall average of only 2% facing traffic. Almost all of the crash groups that are by definition intersection crashes fell into Class 1, in agreement with theory and previous research showing that operating in the wrong direction puts bicyclists at risk because they enter intersections from the right when motorists waiting to enter the intersection are looking left, in the direction from which traffic is coming. The crash group with the second-highest share of wrong-way riding is Head On and Motorist Overtaking, which were combined for the purpose of this analysis (since by definition in the former case bicyclists are operating against traffic and in the latter case bicyclists are operating with traffic).

If wrong-way cycling had no effect on crash risk, one would expect to see the same proportion of cyclists operating against traffic in each crash type. Yet this is clearly not the case in our sample. In fact, in the more than 300 incidents of Bicyclist Lost Control and Dooring, only 4 bicyclists (1%) were operating against traffic. Therefore it may be that the share of wrong-way bicycling miles in Boston is as low as 1%. If this is the case, then the extremely high share of wrong-way bicycling among several other crash types suggests that the behavior creates a highly elevated risk of collision.

### Table 7: Bicyclists Facing Traffic by Crash Group

<table>
<thead>
<tr>
<th>Crash Group</th>
<th>Facing Traffic</th>
<th>Total</th>
<th>% Facing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorist Drive-Out</td>
<td>85</td>
<td>195</td>
<td>44%</td>
</tr>
<tr>
<td>Head On + Motorist Overtaking</td>
<td>34</td>
<td>107</td>
<td>32%</td>
</tr>
<tr>
<td>Other Parallel</td>
<td>1</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>Bicyclist Ride-Out</td>
<td>20</td>
<td>115</td>
<td>17%</td>
</tr>
<tr>
<td>Bicyclist Signal Violation</td>
<td>27</td>
<td>160</td>
<td>17%</td>
</tr>
<tr>
<td>Motorist Signal Violation</td>
<td>2</td>
<td>14</td>
<td>14%</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>22</td>
<td>197</td>
<td>11%</td>
</tr>
<tr>
<td>Pedestrian / Other Bike</td>
<td>5</td>
<td>53</td>
<td>9%</td>
</tr>
<tr>
<td>Motorist Right Turn</td>
<td>12</td>
<td>163</td>
<td>7%</td>
</tr>
<tr>
<td>Motorist Merge/Wrong Lane</td>
<td>3</td>
<td>55</td>
<td>5%</td>
</tr>
<tr>
<td>Other Crossing</td>
<td>5</td>
<td>97</td>
<td>5%</td>
</tr>
<tr>
<td>Bicyclist Overtaking</td>
<td>2</td>
<td>65</td>
<td>3%</td>
</tr>
<tr>
<td>Bicyclist Lost Control</td>
<td>3</td>
<td>99</td>
<td>3%</td>
</tr>
<tr>
<td>Dooring</td>
<td>1</td>
<td>208</td>
<td>0%</td>
</tr>
<tr>
<td>Bicyclist Merge</td>
<td>0</td>
<td>16</td>
<td>0%</td>
</tr>
<tr>
<td>Bicyclist Turn</td>
<td>0</td>
<td>37</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>13</td>
<td>0%</td>
</tr>
<tr>
<td>Motorist Parking</td>
<td>0</td>
<td>31</td>
<td>0%</td>
</tr>
<tr>
<td>Intentional</td>
<td>0</td>
<td>26</td>
<td>0%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>222</td>
<td>1656*</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Subtotal Class 1</strong></td>
<td>208</td>
<td>1009</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Subtotal Class 2</strong></td>
<td>14</td>
<td>647</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Total excludes bicyclist entering roadway from midblock, bicyclist in parking lot, and unknown.

### Sidewalk Bicycling

As with wrong-way riding, sidewalk riding has been found to increase the risk of car-bike collisions because the bicyclist is in an unexpected place, such as crossing a driveway faster than a pedestrian or entering the intersection to the right of right-turning traffic. Wachtel and Lewiston found that overall, sidewalk bicyclists had 1.8 times the risk of collision with motor vehicles at intersections compared to roadway riders. As with wrong-way cycling, sidewalk cycling was not randomly distributed by crash type. Overall, 13% of bicyclists in the BPD data were using a sidewalk or bike path—coincidentally the same percentage as those operating facing traffic. (There is overlap between the groups: some were operating facing traffic on the sidewalk.) Some crash types by their definition are very unlikely to involve sidewalk bicyclists. However, Bicyclist Lost Control crashes could involve sidewalk bicyclists, and only 5% of them did. Thus as with wrong-way bicycling, it appears that crash types where sidewalk riding is disproportionately common (e.g., motorist or bicyclist signal or stop sign violation, all with a sidewalk share of 28% or greater) are indicative of an elevated intersection risk for sidewalk bicyclists. For the Motorist Signal Violation and Motorist Drive Out (from stop sign) crash types, the likely mechanism is that the motorist approaching at a red signal or stop sign is slowing when reaching the crosswalk but has not yet stopped, while the bicyclist approaching on the sidewalk assumes the driver will stop prior to the...
crosswalk. For Motorist Right Turn, bicyclists on the sidewalk can enter the crosswalk much faster than a pedestrian—so motorists do not have time to yield. For Motorist Left Turn, the motorist may be looking for oncoming traffic approaching in the travel lane, rather than traffic approaching on the sidewalk. Sidewalk bicyclists are also disproportionately likely to face traffic, which is an independent risk factor for all of these intersection crash types.

### Table 8: Bicyclists Using Sidewalk by Crash Group

<table>
<thead>
<tr>
<th>Crash Group</th>
<th>Sidewalk</th>
<th>Roadway</th>
<th>Total</th>
<th>% Sidewalk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorist Signal Violation</td>
<td>6</td>
<td>8</td>
<td>14</td>
<td>43%</td>
</tr>
<tr>
<td>Bicyclist Ride-Out</td>
<td>46</td>
<td>90</td>
<td>136</td>
<td>34%</td>
</tr>
<tr>
<td>Motorist Drive-Out</td>
<td>64</td>
<td>131</td>
<td>195</td>
<td>33%</td>
</tr>
<tr>
<td>Bicyclist Signal Violation</td>
<td>44</td>
<td>116</td>
<td>160</td>
<td>28%</td>
</tr>
<tr>
<td>Other Parallel</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>11</td>
<td>13</td>
<td>15%</td>
</tr>
<tr>
<td>Other Crossing</td>
<td>14</td>
<td>83</td>
<td>97</td>
<td>14%</td>
</tr>
<tr>
<td>Motorist Right Turn</td>
<td>23</td>
<td>140</td>
<td>163</td>
<td>14%</td>
</tr>
<tr>
<td>Pedestrian / Other Bike</td>
<td>6</td>
<td>47</td>
<td>53</td>
<td>11%</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>20</td>
<td>177</td>
<td>197</td>
<td>10%</td>
</tr>
<tr>
<td>Motorist Merge/Wrong Lane</td>
<td>3</td>
<td>52</td>
<td>55</td>
<td>5%</td>
</tr>
<tr>
<td>Bicyclist Lost Control</td>
<td>5</td>
<td>94</td>
<td>99</td>
<td>5%</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>110</td>
<td>113</td>
<td>3%</td>
</tr>
<tr>
<td>Head On</td>
<td>1</td>
<td>39</td>
<td>40</td>
<td>3%</td>
</tr>
<tr>
<td>Bicyclist Overtaking</td>
<td>1</td>
<td>64</td>
<td>65</td>
<td>2%</td>
</tr>
<tr>
<td>Dooring</td>
<td>2</td>
<td>206</td>
<td>208</td>
<td>1%</td>
</tr>
<tr>
<td>Bicyclist Merge</td>
<td>0</td>
<td>16</td>
<td>16</td>
<td>0%</td>
</tr>
<tr>
<td>Bicyclist Turn</td>
<td>0</td>
<td>37</td>
<td>37</td>
<td>0%</td>
</tr>
<tr>
<td>Intentional</td>
<td>0</td>
<td>26</td>
<td>26</td>
<td>0%</td>
</tr>
<tr>
<td>Motorist Overtaking</td>
<td>0</td>
<td>67</td>
<td>67</td>
<td>0%</td>
</tr>
<tr>
<td>Motorist Parking</td>
<td>0</td>
<td>31</td>
<td>31</td>
<td>0%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>241</td>
<td>1549</td>
<td>1790</td>
<td>13%</td>
</tr>
<tr>
<td>Subtotal Class 1</td>
<td>226</td>
<td>807</td>
<td>1033</td>
<td>22%</td>
</tr>
<tr>
<td>Subtotal Class 2</td>
<td>15</td>
<td>742</td>
<td>757</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Includes bicyclists in crosswalk and approaching from a bicycle path.

**Night Time**

In the BPD data, 30% of crashes occurred in the dark (after sunset or before dawn), and another 10% happened within an hour before sunset or an hour after dawn. Although there is no readily available source giving the share of bicycling that occurs after dark, it would seem to be much less than 30%, especially given the large proportion of bicycling that is for recreational purposes. After dark, bicyclists are required to use a white headlight and either a red taillight or a red reflector (see the discussion of
legal requirements in Appendix D). There were only four cases\textsuperscript{14} in the data in which the police reported that a bicyclist was using either a front or rear light. In two of these cases, the motorist claimed to have looked but failed to see the bicyclist, despite the front headlight. In the other two, lighting was not relevant to the collision, since one involved a motorist’s passing and then deliberately turning right across the path of the bicyclist, and the other was an assault. Thus there were only two cases where lighting apparently failed to work. In most other nighttime cases, the police did not record whether the bicyclist was using lights or reflectors.

A study in the Netherlands found that the risk of bicyclist collisions at night involving motor vehicles, controlling for distance bicycled, was at least 8 times higher (before midnight) and as much as 40 times higher (after midnight).\textsuperscript{15} The higher risk after midnight may be the result of higher alcohol use both among bicyclists and among motorists.

As shown in Table 9, there were no crash groups that occurred almost entirely in daylight. The explanation is that difficulty in seeing the bicyclist is a risk factor in almost every type of car-bike collision. The lowest, at 21%, was Dooring – suggesting that most motorists do not see bicyclists in this case because they are not looking. Still, in some cases motorists may look but fail to see unlit bicyclists approaching. Other than intersection crashes where the details were not provided, the crash group most likely to occur after dark was Bicyclist Lost Control; this is probably due to the prevalence of drunk bicyclists in this category, and the greater rate of night as opposed to daytime alcohol use.

A disproportionate share of Motorist Overtaking crashes occurs in hours of darkness, suggesting that the failure of the motorist to see a bicyclist in the dark – and quite likely the failure of the bicyclist to use lights – is a cause of many of these crash types. Most of the other crash types that are more likely to occur at night also involve the failure of the motorist to yield to the bicyclist, and, as with the overtaking crashes, are likely caused or at least exacerbated by the failure of the bicyclist to use lights at night.

\textsuperscript{14} The cases were B1006, a motorist left turn; B1265, a dooring, B1274, a motorist right turn, and B1734, an assault.

\textsuperscript{15}Cycling in the Dark. \url{https://www.swov.nl/rapport/Factsheets/UK/FS_Cycling_in_the_dark.pdf}
Table 9: Night Crashes by Crash Group

<table>
<thead>
<tr>
<th>Crash Group</th>
<th>Night</th>
<th>Daytime</th>
<th>Total</th>
<th>% Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Crossing</td>
<td>43</td>
<td>53</td>
<td>96</td>
<td>45%</td>
</tr>
<tr>
<td>Bicyclist Lost Control</td>
<td>44</td>
<td>55</td>
<td>99</td>
<td>44%</td>
</tr>
<tr>
<td>Motorist Overtaking</td>
<td>29</td>
<td>38</td>
<td>67</td>
<td>43%</td>
</tr>
<tr>
<td>Other Parallel</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>40%</td>
</tr>
<tr>
<td>Motorist Parking</td>
<td>12</td>
<td>19</td>
<td>31</td>
<td>39%</td>
</tr>
<tr>
<td>Intentional</td>
<td>10</td>
<td>16</td>
<td>26</td>
<td>38%</td>
</tr>
<tr>
<td>Bicyclist Merge</td>
<td>6</td>
<td>10</td>
<td>16</td>
<td>38%</td>
</tr>
<tr>
<td>Motorist Merge/Wrong Lane</td>
<td>20</td>
<td>35</td>
<td>55</td>
<td>36%</td>
</tr>
<tr>
<td>Motorist Signal Violation</td>
<td>5</td>
<td>9</td>
<td>14</td>
<td>36%</td>
</tr>
<tr>
<td>Unknown</td>
<td>39</td>
<td>74</td>
<td>113</td>
<td>35%</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>67</td>
<td>130</td>
<td>197</td>
<td>34%</td>
</tr>
<tr>
<td>Bicyclist Signal Violation</td>
<td>51</td>
<td>109</td>
<td>160</td>
<td>32%</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>9</td>
<td>13</td>
<td>31%</td>
</tr>
<tr>
<td>Pedestrian / Other Bike</td>
<td>16</td>
<td>37</td>
<td>53</td>
<td>30%</td>
</tr>
<tr>
<td>Nonroadway</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>29%</td>
</tr>
<tr>
<td>Head On</td>
<td>11</td>
<td>29</td>
<td>40</td>
<td>28%</td>
</tr>
<tr>
<td>Bicyclist Ride Out</td>
<td>34</td>
<td>103</td>
<td>137</td>
<td>25%</td>
</tr>
<tr>
<td>Bicyclist Turn</td>
<td>9</td>
<td>28</td>
<td>37</td>
<td>24%</td>
</tr>
<tr>
<td>Motorist Right Turn</td>
<td>38</td>
<td>125</td>
<td>163</td>
<td>23%</td>
</tr>
<tr>
<td>Bicyclist Overtaking</td>
<td>15</td>
<td>50</td>
<td>65</td>
<td>23%</td>
</tr>
<tr>
<td>Motorist Drive Out</td>
<td>43</td>
<td>152</td>
<td>195</td>
<td>22%</td>
</tr>
<tr>
<td>Dooring</td>
<td>43</td>
<td>165</td>
<td>208</td>
<td>21%</td>
</tr>
<tr>
<td>Total</td>
<td>543</td>
<td>1254</td>
<td>1797</td>
<td>30%</td>
</tr>
</tbody>
</table>

Riding in the Door Zone
Striking a car door was the most common crash type in this police-reported data, accounting for 208 or 12% of the identified cases. In virtually all the cases reported, the door was opened as the bicyclist was approaching, giving the bicyclist no time to stop. Bicyclists who make a habit of riding at least 3 feet from parked cars at all times essentially eliminate the risk of “dooring.”

16 Because bicycle handlebars are at least 2 feet wide, for the bicycle to be completely out of reach of the door, the bicycle wheel must be about 4 feet from the parked car, and the leftmost edge of the bicycle about 5 feet away.
The key role of visibility in overtaking collisions can be seen from the fact that 48% of them occurred in non-daylight hours, compared to only 21% of dooring collisions. The solution is for the bicyclist to use a rear light. There were no motorist overtaking collisions where the police officer noted that the bicyclist had a rear light. Bicyclists can avoid swerving by riding far enough into the travel lane to avoid hazards on the edge of the road, and merging further left as soon as an obstacle (such as a double-parked car) ahead is detected, giving an overtaking motorist time to slow or change lanes.

**Passing on the Right**

In city traffic it is common for bicyclists to want to pass queues of stopped cars waiting for traffic lights to turn green. In Boston, at times, these queues can extend the full length of a block, and so there is a strong temptation for bicyclists to pass on the right of stopped or slow traffic. However, this puts bicyclists at risk for several types of collisions, as shown in Table 9. The most common is when the motorist turns right. In addition to the 74 incidents where there was evidence that the bicyclist was riding beside the car, there were another 44 cases, not included in this table, where the bicyclist was hit by a right-turning car but there was no information about which party was overtaking. The 11 cases where the motorist was pulling into on-street parking are essentially the same as the standard right-turn collision (this count excludes three cases of this crash type where there was no evidence that the bicyclist was overtaking).

There were also 39 cases where the bicyclist continued on the right of a stopped motor vehicle, only to be hit by a left-turner coming from the opposite direction whose view of the bicyclist was impeded by the stopped motor vehicle. Finally, there were eight cases where a bicyclist passed a stop car only to realize, too late, that the motorist had stopped to let a pedestrian cross (in a crosswalk or not).

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorist Right Turn</td>
<td>74</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>39</td>
</tr>
<tr>
<td>Pull into On-Street Parking</td>
<td>11</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>132</strong></td>
</tr>
</tbody>
</table>

Overtaking on the right of slow or stopped traffic can save time, but it comes at a risk. One alternative is simply slowing or stopping until traffic starts up again; this is typically the best solution where there are only a few cars waiting at a red signal. However, when traffic is very backed up, bicyclists who filter through the stopped traffic can avoid waiting for more than one light cycle. This is safer if traffic is stopped and cannot move, and bicyclists proceed at reduced speed so that they can see and avoid possibly opening doors or pedestrians walking between the stopped cars. A discussion of the laws concerning overtaking on the right is contained in Appendix D.
Failure to Yield
At least 338 of the crashes involved bicyclist failure to yield when required by traffic law. These include (with number of cases in parentheses):

- Bicyclist Traffic Signal Violation (160)
- Bicyclist Ride Out (134)
- Bicyclist Left Turn (34)
- Bicyclist Unsafe Lane Change (10)

There were also 460 cases of motorist failure to yield:

- Motorist Left Turn (197)
- Motorist Drive Out (194)
- Motorist Merge / Improper Lane Use (55)
- Motorist Traffic Signal Violation (14)

What is striking in comparing these lists is the disparity in traffic signal violations: they are the most common failure to yield among bicyclists but the least common by far among motorists. Bicyclist signal violations outnumber motorist violations by a ratio of 16 to 1. This disparity suggests that bicyclists are much more likely to fail to obey traffic signals than motorists. The other types of violations require that the party who is required to yield look for and see the party that has the right of way, whereas in the Signal Violation case merely obeying the signal is sufficient to prevent a collision. Numerous behaviors make bicyclists hard to see at intersections, for example, failing to use lights at night, riding facing traffic, and overtaking on the right. Only 165 of the 460 motorist failure to yield cases occurred in daylight when the bicyclist was operating in the correct direction and not overtaking on the right, specifically:

- Motorist Left Turn (77)
- Motorist Drive Out (49)
- Motorist Merge / Improper Lane Use (34)
- Motorist Traffic Signal Violation (5)

Crashes Not Involving Motor Vehicles
More than 50 crashes involved other non-motorists, mostly pedestrians but a few other bicyclists. Some single bicycle crashes are the result of road defects, and some are primarily the result of improper or missing brakes (a violation), poor braking skill (e.g. braking too hard), or impairment by alcohol or drugs. It is not clear in Massachusetts whether bicycling while intoxicated is a traffic violation, as it is in many other places; in any case police do not enforce against it. It bears repeating that the hospital data reveal that crashes not involving a motor vehicle result in the majority of bicyclist injuries; it’s just that they are not reported to police (or, possibly, not reported by them).
Motorist Risk Factors

Some car-bike collisions are solely due to motorist error. However, it is not correct to attribute motorist error to all the crash types that appear by definition to be the fault of the motorist, such as Motorist Signal Violation or Motorist Overtaking, because, as discussed, many bicyclists fail to operate in the direction of traffic and to use lights at night as required by law. Sidewalk riding is also a risk factor for collisions. As shown in Table 11, there were 673 crashes involving bicyclists using the roadway in the direction of traffic and not failing to yield when required by law. Other than Dooring collisions, by far the largest number of these involved intersections or driveways.

Table 11: Daylight Crashes Involving Bicyclists Using the Roadway, In the Direction of Traffic, and Not Failing to Yield

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dooring</td>
<td>162</td>
</tr>
<tr>
<td>Motorist Right Turn*</td>
<td>122</td>
</tr>
<tr>
<td>Motorist Left Turn</td>
<td>108</td>
</tr>
<tr>
<td>Motorist Drive Out**</td>
<td>58</td>
</tr>
<tr>
<td>Motorist Overtaking</td>
<td>38</td>
</tr>
<tr>
<td>Motorist Merge/Wrong Lane</td>
<td>34</td>
</tr>
<tr>
<td>Intentional (Motorist Assault)</td>
<td>12</td>
</tr>
<tr>
<td>Backing Motorist</td>
<td>6</td>
</tr>
<tr>
<td>Nonroadway (Parking Lot)</td>
<td>5</td>
</tr>
<tr>
<td>Motorist Signal Violation</td>
<td>5</td>
</tr>
<tr>
<td>Head On-Motorist Wrong Way</td>
<td>1</td>
</tr>
<tr>
<td>Unusual</td>
<td>3</td>
</tr>
<tr>
<td>Subtotal Motorist Caused</td>
<td>548</td>
</tr>
<tr>
<td>Unknown Details</td>
<td>117</td>
</tr>
<tr>
<td>Total</td>
<td>665</td>
</tr>
</tbody>
</table>

*Includes 12 cases of pulling into on-street parking.

**Includes 7 cases of driving out from on-street parking.

Opening Car Doors

These data show that the single most important thing motorists in Boston can do to prevent collisions with bicyclists is to look before opening a car door, whether on the driver side or the passenger side (if not stopped at the curb). But because bicyclists can’t rely on every motorist to look every time (and also every passenger, including children), the only safe course is to avoid the “door zone.” Even if bicyclists go slowly, a door can be opened in their path faster than they can stop. Importantly, motorists should desist from using horns and threatening bicyclists who use the center of a travel lane in order to avoid riding in the door zone.

Motorist Right Turn

There were 122 Motorist Right Turn collisions in daylight (including pulling into on-street parking). Only 11 of these clearly involved a motorist passing a bicyclist and then cutting in front. This action violates
both the rule for safe passing and the rule for making a right turn (see Appendix D). In the other cases, either the bicyclist was passing on the right or there was insufficient information to determine who was passing. In some cases, the motorist may have neglected to signal before turning as required by law. Signaling can help prevent collisions by warning bicyclists that it is not safe to pass on the right, or that it is safe (if the motorist is signaling left). There have recently been assertions that the motorist has a duty to stop and look to the rear for bicyclists approaching on the right in advance of a right turn. This assertion does not fit current law (see Appendix D). Whether or not it is the legal responsibility of the motorist to look and yield, it is clear that the large majority of these right-turn collisions could be avoided if bicyclists do not ride beside or overtake motor vehicles unless they are stopped and cannot move.\footnote{Or if the car ahead is signaling left, or if there are two general travel lanes and the car ahead is in the left lane and the bicyclist is in the right lane. The bicyclist also must take due care that the stopped car is not screening a pedestrian crossing or a left-turning motorist coming from the other direction.}

**Motorist Left Turn**

Close behind Motorist Right Turn in frequency in Table 9 is Motorist Left Turn. Sometimes motorists cause these collisions by underestimating bicyclist’s speed. In a few cases, the motorist apparently believed that the bicyclist was responsible for getting out of the way, even though the motorist was required to yield right of way. In 39 of the Motorist Left Turn cases, the bicyclist was overtaking a stopped motor vehicle on the right, which may have blocked the left-turner’s view.

**Motorist Failure to Yield (Drive Out and Signal Violation)**

In 51 cases, a motorist was entering a road in daylight (most from a stop sign, but others from a driveway, or turning right on red). Motorist traffic-light violations (running a red) accounted for a much smaller number of collisions—only five in all.

**Motorist Unsafe Overtaking**

There were 38 motorist-overtaking crashes in daylight, but in 11 of these cases the bicyclist swerved into the path of the motorist to avoid an object ahead. In all of the remaining 27 cases except one, the bicyclist was sideswiped, suggesting that the motorist saw the bicyclist but attempted to squeeze by where there was not enough room. The one crash that was not a sideswipe involved a motorist who was so obviously impaired that a witness was expecting a collision before it occurred. Although a direct hit from behind by a car is perhaps the most feared crash type, it occurred only once in daylight out of the 1,800 cases examined. This suggests that despite the potential speed differential, motorists rarely run into bicyclists directly in front of them in daylight, at least in urban areas. The other overtaking collisions—where the bicyclist swerved or the motorist squeezed by—are far less common than intersection collisions. Besides giving ample room when passing bicyclists—and slowing and waiting if it is not possible to pass safely—motorists can reduce this crash type by refraining from honking and threatening bicyclists who ride in the middle of a narrow lane, a bicyclist action that can discourage motorists from squeezing by, as well as allow bicyclists to avoid hazards ahead without swerving at the last moment.

Drunk driving (or other impairment) is a source of relatively few crashes (most after dark), but they often result in serious injuries. The number of such crashes may be underestimated because there may
have been several more among the hit-and-run cases. Driving only when unimpaired and undistracted is another way motorists can prevent bicyclist collisions—as well as many other injuries unrelated to bicycling.

**Motorist Merge / Wrong Lane**
The 34 cases in this group shown in Table 9 include 19 cases where a motorist made an unsafe lane change and struck a bicyclist in daylight. Motorists should not only look in rearview and side mirrors before making a lane change, but also look out of the side window to make sure that there is no-one beside them.

Making an unsafe U-turn was also a source of 10 motorist-caused collisions in daylight (plus 5 more in darkness). On Boston’s narrow streets, drivers making U-turns sometimes start from the right edge of the road, risking a collision with those approaching from the same direction – and also from the opposite direction who are not expecting the move. Boston traffic rules prohibit making a U-turn if it would cause another driver (or bicyclist) to slow or stop, but this law is little-known and rarely or never enforced. A safer statute would prohibit U-turns unless they can be made from the portion of the road closest to the centerline.

**Other Risk Factors**
Backing up also involves difficulty in seeing the road; backing motorists caused seven collisions with bicyclists.

There were 12 collisions where a motorist intentionally hit a bicyclist. Most of these seem to stem from a dispute over the bicyclist’s right to use the road. In two cases the motorist seems to have been prompted to attack because the bicyclist was not riding in an adjacent bike lane. These actions are criminal behaviors that should be treated as assault with a dangerous weapon, which is a felony.

**Infrastructure Risk Factors**
The vast majority of collisions can be explained by a road user error, typically a statutory violation. There were also a few injuries reported related to infrastructure:

- Some of the Bicyclist Lost Control crashes were related to road defects such as trolley tracks and potholes.
- In a few intersection collisions, the bicyclist may have lawfully entered on green or yellow but could not complete crossing before the signal changed to green. Extending the all-red clearance interval at such long intersections could reduce this type of problem.
- There was one case that seems to be related to the poor road design and short merging space on Charles Street South where it intersects with Stuart Street.
- Although not clearly noted in the narratives, there may be cases where on-street parking creates poor visibility from side streets, and entering motorists cannot see approaching bicyclists unless the motorist has already nosed into the roadway (or bike lane).
- It could be argued that bike lanes mostly or completely within the door zone create a hazard by encouraging bicyclists to ride too close to parked cars—and creating the impression that they
are legally required to do so. It could also be argued that bike lanes facilitate and encourage bicyclists to pass on the right.\textsuperscript{18}

\section*{Citations Issued}

Many of the crash-typed incidents involved a clear violation of law on the part of a motorist, bicyclist, or pedestrian. Nonetheless, out of 1,797 incidents, there were only 144 cases where a citation, summons, arrest, or warning was given to any party involved—only 8\% of cases (see Table 4). In 94 of these 144 cases, a motorist was cited for violating a rule of operation; in 23 other cases the motorist was cited not for a traffic offense, but only for failure to be operating an insured and registered vehicle while in possession of a valid operator’s license. The police officer took action against a bicyclist in only 24 cases, of which 7 were warnings, 3 were criminal offences, and 2 were violations of city regulations. Thus in only 12 cases was the bicyclist issued a citation for a moving violation. Finally, in one case not otherwise counted in these totals, both the motorist and bicyclist were arrested for assault and battery.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{Cases Where Citation(s) Given} & 144 & 8\% \\
\hline
....to motorist, operating rule & 94 & 5\% \\
....to motorist, insurance, registration, or license & 24 & \\
....to bicyclist, operating rule & 12 & <1\% \\
....to bicyclist, warning only & 7 & \\
....to bicyclist, criminal offence & 3 & \\
....to bicyclist, city regulation & 2 & \\
\hline
\end{tabular}
\caption{Table 12: Citations Issued}
\end{table}

Although only 8\% of cases involved police action (citation, summons, arrest, or warning), there were many more cases where the police could have taken such actions. Many of the police incident reports describe violations confirmed by witnesses or admitted to by participants, with no indication of citations issued. In fact, almost all of the crash types, by their description, involve a violation of the traffic laws by one party or the other. The chief exception is the “bicyclist lost control” crash types, and even there the bicyclist could be cited if the loss of control was due to failure to have working brakes.

In some cases, it would not have been possible to give a citation because the identity of the violator was unknown. Specifically, there were 40 cases where the bicyclist fled the scene, and there were 208 cases where the motorist fled the scene. Only 10 of these motorists were later identified and cited, one for operating with an expired registration, two for failure to yield to a “pedestrian,” one for “Failing to use care when stopping or starting and making a right turn from left turn only lane,” and six for leaving the scene of an injury accident.

\textsuperscript{18} If a bike lane were considered by all to be a lane of travel, then bicyclists would be protected by the traffic rule that requires a right turn to be made from the right-most lane, not the next lane over, and the rule that requires yielding before making a lane change. However bike lanes are too narrow for motorists to treat them as true lanes.
Appendix A: Coding Methods

Table 4 shows the source of the crash report. The vast majority of the reports were made following calls made to police via the E911 system. In this case the officer arrives at the scene after the incident and attempts to collect data from participants and witnesses, and to make observations about the condition of the vehicles involved. The next most common are walk-in reports, where someone went into a police station to make a report. The third most common are “on-site” cases, where the officer happens to be in the vicinity when the incident occurs and either witnesses the crash event or comes upon it soon after it occurs. In most cases where an officer was on the scene (either responding to a 911 call or already on site), there was enough information in the crash narrative to determine the circumstance of the collision, although frequently this had to be supplemented by further research. For example, there were numerous incidents where the narrative did not note that the bicyclist was traveling the wrong way, but the fact could be deduced by comparing the bicyclist’s reported direction of travel to one-way street designations. Google Maps with Street View was used for this purpose, and also for determining if intersections were controlled by stop signs, yield signs, or traffic signals if not otherwise mentioned in the narrative. In the smaller number of walk-in reports, typically very little information about the crash circumstances was provided, and in many cases it was not possible to determine the crash type. Of the 174 walk-in reports, 32, or 18%, were coded “unknown” compared to only 5% of incidents reported by other means.

Table 13: Source of Crash Report

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>E911</td>
<td>1362</td>
</tr>
<tr>
<td>ON-SITE</td>
<td>136</td>
</tr>
<tr>
<td>PHONE-IN</td>
<td>18</td>
</tr>
<tr>
<td>WALK-IN</td>
<td>174</td>
</tr>
<tr>
<td>Unknown</td>
<td>107</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>1797</strong></td>
</tr>
</tbody>
</table>

In addition to incomplete reporting, determining the circumstances of the crash was also made more complicated because of lack of access to crash diagrams, and because many words of the narrative made publicly available were removed in order to prevent identification of the individuals involved. The de-identification process, described in detail in the city’s report, involved using computer logic to remove from the crash narratives all numbers, words that are not in the dictionary, and the words that appear least often, considering all the narratives together. The missing words were replaced with the letter “x” substituting for each missing character (except in the case of names of people, which were uniformly replaced with “xxx”). In terms of understanding the circumstances, the largest problem was the removal of street names. Fortunately, the data file includes an address field. By finding this location on the map, and using the street suffix (St, Ave, etc) and the number of characters in the street name (e.g. “xxxxx” denotes a street name with five letters), it was in most cases possible to verify the location of the collision. The address field in the data is not necessarily the crash location, but rather the location given to the 911 system. In several cases this differed from the actual crash location as described in the
narrative because a) the actual crash was at a nearby intersection (commonly), b) the wrong address was given to the system, or c) the victim was no longer at the location where the crash occurred (rarely). In several cases where the “address” field was left blank, it was possible to determine the location based on the crash narrative. The deduced street names and other missing words were inserted into our working version of the crash database, which is available upon request.

In addition to determining the crash type following the PBCAT coding scheme, the following additional fields were coded based on the narratives supplemented by map investigation:

- Bicyclist direction of travel (with or against traffic flow);
- Bicyclist using crosswalk, sidewalk, or bike path;
- List of any citations given (to bicyclist or motorist);
- Whether motorist (or bicyclist) left the crash scene without providing identification (hit and run);
- Whether the crash occurred on a bike lane or path;
- Bicyclist injury level (0=none, 1=yes but no help accepted, 2=treated at scene by EMS, 3=transported to hospital, 4=fatal, 5=medical help but not by EMS, 8=serious injuries, 9=unknown).

**Codes Added to PBCAT**

The PBCAT system is primarily based on coding bicycle-motor vehicle collisions, even though, as noted, they account for only a minority of bicyclist injuries. The reason for this gap is that in most U.S. states only crashes involving motor vehicles are included in crash reports. The BPD dataset is based on police incident reports, not crash reports, and thus includes a number of cases not involving motor vehicles, although they represent less than 10% of the total. PBCAT has a single “bicycle only” code (code 400). This was supplanted by adding “410 Bicyclist strikes pedestrian” and “420 Bicyclist strikes other bicycle.” For cases where the bicyclist fell due to roadway conditions, improper braking, or impairment (e.g. drinking), one of the pre-existing PBCAT “bicyclist lost control” codes was used. In some of these cases the bicyclist collided with a motor vehicle (often a parked vehicle).

Several existing PBCAT codes were divided into more detailed categories. Code 213, Motorist Right Turn-Same Direction, was divided into cases where there was evidence that the bicyclist was riding beside or overtaking the motorist (213.5) and cases where there was evidence that the motorist was overtaking (213.6). If it was not possible to tell from the crash narrative, the original 213 Motorist Right Turn-Same Direction code was used. Similarly, a “bicyclist on parallel sidewalk” subtype (214.5) was created for Code 214, Motorist Right Turn-Opposite Direction. If the bicyclist was on the roadway (that is, if there was no evidence her or she was on the sidewalk), the original Code 214 was used. Code 215, Motorist Parking, was divided into Motorist Pull into On-Street Parking and a new code 215.5, Motorist Drive Out from On-Street Parking.

In addition, the following crash types were added:

- 165 Bicyclist Ride Out, Unsignalized Crosswalk
• 170 Bicyclist Ride Out, Wrong Way on One-Way Street
• 270 Motorist Unsafe Lane Change
• 271 Bicyclist Unsafe Lane Change
• 290 Motorist Made a U-turn

The first code was used for situations where there was a crosswalk not controlled by a traffic signal and the bicyclist was crossing the street (perpendicular to traffic flow). Although pedestrians have the right of way in unsignalized crosswalks, they may not leave the sidewalk so suddenly that a driver does not have time to stop. This pedestrian rule applies to bicyclists using crosswalks (see Appendix C).

The second new crash type, 170 Bicyclist Ride Out, Wrong Way on One-Way Street, applies to the case where a bicyclist is approaching an intersection from the wrong direction on a one-way street. The bicyclist would not see a stop sign or other traffic control because no traffic is supposed to be coming from that direction.

The next two new crash types, 270 and 271, apply to cases where either the bicyclist or motorist is changing lanes and collides with another party in the new lane. The final crash type applies to the situation where the motorist was making a U turn. The bicyclist may be approaching in the same original direction as the motorist, or, more likely, the bicyclist may be approaching on the opposite side of the street (in the new direction). In a few cases, the bicyclist was traveling against traffic.

The data from the crash narratives, supplemented with other information in the data file and with map and Street View information from Google Maps, was used to make a determination as to the most likely crash circumstance. While in most cases there was only one possible code, in other cases there was more than one code that fit the situation. However these relatively few instances of judgement calls do not affect the overall analysis much because the 95 separate codes were later grouped into 21 categories for ease of explanation.

If it was impossible to determine the circumstances, the crash was coded as one of several “unknown” types. If it was clear the crash occurred at an intersection, one of the following crash types was used:

• 148 Sign-Controlled Intersection—Other/Unknown
• 158 Signalized Intersection—Other/Unknown
• 180 Crossing Paths—Intersection—Other/Unknown Control

If it was unknown if the bicyclist and motorist were on parallel or crossing paths, or if the location was unknown, the following codes were used:

• 970 Unknown Approach Paths
• 980 Unknown Location

**Crashes Excluded**

Eleven case reports in the database were excluded from the final tally. One was a duplicate entry for a fatality (Kelsey Rennebohm), as described in the section on fatalities. The remaining ten were excluded because they did not involve a person riding a bicycle. These incidents instead involved the following:

22
• motorcyclist and passenger car (B2597)
• motor scooter and pickup truck (B2086)
• child who had been riding a bicycle ran across the street (B1209)
• person walking a bicycle on the sidewalk hit by car that swerved onto sidewalk (B1543)
• pedestrian walking a bicycle across the street (B1787)
• bicyclist sitting on a bicycle, not riding it (B1466, B1565)
• bicycle parked on sidewalk hit by car (B1558)
• a pedestrian and two cars (but no bicycle involved) (B1670)
• bicyclist went to police station to retrieve bicycle, no other information (B1699)

There were 1797 reports remaining after excluding these 10 that did not involving injuries sustained while bicycling (plus the one duplicate).

Crashes Involving Multiple Bicyclists
In a small percentage of cases, two or more bicyclists were involved in an incident, and in some cases both were injured. These include a few “dooring” cases where the leading bicyclist struck the opening door and the following bicyclist collided with the leading one. The totals reported below for each crash type represent the number of cases, not the number of bicyclists involved, although in most cases only one bicyclist was involved. Note also that in a significant number of cases the bicyclist was uninjured or had minor injuries (although in some of these another party, such as a pedestrian, was injured).
Appendix B: Police-Reported Crashes by Crash Type

In the sections below, crashes are organized by crash type in descending order of crash frequency, with the number of collisions listed in parentheses following the section title. The four-digit numbers beginning with B (e.g. B1001) are references to the case numbers as designated in the file. A spreadsheet listing individual crash cases and their codes is available by request.

Bicyclist Doored (208)
PBCAT code: 244

“Doorings” were the single most common crash type, accounting for 12% of crash-typed cases.

Who Opened the Door?
Usually, the bicyclist struck a door opened by the driver on the driver’s side. However, in some cases a passenger in a rear seat opened the door, and in 28 cases the bicyclist struck a door opened on the passenger side, as happens when the bicyclist is overtaking a stopped car on the right, and either a passenger decides to get out in the travel lane, or the driver pulls over but not all the way to the right, in some cases deliberately avoiding pulling into a bike lane. In two cases, a bicyclist on the sidewalk struck a door on the passenger side.

In another two cases, the bicyclist didn’t strike the door, but braked or swerved in an attempt to avoid the door, and then fell or collided with a different car. No cases were reported in which a bicyclist was knocked to the ground by an opening door and then struck by an approaching vehicle. Such incidents have occurred, including a fatality in Central Square, Cambridge in 2002.

In two cases, the car door was opened by BPD officers exiting police vehicles. In another case, a BPD officer on a bicycle struck an opening door, and his partner riding close behind ran into him; both fell and were injured. There were two other cases where two bicyclists were injured in the same dooring incident.

Could the Bicyclist Have Prevented the Crash?
Bicyclists can avoid doorings by riding outside the range of opening doors. Also, in a handful of doorings, there was evidence that the door was already open and the bicyclist should have seen it, and avoided it by stopping or merging out of range. But in the vast majority of cases, the door was opened so suddenly that there was little or nothing the bicyclist could have done to avoid striking it.

Could the Motorist Have Prevented the Crash?
In a few cases, the person opening the door claims to have looked first but not seen the bicyclist approaching. When the incident happened at night and the bicyclist did not have a headlight, this claim is credible; even with streetlights, a bicyclist without a headlight can be very difficult to see, especially in the glare of headlights from motor vehicles. In two of the 43 cases of bicyclists who struck opening doors after dark, it was noted that the bicyclist did not have headlights:

- The motorist “stated he was about to exit his m/v that was parked at the curb and opened his door. He did not see the victim who was traveling in the bike path [lane].
The victim could not stop in time and struck the opening door. The victim fell to the ground and received several lacerations to the face. . . . The victim was not wearing a helmet and had no lights or reflectors on the bike." (B1244)

- The bicyclist “was in a marked bike lane without aid of any lights on his bike.” (B2252)

In another case, the driver said she “looked in her mirror [and] didn’t see any car coming.” Since this happened after dark, presumably she was looking for cars based on headlights, and would have seen the bicyclist if he had a light (although the report, like almost all others about crashes which happened after dark, did not mention whether the bicycle had a headlight or not) (B2794).

However, 163 of the 208 doorings (79%) happened during the day. This is one of the highest shares of daylight incidents of any crash type. For doorings in daylight, the most likely explanation for the collision is that the motorist simply failed to look before opening the door (and the bicyclist was riding within range). Even though a law that took effect in 2009 (at the beginning of the data collection period) makes it unlawful to open a door on the side available to moving traffic when that is not safe, many people do not expect moving traffic to be passing so close to their parked vehicle, especially when cars are stopped in traffic in the travel lane, or when opening a door on the right side. In a few cases, the crash narrative specified that the bicyclist was passing between stopped and parked vehicles. In some of these cases, the bicyclist first struck the door of a parked vehicle and then collided with a standing vehicle adjacent.

**Dooring locations**

Nearly 25% (51 of 208) of the dooring cases occurred when the bicyclist was in a bike lane. Most bike lanes in Boston are adjacent to on-street parking. In many cases, the parking lane is 7 ft wide and the bike lane is 5 ft wide. The width of passenger cars ranges from 5 ft 6 in to 6 ft 8 in (but trucks can be as wide as 8 ft 6 in), exclusive of side mirrors. Vehicles can be parked legally 1 ft from the curb. A fully opened door can extend up to 3 ft 9 in from the side of a car. Bicycle handlebars can be 2 ft wide, and bicyclists need at least a foot of additional operating space. With these dimensions, a bicyclist riding in the center of the bike lane is well within the range of an open door, and even a bicyclist in the leftmost part of the bike lane may be within range. It is necessary to ride with a wheel on the left lane stripe--halfway out of the bike lane--to be completely outside of the door-opening zone. The range outside of the door zone begins at 11 ft from the curb, so the bicycle tire must be 12 ft from the curb--on top of the left bike lane line--for the bicycle handlebar to be clear of the door zone.19

**Citations**

Only 11 citations and two written warnings were issued to drivers in these 208 cases for opening a door unsafely. In one case, a bicyclist was given a warning for “illegally passing a motor vehicle” in addition to a warning given to the driver for unsafely opening the door.

**Motorist Left Turn (197)**

PBCAT codes: 211, 212, 212.5 (new)

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19This was the conclusion of NCHRP Report 766, *Recommended Bicycle Lane Widths for Various Roadway Characteristics*, which is also the source for the maximum width of an open door.
The second most common crash type involved a motorist turning left at an intersection or driveway. In most cases (173 of 197, or 88%), the bicyclist was approaching from the opposite direction. However, in 24 cases, the bicyclist was traveling in the same direction as the motorist; most of these cases (18 of 24) involved bicyclists riding against traffic. Six of the 18 riders who were facing traffic were riding on the sidewalk. In the remaining six of the 24 same-direction cases, the bicyclist was on the correct side of road, overtaking on the left side of a left-turning motor vehicle.

Yielding Rules
Generally, a driver turning left is required to yield. The exception is at a signalized intersection with a left green arrow. When there was information in the case narrative that a left-turning motorist was facing a left green arrow, the crash was classified as a bicyclist signal violation. However, in some cases it was not clear whether the motorist was facing a circular green or a green arrow (for example, B1375, B1079, B1941, B1949, B2270, B2278). Most intersections in Boston which have a left green arrow also permit left turns on circular green. In some cases, the bicyclist sees that cross traffic is stopped and thinks that it is safe to proceed on a red signal, only to find that there is a motorist turning left (see examples below under Bicyclist Signal Violation).

Effect of Bicyclist Behaviors
Although the motorist is required to yield, there are several bicyclist behaviors that make it harder to yield:

- **Bicyclist wrong-way on one-way street.** In four cases, the bicyclist was entering the intersection approaching from the wrong direction on a one-way street (from where there should not be any traffic to yield to). In two of these four cases, the bicyclist was in the crosswalk.
- **Bicyclist on sidewalk.** A bicyclist approaching the intersection on the sidewalk is not within the primary field of vision of motorists looking to yield to oncoming traffic, and also may be obscured by parked cars or other objects on the sidewalk. In 14 cases, the bicyclist was approaching on a sidewalk or bicycle path.
- **Bicyclist passing on the right.** In 39 cases, there was evidence that the bicyclist was passing on the right of traffic that had stopped to permit the left-turning motorist to cross. This often happens when traffic is backed up, and motorists who have the right of way to go straight cannot continue because the other side of the intersection is already occupied with stopped traffic. The stopped traffic screens the view of the turning driver, and the bicyclist’s view of the motorist. In 10 of these 39 cases, the bicyclist was in a bike lane.
- **Bicyclist not using headlight after dark.** In 45 cases, the crash occurred after dark (between sunset and sunrise). If the bicyclist failed to use a headlamp, as required by law, the motorist may not have yielded because he or she did not see the bicyclist in time. The motorist’s headlights would not be shining on a bicyclist’s front reflector.

Bicyclist’s Use of Headlight
Although in most cases the police officer recording the incident did not check or ask whether the bicycle was equipped with a headlight, there were three cases where it is clear that the lack of a headlight was the problem:

- After interviewing both parties, the police officer reported that the bicyclist saw the vehicle making the turn and thought the driver would yield, but in fact the motorist did not see him. The officer noted that the bicycle had “front and rear reflectors” but did not have any lights. (B1189)
- In another case, the officer wrote that the motorist told the bicyclist, ”I didn’t see you. You should have lights on your bike.” (B1819)
- In a third case, the officer noted that the driver said he did not see the bicyclist, and the officer saw that there were no lights on the bicycle. Despite this finding, the officer issued a citation only to the motorist, and not to the bicyclist (B1678).

Additional Risk Factors
After subtracting incidents involving the four factors listed above, there were 72 cases of left-turning motorists striking an opposite-direction bicyclist traveling in the correct direction on the roadway in daylight. How can these crashes be explained?

- **Sun glare.** In 12 cases, the crash happened within an hour before sunset or an hour after sunrise. At these times, the low sun can blind a driver who is looking directly into it. Two crashes where sun glare was specifically mentioned were B1045 and B1617. In a third that happened exactly at sunset, the motorist reported that she “did not see the victim but heard him hit the side of her vehicle.” In another case, the motorist “reported that the sun got in his eyes as he was turning and he did not see the bicyclist until after the collision.” (B1025)
- **Motorist underestimated bicyclist’s speed.** At least eight of the crashes occurred when the bicyclist was approaching from a down-sloping roadway (B1025, B1207, B1822, B2258, B2339, B2343, B2585, B2736). Three of these were at the same location, St. Alphonsus Street and Smith Street (B1025, B1822, B2339)
- **Motorist tried to yield.** In these cases the motorist stopped after crossing the centerline but before completing the turn, and the bicyclist ran into the stopped car. (B1663, B2554)
- **Motorist expected bicyclist to yield.** In a few cases, the motorist’s statement makes clear that he or she expected the bicyclist to yield (contrary to the traffic law). In one case, an ambulance driver said he was “making a legal turn” but the bicyclist was “not paying attention.” (B1282). In another case, a taxi driver observed the bicyclist “previous to initiating the left-hand turn, and believed that he was going to stop” (B1664). (In neither of these cases was a citation issued to the motorist despite their statements and despite the presence of a no-left-turn sign in the latter case.)
- **Motorist playing follow the leader:** In one case, the motorist was following behind another left-turning vehicle without checking for oncoming traffic (B2643).

In the 48 remaining cases, either there was not enough information provided to determine whether any of the above circumstances applied, or the motorist simply did not look carefully.
Motorist Drive-Out (194)
PBCAT codes: 141, 143, 147, 151, 217, 321, 322, 329

The third-most-common crash type involves a motorist’s failing to yield when pulling into the roadway at a stop sign, flashing red signal, or driveway without yielding to the bicyclist approaching from a crossing direction. A motorist turn at a red signal also falls into this category, as the legal requirement changes from waiting for the green signal to yielding to approaching traffic.

Bicyclist Opposite the Flow of Traffic
In 85 of 194 cases (44%), the bicyclist was operating against the flow of traffic. In 30 of these 85 cases, the bicyclist was opposite the flow of traffic on the sidewalk, and in the remaining 55, the bicyclist was on the road facing traffic (or going the wrong way on a one-way street). In the other 109 cases, the bicyclist was traveling with the flow of traffic either on the sidewalk (34 cases) or road (75 cases).

Operating against the flow of traffic is a major risk factor for this type of collision. The motorist is looking left for approaching traffic, and seeing none, begins to turn to the right. The bicyclist approaching on the right (on the wrong side of the road) may see the car sticking out, but has no easy escape route, and the two are heading for each other. (This is very similar to the “head on” collision type discussed below, since many of these involve a motorist who has just turned a corner and therefore did not see the bicyclist until too late.) Wrong-way cycling is such a common risk factor in the “Motorist Drive Out Sign-Controlled Intersection” crash type that the crash type illustration in the PBCAT manual depicts a wrong-way bicyclist (see Figure 1).

Bicyclist Using the Sidewalk
Bicycling on the sidewalk is also a risk factor for this type of collision. Frequently, a motorist approaching a sign-controlled intersection will not stop at the crosswalk unless there is already a pedestrian in the crosswalk. The motorist stops at the point where he or she can see traffic approaching on the roadway, which may be a car-length ahead of the crosswalk, particularly when on-street parking obscures the view. As discussed in Appendix B, although a pedestrian in a crosswalk has the right of way, the pedestrian may enter the crosswalk slowly enough that an approaching driver has time to yield. When
bicyclists use the sidewalk, they should follow the pedestrian rules: since bicyclists travel much faster than pedestrians, they should look and wait at every crosswalk to make sure that no one is approaching fast before entering.

**Examples**
The following are typical examples of Motorist Drive-Out collisions, the first involving a wrong-way bicyclist on the roadway and the second a wrong-way bicyclist on the sidewalk:

- The motorist “stated that after she checked for pedestrian traffic, she xxxxxxxx forward looking left for oncoming traffic on Commonwealth Ave” and “as she was stopped and looking left her [right side] vehicle door was struck” by the bicyclist. (B1026)
- The bicyclist “stated she was traveling inbound on Commonwealth Ave while riding her bicycle on the sidewalk. The victim approached University Rd then came to a complete stop before entering the crosswalk. The victim stated she observed a vehicle . . . approach the intersection and came to a complete stop. The victim thought the operator had seen her to his right so she began to cross in front but was struck as the vehicle also proceeded at the same time.” (B2049)

A total of 43 of the 194 cases, 22%, occurred in hours of darkness (between sunset and sunrise). However, when the bicyclist was operating on the road in the direction of traffic 25 of the 75 drive-outs (33%) occurred after dark; otherwise (when the bicyclist was facing traffic or on the sidewalk or both) only 18 of 119 (15%) occurred after dark. In the first situation, the bicyclist is approaching from the expected position, but may be hard to see if not using a headlight at night. In the second situation, the bicyclist’s unexpected position is the major factor in explaining the crash (although darkness surely makes the bicyclist even harder to see).

**Other Scenarios**
Other Motorist Drive-Out scenarios include:

- Bicyclist going downhill unexpectedly fast (7 cases).
- Bicyclist passing traffic on the right that has stopped to let a car enter from a side street (B1337, B1408, B2727).
- Poor visibility due to parked cars (B2356, B2372, B2650) or intersection design (B2001, B2046, B2241).
- Motorist protrudes into the bike lane while attempting to make a right on red (1 case).

**Citations**
In a few of the nearly 200 Motorist Drive-Out cases, the crash narrative noted that citations were given to motorists for moving violations, including:

- Failure to yield to a pedestrian (10 cases)
- Failure to yield at intersection (7)
- Failure to come to a complete stop at a stop sign (1)
- Failure to stop when turning right on red (1)
- Failure to yield when turning left (1)
• “Failure to slow for bicyclist” (1)

Three motorists were cited for operating without a license, and one for operating without a license in possession.

There were only three moving violations issued to bicyclists, one for operating the wrong way, one for “Failure to stay on the right when passing and failure to stay within marked lanes” given to a wrong-way bicyclist, and one for an unspecified “violation of the bicycle laws” given to another wrong-way rider. There were also three warnings given to bicyclists (one for sidewalk riding, one for wrong-way riding, and one for unsafely carrying a child on a bicycle).

Motorist Right Turn (162)

PBCAT codes: 213, 214, plus modified codes 213.5, 213.6, 214.5

Incidents where a bicyclist and motorist were initially on parallel paths and then the motorist turned or merged right across the path of the bicyclist were the fourth most common crash type. Among bicyclists, this crash type is commonly known as a “right hook.”

**Motorist Overtaking and Turning Right**

This crash type is generally thought of as involving the motorist’s overtaking the bicyclist, and then turning right suddenly (instead of first merging back to the right without interfering with the bicyclist, or waiting instead of overtaking).

The following are examples of the motorist overtaking variant:

- “The victim [bicyclist] stated that the operator of a newer silver Acura sped up to pass him, then made a sharp right turn on to Alcorn St. The victim stated that his bicycle struck the car, knocking him to the ground, and was nearly run over as the car continued onto Alcorn St. The operator of the vehicle stopped briefly, then continued on Alcorn St. toward Gardner St.” (B1274)
- “Mr. xxx reports that he was riding his bicycle in the marked bicycle lane on Commonwealth Av inbound, as he was nearing the intersection of Commonwealth Av and Pleasant St, a gray pick-up truck . . . suddenly increased speed and made a right turn onto Pleasant St without using the right directional signal. Mr xxx reports that he rode into the right rear quarter of the pick up truck and then fell to the ground on his bicycle. Mr xxx further reports that the occupants, described as four white males in their xxxxxxxxxx turned and looked at him and laughed, the operator then sped off without stopping.” (B1461)

**Bicyclist Overtaking**

However, there is another type of “right hook:” the bicyclist is approaching on the right side of slow traffic, or riding alongside, and the motorist initiates a right turn without noticing the bicyclist’s presence. The review of the 162 cases shows that the latter situation is far more common. In only 15 cases was there evidence that the motorist was passing, such as a statement to that effect from the
bicyclist or a witness. In 74 cases there was evidence that the motorist was in front and the bicyclist was overtaking on the right, such as a statement from the bicyclist that he or she was riding beside the car, or from the motorist that he never saw the bicyclist until the collision.

The following are examples of the bicyclist-overtaking variant:

- “The operator stated he was taking a right hand turn onto St. Paul Street at a slow rate of speed when a bicyclist struck the front passenger side of his vehicle. . . . Officer spoke to numerous witnesses to the accident, all of whom believed the vehicle operator did nothing wrong. Witnesses stated the bicyclist was traveling extremely fast, weaving through traffic and pedestrians, both on and off the sidewalk. Witnesses also believed the bicyclist appeared to try and beat the vehicle to the turn and almost cut him off, until he collided with the vehicle.” (B1052)
- “Operator stated that as he was attempting to make a right turn onto Amory Street, the front passenger side of his vehicle was struck by a bicyclist . . . who was riding in between the vehicles in the right lane and the parked cars and was attempting to go straight.” (B1165)
- “The operator of the jeep . . . stated that she signaled for a right turn and began the turn. She stated that she did not see the bicyclist beside her. As she made the turn, she heard a scream and turned her head to the right and observed the victim fall to the ground” (B1341)
- “Officers spoke to the victim . . . who did state that she was traveling inbound on Commonwealth Avenue on her bicycle in the marked bicycle lane, when she saw a white T van, which was traveling next to her, take a right turn into a driveway and at that point she and the van collided.” (B2188)
- “Mr. xxx relayed that he was travelling eastbound on Commonwealth. He stated that he was travelling in the ‘marked’ bicycle lane alongside Ms. xxx. It was at this point when Ms. xxx attempted to turn right onto St. Paul St.”

In all, there were five bicyclist overtaking cases for every one motorist overtaking case. In 44 cases there was not enough evidence to determine whether the bicyclist or motorist was overtaking.

Cyclist in Crosswalk

There were also 18 cases where the bicyclist had been riding on the sidewalk and collided with a motor vehicle in the crosswalk. When a bicyclist is operating on the sidewalk, he or she is not in the same operating space as motorists, and overtaking rules do not apply. Instead, pedestrian rules apply to sidewalk (and crosswalk) bicyclists. The relevant rules concern right of way at intersections and driveways, where turning drivers generally must yield to pedestrians. At the same time, pedestrians must not enter the intersection so fast that a driver cannot yield. Because bicyclists, even slow ones, travel at least three times the speed of pedestrians (3 mph for pedestrians, 9-12 mph for slow bicyclists), in order to comply with the intersection rules, sidewalk bicyclists must stop, or at least slow, and check for approaching motorists at every intersection and driveway, but many do not do this.
In the City of Boston, many signalized intersections are set to show a walk signal in an exclusive phase, that is, only when all other traffic is facing a red signal. If sidewalk bicyclists cross on an exclusive phase, in theory there is no conflict from turning traffic. However, sometimes there is no sign prohibiting turn on red where there is an exclusive phase, and sometimes motorists ignore these signs. In other cases pedestrians and sidewalk bicyclists go when the cross traffic is stopped, even if they are facing a Don’t Walk signal. In this case, the crash should be classified as a bicyclist signal violation (ride-out) rather than motorist right turn, but frequently the crash narrative does not say whether the bicyclist was crossing on a pedestrian green (walk) signal. There are also many intersections in Boston where the pedestrian phase is concurrent with the parallel vehicular green.

There were another 11 motorist right turns involving a bicyclist traveling against traffic. In six of these cases the bicyclists had been using the sidewalk.

**Cyclist in Bike lane**
There were 42 cases of motorist right turns where the bicyclist was in a bike lane (plus one wrong-way in a bike lane). In 23 of these, the bicyclist was riding alongside or overtaking the right-turning car, compared to only four cases where there was evidence that the motorist was overtaking the bicyclist (and 14 where it was unclear, and one where the bicyclist was on the sidewalk facing traffic but there was a bike lane on the road). Motorists who wish to turn right are required to merge into the bicycle lane in advance of turning. (The relevant laws are listed in Appendix B.)

**Citations**
In 18 of the right-turn cases, the motorist left the scene. Of the remaining 144 cases of Motorist Right Turn, in only eight cases were motorists cited for moving violations. The violations given were:

- failure to yield to the bicyclist when turning right (2);
- failure to use turn signal (2);
- failure to yield to pedestrian in crosswalk (1);
- unsafe lane change (1);
- operating bus where not permitted (1);
- unknown (1).

Only one of these citations involved a bicyclist in a bike lane (one of the two turn signal violations). In one case where the bicyclist was overtaking on the right, the officer stated he “did not find cause for citation of [the truck driver], as he had the right of way, making a right turn from the right lane.” Among the Motorist Right Turn cases, there was only one example of a citation given to a bicyclist—for going the wrong way on a one-way street. In one other case, the bicyclist was “advised that he is required to walk his bicycle through crosswalks if he intends to use them as a pedestrian.” (This advice does not accurately reflect the traffic law, although it is true that pedestrians and sidewalk bicyclists must not enter the intersection at speed, as discussed.)

Not one motorist was cited for improper lane use, whether there was a bike lane or not. Nor was there any indication that police officers asked any motorist if, in advance of turning right, whether he or she
stopped, checked the right side mirror, and looked out the right side window for bicyclists alongside or approaching from the right. As noted in Appendix B, yielding before turning right is not required by law, nor is it always feasible, especially for truck drivers.

**Right Turn Fatalities**
There was one right-turn fatality during the data collection period, involving a tractor-trailer truck turning right from Commonwealth Avenue eastbound to St. Paul Street, which is on the downhill segment. This incident, the death of Chris Weigl on December 6, 2012 (not described in the police incident reports, but reported in the media), is unusual in that the truck driver apparently started his turn from the second travel lane from the right. There were three more bicyclist fatalities involving right-turning trucks in Boston in the three years following the data collection period, on Beacon Street (Back Bay), Cambridge Street (Charlestown), and Massachusetts Avenue (Back Bay); there were bike lanes present at all three locations.

When a truck is involved in a right-turn collision there are some differences compared to when a passenger car is involved:

- The truck driver needs to start the turn further to the left, typically the leftmost part of the right lane, although in the Weigl case the truck driver started in the next lane, probably because St. Paul St. is narrow and has parking very close to the intersection.
- Trucks generally have significant blind spots to the right which make it difficult or impossible to see a bicyclist beside the trailer.
- When a truck completes the turn, the rear of the trailer shifts toward the curb, possibly trapping an unwary bicyclist.
- Bicyclists can easily get knocked to the ground by the moving trailer, then, once lying on the ground, crushed by the rear wheels as the truck completes the turn.

This last point explains why these types of collisions frequently result in serious or fatal injuries. In the study period, of the nine fatalities, five involved trucks or buses.

**Bicyclist Traffic Signal Violation (160)**

**PBCAT codes: 153, 155**

The fourth-most common crash type involved a bicyclist entering a signalized intersection on a red signal. The signal violation was frequently corroborated by witnesses, or even admitted by the bicyclist. There are a few special situations that in some cases help explain the reason for the violation:

**Wrong-Way Bicyclist**
Wrong-way bicyclists often can’t see traffic signals, especially when entering from a one-way street the wrong way, and so don’t know when it is safe to enter the intersection. In 27 of the 160 Bicyclist Traffic Signal Violation crashes, the bicyclist was operating facing traffic or the wrong way on a one-way street. In 19 of these, the bicyclist was on the road and in the remaining 8 the bicyclist was on the sidewalk.
**Waved on by Driver**

Several of the collisions happened at signalized mid-block crosswalks, many along the Southwest Corridor bicycle path (e.g. at Ruggles Street). In many of these, the bicyclist entered the intersection against the signal when a motorist unnecessarily yielded, only to be struck by a second motorist in the next lane whose view was screened by the first one, and who was approaching on a green signal (B1824, B2479, B2495 and B2553 maybe B2669, B1049, B1060). In another case, the bicyclist was making a U-turn at a signalized midblock crosswalk, also along the Southwest Corridor (B1666). In two other cases not at a midblock crossing, a bicyclist was waved on by a driver stopped in the lane only to be struck by another motorist approaching (B1029, B2622). In one and possibly both of these cases, the bicyclist was using a crosswalk.

**Sidewalk or Path Crossing**

In 41 cases, the bicyclist was on the sidewalk or bike path (eight were facing traffic). It is very common for pedestrians in Boston to ignore pedestrian signals. There are two main reasons why there may be more noncompliance than in other parts of the U.S. First, most signalized intersections in Boston will only display a pedestrian signal (WALK or upraised hand) in an exclusive phase, typically on push-button activation only. Pedestrians are thus required to wait a long time at every intersection in order to cross legally. In some cases, they must wait even though there is no conflicting turning movement (when crossing a one-way street that is entering the intersection). The second reason is that the maximum penalty for crossing illegally is $1, rising to $2 on subsequent offences and enforcement is nonexistent. Bicyclists using the sidewalk are likely to ignore signals for the same reasons.

Bicyclists, and perhaps police, may be unclear about the meaning of crosswalks at signalized intersections. In one case (B1349) the police officer reported that the bicyclist “stated he was riding his bike about to cross Belvidere St. in a marked crosswalk. The victim was unsure if he stopped to look both ways for oncoming traffic.” The police officer apparently also asked the motorist if the bicyclist was in the crosswalk; the motorist “stated that the victim came right out from the sidewalk without stopping, striking the front bumper, and [going] up over the hood cracking the windshield. [The motorist] did state that the victim was in a crosswalk.” The motorist also said that he had been traveling on Belvidere Street, not turning on to it. Although not mentioned in the narrative, Huntington Avenue and Belvidere Street intersect at a signalized intersection, so that there is no need for a sidewalk bicyclist to “look both ways for oncoming traffic” if he waits for the walk signal.

**Left-Turn Arrow**

In seven cases, the bicyclist saw that cross traffic was stopped, proceeded through the red signal, and then was struck by an opposite-direction motor vehicle turning left on a left arrow (B1002, B1045, B1299, B1649, B1962, B2288, B2609). In at least one of these cases, the bicyclist’s thoughts are clear from his statement to police: the bicyclist “was aware he had the red light, and thought it was safe to proceed” (B1002). In two of these six cases the bicyclist was on the sidewalk. In one case where a left-turning police car was the striking vehicle, the officer noted that the bicyclist was passing on the right of stopped traffic in a bike lane and then entered the intersection on red (B2609).

**Drunk Bicyclist**
In four cases, the bicyclist who went through on red had been drinking, and intoxication may well have had an influence on the signal violations (B1107, B1481, B1836, B2525). In another case, the bicyclist was clearly disturbed and possibly had been drinking or was otherwise intoxicated (B2753).

**Long Intersection**

In two cases, the bicyclist was going through a long intersection and may have entered on green, but did not yield to a motorist already in the intersection (B1675, B2387). A driver who lawfully enters an intersection has the right of way to continue across, even if opposing drivers (including bicyclists) get a green signal. The same situation can occur when bicyclists enter a long intersection at the end of the green or in the yellow phase (see below under “Bicyclist Trapped”).

**Didn’t Think Stopping Was Necessary**

In three cases, the bicyclists going through on red assumed that the motorist would see and stop for them. In one of these, the police officer reported that “The victim stated that she thought that the operator of the van observed her and was going to stop. Officer then spoke to the operator/owner of the van who stated that as she was traveling through a green light she did not observe the victim on her bicycle until her van made contact with the bicycle” (B1725). In another case the bicyclist “stated that the vehicle had the green light to continue passing through the intersection, but that he was in the crosswalk”— this phrasing suggests the bicyclist was under the mistaken impression that motorists are required to yield to pedestrians in crosswalks even when going straight on a green signal (B1202). In the third case the bicyclist was playing follow-the-leader: “The victim stated that she was riding a bicycle with her boyfriend and was a little behind him as they crossed the intersection of Boylston St and Charles Street South. The victim stated that while she was crossing she observed that the taxi had started driving towards her and assumed he would stop when he saw her, but he didn't stop and she and the taxi collided” (B2559).

**Did Not See Traffic Signal**

In two cases the bicyclist could not see signal due to sun glare but entered anyway (B1796, B2423). In another case the bicyclist claimed to “not notice any traffic signals at all at that intersection prior to crossing that location” (B2428).

**No Brakes or Lost Control**

In one case, the bicyclist went through the light because he had no brakes and was unable to stop (B1122).

**Citations**

In six cases, the motorist left the scene, and in four cases the bicyclist left the scene. In only four of 160 cases, the bicyclist received a citation for violating the traffic signal. In one more case, the bicyclist received a citation for riding the wrong way on a one-way street. In one case, the bicyclist did not receive a citation even though the incident was witnessed by police (B1099). In another case (B1421), a police officer witnessed the incident and noted that the bicyclist went through a red light and did not have lights on his bicycle, but still did not issue a citation. In still another case, an “investigation determined that the victim was at fault riding his bicycle the opposite way of traffic and not stopping at
the intersection” and “that the victim’s bicycle had no rear brakes”—three separate violations, but still no citation was issued.

Injuries
There was one fatal collision involving a bicyclist (Marly Pineda) entering an intersection on red, discussed more fully in the section on Fatalities below (B1656). As with the other fatalities in the database, there is no information about the circumstances in the crash narrative; media reports were used instead. The bicyclist was approaching at speed on a downslope. The motorist was approaching the intersection at speed (not from a stop). These circumstances contributed no doubt both to the impossibility of avoiding a collision and the seriousness of the injuries.

There was another incident in which the bicyclist had critical, but fortunately not fatal, injuries. The bicyclist was crossing Tremont Street where it has three lanes in each direction at Whittier Street (Ruggles Street is opposite). According to a witness in a vehicle not involved, “the light was green and traffic started going when a man on a bike drove into the middle of the lane and stopped. The Volvo stuck the victim throwing him from his bike” (B1017).

Bicyclist Ride-Out (134)
PBCAT codes: 142, 144, 165 (new), 170 (new), 225, 311, 312, 318, 319

This type of collision involves a bicyclist’s failure to yield at an intersection not controlled by traffic signals or when entering the roadway from a driveway or other midblock location. The subtypes of this collision were:

- Ride-out at stop sign (69);
- Ride-out at unsignalized crosswalk (25);
- Ride-out at driveway (19);
- Ride-out from sidewalk (15);
- Ride out from other or unknown location (9).

Ride-Out at Stop Sign or T intersection
More than half of these (69) occurred when the bicyclist was facing a stop sign. In three of these cases, the bicyclist was going the wrong way on a one-way street. In another 13 of the 69 cases at stop signs, the bicyclist was on the wrong (left) half of the road. Bicyclists on the wrong side of the road or going in the wrong direction are not facing stop signs and may not see them, a factor which may contribute to these crash types.

In several cases, the bicyclist was on the short leg (non-through) of a three-way intersection. On many such intersections in Boston, there is no stop sign posted, but the state custom is that the through traffic has the right of way (see Appendix B on the traffic law). These cases were considered to be equivalent to stop or yield sign violations. It is possible that some bicyclists, especially children, do not understand

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20 The Standards of Fault issued by the state Division of Insurance make the driver entering a through roadway from a T intersection more than 50% liable if a collision occurs—see 211 CMR 74.04(31).
that they do not have the right of way when entering a through roadway at a T-intersection. One bicyclist was facing a stop sign at the exit onto Back Street from the ramp crossing Storrow Drive leading to the Charles River Paths (B1306).

**No Braking**
Sometimes poor or no brakes, or inability to use them, was the reason for a bicyclist ride-out at an unsignalized or signalized intersection. There were several cases where the bicyclist either had improper brakes (B1178, B2040) or did not use the brakes to be in full control of the bicycle, especially going down a steep hill (8 cases). In three cases, the bicyclist had been drinking or using marijuana before going through a stop sign.

**Unsignalized Crosswalk (25)**
At an unsignalized crosswalk, the pedestrian has the right of way, however, the pedestrian may leave the sidewalk slowly enough that the motorist does not have time to yield. Because there were many such cases, a separate category (not previously in PBCAT) was created for bicyclists struck by a motor vehicle when crossing at an unsignalized crosswalk. In some cases, the bicyclist was crossing multiple lanes, and started crossing when a motorist either yielded or was stopped due to congested traffic. In these cases, the bicyclist was struck by a moving vehicle approaching in the next lane, whose driver could not see the bicyclist due to stopped traffic. In 8 of the 25 cases, the bicyclist was on the Southwest Corridor bicycle path and crossing at an unsignalized crosswalk; six were at Prentiss Street and two at New Minton Street. In four of the 25 cases, none at bicycle path intersections as it happens, motorists were given a citation for “Failure to yield to pedestrian.”

**Driveway (19)**
There were 19 bicyclist ride-out cases at driveways, of which 13 were residential driveways and 6 were commercial. Thirteen of the 19 cases at driveways involved minor children.

**Bicyclist Ride-Out from Sidewalk (15)**
Fifteen cases involved bicyclists riding on the sidewalk who entered the street from between parked cars without yielding, including B1908, B1140, B1150, B1414, B1626, B2071, B2130, and B2190. In some cases the bicyclist was intending to cross the street, in other cases the bicyclist was riding along the sidewalk and either hopped off the curb or swerved at a driveway to enter the street (without yielding to approaching traffic). In one of these cases it may be that the child pedaling the bike swerved because of another child riding on the handlebars (B1206).

**Other and Unknown Ride-Out (9)**
Another case occurred on Prentiss Street near the intersection with Tremont Street; the bicyclist may have been riding along the Southwest Corridor Path (as in the cases previously mentioned) or riding along the sidewalk of Tremont Street; it is not clear from the narrative (B1035). In other cases it was not clear whether the bicyclist was entering the road from a driveway, over a curb, or at an intersection.

In one case, a bicyclist was critically injured after riding out over the curb into traffic (B2631). None of the Bicyclist Ride-Out collisions involved a motorist leaving the scene.
Bicyclist Lost Control (98\textsuperscript{21})

*PBCAT codes: 121, 122, 123, 124, 129*

Because bicycles are balance vehicles, bicyclists can easily fall. A fall can be precipitated by bumps, slots or holes; excessive braking; slippery surfaces, or grooves parallel to the bicyclist’s line of travel such as trolley tracks. Falls where no other person is involved are by far the most common circumstance leading to bicyclist injuries (for example, 2009 Boston Bicyclist Survey). However, police incident reports capture only a small fraction of these events, particularly when a motor vehicle is not involved. Bicyclists also sometimes collide with objects because they lose steering and/or braking control, for example due to excessive speed, poor brakes, operator inexperience, intoxication, or a combination of these factors. The object they collide with is frequently a parked, stationary, or moving motor vehicle (since there are a lot of them on the roads). The specific types of Bicyclist Lost Control incidents were as follows:

*Mechanical Problems, Improper Braking, or Too Fast (28)*

These crashes included losing control when braking *insufficiently* (or riding a bicycle lacking proper brakes) and also braking *too hard* and being ejected from the bicycle as a result. Specific circumstances included in this subtype are:

- Non-working brakes or going too fast to stop (five cases - B1254, B1413, B1892, B1991, B2225);
- Did not know how to use brakes (B1653);
- Braked too hard (five cases - B1267, B1589, B2076, B2206, B2661);
- Skidding fall due to wet brakes (B1064);
- Front wheel fell off (B1450);
- Tried to ride from road onto sidewalk (B1502);
- Lost control after riding with no hands on handlebars (B1942);
- Police drug task force asked bicyclist to stop (due to no headlight and riding wrong way), bicyclist fled, lost control and crashed (B2295).

Eleven of the 28 crashes (39\%) in this subtype occurred when the bicyclist was going down a hill, suggesting that the higher speeds that can be easily attained when descending are a risk factor for this type of crash.

*Surface Conditions (25)*

The next most common factor leading to loss-of-control crashes was poor surface conditions. These include:

- Trolley tracks (13 cases);
- Ran into curb (B1654, B1735, B1916, B2207). The first case involved a head-on collision with a curb at speed that resulted in “serious head trauma.” In the third case, a bicyclist riding in the left-side bike lane on Commonwealth Avenue ran into the curb along the median.
- Fire hydrant hose across street (B2014);

\textsuperscript{21} There were 99 records of this type in the dataset because there is a duplicate record for the case involving the fatal injury of Kelsey Rennebohm.
• Skidded on wet pavement (B1393);
• Bumps, holes, other or unspecified road defects (B1507, B1689, B1757, B2162, B2227, B2543).

With 13 of the 25 cases, trolley tracks were by far the most common factor related to surface conditions among the police-reported crashes. At one time, Boston and surrounding communities had an extensive network of streetcar tracks in travel lanes. However, most of the remaining trolley tracks are in subways or median reservations where bicyclists never ride alongside them. However, there are a few remaining places where tracks are laid in travel lanes, where these crashes occurred. Most of these occurred either around Cleveland Circle or South Huntington Avenue, or in one case, the very small length of tracks remaining in the roadway at the intersection of Brighton Ave and Commonwealth Ave. One of the bicyclists who fell on the tracks was a BPD officer on duty (B2282). At least two of the trolley-track cases resulted in serious injuries. There was also a fatality related to falling on the tracks (see Eric Hunt in the listing of fatalities below).

*Bicyclist Using Alcohol or Drugs—17*
Generally either a witness observed the bicyclist lose control and fall, or the bicyclist was found already on the ground and it was not apparent what caused the fall (but there was no evidence of the involvement of a motor vehicle, except in cases where the bicyclist hit a parked car). In a few cases, there were other specific factors besides intoxication that led to the fall:

• poor road surface conditions;
• extremely intoxicated bicyclist made left turn from center lane and hit car;
• bicyclist drinking beer swerved off sidewalk to avoid pedestrian and fell.

In one case, a police officer advised the bicyclist not to ride his bicycle after drinking alcohol (B2113), but no citations were given in this case or any other where the bicyclist had apparently been drinking. There were another 26 cases where there was an indication in the narrative that the bicyclist had been drinking or using drugs, but that were coded under other crash types. As discussed in the appendix, it is not clear whether bicyclists in Massachusetts can be cited for bicycling under the influence.

*Other Falls—28*
A total of 28 other falls did not involve one of the above conditions. Of these, five involved a bicyclist losing control going downhill (these are in addition to 11 downhill crashes mentioned earlier). One involved a bicyclist riding on the sidewalk who fell while trying to hop off the curb to avoid children on the sidewalk (case B1261), and the remaining 22 reports had no additional information as to the specific cause of the fall.

In addition to the fatality involving trolley tracks, there was another which apparently occurred when a bicyclist lost control and fell into the roadway and then was struck by an approaching MBTA bus, reported in two separate items in the data set (B2815 and B2473)22. As with all the other fatalities included in the dataset, there is no information about the crash circumstances in the narrative. However, news reports matching the date and location of the incident and the age and gender of the

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22 This was the only case identified where an incident was reported more than once in the dataset.
bicyclist reveal that the victim was Kelsey Rennebohm and that although the fatal injuries resulted from being struck by an MBTA bus, there was another event that caused her to fall prior to being struck.23

Other Crossing Collisions (96)
PBCAT codes: 111, 112, [113], 114, [115], [116], 148, 156, [157], 158, 160, 180

This group includes intersection-related crashes that would fall into one of the other categories except that the narrative is lacking key details. This group also includes a small number of other types of intersection collisions.

Crash Types
The specific types are as follows:

- The crash happened at a signalized intersection, but the narrative does not clearly indicate who had a green light (either not reported or conflicting reports with no independent witness) (63).
- The crash happened at a sign-controlled intersection, but the narrative does not indicate who was facing the stop sign (17).
- The crash happened at an uncontrolled intersection and it is not clear who was required to yield right of way (6).
- The bicyclist was trapped in a signalized intersection after the signal changed (6).
- Either the bicyclist or motorist made a turn too wide (bicyclist and motorist were initially on crossing, not parallel paths):
  - Left turn too wide (1 motorist, 1 bicyclist)
  - Right turn too wide, crossing over to wrong side (3 motorists)
    All but one of the wide turns happened on narrow two-way streets (without center lines).

Long Intersections (6)
There were only a few cases where it seems that the bicyclist was trapped in the intersection, but these cases are notable in that they are one of the few cases where infrastructure (as opposed to road user behavior) was a predominant factor in the collision. The problems are all at long or wide intersections where there may be not enough time for a bicyclist to cross on green, especially if he or she starts at the end of the green. The specific areas that were potentially problematic, and the approximate crossing distance, include:

- Surface Road at Lincoln St / Essex Street (210 ft) — one collision where the bicyclist claims to have entered on green, and another one where the bicyclist could not recall if he and another bicyclist entered on green. (B1190 and B1675)
- St. James Ave at Arlington Street (160 ft, B2369)

23 See Boston Globe, Bicyclist Killed After Falling into Traffic, June 2, 2012.
http://www.bostonglobe.com/metro/2012/06/02/bicyclist-killed-after-falling-into-traffic-huntington-avenue-friday-night/KTCc97wo1HcRobnKuZPiJ/story.html
Huntington Ave at Parker Street/Forsyth Way (180 ft, B2577)
Blue Hill Avenue at Warren St, Grove Hall (185 ft, B2072)
Shopping Center exit crossing Blue Hill Ave to Warren St, Grove Hall (130 ft, B2055)

Motorist Overtaking (67)
PBCAT codes: 231, 232, 235, 239

Motorist-overtaking crashes involve a motor vehicle colliding with a bicyclist ahead traveling in the same direction, either from behind (rear end collision) or from the side (sideswipe, typically making contact with a side mirror). PBCAT codes include four subtypes:

- Motorist Misjudged Passing Space (8)
- Undetected Bicyclist (7)
- Bicyclist Swerved (13)
- Other and Unknown (39)

The last category was the most common, perhaps due to the large number of hit and run cases: in 27 of the 39 other and unknown cases (69%), the motorist fled the scene. Only by interviewing the motorist is it possible to know whether the motorist was not able to see the bicyclist in time, or the motorist saw the bicyclist but failed to leave enough room to pass safely. It is also possible that some of these hit-and-run drivers were intoxicated and did not want to stop for fear of being subjected to a sobriety test. Two of the other and unknown cases involved drunk motorists who were apprehended and arrested. In addition to impairment, there are several other factors that help explain the circumstances of motorist overtaking crashes:

**Crash Occurred at Night**
Forty-two percent of the motorist-overtaking crashes happened at night (28 of 67), and another four crashes happened at dusk or dawn. Thus, in total, 48% of motorist-overtaking crashes happened in non-daylight conditions. In none of the nighttime overtaking cases was the bicyclist reported to be using a rear light. In two cases, the bicyclist was reported to be using a rear reflector. Bicyclists in Massachusetts are not required to have rear lights; a rear reflector is legally sufficient. All new bicycles are sold with rear reflectors per Federal regulations. However, these reflectors are small and do not reflect very brightly, and are frequently obscured by clothing or packs, or they are damaged, dirty or have been removed. Seventeen of the 29 hit-and run overtaking crashes occurred at night. As mentioned, it is possible that some of the drivers who fled were drunk, since people are more likely to drink alcohol after dark. Some of the specific nighttime motorist overtaking scenarios were:

- Bicyclist was waiting to turn left (B1090).
- Motorist swerved into bike lane (B1292); two night-time overtaking crashes happened when the bicyclist was in a bike lane.
- Sideswipe of bicyclist using left-side bike lane on Commonwealth Avenue in the Back Bay (B1869).
• Bicyclist with rear reflector but no rear light was seen at last moment by motorist who tried to brake, but not in time (B1882).
• Motorist braked as soon as he saw bicyclist ahead, but not in time. No information in the report about lights or reflectors on the bicycle (B1944).
• Reckless driver, whom witness noticed had been driving at high speeds, with screeching tires, and making multiple lane changes, struck a bicyclist. The bicyclist lost teeth and fractured a wrist; the motorist fled and was not found (B2138).
• Bicyclist reported that his “handlebars made contact” with an overtaking car but the contact was so slight that he was not sure if the motorist knew he had fallen (B2150).
• High-speed driver sideswiped bicyclist at 3:15 am and then fled; likely a drunk driver, given the time of day (B2138).
• Driver using a mobile phone (B2260).
• A taxi driver claimed that an injured bicyclist fell while trying to pass the taxi. However a witness said the taxi struck the bicyclist while overtaking (on a narrow street), probably with the passenger side mirror. The bicyclist was seriously injured with head, back and leg injuries, but there was no mention of a citation issued to the taxi driver, even though he admitted seeing the bicyclist ahead before striking her (B2436).
• A bicyclist and taxi driver exchanged words, and several blocks later, the taxi bumped into the bicyclist. The taxi driver claimed that the bicyclist was operating erratically. The bicyclist was knocked to the ground but not injured (B2521).

Bicyclist Swerved (13)
Only one of the 13 cases where the bicyclist swerved occurred in non-daylight hours (8%), compared to 31 of 53 of the other types (58%). The specific scenarios included:

• Motorist noticed that bicyclist was weaving from side to side (but decided to pass within the same lane anyway) (B1193).
• Bicyclist started to wobble and then swerved in front of motorist (B1326).
• Twelve-year old bicyclist swerved when school bus ahead stopped short, and collided with motorist behind (B1490).
• Bicyclist was seen by overtaking motorist but unexpectedly swerved to avoid a double-parked truck (B1759) or a raised casting (B2633).
• Bicyclist swerved left to avoid bulb-out in parking lane on Centre Street, West Roxbury (B2320).
• Motorist approaching red light bumped bicyclist who she claimed was weaving in and out of traffic, without injury (B2491).

Daytime, Bicyclist Did not Swerve (27)
There were 27 motorist-overtaking crashes in daylight in which the bicyclist did not swerve into the path of the motorist. In all of these cases except one, the bicyclist was sideswiped, suggesting that the motorist saw the bicyclist but attempted to squeeze by where there was not enough room.
The one crash that was not a sideswipe involved an erratic and likely impaired motorist (B1072). A witness to the crash told police that a “black Honda Accord nearly struck her [the witness, traveling in a car] as it pulled out behind her . . . [and] continued to operate in an erratic manner behind her as both vehicles traveled on Washington St.” The witness “was monitoring the vehicle from her rear view mirror when she observed the vehicle . . . drive directly into [the bicyclist], making no attempt to swerve away.” Fortunately, the bicyclist was not critically injured, was able to speak to the police officer, and said he could identify the motorist. The motor vehicle was found parked, but the driver was not located, and there is no suggestion in the narrative that the motorist was ever charged with an offense.

The most serious daytime crash involved a Peter Pan Bus. Although it was a sideswipe, this type of crash can easily be fatal when it involves a bus or truck, as the bicyclist can get knocked over and then be crushed by the rear wheels (B1344). The bus driver said he observed a bicyclist “riding next to the parked” motor vehicles. “As [the bus driver] passed the victim he attempted to move the bus to the left towards the white lane marking;” and “he passed the victim with half the bus when he heard a bang towards the right rear. He stated he looked in the mirror and observed the victim laying on the ground near the rear wheel.” The bicyclist “stated that as the bus passed her the bus hit her bike’s handle bars; . . . the impact knocked her off the bike and under the bus where the rear wheel ran over her left leg.” In this case the bicyclist was very lucky not to have been killed or even more seriously injured. The incident occurred on Massachusetts Avenue where it is divided into two narrow lanes for each direction with on-street parking. The bus driver says he moved the bus to the white (not yellow) lane marking instead of waiting until it was possible to move into the passing lane. In other words, the bus driver was attempting to maneuver an 8.5 ft-wide vehicle into a 10 ft-wide lane already occupied by a bicyclist. Given these dimensions, it is not surprising that the side of the bus collided with the handlebar before the driver had completed the pass. There was no record of a citation issued to the driver in this case.

Some of the other sideswipes in daylight included:

- Motorist attempted to pass a bicyclist within the service lane of Commonwealth Avenue where there is on-street parking (B2734).
- Motorist attempted to turn right on red around bicyclist stopped at red light (B2649).
- Motorist had just turned into street where bicyclist was riding (B2236).
- Bicyclist waiting to turn left was struck by motorist coming from the same direction who was also going to turn left but then changed her mind (B1711).
- Bicyclist waiting to turn left was struck by motorist distracted by looking at police activity (B2605).
- A motorist stated that “she did not see the bicyclist until it was too late” on a rainy day less than an hour before sunset (B1106).
- Bicyclist was going uphill in a bike lane in Franklin Park in daylight; motorist claims not to have seen the bicyclist—which probably means the motorist was not looking at the road ahead (B2382).
- Bicyclist in bike lane was sideswiped by a motorcyclist who was probably attempting to pass to the right of a motor vehicle. Fortunately, the bicyclist suffered only “minor scrapes” (B1132). Including this one, there were a total of four cases in daylight where the bicyclist was in a bike lane.
In one case a motorist saw the bicyclist ahead and claimed “that upon passing the bicyclist the bicycle made a sudden left turn striking the suspect vehicle.” The bicyclist said he “was traveling . . . close to the curb, and out of the corner of his eye noticed a green vehicle very close to him and almost right away was struck by the vehicle’s right mirror causing him to lose control of the bike and bounce off the car before falling to the ground.” Apparently, the police officer did not believe the motorist’s dubious story, because the officer gave him a citation for “unsafe passing of a bicyclist.” (B1192)

**Citations Issued**
There were only five police actions against motorists in the 67 cases of motorist overtaking: two were arrests for drunk driving, and three citations: one for unsafe passing of a bicyclist, one for failure to slow when approaching a bicyclist, and one unspecified violation.

**Injuries**
The most serious injuries in this crash type contained in the database appear to be that of a bicyclist who was hit from behind by a drunk motorist on Commonwealth Avenue. He had serious but non-life-threatening injuries, and was able to speak to the police on the scene.

**Motorist-Overtaking Fatality**
Bicyclist Doan Bui was killed by an overtaking motorist on Sept. 14, 2012. This incident was not included in the database although it is within the 2009-2012 period. This single motorist-overtaking fatality within the study time period had the “perfect storm” of risk factors: darkness, narrow travel lane, drunk and speeding motorist. More details about this case are included in the Fatalities section.

**Bicyclist Overtaking (64)**
**PBCAT codes: 241, 242, 243, 249**

There were a number of collisions in which a bicyclist ran into a motor vehicle ahead that was moving more slowly, stopped in traffic, or parked. The bicyclist either ran into the back of the vehicle or sideswiped a side panel or side mirror. The distribution of crashes by type was as follows:

- Rear End (27 cases),
- Sideswipe (26),
- Parked Car (11).

Only three of the sideswipe incidents involved a bicyclist passing on the left of a car; the remaining 23 involved a bicyclist colliding with the right side of a motor vehicle. One reason for these types of crashes is that passenger cars can decelerate faster than bicyclists, and the bicyclist may be riding too closely behind (possibly with poorly adjusted brakes). However in other cases, the bicyclist was not paying attention or was squeezing by, typically in the narrow space between parked and moving cars. Where they could be identified, the specific circumstances associated with the bicyclist overtaking crash type included:

**Bicyclist following too closely (11)**
• Motorist stopped unexpectedly to let police car pass (B2735; B1857) or to let pedestrian cross the street (B1365, B2366, B2027).
• Motorist was looking for parking (B1139) or in the process of parking (B1674, B1706).
• Bicyclist was going fast (downhill or otherwise) (B2247, B2548).
• Bicyclist said he could not stop in time (B2788).

**Bicyclist not keeping a lookout (5)**
• Bicyclist was not paying attention (B1302).
• Bicyclist “stated that while we was driving his bike he turned his head and lost track of where we was going, then striking [sic] the rear end of the vehicle” (B1512).
• Bicyclist in bike lane hit car parked in bike lane (1321).
• Pedicab hit parked car, both passengers fell out, pedicab operator pedaled away (B2621).
• Bicyclist had a few drinks and claimed that his ‘brakes failed’ (B1313).

**Bicyclist swerved (3)**
• Bicyclist swerved to avoid vehicle, hit parked car (1 case).
• Bicyclist swerved to avoid road surface hazard, hit parked car (B2078.)
• Bicyclist moved left to avoid taxi parked in bike lane, hit vehicle in travel lane (B1242).

Bicyclist squeezing through (6)
• Bicyclist was passing between the parking lane and travel lanes and hit the side mirror of a car in the travel lane (4 cases, B1694, B1463, B2720, B2673). In the last example, the bicyclist was riding fast downhill on Cambridge Street (towards Cambridge), caught his handlebars on the passenger side mirror of a car on his left, then struck the driver’s side mirror of a car parked to his right, then struck the side of the car in front of the first one he had struck.
• Bicyclist passing between an MBTA bus and a truck got her bag caught on the truck (B1753: in this case the bicyclist was lucky to escape with only relatively minor injuries).
• While trying to get onto the sidewalk, bicyclist hit the side mirror of parked vehicle (B2435)

**Bicyclist riding alongside a bus or other long vehicle (in the same lane) (4)**
There were four cases of this type:
• Bicyclist Chung-Wei "Victor" Yang was fatally injured while riding alongside an MBTA bus. There is no description of the situation in the incident report narrative, but press accounts report that neither the bus driver nor passengers realized that the bus had collided with a bicyclist, who seems to have been riding beside the bus (B2777).
• There was another similar incident involving a bicyclist riding beside a bus in which the bicyclist received cuts and a serious knee injury, but fortunately nothing worse (B2234).
• In a third case, a bicyclist riding beside a tour bus in the same lane was struck when the driver turned to merge left out of the lane and the rear of the bus swung to the right (B1485).
• In the fourth case, the bicyclist was “riding alongside” a shuttle bus and collided with the “right rear bus wheel well” (B1314).
Only 15 of the 64 (24%) bicyclist-overtaking incidents happened in hours of darkness; this is one of the lowest shares of night crashes of any major crash type. This suggests that the major cause is not the inability of the bicyclist to see the vehicle in front, but the inability of the bicyclist to stop in time if the vehicle in front stops short, or the bicyclist’s overtaking very closely between rows of vehicles, or bicyclist distraction.

In one case, the bicyclist was given a citation for Following Too Closely (B2788); this was the only moving violation issued in any of the crashes coded as “bicyclist overtaking.”

**Motorist Merge / Improper Lane Use (55)**

PBCAT codes: 219, 226, 270, 290

This grouping primarily consists of situations where the motorist made an unsafe lane change, used the wrong lane at an intersection (that is, went straight from a right-turn-only lane), or made an unsafe U-turn. None of these scenarios is included in the PBCAT typing, but they would be part of code 219, “Motorist Turn/Merge—Other/Unknown,” which is also included in this grouping.

**Motorist Unsafe Lane Change (27)**

Eight of these cases occurred after sunset, when bicyclist visibility may have been an issue. Only one motorist was issued a citation for an unsafe lane change; another was issued a citation for unsafe overtaking. In the latter case, the bicyclist was also issued a citation for failure to stay right even though he was in the leftmost lane of a one-way street (B1707).24

**Motorist U-turn (18)**

Making a U-turn on a narrow street can be dangerous because it is necessary to look for and yield to traffic coming from two directions (behind and in front) at the same time. In two of these cases, the bicyclist was traveling on the sidewalk; in one of these cases, facing traffic. In one case, the motorist admitted to seeing the bicyclist, but assumed the bicyclist would yield (the motorist was given a citation). Overall, only four of the 18 motorists were given citations. Seven of these 18 cases occurred after sunset, when failure to see the bicyclist may have been a factor.

**Improper Lane Use at Intersection (3)**

24According to the incident report narrative, on a one-way street with three marked lanes, the motorist “was traveling in the second left hand lane when he was passing a parked Boston Fire vehicle, which was parked in the left hand lane. Operator [of the motor vehicle] stated that once he passed this parked vehicle he attempted to change lanes into the left lane when he heard an impact. Operator believed he might have clipped this parked vehicle’s front right fender, however, this impact was from a bicyclist who was traveling in the extreme right portion of the left lane.” The narrative also gives the account of the bicyclist, who “stated that he was traveling in the left hand lane when he was approaching a parked Boston Fire vehicle which was in the left lane. . . . He began moving towards the extreme right portion of this left lane to go around this parked vehicle [and] he was struck by [motorist] who was changing lanes. Officer cited [motorist] for a violation of Unsafe Overtaking of a bicyclist. Officer, further, cited the bicyclist for failure to stay right” (B1707).
In all three of these cases, the motorist went straight from a right-turn-only lane, and struck a bicyclist to the left. No citations were issued, even when there was a witness.

**Motorist Turn/Merge—Other/Unknown (7)**

There were seven cases in which the motorist was turning or merging but the specific circumstances were unclear. Four of these seven were hit and runs. The cases included the following circumstances:

- In one of the hit-and-runs, it was unclear whether the motorist was overtaking the bicyclist or the other way around (B1907).
- In one case, two bicyclists were crossing at an unsignalized intersection with no crosswalk, and were struck by driver coming out from a side street, but it was not stated whether the driver was turning left or right (B2131)
- In a similar case, the bicyclist was struck by turning driver, but it is unclear in the narrative whether the driver was coming from the opposite direction and turning left, or the same direction and turning right (B2793)
- Motorist swerved right to avoid oncoming truck which was making a wide turn into his lane, struck bicyclist riding alongside to his right (B2668)
- Motorist pulled over for emergency vehicle, struck bicyclist riding to his right (B2763)
- Bicyclist claimed motorist swerved (deliberately) to hit him and said that although there was contact with his handlebars, he did not fall. The motorist claimed that the bicyclist “punched the side of his vehicle”, presumably after the initial contact. (B2709)
- One case involved a bicyclist riding facing traffic who fled the scene after colliding with a motorist turning into a driveway (B1297)

**Pedestrian or Other Bicyclist Collisions (53)**

**PBCAT codes: 410, 420**

The vast majority of these cases, 50 of the 53, involved collisions with pedestrian; only three involved a collision with another bicyclist. As with many other crash types, bicyclist visibility may be a factor. Nearly one third (16 of 53) of the incidents happened after dark. In 10 of the cases, the bicyclist left the scene (“hit and run”). In many cases the bicyclist was uninjured or only lightly injured and the pedestrian was transported to the hospital, although in a few cases the opposite outcome occurred. There were several specific types:

*Wrong-way bicyclist collides with pedestrian (5)*

Pedestrians in Boston frequently cross midblock; this is legal provided that the pedestrian looks for and yields to traffic on the roadway (technically, the pedestrian must also be at least 300 feet from a crosswalk). A pedestrian looking for traffic coming in the proper direction may step off the curb into the path of a bicyclist coming from the wrong direction.

*Bicyclist passing on the right (8)*

The bicyclist who passes a motor vehicle which is stopped (perhaps for an unknown reason) may go directly into the path of pedestrian who is crossing, not expecting the bicyclist passing stopped traffic,
and may not be able to see the bicyclist approaching if stopped vehicles block sight lines. The specific cases included:

- Other vehicles stopped at crosswalk (B2400, B2472)
- Bicyclist in a bike lane, with stopped bus to the left, struck pedestrian trying to enter parked vehicle (B2432)
- Pedestrian walking between stopped vehicles, not at a crosswalk (B2567, B2103)
- Bicyclist passing on the right of stopped bus, strikes person exiting bus (bicyclist in bike lane: B2619, B2655; not in a bike lane: B1758)

**Signal violation (9)**
At least nine cases occurred at a signalized intersection. In three of these, the bicyclist violated the signal (B1220, B1723, B1935). In six cases, the pedestrian violated the signal (B1387, B1628, B1911, B2238, B2266, B2293).

**Pedestrian crossing midblock (8)**
In eight cases, the pedestrian was not crossing at a crosswalk and the bicyclist was evidently neither going the wrong way nor overtaking on the right of stopped traffic (B1760, B1805, B2790, B1143, B1449, B2333, B2349, B2817). In the last case it was noted that the pedestrian emerged from between parked cars.

**Bicyclist on sidewalk or bicycle path (6)**
In five cases, the bicyclist was riding on the sidewalk (B1522, B2204, B2677) or a bike path (B1399, B1970, B1996). Some of the specific situations included:

- BPD officer on bicycle bicycling on the Southwest Corridor Path struck pedestrian (B1996).
- A bicyclist riding on a path in the Boston Common struck 4-year old child; the bicyclist was cited for riding on a park path (B1970).
- A bicyclist riding on a sidewalk lost control, struck stopped a BPD bicycle officer on sidewalk. "Officer issued the cyclist a verbal warning regarding him riding on the sidewalk and further informed him about the use of the Surface Road bike lanes in order to prevent him from getting involved in future accident" (B2677).

**Head-On (40)**
**PBCAT codes: 250, 255**
These crashes involved a head-on collision between a bicyclist and a motorist; one party or the other was traveling on the wrong side of the road. In all but two cases, the bicyclist was on the wrong side. (Head-on collisions are, however, only one of many categories that involve bicyclists operating on the wrong side of the road or against the flow of traffic.)

**Bicyclist Wrong Way (38)**
In three cases, the bicyclist crossed the centerline (for example, to pass), but had not been riding on the left (wrong) side of the road (B2243, B2530, B2671). In the remaining 35 cases, the bicyclist had been riding the wrong way. The bicyclist was given a citation in only one of these cases, and it was for failure to have a headlight at night, not for operating on the wrong side of the road (B1798).

When the bicyclist is on the wrong side of the road, he or she is closing on the approaching motorist at the sum of their speeds, contributing to the difficulty in avoiding a collision. There are several other factors that may explain some of these crashes:

- Ten happened after sunset (and most likely the bicyclist did not have a headlight);
- In two cases, the bicyclist was on a narrow street and not looking ahead (B1243, B1606);
- In ten cases the motorist had just turned a corner onto the street where the bicyclist had been riding (B1205, B1782, B1798, B1984, B2026, B2077, B2476, B2549, B2671, B2678);
- In five cases, the bicyclist was riding downhill, meaning at higher than normal speed;
- In four cases, the bicyclist had just turned a corner onto the street where the motorist was traveling (B1914, B2453, B2569, B2642);
- In one case, both parties were coming around a sharp corner (B1943);
- In one case, a wrong-way bicyclist swerved to avoid a pedestrian and struck an approaching car (B2008);
- In two cases, the motorist was turning right at the same time the bicyclist was turning left from the wrong side (B2226, B1014).

**Motorist Wrong Way (2)**

In two cases the motorist was on the wrong side, specifically:

- The motorist deliberately went the wrong way for about 30 feet on Washington Street to get from Avery Street to Hayward Place (which is almost opposite); the motorist was cited for operating the wrong way on a one-way street (B1284).
- On a very narrow residential street, the motorist moved left of center to avoid tree branches and struck an approaching bicyclist coming from the other direction (B1740).

**Bicyclist Turn (37)**

**PBCAT codes: 221, 222, 223**

In 34 of these cases, the bicyclist was turning left at an intersection or driveway and in three cases the bicyclist was turning right. When turning left, drivers (bicyclists included) are required to yield to traffic approaching from the opposite direction. However, only 11 of the left-turn cases were of this type; most of them (23) involved a left turning bicyclist’s colliding with a motor vehicle approaching from the same direction, suggesting that the bicyclist may have initiated the turn from the right part of the road rather than in the left-turn lane or near the center line25. These are the subtypes in detail:

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25There have been cases where motorists cross the centerline and collide with a left-turning bicyclist attempting a left turn from the center of the road, but no such cases were reported in the sample at hand.
Bicyclist Left Turn, Same Direction (23)

In seven cases, the bicyclist made a left turn from the bike lane (B1482, B2246, B2531, B2627, B2692, B2693, B2686). In the last case, the bicyclist was “riding in the bicycle lane on South Huntington Avenue when she saw the bus begin to stop for a vehicle waiting to take a left into the 7-11 parking lot . . . . she attempted to make a left across the street in front of the bus. Just after [she] exited the bicycle lane, the bus proceeded on its original path of travel, striking her and knocking her to the ground.” In this case, the bicyclist must have looked (since she saw that the bus was pausing), but made the mistake of turning from the edge of the road. The traffic law requires that left turns must be made from the lane closest to the center of the road (on a two-way street). In at least one case, the bicyclist was in the left lane, but attempted the turn from the right side of the lane (B1214). Although the law is silent on placement within the lane, it is dangerous for bicyclists to make a left turn from a position that leaves room for motorists to continue straight from the left of the bicyclist.

In other cases, the bicyclist did not look behind, but assumed that signaling was sufficient to let an approaching motorist know exactly when the bicyclist was going to turn (for example, B1293). In yet another case, the bicyclist stated that he was relying on hearing the sound of an approaching vehicle and “thought” the approaching same-direction truck would also turn left (B2751).

There were two crashes at the same location, the traffic circle at the intersection of Centre Street and Perkins Street in Jamaica Plain, which appear to be related to the design of the intersection (see Figure 1). In both cases, the bicyclist was trying to continue straight on Centre Street while the motorist was exiting right onto Perkins Street (B1351, B1775). However, continuing straight on Centre involves traveling left around the circle and is akin to making a left turn (while turning right on to Perkins Street feels like going straight ahead). It is not safe for a bicyclist to continue on Centre Street at the right edge, because there is plenty of room for a vehicle to overtake on the left and immediately turn right (which feels like continuing straight ahead). The bike lane on the Centre Street approach to this intersection may encourage bicyclists to stay to the right even if they are not intending to exit onto Perkins Street.
There was one fatality involving a left-turning bicyclist, Tanya Connolly, and a truck in the same direction also turning left (B2687). More detail is provided in the Fatalities section.

**Left Turn, Opposite Direction (11)**
Generally, in these cases, the bicyclist failed to yield when turning left. There were a few special circumstances:

- The motorist signaled left, then continued straight (B1329);
- The bicyclist was turning on a left arrow; the motorist was probably making a right turn on red (which would be a signal violation if that was the case) (B2285);
- The bicyclist was drunk (B2268);
- There was a No Left Turn sign posted (B2665).

**Motorist Parking (31)**
**PBCAT codes: 215, 215.5**

Crashes involving a motorist parking on the street, which are a single category in PBCAT, were divided into two types: pull into on-street parking and drive-out from on-street parking. The former could be grouped with Motorist Right Turn crashes since in most cases, the bicyclist was alongside or passing on
the right of a motor vehicle, and then the motorist turned right to enter a parking spot. The latter type, drive out from parking, could be grouped with Motorist Drive Out, and although these crashes generally do not involve wrong-way bicyclists, they frequently occur at night when the motorist may not have been able easily to see the bicyclist due to lack of a headlight on the bicycle.

**Pull Into On-Street Parking (14)**

Generally either the bicyclist said he or she was riding beside the motor vehicle or the motorist said he did not see the bicyclist in advance of collision, indicating that the bicyclist was most likely beside the car. These crashes did not involve backing, or they would have been coded under that category. Two cases involved angle parking on the Commonwealth Avenue service lane (one right turn and one left turn). (Other incidents involving backing out from angle parking, also along the Commonwealth Avenue service road, are discussed below under Backing.)

**Drive Out from On-Street Parking (17)**

Ten of the 17 cases of motorist drive-out from parking occurred in non-daylight hours; visibility of the bicyclist may have been the key factor. In one daylight case, the motorist claimed to have looked but apparently did not not (B2461). In another case, the bicyclist said that the motorist who pulled out from the parking space without yielding “was very rude and blamed the victim for the accident and [said] that he doesn't feel sorry for the victim, because she doesn't have the right to be on the road” (B2073).

**Intentional (29)**

PBCAT codes: 510, 520, plus police officer tackles (coded 800, “other”)

These 29 incidents should not be considered “traffic accidents,” since “accidents” are considered to be unintentional injuries. In three cases, the bicyclist was tackled by a police officer following the bicyclist’s failure to obey the officer’s order. In the other 26 cases, one or more parties were committing an assault and battery. Some of the incidents stem from an initial confrontation (“road rage”) or from an unintentional collision, typically slight. In the majority of cases, 19, the motorist caused the collision, but in seven cases, the bicyclist caused the collision.

**Motorist Intentionally Caused (19)**

The specific circumstances of these cases included the following:

- A bicyclist observed a car driving erratically, wrote down the plate number, which incited the motorist to say “If you have something to say to me then say it to my face." The motorist then “bumped” the bicyclist with his vehicle (B1117).
- A bicyclist pulled in front of motorist, who then honked, and the bicyclist retaliated by pushing the motorist’s side mirror, at which point the motorist “cut off” the bicyclist causing him to collide with a parked car (B1218).
- A bicyclist was honked at for “being in the middle of the road” and replied by showing his middle finger, then after having been passed by the motorist, “the next thing he knew he was hit from behind on his bike” by the same person (B1378).
• Following an unspecified dispute, the bicyclist left his bicycle in front of the motor vehicle and went behind the vehicle to get the plate number, at which point the motorist drove over the bicycle (B1443).

• Motorist struck a bicyclist; the passenger, who was known to the bicyclist, then exited the car and physically assaulted the bicyclist (B1516).

• A young driver in a car full of teens swerved toward a youth on a bicycle, forcing him into a parked car (B1576).

• A motorist put on high beams, the bicyclist moved right, and then the motorist passed and pulled to the right in front of the bicyclist, causing a rear-end collision (B1734).

• While the bicyclist was traveling on a narrow residential street, an approaching van driver honked "continuously," then accelerated and passed closely, striking the bicyclist (B1766).

• The bicyclist was "waiting in left lane for light to change from red to green. [The] right lane light turned green for right turn and suspect who was operating vehicle described directly behind victim in left lane began honking her horn and moving her car forward hitting the rear tire of victim bicycle three times then making the right turn from the left turn only lane and fleeing down Cambridge Street." The police officer issued a citation "for failing to use care when stopping or starting and making a right turn from left turn only lane" but not for assault (B1826).

• In two cases, both on Commonwealth Avenue, it seems that the motorist was prompted to attack by the bicyclist’s failure to use a bike lane. In the first case, "The victim [bicyclist] stated that he was riding his bicycle inbound on Commonwealth Ave when he had to get around a truck that was double parked on the bike lane. The victim stated that he made his way around the double parked truck and continued in the same direction. The victim stated that a driver/suspect that was beside him . . . ran a red light to catch up with him and began weaving between the right lane and the bicycle lane to force him off the road. The victim stated he tried to maintain control on the bicycle lane while the suspect deliberately attempted to hit him with his vehicle. The victim stated that the suspect eventually sped up ahead of him and opened his passenger side door in time to cause the victim to collide with it and fall over onto the street near the intersection of Commonwealth Ave and BU Bridge. The victim stated that the suspect then exited his vehicle and took a swing at the victim. The victim stated that the suspect then got back into his vehicle, made a U-turn going onto the opposite side of the road and traveled west (outbound) on Commonwealth Ave.” A witness who had been driving behind and corroborated the story. The bicyclist provided a license plate number, and the vehicle registered with that plate matched the description given by the bicyclist. Furthermore, the bicyclist identified the owner from a photo. However, there is no indication in the narrative that the motorist was located or brought to justice. (B2142)

• In the second case on Commonwealth Avenue, the bicyclist [victim] “stated that he was on his bicycle traveling outbound on Commonwealth Ave in the bike lane. The victim then signaled to enter in the right lane of motor vehicle traffic because a parked car was blocking the bike lane. While in the right lane, [the motorist] honked the horn of the car and struck the bicycle from behind. The victim maintained his balance and then the car honked the horn and struck the victim on his bicycle a second time. The car then stopped at a red light and the victim
approached the driver’s side window. The suspect put the window down and the victim informed him he was calling the police. At this time the suspect put the window back up and fled outbound on Commonwealth Ave.” (B2145). No plate number was provided, and the police were unable to find the suspect.

- In a another case, “Victim states that he was riding his bike on Beacon Street and going towards Newton when a black sedan began riding in the bike lane he was in. The black car came very close to the victim. Victim with his open hand hit the passenger side door of the black car. This was done to warn the driver of the black car he was very close to the victim. The driver of the black car then moved more into the bike lane, cutting the victim off and forcing him into the curb of the sidewalk. The victim and his bike flipped over landing on his left side causing injury to his left elbow, the left side of his body, left knee and xxxxxxxx [shoulder?]. The victim states that after he was down on the ground the driver of the black car got out standing over him and stated “what's the fuck is wrong with you.” The driver made other threatening xxxxxxxx toward the victim. Victim asked to exchange information with the driver. The driver stated his license plate number and then drove off leaving the victim on the side of the road. A witness gave the victim his phone number and also took the license plate number of the black car.” The narrative provides no information about any police follow up, citation, or arrest of motorist (B1891).

- Another case involved a motorist attempting to turn right on red despite the presence of a bicyclist ahead: “The suspect vehicle came from behind and signaled to make a right hand turn. The victim states that he told the driver of the suspect vehicle there is no right on red and that there is a sign posted. The suspect began honking the vehicle horn. The victim did not move and the suspect then hit the victim's bike in the rear. The [motorist] backed up and went around the victim.” (B2070)

- A motorist pursued a bicyclist who he accused of stealing beer and struck him with his truck. (B2307)

- A bicyclist was “cut off” by a motorist, which led to “shouting match,” following which the bicyclist kicked the car and then the motorist deliberately doored the bicyclist, knocking him to the ground, and then grabbed him and pushed him to the ground. There were multiple witnesses, but no charges were mentioned in the police narrative (B2510).

**Bicyclist Intentionally Caused (7)**

The specific circumstances of several of these are worth describing as well:

- The bicyclist, who had been drinking, was playing a chase game with a taxi driver, per two witnesses, and then the bicyclist tried to cut off the left-turning taxi. The bicyclist was given a summons for disturbing the peace. (B1599)

- A bicyclist riding on Southwest Corridor path was deliberately hit by another bicyclist who was part of a gang of kids. (B1632)

- A bicyclist passed a car on the right and cut in front; the motorist honked. The bicyclist stopped and struck the car with his bicycle; there was a witness, (B1861)
• Two bicyclists struck a motor vehicle and then asked the driver to give them money or they would report the crash; the motorist called 911 and the bicyclists fled. (B2272)

• A pedestrian in a crosswalk collided with a bicyclist's handlebar but continued walking; subsequently the bicyclist “suddenly attacked victim from behind knocking victim to the pavement. [They] struggled on the ground. . . . the suspect bit victim's right hand and held on . . . the suspect got up and attempted to strike victim with his bicycle.” Bystanders removed the attacking bicyclist, who then fled on his bike and was not apprehended. (B2478)

Police Officer Stop (3)
There were three cases where a police officer on foot tackled a bicyclist who failed to stop when ordered to by the officer, specifically:

• A bicyclist rode the wrong way through a closed-off construction zone close to construction equipment and ignored an officer’s command to stop. The officer reported, “I stepped into the path of the bicycle and it collided with my lower body. I grabbed the bicycle's handlebars in an attempt to stop its movement. The momentum of the bicyclist caused it to [fall] to its right side, with myself, holding onto the handlebars, all the way to the ground. At that time, I informed the operator of the bicycle that he was travelling in a construction zone, the wrong way on a one way street and that he was endangering his own life.” The bicyclist fled but later rode back the same way, and, according to the officer, “Once past my position, he darted his bicycle back into the construction zone and gave me the middle finger as he accelerated away.” The bicyclist was later identified (B1494).

• A bicyclist went through a red signal; a uniformed police officer with his hands in the air ordered him to stop, but the bicyclist swerved around the officer, onto the wrong side of the road. The “officer was able to stop [the bicyclist] by physically preventing him from passing;” they collided and both fell to the ground.

• A police officer was assisting a group of pedestrians to cross the street in front of Symphony Hall and had signaled traffic to stop. A bicyclist passed between stopped cars and failed to stop for the officer. According to the narrative, “as the bike began to pass the officer, failing to stop, it was in such close proximity [that the] officer was able to reach his left hand out and attempt to physically stop the bike as the operator had already ignored the officer’s hand signal and verbal command to stop. Officer was able to grab the bicyclist’s left arm for a split second, pulling the officer forward, but due to the speed of the bike was unable to hold on . . . . The bike continued forward passed [sic] the officer where the operator of the bike lost control of the bike falling down.” (B2403)

In each of these three cases, the bicyclist was given one or more citations or summonses, specifically, in the order listed above:

• Disorderly conduct;
• Failure to stop for a red light, failure to stop for a police officer, assault, and disturbing the peace (bicyclist arrested on the scene);
• Failure to stay within marked lanes, improper passing (stopped traffic), and failure to stop for a police officer.

However, only one motorist who intentionally struck a bicyclist was cited (B1826, for moving violations, but not for assault); and only one of the bicyclists who intentionally struck another road user was cited (B1599, for disturbing the peace).

**Bicyclist Unsafe Lane Change (16)**  
**PBCAT code 271**

This code was created for cases where the bicyclist was moving into a new lane, or even across a single lane, without yielding to traffic approaching from behind. (A similar code was created for motorists changing lanes unsafely, as discussed above.) Generally, the bicyclist was preparing for a left turn or avoiding a parked car, bad pavement, or other obstacle. In two cases, the bicyclist stated that he signaled an intention to move left (but signaling does not give the right of way). In no case did the bicyclist report looking first before changing lane position. Six cases occurred at night, 10 during the day. In one case, the bicyclist was aware of an approaching motorist, but thought the motorist was going to “let him cross to the other side of the street” (B2154).

![Figure 3 N. Harvard Street southbound approaching Western Avenue. Bike lane swerves left.](image)

Three cases involved bike lanes:
• A bicyclist was moving from a bike lane to the left lane and signaled but apparently did not look and yield (B2080).
• A bicyclist was entering a “bike box” while the traffic signal was red, but while he was merging the signal changed to green and traffic started moving forward (B2409).
• A bicyclist following a bike lane that was crossing diagonally to the left of a right-turn lane struck the right rear portion of a vehicle in the left lane (possibly the motorist was beginning a merge right to get into the right-only lane). The collision “occurred at the point where the marked bicycle lane came out from along the curb to the center lane” on North Harvard Street southbound approaching Western Avenue, as shown in the figure below (B2486).

Motorist Traffic Signal Violation (14)
PBCAT codes: 152, 154

There were only 14 cases where the motorist caused a collision by going through a red signal, compared to 160 cases where the bicyclist went through on red. In two of the 14 cases in which a motorist went through on red, the motorist left the scene; among the remaining 12 cases, only two motorists were cited for the violation.

Some of the specific circumstances included the following:

Bicyclist was coming from a sidewalk or bike path (6)
• A motorist on Ruggles Street probably did not see the midblock signal for the Southwest Corridor Path crossing close to the major intersection with Tremont Street (B1020).
• A bicyclist on the Southwest Corridor Path was crossing Heath Street (B2066).
• A motorist stopped for a red signal, but ahead of the stop line, in the crosswalk, and struck a bicyclist entering the crosswalk from a sidewalk (B1039).
• A child bicyclist reported that “the cab was waiting at the red light on Shawmut when [the driver] pulled out past the crosswalk and hit” the bicyclist. It is possible that the taxi driver was attempting a right turn on red and did not see the bicyclist, who was traveling facing traffic (B2641).
• A bicyclist “was crossing with the walk signal” (B2414).
• A witness reported that the traffic signal “had just changed from green to red as the suspect vehicle passed through and that the victim [bicyclist] had attempted to cross the street before the pedestrian walk signal had changed in his favor.” (B2480)

Other Special Circumstances (5)
• A motorist turned right on red without stopping, and struck a wrong-way bicyclist approaching on the major street head on (B1050).
• A motorist was stopped for a red signal, blocking the crosswalk and possibly protruding into the bike lane on the intersecting street, and was struck by a bicyclist crossing the street while in the bike lane or possibly the sidewalk (B2414).
• A motorist was going through two sets of closely spaced but independent signals on Commonwealth Avenue in the Back Bay where it has a wide median (B1294).
• A bicyclist was possibly trapped in a long intersection after the signal changed (B2055); if this was clearly the case it would have been coded as Bicyclist Failed to Clear (code 156).
• A motorist entered the intersection either on yellow or on red, and it was not clear whether the bicyclist waited for green or entered on red (B2235).

Parking Lot (7)
PBCAT code: 910

There were seven cases where a bicyclist collided with a motor vehicle in a parking lot. This crash type is called “Non-roadway” in PBCAT. In the Boston database, all non-roadway crashes took place in parking lots. Three of the seven crashes involved children under 18. In one of these cases, the bicycle did not have working brakes, the motorist was driving too fast for a parking lot, and the crash occurred in the dark (B1231). Other specific circumstances included:

• A bicyclist riding on one wheel lost control and fell on top of a car that was stopped (B2269).
• A bicyclist riding into a parking lot saw a motor vehicle backing up and jumped off the bicycle to get out of the way (B2499).
• A bicyclist operating at high speed (according to the motorist) hit a car pulling into the parking lot.

Backing Vehicle (9)
PBCAT code 600

There were nine cases that involved a motorist’s backing. The difficulty in seeing to the rear when backing a car can be assumed to be a primary factor related to these collisions. These are the three subcategories:

Backing in the Street (4)

There were four cases where the motorist was backing up in the street. In one somewhat unusual case, the motorist reported that “while driving down Commonwealth Av. a group of five white non-Hispanic males began banging on the front of his vehicle” and “then stated that he put his vehicle in reverse to get away from the group of men, at which time he hit a bicyclist.” (B1013)

Backing out of On-street Parking (2)

Both of these incidents happened on the Commonwealth Avenue service road where there is head-in, back-out angle parking (B1087, B1511). Bicyclists frequently use the service road in preference to the main road, which has high-speed traffic and narrow travel lanes. However, bicyclists do not always know to keep a significant distance away from angle-parked cars, since motorists sometimes cannot see approaching traffic at all when backing out.
**Backing In or Out of a Driveway (3)**
There were two cases where the motorist was backing out of a driveway; in both cases the bicyclist was riding on the sidewalk. In one case a motorist was backing into a driveway.

**Other Parallel (5)**
**PBCAT code 280**
There were five cases in which the bicyclist and motorist were on parallel paths but there was not enough information to determine exactly what happened:

- A bicyclist passing through stopped traffic “came into contact with the closed right front door” of a taxi, but neither party could explain how this happened (B1615).
- A bicyclist was struck by Boston school bus traveling in the same direction. Neither bus driver nor anyone else on the bus saw the bicyclist. This would be consistent with the bicyclist’s riding alongside the bus, but this was not confirmed in the account. (B1807).
- A bicyclist was waiting at a red signal between two stopped vehicles. When the light turned green, one car struck the bicycle, knocking the bicyclist over, and then the truck on the other side stopped just short of running over his foot (B1838).
- A bicyclist operating facing traffic on the sidewalk was struck by a car turning into a commercial driveway. This incident would be classified as Motorist Right Turn-Opposite Direction or Motorist Left Turn-Same Direction, except that it is not stated whether the motorist was turning right or left (B2484).
- A bicyclist in the bike lane on Commonwealth Avenue approaching the BU Bridge at the place where the bike lane swerves left was stuck on his right leg by a vehicle. It was not stated what the motorist was doing; since the bicyclist was struck on his right side, perhaps the motorist was merging from the right-only lane to the straight-through lane. (B2764).

**Unusual (1)**
**PBCAT code 800**
The one crash that could not be otherwise categorized was a case where an unoccupied car rolled backward and struck a bicyclist (B1722).
Appendix C: Fatalities

Nine bicyclists were fatally injured in the City of Boston between 2009 and 2012; however, only five of them were listed in the BPD database as provided by the Boston Area Research Initiative. (There were six records for fatalities because one case, Kelsey Rennebohm, was listed twice.26) Many of these fatalities have been mentioned already in the text above. For all of the fatalities listed in the database, there is no information in the police narrative about the circumstances that led to the injury. In the descriptions below, the circumstances were determined from press accounts, which were matched to the database based on age and gender of the bicyclist and the date and place of the incident. The cases below are listed by date and name of the fatally injured bicyclist.

4/29/2010, Eric Hunt. This incident was not listed in the crash database. “According to MBTA spokesperson Joe Pesaturo, [Eric] Hunt was killed just east (heading downtown) of the S. Huntington Avenue intersection while trying to pass a Route 39 bus on the left, lost control and fell under the bus.”27 A later press release changed the story a bit: “The bicyclist was . . . trying to pry his bicycle wheels from the trolley tracks. T police said the bicyclist was struck after he made contact with the rear of the bus.” There are two narrow lanes (plus a parking lane) in each direction on this section of Huntington Avenue. There are streetcar tracks in the left lane. Based on these accounts, the most likely explanation is that the bicyclist was beside the bus when the tracks caused him to fall, and that he then struck the side of the bus and fell underneath its rear wheels. Trolley tracks can easily cause a diversion-type fall when a bicyclist rides alongside them (rather than turning at a sharp angle to cross the tracks). It is impossible that a wheel would have gotten “stuck” in the tracks without also causing the bicyclist to fall. It is possible that the bicyclist fell first and was trying to get up when the bus approached, but this is not consistent with the report that the bicyclist made contact with the rear of the bus.

8/9/2010, Marly Pineda. According to press accounts, the bicyclist was coming downhill on the Commonwealth Avenue service road approaching Kelton Street and went through a red signal. A motorist was approaching on Kelton Street on a new green light (from a moving start, not from a stop) and they collided. The following account labeled “I saw the whole thing!” was posted by “Sky” on 8/10/2010 at 10:37am:

“I was the 1st car at the red light looking to go straight onto Kelton Street. There were no cars at the red light coming from Kelton but one was driving from a distance. The light turned green, and just like anyone coming up to a green light, the car just proceeded to drive through the intersection as he should. Right when he got to the cross walk a biker (girl, mid-late 20’s) FLEW through the intersection with no caution whatsoever and got SMOKED by the car! I am not saying anyone is to blame since it was purely an accident...but common sense- whether you have the right of way or not, you’re on a bike unprotected you should probably take caution and slow down to look around you for cars- however in such a busy intersection, the driver should have been more aware, as well, even if he did have the right of way. It was absolutely horrific. This girl went about 20 feet high in the air, spun extremely fast in mid-air about 30

26 This is the only case in the database where such duplication was noted, although it is possible that there are others.
27 http://jamaicaplaingazette.com/2010/04/30/bicyclist_killed_in_bus_accident/#sthash.oIRAbUfl.dpuf
times as she was thrown about 20 feet where she landed on her head (no helmet) on concrete. She was not moving and blood was flooding out of her head. I have never seen anything like it."

Based on this account, this crash was coded as “Bicyclist Ride-Through—Signalized Intersection.”

1/24/2011, Guo Zhen

This was one of the three bicyclist fatalities during the study period that was not included in the BPD database. The BPD press release stated, “At about 8:10am, on Monday, January 24, 2011, officers from Area D-4 (South End) responded to a radio call for a bicyclist struck in the area of Arlington and Tremont Streets. On arrival, officers located the victim (bicyclist), a 74 year old Asian male suffering from life threatening injuries. The victim was transported to the Boston Medical Center where he was pronounced. The cause of the accident is under investigation.” The Boston Globe added that “The South End resident was only a few blocks from his Village Court apartment when he was struck by a car at the corner of Tremont and Arlington Streets at about 8:10 a.m. that Monday. A relative who answered the phone at Zhen’s residence but did not wish to be identified said that he biked around the neighborhood every morning. . . . The white sedan involved in the accident seemed to have been turning east onto Herald Street when it collided with the bike, authorities said, and solar glare may have blocked the driver’s vision.” The information available is only sufficient to determine that the collision occurred at an intersection, and that the motorist was turning. It is not stated which direction the motorist was coming from; he could have been southbound on Tremont and turning left on to Herald eastbound, or northbound on Tremont during right on to Herald eastbound. Although the incident was not listed in the database, it would have to be coded as 158, Signalized Intersection—Other/Unknown.

6/1/2012 Kelsey Rennebohm

One fatality apparently occurred when a bicyclist lost control and fell into the roadway and then was struck by an approaching MBTA bus, reported in two separate items in the data set (B2815 and B2473). As with all the other fatalities included in the dataset, there is no information about the crash circumstances in the narrative. However, news reports matching the date and location of the incident and the age and gender of the bicyclist reveal that the victim was Kelsey Rennebohm and that although the fatal injuries resulted from being struck by an MBTA bus, there was another event that caused her to fall prior to being struck. The incident occurred on Huntington Avenue near Forsyth Street on the outbound (westbound) side. The Boston Cyclists Union reported, “Eyewitnesses to the crash told the police that Rennebohm appeared to have lost her balance and fallen off her bike from the sidewalk and into the path of a Route 39 MBTA bus, according to Boston Police Department sources familiar with the

http://bpdnews.com/blog/2011/02/03/update-victim-identified-in-fatal-bicycle-accident

This was the only case identified where an incident was reported more than once in the dataset.

See Boston Globe, Bicyclist Killed After Falling into Traffic, June 2, 2012.
http://www.bostonglobe.com/metro/2012/06/02/bicyclist-killed-after-falling-into-traffic-huntington-avenue-friday-night/KTCc97wo1HcRobnKuZPijJ/story.html
Based on the available information, this crash was coded as “Bicyclist Lost Control—Other/Unknown”.

9/14/2012 Doan Bui
A fatal motorist-overtaking case occurred on Sept. 14, 2012, and was not included in the database although it is within the 2009-2012 period (and has been previously described above). Based on press accounts, bicyclist Doan Bui, age 63, was bicycling in the right-hand of three lanes on Morrissey Boulevard near Malibu Beach in Dorchester at 12:25 am. Although there is a shoulder on other parts of Morrissey Boulevard, Bui was on the portion that is a bridge structure with no shoulder and narrow travel lanes. Michael Ahern was driving in the same direction in a Ford F-150 pickup truck after he had several drinks—state police on the scene believed he was drunk. Ahern was traveling 50 mph in a 30 mph zone and hit Bui with such force that he was sent flying 150 feet. Ahern was later convicted of motor vehicle homicide. Facing up to 15 years in prison, Ahern was sentenced to only 1.5 years even though he had a lengthy record of traffic violations and traffic crashes. The public reports about this

33 http://bostoncyclistsunion.org/uncategorized/cyclist-in-huntington-crash-lost-balance/comment-page-1/

34 “According to court records, State Police crash scene investigators recovered the “black box” from Ahern’s truck and believed that he was travelling about 50 miles an hour just before he hit Bui near Malibu Beach. The speed limit there is 30 miles an hour, prosecutors said. Bui was heading home from a night of fishing and was legally riding in the right hand lane of the multi-lane boulevard when he was struck, prosecutors said. Ahern told State Police that he may have had one beer, but investigators learned that he had started drinking around 5 p.m. at the Sel de la Terre on Boylston Street. Around 9 p.m., he went to the Slate Restaurant, which he then co-owned, and where he was seen drinking champagne with a bartender, prosecutors said. After the crash, Ahern was taken to a hospital for treatment before troopers could administer a chemical breath test for sobriety. At the hospital, Ahern refused a doctor’s request to provide a blood sample for medical reasons, prosecutors said. According to state troopers, Ahern slurred his words, was unsteady on his feet, and emitted an odor of alcohol, prosecutors said in court papers.”

35 According to the Suffolk District Attorney: “[Judge] Muse gave Ahern a 2½-year sentence, with 18 months incarceration. He also faces an additional year if he reoffends, or violates judge’s orders, within six years after his release. During that time, he will undergo alcohol abuse evaluation and take part in any necessary treatment, perform 500 hours of community service and will not be able to drive. Daniel O’Malley, Ahern’s lawyer, had asked the judge for the 2½-year sentence, saying Ahern was a man who helped serve his community and had not been driving recklessly. Bui had been riding his bike in the right-hand lane on Morrissey Boulevard near Malibu Beach at about 12:25 a.m. Ahern called 911. He repeatedly told the dispatcher the cyclist had pulled in front of him. State troopers said Ahern, who drove a Ford F-150 pickup truck, appeared to be under the influence as they spoke to him after the crash. Video taken earlier in the day at a Boston restaurant that Ahern co-owned at the time showed Ahern drinking alcoholic beverages and then getting into his truck, according to prosecutors. According to Registry of Motor Vehicles records, Ahern’s license was suspended after the crash that killed Bui. He has a separate, overlapping suspension for defaulting on payment of an August 2012 citation for failing to yield the right of way. He has a seven-page driving record that includes multiple citations for failure to stop, speeding, and accidents. In 1992, his license was revoked as a habitual offender but reinstated two years later.”
http://www.suffolkdistrictattorney.com/jury-convicts-in-crash-that-killed-cyclist/
crash do not indicate whether Bui’s bicycle had a rear reflector or rear light. This single motorist-overtaking fatality within the study time period had the “perfect storm” of risk factors: darkness, narrow travel lane, drunk and speeding motorist.

**9/18/2012, Tanya Connolly.**
This fatality involved a left-turning bicyclist and a truck in the same direction also turning left (B2687). According to news reports, the bicyclist, Tanya Connolly, “was riding her bike on A Street heading toward Dorchester Avenue . . . When she tried to take a left onto West Broadway, she came into contact with a tire on the tractor-trailer, which was also turning left at the intersection, and she was run over.” The account in the Boston Herald says that police said she contacted the right side of the truck. From these details, it appears that the bicyclist was riding too closely beside the truck, unaware that the rear wheels of the trailer may swing wide on the turn. As in the more common case of a right-turning truck, a bicyclist who gets knocked over by the side of the trailer can fall under the rear wheels, often with devastating results.

**11/12/2012, Chung-Wei Yang**
Bicyclist Chung-Wei “Victor” Yang was fatally injured, probably while riding alongside a route 57 inbound MBTA bus on Brighton Avenue just past the intersection with Harvard Avenue in Allston. There is no description of the situation in the police report narrative, but MBTA and BPD statements quoted in the press report that neither the bus driver nor passengers realized that the bus had collided with a bicyclist, who seems to have been riding beside the bus and fell under the rear wheels (B2777). This case was coded as Bicyclist Overtaking—Passing on Right.

**12/6/2012. Chris Weigl**

This fatality involved a tractor-trailer truck turning right from a downhill segment of Commonwealth Avenue eastbound to St Paul Street.\(^{36}\) This incident, the death of Chris Weigl on December 6, 2012 is unusual in that the truck driver apparently started his turn from the second lane from the right lane.

\(^{36}\) News article: http://www.bu.edu/today/2012/student-cyclist-killed-on-comm-ave/
Appendix D: Relevant Traffic Laws

Bicyclist Use of Roadways

City of Boston traffic regulations state that the term “vehicle” includes “bicycles, when the provisions of these Rules are applicable to them.” A driver is “A person who is in actual physical control of a vehicle.” Therefore all of the rules concerning movement of vehicles apply to bicyclists.

Chapter 89 of the Massachusetts General Laws, The Law of the Road, predates both bicycles and motor vehicles, but has been held by the courts to apply to them. Furthermore, Chapter 85 Section 11B says in part that “Every person operating a bicycle upon a way . . . shall have the right to use all public ways in the commonwealth except limited access or express state highways where signs specifically prohibiting bicycles have been posted, and shall be subject to the traffic laws and regulations of the commonwealth.” Although not stated explicitly, the general interpretation of this rule is that bicyclists may use the roadway and when doing so must follow the rules for drivers of vehicles. However bicyclists are in some cases permitted to use sidewalks; implicit in this permission is that bicyclists should follow pedestrian rules when doing so.

The Code of Massachusetts Regulations (CMR) contains traffic laws that apply only to roads defined as state highways, but there are few roads under state control where bicyclists are permitted in the City of Boston. The state traffic rules, in 720 CMR, have the same definition of vehicle as the Boston traffic regulations.

Manner of Making Right Turns

Drivers have two legal responsibilities when preparing a turning to the right:

1. Merge right. "When turning to the right, an operator shall do so in the lane of traffic nearest to the right-hand side of the roadway and as close as practicable to the right-hand curb or edge of the roadway." Massachusetts General Law (MGL) Chapter 90, Section 14
2. Signal. "Every person operating a motor vehicle, before stopping said vehicle or making any turning movement which would affect the operation of any other vehicle, shall give a plainly visible signal . . ." Massachusetts General Law (MGL) Chapter 90, Section 14B

Since a bike lane is a lane of traffic, the first rule means merging into the bike lane in advance of turning, rather than making the turn from the next lane over, across the bike lane. Right-turning motorists who merge into the bike lane (that is, after making a safe lane change) may temporarily block the lane, but they make it much harder for bicyclists to pass unsafely on their right.

It is frequently not "practicable" for large trucks to merge all the way to the curb and still complete the turn without rolling over the sidewalk.

Motorists are not allowed to pass a bicyclist and then immediately turn; this is a violation of the lane position rule. If a driver passes at a safe distance to the left as required by MGL Ch. 89 Sec 2, the vehicle cannot also be "as close as practicable to the right-hand curb or edge of roadway," which is where it is
required to be before making a turn. This idea is reinforced by another part of Ch. 90 Sec 14: "No person operating a vehicle that overtakes and passes a bicyclist proceeding in the same direction shall make a right turn at an intersection or driveway unless the turn can be made at a safe distance from the bicyclist at a speed that is reasonable and proper." This rule only applies to the case where the motorist is passing the bicyclist, not when the bicyclist is passing the motorist. Despite its clear meaning, it has been used to mean that bicyclists must stop and look right and to the rear for bicyclists before making any right turn.37

Massachusetts law, uniquely among the 50 states, gives bicyclists permission to pass on the right without limitation. However, just because a bicyclist does not commit a violation for passing on the right doesn’t mean it is illegal for motorists to turn right without first checking their mirrors. The Turning Vehicles Yield to Bikes signs (see illustration) that have been installed in various locations in Boston since 2013 are not enforceable, since there is no statute requiring motorists to yield when turning right to bicyclists on the roadway, only to pedestrians in the crosswalk.

Opening Vehicle Door

Massachusetts General Laws (MGL) Chapter 90, Section 14 states, among many other things, “No person shall open a door on a motor vehicle unless it is reasonably safe to do so without interfering with the movement of other traffic, including bicyclists and pedestrians.” Although this rule has long been included in the traffic laws of most U.S. states, it went into effect in Massachusetts only in January 2009, at the beginning of the data collection period.

Operating on the Sidewalk

Massachusetts General Laws (MGL) Chapter 90, Section 14 states that “bicycles may be ridden on sidewalks outside business districts when necessary in the interest of safety, unless otherwise directed by local ordinance.” City of Boston Traffic Rules and Regulations say that a bicycle is a vehicle “when the provisions of these Rules are applicable to them.” Further, they say that “The driver of a vehicle shall not drive on or over any sidewalk except at a permanent or temporary driveway.” This could be interpreted as a local regulation that further restricts sidewalk bicycling. Alternatively, this could be one of those unspecified places where the provisions of the rules are not applicable. If bicyclists do use the sidewalk, they should follow pedestrian rules (as is explicitly stated in many state vehicle codes). One of these rules is “No pedestrian shall leave a sidewalk or safety island and walk or run into the path of a moving vehicle which is so close that it is impossible for the driver to yield the right-of-way.” This means that a sidewalk bicyclist should slow, look, and yield before entering a crosswalk or crossing a driveway.

37 It is given this meaning in the video that MassBike made cooperated with several police departments) and in the Massachusetts Separated Bike Lane Planning & Design Guide.
Operating with the Flow of Traffic

Keeping to Right Half of Roadway
Massachusetts lacks a statute generally requiring all vehicles to keep to the right half of the road. However, courts have said that the rule that a vehicle must turn out to the right when meeting a vehicle approaching from the other direction means that vehicles must normally operate on the right half of the road. City of Boston traffic rules say that “The driver of a vehicle shall not drive other than on the right half of the roadway, except on one-way streets, where signs have been erected to the contrary, or when overtaking and passing another vehicle.”

Operating Only in the Designated Direction on One-Way Streets
Massachusetts lacks a statute requiring drivers to operate only in the correct direction on streets that have been designated as one-way streets. However, City of Boston traffic rules require drivers to obey all official traffic signs and include a list of streets designated for one-way operation.

Nighttime Equipment
MGL Ch. 85 Section 11B includes the basic rule for nighttime equipment on bicycles: “(8) During the period from one-half hour after sunset to one-half hour before sunrise, the operator shall display to the front of his bicycle a lamp emitting a white light visible from a distance of at least five hundred feet, and to the rear of said bicycle either a lamp emitting a red light, or a red reflector visible for not less than six hundred feet when directly in front of lawful lower beams of headlamps on a motor vehicle. A generator powered lamp which emits light only when the bicycle is moving shall meet the requirements of this clause.”

In addition to requiring front and rear illumination, Massachusetts has a rule that requires pedal or leg reflectors: “(9) During the period from one-half hour after sunset to one-half hour before sunrise, the operator shall display on each pedal of his bicycle a reflector, or around each of his ankles reflective material visible from the front and rear for a distance of six hundred feet, and reflectors or reflective material, either on said bicycle or on the person of the operator, visible on each side for a distance of six hundred feet, when directly in front of lawful lower beams of headlamps of a motor vehicle. This clause shall not prohibit a bicycle or its operator to be equipped with lights or reflectors in addition to those required by clauses (8) and (9).”

Driving Motor Vehicles in Bike Lanes
The only city or state law applying to the use of bike lanes is MGL Chapter 89 Section 4B: “Upon all ways the driver of a vehicle shall drive in the lane nearest the right side of the way when such lane is available for travel, except when overtaking another vehicle or when preparing for a left turn. When the right lane has been constructed or designated for purposes other than ordinary travel, a driver shall drive his vehicle in the lane adjacent to the right lane except when overtaking another vehicle or when preparing for a left or right turn; provided, however, that a driver may drive his vehicle in such right lane if signs have been erected by the department of highways permitting the use of such lane.”
Since a bike lane is “designated for purposes other than ordinary travel,” motorists must use the “lane adjacent” except when overtaking or preparing for a left or right turn. Thus it is explicitly authorized for motorists to use a bike lane to overtake on the right (when the vehicle ahead is signaling left) and to prepare for a right turn. However, in either case, MGL Ch. 89 Section 4A applies: “the driver of a vehicle . . . shall not move from the lane in which he is driving until he has first ascertained if such movement can be made with safety.”

The statute does not contemplate left-side bike lanes. There is no general prohibition on driving in them. It could be argued that a driver who attempts to drive a 6-ft wide motor vehicle in a 4-ft wide bike lane is violating the rule that “the driver of a vehicle shall so drive that the vehicle shall be entirely within a single lane.” However, if this were the case, when making a right turn, he or she would also be violating the rule that the right turn must be made “in the lane of traffic nearest to the right-hand side of the roadway and as close as practicable to the right-hand curb or edge of roadway.” And in the case of left-side bike lanes, he or she would be violating the rule that the turn must be made from “the lane of traffic to the right of and nearest to the center line of the roadway.”

Parking in Bike Lanes

City of Boston Traffic Rules and Regulations prohibit stopping, standing, or parking “Upon any roadway, unless both wheels on the side of the vehicle adjacent to the curb are within one (1’) foot of the curb or edge of the roadway, except where angle parking is permitted or commercial vehicles, as defined, are permitted to back to the curb or edge of the roadway.” Therefore, where bike lanes are adjacent to on-street parking it is illegal to “stop, stand, or park” in them. Each of these terms has a specific meaning:

- Stopping is defined as “The halting, even momentarily of a vehicle, whether occupied or not, except when necessary to avoid conflict with other traffic.”
- Standing is defined as “The halting of a vehicle, whether occupied or not, other than for the purpose of, and while actually engaged in, receiving or discharging passengers.”
- Parking is defined as “The stopping or standing of a vehicle, whether occupied or not.”

Therefore, if there is an occupied parking lane, it is not lawful to discharge passengers while stopped in a travel lane or a bike lane. However, motorists must stop at least temporarily to back into on-street parking, and because on-street parking in Boston is generally priced well below market levels, it is common for motorists to wait next to spaces that might soon become available. In addition, taxi drivers frequently discharge passengers in travel lanes because it is impossible to reach the curb. Bus stops would be a logical place for taxis to pick up and discharge passengers, but the Traffic Rules and Regulations prohibit even “stopping” (to discharge passengers) in all bus stops.

Where bike lanes are adjacent to a curb, there was no general prohibition on parking in them until the adoption of a new ordinance in 2009 that prohibits standing or parking in a marked bike lane. The ordinance does not prohibit stopping to discharge or receive passengers. However, the standard sign for bike lanes in the Boston Sign Code Book is “No Stopping Bike Lane.”