Dane County

Bicycle and Pedestrian Crash Study

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February 2018

Madison Area Transportation Planning Board

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The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation or WisDOT.

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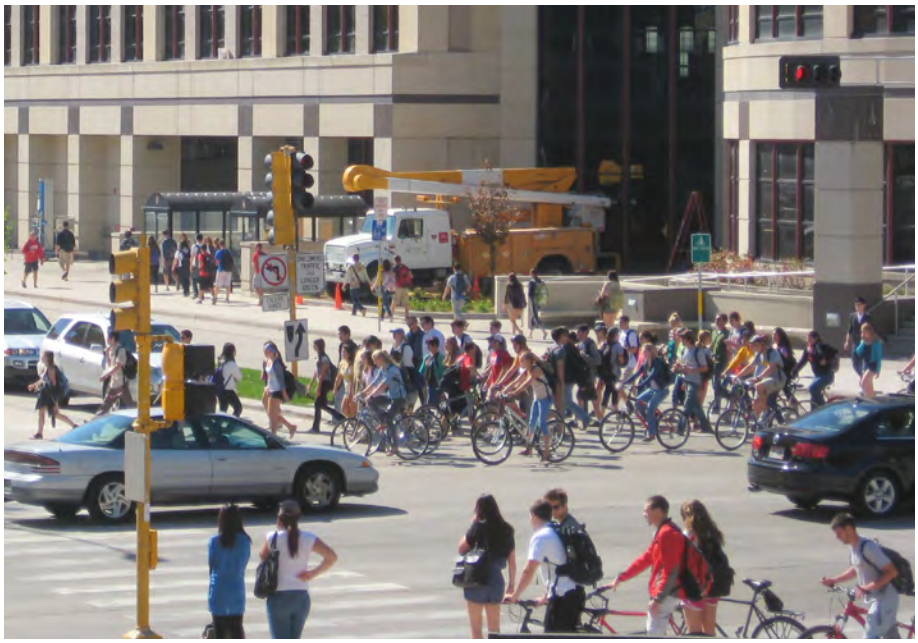
Introduction

During the years 2011-2015, there were 798 documented motor vehicle crashes involving bicyclists and 552 involving pedestrians in Dane County, resulting in a total of 29 deaths. The purpose of this study was to identify the common features of these crashes to guide safety improvement efforts, measure the change in bicycle safety since the City of Madison's 1992 bicycle crash study, and set a benchmark for future safety performance measurement in the Madison metropolitan area and Dane County.

Methodology

The data used in this study was developed from a careful review of the crash report filed for each crash, along with data included in the general purpose crash data file produced by the Wisconsin Department of Transportation (WisDOT) Bureau of Traffic Operations (BTO), and distributed by the Wisconsin Traffic Operations and Safety (TOPS) Laboratory at the University of Wisconsin-Madison. All bicycle and pedestrian crashes were categorized according to two different crash categorization systems, the type of facility on which the bicyclist or pedestrian was traveling, whether the bicyclist or pedestrian was traveling with or against motor vehicle travel in the adjacent lane, the location of pedestrian crash victims in or outside of available crosswalks, and other factors.

Unfortunately, comprehensive data regarding bicyclist and pedestrian exposure—such as total annual miles of bicycle or pedestrian travel—is not available. This makes it impossible to quantify overall bicycle and pedestrian safety risk and the comparative bicycle and pedestrian crash risk of different locations. The lack of demographic and other data on bicyclists and pedestrians also limits conclusions that can be drawn from the crash data. For example, is the higher number of crashes involving male bicyclists a result of their bicycling behavior or mostly due to the fact they bicycle at much higher rates?

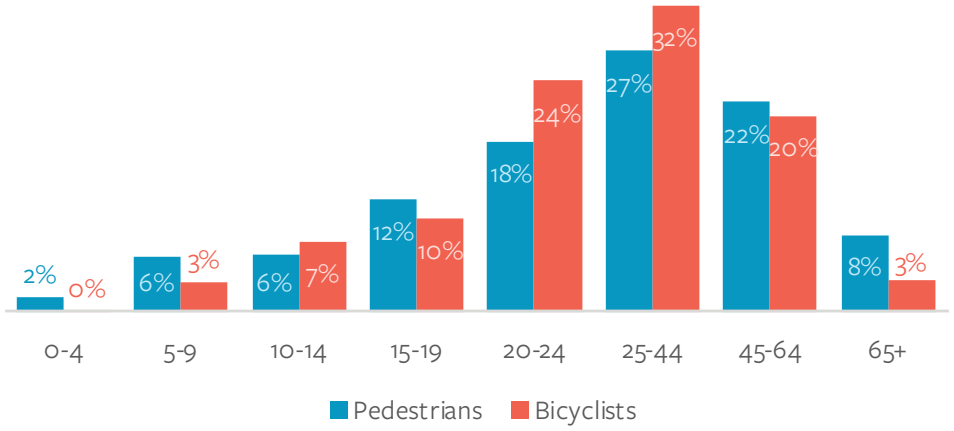


Overview

Demographics

As shown in Figure 1, bicyclists involved in crashes tend to be somewhat more concentrated in the center of the age spectrum than pedestrians. Males are more heavily represented than females among both bicyclists and pedestrians involved in crashes, representing about 70% of bicycle crash victims and 55% of pedestrian crash victims.

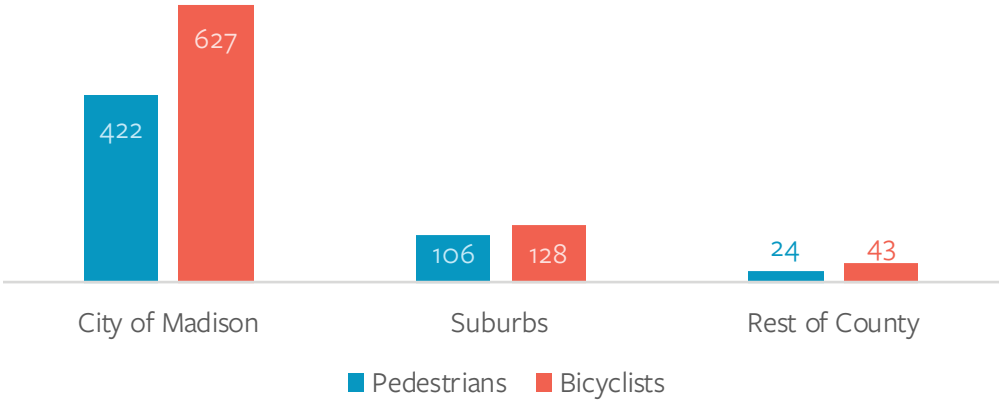
Figure 1: Age of Bicyclists and Pedestrians Involved in Crashes



Crash Summary

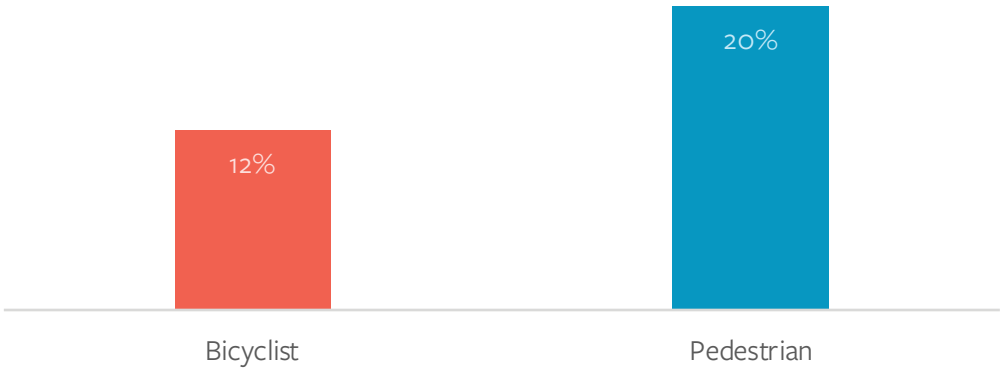
The City of Madison accounts for nearly 80% of the 1,350 bicycle and pedestrian crashes that took place in Dane County during the 2011-2015 study period, with the suburbs in the MPO planning area accounting for most of the remainder.

Figure 2: Bicycle and Pedestrian Crashes in Dane County



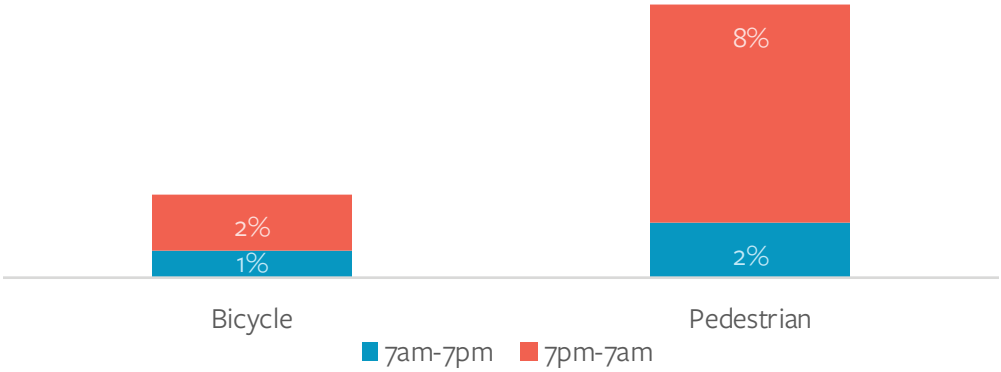
12% of bicycle crashes and 20% of pedestrian crashes were hit-and-runs. Interestingly, most of these crashes occurred during the day. 72% of the hit and run crashes involving bicyclists, and 63% of those involving pedestrians, occurred during the 7:00 am – 7:00 pm period.

Figure 3: Hit-and-Run Crashes as a Percentage of All Pedestrian and Bicycle Crashes



Alcohol use by one or both parties was a factor in nearly 10% of pedestrian crashes and about 3% of bicycle crashes. Most of this disparity is due to crashes taking place in the evening hours, between 7:00 pm and 7:00 am, as shown in Figure 4.

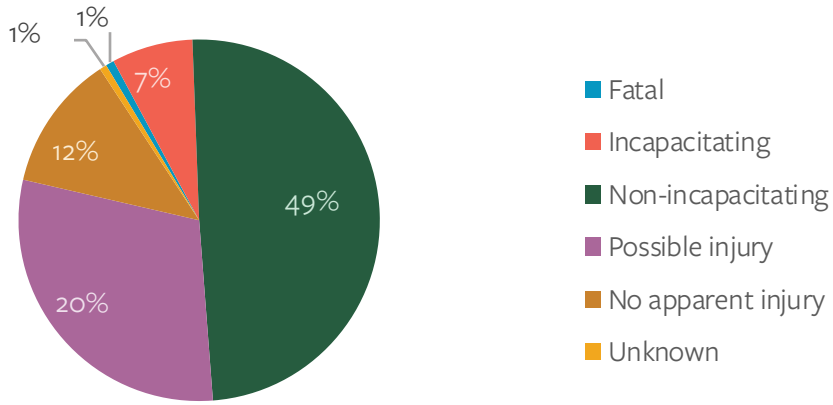
Figure 4: Alcohol-Related Bicycle and Pedestrian Crashes



Bicycle Crashes

Overall, there were 798 reported bicycle crashes in Dane County during the study period. Of these, 0.8% (6) were fatal and another 7.3% (58) resulted in an incapacitating injury. The term "incapacitating," as used in the MV4000 crash reports that are the basis for the data used in this study, refers to an injury that makes it impossible for the injured person to transport themselves away from the scene of the crash, and encompasses a wide range of injury severities. The vast majority of reported bicycle crashes do not result in serious injuries. Injury severity is closely correlated with posted speed limits. Five of the six fatal bicycle crashes that took place during the study period occurred on roads with speed limits of at least 35 mph, despite these roads accounting for only 20% of total reported bicycle crashes.

Figure 5: Bicyclist Injury Severity



Bicycle Crash Types

Bicycle crashes were categorized according to two separate typologies. The first was developed by the National Highway Transportation Safety Administration (NHTSA). The 39 NHTSA types used to classify crashes can be grouped into larger categories for analysis—e.g. *Motorist Left Turn* includes both *Motorist Left Turn – Facing Bicyclist* and *Motorist Left Turn – In Front Of Bicyclist*. Table 1 details the top NHTSA crash type categories in Dane County.

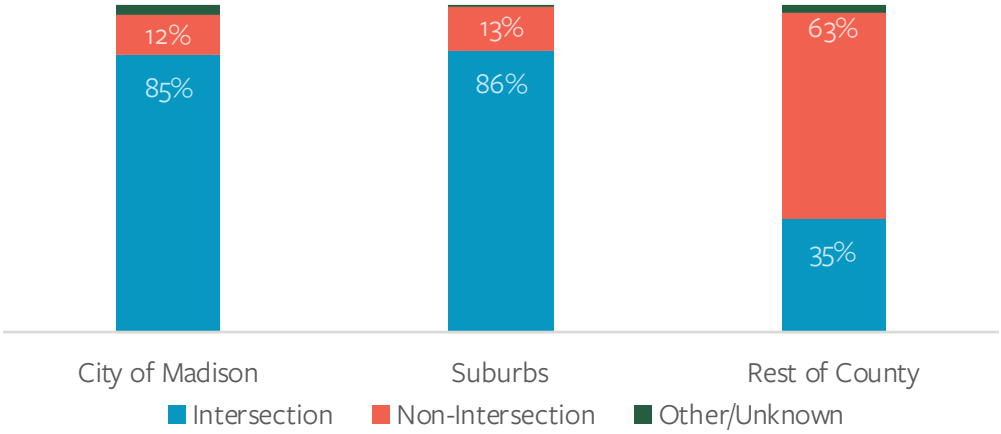
Dooring, crashes that involve a bicyclist striking the open door of a stopped vehicle, accounted for just 1% of crashes in Dane County, a much lower percentage than in many larger cities.

Table 1 : Top NHTSA Bicycle Crash Categories in Dane County

Crash Category	#	%
Motorist Left Turn	174	22%
Motorist Drive Out/Through at Intersection	147	18%
Motorist Right Turn	141	18%
Bicycle Ride Out/Through at Intersection	95	12%
Motorist Overtaking	55	7%
Bicycle Right or Left Turn	31	4%
Bicycle Overtaking	32	4%
Bicycle Ride Out at Midblock	24	3%
Motorist Drive Out at Midblock	23	3%
Other	76	9%
Total	**798**	**100%**

Unlike the NHTSA crash types, Location Movement Classification Method (LMCM) crash types are based exclusively on where a crash occurs and the relative movements by the parties to the crash, without regard to traffic control devices or other circumstances that may have influenced the crash. This focus on location and direction of movement makes LMCM types useful in identifying differences and commonalities in crash location. As shown in Figure 6, roughly 85% of crashes in the City of Madison and the suburbs in the MPO planning area occurred at intersections. Elsewhere in the County, the majority of crashes occurred at non-intersection locations.

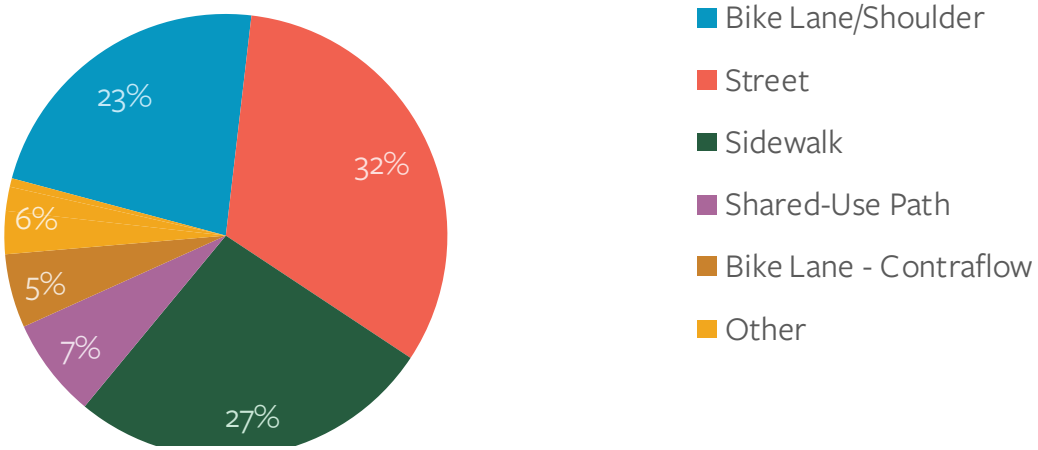
Figure 6: LMCM Crash Types By Community



Facilities

Bicyclists are almost always in the roadway when they are struck by motor vehicles, but many are merely crossing the roadway in order to continue along the shared-use path or sidewalk on which they are riding. As shown in Figure 7, streets were the most common type of facility being used by bicyclists involved in crashes, with sidewalks being the second most common. While we lack reliable information about the relative share of miles ridden by bicyclists on sidewalks compared to other types of facilities, bicyclists riding on sidewalks almost certainly face a higher overall crash risk than those using other types of facilities. This may be in part due to the types of bicyclists (e.g., younger, less experienced) that ride on the sidewalk as well as the false sense of security it provides, given that street intersections are where most crashes occur.

Figure 7: Facility Used by Bicyclists Involved in Crashes



Traveling With/Against Traffic

Bicyclist travel direction relative to adjacent motor vehicle traffic appears to play a significant role in crash risk. Traveling against traffic does not necessarily indicate that a bicyclist was riding in the wrong direction. For example, contraflow bicycle lanes, like the one on the south side of University Avenue in the UW campus area, are designed so that bicycle traffic flows against motor vehicle traffic. Generally, bicycle traffic should flow with motor vehicle traffic on bike lanes, shoulders, and streets.

Sidewalks and shared-use paths are unique in that riders may travel in either direction. Crashes involving bicyclists using these facilities dramatically illustrate the increased risk faced by bicyclists traveling against traffic. In both cases, the number of crashes involving bicyclists traveling against traffic is more than 3.5 times those involving bicyclists traveling with traffic. This disparity does not appear in pedestrian crashes and suggests that bicyclists' higher speeds may put them at particular risk when traveling against traffic.

Half of all crashes involving children under the age of 14 involve a bicyclist riding on the sidewalk, and in 60% of these cases the bicyclist was riding against traffic.

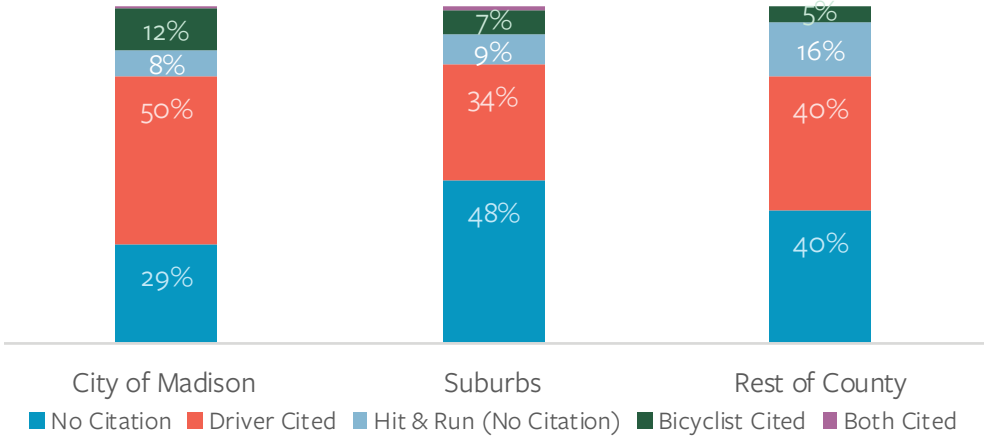
Table 2: Facility Used by Bicyclist and Direction Relative to Motor Vehicles in Adjacent Roadway Travel Lane

	With	Against	Intersection	Stopped	Unknown	Total	
Facility Type	%	%	%	%	%	#	%
Bike Lane/Shoulder	97%	3%	0%	0%	0%	181	100%
Bike Lane - Contraflow	2%	98%	0%	0%	0%	43	100%
Street	89%	3%	5%	0%	2%	259	100%
Bike Boulevard	100%	0%	0%	0%	0%	14	100%
Shared-Use Path	14%	53%	31%	0%	2%	58	100%
Sidewalk	20%	69%	5%	0%	6%	213	100%
Unknown	68%	16%	4%	4%	8%	25	100%
Driveway	0%	0%	100%	0%	0%	5	100%
Grand Total	**61%**	**30%**	**6%**	**0%**	**3%**	**798**	**100%**

Citations

As shown in Figure 8, following crashes both bicyclists and drivers were cited at a higher rate in the City of Madison than elsewhere in the county. Potential reasons for this disparity include differences in law enforcement experience and training dealing with bicycle crashes, or a greater number of potential witnesses to crashes within the City.

Figure 8: Citations Issued in Bicycle Crashes by Municipality



Common Crash Scenarios

Certain common crash scenarios are not directly identified by the NHTSA and LMCM crash types used to classify bicycle crashes in this study. The following common crash scenarios were identified based on data aggregated by using a combination of NHTSA and LMCM crash types.

Motorist Right Turn from Stop – Bicyclist Approaching from the Right

Crashes between motorists making a right turn from a stop at a stop sign or red light and bicyclists traveling against traffic on a sidewalk or shared-use path approaching from the motorist's right are among the most common in the Madison area. These made up 12% of all crashes during the study period, with just over half of these occurring at traffic lights.

Right/Left Hook Crashes

Right hook crashes are those that occur when a car makes a right turn into or right in front of a bicyclist traveling in the same direction on the right side of a motorist, often in a bicycle lane. Left hook crashes, as defined in this report, are the mirror image of right hook crashes, involving a bicyclist traveling on the left side of a motorist traveling in the same direction who is hit or cut off when the motorist makes a left turn. These crashes made up 12% of all bicycle crashes during the study period, the vast majority of which occurred in the City of Madison.

Overtaking Crashes

Crashes involving bicyclists traveling straight being struck from behind by straight traveling motorists were dominant in rural parts of Dane County. These provoke particular anxiety among cyclists due to the fact that the motor vehicle is approaching from behind, making it nearly impossible for the bicyclist to anticipate and avoid the crash. Overtaking crashes accounted for 6% of all bicycle crashes that occurred during the study period. Nearly half of these crashes were hit-and-runs.

Comparison to the 1992 City of Madison Bicycle Crash Study

This study comes 25 years after a similar study, which focused on bicycle crashes in the City of Madison during the four-year 1987-1990 period. Despite population growth of more than 25% and a 50% increase in the rate of bicycle commuting, the annual crash rate between bicycles and motor vehicles has declined substantially. It is likely that this reduction in bicycle crashes has been driven by both large-scale investments in bicycle infrastructure and smaller safety improvement projects during the intervening years, along with safety education efforts. It also provides some validation for the "safety in numbers" theory: as the number of bicyclists increases, motorists are more inclined to look for, notice, and yield to them when appropriate. Table 3 provides an overview of these two studies.

Table 3: Comparison of 2018 and 1992 Crash Studies

	2018 Study	**1992 Study**
Time Period	2011-2015	1987-1990
Number of Years	5	4
Study Area	Dane County	City of Madison
Total Crashes*	798	774
Bicycle Crashes - City of Madison		
Total Crashes	627	774
Population	243,122 (2011-2015 est.)	190,766 (1990)
Annual Crashes	125	194
Bicycle Commuting Pct.	5.2% (2011-2015 est.)	3.3% (1990)
Crash Rate per 100,000 pop.	51.4	101.7

* Includes only motor vehicle – bicycle crashes

Pedestrian Crashes

Overall, there were 552 reported pedestrian crashes in Dane County during the study period. Of these, 4.2% (23) were fatal and another 14.3% (79) resulted in an incapacitating injury. While the majority of reported pedestrian crashes do not result in serious injuries, the rate of fatal and incapacitating injury in crashes with motor vehicles is much higher for pedestrians than for bicyclists.

While the overall fatality rate for pedestrians involved in reportable crashes was 4.2%, the fatality rate was much higher for streets with higher speed limits. 22% of the crashes that occurred on roads with speed limits of at least 40 mph were fatal, compared to just 1% of the crashes that occurred on roads where the speed limit is 25 mph or below.

Pedestrian Crash Types

Like bicycle crashes, pedestrian crashes were categorized according to both NHTSA and LMCM typologies. Table 4 details the top NHTSA pedestrian crash type categories in Dane County. Most common are crashes involving turning or merging vehicles at intersections in which the driver fails to yield to the pedestrian. These

Table 4: Top NHTSA Pedestrian Crash Categories in Dane County

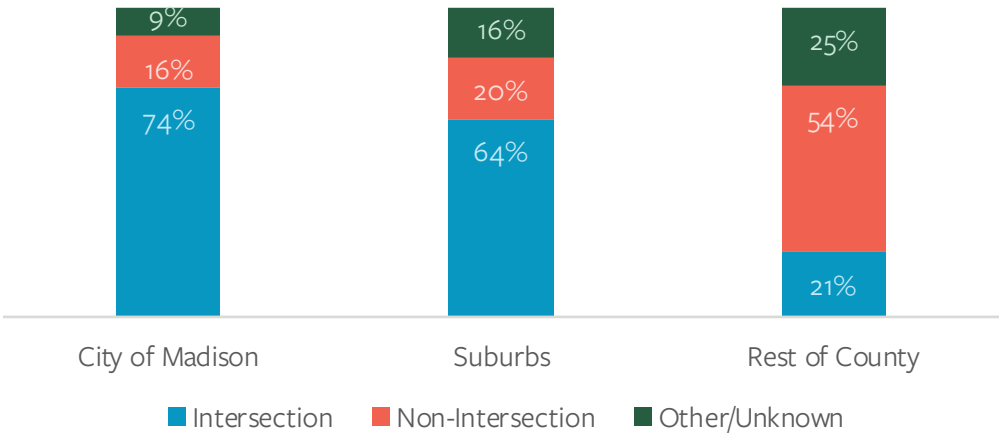
Crash Category	**#**	**%**
Intersection - Vehicle Turn Or Merge	187	34%
Intersection Dash/Walkout	80	14%
Driver Violation (Intersection or Midblock)	66	12%
Midblock Dart Out/Dash/Walkout	38	7%
Working/Playing in Roadway	27	5%
Multiple Threat/Trapped	26	5%
Walked Into Vehicle	18	3%
Special Circumstances	17	3%
Not in Road	14	3%
Backing Vehicle	13	2%
Walking Along Road	12	2%
Other and Unknown	54	10%
Total	**552**	**100%**

crashes account for more than 1/3 of all pedestrian crashes. Intersection dashes, where a pedestrian fails to yield and runs into an intersection or is obstructed from the driver's view as they enter the intersection, and walkouts, where the pedestrian fails to yield to traffic as they walk out into the intersection, represent the next most common pedestrian crash type. Thirty of the 52 crashes identified as walkouts, 30 involved pedestrians violating a traffic signal as they walked out into the intersection. Driver violations involve straight-traveling motorists that committed some type of violation, which could include anything from failure to yield to driving while intoxicated.

It is important to note that each crash is unique and that these crash types do not necessarily imply fault on the part of any one party to the crash.

Figure 9 details the number of intersection, non-intersection, and other crashes, based on pedestrian LMCM crash types. Intersection crashes are most numerous in the City of Madison and the suburbs, but non-intersection crashes dominate in the rest of Dane County.

Figure 9: Top LMCM Crash Categories by Community

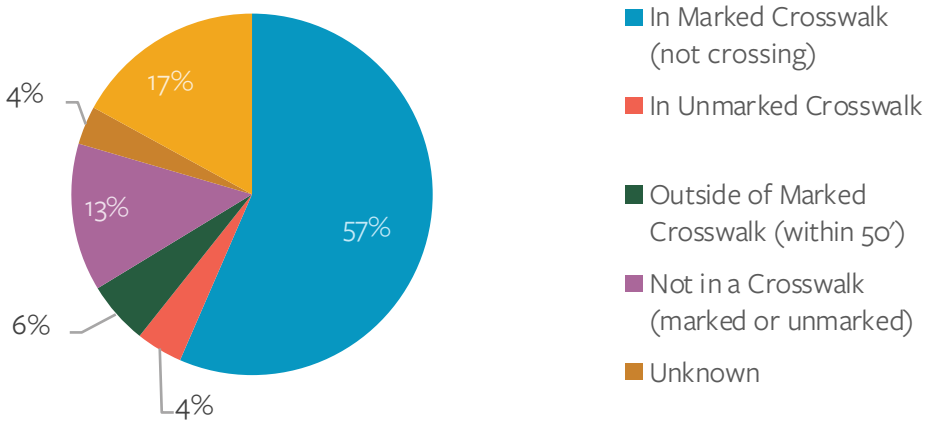


Use of Crosswalk

Overall, 57% of pedestrians involved in crashes were struck while using a marked crosswalk. An additional 4% were struck while using a legal unmarked crosswalk. 6% were struck while crossing outside of the marked crosswalk within 50 feet of an available marked crosswalk. 13% of pedestrians were struck crossing a roadway without a crosswalk; of these 73 crashes, 72 occurred at midblock locations (some of these were within 50 feet of an unmarked crosswalk) and one occurred at an intersection where no unmarked crosswalk was available[1].

Of the 17% of pedestrians that were not crossing when they were struck, just over half were walking in the street or in a bike lane or shoulder. Only 7% were on the sidewalk.

Figure 10: Pedestrian Crashes by Crosswalk Usage



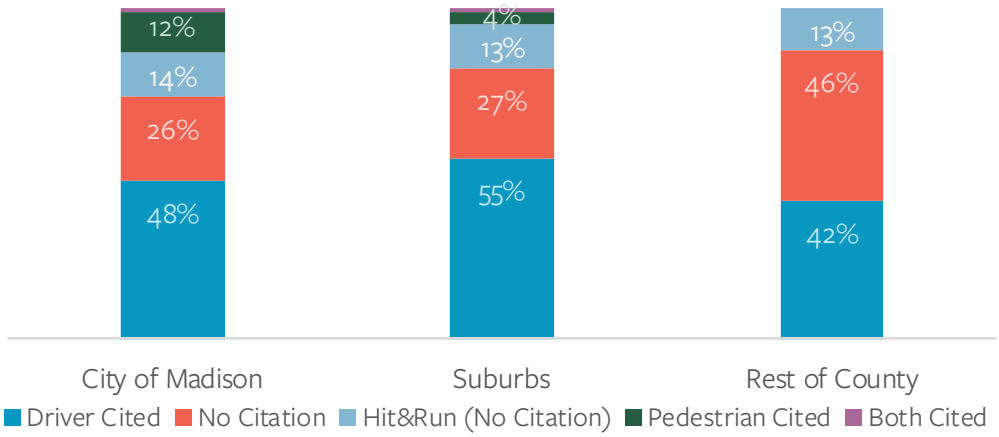
1 Under State of Wisconsin Statutes, unmarked crosswalks exist only at locations where there is a sidewalk on at least one side of an intersection. 340.01 (10) https://docs.legis.wisconsin.gov/document/statutes/340.01(10)

Citations

Overall, drivers in Dane County received a citation in about half of all pedestrian crashes while pedestrians were cited in nearly 10%. In about 40% of crashes, including hit-and-runs, neither party received a citation. However, the rate of citations among drivers and pedestrians varied between communities.

Pedestrians were much more likely to receive citations following crashes in the City of Madison than in other parts of Dane County. Crashes in which no citation was issued to either party were much more common outside of the metro area. While there was no citation issued in about 40% of the crashes occurring in Madison and its surrounding suburbs, this figure climbs to 60% outside of the metro area. Possible reasons for these disparities include differences in the availability of witnesses, pedestrian behavior, law enforcement practices, or other variables.

Figure 11: Citations Issued in Pedestrian Crashes by Municipality



Highlights

- The bicycle-motor vehicle crash rate per 100,000 people in the City of Madison during the 2011-15 period was roughly half of the 1987-90 rate, despite substantial population growth and an increase in bicycle commuting. (historical data not available for Dane County)
- During the years 2011-15 in Dane County, there were 798 documented motor vehicle crashes involving bicyclists and 552 crashes involving pedestrians.
- While there were fewer pedestrian crashes than bicycle crashes, pedestrian crashes were more likely to be fatal. About 4.2% of reported pedestrian crashes were fatal, compared to 0.8% of bicycle crashes.
- Hit-and-run crashes accounted for 12% of all bicycle crashes and 20% of pedestrian crashes.
- Most bicycle and pedestrian crashes involved turning motorists at intersections.
- Bicyclists riding on sidewalks against adjacent motor vehicle traffic face a crash risk roughly 3.5 times greater than those riding with traffic.
- Over 60% of pedestrians involved in crashes were in a marked or unmarked crosswalk at the time of the collision.

Next Steps

Dangerous behaviors—speeding, impairment, inattention, or simply failing to obey traffic controls—are a contributing factor in the vast majority of crashes. These behaviors must be addressed through education and enforcement. Engineering solutions should continue to be used to mitigate the risk of crashes at certain locations, particularly at high volume intersections with many roadway users and conflict points. Finally, in order to better evaluate safety needs and target these solutions, better information about crashes and travel trends is required. Maximizing safety for bicyclists and pedestrians will require a comprehensive approach that involves strategies in all of these areas.

Evaluation

The two most significant limitations to the present study were both related to data availability. Usage cannot be determined without comprehensive bicycle and pedestrian count data, and a lack of information about crashes for which no report was filed means some crashes are missing from the analysis. The Madison Area Transportation Planning Board (MATPB) will work to address both of these limitations to improve bicycle and pedestrian safety information in the coming years.

MATPB staff will work with City of Madison Traffic Engineering and other local community staff to supplement Madison's extensive permanent bicycle count program with a short-duration count program using portable counters. This will allow more comprehensive tracking of bicycling activity over time and allow an estimate of annual average bike volumes by applying factors derived from the permanent count locations to the short-duration count locations. In addition to enabling location-based risk or exposure analysis, this data could be used to evaluate the likely impacts of new infrastructure on bicycle use, which would be helpful in project prioritization. While collecting pedestrian exposure data is more challenging, MATPB will continue to investigate ways to gather this information as well.

Over the coming year, MATPB also plans to analyze National Household Travel Survey (NHTS) data and the findings of a separate local household survey using the same questions and travel logs to better understand bicyclist and pedestrian travel and demographics of those using these modes.

In order to gather information about unreported crashes, MATPB will look into integrating emergency room admission data and other information sources, such as bikemaps.org, into future updates of this study.

Engineering

MATPB's Regional Transportation Plan (RTP) 2050 highlights high priority gaps and barriers in the bicycle and pedestrian networks. MATPB is building upon this analysis by identifying and mapping the "low-stress" bikeway network and its gaps using a new "bicycle level of traffic stress" methodology. MATPB's RTP 2050 also makes recommendations related to other policies that set the stage for future development that supports pedestrian and bicyclist safety.

MATPB will supplement future updates to this bicycle and pedestrian crash analysis with an evaluation of different types of recently installed pedestrian and bicycle safety treatments by monitoring crash data at locations where these treatments have been installed.

MATPB will continue efforts to inform local officials and staff about available resources related to designing streets and other facilities for safe pedestrian and bicycle travel. Cities and villages in Dane County should ensure that their local transportation policies (e.g., Vision Zero), plans, and engineering design guidelines adequately address appropriate countermeasures.

Education

MATPB staff will support the efforts of the Dane County Traffic Safety Commission, Safe Communities of Madison and Dane County, and other groups to educate drivers, bicyclists, and pedestrians about common crash scenarios and promote traffic safety.

Enforcement

MATPB is working with the Dane County Traffic Safety Commission and Safe Communities of Madison and Dane County to communicate county-specific information to law enforcement in Dane County and to encourage targeted enforcement efforts performed in conjunction with education campaigns to improve bicyclist and pedestrian safety.

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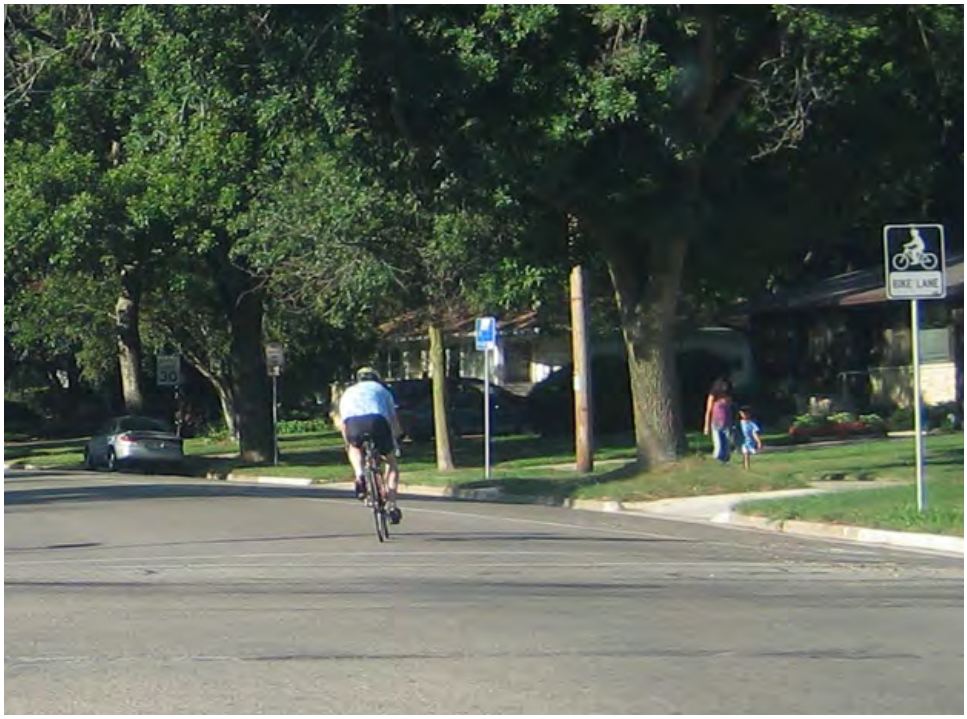
Chapter 1

Introduction & Methodology

- Introduction
- Purpose
- Methodology

Introduction

This study follows an analysis conducted 25 years ago by City of Madison Traffic Engineering staff, which analyzed bicycle crashes in the city between 1987 and 1990. In the intervening years, the city's population has grown by about 30% while the county's has grown by nearly 45%. In addition to the area's higher population, data from the US Census shows that between 1990 and the 2011-2015 period the proportion of adult bicycle commuters grew from an estimated 3.4% to 5.2% in the City of Madison and from 1.9% to 2.9% in Dane County overall. The percentage of adults walking to school and work declined during this period, falling from 12.7% to 9.5% in the City of Madison and from 8.3% to 5.6% in Dane County.



Purpose

There were three primary goals for this study: (1) identify the common types, characteristics, and locations of motor vehicle crashes involving bicyclists and pedestrians to inform education and enforcement efforts and facility design; (2) assess the changes in bicyclist safety in the City of Madison since the 1992 study; and (3) set a baseline of bicyclist and pedestrian crash statistics against which to assess changes in the future. Understanding the common circumstances behind these crashes—location, facility type, driver and pedestrian/bicyclist actions, etc.—will help planners, engineers, policymakers, law enforcement, and safety advocates maximize the impacts of their traffic safety activities. Quantifying how bicycle crashes have changed over the last 25 years will help us understand how bicycle safety has been affected by new bicycle infrastructure, policies, and broader changes in the community. This detailed collection of bicycle and pedestrian crash data will also be a valuable benchmark in the years to come, making it possible to more accurately assess the impacts of new bicycle- and pedestrian-focused policies and facilities.

Methodology

Data Sources

The crash data used for this analysis was based on the general purpose crash database produced by the Wisconsin Department of Transportation (WisDOT) Bureau of Traffic Operations (BTO), and distributed by the Wisconsin Traffic Operations and Safety (TOPS) Laboratory at the University of Wisconsin-Madison. The crash database includes a wide variety of data about the drivers and vehicles involved, weather conditions, roadway characteristics, time of day, and crash locations of all reportable crashes for which a MV4000 crash report was completed by a police officer.

Because crash reports are only required in cases involving personal injury, damage exceeding $1000 to any one person's property, government vehicle damage exceeding $1000, or other government property damage exceeding $200; there may be no crash report filed, even if police are called following a crash. In addition, drivers, bicyclists, and pedestrians may avoid contacting the police following a crash—even one involving personal injury or significant property damage for a variety of reasons. Therefore, many bicycle and pedestrian crashes are, unfortunately, not included in this dataset because there was no crash report filed.

This analysis was limited to those motor vehicle crashes identified in the database as occurring in Dane County between 2011 and 2015 and involving a pedestrian or bicyclist. The original crash report was reviewed for each of these crashes to classify them according to crash type and other characteristics described on the next page.

Municipality Groups

In many areas throughout this report, crashes are grouped by community type to facilitate more useful analysis. Crashes are grouped accordingly:

- City of Madison
- Suburban Communities within the MPO Planning Area, including:
  - Cities of Fitchburg, Middleton, Monona, Stoughton, Sun Prairie, and Verona
  - Villages of Cottage Grove, Cross Plains, DeForest, Maple Bluff, McFarland, Oregon, Shorewood Hills, Waunakee, and Windsor (unincorporated during the study period)
  - Town of Madison
- Other Communities, including:
  - Other unincorporated areas within the boundaries of the MPO Planning Area
  - Small villages and rural towns elsewhere in Dane County

Fields for analysis

While the crash database provided by the TOPS lab includes a wealth of information, this analysis is primarily focused on new data fields added to the database by MPO staff containing additional crash characteristics derived from the original crash reports, particularly the narrative description of the crash and the accompanying diagram.

Crash Types

The most important of these additional data fields are the two crash typologies used to categorize crashes. The first is based on crash types developed by the National Highway Traffic Safety Administration (NHTSA) and the second, the Location Movement Classification Method (LMCM), was developed by researchers at the University of Wisconsin-Milwaukee. The two crashttyping systems differ primarily in that the NHTSA types focus on the cause of the crash—e.g. "Motorist Left Turn in Front of Bicyclist," while the LMCM types are based solely on the relative directions and locations of the vehicles and pedestrians involved in the crash, without regard to the precipitating circumstances.

NHTSA Crash Types

Bicycle Crash Types

The 38 bicycle crash types identified in FHWA's *Crash Type Manual for Bicyclists* were expanded to 39 for the present study with the division of the category "Bicyclist Strikes Parked Vehicle" into crashes where the bicyclist strikes the open car door of a parked vehicle and those where the bicyclist strikes a parked car in any other manner.

Pedestrian Crash Types

The 38 pedestrian crash types used in this study mirror the 36 crash types identified in FHWA's *Pedestrian Crash Types: A 1990's Informational Guide* with the addition of two additional types, "Driver Violation at Midblock" and "Motorist Lost Control."

A complete list of the NHTSA bicycle and pedestrian crash types used to categorize crashes is available in Appendix B.

Location Movement Classification Method (LMCM) Crash Types

There are 57 Location Movement Classification Method (LMCM) crash types that can be applied to crashes involving bicycles and pedestrians. The LMCM crash types are organized into four categories: roadway intersection crashes, roadway non-intersection crashes, crashes on private property/parking lots, and other crashes that do not fit in the first three categories. Roadway intersection and non-intersection crashes make up 52 of the 57 crash types and account for the vast majority of reported bicycle and pedestrian crashes. Each crash type is defined by a code of between two and six letters.

All intersection crash types begin with "I" followed by "NS" or "FS" to indicate whether the crash occurred on the near side or far side of the intersection relative to the motorist's direction; the next part of the code indicates the motorist's action: going straight (ST), making a left turn (LT), or making a right turn (RT); and the last part of the code indicates the pedestrian or bicyclist movement relative to the motorist's pre-turn direction: going in the same (S) or opposite (O) direction as the motorist, approaching from the motorist's left (L) or right (R), or no/unknown direction (X). A crash in which a motorist hit a pedestrian traveling in the same direction while making a left turn would be coded as I_FS_LT_S.

Non-intersection crashes begin with "N" followed by a three-letter code indicating the position on the roadway where the crash occurred: right-side roadway lane (RRD), left-side roadway lane (LRD), right-side shoulder or bike lane (RSH), left-side shoulder or bike lane (LSH), right-side sidewalk (RSW), or left-side sidewalk (LSW); the final part of the code, which indicates the pedestrian or bicyclist movement relative to the motorist's direction, is the same as that used in intersection crashes. A crash in which a motorist drifted into the right-side bicycle lane and hit a bicyclist traveling in the same direction would be coded as N_RSH_S.

Bicycle Crash Subtype

The bicycle crash subtype field was created to allow certain NHTSA crash types used in this study to be compared to the crash types used in the 1992 City of Madison bicycle crash study. See Appendix C for more information on the bicycle crash subtypes, their definitions, and the corresponding crash types used in the 1992 study.

Bike/Pedestrian Facility Type

The "facility type" field identifies the transportation facility being used by the bicyclist or pedestrian at the time of the crash, excluding incidental use of the roadway at intersections: bicycle lane/shoulder, contraflow bicycle lane, shared-use path, street, bicycle boulevard, sidewalk, driveway, non-roadway/other, or unknown facility.

Crosswalk

The "crosswalk" field, which was only coded for pedestrians, identifies whether a marked or unmarked crosswalk was available and whether it was used by the pedestrian involved in the crash.

With/Against Traffic

The "with/against traffic" field identifies whether the bicyclist or pedestrian was traveling with or against motor vehicle traffic in the nearest traffic lane. Bicyclists' and pedestrians' direction of travel relative to motor vehicle traffic may affect how likely they are to be noticed by drivers.

Other Fields

Several additional fields were created to investigate other potential crash factors. However, information about most of these crash factors was limited, and therefore was of limited use for this study.

Transit Flag
The transit flag field was added to identify those crashes that directly or indirectly involved a transit vehicle, a transit stop area, or transit passengers exiting or waiting to board. This field was included to determine the frequency of transit-related crashes and to identify potential commonalities between these types of crashes.

Bicycle/Pedestrian Light
As shown in Table 5, only a small number of crash reports mention whether the bicyclist or pedestrian was equipped with lights. While many crash reports mention whether the crash occurred in a lighted area, the presence or absence of lights is only rarely included. For example, only 17 of the 78 crash reports about bicycle crashes occurring between 8:00 pm and 4:00 am note whether the bicycle was equipped with lights.

Table 5: Use of Lights by Bicyclists and Pedestrians Involved in Crashes

	Yes	No	Unknown
Bicyclist	13	25	760
Pedestrian	0	2	550

Bike Trailer
Only 3 out of 798 bicycle crashes involved bicycles with trailers. The circumstances of these crashes differed significantly from one another.

Aggression
The aggression field was included to determine the number of crashes involving aggression, i.e. "road rage", on the part of the driver or bicyclist/pedestrian, prior to the crash. As shown in Table 6, only a handful of crashes were identified as involving aggression. Because drivers have an incentive to avoid disclosing to law enforcement any role their aggression may have had in crashes with bicyclists or pedestrians, it is uncertain whether these statistics accurately reflect the role that aggression played in bicycle and pedestrian crashes during the study period.

Table 6: Aggression-Related Crashes

	Driver	Bicyclist/ Pedestrian	None/ Unknown
Bicyclist	3	0	795
Pedestrian	7	4	541

Phone
According to the crash reports, only eight crashes involved a motorist and/or a bicyclist/pedestrian who was using the phone. This amounts to less than one percent of all crashes analyzed. However, it is likely that the true number of crashes involving drivers distracted by their phones is higher. Following a collision, drivers may wish to avoid implicating themselves by admitting phone use to law enforcement officials. In addition, evidence suggests that cellular phone use often goes unrecorded in crash reports even in cases where it is apparent.

Table 7: Phone-Related Crashes

	Yes	No/ Unknown
Bicyclist	4	794
Pedestrian	4	548

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Chapter 2

Bicycle & Pedestrian Crash Overview

- Demographics
- Crash Summary
- Comparing Bicyclist and Pedestrian Safety in Dane County with Elsewhere

Demographics

The genders and ages of bicyclists and pedestrians involved in crashes are detailed in Figure 12 and Figure 13. Overall, the bicyclists appear to represent a somewhat narrower segment of the population than the pedestrians, being more concentrated in the 20-44 age range and more than 70% male.

According to the US Census American Community Survey (ACS) 2011-2015 5-year estimates, 3.9% of men and 1.8% of women over 16 years of age commute to work by bicycle in the Dane County. Assuming bicycling in general follows the same pattern as commuting behavior, the gender disparity in bicycling crashes is primarily due to differing rates of ridership. ACS 2011-2015 5-year estimates of the percentage of the population walking to work tell a different story. 5.5% of men and 5.8% of women in Dane County report walking as their primary means of transportation to work, which, if the same pattern holds for walking behavior in general, would suggest that the disparity between male and female involvement in pedestrian crashes is being driven by some other factor.

However, given the margin of error in ACS estimates and uncertainty regarding the degree to which general walking and bicycling behavior can be generalized from commuting behavior, it is impossible to know the degree to which ages and genders are over- or underrepresented in crashes relative to their total share of bicyclists and pedestrians. National Household Travel Survey (NHTS) data from more than 2,000 households in Dane County will be available in 2018, which will help begin to answer this question.

Figure 12: Age of Bicyclists and Pedestrians Involved in Crashes

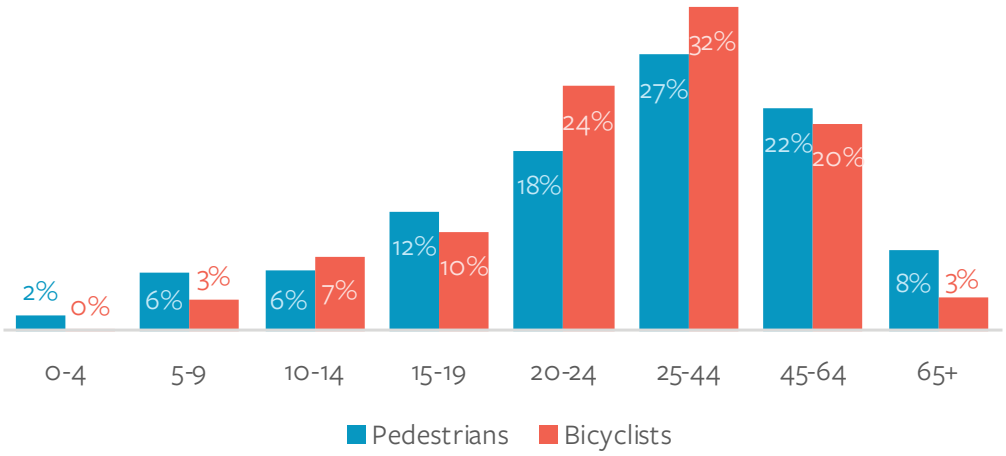
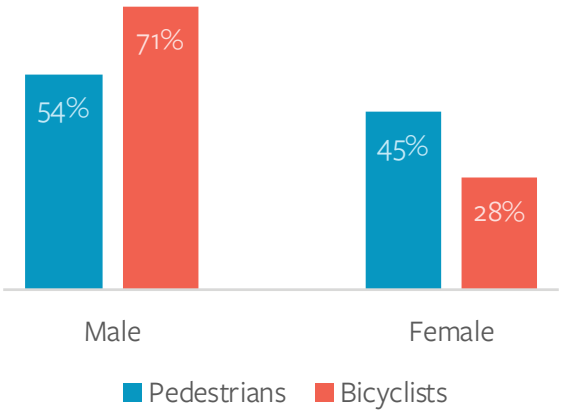


Figure 13: Gender of Pedestrians and Bicyclists Involved in Crashes

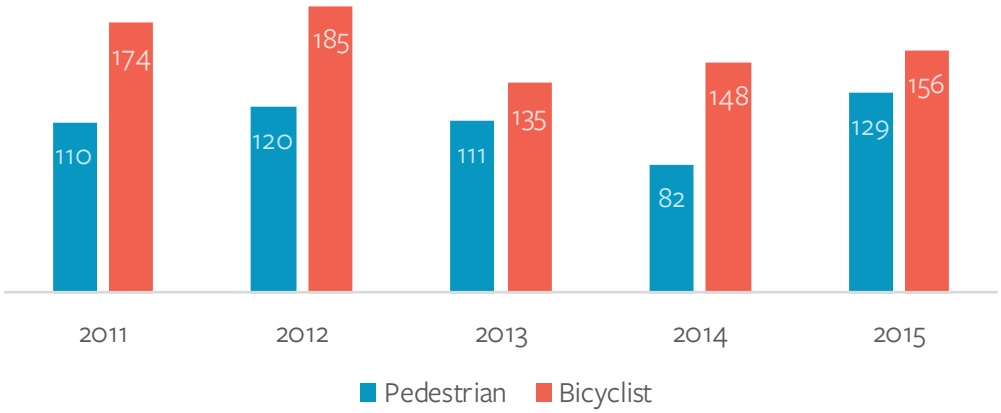


Crash Summary

Crashes by Year

Bicycle and pedestrian crashes were fairly evenly distributed over the 5-year 2011-2015 study period, ranging from a low of 230 total crashes in 2014 to a high of 305 in 2012.

Figure 14: Pedestrian and Bicycle Crashes by Year



Crash Severity

Overall, pedestrians involved in crashes tended to sustain more severe injuries than bicyclists. While 4% of pedestrian crashes were fatal, less than 1% of bicycle crashes resulted in fatalities. Incapacitating injuries show a similar pattern, with 14% of pedestrian crashes resulting in an incapacitating injury versus 7% of bicycle crashes.

The difference in the severity of injuries sustained by bicyclists and pedestrians may be due to the fact that bicyclists were often not struck directly. Many of the bicycle crash reports described the bicycle tire impacting the motor vehicle after which the bicyclist was thrown from the bicycle. Conversely, pedestrians were normally struck by the vehicle directly.

Figure 15: Pedestrian and Bicycle Crashes in Dane County by Injury Severity

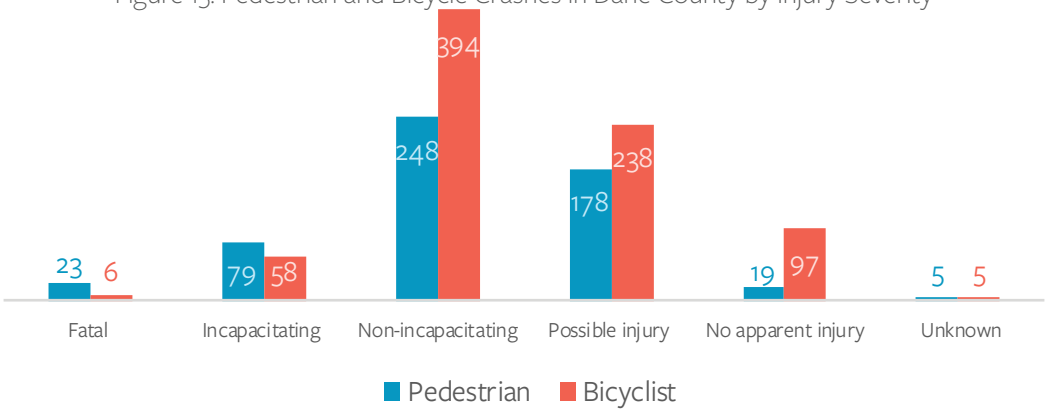


Table 8 details Dane County's fatal and incapacitating crashes during the study period. Crashes involving bicycles and pedestrians accounted for 17% of the total even though they accounted for only 3% of all crashes.

Table 8: Severe Bicycle and Pedestrian Crashes as a Percent of Dane County Total, 2011-2015

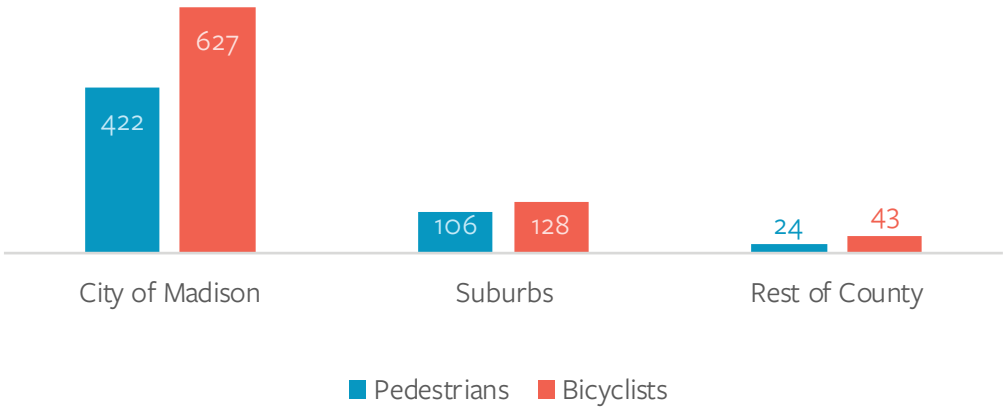
	Fatal		Incapacitating	
Crash Category	**#**	**%**	**#**	**%**
Bicycle - Motor Vehicle	7	5%	58	7%
Pedestrian - Motor Vehicle*	23	15%	79	10%
Motor Vehicle Only	125	81%	679	83%

*Includes 3 fatalities excluded from the Fatality Analysis Reporting System (FARS).

Deer-related crashes and crashes occurring entirely in parking lots or private property are excluded.

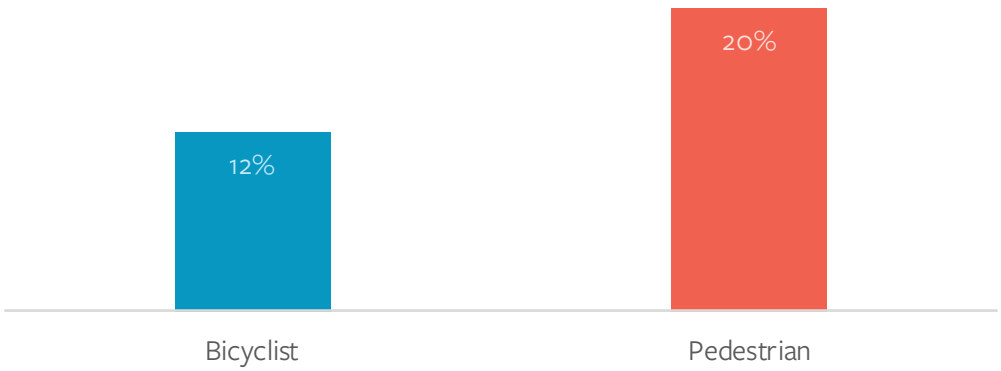
Crashes by Municipality

Figure 16: Pedestrian and Bicycle Crashes by Location



Hit-and-Run Crashes

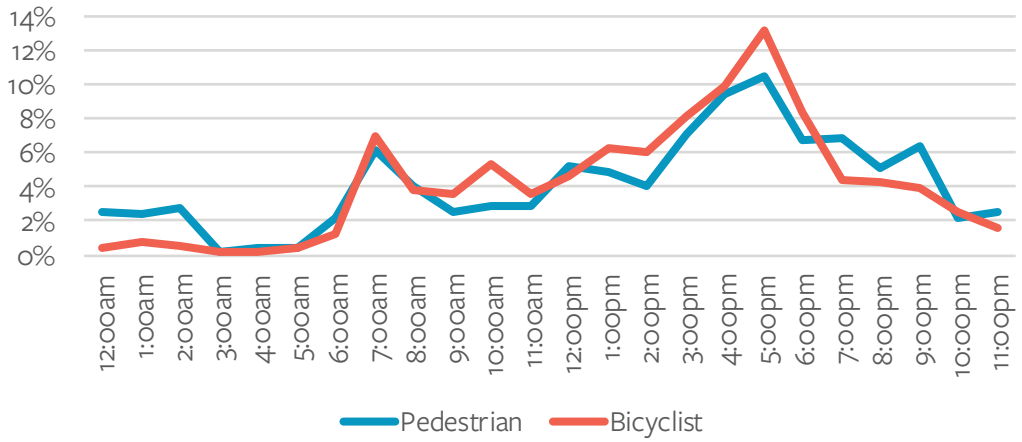
Figure 17: Hit-and-Run Crashes as a Percentage of All Pedestrian and Bicycle Crashes



Time of Crashes

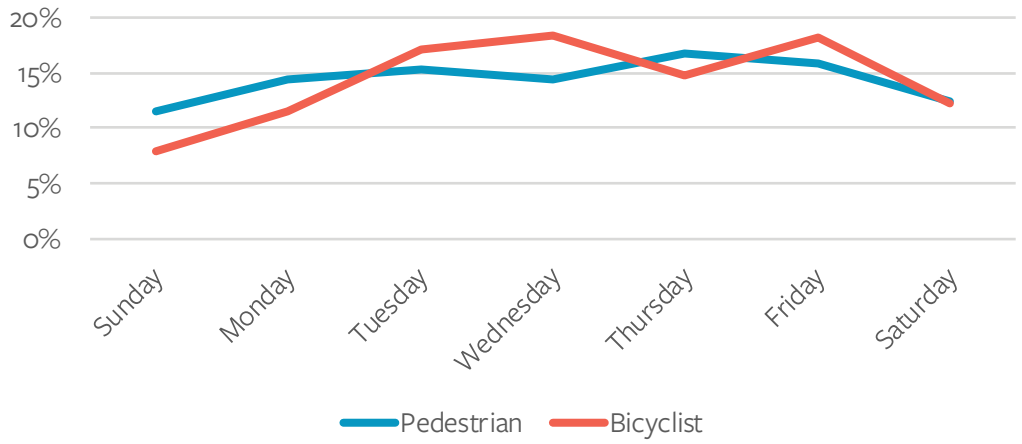
Pedestrian and bicyclist crashes follow a similar pattern throughout the day with a peak in the morning between 7:00 and 8:00 and another in the afternoon between 5:00 and 6:00 during the typical commuting period. The most notable difference between bicyclist and pedestrian crashes, in terms of when they occur throughout the day, is that a larger portion of pedestrian crashes occur in the evening hours between 7:00 pm and 2:00 am, while bicycle crashes are more concentrated during the day.

Figure 18: Pedestrian and Bicycle Crashes by Hour of Day



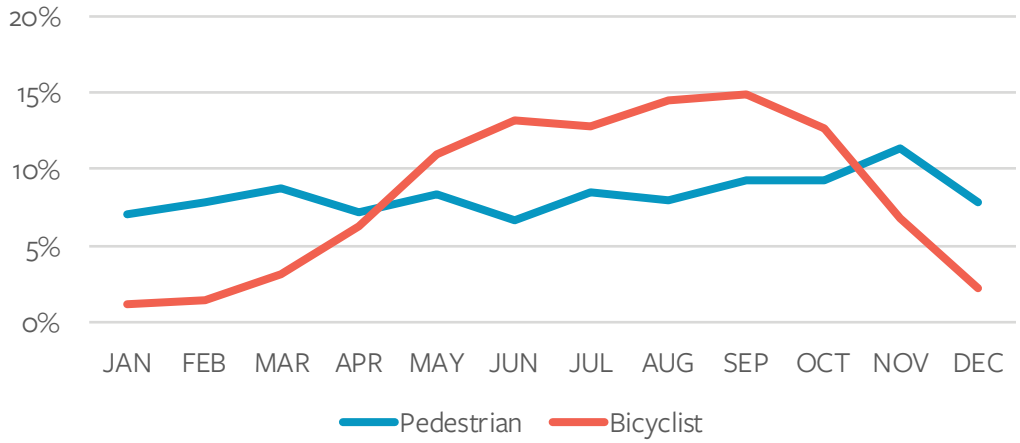
From day to day during the week, there is greater fluctuation in bicycle crashes than pedestrian crashes. Both bicycle and pedestrian crashes are more common on weekdays than weekends, but this pattern is more noticeable for bicycle crashes. As shown in Figure 19, bicycle crashes between Tuesday and Friday are about twice as common as crashes on Sunday.

Figure 19: Bicyclist and Pedestrian Crashes by Day of Week



As shown in Figure 20, nearly 80% of bicycle crashes occur between May and October, while less than 5% occur between December and February. This appears to match relatively closely with bicycling levels. According to 2016 bicycle traffic counts on the John Nolen, East Rail, and Southwest paths, 74% to 78% of bicycle traffic occurred between May and October, while 7.4% to 8.7% of traffic occurred between December and February. Pedestrian crashes show much less fluctuation from month to month, ranging between a low of 7% and a high of 11%.

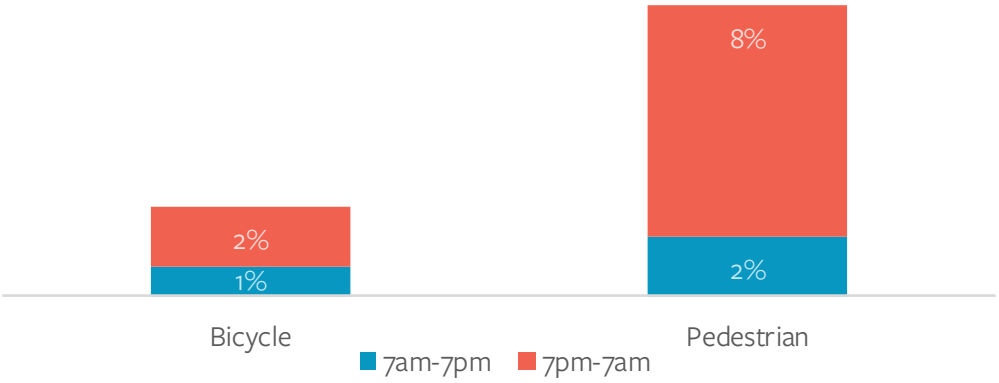
Figure 20: Bicyclist and Pedestrian Crashes by Month



Alcohol-Related Crashes

Alcohol use by either drivers or bicyclists/pedestrians was a factor in about 3% of bicycle crashes and 10% of pedestrian crashes. The times that these crashes tend to occur most frequently may explain some of this disparity. As shown in Figure 21, the majority of these crashes happen between 7:00 pm and 7:00 am, when bicycle crashes are much less frequent than pedestrian crashes. The small number of bicyclists during the evening and early morning hours, when alcohol-related crashes are most frequent, may partially explain the lower frequency of alcohol-related bicycle crashes.

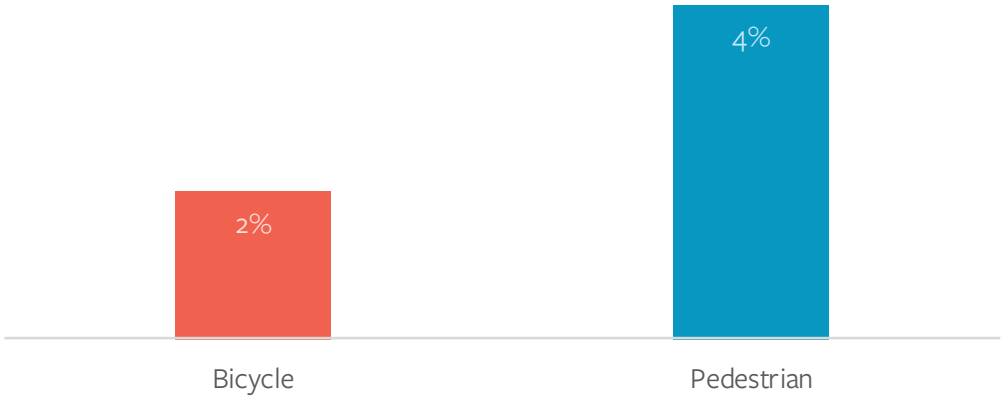
Figure 21: Alcohol-Related Bicycle and Pedestrian Crashes



Large Vehicle-Related Crashes

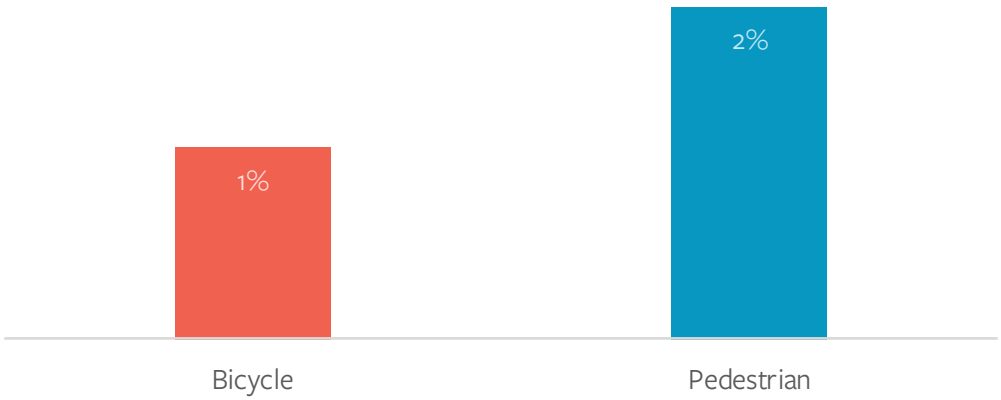
As shown in Figure 22, about 2% of bicycle crashes and 4% of pedestrian crashes directly or indirectly involved a transit vehicle, a transit stop area, or transit passengers exiting or waiting to board. The specific circumstances surrounding these crashes varied widely.

Figure 22: Transit-Related Bicycle and Pedestrian Crashes



Large trucks, including tractors with or without trailers and single-unit straight trucks, were directly involved in 12 pedestrian crashes and 10 bicycle crashes, representing 2.2% and 1.3% of total pedestrian and bicycle crashes during the study period. These crashes occurred under a wide variety of circumstances in urban, suburban, and rural areas.

Figure 23: Bicycle and Pedestrian Crashes Involving Large Trucks



Comparing Bicyclist and Pedestrian Safety in Dane County with the Rest of the State

While comparing bicyclist and pedestrian safety in different places is imperfect due to data limitations and the unique characteristics of different communities, these comparisons are helpful in assessing non-motorized transportation safety.

Table 9 and Table 10 compare bicycle and pedestrian crash statistics in Dane County and the State of Wisconsin, as a whole. Data for the State of Wisconsin was presented in a 2015 WisDOT study, which relied on the same WisDOT crash data that was the foundation for the present study. The Dane County data uses VMT estimates from WisDOT and population and commute mode estimates from the US Census Bureau.

As shown in Table 9, while the rate of bicycle crashes per 100,000 population is much higher in Dane County than in the state as a whole, the rates of fatal and incapacitating crashes are similar. The rate of bicycle crashes per million VMT is also higher in Dane County than it is statewide. Although the rate of bicycle crashes per 1,000 bicycle commuters is somewhat higher in Dane County than in the rest of the state, the rate of fatal and incapacitating crashes is much lower.

A lack of data on bicyclist exposure (e.g. total bicycle-miles ridden) combined with the error inherent in Census estimates of bicycle ridership limits the usefulness of these types of comparisons.

Table 9: Bicycle-Motor Vehicle Crash Comparison, State of Wisconsin vs. Dane County, 2011-2013

	Wisconsin			Dane County		
	2011	2012	2013	2011	2012	2013
Population (in 100,000s)	57.09	57.25	57.43	4.96	5.03	5.10
Bicycle crashes per 100,000 people	20	21	18	35	37	26
Bicycle K&A (fatal and incapacitating) crashes per 100,000 people	2.0	2.2	1.7	2.6	4.2	2.2
Vehicle Miles Traveled (VMT) (in millions)	58,554	59,087	59,484	4,788	5,009	4,851
Bicycle Crashes per million VMT	0.019	0.021	0.017	0.036	0.037	0.028
Bicycle Commuters (in 1,000s)	19.08	24.46	23.48	7.15	9.02	8.20
Bicycle crashes per 1,000 bicycle commuters	17	18	16	24	21	16
Bicycle K&A (fatal and incapacitating) crashes per 1,000 bicycle commuters	6.1	5.2	4.1	1.8	2.3	1.3

Dane County is much safer for pedestrians than the state of Wisconsin as a whole, as shown by Table 10. Pedestrian crashes, including fatal and incapacitating crashes, are less common in Dane County relative to population, motor vehicle travel, and total walk commuting population.

Table 10: Pedestrian-Motor Vehicle Crash Comparison, State of Wisconsin vs. Dane County, 2011-2013

	Wisconsin			Dane County		
	2011	2012	2013	2011	2012	2013
Population (in 100,000s)	57.09	57.25	57.43	4.96	5.03	5.10
Pedestrian crashes per 100,000 people	28	29	29	22	24	22
Pedestrian K&A (fatal and incapacitating) crashes per 100,000 people	5.6	5.4	5.2	4.0	4.2	4.3
Vehicle Miles Traveled (VMT) (in millions)	58,554	59,087	59,484	4,788	5,009	4,851
Pedestrian Crashes per million VMT	0.027	0.028	0.028	0.023	0.024	0.023
Walk Commuters (in 1,000s)	94.27	91.65	99.93	14.15	15.10	17.55
Pedestrian crashes per 1,000 walk commuters	17	18	16	7.77	7.95	6.32
Pedestrian K&A (fatal and incapacitating) crashes per 1000 walk commuters	3.4	3.4	3.0	1.4	1.4	1.3

Chapter 3

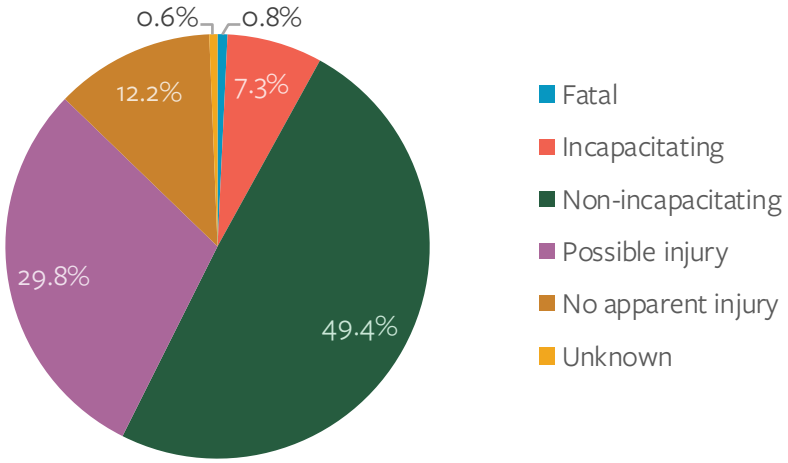
Bicycle Crashes

- Number of Crashes and Crash Severity
- Speed and Crash Severity
- Crash Location
- Bicycle Crashes Near Environmental Justice Populations
- Demographic Characteristics of Bicyclists Involved in Crashes
- Bicycle Crash Types
- Facilities
- Citations
- Common Crash Scenarios
- Comparison to the 1992 City of Madison Bicycle Crash Study

Number of Crashes and Crash Severity

Overall, there were 798 reported bicycle crashes in Dane County during the study period. Of these, 0.8% (6) were fatal and another 7.3% (58) resulted in an incapacitating injury. The term "incapacitating," as used in the MV4000 crash reports that are the basis for the data used in this study, refers to an injury that makes it impossible for the injured person to transport themselves away from the scene of the crash, and encompasses a wide range of injury severities. The vast majority of reported bicycle crashes do not result in serious injuries.

Figure 24: Bicyclist Injury Severity



Speed and Crash Severity

Overall, less than 1% of reported bicycle crashes resulted in fatalities. However, the fatality rate for bicycle crashes on higher speed roads is significantly higher, as shown in Table 11. Of the six fatal crashes during the study period, five occurred on roads with speed limits of at least 35 mph, despite the fact that only 20% of bicycle crashes occurred on these higher speed roads.

Table 11: Posted Speed Limit and Bicyclist Injury Severity

Posted Speed Limit	Fatal		Incapacitating		Non-Severe		Unknown		Total
	#	%	#	%	#	%	#	%	#
< 25	1	0.2%	37	6.9%	494	92.5%	2	0.4%	534
30	0	0.0%	3	3.0%	97	97.0%	0	0.0%	100
35	3	2.8%	8	7.5%	94	87.9%	2	1.9%	107
40+	2	3.5%	10	17.5%	44	77.2%	1	1.8%	57
Total	6	0.8%	58	7.3%	729	91.4%	5	0.6%	798

Roadway Travel Lanes and Crash Severity

The number of roadway travel lanes does not appear to be related to bicyclist crash injury severity.

Crash Location

Figure 25 and Figure 26 show the locations where crashes have occurred in Dane County and in central Madison, respectively. The vast majority of crashes occurred in downtown Madison and the University of Wisconsin campus areas, but nearly every community in the county saw at least one bicycle crash during the study period. It is important to note that the maps below do not illustrate crash risk; many of the locations with the highest numbers of crashes also have very high bicycle traffic.

Figure 25: Bicycle Crash Locations- Dane County

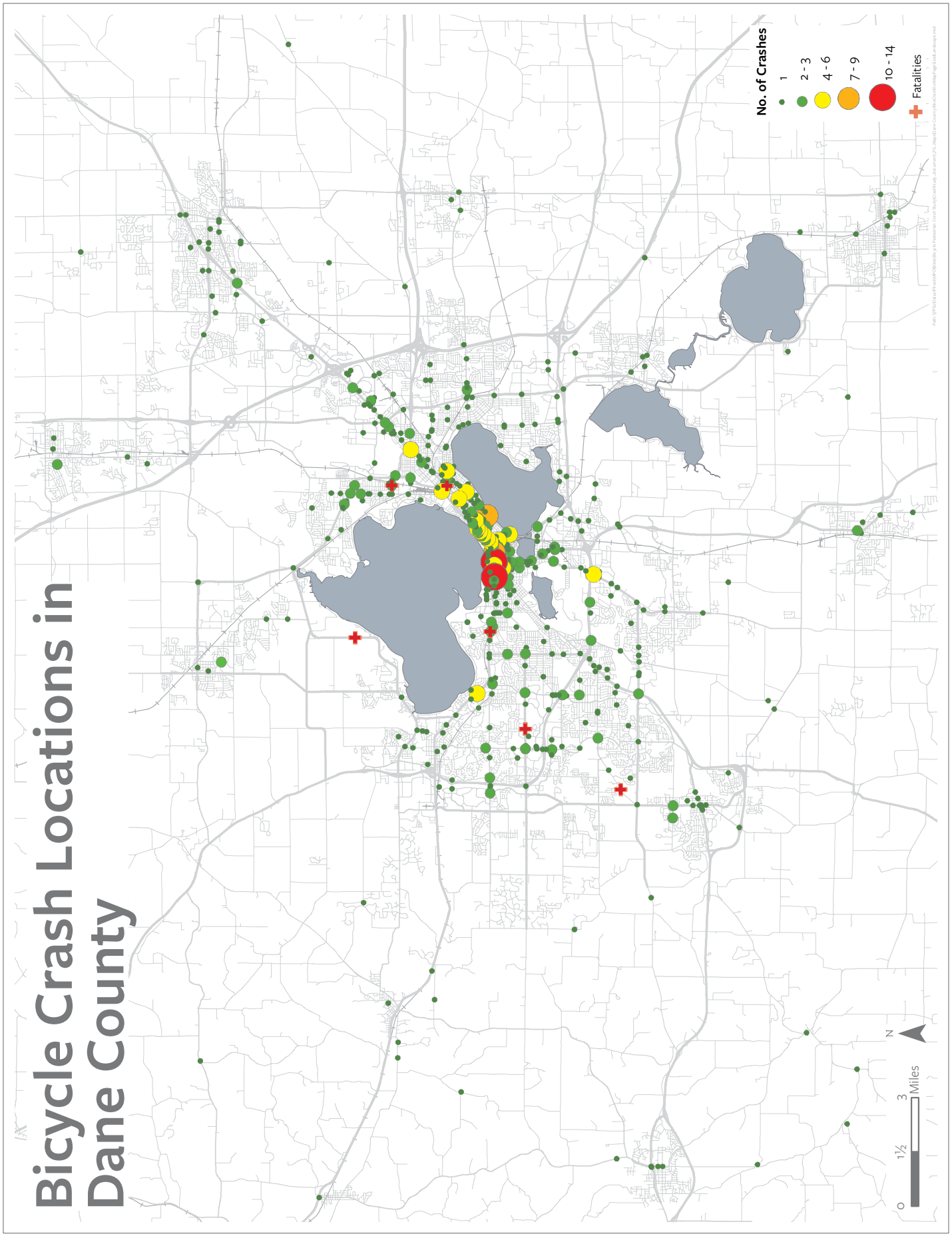
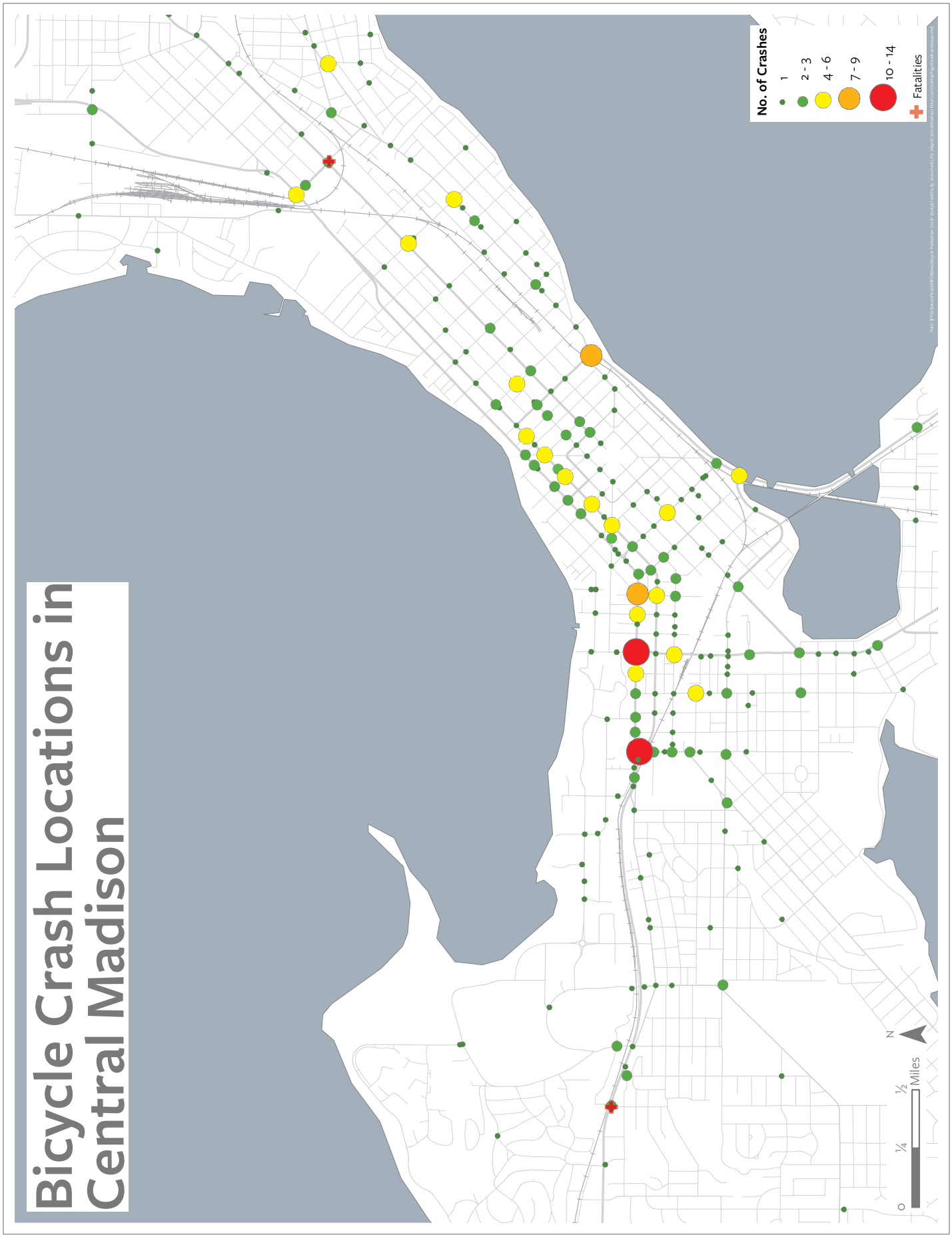


Figure 26: Bicycle Crash Locations- Central Madison



Nearly 80% of crashes occurred in the City of Madison, 16% occurred in suburbs, and the remaining 5% occurred in rural areas and communities outside the MPO planning area.

Figure 27: Bicycle Crashes by Location

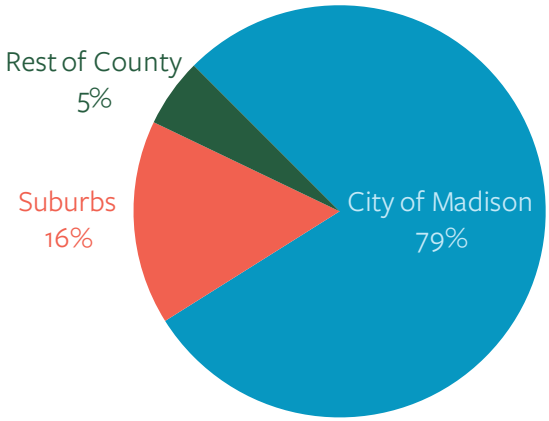


Table 12 details the top bicycle crash locations in Dane County. There were two intersections with more than 10 bicycle crashes during the study period, both of which were located along University Avenue on the UW campus, where there are high numbers of bicyclists, pedestrians, and motor vehicle traffic; standard and contra-flow bicycle lanes, and bus lanes. The very high number of bicyclists at these locations means that, while the absolute number of crashes is higher than anywhere else, the crash risk for bicyclists is not necessarily higher at these locations. Despite the large number of crashes shown at the locations in Table 12, there were no fatalities at any of these intersections.

Table 12: Top Bicycle Crash Locations

Location	Crashes	Fatalities
University Ave at North Park St	14	0
University Ave at North Randall St	12	0
John Nolen Dr at South Blair St	9	0
University Ave at North Frances St	9	0
John Nolen Dr at North Shore Dr	6	0
University Ave at North Brooks St	6	0
E. Johnson St at North Pinckney St	6	0
E. Johnson St at North Hamilton St	6	0

Bicycle Crashes near Environmental Justice Populations

Figure 28 and Figure 29 show the location of bicycle crashes alongside low-income and minority populations, respectively. While it does not appear that bicycle crashes are concentrated in low-income and minority areas, the degree to which these populations are affected by bicycle crashes is uncertain. Because crash reports do not provide information on the race and income of people involved in crashes, it is impossible to determine whether low-income and minority groups are disproportionately impacted by bicycle crashes.

Figure 28: Bicycle Crashes and Low-Income Populations

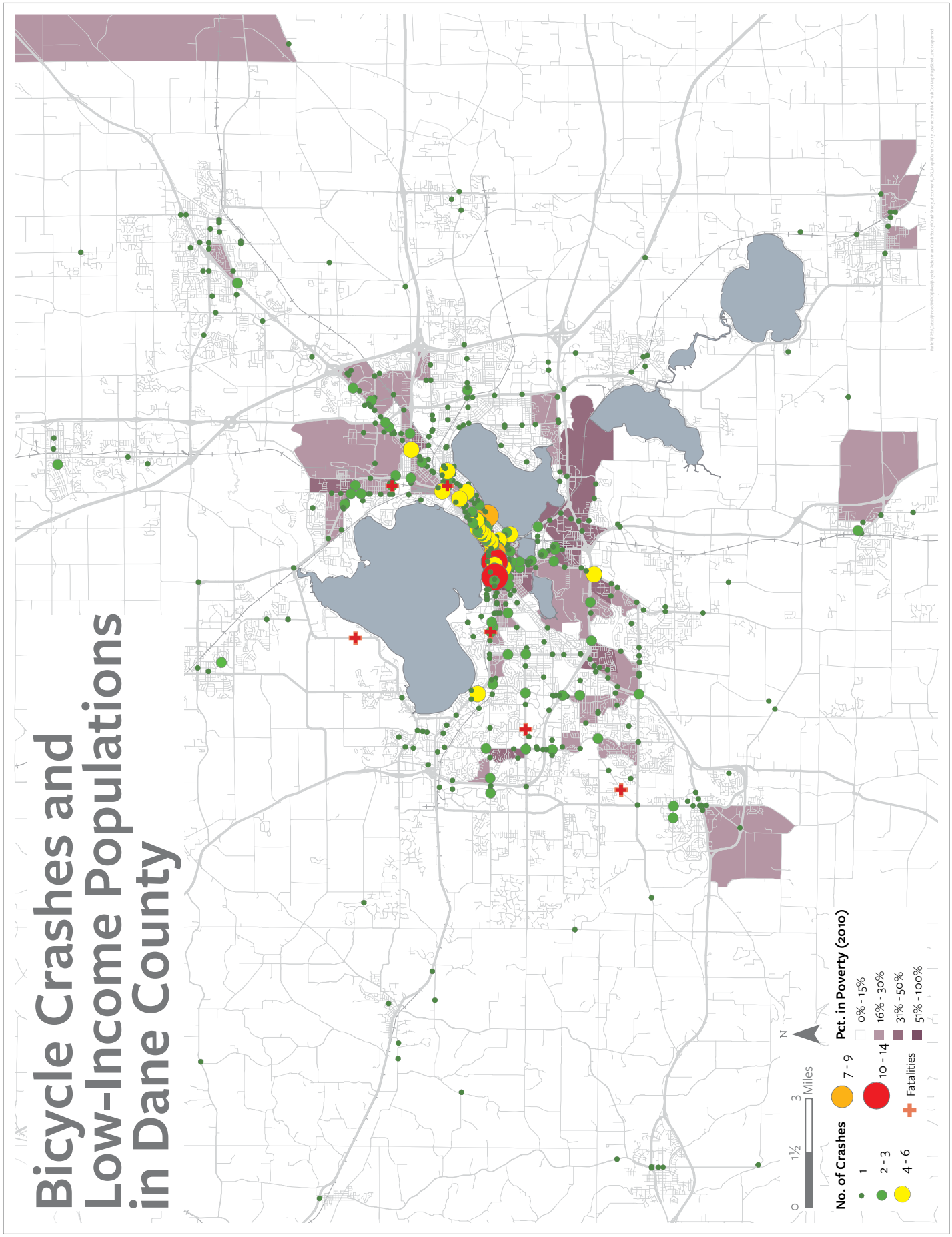
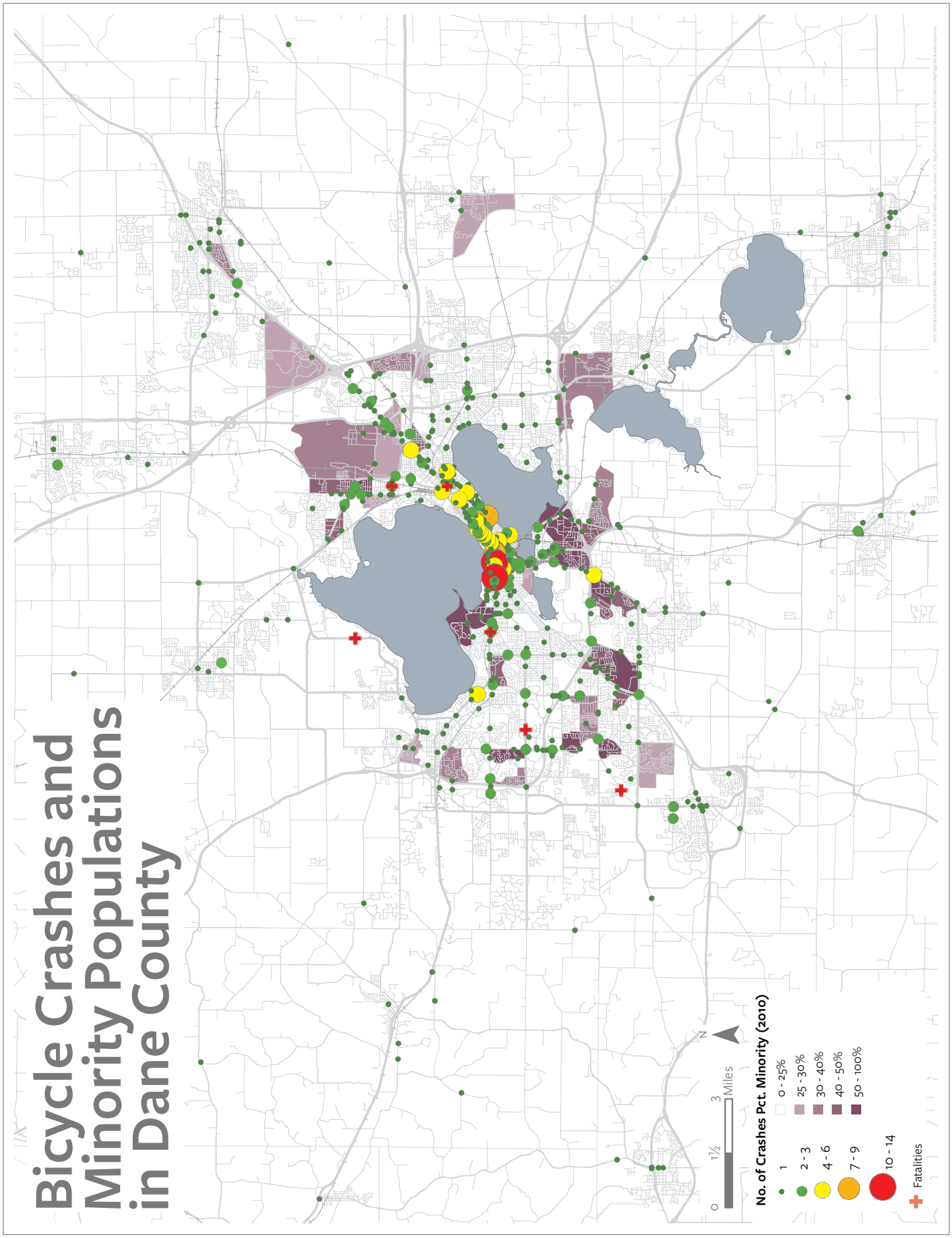


Figure 29: Bicycle Crashes and Minority Populations



Demographic Characteristics of Bicyclists Involved in Crashes

Bicyclists involved in crashes spanned the age spectrum, as shown in Figure 30. Adults between the ages of 25 and 64 accounted for just over half of all crashes, while the 20-24 age group accounted for nearly a quarter. Males made up a sizable majority of the bicyclists involved in crashes in all age groups.

Figure 30: Age and Gender of Bicyclists Involved in Crashes

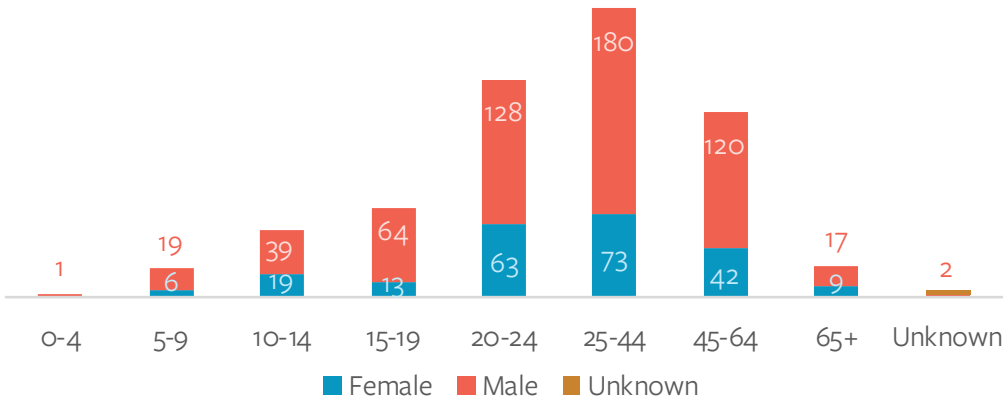
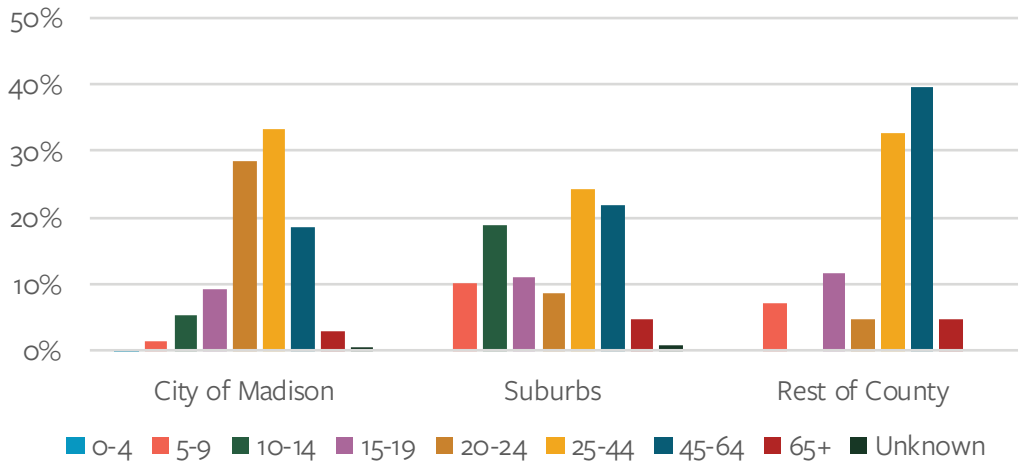


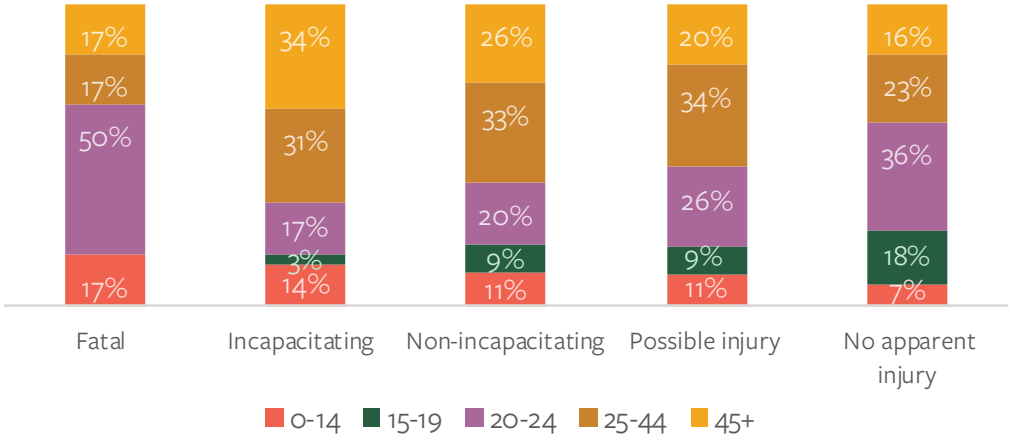
Figure 31 details the relative proportion of crashes involving bicyclists of different ages in the City of Madison, the suburbs, and the rest of the Dane County. In the suburban communities outside of the City of Madison, children between 5 and 14 years of age account for nearly 30% of all crashes, while they make up no more than about 7% of crashes in other parts of the county. The 45-64 age group is similarly over represented among bicycle crashes outside of the urban MPO area.

Figure 31: Age of Bicyclists Involved in Crashes by Municipality



Nearly 70% of fatal crashes involved bicyclists under 24 years of age. This is in sharp contrast to crashes of all other injury severity levels which show older riders overrepresented at the more serious injury levels and younger riders overrepresented at the less serious injury levels. One possible explanation for this distribution is that older riders may generally suffer more serious injuries when they are involved in crashes, but that younger riders may be more likely to take greater risks or make unsafe maneuvers that more frequently expose them to the possibility of a fatal crash.

Figure 32: Bicyclist Age and Injury Severity



Bicycle Crash Types

Crashes were classified according to two different typologies:

- NHTSA Crash Types – Under this classification system, crashes are grouped according to what the motorist or bicyclist was doing (such as *Right On Red* or *Ride Out At Residential Driveway*) or other circumstances (such as *Non-Roadway*). These crash types are detailed in FHWA's Crash Type Manual For Bicyclists, with the addition of *Bicyclist Strikes Parked Vehicle – Dooring*. These crashes were separated from the NHTSA crash category of *Bicyclist Strikes Parked Vehicle*.
- Location Movement Classification Method (LMCM) Crash Types – Under this classification system, developed by researchers at the University of Wisconsin – Milwaukee and detailed in Wisconsin Pedestrian and Bicycle Crash Analysis: 2011-2013, crashes are categorized exclusively based on where on the roadway they occurred and the relative directions of the vehicle and bicyclist or pedestrian involved.

These two systems of classification provide information on the circumstances surrounding each crash as well as the specific manner in which the collision occurred. Classifying crashes using both systems will also help to ensure that the findings of this study can be compared to future studies in the Madison region and elsewhere.

Top NHTSA Crash Types

Table 13 details the top categories of NHTSA crash types in Dane County. These categories include multiple NHTSA crash types:—e.g. *Motorist Left Turn* includes both *Motorist Left Turn – Facing Bicyclist* and *Motorist Left Turn – In Front Of Bicyclist*.

Table 13: Top NHTSA Bicycle Crash Categories in Dane County

Crash Category	#	%
Motorist Left Turn	174	22%
Motorist Drive Out/Through at Intersection	147	18%
Motorist Right Turn	141	18%
Bicycle Ride Out/Through at Intersection	95	12%
Motorist Overtaking	55	7%
Bicycle Right or Left Turn	31	4%
Bicycle Overtaking	32	4%
Bicycle Ride Out at Midblock	24	3%
Motorist Drive Out at Midblock	23	3%
Other	76	10%
Total	**798**	**100%**

Table 14 details the most common NHTSA bicycle crash types in the City of Madison. The most common crash type, *Motorist Left Turn – Facing Bicyclist*, which also appears among the most common crash types in other urban MPO communities and in other parts of the county, is particularly common in the City of Madison. While bicyclists involved in these crashes may be using any type of facility, more than a quarter of these crashes (37) involved bicyclists using the contraflow bike lane on University Avenue near the UW

campus. Over 90% of *Motorist Left Turn – In Front Of Bicyclist* crashes in Dane County occurred in the City of Madison. About half of these crashes (17) involved bicyclists using the bicycle lane on Johnson Street between Bassett and Baldwin streets, which is located on the left side of the street.

Table 14: Top NHTSA Crash Types in the City of Madison

Crash Type	% of Total	Description
Motorist Left Turn – Facing Bicyclist	19.8%	Motorist turned left while facing approaching bicyclist
Motorist Right Turn – Other	11.6%	Motorist was turning right and bicyclist was riding in same or opposing direction
Motorist Drive Out – At Stop Sign	11.3%	Motorist stopped at a stop sign but then failed to yield
Bicycle Ride Out – At Intersection, Other	8.3%	Bicyclist failed to yield at a signalized or uncontrolled intersection
Motorist Right Turn – On Red	7.8%	Motorist turned right while facing a red light
Motorist Left Turn – In Front Of Bicyclist	5.3%	Both parties were traveling in the same direction and the motorist turned in front of the bicyclist
Other Types	35.9%	

Dooring, crashes in which a bicyclist strikes an open door on a stopped vehicle, accounted for just 1% of all crashes in Dane County during the study period. While this crash type looms large in the minds of many urban bicyclists, it is much less common in the Madison area than in some other cities. For example, dooring accounts for 5% of all bicycle crashes in the City of Seattle and roughly 2.5% of all bicycle crashes in Minneapolis.

The most common crash type in suburbs within MPO planning area is *Motorist Drive Out – At Stop Sign*. There were 30 of these crashes during the study period, representing nearly a quarter of all bicycle crashes in these communities. 14 of these crashes involved a motorist hitting a bicyclist approaching from the right who was traveling against traffic, and in 10 of these cases the bicyclist was riding on the sidewalk.

Table 15: Top NHTSA Crash Types in Suburban MPO Communities

Crash Type	% of Total	Description
Motorist Drive Out – At Stop Sign	23.4%	Motorist stopped at a stop sign but then failed to yield
Bicycle Ride Out – At Stop Sign	9.4%	Bicyclist stopped at a stop sign but then failed to yield
Motorist Left Turn – Facing Bicyclist	9.4%	Motorist turned left while facing approaching bicyclist
Motorist Right Turn – On Red	7.0%	Motorist turned right while facing a red light
Motorist Right Turn – Other	7.0%	Motorist was turning right and bicyclist was riding in same or opposing direction
Bicycle Ride Out – At Intersection, Other	7.0%	Bicyclist failed to yield at a signalized or uncontrolled intersection
Other	36.7%	

Crashes outside of the urban MPO area are much more likely to involve a motorist overtaking a bicyclist. These overtaking crashes represent nearly half of all bicycle crashes in these communities.

Table 16: Top NHTSA Crash Types in Dane County outside of Urban MPO Area

Crash Type	% of Total	Description
Motorist Overtaking – Other	18.6%	Motorist was overtaking a bicyclist and the circumstances could not be specified
Motorist Overtaking – Failed To Detect	16.3%	Motorist was overtaking and failed to detect the bicyclist
Bicycle Lost Control	11.6%	Bicyclist lost control and swerved into the path of the motorist
Motorist Drive Out – At Stop Sign	7.0%	Motorist stopped at a stop sign but then failed to yield
Motorist Left Turn – Facing Bicyclist	7.0%	Motorist turned left while facing approaching bicyclist
Motorist Overtaking – Counteractive Evasive Actions	7.0%	Motorist was overtaking and the bicyclist swerved and crashed
Motorist Overtaking – Misjudged Passing Space	7.0%	Motorist was overtaking and misjudged the width or length required to pass the bicyclist
Other Types	25.6%	

There were 84 bicycle crashes involving children under 14 years of age in Dane County during the study period. The two most common types, representing 29% of these crashes, involve bicyclists failing to yield at an intersection. The next three most common crash types, which account for 27% of these crashes, all involve motorists failing to yield to bicyclists at intersections.

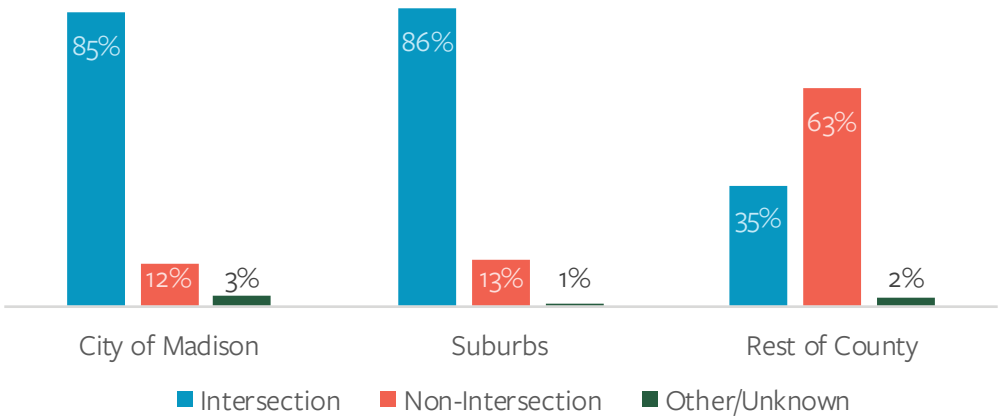
Table 17: Top NHTSA Crash Types involving Children Under 14 Years of Age

Crash Type	#	%
Bicycle Ride Out – At Intersection, Other	14	17%
Bicycle Ride Out – At Stop Sign	10	12%
Motorist Drive Out – At Stop Sign	9	11%
Motorist Drive Out – At Intersection, Other	7	8%
Motorist Right Turn – On Red	7	8%
Other/Unknown	37	44%

Top LMCM Crash Types

Unlike the NHTSA crash types, Location Movement Classification Method (LMCM) crash types are based exclusively on where a crash occurs and the relative movements by the parties to the crash, without regard to traffic control devices or other circumstances that may have influenced the crash. This focus on location and direction of movement makes LMCM types useful in identifying differences and commonalities in crash location. As shown in Figure 33, roughly 85% of crashes in the City of Madison and suburbs in the MPO planning area occurred at intersections. Elsewhere in the county, the majority of crashes occurred at non-intersection locations.

Figure 33: Top NHTSA Crash Types involving Children Under 14 Years of Age



The top LMCM crash type in the City of Madison, I_FS_LT_O, closely parallels the top NHTSA crash type in the City, *Motorist Left Turn – Facing Bicyclist*, but includes some crashes that may have been classified as a different NHTSA crash type due to another factor, such as a failure to yield by the driver or bicyclist. Although the most common crash types in the city are primarily intersection-related, they vary greatly in terms of where in the intersection they occurred, near or far side, and the movements of the motor vehicles and bicyclists.

Table 18: Top LMCM Crash Types, City of Madison

LMCM Type	#	%
Left-turning motorist collides with oncoming bicyclist on far side of intersection (I_FS_LT_O)	135	22%
Right-turning motorist collides with bicyclist coming from the right on near side of intersection (I_NS_RT_R)	89	14%
Straight-traveling motorist collides with bicyclist coming from the left on near side of intersection (I_NS_ST_L)	49	8%
Straight-traveling motorist collides with bicyclist coming from the right on far side of intersection (I_FS_ST_R)	46	7%
Motorist collides with bicyclist traveling in the same direction on the right side of the road (N_RRD_S)	37	6%
Right-turning motorist collides with bicyclist traveling in the same direction on the far side of intersection (I_FS_RT_S)	36	6%
Other Types	235	37%

The most common LMCM crash type in the suburbs involves a right turning motorist colliding with a bicyclist approaching from the motorist's right as they enter the intersection. In over 70% of these crashes, the bicyclist was on the sidewalk as they approached the motorist.

Table 19: Top LMCM Crash Types, Suburbs

LMCM Type	#	%
Right-turning motorist collides with bicyclist coming from the right on near side of intersection (I_NS_RT_R)	28	22%
Left-turning motorist collides with oncoming bicyclist on far side of intersection (I_FS_LT_O)	12	9%
Straight-traveling motorist collides with bicyclist coming from the left on near side of intersection (I_NS_ST_L)	12	9%
Motorist collides with bicyclist traveling in the same direction on the right side of the road (N_RRD_S)	10	8%
Straight-traveling motorist collides with bicyclist coming from the left on far side of intersection (I_FS_ST_L)	9	7%
Other Types	57	45%

The two most common crash types outside of the urban MPO area both involve motorists striking bicyclists traveling in the same direction on the right side of the roadway or in a bike lane or shoulder at a non-intersection location.

Table 20: Top LMCM Crash Types, Dane County Outside of Urban MPO Area

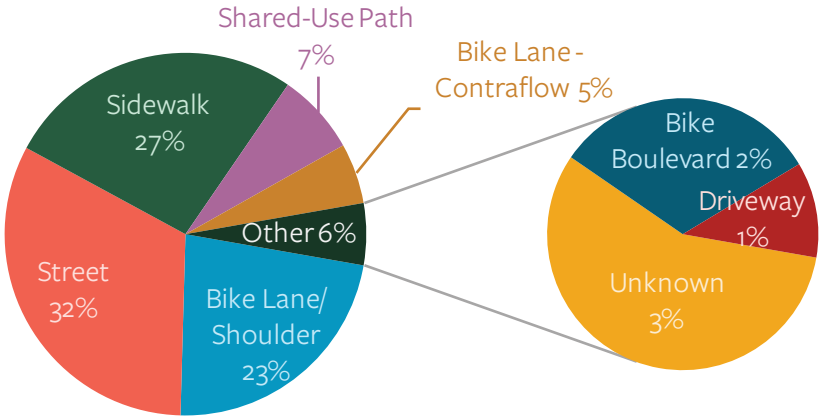
LMCM Type	#	%
Motorist collides with bicyclist traveling in the same direction on the right side of the road (N_RRD_S)	16	37%
Motorist collides with bicyclist traveling in the same direction in the bicycle lane or shoulder on the right side of the road (N_RSH_S)	6	14%
Straight-traveling motorist collides with bicyclist coming from the right on far side of intersection (I_FS_ST_R)	3	7%
Left-turning motorist collides with bicyclist coming from the left on far side of intersection (I_FS_LT_L)	2	5%
Left-turning motorist collides with oncoming bicyclist on far side of intersection (I_FS_LT_O)	2	5%
Motorist collides with oncoming bicyclist on the right side of the road (N_RRD_O)	2	5%
Other Types	12	28%

Facilities

Facility Type

Bicyclists are almost always in the roadway when they are struck by motor vehicles, but many are only crossing the roadway in order to continue along the shared-use path or sidewalk on which they are riding. Figure 34 details the facilities used by bicyclists involved in crashes. While we lack reliable information about the relative share of miles ridden by bicyclists on sidewalks compared to other types of facilities, bicyclists riding on sidewalks almost certainly face a higher crash risk than those using other types of facility. This may be in part due to the types of bicyclists (e.g. younger, less experienced) that ride on the sidewalk as well as the false sense of security it provides, given that street intersections are where most crashes occur.

Figure 34: Facility Used by Bicyclists



Signalized Intersections

The 80% of bicycle crashes that occurred at intersections are nearly evenly split between those that occurred at signalized and unsignalized intersections.

Table 21: Bicycle Crashes at Signalized Intersections

Bicycle Crashes	%	#
Signalized Intersections	41%	329
Unsignalized Intersections	39%	311
Non-intersection/Unknown	20%	158

Traveling With/Against Traffic

Bicyclist travel direction relative to adjacent motor vehicle traffic appears to play a significant role in crash risk. Traveling against traffic does not necessarily indicate that a bicyclist was riding in the wrong direction. For example, contraflow bicycle lanes, like the one on the south side of University Avenue in the UW campus area, are designed so that bicycle traffic flows against motor vehicle traffic. Generally, bicycle traffic should flow with motor vehicle traffic on bike lanes, shoulders, and streets.

Sidewalks and shared-use paths are unique in that riders may travel in either direction. Crashes involving bicyclists using these facilities dramatically illustrate the increased risk faced by bicyclists traveling against traffic. In both cases, the number of crashes involving bicyclists traveling against traffic is more than 3.5 times those involving bicyclists traveling with traffic. This disparity does not appear in pedestrian crashes (see Table 35) and suggests that bicyclists' higher speeds may put them at particular risk when traveling against traffic.

Half of all crashes involving children under the age of 14 involve a bicyclist riding on the sidewalk, and in 60% of these cases the bicyclist is riding against traffic.

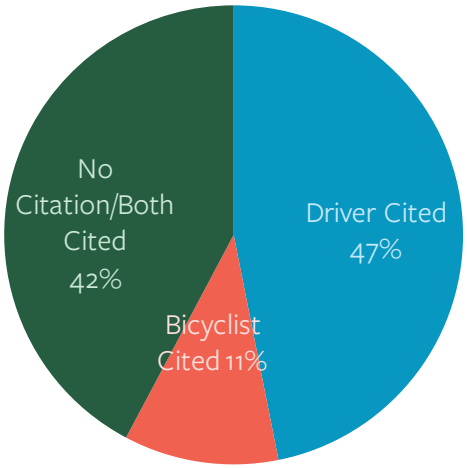
Table 22: Facility Used by Bicyclists and Direction Relative to Motor Vehicles in Adjacent Roadway Travel Lane

	With		Against		Intersecting		Stopped		Unknown		Total	
Facility Type	#	%	#	%	#	%	#	%	#	%	#	%
Bike Lane/Shoulder	175	97%	6	3%	0	0%	0	0%	0	0%	181	100%
Bike Lane - Contraflow	1	2%	42	98%	0	0%	0	0%	0	0%	43	100%
Street	231	89%	9	3%	13	5%	1	0%	5	2%	259	100%
Bike Boulevard	14	100%	0	0%	0	0%	0	0%	0	0%	14	100%
Shared-Use Path	8	14%	31	53%	18	31%	0	0%	1	2%	58	100%
Sidewalk	42	20%	148	69%	10	5%	0	0%	13	6%	213	100%
Unknown	17	68%	4	16%	1	4%	1	4%	2	8%	25	100%
Driveway	0	0%	0	0%	5	100%	0	0%	0	0%	5	100%
Grand Total	**488**	**61%**	**240**	**30%**	**47**	**6%**	**2**	**0%**	**21**	**3%**	**798**	**100%**

Citations

Crashes between bicycles and motor vehicles have a number of contributing factors that affect their likelihood and severity, with each crash the product of a unique set of circumstances. Citations issued by law enforcement provide some insight into whether crashes resulted primarily from a bicyclist or motorist action. It is important to note, however, that citation information detailed in this report comes exclusively from crash reports filed by law enforcement at the time of the crash and does not include citations issued after the fact or citations that were later dismissed.

Figure 35: Citations Issued by Bicycle Crashes- Dane County



As shown in Figure 36, both bicyclists and drivers were cited at a higher rate in the City of Madison than elsewhere in the county. Potential reasons for this disparity include differences in law enforcement training and experience dealing with bicycle related traffic laws and crashes, or a greater number of witnesses to crashes within the city.

Figure 36: Citations Issued by Bicycle Crashes by Municipality

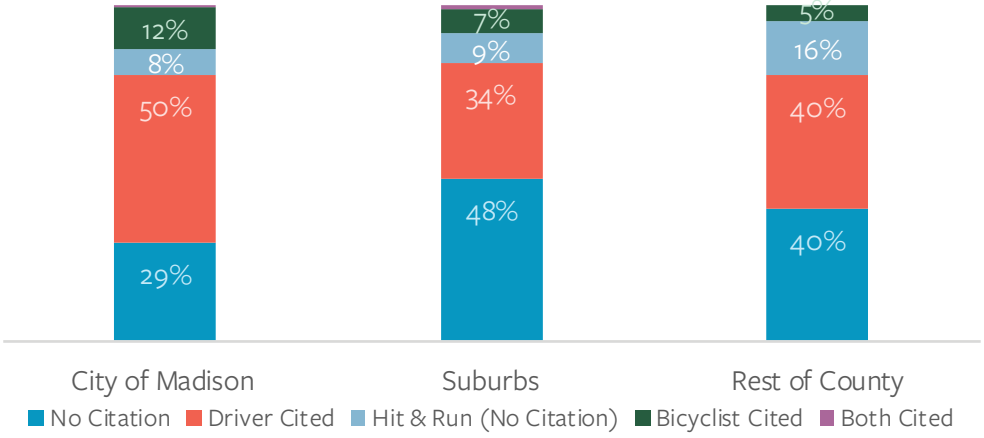


Table 23 details the parties that received citations in crashes of each NHTSA type, arranged by crash frequency. In five of the seven most common crash types, drivers received citations at least 62% of the time.

Table 23: Citations Issued by NHTSA Bicycle Crash Type

		Citation			
Crash Type	**Total**	**Driver**	**Bicyclist**	**Both**	**None**
Motorist Left Turn – Facing Bicyclist	139	77%	1%	1%	22%
Motorist Drive Out – At Stop Sign	104	62%	8%	1%	30%
Motorist Right Turn – Other	83	66%	4%	1%	29%
Bicycle Ride Out – At Intersection, Other	61	5%	44%	3%	48%
Motorist Right Turn – On Red	58	62%	2%	0%	36%
Motorist Left Turn – In Front Of Bicyclist	35	71%	6%	0%	23%
Bicycle Ride Out – At Stop Sign	34	0%	38%	0%	62%
Other – Controlled Intersection	26	12%	8%	0%	81%
Motorist Overtaking – Other	24	25%	0%	0%	75%
Motorist Drive Through	23	78%	0%	0%	22%
Motorist Drive Out – At Intersection, Other	20	55%	0%	0%	45%
Bicycle Left Turn – In Front Of Traffic	20	5%	40%	5%	50%
Motorist Drive Out – At Midblock	18	61%	0%	0%	39%
Motorist Overtaking – Failed To Detect	16	75%	0%	0%	25%
Bicycle Overtaking	13	0%	8%	0%	92%
Bicycle Lost Control	13	8%	23%	0%	69%
Other – Unknown	11	9%	0%	0%	91%
Bicycle Strikes Stopped Vehicle – Other	11	0%	18%	0%	82%
Motorist Overtaking – Misjudged Passing Space	9	56%	0%	0%	44%
Bicycle Left Turn – Facing Traffic	9	0%	33%	0%	67%
Bicycle Ride Out – At Commercial Driveway	8	0%	75%	0%	25%
Bicycle Strikes Stopped Vehicle – Dooring	8	38%	0%	13%	50%
Bicycle Failed To Clear – Trapped	7	0%	43%	0%	57%
Bicycle Ride Out – At Midblock	6	0%	17%	0%	83%
Motorist Drive Out – From On-Street Parking	5	80%	0%	0%	20%
Other – Weird	5	40%	0%	0%	60%
Bicycle Ride Out – From Sidewalk	5	20%	0%	0%	80%
Bicycle Ride Out – At Residential Driveway	5	0%	0%	0%	100%
Motorist Backing	4	25%	0%	0%	75%
Other – Uncontrolled Intersection	4	25%	0%	0%	75%
Motorist Overtaking – Counteractive Evasive Actions	4	0%	25%	0%	75%
Motorist Overtaking – Bicyclist Path Obstructed	2	50%	0%	0%	50%
Bicycle Right Turn	2	0%	50%	0%	50%
Bicycle Wrong Way	2	0%	50%	0%	50%
Bicycle Failed To Clear – Multiple Threat	2	0%	0%	0%	100%
Motorist Lost Control	2	100%	0%	0%	0%
Total	**798**	**47%**	**11%**	**1%**	**41%**

Table 24 details the citation issued in bicycle crashes according to LMCM crash type. Drivers were cited in 50% of intersection crashes and 40% of non-intersection crashes, while bicyclists were cited in 13% of intersection crashes and 10% of non-intersection crashes. 38% of intersection crashes and 53% of non-intersection crashes did not result in a citation.

Table 24: Citations Issued by LMCM Crash Type

Crash Type	Total	Driver	Bicyclist	Both	None
Far side of intersection, left-turning motorist, bicyclist approaching from opposite direction (I_FS_LT_O)	149	70%	4%	1%	25%
Near side of intersection, right-turning motorist, bicyclist approaching from the right (I_NS_RT_R)	118	53%	9%	0%	37%
Non-intersection, right roadway lane, bicyclist riding in same direction (N_RRD_S)	63	30%	5%	3%	62%
Near side of intersection, straight-traveling motorist, bicyclist approaching from the left (I_NS_ST_L)	61	26%	30%	0%	44%
Far side of intersection, straight-traveling motorist, bicyclist approaching from the right (I_FS_ST_R)	55	16%	38%	4%	42%
Far side of intersection, right-turning motorist, bicyclist riding in same direction (I_FS_RT_S)	38	53%	3%	3%	42%
Near side of intersection, straight-traveling motorist, bicyclist approaching from the right (I_NS_ST_R)	34	18%	15%	0%	68%
Far side of intersection, straight-traveling motorist, bicyclist approaching from the left (I_FS_ST_L)	31	23%	19%	3%	55%
Near side of intersection, right-turning motorist, bicyclist riding in same direction (I_NS_RT_S)	29	69%	0%	0%	31%
Near side of intersection, right-turning motorist, bicyclist approaching from the left (I_NS_RT_L)	26	62%	8%	0%	31%
Far side of intersection, left-turning motorist, bicyclist riding in same direction (I_FS_LT_S)	26	73%	8%	0%	19%
Near side of intersection, left-turning motorist, bicyclist approaching from the left (I_NS_LT_L)	22	55%	9%	0%	36%
Non-intersection, right shoulder or bicycle lane, bicyclist riding in same direction (N_RSH_S)	22	68%	0%	0%	32%
Far side of intersection, right-turning motorist, bicyclist traveling in opposite direction (I_FS_RT_O)	19	68%	11%	0%	21%
Non-intersection, right roadway lane, bicyclist approaching from the right (N_RRD_R)	11	27%	18%	0%	55%
Other (OTH)	11	36%	9%	0%	55%
Far side of intersection, left-turning motorist, bicyclist approaching from the left (I_FS_LT_L)	9	56%	0%	0%	44%
Non-intersection, left shoulder or bicycle lane, bicyclist riding in same direction (N_LSH_S)	7	86%	0%	0%	14%
Near side of intersection, left-turning motorist, bicyclist approaching from the right (I_NS_LT_R)	7	57%	0%	0%	43%
Unknown (UNK)	7	14%	0%	0%	86%
Near side of intersection, left-turning motorist, bicyclist approaching from opposite direction (I_NS_LT_O)	6	33%	17%	0%	50%
Non-intersection, right roadway lane, bicyclist approaching from the left (N_RRD_L)	5	0%	20%	0%	80%
Far side of intersection, straight-traveling motorist, bicyclist riding in same direction (I_FS_ST_S)	5	0%	0%	0%	100%
Far side of intersection, left-turning motorist, bicyclist approaching from the right (I_FS_LT_R)	5	40%	0%	0%	60%

Table 24 (Continued): Citations Issued by LMCM Crash Type

Crash Type	Total	Driver	Bicyclist	Both	None
Far side of intersection, left-turning motorist, bicyclist approaching from the right (I_FS_LT_R)	5	40%	0%	0%	60%
Non-intersection, right roadway lane, bicyclist approaching from the opposite direction (N_RRD_O)	4	0%	50%	0%	50%
Near side of intersection, straight-traveling motorist, bicyclist riding in same direction (I_NS_ST_S)	4	50%	0%	0%	50%
Near side of intersection, left-turning motorist, bicyclist riding in same direction (I_NS_LT_S)	4	0%	0%	0%	100%
Non-intersection, left roadway lane, bicyclist approaching from opposite direction (N_LRD_O)	3	67%	33%	0%	0%
Near side of intersection, right-turning motorist, bicyclist riding in unknown direction (I_NS_RT_X)	3	67%	0%	0%	33%
Non-intersection, left roadway lane, bicyclist traveling in same direction (N_LRD_S)	2	0%	0%	0%	100%
Far side of intersection, right-turning motorist, bicyclist approaching from the right (I_FS_RT_R)	2	0%	0%	0%	100%
Far side of intersection, right-turning motorist, bicyclist approaching from the left (I_FS_RT_L)	2	50%	0%	0%	50%
Driveway, motorist traveling forward (D_F)	2	0%	0%	0%	100%
Driveway, motorist backing (D_B)	2	0%	0%	0%	100%
Non-intersection, right roadway lane, bicyclist riding in unknown direction (N_RRD_X)	1	0%	0%	0%	100%
Non-intersection, left roadway lane, bicyclist approaching from the right (N_LRD_R)	1	0%	0%	0%	100%
Near side of intersection, straight-traveling motorist, bicyclist traveling in unknown direction (I_NS_ST_X)	1	0%	0%	0%	100%
Near side of intersection, right-turning motorist, bicyclist approaching from opposite direction (I_NS_RT_O)	1	0%	0%	0%	100%
Total	798	47%	11%	1%	41%

Common Crash Scenarios

Certain common crash scenarios are not directly identified by the NHTSA and LMCM crash types used to classify bicycle crashes in this study. In these cases, the NHTSA and LMCM types may capture crashes with different characteristics and/or be too narrow to capture all crashes that share certain features. The data used to identify the common crash scenarios below was aggregated by using a combination of NHTSA and LMCM crash types.

Motorist Right Turn from Stop – Bicyclist Approaching from the Right

Crashes between motorists making a right turn from a stop at a stop sign or red light and bicyclists traveling against traffic on a sidewalk or shared-use path approaching from the motorist's right are among the most common in the Madison area. It is likely that many of these crashes occurred after the motorist had initially looked to their right (or failed to do so) but then shifted their attention to their left as they waited for an opening to merge into traffic. These crashes—classified as LMCM type I_NS_RT_R and as either NHTSA crash type *Motorist Drive Out – At Stop Sign, Motorist Drive Out – At Midblock, or Motorist Right Turn – On Red*—accounted for 94 (12%) crashes during the study period. Of these, 71 occurred within the City of Madison, 22 occurred in suburban MPO communities, and 1 occurred elsewhere in the county. 45 (48%) of these crashes occurred at stop signs, while the remainder occurred at traffic signals. All 5 of the *Motorist Drive Out – At Midblock* crashes of this type occurred at commercial driveway entrances.

Right/Left Hook Crashes

Right hook crashes are those that occur when a car makes a right turn into or right in front of a bicyclist traveling in the same direction on the right side of a motorist, often in a bicycle lane. Left hook crashes, as defined in this report, are the mirror image of right hook crashes, involving a bicyclist traveling on the left side of a motorist traveling in the same direction who is hit or cut off when the motorist makes a left turn. There were a total of 93 right and left hook crashes in Dane County during the study period, accounting for nearly 12% of all bicycle crashes.

For this analysis, all crashes of NHTSA type *Motorist Right Turn – Other* and LMCM type of either I_NS_RT_S, I_FS_RT_S, N_RRD_S, or N_RSH_S were classified as right hooks; and all crashes of NHTSA type *Motorist Left Turn – In Front of Bicyclist* and LMCM type of I_NS_LT_S, I_FS_LT_S, N_LRD_S, or N_LSH_S, were classified as left hooks.

A total of 63 right hook crashes occurred in Dane County during the study period, 55 (87%) of which occurred in the City of Madison. In 37 (59%) of these crashes, the bicyclist was traveling in a bike lane or shoulder, and in another 13 (21%) the bicyclist was riding in the street.

A total of 30 left hook crashes occurred in Dane County during the study period, 28 (93%) of which occurred in the City of Madison. In 17 (57%) of left hook crashes that occurred in Dane County the bicyclist was riding in the left-side bicycle lane along Johnson Street in downtown Madison, and in another 7 (23%) the bicyclist was riding on the sidewalk.

Overtaking Crashes

Crashes involving bicyclists traveling straight being struck from behind by motorists traveling in the same direction were analyzed to determine their common features. These crashes are dominant in rural parts of Dane County and provoke particular anxiety among cyclists due to the fact that the motor vehicle is approaching from behind, making it nearly impossible for the bicyclist to anticipate and avoid the crash.

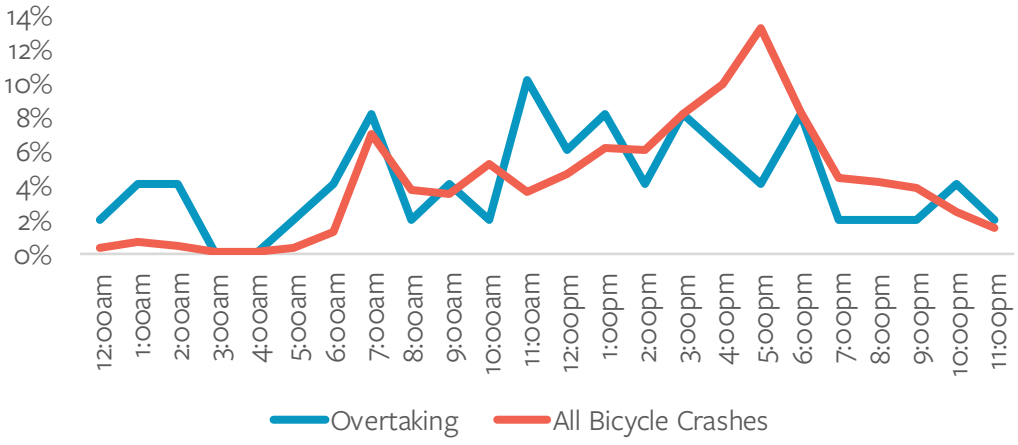
The crashes included in this analysis include all of those that are categorized both as one of the *Motorist Overtaking* NHTSA crash types and as one of the LMCM crash types identifying crashes involving straight-traveling motorists and straight-traveling bicyclists: N_RRD_S, N_RSH_S, I_FS_ST_S, I_NS_ST_S.

There were 49 crashes of this type in Dane County during the study period, accounting for 6% of total bicycle crashes. Just over half of these (25) occurred in the City of Madison, 4 occurred in the suburbs, and the remainder (20) occurred outside of the urban MPO area. Overtaking crashes outside of the urban MPO area were the most severe, with one fatal crash and four incapacitating crashes, while there were no fatalities and just two incapacitating crashes of this type within the urban MPO area.

About half of these crashes (25) occurred on roads that had a bike lane or shoulder. Excluding the fatal crash, which occurred on a road with a shoulder, the crashes occurring on roads with and without bike lanes/shoulders look remarkably similar in terms of injury severity. Posted speed limit is more closely associated with injury severity in these types of overtaking crashes. Of the 16 crashes that took place on roads with a 55 mph posted speed limit, 25% were either incapacitating (3) or fatal (1). On roads with posted speed limits below 55 mph, there were no fatal crashes and just 9% (3) were incapacitating.

There is some evidence that overtaking crashes may be more common during nighttime hours. As shown in Figure 37, overtaking crashes appear to be somewhat more spread out through the course of the day than bicycle crashes are overall.

Figure 37: Hourly Distribution of Overtaking Crashes vs. All Bicycle Crashes



Hit-and-run crashes were far more common among overtaking crashes than among all bicycle crashes. 22 overtaking crashes, representing 45% of the total, were hit-and-runs. Only a few overtaking hit-and-run crashes occurred outside of the urban MPO area, as shown in Figure 40.

Figure 38: Motorist Right Turn from Stop- Bicyclist Approaching from the Right

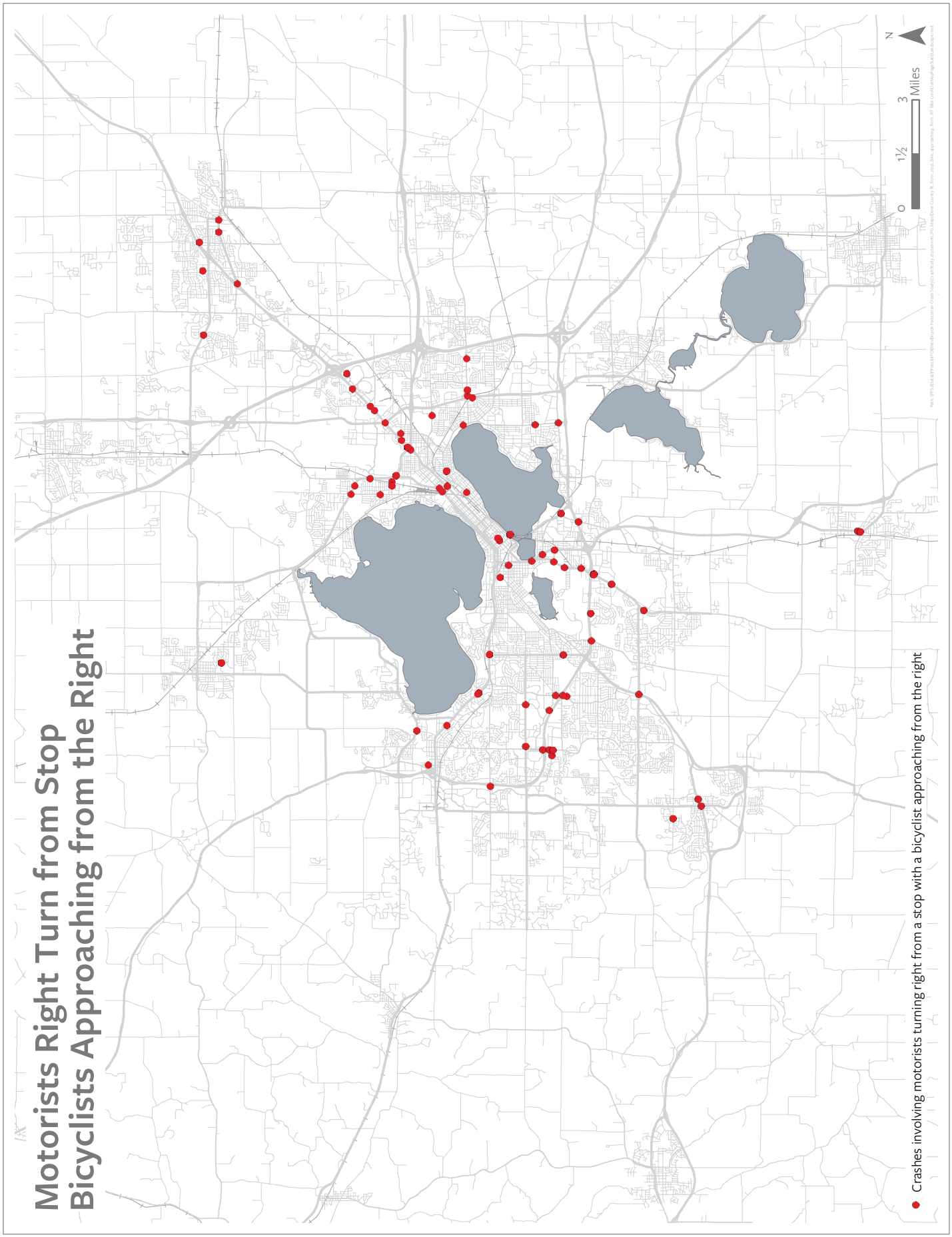


Figure 39: Right Hook/Left Hook Crashes

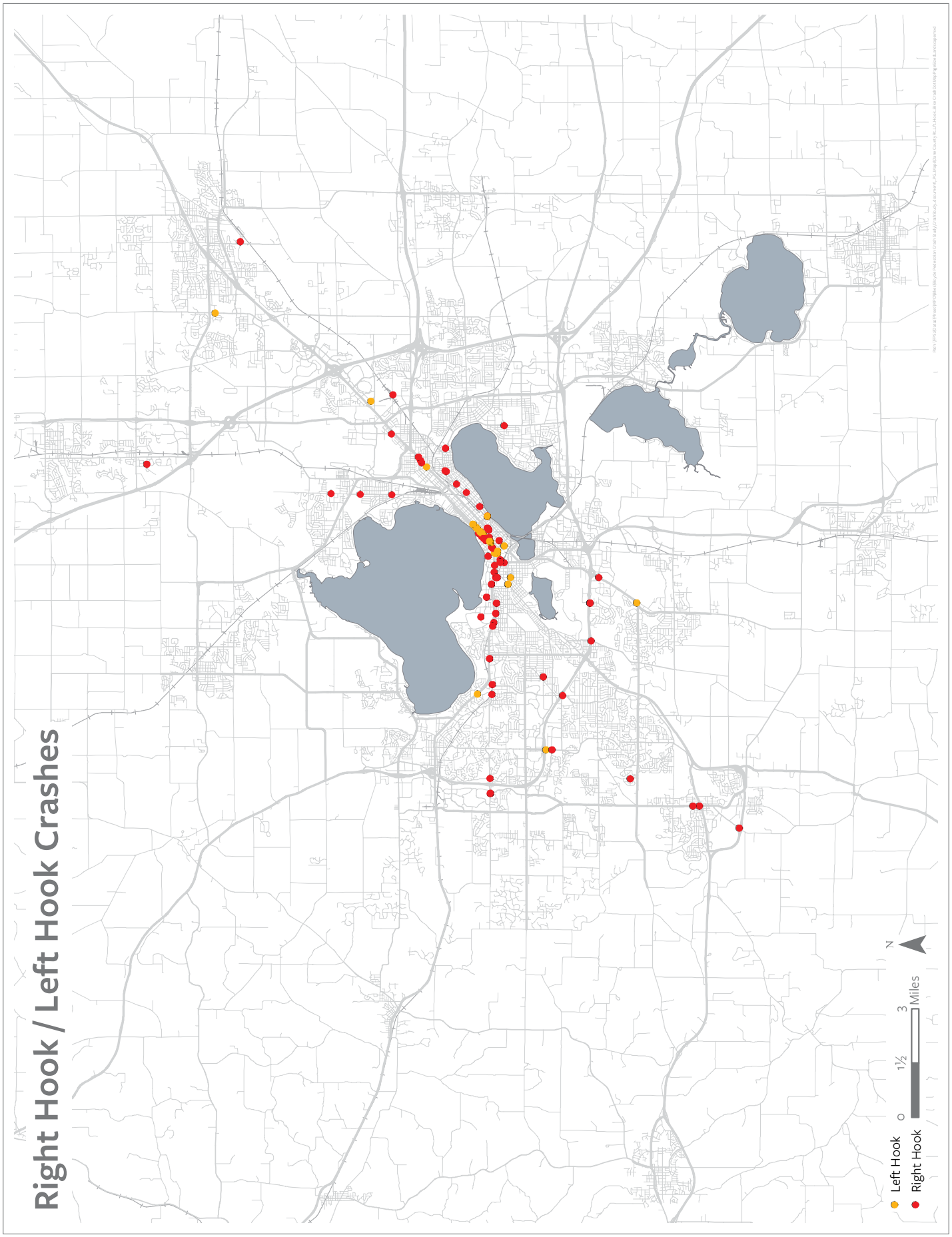
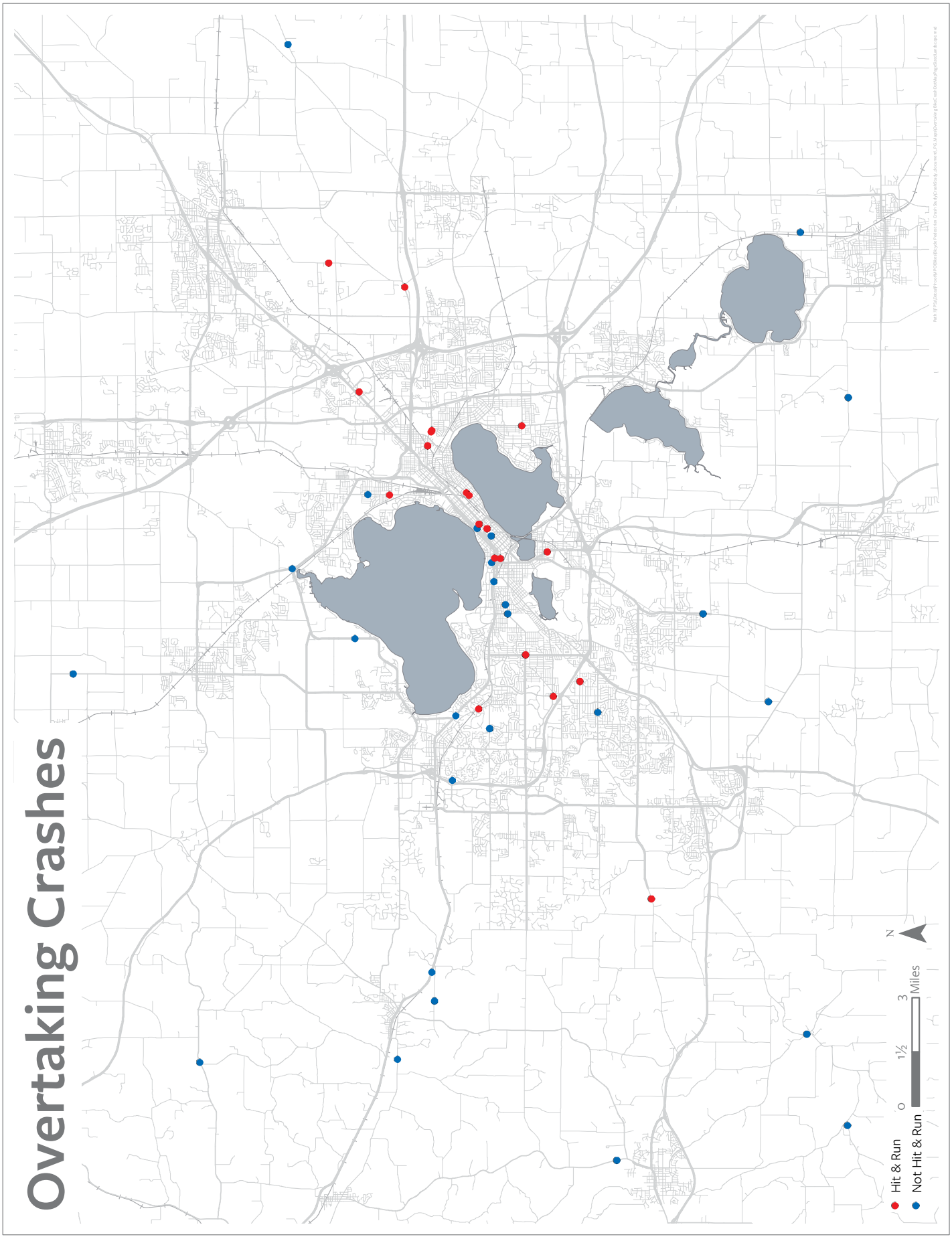


Figure 40: Overtaking Crashes



Comparison to the 1992 City of Madison Bicycle Crash Study

Overview

This study comes 25 years after the publication of a similar study, published in 1992, which focused on bicycle crashes within the City of Madison during the four-year 1987-1990 period. Despite population growth of more than 25% and a 50% increase in the rate of bicycle commuting, the annual crash rate between bicycles and motor vehicles has declined substantially. It is likely that this reduction in bicycle crashes has been driven in part by large scale investments in bicycle infrastructure during the intervening years as well as safety education and targeted enforcement efforts. It also validates the "safety in numbers" theory. As the number of bicyclists increase, motorists are more inclined to look for, notice, and yield to them when appropriate. Table 25 provides an overview of these two studies.

Table 25: Comparison of 2018 and 1992 Crash Studies

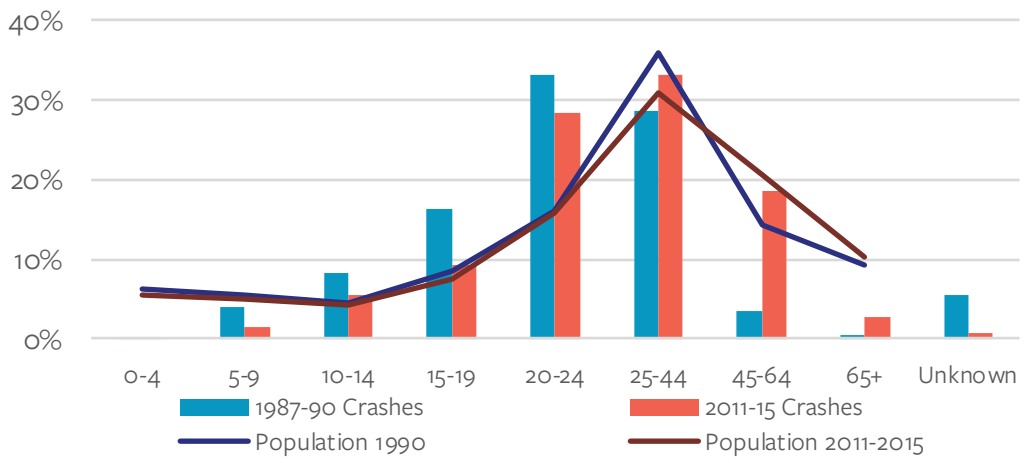
	2018 Study	1992 Study
Time Period	2011-2015	1987-1990
Number of Years	5	4
Study Area	Dane County	City of Madison
Total Crashes*	798	774
Bicycle Crashes - City of Madison		
Total Crashes	627	774
Population	243,122 (2011-2015 est.)	190,766 (1990)
Annual Crashes	125	194
Bicycle Commuting Pct.	5.2% (2011-2015 est.)	3.3% (1990)
Crash Rate per 100,000 pop.	51.4	101.7

* Includes only motor vehicle – bicycle crashes

Demographics

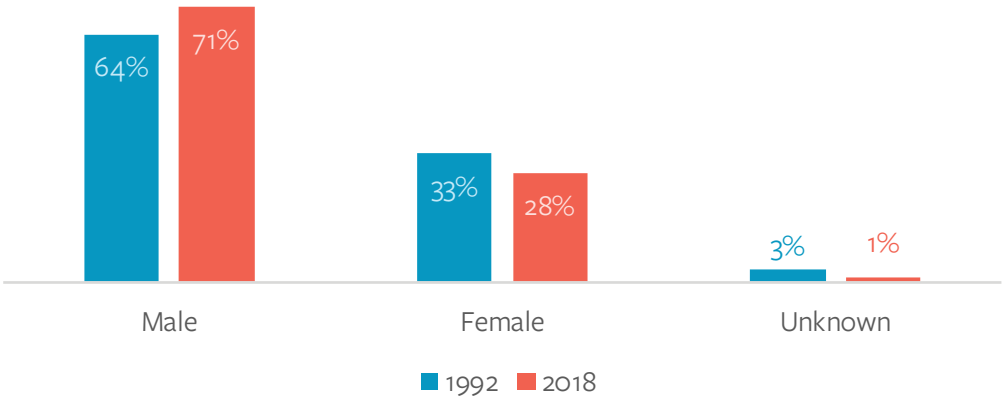
Compared to the 1992 study, the current analysis reveals adults over age 45 to be a substantially larger share of bicyclists involved in crashes. These older bicyclists made up just 4.0% of those involved in crashes during the 1987-1990 study period, but accounted for 21.5% of crashes during the 2011-2015 period. This change far outpaces the growth of over-45 people as a share of the city's total population. Figure 41 details the age of bicyclists involved in crashes during the 1987-90 and 2011-15 periods, with the total City of Madison population in each age group during the two periods shown by the lines.

Figure 41: City of Madison Bicycle Crash and Population Age Groups



The 2018 analysis reveals a larger gender disparity in bicyclists involved in crashes than was found in the 1992 study, as shown in Figure 42. It is, however, impossible to know the degree to which this disparity reflects greater male bicycle ridership versus disproportionate involvement in bicycle crashes by males due to a lack of reliable bicycle ridership data.

Figure 42: Gender of Bicyclists Involved in Crashes- 1992 and 2018 Studies



Comparison Methodology

The crash types used in the present study differ from those used in the 1992 analysis. The NHTSA crash types used in this study were similar enough to those used in the previous study that it was possible, in most cases, to convert them into the crash types used in the 1992 study. In many cases, the NHTSA crash types used in the current study were directly equivalent to crash types used in the previous study. To facilitate conversion in cases where a single NHTSA crash type had to be divided into subcategories for comparison to the categories used in the 1992 study, bicycle crash subtypes corresponding to the 1992 study's categories were assigned to all crashes of NHTSA types that were not comparable to the 1992 categories. See Appendix C for specific information about how NHTSA crash types were converted to the crash types used in the 1992 analysis.

Crash Types

As shown in Table 26, with a few exceptions, bicycle crash type frequencies have remained fairly constant since the previous study. The most common crash type during both study periods involved motorists turning left into the path of oncoming bicycles, accounting for nearly 20% of all crashes during the 2011-2015 period.

Table 26: Comparison of Crash Type Frequencies

Crash Type	1987-90	2011-15	Change
Motorist turn/merge into the bicyclist's path	34.0%	37.5%	3.5%
Motorist left turn or merge	26.2%	25.0%	-1.2%
Motorist/bicyclist in opposing directions	23.3%	19.8%	-3.5%
Motorist/bicyclist same direction	3.0%	5.3%	2.3%
Motorist right turn or merge	7.1%	11.6%	4.5%
Motorist enter or exit on-street parking	0.6%	0.8%	0.2%
Motorist drive out from a stop sign	16.0%	13.2%	-2.8%
Motorist obeyed sign, but failed to yield	14.3%	11.3%	-3.0%
Motorist ran stop sign	1.7%	1.9%	0.2%
Motorist drive out from a driveway or alley	9.9%	2.6%	-7.4%
Motorist exited forward	8.8%	1.9%	-6.9%
Motorist backing	1.2%	0.6%	-0.5%
Bicyclist turn/merge into motorist's path	6.3%	4.1%	-2.2%
Bicyclist left turn or merge	4.4%	3.2%	-1.2%

Table 26 (continued): Comparison of Crash Type Frequencies

Crash Type	1987-90	2011-15	Change
Bicyclist/motorist same direction	3.0%	2.2%	-0.7%
Bicyclist/motorist opposing directions	1.4%	1.0%	-0.5%
Bicyclist merging into street from sidewalk	1.2%	0.6%	-0.5%
Bicyclist right turn or merge	0.8%	0.3%	-0.5%
Bicyclist overtaking motorist	6.2%	4.3%	-1.9%
Bicyclist hit parked motor vehicle	3.0%	0.2%	-2.8%
Bicyclist hit open car door	2.1%	1.0%	-1.1%
Bicyclist hit motor vehicle in travel lane	1.2%	1.9%	0.8%
Bicyclist strikes stopped car (from side)$_1$	N/A	1.3%	N/A
Bicyclist ride out at a traffic signal	4.8%	7.2%	2.4%
Bicyclist on street	2.7%	1.6%	-1.1%
Bicyclist on sidewalk/crosswalk	1.9%	2.2%	0.3%
Location unknown	0.1%	0.6%	0.5%
Bicyclist in bike lane/shoulder$_1$	N/A	1.6%	N/A
Bicyclist on shared-use path$_1$	N/A	1.1%	N/A
Motorist overtaking bicyclist	4.1%	4.5%	0.3%
Motorist failed to detect bicyclist	1.2%	1.4%	0.3%
Motorist misjudged space to pass bicyclist	1.0%	0.3%	-0.7%
Other (not evident from description)	1.9%	2.2%	0.3%
Motorist Overtaking - Bicyclist Path Obstructed1	N/A	0.3%	N/A
Motorist Overtaking - Counteractive Evasive Actions1	N/A	0.2%	N/A
Motorist drive out at a traffic signal	3.9%	8.9%	5.1%
Right turn on red	2.5%	7.8%	5.4%
Motorist ran red or yellow signal	1.4%	1.1%	-0.3%
Bicyclist ride out at stop sign	3.0%	3.5%	0.5%
Bicyclist doesn't stop at sign$_1$	N/A	2.1%	N/A
Bicyclist obeys sign, fails to yield$_1$	N/A	0.6%	N/A
Unknown if cyclist obeyed or ran sign$_1$	N/A	0.8%	N/A
Bicyclist ride out, midblock	2.6%	2.4%	-0.2%
From a driveway	1.6%	1.8%	0.2%
From non-driveway location (over curb)	1.0%	0.6%	-0.4%
Bicyclist ride out, uncontrolled intersection	2.2%	0.8%	-1.4%
Bicyclist on street	1.2%	0.5%	-0.7%
Bicyclist on sidewalk/crosswalk	0.8%	0.3%	-0.5%
Bicyclist on bike path	0.1%	0.0%	-0.1%
Bicyclist in bike lane with traffic	0.1%	0.0%	-0.1%
Bicyclist turning	1.3%	0.0%	-1.3%
Right, too wide	1.0%	0.0%	-1.0%
Left, cut corner	0.3%	0.0%	-0.3%
Motorist drive out, uncontrolled intersection	0.9%	1.1%	0.2%
Bicyclist wrong way, head-on	0.5%	0.3%	-0.2%
Bicyclist did not clear intersection before signal turned green for cross traffic (trapped by signal)	0.5%	1.1%	0.6%
Motorist backing on the street$_2$	0.5%	N/A	N/A

Table 26 (continued): Comparison of Crash Type Frequencies

Crash Type	1987-90	2011-15	Change
Bicyclist lost control	0.4%	1.1%	0.7%
Motorist lost control	0.3%	0.2%	-0.1%
Motorist turning	0.3%	0.6%	0.4%
Right, too wide	0.1%	0.2%	0.0%
Left, cut corner	0.1%	0.5%	0.3%
Motorist wrong-way, head-on	0.1%	0.0%	-0.1%
Unknown types	2.2%	5.1%	2.9%
Bicyclist and motorist on crossing paths	1.7%	2.9%	1.2%
Signal controlled intersection	0.9%	1.6%	0.7%
Uncontrolled intersection	0.4%	0.5%	0.1%
Stop sign controlled intersection	0.3%	0.8%	0.5%
Midblock crosswalk	0.1%	0.0%	-0.1%
Bicyclist and motorist on parallel paths	0.3%	1.9%	1.7%
Unknown paths	0.3%	0.3%	0.1%
Bicyclist rides out at controlled intersection - either not facing a control or facing a yield sign[1]	N/A	0.3%	N/A
Motorist failed to yield at a yield sign[1]	N/A	0.5%	N/A
Motorist failed to yield at a crosswalk with pedestrian crossing warning signs or signals[1]	N/A	0.5%	N/A
Motorist drive out - other[1]	N/A	0.2%	N/A
Total	**100%**	**100%**	**N/A**

1 Not categorized in 1992 study

2 Category not included in 2018 study

The biggest changes are in the reduced frequency of crashes involving motorists driving out at alleyways and driveways, and the increased frequency of crashes involving motorists driving out at traffic signals. Motorist drive-outs at alleyways and driveways have declined from 9.9% to 2.6% of all crashes. Drive-outs at traffic signals have increased from 3.9% to 8.9%, with most of this change being driven by an increase in the number of crashes involving motorists making a right turn on red.

Facility and Travel Direction

Table 27 details the facilities being used by bicyclists involved in crashes and the direction that they were traveling relative to motor vehicle travel in the adjacent lane. Some of the most striking changes include the higher percentage of crashes involving bicyclists in bicycle lanes and on shared-use paths, and the reduction in crashes occurring on streets, other than in bicycle lanes. It is likely that the shifts in facility usage have been driven by changes in bicycle infrastructure in the City of Madison over the past 25 years. During that period, bicycle lanes and shared-use paths have become much more common, which has most likely led some riders to shift from riding on sidewalks and streets onto these newly available facilities.

The increase in the percentage of crashes in which riders were not traveling either with or against traffic may be attributable to the larger number of mid-block crosswalks and shared-use path crossings, where there is no adjacent motor vehicle lane.

Table A-1 in Appendix A combines information about crash type, facility, and travel direction to offer a more detailed perspective on the relationship between these variables.

Table 27: Facility and Travel Direction of Bicyclists Involved in Crashes

Facility Used and Travel Direction	1987-90	2011-15	Change
On Street (incl. all bicycle lanes and bicycle boulevards)	66.4%	62.7%	-3.7%
With traffic	63.3%	51.5%	-11.8%
Against traffic	3.1%	8.6%	5.5%
Other/unknown direction	0.0%	2.6%	2.6%
Total Bike Lane	18.7%	30.8%	12.0%
With traffic	18.2%	23.3%	5.1%
Against traffic	0.5%	7.5%	7.0%
Total Other On-Street	47.7%	31.9%	-15.8%
With traffic	43.9%	28.2%	-15.7%
Against traffic	2.6%	1.1%	-1.5%
Other/unknown direction	0.0%	2.6%	2.6%
Sidewalk or Crosswalk	30.1%	27.1%	-3.0%
With traffic	7.1%	5.6%	-1.5%
Against traffic	21.7%	18.7%	-3.0%
Other/unknown direction	1.3%	2.9%	1.6%
Shared-Use Path	1.6%	6.9%	5.3%
With traffic	0.6%	1.0%	0.3%
Against traffic	0.8%	3.2%	2.4%
Other/unknown direction	0.1%	2.7%	2.6%
Driveway	1.6%	0.6%	-0.9%
Unknown Location	0.4%	2.7%	2.3%
With traffic	0.1%	1.9%	1.8%
Against traffic	0.1%	0.3%	0.2%
Other/unknown direction	0.1%	0.5%	0.3%
Total Bicyclist-Motorist Crashes	100%	100%	0%
Total with traffic	71%	60%	-11%
Total against traffic	26%	31%	5%
Total other/unknown	3%	9%	6%

Chapter 4

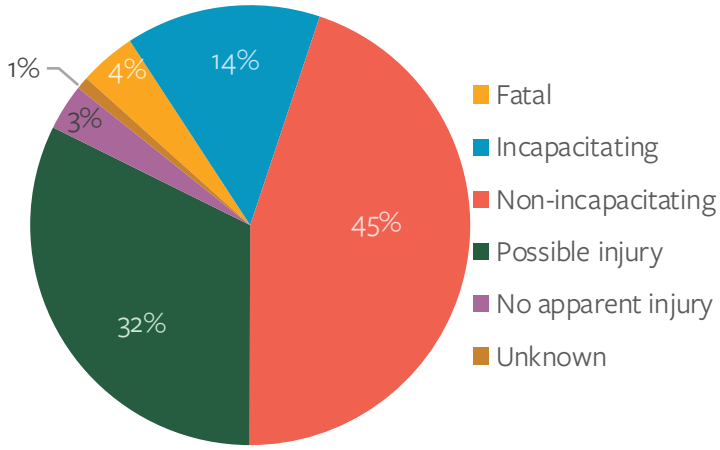
Pedestrian Crashes

- Number of Crashes and Crash Severity
- Speed and Crash Severity
- Roadway Travel Lanes and Crash Severity
- Crash Location
- Pedestrian Crashes Near Environmental Justice Populations
- Demographic Characteristics of Crash Victims
- Top Crash Sites
- Facilities
- Citations

Number of Crashes and Crash Severity

Overall, there were 552 reported pedestrian crashes in Dane County during the study period. Of these, 4% (23) were fatal and another 14.3% (79) resulted in an incapacitating injury. The term "incapacitating," as used in the MV4000 crash reports that are the basis for the data used in this study, refers to an injury that makes it impossible for the injured person to transport themselves away from the scene of the crash, and it encompasses a wide range of injury severities. While the majority of reported pedestrian crashes do not result in serious injuries, the rate of fatal and incapacitating injury in crashes with motor vehicles is much higher for pedestrians than for bicyclists.

Figure 43: Pedestrian Injury Severity



Speed and Crash Severity

While the overall fatality rate for pedestrians involved in reportable crashes is 4.2%, the fatality rate varies widely by speed limit. 22% of the crashes that occurred on roads with speed limits of at least 40 mph were fatal, compared to just 1% of the crashes that occurred on roads where the speed limit is 25 mph or below.

Table 28: Posted Speed Limit and Pedestrian Injury Severity

Posted Speed Limit (mph)	Fatal		Incapacitating		Non-Severe		Unknown		Total
	#	%	#	%	#	%	#	%	#
< 25	4	1.1%	48	13.4%	303	84.4%	4	1.1%	359
30	5	5.8%	11	12.8%	69	80.2%	1	1.2%	86
35	6	8.5%	13	18.3%	52	73.2%	0	0.0%	71
40+	8	22.2%	7	19.4%	21	58.3%	0	0.0%	36
Total	**23**	**4.2%**	**79**	**14.3%**	**445**	**80.6%**	**5**	**0.9%**	**552**

Roadway Travel Lanes and Crash Severity

The number of roadway travel lanes does not appear to be related to pedestrian crash injury severity.

Crash Location

Figures 44 and 45 show the locations where pedestrian crashes have occurred in Dane County and in central Madison, respectively. The majority of crashes occurred in downtown Madison and the University of Wisconsin campus areas, but pedestrian crashes occurred in nearly every community in the county during the study period. Fatal pedestrian crashes during the study period were widely dispersed across the metropolitan area.

Figure 44: Pedestrian Crash Locations- Dane County

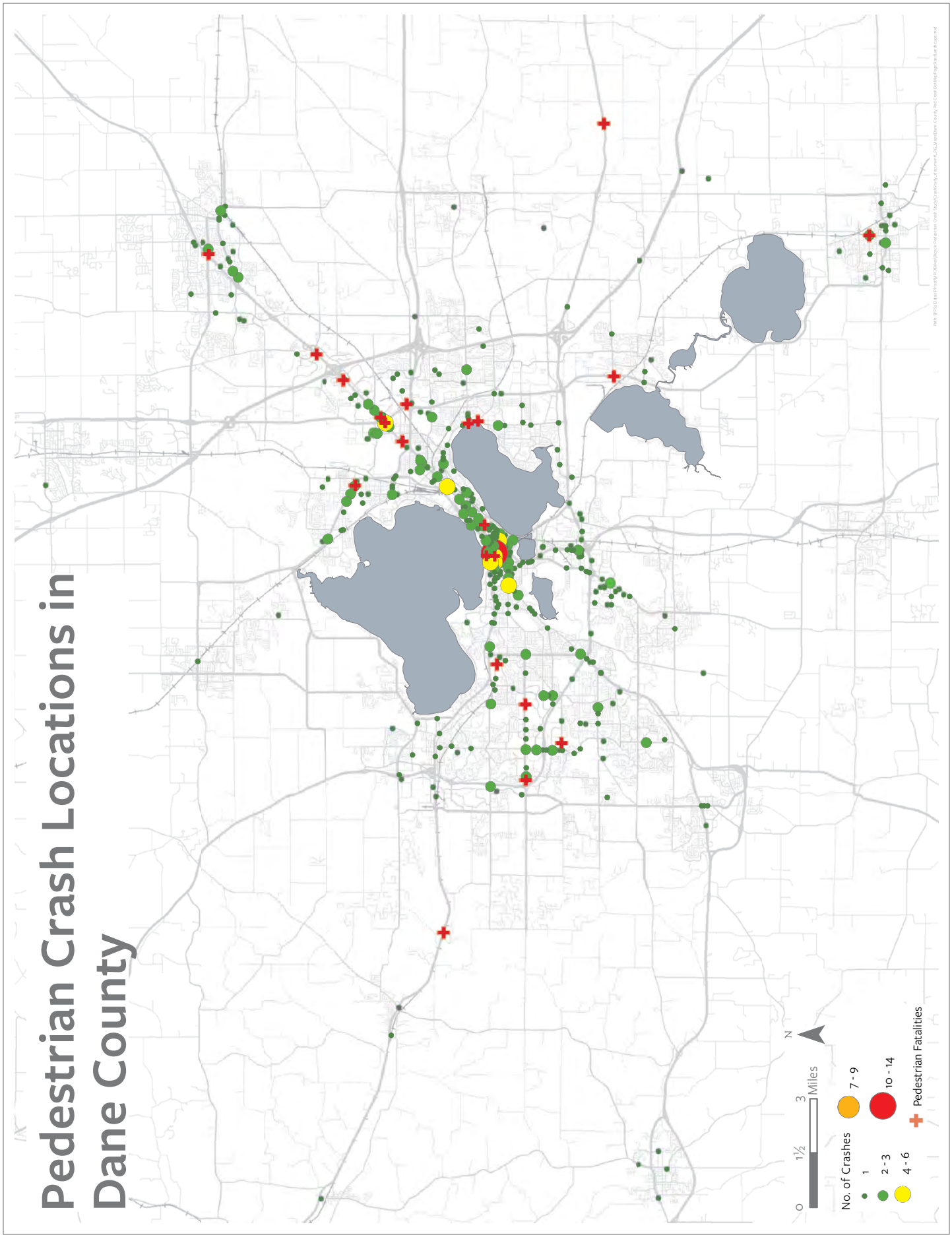
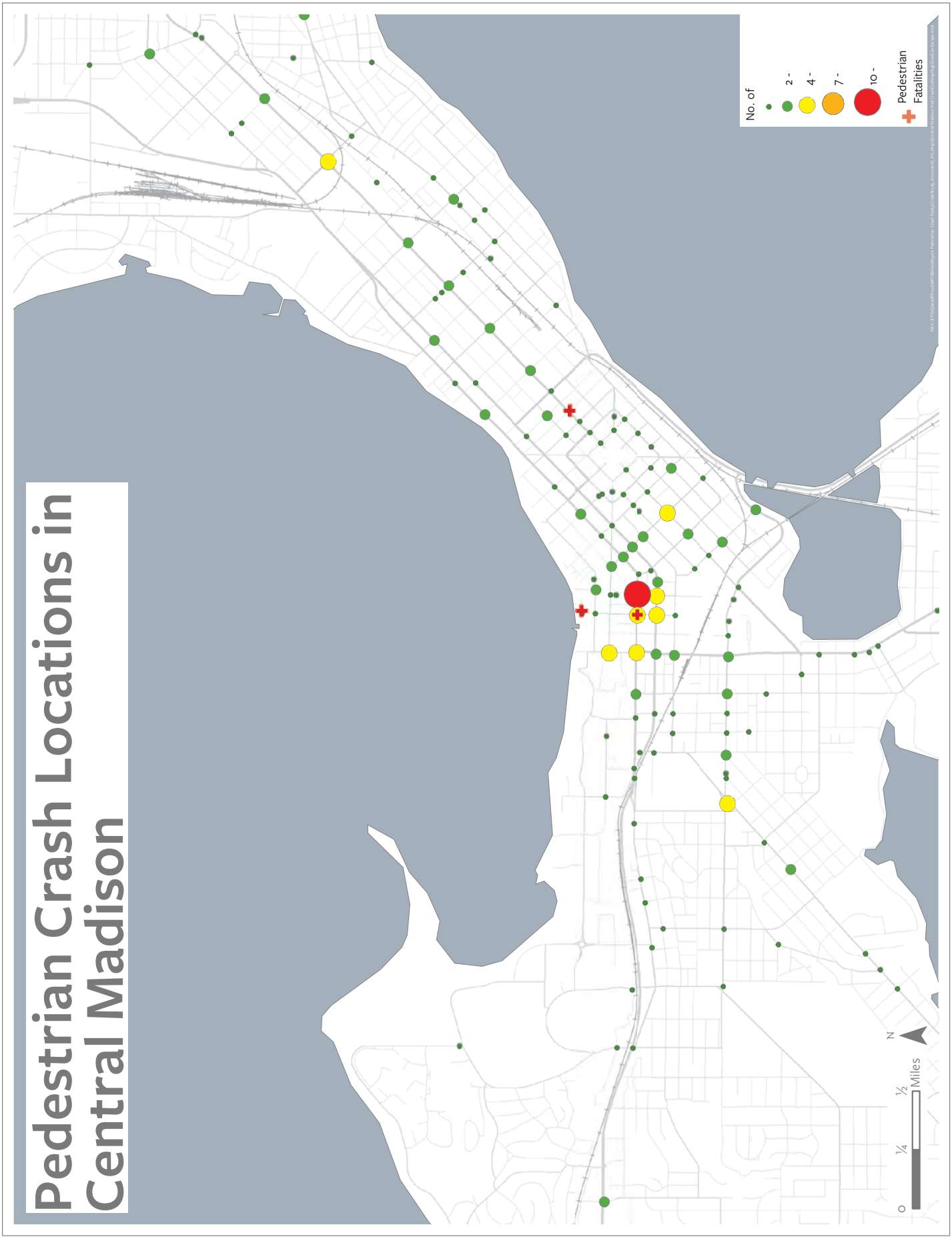


Figure 45: Pedestrian Crash Locations- Central Madison



The City of Madison accounted for 76% of pedestrian crashes that occurred during the study period, while 19% took place in suburbs, and the remainder occurred elsewhere in Dane County.

Figure 46: Pedestrian Crashes by Location

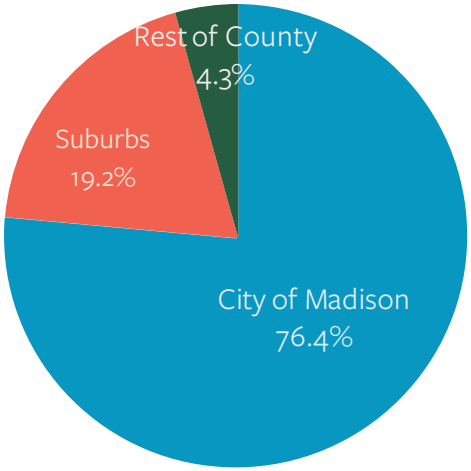


Table 29 details the top pedestrian crash locations in Dane County. Like bicycle crashes, pedestrian crashes are concentrated in the campus and downtown areas. The intersection of Stoughton Road and East Washington Avenue is the only high crash location outside of central Madison. No location outside of the City of Madison had more than two pedestrian crashes during the study period.

Table 29: Top Pedestrian Crash Locations

Location	Crashes	Fatalities
University Ave at North Frances St	11	0
Monroe St at Regent St	6	0
University Ave at North Lake St	5	1
East Washington Ave at Stoughton Rd	4	2
University Ave at North Park St	4	0
West Johnson St at North Frances St	4	0
West Johnson St at North Lake St	4	0
West Washington Ave at Broom St	4	0

Pedestrian Crashes near Environmental Justice Populations

Figures 47 and 48 show the location of pedestrian crashes in relationship to areas with higher concentrations of low-income and minority populations, respectively. Because crash reports do not detail race and income information of those involved in crashes, it is impossible to know whether low-income or minority groups are disproportionately affected. However, outside of downtown Madison, it appears that pedestrian crashes may be somewhat more common near areas with higher minority and low-income populations.

This could be due to the limited transportation options available to low-income and minority people, which may lead them to walk more frequently in areas where they face higher crash risk. Census 5-year ACS data show that minorities and low-income people walk or take public transportation to work at a much higher rate than whites and those with higher incomes. For example, 14% of black people in the Madison urban area used public transportation to get to work compared to 5% of white people. 17% of people with incomes below 150% of the poverty level walked to work compared to under 4% of those with higher incomes. 13.5% of low-income people used public transit versus 5% of people at or above 150% of the poverty level.

Figure 47: Pedestrian Crashes and Low-Income Populations

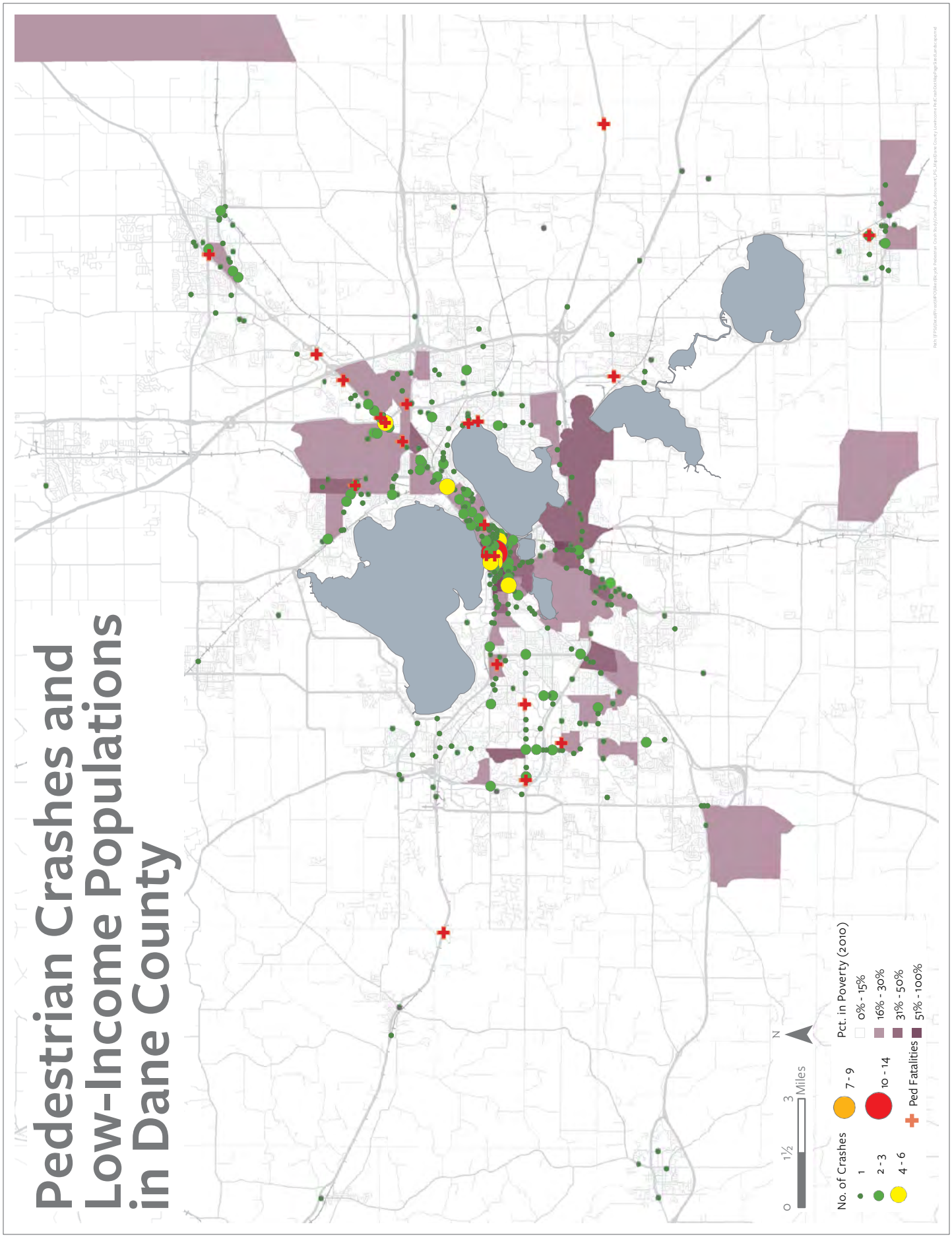
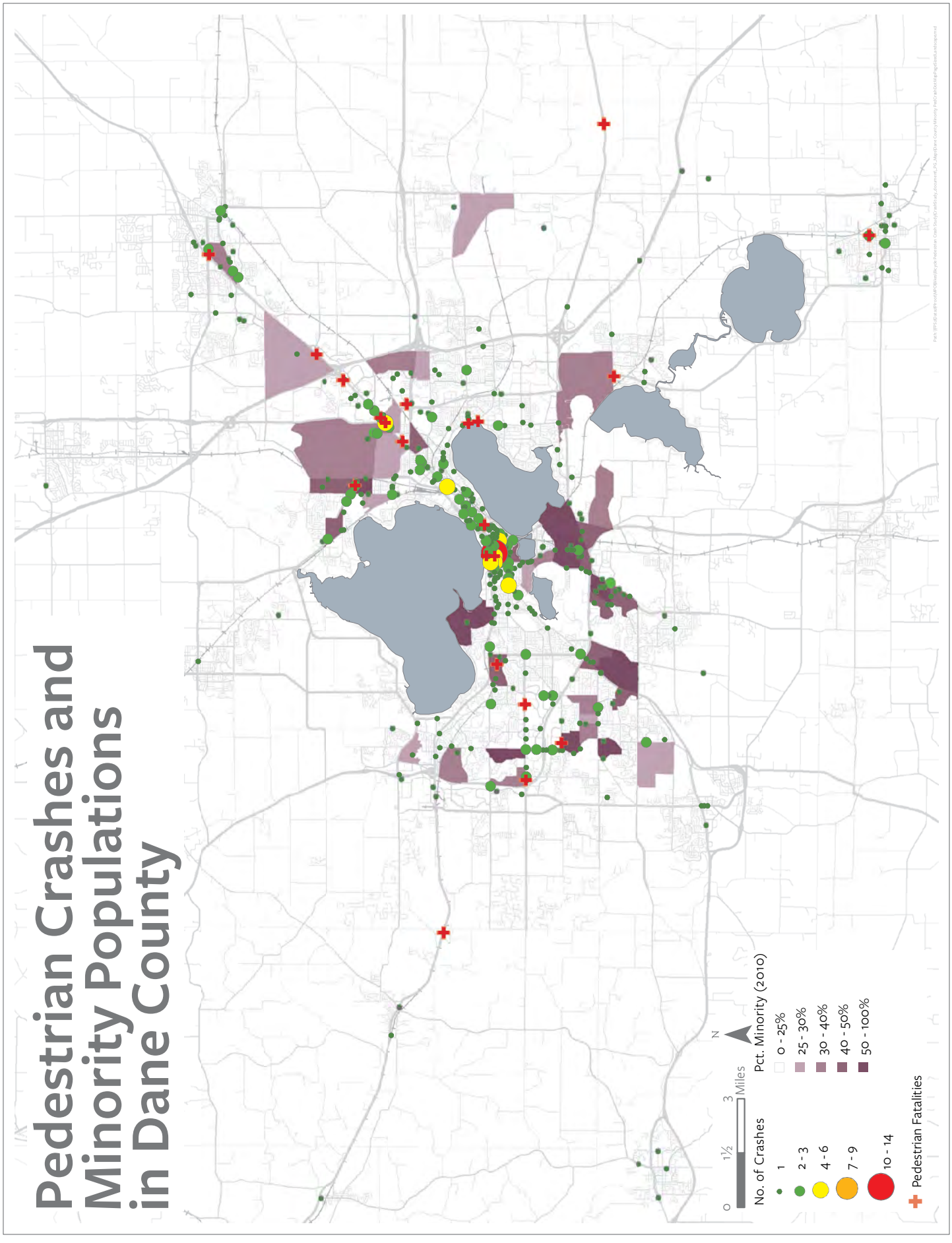


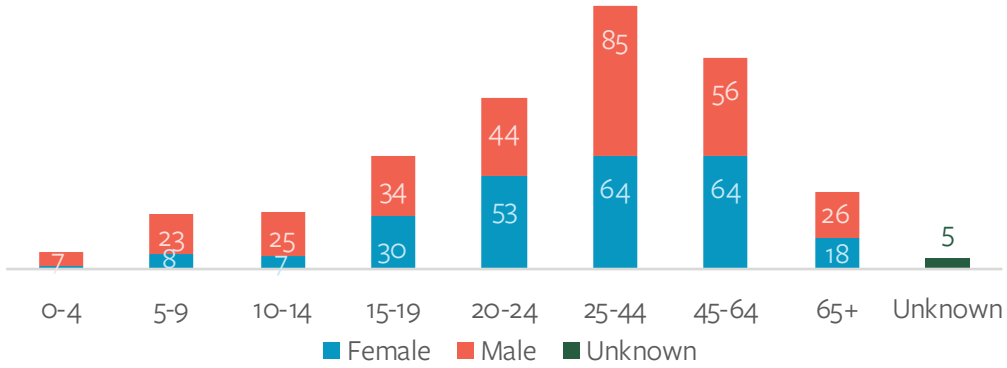
Figure 48: Pedestrian Crashes and Minority Populations



Demographic Characteristics of Crash Victims

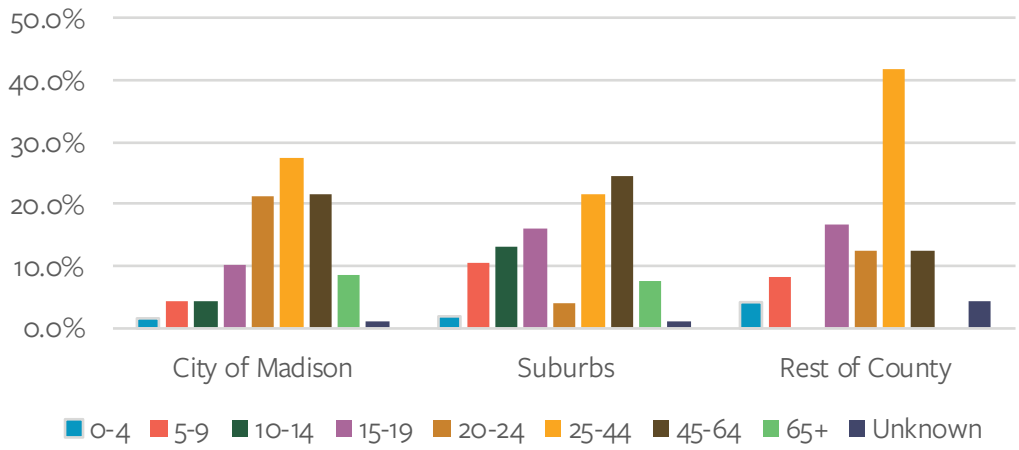
Pedestrians of all ages were involved in crashes and, excluding pedestrians under 15 years of age, were fairly evenly divided between males and females. People older than 65 and younger than 10 are involved in a significantly larger share of pedestrian than bicycle crashes.

Figure 49: Age and Gender of Pedestrians Involved in Crashes



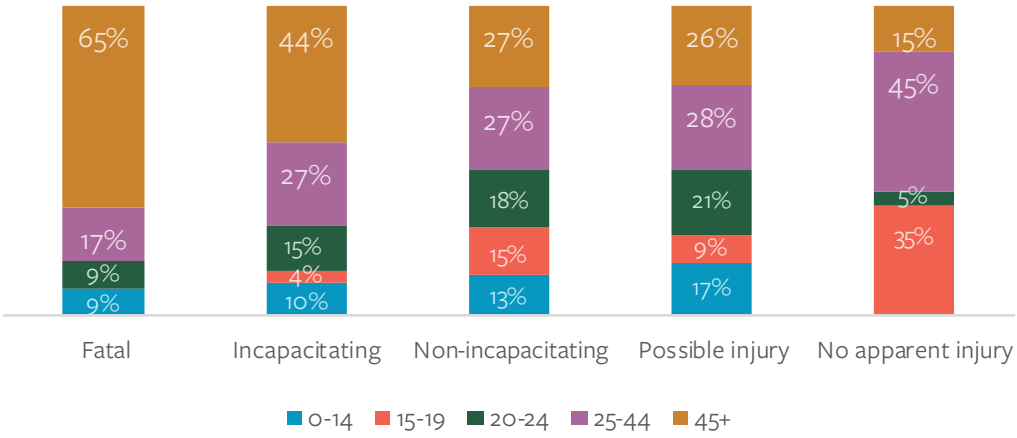
The age of pedestrians involved in crashes varied among Madison, suburbs in the MPO planning area, and the rest of the county. Children under 19 years of age made up a greater share of pedestrian crash victims outside of the City of Madison, comprising about 40% in the suburbs and 30% in the rest of the county, versus just 20% in the City.

Figure 50: Age of Pedestrians Involved in Crashes by Municipality



People 45 and older were overrepresented among fatal crash victims, making up 64% of all pedestrian crash fatalities. The 25-44 age group represents nearly half of pedestrian crash victims without apparent injury.

Figure 51: Pedestrian Age and Injury Severity



Top Crash Types

Each pedestrian crash was classified by type according to both NHTSA and LMCM typologies. NHTSA crash types are based on crash location and a variety of other circumstances. By contrast, LMCM types are rooted exclusively in crash location and the relative directions of the vehicle and pedestrian involved in the crash.

Top NHTSA Crash Types

Table 30 details the most common pedestrian crash categories in Dane County. About a third of all pedestrian crashes involved vehicles turning or merging at an intersection. The second most common crash category, *Intersection Dash/Walkout*, includes all crashes in which a pedestrian walks or runs in front of oncoming traffic at an intersection. While legal fault for crashes does not follow crash types directly, drivers are much more likely to receive citations following *Vehicle Turn Or Merge* crashes, while pedestrians are more likely than drivers to receive citations for *Intersection Dash/Walkout* crashes.

Table 30: Top NHTSA Pedestrian Crash Categories in Dane County

Crash Category	#	%
Intersection - Vehicle Turn Or Merge	187	34%
Intersection Dash/Walkout	80	14%
Driver Violation (Intersection or Midblock)	66	12%
Midblock Dart Out/Dash/Walkout	38	7%
Working/Playing in Roadway	27	5%
Multiple Threat/Trapped	26	5%
Walked Into Vehicle	18	3%
Special Circumstances	17	3%
Not in Road	14	3%
Backing Vehicle	13	2%
Walking Along Road	12	2%
Other and Unknown	54	10%
Total	**552**	**100%**

The following three tables detail the most common crash types in the City of Madison, suburban MPO communities, and in the rest of Dane County.

Table 31: Top NHTSA Pedestrian Crash Types in the City of Madison

Crash Type	% of Total	Description
Intersection Related - Vehicle Turn Or Merge	38%	The vehicle was preparing to turn, in the process of turning, or had just completed a turn (or merge)
Intersection Related - Driver Violation At Intersection	11%	The vehicle was proceeding straight ahead and the report indicated that the driver committed a violation such as careless driving, failure to yield, DWI, etc.
Intersection Related - Other	10%	The crash occurred at an intersection but does not conform to any other specified crash type (Note: All of these crashes involved a pedestrian walking in front of traffic at an intersection.)
Intersection Related - Intersection Dash	5%	The pedestrian was running through an intersection and/or the motorist's view of the pedestrian was blocked until an instant prior to impact
Midblock Related - Other	4%	The crash occurred at midblock but does not conform to any other specified crash type (Note: All of these crashes involved a pedestrian walking into the street at midblock.)
Other Crash Types	33%	

Table 32: Top NHTSA Pedestrian Crash Types in Suburban MPO Communities

Crash Type	% of Total	Description
Intersection Related - Vehicle Turn Or Merge	25%	The vehicle was preparing to turn, in the process of turning, or had just completed a turn (or merge)
Intersection Related - Other	9%	The crash occurred at an intersection but does not conform to any other specified crash type (Note: All of these crashes involved a pedestrian walking in front of traffic at an intersection.)
Intersection Related - Driver Violation At Intersection	9%	The vehicle was proceeding straight ahead and the report indicated that the driver committed a violation such as careless driving, failure to yield, DWI, etc.
Intersection Related - Multiple Threat At Intersection	8%	The pedestrian entered the traffic lane in front of stopped traffic and was struck by another vehicle traveling in the same direction as the stopped traffic
Intersection Related - Intersection Dash	6%	The pedestrian was running through an intersection and/or the motorist's view of the pedestrian was blocked until an instant prior to impact
Working/Playing In Roadway - Play Vehicle Related	6%	The pedestrian was struck while riding a play vehicle such as a skateboard, wagon, tricycle, etc.
Other Crash Types	38%	

Table 33: Top NHTSA Pedestrian Crash Types in Dane County outside of Urban MPO area

Crash Type	% of Total	Description
Working On Roadway	13%	The pedestrian was struck while working on/over/under the roadway
Vehicle Turn Or Merge At Intersection	8%	The vehicle was preparing to turn, in the process of turning, or had just completed a turn (or merge)
Intersection Related - Driver Violation At Intersection	8%	The vehicle was proceeding straight ahead and the report indicated that the driver committed a violation such as careless driving, failure to yield, DWI, etc.
Walking Along Road	8%	The pedestrian was struck while walking or running along a road without sidewalks
Midblock Related - Other	8%	The crash occurred at midblock but does not conform to any other specified crash type (Note: All of these crashes involved a pedestrian walking into the street at midblock.)
Backing Vehicle	8%	The pedestrian was struck by a vehicle that was backing
Not In Roadway	8%	The pedestrian was struck in a parking lot, sidewalk, yard, or other non-roadway location
Disabled/Emergency Vehicle Related	8%	The pedestrian was struck walking to/from or while near a disabled or emergency vehicle
Other/Unknown Types	31%	The pedestrian was struck while riding a play vehicle such as a skateboard, wagon, tricycle, etc.

There were 72 crashes involving pedestrians under 14 years of age in Dane County. Three of the most common types, as shown in Table 34, involve the pedestrian failing to yield to oncoming traffic.

Table 34: Top NHTSA Pedestrian Crash Types Involving Children Under 14 Years of Age

Crash Type	#	%
Intersection Related - Vehicle Turn Or Merge	10	13.9%
Intersection Related - Intersection Dash	10	13.9%
Intersection Related – Other*	8	11.1%
Intersection Related - Multiple Threat At Intersection	6	8.3%
Midblock Related - Midblock Dart Out	6	8.3%
Other/Unknown	32	44.5%

*All of these crashes involved a pedestrian walking in front of traffic at an intersection

Top LMCM Crash Types

The LMCM crash-typing system differs from the NHTSA crash types primarily in that it focuses exclusively on the location and relative directions of the parties involved in the crash.

Figure 52 details the relative percentage of intersection, non-intersection, and other crashes occurring in different parts of the county. Intersection crashes are most numerous in both the City of Madison and the suburbs, but non-intersection crashes dominate in the rest of Dane County. The following three tables detail the most common LMCM crash types in each community type.

Figure 52: Top LMCM Crash Categories by Community

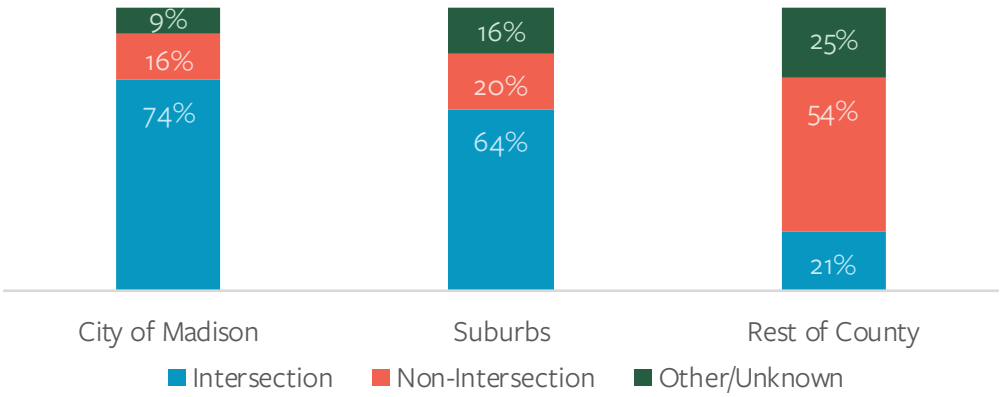


Table 35: Top LMCM Crash Types, City of Madison

LMCM Type	#	%
Left-turning motorist collides with oncoming pedestrian on far side of intersection (I_FS_LT_O)	69	16%
Right-turning motorist collides with pedestrian approaching from the right on near side of intersection (I_NS_RT_R)	36	9%
Straight-traveling motorist collides with pedestrian approaching from the right on near side of intersection (I_NS_ST_R)	36	9%
Left-turning motorist collides with pedestrian traveling in motorist's original direction on far side of intersection (I_FS_LT_S)	35	8%
Straight-traveling motorist collides with pedestrian approaching from the right on far side of intersection (I_FS_ST_R)	33	8%
Other Types	213	50%

Table 36: Top LMCM Crash Types, Suburbs

LMCM Type	#	%
Crash not conforming to any other LMCM crash type (OTH)	14	13%
Straight-traveling motorist collides with pedestrian approaching from the left on the near side of intersection (I_NS_ST_L)	10	9%
Straight-traveling motorist collides with pedestrian approaching from the right on far side of intersection (I_FS_ST_R)	9	8%
Straight-traveling motorist collides with pedestrian approaching from the right on near side of intersection (I_NS_ST_R)	8	8%
Right-turning motorist collides with pedestrian approaching from the right on near side of intersection (I_NS_RT_R)	8	8%
Other Types	57	54%

Table 37: Top LMCM Crash Types, Dane County Outside of Urban MPO Area

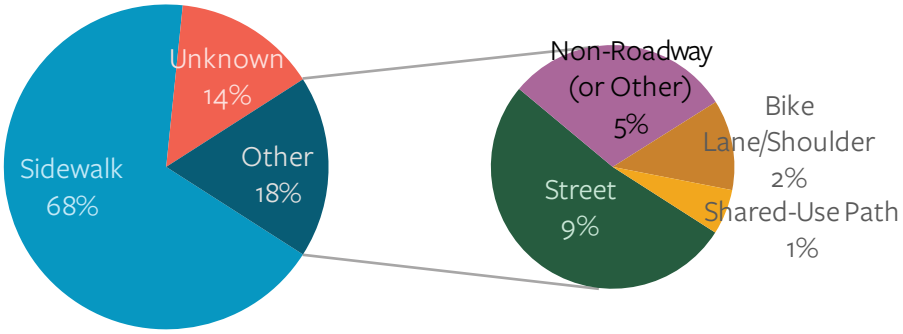
LMCM Type	**#**	**%**
Crash not conforming to any other LMCM crash type (OTH)	4	17%
Motorist collides with pedestrian approaching from the right on the right side of the road (N_RRD_R)	3	13%
Motorist collides with pedestrian traveling in an unknown direction on the right side of the road (N_RRD_X)	3	13%
Straight-traveling motorist collides with pedestrian approaching from the left on far side of intersection (I_FS_ST_L)	2	8%
Unknown	2	8%
Motorist collides with pedestrian traveling in the same direction on the right side of the road (N_RRD_S)	2	8%
Other Types	8	38%

Facilities

Facility Type

Figure 53 details the type of facilities being used by pedestrians prior to crashes. Nearly 70% of pedestrians involved in crashes had been traveling on the sidewalk prior to being struck.

Figure 53: Pedestrian Facility Type



Signalized Intersections

35% of pedestrian crashes during the study period occurred at signalized intersections while 38% occurred at unsignalized intersections.

Table 38: Pedestrian Crashes at Signalized Intersections

Pedestrian Crashes	%	#
Signalized Intersections	35%	195
Unsignalized Intersections	38%	212
Non-intersection/Unknown	26%	145

Traveling With/Against Traffic

Pedestrian travel direction relative to adjacent motor vehicle traffic does not appear to be a significant crash risk factor.

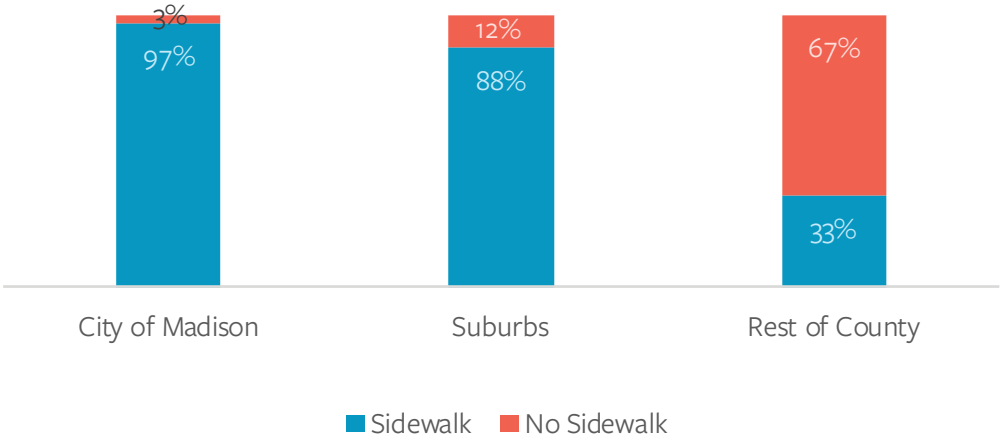
Table 39: Facility Used by Pedestrian and Direction Relative to Motor Vehicles in Adjacent Roadway Travel Lane

	With		Against		Unknown		Intersecting		Stopped		Other		Total	
Facility Type	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Sidewalk	156	28%	152	28%	11	2%	50	9%	4	1%	0	0%	373	68%
Street	14	3%	10	2%	3	1%	6	1%	13	2%	6	1%	52	9%
Non-Roadway	1	0%	3	1%	3	1%	7	1%	11	2%	5	1%	30	5%
Bike Lane/ Shoulder	1	0%	0	0%	1	0%	2	0%	8	1%	0	0%	12	2%
Shared-Use Path	2	0%	3	1%	0	0%	1	0%	0	0%	0	0%	6	1%
Unknown	15	3%	5	1%	17	3%	37	7%	3	1%	2	0%	79	14%
Total	**189**	**34%**	**173**	**31%**	**35**	**6%**	**103**	**19%**	**39**	**7%**	**13**	**2%**	**552**	**100%**

Presence of Sidewalks

Figure 54 details the percentage of pedestrian crashes during the study period that occurred on roads with and without sidewalks in the City of Madison, the suburbs, and in Dane County outside of the urban MPO area. While the percentage of crashes on roads with sidewalks is much higher in urban areas, the differences shown here primarily reflect the extent of sidewalks in different communities. A lack of exposure data makes it impossible to know, based on these findings, how the presence of sidewalks impacts pedestrian safety.

Figure 54: Pedestrian Crashes by Presence of Sidewalks



Fatal and incapacitating injuries to pedestrians were somewhat more common on roads without sidewalks, as shown in the table below. However, the degree to which injury severity is influenced by the presence of sidewalks is unknown. The higher rate of serious pedestrian injuries resulting from crashes on roads lacking sidewalks may be due to higher traffic speeds on rural highways that lack sidewalks.

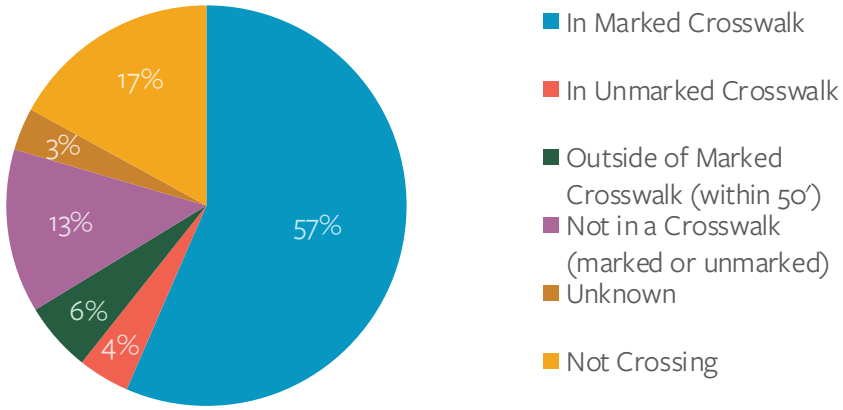
Table 40: Pedestrian Injury Severity by Presence of Sidewalks

	Fatal	Incapacitating	Non Severe	Total
Sidewalk Available	78%	86%	94%	92%
No Sidewalk	22%	14%	6%	8%
Total	100%	100%	100%	100%

Crosswalk Usage

Overall, 57% of pedestrians involved in crashes were struck while using a marked crosswalk. An additional 4% were struck while using a legal unmarked crosswalk. 6% were struck while crossing outside of the marked crosswalk within 50 feet of an available marked crosswalk.[1] 13% of pedestrians were struck crossing a roadway without a crosswalk; of these 73 crashes, 72 occurred at midblock locations (some of these were within 50 feet of an unmarked crosswalk) and 1 occurred at an intersection where no unmarked crosswalk was available.

Figure 55: Pedestrian Crashes by Crosswalk Usage



Of the 17% of pedestrians that were not crossing when they were struck, just over half were walking in the street or in a bike lane or shoulder. Only 7% were on the sidewalk.

Pedestrians were more likely to suffer fatal and incapacitating injuries when struck while crossing in locations without crosswalks or crossing within 50 feet of marked crosswalks. This is likely due, in part, to the lack of crosswalks on high-speed rural routes that lack sidewalks. However, it may also reflect the higher risk faced by pedestrians when crossing in areas where drivers do not expect to see them.

Table 41: Pedestrian Injury Severity by Crosswalk Usage

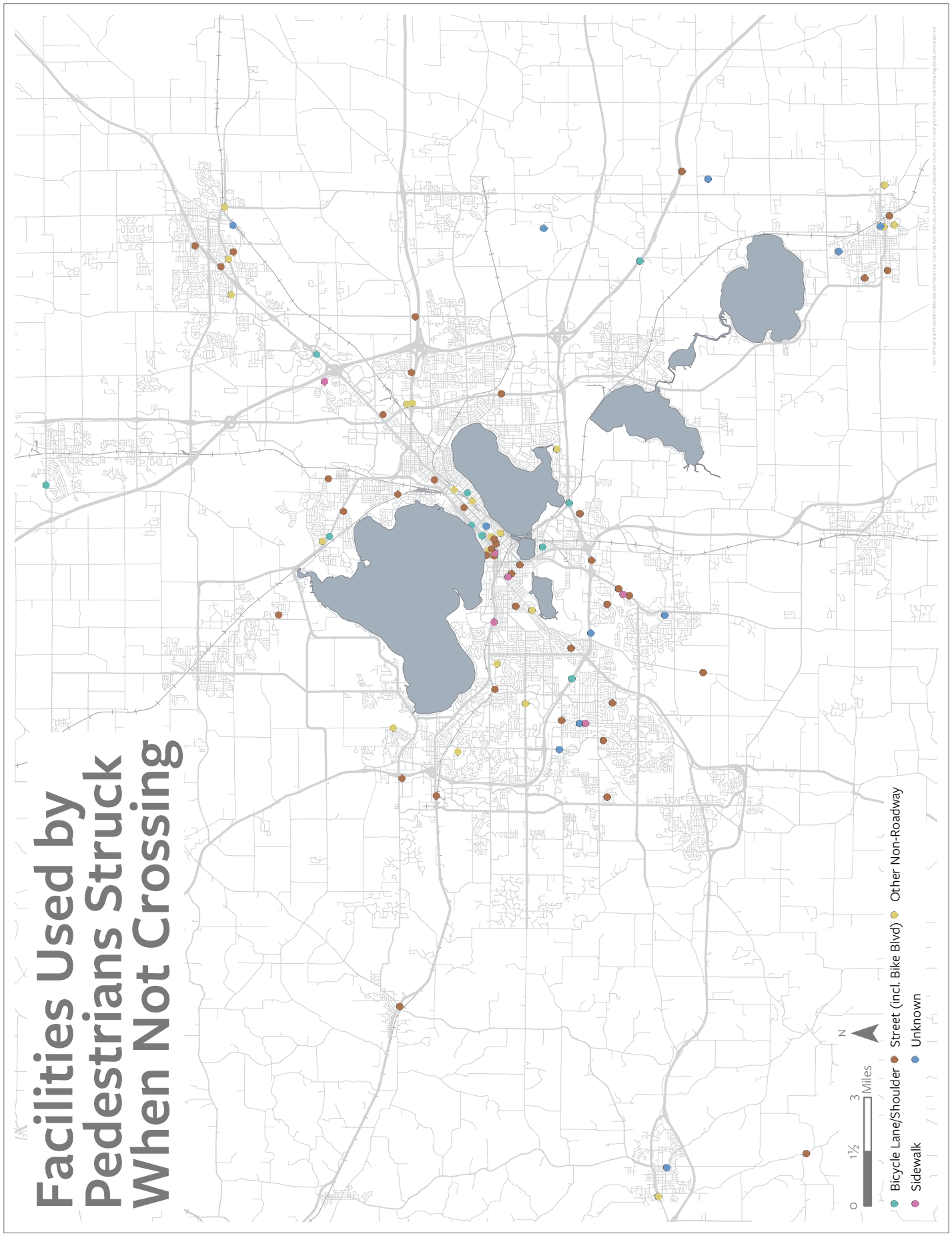
	Fatal	Incapacitating	Non Severe	Unknown	Total
In Marked Crosswalk	26%	43%	61%	40%	57%
In Unmarked Crosswalk	0%	9%	4%	0%	4%
Outside of Marked Crosswalk	13%	5%	5%	0%	6%
Not in a Crosswalk	30%	18%	11%	20%	13%
Unknown	9%	3%	3%	0%	3%
Not Crossing	22%	23%	16%	40%	17%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Crashes Involving Pedestrians Not Crossing a Roadway

Of the pedestrians who were struck while not attempting to cross the roadway, 55% were in the street or in a bike lane or shoulder when they were hit. Nearly 40% were not in the roadway or were in an unknown location. Figure 56 shows the locations of crashes involving pedestrians who were not crossing a roadway and the facility that they were using.

1 Under State of Wisconsin Statutes, unmarked crosswalks exist only at locations where there is a sidewalk on at least one side of an intersection. 340.01 (10) https://docs. legis.wisconsin.gov/document/statutes/340.01(10)

Figure 56: Facility Used by Pedestrians Struck When Not Crossing

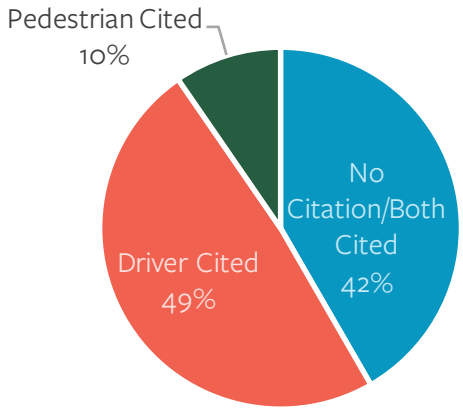


Citations

Information about traffic citations issued following pedestrian-motor vehicle crashes provide an indication of crash fault. It is important to note, however, that citation information detailed in this report comes exclusively from crash reports filed by law enforcement at the time of the crash and does not include citations issued after the fact or citations that were later dismissed.

As shown in Figure 57, drivers received a citation in about half of all pedestrian crashes while pedestrians were cited in nearly 10%. In about 40% of crashes, neither party received a citation. Crashes in which both the driver and pedestrian were cited were very rare and amounted to about 1% of all pedestrian crashes. However, the rate of citations among drivers and pedestrians varied between communities.

Figure 57: Citations Issued in Pedestrian Crashes- Dane County



Pedestrians were much more likely to receive citations following crashes in the City of Madison than in other parts of Dane County. Crashes in which no citation was issued to either party were much more common outside of the urban MPO area. While there was no citation issued in about 40% of the crashes occurring in Madison and its surrounding suburbs, this figure climbs to 60% in other parts of the county. Possible reasons for these disparities include differences in the availability of witnesses, pedestrian behavior, law enforcement practices, or other variables.

Figure 58: Citations Issued in Pedestrian Crashes by Municipality

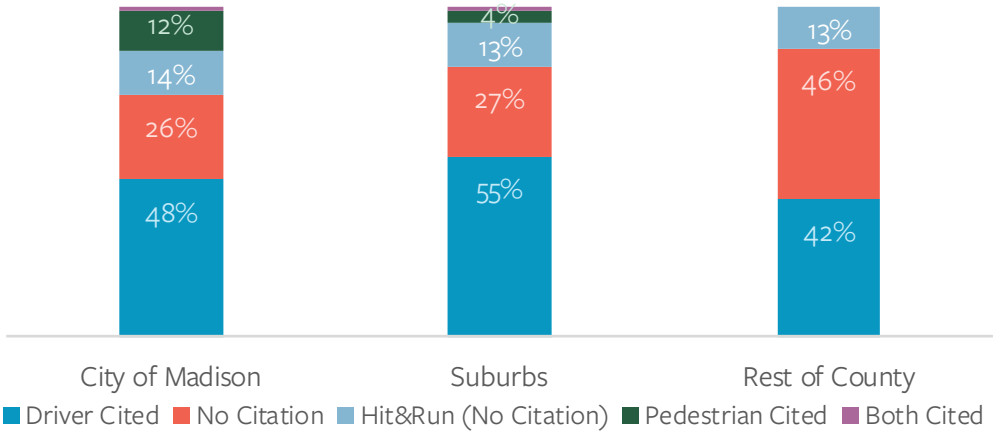


Table 42 details the parties receiving citations following crashes of each NHTSA type, in order of crash frequency. While the two most common crash types resulted in driver citations about 75% of the time, pedestrians were cited much more frequently in the next three most common crash types: *Intersection Related – Other, Intersection Related – Intersection Dash*, and *Midblock Related – Other*. All of the crashes classified as *Intersection Related – Other* and *Midblock Related – Other* involved pedestrians walking out into traffic.

Table 42: Citations issued by NHTSA Pedestrian Crash Type

Crash Type	Total	Driver	Pedestrian	Both	None
Intersection Related - Vehicle Turn Or Merge	187	75%	1%	0%	24%
Intersection Related - Driver Violation At Intersection	57	74%	0%	0%	26%
Intersection Related - Other	52	12%	23%	6%	60%
Intersection Related - Intersection Dash	28	14%	32%	0%	54%
Midblock Related - Other	23	13%	13%	9%	65%
Intersection Related - Multiple Threat At Intersection	20	50%	10%	0%	40%
Other - Inadequate Information	20	40%	10%	0%	50%
Working/Playing In Roadway - Play Vehicle Related	18	6%	11%	6%	78%
Vehicle Specific - Backing Vehicle	13	54%	0%	0%	46%
Not In Road - Not In Roadway	12	50%	0%	0%	50%
Walking Along Road	12	25%	8%	0%	67%
Midblock Related - Walked Into Vehicle At Midblock	10	0%	50%	0%	50%
Driver Violation at Midblock	9	89%	0%	0%	11%
Other - Weird	8	13%	25%	0%	63%
Intersection Related - Walked Into Vehicle At Intersection	8	0%	50%	0%	50%
Working/Playing In Roadway - Working On Roadway	8	38%	0%	0%	63%
Midblock Related - Midblock Dart Out	8	25%	25%	0%	50%
Disabled/Emergency Vehicle Related	6	67%	0%	0%	33%
Other - Vehicle-Vehicle Crash	6	100%	0%	0%	0%
Other - Assault With A Vehicle	6	67%	0%	0%	33%
Midblock Related - Midblock Dash	6	0%	50%	17%	33%
Other - Pedestrian On Vehicle	5	60%	0%	0%	40%
Intersection Related - Trapped	5	40%	0%	0%	60%
Special Circumstances - Exiting or Entering Parked Vehicle	4	0%	0%	0%	100%
Special Circumstances - Commercial Bus Related	4	0%	50%	0%	50%
Other - Vehicle-Object Crash	3	67%	0%	0%	33%
Motorist Lost Control	3	67%	0%	0%	33%
Not In Road - Waiting To Cross	2	0%	0%	0%	100%
Special Circumstances - School Bus Related	2	0%	0%	0%	100%
Other - Suicide	1	0%	0%	0%	100%
Special Circumstances - Vendor	1	100%	0%	0%	0%
Vehicle Specific - Hot Pursuit	1	0%	100%	0%	0%
Working/Playing In Roadway - Playing In Roadway	1	0%	0%	0%	100%
Midblock Related - Multiple Threat At Midblock	1	0%	0%	0%	100%
Expressway Crossing	1	0%	100%	0%	0%
Vehicle Specific - Driverless Vehicle	1	0%	0%	0%	100%
Total	**552**	**49%**	**10%**	**1%**	**40%**

Drivers tend to receive the majority of citations in the most common LMCM crash types, as shown in Table 43. Comparing intersection and non-intersection crashes (those beginning with I and N, respectively), there is a substantial difference in citation issuance. In intersection crashes, drivers were cited 56% of the time, while pedestrians were cited just 10% of the time, including crashes in which both party was cited. By contrast, in non-intersection crashes, drivers were cited 26% of the time, while pedestrians were cited 18% of the time.

Table 43: Citations Issued by LMCM Crash Type

Crash Type	Total	Driver	Pedestrian	Both	None
Far side of intersection, left-turning motorist, pedestrian approaching from opposite direction (I_FS_LT_O)	77	73%	9%	1%	17%
Near side of intersection, right-turning motorist, pedestrian approaching from the right (I_NS_RT_R)	45	67%	0%	0%	33%
Other (OTH)	45	58%	2%	0%	40%
Near side of intersection, straight-traveling motorist, pedestrian approaching from the right (I_NS_ST_R)	44	36%	23%	2%	39%
Near side of intersection, straight-traveling motorist, pedestrian approaching from the left (I_NS_ST_L)	42	33%	14%	2%	50%
Far side of intersection, straight-traveling motorist, pedestrian approaching from the right (I_FS_ST_R)	42	40%	14%	2%	43%
Far side of intersection, left-turning motorist, pedestrian traveling in same direction (I_FS_LT_S)	42	76%	2%	0%	21%
Non-intersection, right roadway lane, pedestrian approaching from the right (N_RRD_R)	34	12%	9%	3%	76%
Far side of intersection, straight-traveling motorist, pedestrian approaching from the left (I_FS_ST_L)	30	33%	13%	0%	53%
Non-intersection, right roadway lane, pedestrian approaching from the left (N_RRD_L)	24	21%	38%	4%	38%
Non-intersection, right roadway lane, pedestrian approaching from an unknown direction (N_RRD_X)	17	35%	12%	0%	53%
Near side of intersection, right-turning motorist, pedestrian approaching from the left (I_NS_RT_L)	14	50%	0%	0%	50%
Unknown (UNK)	11	27%	18%	0%	55%
Far side of intersection, right-turning motorist, pedestrian approaching from opposite direction (I_FS_RT_O	10	60%	0%	0%	40%
Far side of intersection, right-turning motorist, pedestrian traveling in same direction (I_FS_RT_S)	10	60%	0%	0%	40%
Non-intersection, right roadway lane, pedestrian traveling in same direction (N_RRD_S)	9	22%	0%	0%	78%
Far side of intersection, straight-traveling motorist, pedestrian traveling in unknown direction (I_FS_ST_X)	7	57%	0%	0%	43%
Near side of intersection, left-turning motorist, pedestrian approaching from the left (I_NS_LT_L)	6	83%	0%	0%	17%
Far side of intersection, left-turning motorist, pedestrian traveling in unknown direction (I_FS_LT_X)	6	83%	0%	0%	17%
Non-intersection, right roadway lane, pedestrian approaching from opposite direction (N_RRD_O)	4	25%	25%	0%	50%
Near side of intersection, left-turning motorist, pedestrian approaching from the right (I_NS_LT_R)	4	50%	25%	0%	25%
Non-intersection, left roadway lane, pedestrian approaching from the left (N_LRD_L)	3	33%	0%	33%	33%
Non-intersection, left roadway lane, pedestrian traveling in unknown direction (N_LRD_X)	3	33%	0%	0%	67%
Non-intersection, right shoulder or bicycle lane, pedestrian traveling in unknown direction (N_RSH_X)	3	67%	0%	0%	33%
Near side of intersection, right-turning motorist, pedestrian traveling in unknown direction (I_NS_RT_X)	2	0%	0%	0%	100%
Far side of intersection, right-turning motorist, pedestrian traveling in unknown direction (I_FS_RT_X)	2	50%	0%	0%	50%
Driveway, motorist driving forward (D_F)	2	0%	0%	0%	100%
Driveway, motorist backing (D_B)	2	50%	0%	0%	50%

Table 43 (Continued): Citations Issued by LMCM Crash Type

Crash Type	Total	Driver	Pedestrian	Both	None
Non-intersection, right sidewalk, pedestrian traveling in unknown direction (N_RSW_X)	1	100%	0%	0%	0%
Non-intersection, left shoulder or bicycle lane, pedestrian traveling in unknown direction (N_LSH_X)	1	100%	0%	0%	0%
Non-intersection, left roadway lane, pedestrian approaching from the right (N_LRD_R)	1	0%	0%	0%	100%
Non-intersection, right sidewalk, pedestrian approaching from opposite direction (N_RSW_O)	1	0%	0%	0%	100%
Near side of intersection, straight-traveling motorist, pedestrian approaching from opposite direction (I_NS_ST_O)	1	100%	0%	0%	0%
Near side of intersection, straight-traveling motorist, pedestrian traveling in same direction (I_NS_ST_S)	1	0%	0%	0%	100%
Non-intersection, left sidewalk, pedestrian traveling in unknown direction (N_LSW_X)	1	0%	0%	0%	100%
Far side of intersection, straight traveling motorist, pedestrian approaching from opposite direction (I_FS_ST_O)	1	100%	0%	0%	0%
Far side of intersection, right-turning motorist, pedestrian approaching from the left (I_FS_RT_L)	1	0%	0%	0%	100%
Parking lot, motorist driving forward (P_F)	1	0%	0%	0%	100%
Parking lot, motorist backing (P_B)	1	100%	0%	0%	0%
Non-intersection, right shoulder or bicycle lane, pedestrian traveling in same direction (N_RSH_S)	1	100%	0%	0%	0%
Total	**552**	**49%**	**10%**	**1%**	**40%**

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Chapter 5

Next Steps

- Evaluation
- Engineering
- Education
- Enforcement

Dangerous behaviors—speeding, impairment, inattention, or simply failing to obey traffic controls—are a contributing factor in the vast majority of crashes. These behaviors must be addressed through education and enforcement. Engineering solutions should continue to be used to mitigate the risk of crashes at certain locations, particularly at high volume intersections with many roadway users and conflict points. Finally, in order to better evaluate safety needs and target these solutions, better information about crashes and travel trends is required. Maximizing safety for bicyclists and pedestrians will require a comprehensive approach that involves strategies in all of these areas.

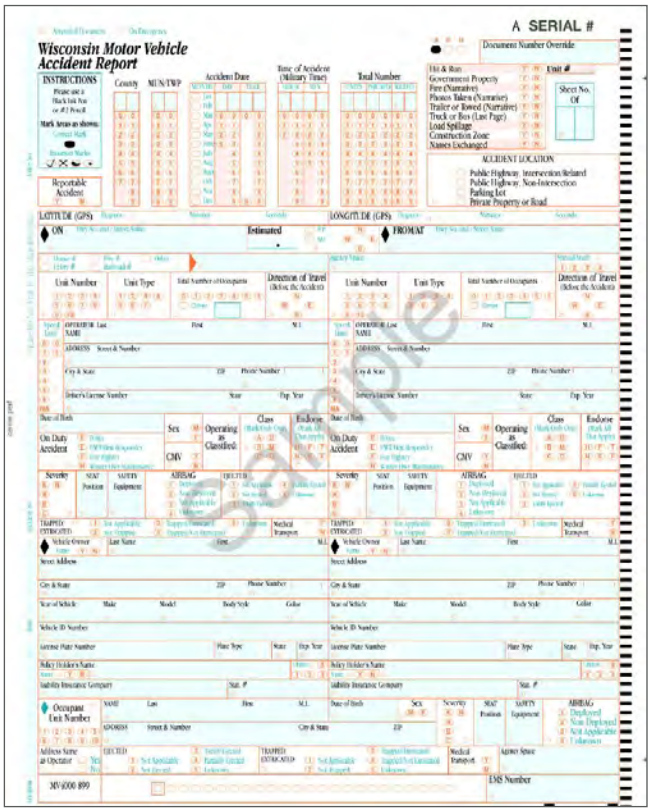
MATPB's plans and recommendations to improve bicycle and pedestrian safety in Dane County complement the recommendations identified in the Wisconsin Strategic Highway Safety Plan 2017-2020 (SHSP) and the Wisconsin Pedestrian and Bicycle Crash Analysis: 2011-2013 to improve safety for bicyclists and pedestrians throughout the state.

Some of the SHSP recommendations address ongoing state initiatives such as WisDOT's Designing for Pedestrian Safety workshops, Teaching Safe Bicycling series, Pedestrian/Bicycle Law Enforcement training course, WisDOT sponsored Share & Be Aware program, and high visibility enforcement grants related to non-motorist users. Others are new. A new pedestrian/bicyclist safety campaign is proposed similar to Click It or Ticket focusing on behaviors that cause crashes. In addition, MATPB is participating in a new WisDOT-led work group, focusing on non-motorist safety. General infrastructure and engineering recommendations in the SHSP include prioritizing facilities that increase pedestrian and bicyclist safety, filling gaps in the pedestrian and bicycle transportation networks, and increasing the use of signage and pavement markings to improve bicyclist and pedestrian safety.

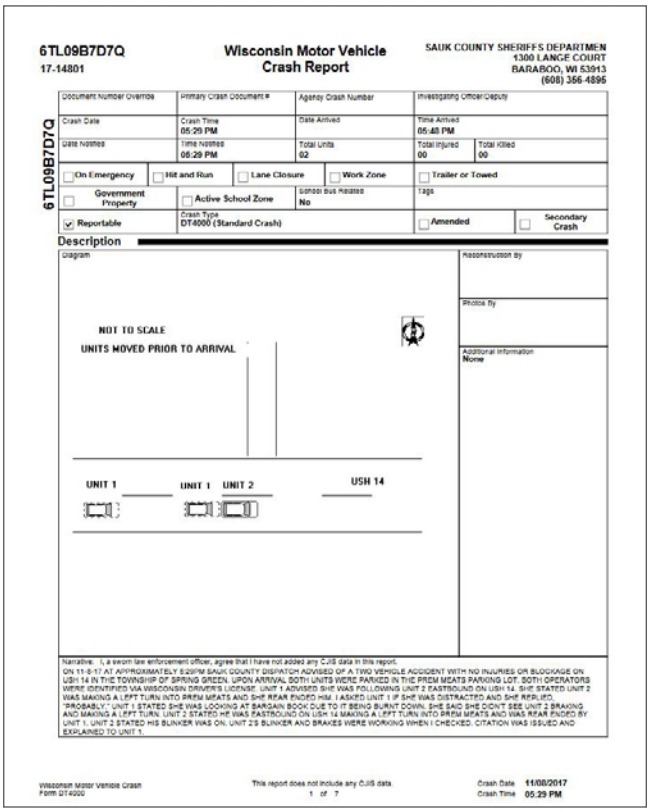
The Wisconsin Pedestrian and Bicycle Crash Analysis report offers information and recommendations that complement those in the SHSP. The report provides information on the types of engineering treatments to improve pedestrian and bicyclist safety; safety education messages for motorists, bicyclists, pedestrians, and law enforcement officers; and recommendations to improve crash reporting and evaluation.

Some of these recommendations have already been implemented. For instance, the DT4000 crash report form that replaced the MV4000 in January 2017 has been revised to capture more detail about crashes, including non-motorist location, safety equipment, and driver distraction. These changes will provide a clearer picture of crash circumstances. Many of the bicycle crash reports reviewed for this study lacked some of this pertinent information. For example, reports for many of the bicycle crashes occurring at night contained no information about bicycle lights or reflectors.

MATPB's recommendations and planned activities to support bicyclist and pedestrian safety in the areas of evaluation, engineering, education, and enforcement are detailed below.



Old MV 4000 Form



New DT 4000 Output

Evaluation

The two most significant limitations to the present study were both related to data availability. Usage cannot be determined without comprehensive bicycle and pedestrian count data, and a lack of information about crashes for which no report was filed means that some crashes are missing from the analysis. MATPB will work to address both of these limitations to improve bicycle and pedestrian safety information in the coming years.

MATPB staff will work with City of Madison Traffic Engineering and other local community staff to supplement Madison's extensive permanent bicycle count program with a short-duration count program using portable counters. This will allow more comprehensive tracking of bicycling activity over time and allow an estimate of annual average bicycle volumes by applying factors derived from the permanent count locations to the short-duration count locations. In addition to enabling location-based risk or exposure analysis, this data could be used to evaluate the likely impacts of new infrastructure on bicycle use, which would be helpful in project prioritization. While collecting pedestrian exposure data is more challenging, MATPB will continue to investigate ways to gather this information as well.

MATPB also plans to analyze National Household Travel Survey (NHTS) data to better understand bicyclist and pedestrian travel and demographics of those using these modes. MATPB worked with the City of Madison and the UW Survey Center to administer a separate local household survey using the same NHTS questions and travel logs, which will provide a rich dataset with responses from over 2,000 area households. MATPB will be analyzing this data over the coming year.

To address crashes for which no official crash report is filed, MATPB will look into integrating emergency room admission data into future updates to this study. MATPB is also looking into the possible use of bikemaps.org as an additional information source, which allows users to map bicycle crashes, near misses, and other information. Because of the limited use of this site by local bicyclists, this would first require a campaign to inform people in Dane County about the site and encourage its use.

MATPB will work to identify and collect required data for pedestrian and bicycle crash risk analysis and utilize new tools as they become available.

Engineering

While engineering and infrastructure decisions are ultimately made by other levels of government, MATPB insights and recommendations can inform their decisions to strengthen bicycle and pedestrian safety and mobility.

MATPB's Regional Transportation Plan (RTP) 2050 highlights high priority gaps and barriers in the bicycle and pedestrian networks. MATPB is building upon this analysis by identifying and mapping

the "low stress" bikeway network using a new "bicycle level of traffic stress" methodology. This will allow easy identification of gaps in the "low stress" network. MATPB's RTP 2050 also makes recommendations related to complete streets policies as well as land use, parking, and site design policies that set the stage for future development that supports pedestrian and bicyclist safety.

MATPB will supplement future updates to this bicycle and pedestrian crash analysis with an evaluation of different types of recently installed pedestrian and bicycle safety treatments by monitoring crash data at locations where these treatments have been installed.

This recommendation echoes the Wisconsin Pedestrian and Bicycle Crash Analysis's recommendation to "quantify the impacts of pedestrian and bicycle safety strategies to inform future recommendations."

MATPB will continue efforts to inform local officials and staff about available resources related to designing streets and other facilities for safe pedestrian and bicycle travel. Cities and villages in Dane County should ensure that their local transportation policies (e.g., Vision Zero), plans, and engineering design guidelines adequately address appropriate countermeasures. Guidance for selecting designs that increase pedestrian and bicyclist safety should be incorporated into the local community's design manuals, practices, and procedures. This ensures that new and reconstructed streets are designed with appropriate safety features.

The National Association of City Transportation Officials (NACTO) and FHWA have both published useful guidance documents for local governments working to improve bicycle and pedestrian safety. NACTO's Designing for All Ages and Abilities: Contextual Guidance for High-Comfort Bike Facilities provides guidelines for appropriate bicycle infrastructure on different types of streets. FHWA's How to Develop a Pedestrian and Bicycle Safety Action Plan report outlines a number potentially useful strategies, including the use of tools to review existing speed limits to determine whether they are set appropriately.

Education

MATPB staff will support the efforts of the Dane County Traffic Safety Commission, Safe Communities of Madison and Dane County, and other groups to educate drivers, bicyclists, and pedestrians about common crash scenarios and promote traffic safety.

Enforcement

MATPB is working with the Dane County Traffic Safety Commission and Safe Communities of Madison and Dane County to communicate county-specific information to law enforcement in Dane County and encourage targeted enforcement efforts performed in conjunction with education campaigns to improve bicyclist and pedestrian safety.

Appendix A

The tables below detail the percentage of total crashes in the 2018 and 1992 studies according to the crash type, facility, and direction. Crashes are categorized according to the crash types used in the 1992 study. See Appendix C for more information on how the NHTSA crash types used in the present study were converted to the 1992 study crash types.

Table A-1: Bicyclist - Motorist Crashes by Crash Type, Bicyclist's Location and Bicyclist's Direction of Travel, Madison, Wisconsin 2011-2015

	Shared-Use Path				Sidewalk				Bike Lane/ Shoulder				Street				Total	
	With		Against		With		Against		With		Against		With		Against			
Crash Type [crash type code(s) used in 1992 study]	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
(M) Motorist enter/exit on-street parking [111, 112]		0%		0%		0%		0%	4	80%		0%	1	20%		0%	5	1%
(M) Motorist left turn/merge - bicyclist traveling in same direction [113]		0%	1	3%	1	3%	6	18%	19	58%		0%	4	12%		0%	33	5%
(B) Bicyclist left turn/merge - motorist traveling in same direction [122]	1	7%		0%		0%		0%	2	14%		0%	11	79%		0%	14	2%
(M) Motorist left turn/merge facing bicyclist [114]	1	1%		0%	4	3%	2	2%	32	26%	36	29%	43	35%		0%	124	20%
(B) Bicyclist left turn/merge facing motorist [123]		0%		0%		0%		0%	1	17%	1	17%	2	33%		0%	6	1%
(M) Motorist right turn/merge - bicyclist traveling in same or opposing direction [115]	1	1%	3	4%	9	12%	12	16%	34	47%	2	3%	10	14%		0%	73	12%
(B) Bicyclist right turn/merge - motorist traveling in same or opposing direction [124]		0%		0%		0%		0%	2	100%		0%		0%		0%	2	0%
(B) Bicyclist turned/merged onto street from sidewalk [121]		0%		0%		0%		0%		0%		0%		0%		0%	4	1%
(B) Head-on: bicyclist wrong way [133]		0%		0%		0%		0%		0%		0%		0%	2	100%	2	0%
(M) Overtaking: Motorist failed to detect bicyclist [141]		0%		0%		0%		0%	4	44%		0%	5	56%		0%	9	1%
(M) Motorist misjudged passing space, length or width to pass [143]		0%		0%		0%		0%	1	50%		0%	1	50%		0%	2	0%
(M) Motorist overtaking, other [149]		0%		0%		0%		0%	5	29%		0%	11	65%		0%	17	3%
(B) Bicycle struck slower/stopped vehicle in traffic lane [151]		0%		0%		0%	5	25%	2	10%		0%	10	50%	1	5%	20	3%
(B) Bicyclist hit parked vehicle		0%		0%		0%		0%	1	100%		0%		0%		0%	1	0%
(?) Bicyclist hit open vehicle door [153]		0%		0%		0%		0%	3	50%		0%	3	50%		0%	6	1%
(M) Motorist lost control [161]		0%		0%		0%		0%		0%		0%		0%		0%	1	0%
(B) Bicyclist lost control [162]		0%		0%		0%	1	14%	1	14%		0%	4	57%	1	14%	7	1%
(M) Motorist failed to yield at a driveway, alley or other midblock (orig. path orthogonal to street) [221, 222, 223, 224]		0%		0%	2	17%	5	42%	1	8%		0%	4	33%		0%	12	2%
(B) Bicyclist failed to yield at a driveway, alley or other midblock (orig. path orthogonal to street) [231, 232,233]		0%		0%		0%		0%		0%		0%		0%		0%	15	2%
(M) Motorist drive out at stop sign, failed to stop [226]		0%		0%		0%	3	25%	2	17%	1	8%	5	42%		0%	12	2%
(M) Motorist drive out at stop sign, stopped but failed to yield [227]		0%	4	6%	4	6%	30	42%	12	17%	1	1%	17	24%		0%	71	11%
(B) Bicyclist drive out at stop sign, failed to stop or stopped but failed to yield [241]		0%		0%		0%		0%	1	5%		0%	18	82%		0%	22	4%
(M) Motorist drive out at traffic signal, fail to stop [225]		0%		0%	1	14%	2	29%		0%		0%	3	43%		0%	7	1%
(M) Motorist drive out at traffic signal, right turn on red [228]	1	2%	8	16%	2	4%	33	67%		0%	1	2%		0%	1	2%	49	8%
(B) Bicyclist drive out at traffic signal, failed to stop or yield [242]	2	4%	2	4%	6	13%	8	18%	9	20%	1	2%	9	20%		0%	45	7%
(B) Bicyclist trapped by signal (did not clear intersection before cross traffic got green) [211, 212]		0%		0%	1	14%	1	14%	3	43%	2	29%		0%		0%	7	1%
(M) Motorist failed to yield at intersection, other [229]		0%		0%	1	7%	1	7%	1	7%		0%	1	7%	1	7%	14	2%
(B) Bicyclist failed to yield at intersection - other [249]		0%		0%	1	14%	1	14%		0%		0%	1	14%	1	14%	7	1%
(?) Uncontrolled intersection, insufficient information [271]		0%		0%		0%		0%		0%		0%		0%		0%	3	0%
(?) Controlled intersection, insufficient information [no 1992 equivalent]		0%	1	5%		0%	6	32%	3	16%	2	11%	6	32%		0%	19	3%
(M) Motorist turning left, cut corner [251]		0%		0%		0%		0%		0%		0%	3	100%		0%	3	0%
(M) Motorist turning right, too wide [252]		0%		0%		0%		0%	1	100%		0%		0%		0%	1	0%
(M) Motorist backing on the street [031, 032 (2017 data includes backing at any location)]		0%		0%	2	50%	1	25%		0%		0%	1	25%		0%	4	1%
(?) Unknown [099]		0%	1	14%	1	14%		0%	2	29%		0%	3	43%		0%	7	1%
(?) Weird (no 1992 equivalent)		0%		0%		0%		0%		0%		0%	1	33%		0%	3	0%
Grand Total	**6**	**1%**	**20**	**3%**	**35**	**6%**	**117**	**19%**	**146**	**23%**	**47**	**7%**	**177**	**28%**	**7**	**1%**	**627**	**100%**

Bicyclist - Motorist Crashes by Crash Type, Bicyclist's Location and Bicyclist's Direction of Travel (number and percent of type) Madison, Wisconsin 1987 - 1990

			Bike Path				Crosswalk or Sidewalk				Bike Lane				Street (other than bike lane)				Total				Total
	Code(s)	B/M	with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		All Crashes
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Codes 100: bicyclist and motorist initially on parallel paths																							
Enter/exit on-street parking	111, 112	M									3	60.0			2	40.0			5	100.0			5	0.6
Left turn/merge traveling in same direction	113	M			3	13.0			5	21.7	14	60.9			1	4.3			15	65.2	8	34.8	23	3.0
	122	B									6	26.1			17	73.9			23	100.0			23	3.0
Left turn/merge facing each other as approached	114	M					8	4.4	4	2.2	68	37.8	1	0.6	97	53.9	1	0.6	174	96.7	6	3.3	180	23.3
	123	B													11	100.0			11	100.0			11	1.4
Right turn/merge going either	115	M	2	3.6	1	1.8	9	16.4	12	21.8	10	18.2	1	1.8	20	36.4			41	74.5	14	25.5	55	7.1
same or opposing directions	124	B							1	16.7	2	33.3			1	16.7	2	33.3	3	50.0	3	50.0	6	0.8
Turned/merged onto street from sidewalk (see also 231 -233)	121	B					5	55.6	4	4.4									5	55.6	4	44.4	9	1.2
Head-on: (motorist wrong way)	132	M													1	100.0			1	100.0			1	0.1
(bicyclist wrong way)	133	B															4	100.0			4	100.0	4	0.5
Overtaking: Motorist failed to detect bicyclist	141	M									1	11.1			8	88.9			9	100.0			9	1.2
Motorist misjudged space, length or width to pas	143	M													8	100.0			8	100.0			8	1.0
Motorist overtaking, other	149	M									4	26.7			11	73.3			15	100.0			15	1.9
Bicyclist struck slower/stopped vehicle in traffic la	151	B									3	33.3			6	66.7			9	100.0			9	1.2
Bicyclist hit parked vehicle	152	B													20	87.0	3	13.0	20	87.0	3	13.0	23	3.0
Bicyclist hit opened vehicle door	153	?													16	100.0			16	100.0			16	2.1
Operator lost control: Motorist	161	M					1	50.0			1	50.0							2	100.0			2	0.3
Bicyclist	162	B									2	66.7			1	33.3			3	100.0			3	0.4
Parallel paths, insufficient information	199	?							2	100.0											2	100.0	2	0.3
Codes 200, bicyclist and motorist originally on orthogonal (crossing) paths																								
Failed to yield at a driveway, alley or	221, 222	223, 224	M			1	1.3	13	16.9	45	58.4	3	3.9	2	2.6	12	15.6	1	1.3	28	36.4	49	63.6	77	9.9
other midblock (orig. path orthogonal to street)	231	232, 233	B																				20	2.6
Stop sign driveout, failed to stop	226	M							5	38.5	1	7.7			7	53.8			8	61.5	5	38.5	13	1.7
Stop sign driveout, stopped but failed to yield	227	M	2	11.8	1	0.9	4	3.6	53	47.7	20	18.0			29	26.1	2	1.8	55	49.5	56	50.5	111	14.3
Stop sign driveout, failed to stop or stopped but FT	241	B													22	95.7	1	4.3	22	95.7	1	4.3	23	3.0
Stop sign driveout, insufficient information	292	?													2	100.0			2	100.0			2	0.3

Table continued on other side

Bicyclist - Motorist Crashes by Crash Type, Bicyclist's Location and Bicyclist's Direction of Travel (number and percent of type) Madison, Wisconsin 1987 - 1990

page 2	Code(s)	B/M	Bike Path				Crosswalk or Sidewalk				Bike Lane				Street (other than bike lane)				Total				Total
			with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		with traffic		wrong way		All Crashes	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Codes 200, bicyclist and motorist originally on orthogonal (crossing) paths [continued]																								
Traffic signal driveout, fail to stop	225	M					1	9.1	1	9.1	1	9.1			8	7.2			10	90.9	1	9.1	11	1.4
Traffic signal driveout, right turn on red	228	M					1	5.3	17	89.5	1	5.3							2	10.5	17	89.5	19	2.5
Traffic signal driveout, failed to stop or yield	242	B					6	16.2	9	24.3					17	45.9	4	10.8	23	62.2	13	35.1	37	4.8
Trapped by signal (did not clear intersection before cross traffic got green)	211, 212	B													4	100.0			4	100.0			4	0.5
Traffic signal driveout, insufficient information	291	?							4	57.1					3	42.9			3	42.9	4	57.1	7	0.9
Failed to yield at an intersection, other (uncontrolle	229	M					3	42.9							4	57.1			7	100.0			7	0.9
	249	B	1	5.9			2	11.8	4	23.5	1	5.9			9	52.9			13	76.5	4	23.5	17	2.2
Uncontrolled intersection, insufficient information	271	?							2	66.7											3	100.0	3	0.4
Midblock crosswalk, insufficinet information	272	?																					1	0.1
Turning left, cut corner	251	M													1	100.0			1	100.0			1	0.1
	261	B													1	50.0	1	50.0	1	50.0	1	50.0	2	0.3
Turning Right, too wide	252	M													1	100.0			1	100.0			1	0.1
	262	B													7	87.5	1	12.5	7	87.5	1	12.5	8	1.0
Other Miscellaneous crash codes																								
Motorist backing on the street	031, 032	M					2	50.0							1	25.0			3	75.0			4	0.5
Unknown	099	?													1	100.0			1	100.0			1	0.1
Crash did not involve a bicyclist	013	?																					1	0.1
Totals (see note below)			**5**	**0.6**	**6**	**0.8**	**55**	**7.1**	**168**	**21.7**	**141**	**18.2**	**4**	**0.5**	**349**	**45.1**	**20**	**2.6**	**551**	**71.2**	**199**	**25.7**	**774**	**100.1**

Add to totals for the categories indicated:

1 (0.1%) Bike path, direction of travel unknown (code 231,232,233)
10 (1.3%) Sidewalk/crosswalk, direction of travel unknown (7 code 231,232,233; 1 code 272; 1 code 031, 032; and 1 code 013)
12 (1.6%) Bicyclist entering street from driveway (all code 231,232,233)
1 (0.1%) Unknown location, with traffic (code 114)
1 (0.1%) Unknown location, against traffic (code 271)
1 (0.1%) Unknown loocation, unknown direction of travel (code 242)

26 (3.4%) [24 or 3.1% are direction of travel unknown]

Appendix B

NHTSA Bicycle Crash Types

Includes all crash types listed in FHWA's Crash Type Manual for Bicyclists. "Bicyclist Strikes Parked Vehicle" was split into " – Dooring" and " – Other".

1. Bicycle Failed to Clear – Multiple Threat: The bicyclist did not clear the intersection before the light turned green for cross traffic, and the motorist's view of the bicyclist was obstructed by standing traffic
2. Bicycle Failed to Clear – Trapped: The bicyclist did not clear the intersection before the traffic signal turned green for cross traffic, and the motorist's view of the bicyclist was not obstructed.
3. Bicycle Left Turn – Facing Traffic: The bicyclist made a left turn in front of facing approaching traffic.
4. Bicycle Left Turn – In Front of Traffic: The bicyclist made a left turn in front of traffic traveling in the same direction.
5. Bicycle Lost Control: The bicyclist lost control and inadvertently served into the path of the motorist.
6. Bicycle Ride Out – At Commercial Driveway: The bicyclist was entering the roadway from a commercial driveway
7. Bicycle Ride Out – At Intersection, Other: The crash occurred at an intersection, signalized or uncontrolled, at which the bicyclist failed to yield.
8. Bicycle Ride Out – At Midblock: The bicyclist entered the roadway at a shoulder or curb midblock location.
9. Bicycle Ride Out – At Residential Driveway: The bicyclist entered the roadway from a residential driveway or alley
10. Bicycle Ride Out – At Stop Sign: The crash occurred at an intersection at which the bicyclist was facing a stop sign or flashing red light.
11. Bicycle Ride Out – From Sidewalk: Initially riding along a sidewalk, the bicyclist entered the roadway from a driveway or alley cut.
12. Bicycle Right Turn – The bicyclist was making a right turn while riding facing traffic.
13. Bicycle Strikes Parked Vehicle – Dooring: The bicyclist struck a motor vehicle parked within the roadway right-of-way.
14. Bicycle Strikes Stopped Vehicle – Other: The bicyclist struck a stopped or parked vehicle.
15. Bicycle Wrong Way: The bicyclist was on a parallel path with the motorist and was riding in the roadway against traffic.
16. Bicycle Overtaking: The bicyclist struck a slow or stopped motor vehicle in a travel lane.
17. Motorist Backing: The crash involved a motor vehicle which was backing.
18. Motorist Drive Out – At Midblock: The motorist was entering the roadway from a driveway or alley.
19. Motorist Drive Out – At Intersection, Other: The crash occurred at an intersection, signalized or uncontrolled, at which the motorist failed to yield. The circumstances did not conform to any other crash type.
20. Motorist Drive Out – At Stop Sign: The occurred at an intersection at which the motorist was facing a stop sign or a flashing red signal.
21. Motorist Drive Out – From On-Street Parking: The motorist was exiting or entering on-street parking.
22. Motorist Drive Through: At a controlled intersection, the motorist ran a sign or signal.
23. Motorist Left Turn – Facing Bicyclist: The motorist made a left turn while facing the approaching bicyclist.
24. Motorist Left Turn – In Front Of Bicyclist: Both parties were traveling in the same direction and the motorist turned left in front of the bicyclist.
25. Motorist Lost Control: The motorist lost control and inadvertently swerved into the path of the bicyclist.
26. Motorist Overtaking – Bicyclist Path Obstructed: The motorist was overtaking a bicyclist whose path was obstructed. The bicyclist struck the obstruction or overtaking motorist.
27. Motorist Overtaking – Counteractive Evasive Actions: The motorist was overtaking the bicyclist and the evasive actions were counteractive. The bicyclist swerved left (or very rarely, right).
28. Motorist Overtaking – Failed to Detect: The motorist was overtaking and failed to detect the bicyclist.
29. Motorist Overtaking – Misjudged Passing Space: The motorist was overtaking and misjudged the width or length

required to pass the bicyclist.

30. Motorist Overtaking – Other: The motorist was overtaking a bicyclist and the circumstances could not be specified.
31. Motorist Right Turn – On Red: At an intersection controlled by a signal, the motorist struck the bicyclist while making a right turn on red.
32. Motorist Right Turn – Other: The motorist was making a right turn and the bicyclist was riding in either the same or opposing direction.
33. Motorist Wrong Way: The motorist was on a parallel path with the bicyclist and was driving in the roadway against traffic.
34. Other – Controlled Intersection: The crash occurred at an intersection that was controlled by a stop sign or traffic signal and did not conform to any of the other crash types.
35. Other – Non-Roadway: The crash occurred in a non-roadway location such as a parking lot, driveway/alley, open area, etc.
36. Other – Play Vehicle: The bicyclist was riding a child's vehicle such as a tricycle, a "Big Wheel" type tricycle, or a bicycle with training wheels.
37. Other – Uncontrolled Intersection: The crash occurred at an intersection that had neither stop sign nor traffic signals, and did not conform to any of the other crash types.
38. Other – Unknown: Insufficient information was available to specify a crash type.
39. Other – Weird: The crash was weird because the motorist intentionally caused the crash; the bicyclist was struck by falling cargo, extended cargo, construction equipment, etc.; or other unusual circumstances.

NHTSA Pedestrian Crash Types

Includes all types listed in FHWA's Pedestrian Crash Types: A 1990s Informational Guide with the addition of "Motorist Lost Control" and "Driver Violation at Midblock," added by MPO staff.

1. Special Circumstances – Commercial Bus Related: Pedestrian was struck by another vehicle while crossing in front of a commercial bus stopped at a marked bus stop.
2. Special Circumstances – School Bus Related: Pedestrian was struck going to or from a school bus or school bus stop.
3. Special Circumstances – Vendor: Pedestrian was struck going to or from an ice cream or other type of vehicle-based vendor and the striking vehicle was on the same street as the vendor.
4. Special Circumstances – Mailbox Related: Pedestrian was struck while going to or from a private residence mail- or newspaper box.
5. Special Circumstances – Exiting Or Entering Parked Vehicle: Pedestrian was in the process of exiting or entering a parked or stopped vehicle and was struck in the adjacent traffic lane.
6. Vehicle Specific – Driver-less Vehicle: Pedestrian was struck by a vehicle that was moving without a driver at the controls or was set into motion by the actions of a child.
7. Vehicle Specific – Backing Vehicle: Pedestrian was struck by a vehicle that was backing.
8. Vehicle Specific – Hot Pursuit: Pedestrian was struck by a vehicle on an emergency/police mission or by a vehicle being pursued.
9. Disabled/Emergency Vehicle Related: Pedestrian was struck while walking to or from, or while next to a disabled vehicle, or while near an active police or emergency vehicle.
10. Working/Playing in Roadway – Working On Roadway: Pedestrian was struck while working on, in, over, or under the roadway.
11. Working/Playing in Roadway – Play Vehicle Related: Pedestrian was struck while riding a play vehicle such as a wagon, sled, skateboard, skates—does not include tricycles, "Big Wheel" type tricycles, or bicycles with training wheels].
12. Working/Playing in Roadway – Playing in Roadway: Pedestrian was struck while playing on foot in the roadway prior to the vehicle's appearance.
13. Walking Along Road: Pedestrian was struck while walking or running along a road without sidewalks.

14. Expressway Crossing: Pedestrian was struck while crossing a limited access expressway.
15. Not in Road – Waiting to Cross: Pedestrian was struck while standing at or near the curb or roadway edge waiting to cross.
16. Not in Road – Not in Roadway: Pedestrian was struck when not in the roadway.
17. Intersection Related – Multiple Threat at Intersection: At an intersection, the pedestrian entered the traffic lane in front of standing or stopped traffic and was struck by another vehicle traveling in the same direction as stopped traffic.
18. Intersection Related – Vehicle Turn or Merge: Pedestrian and vehicle collided while vehicle was preparing to turn, in the process of turning, or had just completed a turn (or merge).
19. Intersection Related – Intersection Dash: Pedestrian was struck while running through and intersection and/or the motorist's view of the pedestrian was blocked until an instant before impact.
20. Intersection Related – Trapped: Pedestrian was struck while crossing at a signalized intersection when the light changed and traffic started moving.
21. Intersection Related – Walked into Vehicle at Intersection: Pedestrian struck the vehicle at an intersection.
22. Intersection Related – Driver Violation at Intersection: Pedestrian was struck by a vehicle proceeding straight ahead and the report indicated that the driver committed a violation such as careless driving, failure to yield, signal/sign violation, speeding, DWI, etc.
23. Intersection Related – Other: Pedestrian was struck at an intersection but the crash does not conform to any other specified crash types] All crashes of this type in the 2017 Madison study involved a pedestrian "walking out."
24. Midblock Related – Multiple Threat at Midblock: Pedestrian entered the traffic lane at midblock in front of standing or stopped traffic and was struck by another vehicle moving in the same direction as the stopped traffic.
25. Midblock Related – Midblock Dart Out: Pedestrian crossed at a midblock location and the motorist's view of the pedestrian was blocked until an instant before impact.
26. Midblock Related – Midblock Dash: Pedestrian was struck while running across the street at midblock and the motorist's view of the pedestrian was not obstructed.
27. Midblock Related – Walked into Vehicle at Midblock: Pedestrian struck the vehicle at a midblock location.
28. Midblock Related – Other: Pedestrian was struck at a midblock location but the crash does not conform to any other specified crash types. All crashes of this type in the 2017 Madison study involved a pedestrian "walking out."
29. Other – Lying in Road: Pedestrian was lying in the road and was struck by a moving vehicle.
30. Other – Suicide: Pedestrian committed or attempted to commit suicide by deliberately walking, running, jumping, etc. in front of a moving vehicle.
31. Other – Assault with A Vehicle: Driver intentionally caused the vehicle to strike the pedestrian.
32. Other – Pedestrian On Vehicle: Pedestrian was sitting on, leaning against, or clinging to a vehicle which began to move or was moving.
33. Other – Vehicle-Vehicle Crash: Pedestrian was struck as a result of a prior vehicle-vehicle crash.
34. Other – Vehicle-Object Crash: Pedestrian was struck as a result of a prior vehicle-object crash.
35. Other – Weird: Pedestrian was struck by a vehicle but the circumstances were unusual and do not conform to any specified crash type.
36. Other – Inadequate Information: Insufficient information available to specify crash type.
37. Motorist Lost Control: Crash occurred as a result of motorist failure to maintain control of vehicle.
38. Driver Violation at Midblock: Pedestrian was struck by a vehicle proceeding straight ahead and the report indicated that the driver committed a violation such as careless driving, failed to yield, signal/sign violation, speeding, DWI, etc.

Appendix C

Bicycle Crash Subtypes

Bicycle crash subtypes, detailed in Table 40, were created in order to divide the NHTSA crash types used in this study so that they could be more easily compared to the crash types used in the 1992 bicycle crash study. NHTSA crash types used in the current (2018) study that clearly match categories used in the 1992 study are not included in the table below.

Table C-1: Bicycle Crash Subtypes

NHTSA Category	Bicycle Crash Subtype	Subtype Definition	Corresponding 1992 Category
7. Bicycle Ride Out – At Intersection, Other	7A. Bicyclist Ride Out at Signal	Bicyclist fails to yield at a signalized intersection.	6. Bicyclist ride out at a traffic signal
	7B. Bicycle Ride Out – Uncontrolled Intersection	Bicyclist fails to yield at an intersection that is not controlled by signs or signals.	11. Bicyclist ride out, uncontrolled intersection
	7C. Bicycle Ride Out at Signed Intersection	Bicyclist fails to yield at an intersection controlled with signs. Cyclist could have been facing a sign other than a stop sign or may not have been facing a sign (ex. Riding on sidewalk).	NONE
10. Bicycle Ride Out at Stop Sign	10A. Bicycle Ride Through Stop Sign – No Stop	Bicyclist does not stop for a stop sign.	9A. Bicyclist doesn't stop at sign
	10B. Bicycle Ride Out at Stop Sign – Stop, Fail to Yield	Bicyclist stops at the stop sign, but then fails to yield.	9B. Bicyclist obeys sign, fails to yield
14. Bicyclist Strikes Stopped Vehicle	14A. Bicyclist Strikes Parked Car	Bicyclist struck a motor vehicle parked within the roadway right-of-way.	5A. Bicyclist hit parked motor vehicle
	14B. Bicyclist Strikes Stopped Car	From the side, the bicyclist struck a motor vehicle that had been clearly established as stopped at an intersection. Motorist could be stopped over a sidewalk at a driveway and or at a controlled intersection.	NONE
19. Motorist Drive Out – At Intersection, Other	19A. Motorist Drive Out – Uncontrolled Intersection	The motorist failed to yield at an intersection that was not controlled by a sign or signal.	13. Motorist drive out, uncontrolled intersection
	19B. Motorist Drive Out - At Yield Sign	Motorist failed to yield while facing a yield sign.	NONE
	19C. Motorist Drive Out - At Pedestrian Crossing Sign	Motorist failed to yield at a crosswalk with pedestrian crossing warning signs or signals.	NONE
22. Motorist Drive Through	22A. Motorist Drive Through at Stop Sign	The motorist failed to stop at a stop sign.	2B. Motorist ran stop sign
	22B. Motorist Drive Through at Signal	The motorist failed to yield at a traffic signal. This does not include right turn on red, which has its own category.	8B. Motorist ran red or yellow signal
34. Other – Controlled Intersection	34A. Cyclist Turn - Right, Too Wide	The cyclist was taking a right turn too wide and entered the opposing travel lane.	12A. Bicyclist turning right, too wide
	34B. Cyclist Turn - Left, Cut Corner	The cyclist was turning left too tightly (cutting the corner) and entered the opposing travel lane.	12B. Bicyclist turning left, cut corner
	34C. Motorist Turn - Right, Too Wide	The motorist was taking a right turn too wide and entered the opposing travel lane.	19A. Motorist turning right, too wide
	34D. Motorist Turn - Left, Too Tight	The motorist was turning left too tightly (cutting the corner) and entered the opposing travel lane.	19B. Motorist turning left, cut corner