# Reducing Median Crossover Crashes in Wisconsin

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**Abstract.** The Wisconsin Department of Transportation (WisDOT) sought to determine the magnitude of median crossover crashes on Wisconsin's divided highways. An analysis of crash reports for 1,483 miles of freeways and expressways from 2001 through 2003 was completed to quantify median entry crashes and median crossover crashes. Median width and ADT data were also collected for each selected crash site and added to the data obtained from each crash report.

A total of 15,194 crash reports were reviewed for the three-year period revealing 631 median crossover crashes. The crashes resulted in over 600 injuries and 53 fatalities. A majority of the roadways examined have 50 or 60 feet median widths, as per Wisconsin standards. Current Wisconsin guidelines do not warrant a median barrier for a roadway with a median width greater than 60 feet. Nevertheless, 81.5 percent of the median crossover crashes identified occurred at ADT and median width combinations where a median barrier is not warranted.

Data did not reveal a strong correlation between median width and crossover median crashes. Both roadways with narrow and wide median widths exhibited varying median crash rates. Five locations were identified that exceeded the selected benchmark of 0.5 median crossover crashes per mile per year. Additionally, one location exceeded the benchmark of 0.12 median crossover fatalities per mile per year. It is recommended that median barrier installation be considered at the locations identified. Installation of median barriers in these locations will help reduce the number of median crossover crashes in the state. It is also recommended that the procedure used to warrant median barrier installation be reconsidered.

## INTRODUCTION

Over the four year period from 2000 to 2003, 169,789 people lost their lives on United States' roadways (1). In 2003 alone, 42,643 people were killed. Of the 42,643 fatalities in 2003, over 25,000 died when their vehicle departed from their travel lane and crashed. Lane departure or run-off-road (ROR) crashes are associated with vehicles that leave the travel lane, encroach onto the shoulder and beyond, and hit one or more of any number of objects including opposing vehicles, bridge walls, poles, embankments, guardrails, parked vehicles, or trees (2). ROR crashes usually involve only a single vehicle, and consist of a vehicle encroaching onto the right shoulder and roadside, on the median side where the highway is separated, or on the opposite side when the vehicle crosses the opposing lanes of a highway. In recent years, approximately 55 percent of traffic fatalities were a result of ROR type crashes (3). Approximately 40 percent of fatal crashes were single-vehicle ROR crashes.

Over that same four-year period, 3,206 people were killed in traffic crashes on Wisconsin's roadways, representing approximately 1.9 percent of the nation's total (4). In 2003 alone, Wisconsin experienced 836 fatalities in 748 fatal crashes. Wisconsin is also no exception to the high number of ROR crashes experienced nationally. A recent study found that approximately

54 percent of all non-intersection crashes on undivided roadways in Wisconsin were ROR type crashes (5). This number may be even higher on the divided roadway system.

Medians of divided highways are an important design and traffic safety feature when considering ROR crashes. The American Association of State Highway Transportation Officials (AASHTO) defines a median as the "portion of a highway separating directions of the traveled way" (6). AASHTO's *A Policy on Geometric Design of Highways and Streets* states that "medians are highly desirable on arterials carrying four or more lanes" of traffic (6). Separation of opposing volumes can be important in the attempt to prevent head-on collisions, one of the most potentially serious types of crashes.

Medians generally consist of a vegetated area of land and the interior shoulders of the travel lanes placed between opposing traffic flows. For freeways, a shallow depressed slope is typically preferred for drainage and to minimize the probability of a rollover during a crash should a vehicle enter the median. Various combinations of median width and slope may be supplemented with a median barrier if conditions warrant. A median barrier is a system erected to decrease the probability of a vehicle crossing over the median into the path of vehicles traveling in the opposing direction (6). Examples of selected median barriers are presented in Figure 1.

AASHTO has design guidelines but no specific standards regarding median width. For medians 40 feet or wider, AASHTO states that drivers are given a "sense of separation from opposing traffic" and a "desirable ease and freedom of operation" (6). The Facilities Development Manual (FDM) for the Wisconsin Department of Transportation (WisDOT) specifies a minimum median width of 60 feet for all Design Class A3 freeways and expressways with a speed limit greater than 55 miles per hour (mph) and a minimum median width of 50 feet for all Design Class A3 expressways with speed limits of 50 or 55 mph (7). A Design Class A3 highway is an arterial with a minimum volume of 7,000 vehicles per day (vpd) and a minimum design speed of 65 mph (8). A typical median design used on Wisconsin highways is depicted in Figure 2.

It is believed that these median slope and width standards are adequate in providing sufficient vehicle recovery space to maximize safety and in preventing vehicles from traveling across the median into opposing lanes of traffic. However, there are numerous roadways throughout the state that do not meet these standards (i.e., a narrower median width) and do not provide any additional safety features such as median barriers. As depicted in Figure 3, state guidelines do not warrant a barrier for median widths greater than 60 feet. A barrier is also not warranted for medians widths as narrow as 20 feet when average daily traffic volumes are less than 20,000 vehicles per day.

Median crossover crashes are increasing in frequency across the United States, and Wisconsin is believed to be no exception to this trend. However, the magnitude of the median crossover crash problem is not well known, nor is the characteristics and causes of such crashes. Furthermore, the current median width guidelines and/or median barrier policy may no longer be adequate for today's traffic conditions. Studies have suggested that wider median widths are safer, but it is not well understood what median width is necessary to maximize the safety of a roadway.

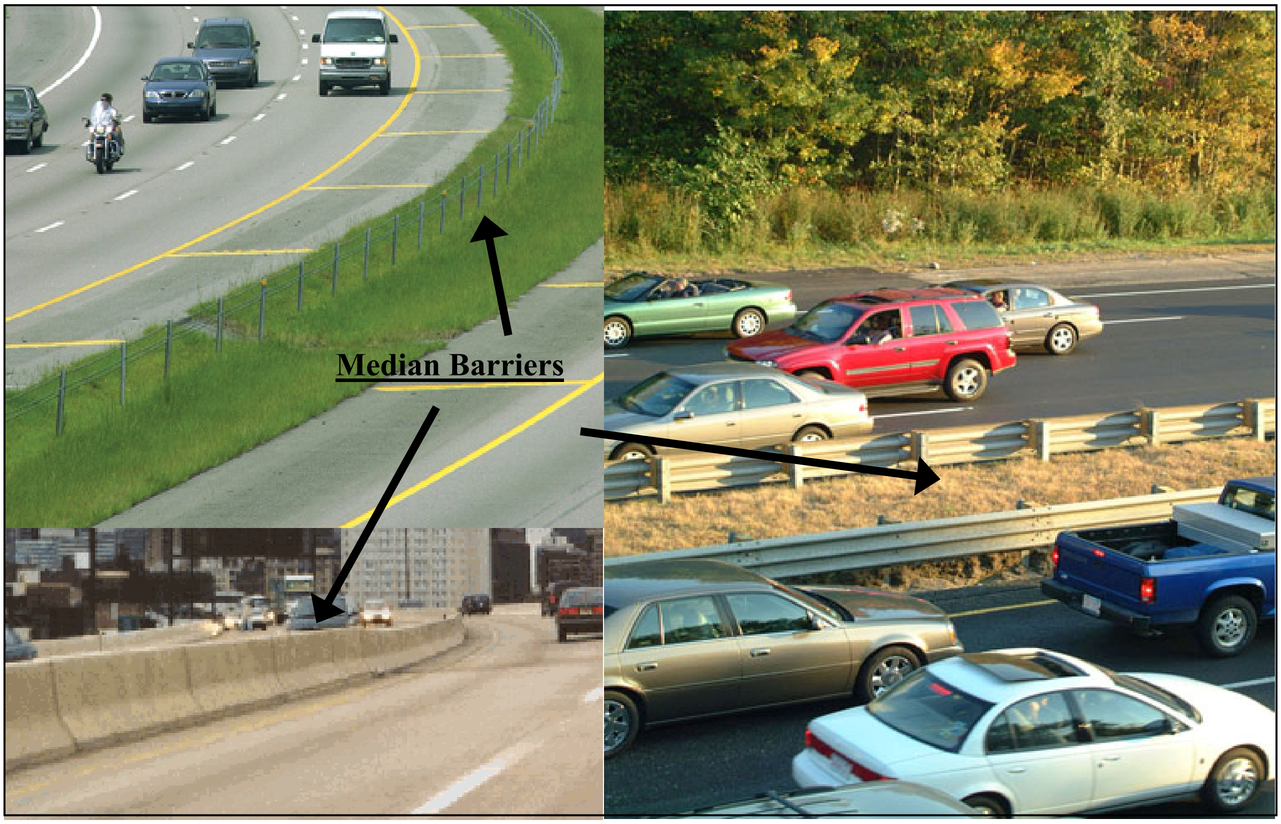


**FIGURE 1 Typical Median Barriers (9).**

**FIGURE 2 Typical Wisconsin Highway Median (9).**

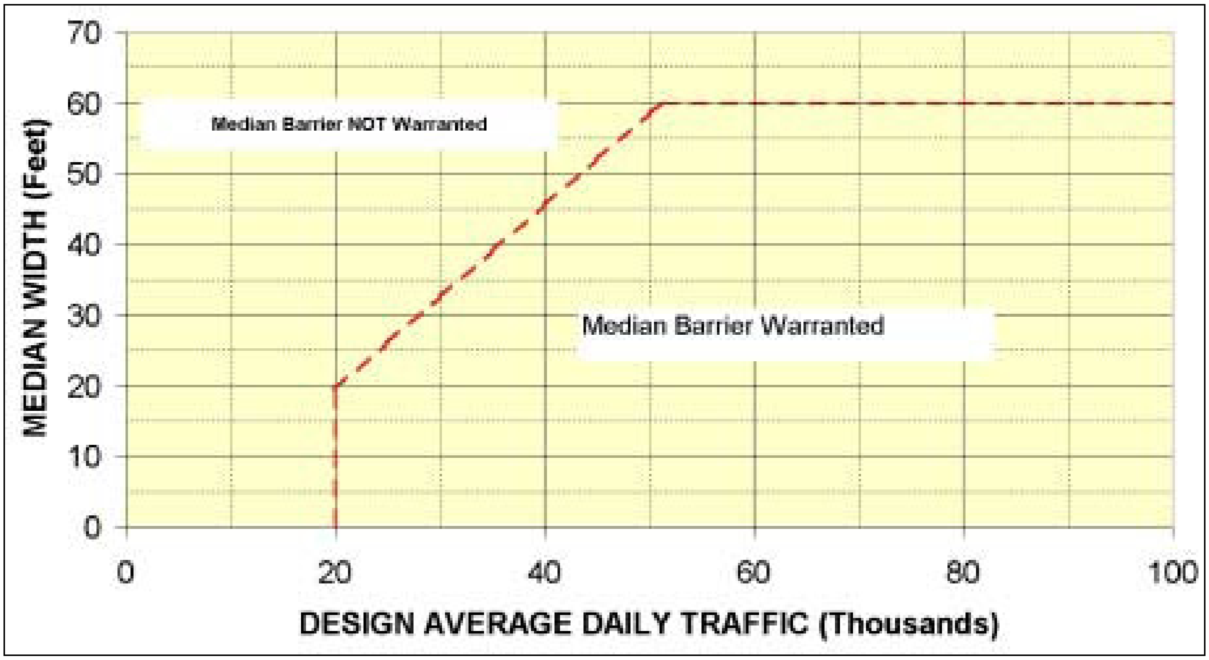


**FIGURE 3 Wisconsin Median Barrier Warrant Guidelines (7).**

Given the unknown frequency of median crossover crashes in Wisconsin, there is a need to determine the magnitude and severity of median crossover crashes and establish common characteristics and causes of these crash types.

**Research Objectives**

The objective of this research was to investigate and evaluate the present state of median crossover crashes on Wisconsin freeways and expressways. Specific objectives were:

- Quantify the magnitude of median crossover crashes in Wisconsin;
- Establish a relationship between median width, traffic volumes, and crossover crashes; and
- Identify the most critical factors affecting crossover crashes.

This paper presents a summary of the key findings from a comprehensive study of median crossover crashes (9). The scope of this research was limited to crossover crashes on Wisconsin freeways and expressways from the period of 2001 to 2003. Most, but not all, divided highway sections in Wisconsin were considered. Crashes that occurred where a vehicle broke through or vaulted over a median barrier, where a vehicle intentionally crossed over the median, or where an object crossed over the median that a barrier would not have prevented, were excluded from the analysis.

## LITERATURE REVIEW

A complete literature review on median widths and median crossover crashes was presented by Noyce and McKendry (9). Nevertheless, several studies are worth reiterating in this paper. The Pennsylvania Department of Transportation (PennDOT) undertook a comprehensive review of median crossover crashes in 2002 (10, 11). A cross-median crash (CMC) was classified as one "in which a driver lost control of his or her vehicle, traversed the entire width of the median, entered the opposing roadway, and collided with a vehicle traveling on that opposing roadway" (10). Researchers discovered 267 crashes in this five year period that met the CMC definition. Their findings included:

- Number of vehicles:
  - 63% of CMCs were two vehicle crashes
  - 25% of CMCs were three vehicle crashes
- Reason for crash:
  - 71% of CMCs occurred when a driver lost control of the vehicle
  - 20% of CMCs occurred as a result of another same-direction vehicle collision
  - 8% of CMCs occurred as a result of a driver trying to avoid a same-direction vehicle
- Time of day
  - 63% of CMCs occurred during daylight (vs. 58% of all crashes)
  - 32% of CMCs occurred while dark (vs. 37% of all crashes)
  - 4% of CMCs occurred during dawn or dusk vs. (5% of all crashes)
- Weather
  - 43% of CMCs occurred under dry conditions vs. (61% of all crashes)
  - 32% of CMCs occurred under wet conditions vs. (19% of all crashes)
  - 25% of CMCs occurred under snow and ice conditions vs. (21% of all crashes)
- Other
  - 12% involved alcohol and/or drugs vs. (6% of total crashes)

Of the 267 CMC found, 216 occurred at sites that had earth-divided, traversable medians (10). These crashes were compared against median width and exposure, using units of crashes per hundred million vehicle miles traveled (HMVMT). Results generally indicated that crash rates decreased as median width increased. The PennDOT data demonstrated that a median width of 60 feet still contained a high incidence of median crossover crashes. Also of note was the fact that a majority of the median crossover crashes found occurred on roadway segments with either lower traffic volumes or wider medians than what would warrant median barriers based on AASHTO guidelines.

More recently, some states have chosen to be more proactive in their median barrier requirements. States such as South Carolina, Connecticut, North Carolina, Washington, and California have begun to implement median barriers in medians that were not previously deemed barrier-necessary. The drop in median crossover crashes and fatalities since the installation of the median barriers has been noticeable and significant.

In South Carolina, median crossover fatalities dropped from over 70 fatalities during the two-year period of 1999 to 2000, to only 8 fatalities during the three years after the installation of cable guard median barrier on all freeway sections with a median width less than 60 feet (12). Overall Interstate freeway fatalities fell by 36 percent over a two-year period during the implementation of the cable guard.

North Carolina recently completed a five year project of implementing cable guard median barrier for all freeway sections with a median width less than 70 feet (13). Between 1999 and 2004, over 1,000 miles of freeway had cable guard installed, resulting in an average of 25 to 30 lives saved per year plus an estimated 90 percent reduction in the amount of crossover crashes.

Washington State has installed cable median barrier at approximately 25 miles of test sites on Interstate 5 with median widths of 40 feet, 48 feet, and 48 to 82 feet (14). The annual crash rate for the experimental sites for all median crossover crashes decreased from 16 crashes per year before installation to 3.83 crashes per year afterwards. The rate of disabling and fatal crashes decreased from 3.8 crashes per year to 0.33 crashes per year, with no fatal crashes to date since the installation of the cable median barrier.

California revised its traffic manual in 1998 with updated standards on when median barriers were appropriate. Similar to Wisconsin, a relationship between ADT and median width is one of the primary criteria in determining the need for a median barrier. Figure 4 shows the appropriate median width and ADT combinations that warrant a study to determine if a median barrier is required (15). In California, the crash history of a site is also an important factor in deciding whether a median barrier is necessary. California Department of Transportation (CalTrans) indicates that if there are 0.5 median crossover crashes per mile per year, or 0.12 fatal median crossover crashes per mile per year, there is justification to study the feasibility of installing a median barrier (15). CalTrans recommended that the rate be determined based on at least three crashes over a five year period. Though standards for freeways, they may also be applied to other multi-lane roads.

## STUDY DESIGN

Crashes that were identified as potential crossover crashes were initially selected for this analysis. Copies of the actual crash reports, showing diagrams and narrative provided by the reporting police office, were obtained. Interstate, expressway, and freeway segments with a divided median were selected as examination sites from the state's roadway database. The roadways selected are presented in Table 1. Crash reports for the examination sites were gathered for the three most recent years of data, from 2001 to 2003.

Each of the over 15,000 crash reports identified was reviewed on microfilm by a researcher to inspect whether or not the crash involved a vehicle that entered the median, and/or crossed the median. Determination of crashes was made by examining the narrative and pictorial representation written by the reporting police officer. After gathering the crashes records, median widths and ADTs for the crash sites were added to each crash report's data summary.

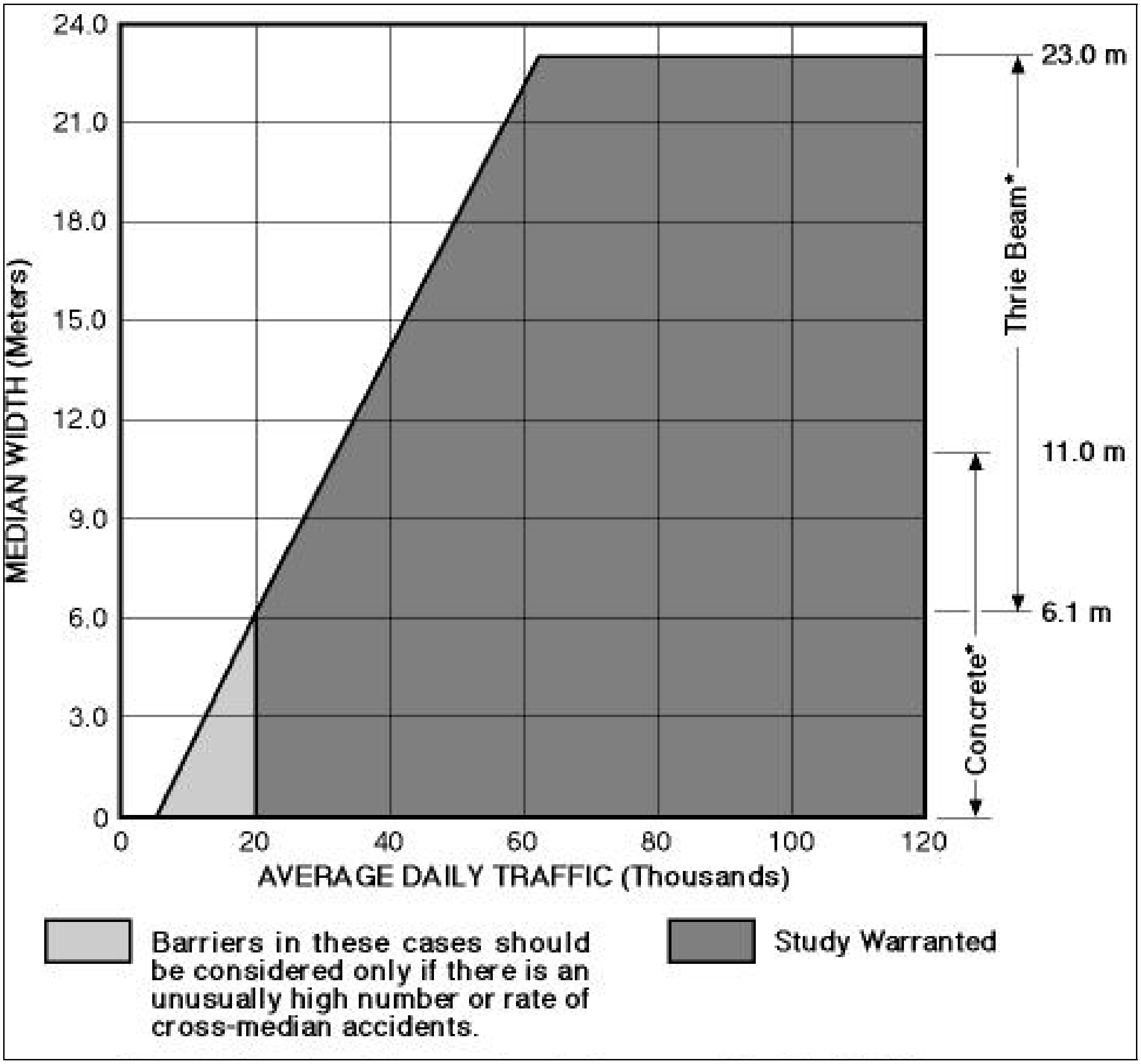


**FIGURE 4 CalTrans Median Barrier Warrant Guidelines (15).**

**TABLE 1 Wisconsin Roadways Reviewed for Crossover Crashes**

| | |
|---|---|
| Interstates | 39, 43, 90, 94 |
| U.S. Roadways | 10, 12, 14, 18, 41, 51, 53, 141, 151 |
| Wisconsin State Roadways | 23, 29, 30, 35, 54, 57, 172, 441 |

Basic statistical data were initially derived including the number of crashes by type, location, and frequency, by demographic variables and related variables in the data set, including weather and ADT. The following information was determined:

- Median Width and Crossover Crash Rate Relationship
- Initial First Action
  - *Lost Control on Dry Pavement*
  - *Lost Control Due to Weather*
  - *Vehicle Collision*
  - *Struck Barrier*
  - *Hit Signpost*
  - *Other*
- Median Crossover Extent
  - *Partial*: Vehicle crossed over the median and came to rest with some portion of the vehicle having made it onto the paved surface, including the interior shoulder.
  - *Into*: Vehicle crossed over the median and came to rest within the paved surface of the opposite roadway.
  - *Beyond*: Vehicle crossed over the median, the opposite roadway, and came to rest at a location beyond the exterior shoulder of the opposite roadway.
  - *Object*: No vehicle crossed over the median, but an object, a trailer that detached from a passenger vehicle, crossed over to the opposite roadway.
- Crash Vehicle
  - *Passenger Car*
  - *Truck*
  - *Passenger Car – Passenger Car*: Passenger vehicle crossed over the median and initially struck another passenger car in the opposite roadway.
  - *Passenger Car – Truck*: Either a passenger vehicle crossed over the median and initially struck a commercial truck in the opposite roadway or a commercial truck crossed over the median and initially struck a passenger vehicle in the opposite roadway.
  - *Truck – Truck*: Commercial truck crossed over the median and initially struck another commercial truck in the opposite roadway.
  - *Motorcycle*: Motorcycle crossed over the median without striking another vehicle in the opposite roadway.
  - *Trailer*: Trailer in tow detached from a passenger vehicle and crossed over the median without striking another vehicle in the opposite direction.
  - *Trailer – Passenger Car*: Trailer in tow detached from a passenger vehicle and crossed over the median and initially struck a passenger vehicle in the opposite roadway.
- Crash Severity
  - *Fatal*
  - *Personal Injury*
  - *Property Damage Only*

Discrete outcome multivariate analysis techniques were used to identify the key variables associated with median crossover crashes. Analysis was done to show both what factors were more likely to cause a median crossover crash as well as what factors were more likely to increase the severity of a median crossover crash. To evaluate each variable's effect on the severity of a median crossover crash, the total crashes were divided into property damage only, personal injury, and fatal crashes. Driver demographics were also considered. Predictive models were developed to identify locations and conditions that are conducive to crossover crashes.

## RESEARCH RESULTS

After completing the crash report review and analysis, 732 median crossover crashes were initially identified. Each selected median crossover crash was re-examined to both determine the first action (potential cause) of the crash and to also confirm that each was an actual median crossover crash. A total of 101 crashes were disqualified from the selected crossover crash total because they involved objects such as a tire, animal, crash debris, or person crossing the median. Only crashes that occurred at a location without a median barrier were selected. Table 2 summarizes the reductions taken to achieve the final median crossover crash total.

Table 3 shows the crash distribution of each of the three years evaluated, while Table 4 shows the breakdown of crashes selected for each roadway reviewed. The median width of each selected median crossover crash was then correlated to the ADT at the crash location.

**TABLE 2 Summary of Crossover Crash Total Calculations**

| **Initial Selected Crossover Crashes** | **732** |
|---|---|
| Object Crossover Crashes<br>*Tire Crossover Crashes*<br>*Other Object Crossover Crashes* | -64<br>*(-52)*<br>*(-12)* |
| Median Barrier Crossover Crashes<br>(vehicle jumped existing barrier) | -32 |
| Intentional Crossover Crashes<br>(median u-turns or police evasion) | -5 |
| **Final Selected Crossover Crashes**<br>Vehicle Crossover Crashes<br>Trailer Crossover Crashes | **631**<br>624<br>7 |

**TABLE 3 Median Crossover Crashes by Year**

| **Year** | **Median crossover crashes** |
|---|---|
| 2001 | 197 |
| 2002 | 229 |
| 2003 | 205 |
| **Total** | **631** |

**TABLE 4 Selected Median Crossover Crashes by Highway**

| Highway | Counties | Median crossover crashes | Highway Length (miles) | Crashes/ Year/ Mile |
|---|---|---|---|---|
| I-39 | Rock, Dane, Columbia, Marquette, Waushara, Portage, Marathon | 107 | 182.38 | 0.196 |
| I-43 | Waukesha, Milwaukee, Ozaukee, Sheboygan, Manitowoc, Brown | 44 | 148.86 | 0.0985 |
| I-90 | La Crosse, Monroe[1], Juneau[1], Sauk[1], Columbia[1,2], Dane[2], Rock[2] | 19 | 45.27 | 0.140 |
| I-94 | St. Croix, Dunn, Eau Claire, Jackson, Monroe, Juneau, Sauk, Columbia[2], Dane[2], Jefferson, Waukesha | 127 | 269.46 | 0.157 |
| USH 10 | Portage, Waupaca, Calumet | 6 | 31.35 | 0.0638 |
| USH 12 | Dane, Walworth | 16 | 40.54 | 0.132 |
| USH 14 | Dane[3] | 3 | 7.17 | 0.140 |
| USH 18 | Iowa, Dane[3] | 15 | 26.67 | 0.187 |
| USH 41 | Washington, Fond Du Lac, Winnebago, Outagamie, Brown, Oconto | 112 | 136.54 | 0.273 |
| USH 45 | Washington[4] | 7 | 26.11 | 0.0894 |
| USH 51 | Dane, Columbia[2], Marquette[2], Waushara[2], Portage[2], Marathon[2], Lincoln | 19 | 61.59 | 0.103 |
| USH 53 | La Crosse, Chippewa, Barron, Washburn, Douglas | 35 | 149.37 | 0.0781 |
| USH 141 | Oconto | 2 | 8.40 | 0.0794 |
| USH 151 | Grant, Iowa[5], Dane[5], Columbia, Dodge | 41 | 99.75 | 0.137 |
| STH 23 | Sheboygan | 1 | 12.73 | 0.0262 |
| STH 29 | Chippewa, Clark, Marathon, Shawano, Brown | 64 | 183.46 | 0.116 |
| STH 30 | Dane | 4 | 3.28 | 0.407 |
| STH 35 | St. Croix | 2 | 8.36 | 0.0797 |
| STH 54 | Portage, Brown | 1 | 16.77 | 0.0199 |
| STH 57 | Sheboygan | 3 | 15.36 | 0.0651 |
| STH 172 | Brown | 1 | 9.29 | 0.0359 |
| | **Total** | **631** | **1,482.71** | **0.142** |

[1]*Crashes on concurrent sections of I-90/I-94 were counted as part of I-94.*
[2]*Crashes on concurrent sections of I-39/I-90, I-39/I-90/I-94, and I-39/USH 151 were counted as part of I-39.*
[3]*Crashes on concurrent sections of USH 12/USH 14 and USH 12/USH 18 were counted as part of USH 12.*
[4]*Crashes on concurrent sections of USH 41/USH 45 were counted as part of USH 41.*
[5]*Crashes on concurrent sections of USH 18/USH 151 were counted as part of USH 18.*

Table 5 lists the total number of median crossover crashes by median width. The median barrier standard was then inserted into the plot to indicate which crashes occurred in areas that warrant a median barrier. Figure 5 also displays the median width and ADT of each crash, with the Wisconsin median barrier standard inserted. Of the 631 selected crashes, 514 median crossover crashes (81.5%) occurred at locations at which the Wisconsin FDM did not warrant a median barrier.

**TABLE 5 Median Crossover Crashes and Median Width**

| Median Width (ft) | Median crossover crashes |
|---|---|
| < 30 | 13 (2.1%) |
| 30 – 39 | 33 (5.2%) |
| 40 – 49 | 34 (5.4%) |
| 50 – 59 | 135 (21.4%) |
| 60 – 69 | 348 (55.1%) |
| 70 – 79 | 10 (1.6%) |
| 80 + | 58 (9.2%) |

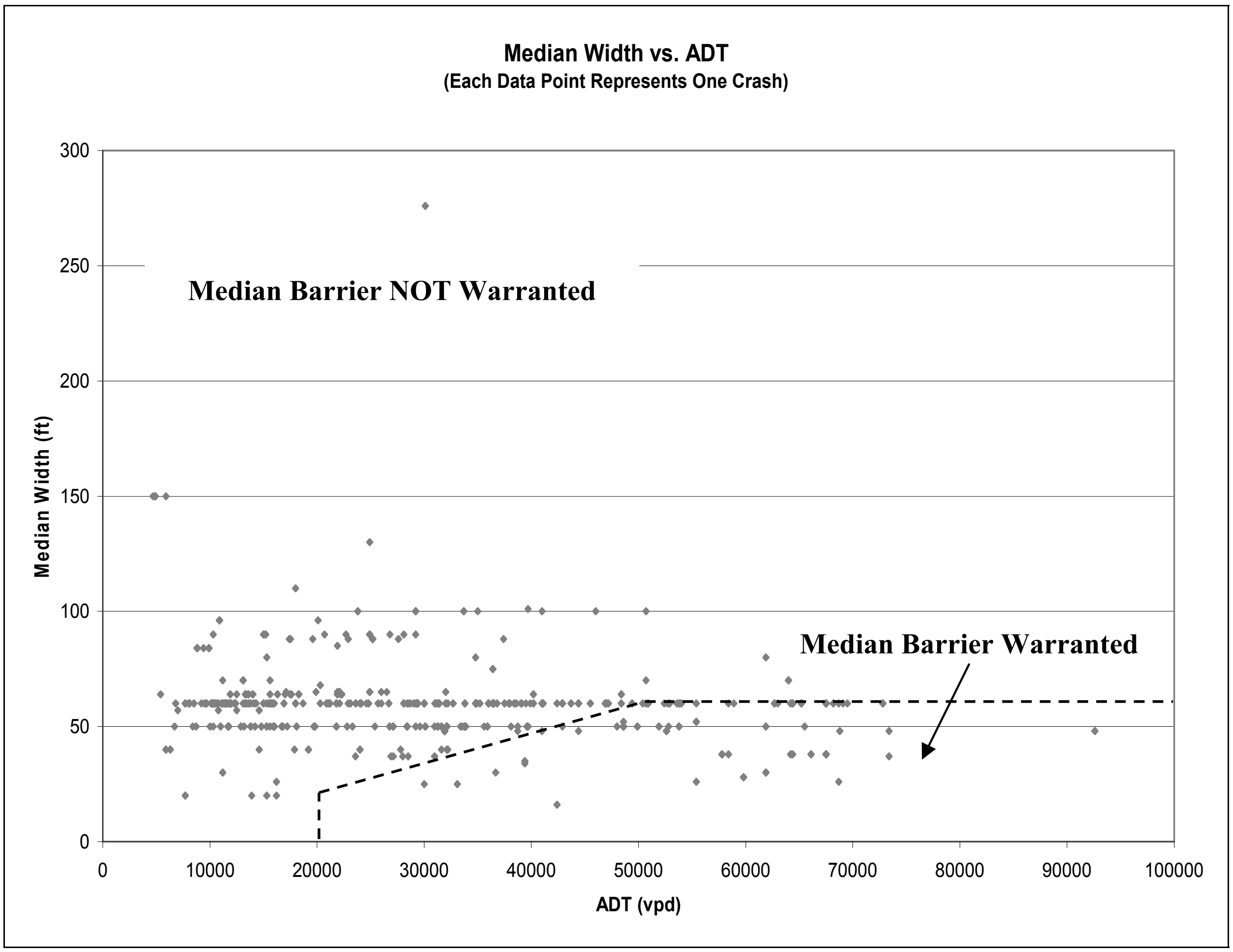


**FIGURE 5 Median Crossover Crashes with the Wisconsin FDM Median Barrier Standard.**

In an attempt to derive a median crossover crash rate, crashes were grouped together based on their location. Crash segments were created by grouping crashes for a particular highway within a county. The median crossover crashes for each segment were normalized by VMT to obtain a median crossover crash rate. The rates were plotted against the average median width for each segment. Figure 6 displays the 66 highway segment points and their average median width. There is some decrease in the median crossover crash rate as median widths increase, although the improvement is not significant. Note that several highway segments exhibit noticeably high median crossover crash rates at large median widths.

The vehicle type and crash manner were considered next. In some instances, a vehicle sustained a collision with a vehicle traveling in the same direction on the roadway, but did not make contact with another vehicle after crossing over the median. For this case, such a crash would involve multiple vehicles, but would be classified as a single vehicle type median crossover crash. Table 6 lists the number of crashes for each crossover crash vehicle type. Crashes that involved an object crossing through the median, such as a trailer, are also listed.

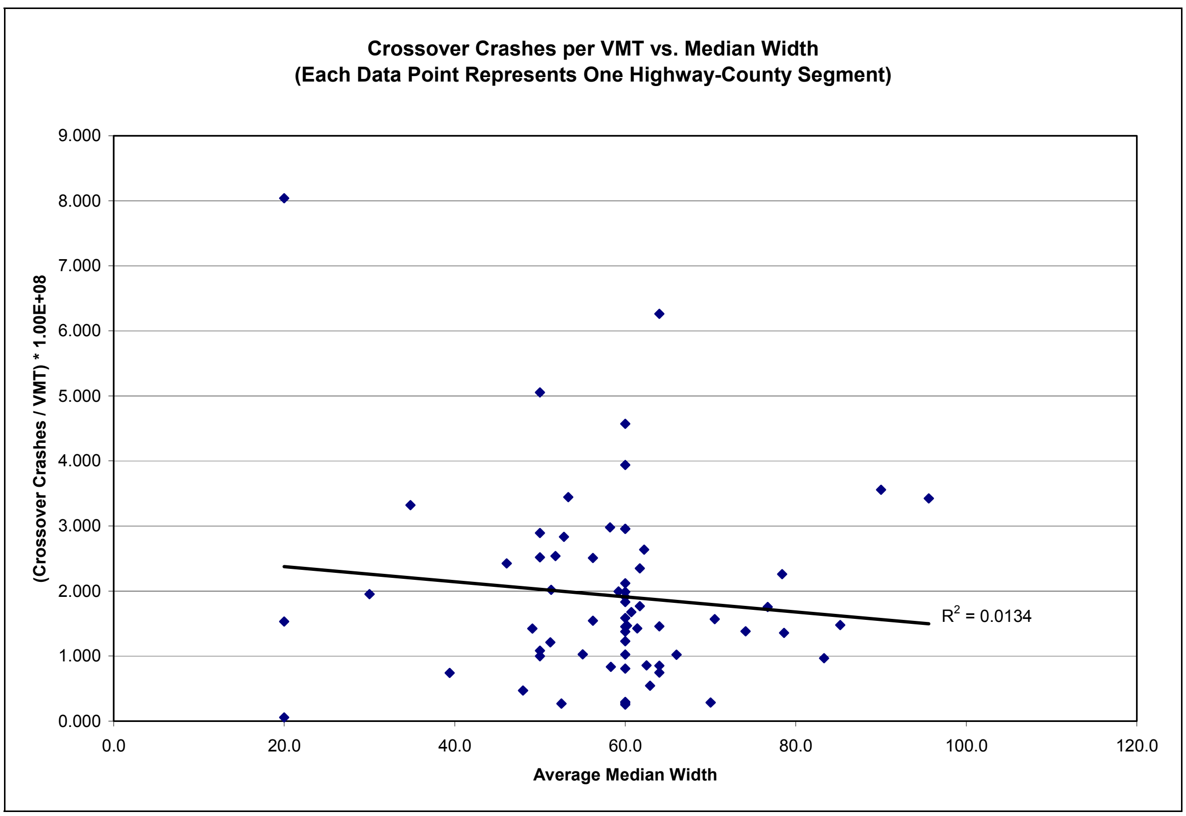


**FIGURE 6 Median crossover crash Rates vs. Average Median Width.**

**TABLE 6 Median Crossover Crashes by Crash Vehicle Type**

| Crossover Crash Vehicle Type | Crashes |
|---|---|
| **Single Vehicle Total** | **511 (81.0%)** |
| Passenger Car | 452 |
| Truck | 58 |
| Motorcycle | 1 |
| **Multiple Vehicle Total** | **113 (17.9%)** |
| Passenger Car – Passenger Car | 77 |
| Passenger Car – Truck | 35 |
| Truck – Truck | 1 |
| **Object Total** | **7 (1.1%)** |
| Trailer | 5 |
| Trailer – Passenger Car | 2 |
| **Total Median Crossover Crashes** | **631 (100%)** |

Next, it was necessary to determine which median crossover crashes were the most severe. It was believed that crashes involving multiple vehicles, particularly those involving vehicles from opposite directions on the roadway, would be more severe than other median crossover crashes. Figure 7 displays the relationship between the total vehicles involved in a median crossover crash and the severity of a crash.

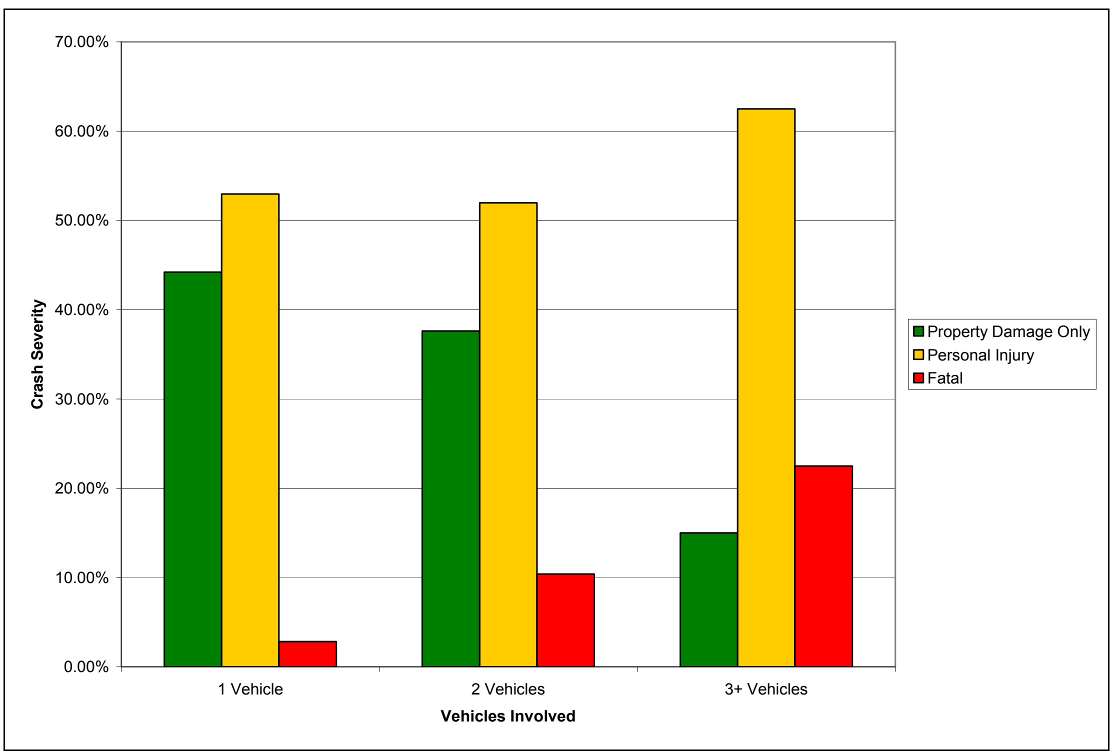


**FIGURE 7 Median Crossover Crash Severity by Total Vehicles Involved.**

As the number of vehicles involved in a median crossover crash increased, the severity of the injuries increased. Fatal crashes made up only three percent of all single vehicle median crossover crashes, increasing to 10 percent of all two vehicle median crossover crashes, and 23 percent of all three or more vehicle median crossover crashes. Median crossover crashes with only property damage dropped from 44 percent of all single vehicle crossover crashes to 38 percent of all two vehicle crossover crashes and 15 percent of all three or more vehicle crossover crashes.

Figure 8 displays the relationship between the median crossover crash vehicle type and the crash severity. Similar to the results found through examination of the total number of vehicles involved in a median crossover crash, fatal crashes significantly increase when a vehicle that has crossed the median makes impact with a vehicle traveling in the opposite direction. Only 3.1 percent of all the passenger car or truck single crossover vehicle crashes were fatal compared to 22.3 percent of the passenger car–passenger car or passenger car–truck median crossover vehicle crashes. Conversely, 44.7 percent of all the passenger car or truck single median crossover vehicle crashes involved only property damage as opposed to only 17.9 percent of the passenger car–passenger car or passenger car–truck multiple median crossover vehicle crashes.

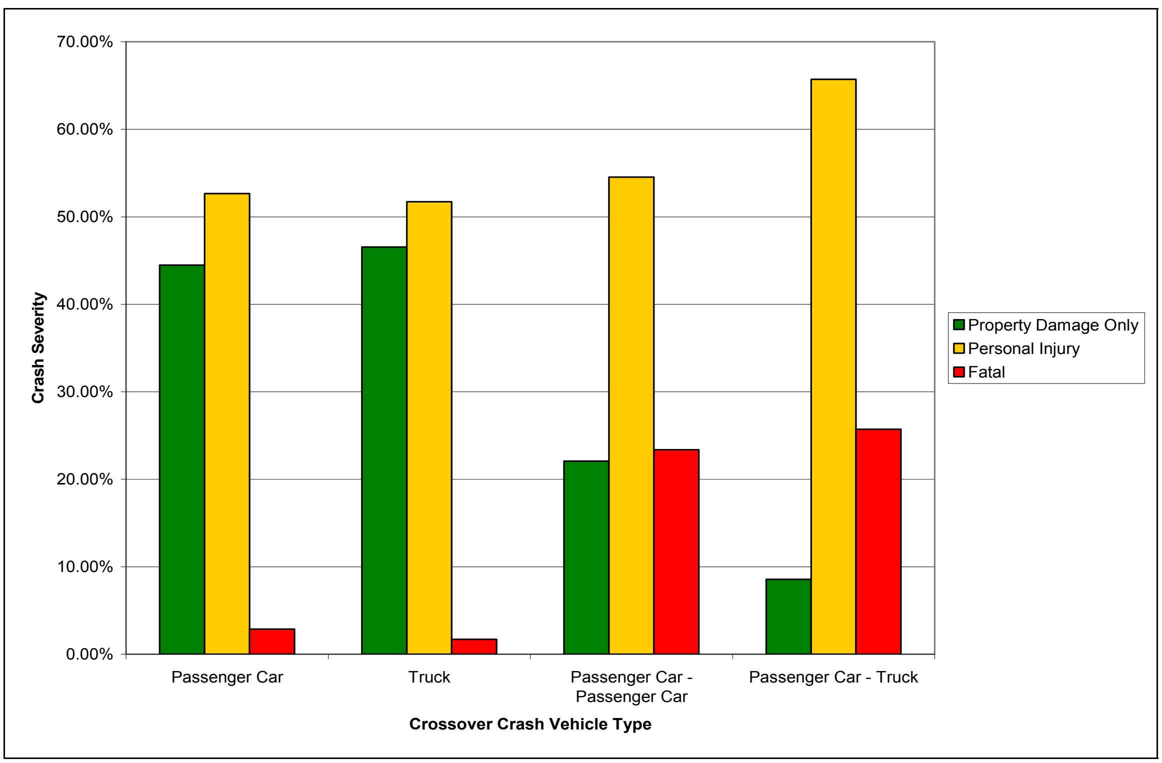


**FIGURE 8 Median Crossover Crash Severity by Crossover Crash Vehicle Type.**

**Fatal Median Crossover Crashes**

Fatal median crossover crashes are of significant importance due to their high cost, both financially and in terms of loss of life. Over the three year period studied, there were 41 fatal median crossover crashes on the selected roadways resulting in 53 fatalities. Table 7 presents a breakdown of fatal median crossover crashes by vehicles involved and crash vehicle type. Figure 9 displays a map of the locations of the 41 fatal crossover crashes.

As previously mentioned, a benchmark for determining if a median barrier may be warranted is a 0.12 fatal crashes per mile rate observed for three years out of a five year period (15). There was only one site, a 5 mile stretch of I-39/I-90/I-94 near the Dane County/Columbia County line, that satisfied this requirement for each of the three years.

The most common fatal crash type was impact with an opposing direction vehicle. Approximately 60 percent of the fatalities, 32 out of 53, were due to impact with an opposing direction vehicle. An additional 15 fatalities were due to either a driver or passenger being ejected from a vehicle during a crash. The fact that 28 percent of the fatalities were caused by ejections further stresses the already documented importance of seatbelt use.

**TABLE 7 Median Crossover Crash Severity by Crash Vehicle Type**

| Crash Severity / Crossover Crash Vehicle Type | | Property Damage Only | Personal Injury | Fatal | Totals |
|---|---|---|---|---|---|
| **Single Vehicle Type** | Passenger Car | 201 (44.4%) | 238 (52.7%) | 13 (2.9%) | **452 (100%)** |
| | Truck | 27 (46.6%) | 30 (51.7%) | 1 (1.7%) | **58 (100%)** |
| | Motorcycle | 0 | 1 | 0 | **1 (100%)** |
| **Multiple Vehicles Type** | Passenger Car – Passenger Car | 17 (22.1%) | 42 (54.6%) | 18 (23.4%) | **77(100%)** |
| | Passenger Car – Truck | 3 (8.6%) | 23 (65.7%) | 9 (25.7%) | **35 (100%)** |
| | Truck – Truck | 1 | 0 | 0 | **1 (100%)** |
| **Object** | Trailer | 4 (80.0%) | 1 (20.0%) | 0 | **5 (100%)** |
| | Trailer – Passenger Car | 1 (50.0%) | 1 (50.0%) | 0 | **2 (100%)** |

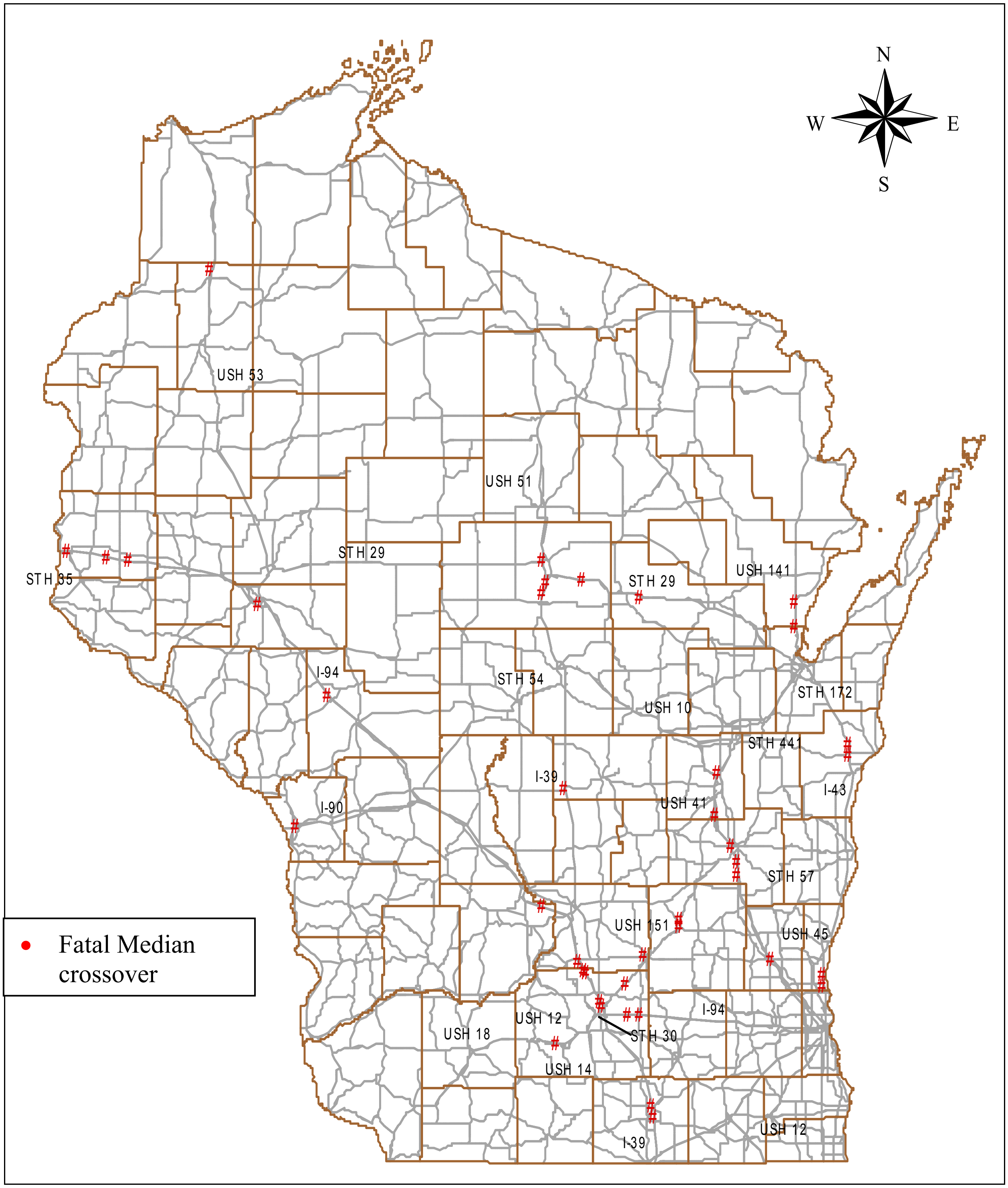


**FIGURE 9 Wisconsin Fatal Median Crossover Crashes (2001 – 2003).**

**Median Crossover Crash Extent**

Median crossover crashes were classified in one of three categories: partial, into, or beyond. 'Partial' median crossover crashes were those in which some portion of the vehicle had crossed the median and came to final rest having entered into at least the shoulder of the opposing roadway. 'Into' median crossover crashes were those in which the vehicle had crossed the median and came to final rest within the confines of the opposing roadway. 'Into' median crossover crashes include crashes where vehicles completely entered the opposing roadway, though they later came to rest only partially on the opposing roadway surface. 'Beyond' median crossover crashes were those in which the vehicle had crossed the median and passed through the opposing lanes before coming to final rest completely beyond the outside shoulder of the opposing roadway. 'Partial' crossover crashes accounted for 26.6 percent of the 624 total vehicle crossover crashes, while 39.7 percent were 'into' crossover crashes and 33.7 percent were 'beyond' crossover crashes. Table 8 presents the data regarding the extent of median crossover and the median crossover crash vehicle type.

Single vehicle type crashes account for 81 percent of all selected median crossover crashes. In other words, 81 percent of single vehicles who crossed over the median and entered the opposing lane found a gap in traffic and did not hit an opposing vehicle. Note that a significant majority of 'partial' and 'beyond' crossover crashes involve single crossover vehicles. Ninety percent of crossover crashes that went beyond the opposing outside shoulder did not make impact with vehicle traveling in the opposite roadway; the same is true for nearly 98 percent of median crossover crashes that only partially enter the opposing roadway. While a majority of median crossover crashes that come to final rest in the opposite roadway also involve a single crossover vehicle type, the number that escaped opposing traffic is significantly less. Only 64.5 percent of crashes that come to rest in the opposite roadway have no impact with an opposing vehicle, while 35.5 percent of those crashes do collide with another vehicle traveling in the opposite direction.

**TABLE 8 Median Crossover Crash Crossover Extent**

| Crossover Extent<br>Crossover Crash Vehicle Type | Partial | Into | Beyond |
|---|---|---|---|
| **Single Vehicle Type Crashes** | **163 (98.2%)** | **159 (64.5%)** | **189 (90.0%)** |
| Passenger Car | 135 (81.3%) | 145 (58.5%) | 172 (81.9%) |
| Truck | 28 (16.9%) | 13 (5.2%) | 17 (8.1%) |
| Motorcycle | 0 | 1 (0.4%) | 0 |
| **Multiple Vehicle Type Crashes** | **3 (1.8%)** | **89 (35.9%)** | **21 (10.0%)** |
| Passenger Car–Passenger Car | 2 (1.2%) | 58 (23.4%) | 17 (8.1%) |
| Passenger Car–Truck | 1 (0.6%) | 30 (12.1%) | 4 (1.9%) |
| Truck–Truck | 0 | 1 (0.4%) | 0 |
| **Totals** | **166 (100%)** | **248 (100%)** | **210 (100%)** |

The number of available gaps of sufficient size in the opposing traffic affected the likelihood of a multiple vehicle type crash. As the ADT on a roadway increased, the probability of finding a gap of sufficient size to pass through and avoid collision after crossing over the median decreased. Figure 10 displays the percentage of single vehicle type and multiple vehicles type crashes based on ADT. With the exception of the 60,001 – 70,000 vpd range, there is a steady increase in the percentage of multiple vehicles type crashes as the ADT of the roadway increases.

Figure 11 displays the crash severity based on the extent of the median crossover by the crash vehicle. Among property damage only crashes, the extent of vehicle crossover is rather evenly distributed. Personal injury crashes that came to their final rest in the opposing roadway varied from those crashes that partially entered the opposing roadway and those that came to final rest beyond the outside shoulder of the opposite roadway. For fatal crashes, those that came to final rest in the opposing roadway make up 75 percent of all fatal crashes.

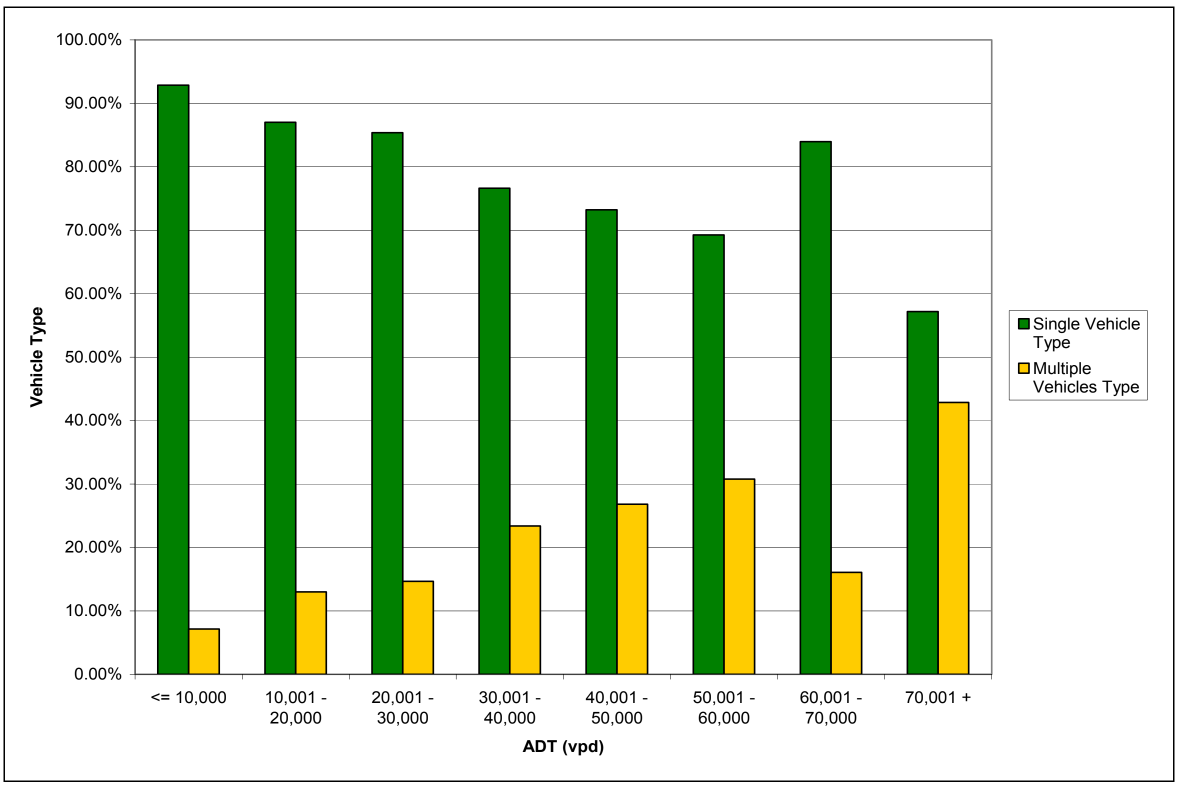


**FIGURE 10 Median Crossover Crash Vehicle Type by ADT.**

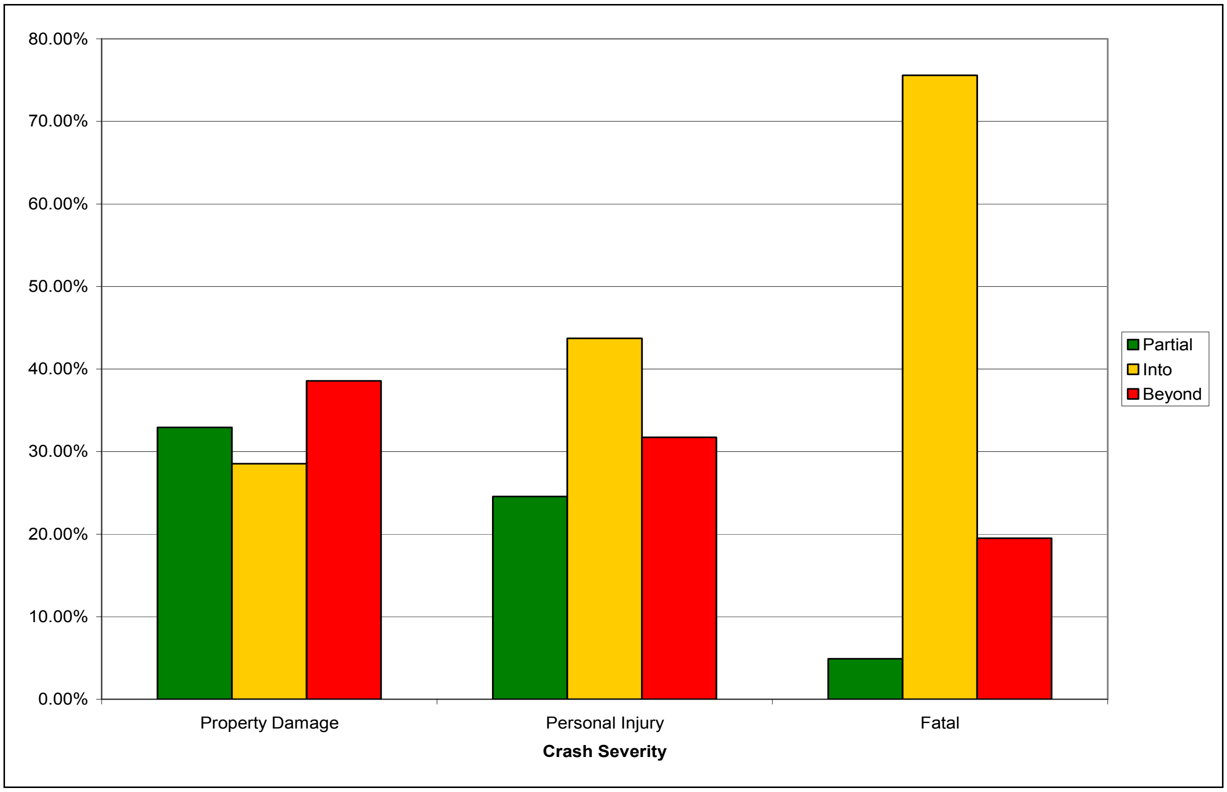


**FIGURE 11 Median Crossover Crash Crossover Extent by Crash Severity.**

**Vehicle Action at Crash**

Information regarding each vehicle's actions at the time of the crash was obtained from the associated median crossover crash reports. The majority of crashes involved a vehicle or vehicles, going straight at the time of the crash. Vehicles going straight at the time of the crash account for approximately 77 percent of all median crossover crashes. The next most common causes, changing lanes and negotiating a curve, were present in only eight percent and four percent of the total number of median crossover crashes, respectively. The vehicle action data suggest that median crossover crashes are commonly a result of either driver inattention or a sudden, unexpected change in the driving environment, i.e., stopped traffic ahead, low friction (ice, snow, or water) on the roadway surface, or other conditions that caused a loss of control of the vehicle. Ordinary driving maneuvers, such as negotiating a curve, changing lanes, merging, or passing a vehicle, do not contribute significantly to the median crossover crash total. Table 9 presents a breakdown of the actions performed prior to the 631 median crossover crashes.

Additionally, a review of the selected crash reports was performed to determine the most likely initial event leading to each median crossover crash. Crashes were classified into one of six categories: lost control on dry pavement, lost control due to weather, vehicle collision, barrier, signpost, or other. These data are presented in Table 10.

**TABLE 9  Vehicle Action at Crash**

| Vehicle Action | Median Crossover Crashes |
|---|---|
| Going Straight | 486 (77.0%) |
| Slowing or Stopping | 21 (3.3%) |
| Changing Lanes | 50 (7.9%) |
| Overtaking on Left | 21 (3.3%) |
| Overtaking on Right | 8 (1.3%) |
| Merging | 5 (0.8%) |
| Negotiating Curve | 27 (4.3%) |
| Other | 13 (2.1%) |
| **Total** | **631 (100%)** |

**TABLE 10  Median Crossover Crashes by  Initial Causes**

| Initial Cause of Crash | Crashes |
|---|---|
| Lost Control on Dry Pavement | 263 (41.7%) |
| Lost Control Due to Weather | 278 (44.0%) |
| *Ice* | *118* |
| *Snow* | *93* |
| *Wet* | *66* |
| *Wind* | *1* |
| Vehicle Collision | 70 (11.1%) |
| Barrier | 5 (0.8%) |
| Signpost | 5 (0.8%) |
| Other | 3 (0.5%) |
| Object / Trailer Crashes | 7 (1.1%) |
| **Total Crossover Crashes** | **631 (100%)** |

Lost control on dry pavement and loss of control due to weather were determined to be the two dominant initial actions that caused a median crossover crash, each with similar totals.  To understand the different types of crossover crashes and what leads to the most severe crashes, the six initial causations were examined to see how many crashes of each cause were property damage only, personal injury, and fatal.  Figure 12 displays the results.  Weather is the dominant cause of property damage only median crossover crashes, while lost control and weather represent the same amount of personal injury crossover crashes.  However, for fatal crashes, loss of control on dry pavement is the dominant initial action that leads to a median crossover crash.

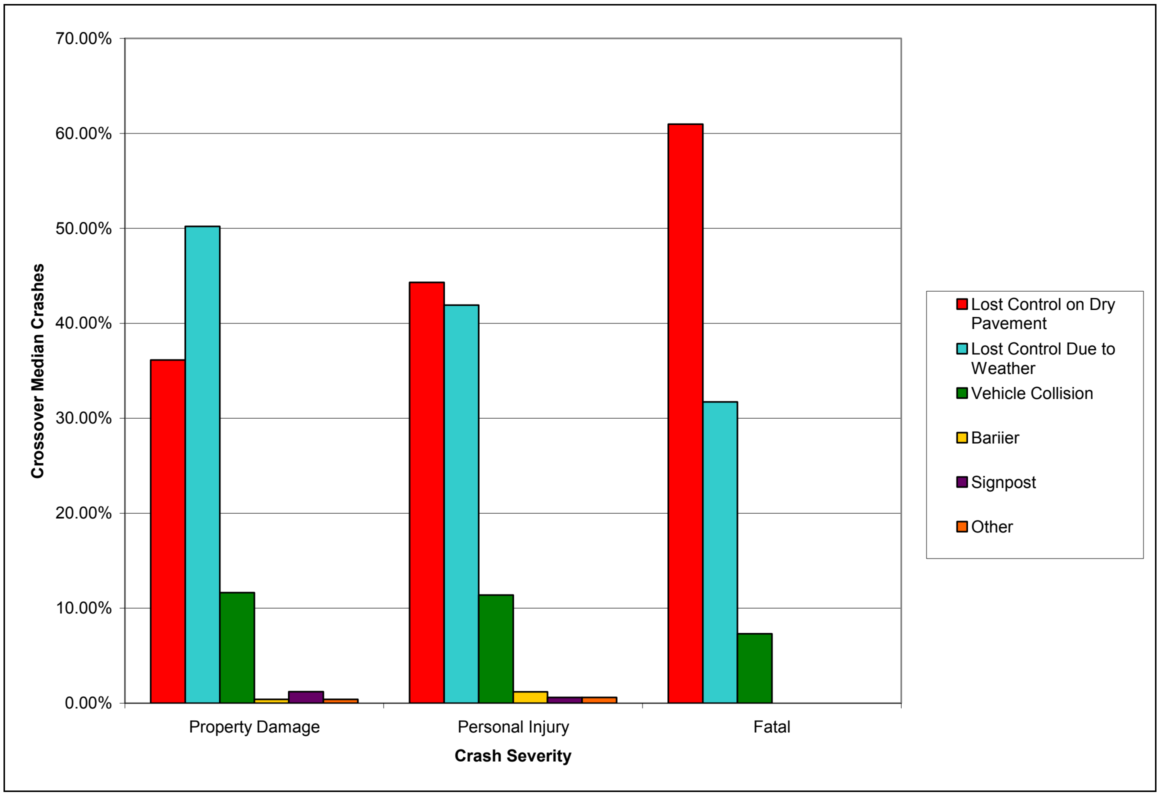


**FIGURE 12 Median Crossover Crash Initial Causation by Crash Severity.**

**Crossover Crash Demographics**

Researchers were specifically interested in the demographic and related attributes of each median crossover crash. First, the dates of the median crossover crashes were grouped together by month. Figure 13 displays a month-by-month breakdown of the selected median crossover crashes. Though some months showed fluctuation from year to year, the three year averages show a definite pattern of an increase in median crossover crashes during winter weather months, December to April.

Approximately 80 percent of the weather-caused median crossover crashes occurred during the five month period of December to April. The increase in median crossover crashes during winter months contrasts with average annual daily traffic (AADT) data. As illustrated in Figure 14, AADT for Wisconsin peaks during the summer in August, with the lowest volumes during the winter months from January through March. This result shows little correlation between AADT and median crossover crash frequency as three of the four highest months for median crossover crashes are January, February, and March.

The age of drivers involved in median crossover crashes were grouped into ten-year segments, beginning with the youngest drivers involved – fifteen year-olds – up to a final grouping of drivers 80 years of age or older. Figure 15 displays the results of 630 crossover crashes; one crash was a hit and run with a trailer crossover, so no age was available.

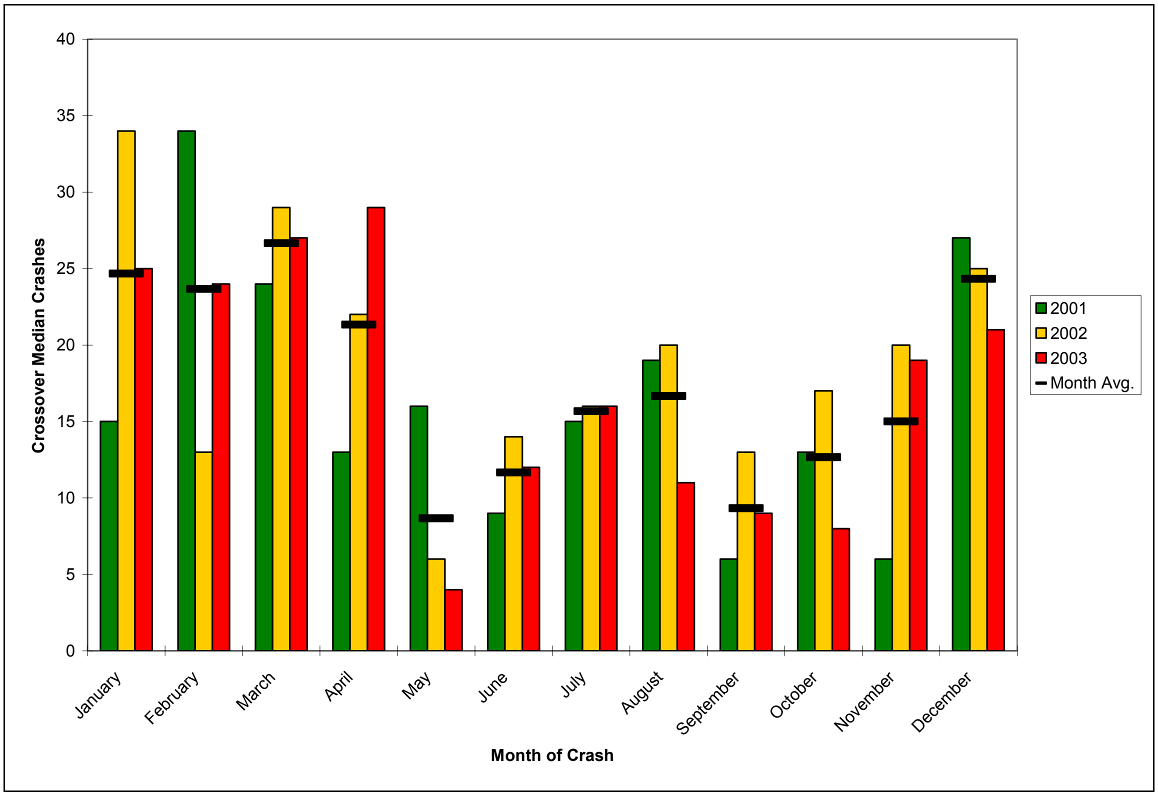


**FIGURE 13 Median Crossover Crashes by Month.**

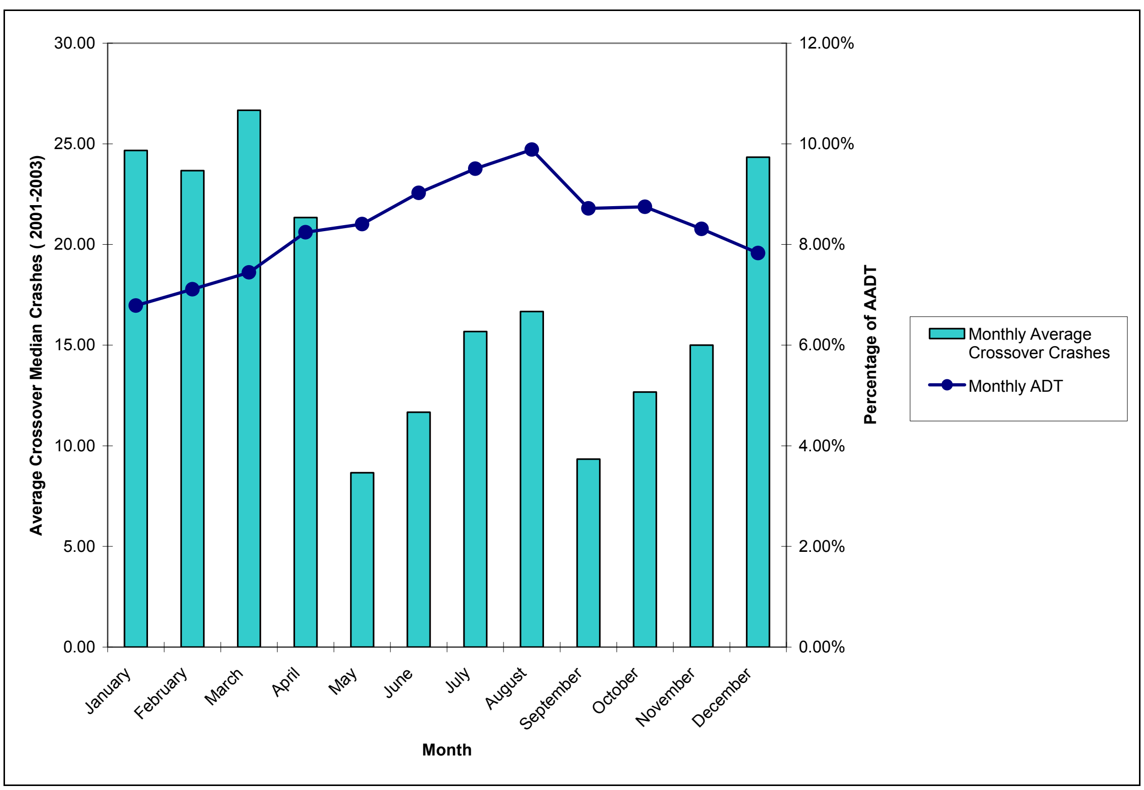


**FIGURE 14 Monthly Median Crossover Crashes and ADT.**

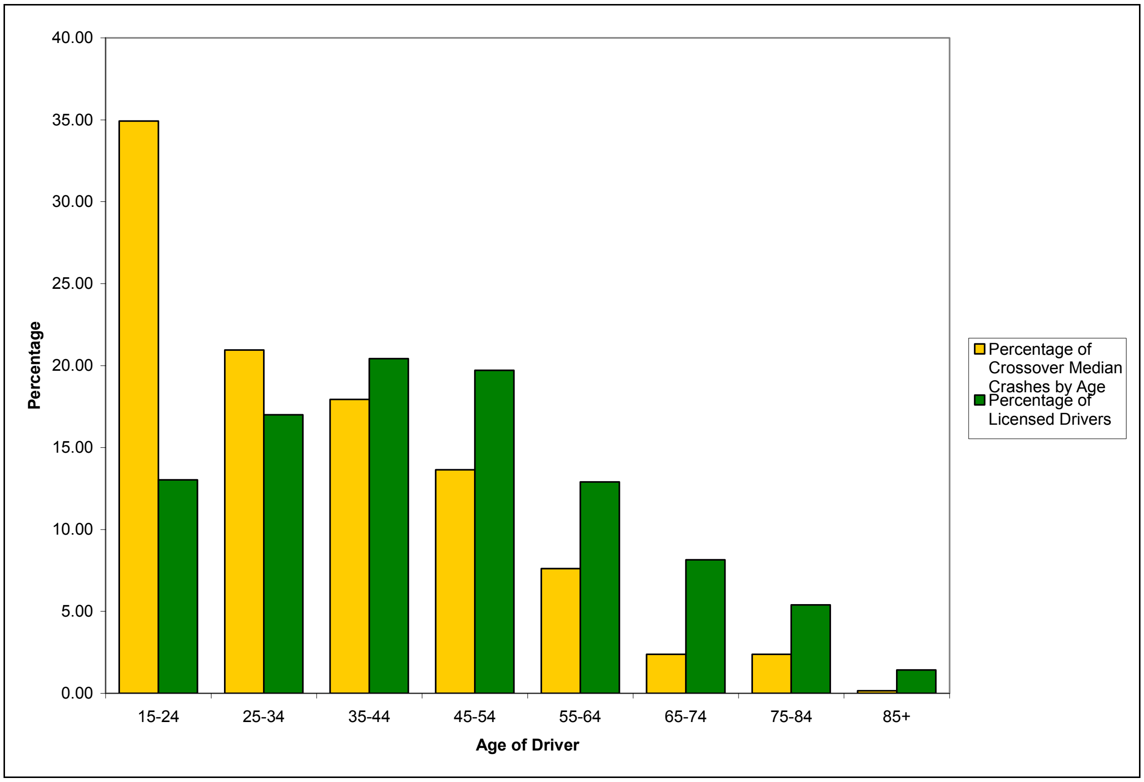


**FIGURE 15 Median Crossover Crashes by Age of Driver.**

The single largest cohort was drivers aged 15 to 24. Approximately 35 percent of the median crossover crashes involved drivers under the age of 25. Numbers did not drop off sharply at the age of 25, but they show a steady decline. Using 2003 licensed driver data, the number of median crossover crashes by age were calculated as a rate of the total drivers for each age bracket. Figure 16 displays the results, clearly showing that younger drivers are more likely to be involved in a median crossover crash. The crossover crash rate of drivers under the age of 25 is almost twice as high as drivers aged 25 to 34, and three to four times higher than drivers aged 45 and over. There is a small spike in the crossover rate for drivers aged 75 to 84. The small amount of driving done by licensed drivers aged 85 and over explains the reason the spike in crossover crash rate does not continue.

Alcohol was marked as a factor on 69 median crossover crashes, or 10.9 percent of all the selected median crossover crashes. The exact blood-alcohol level (BAC) was not recorded.

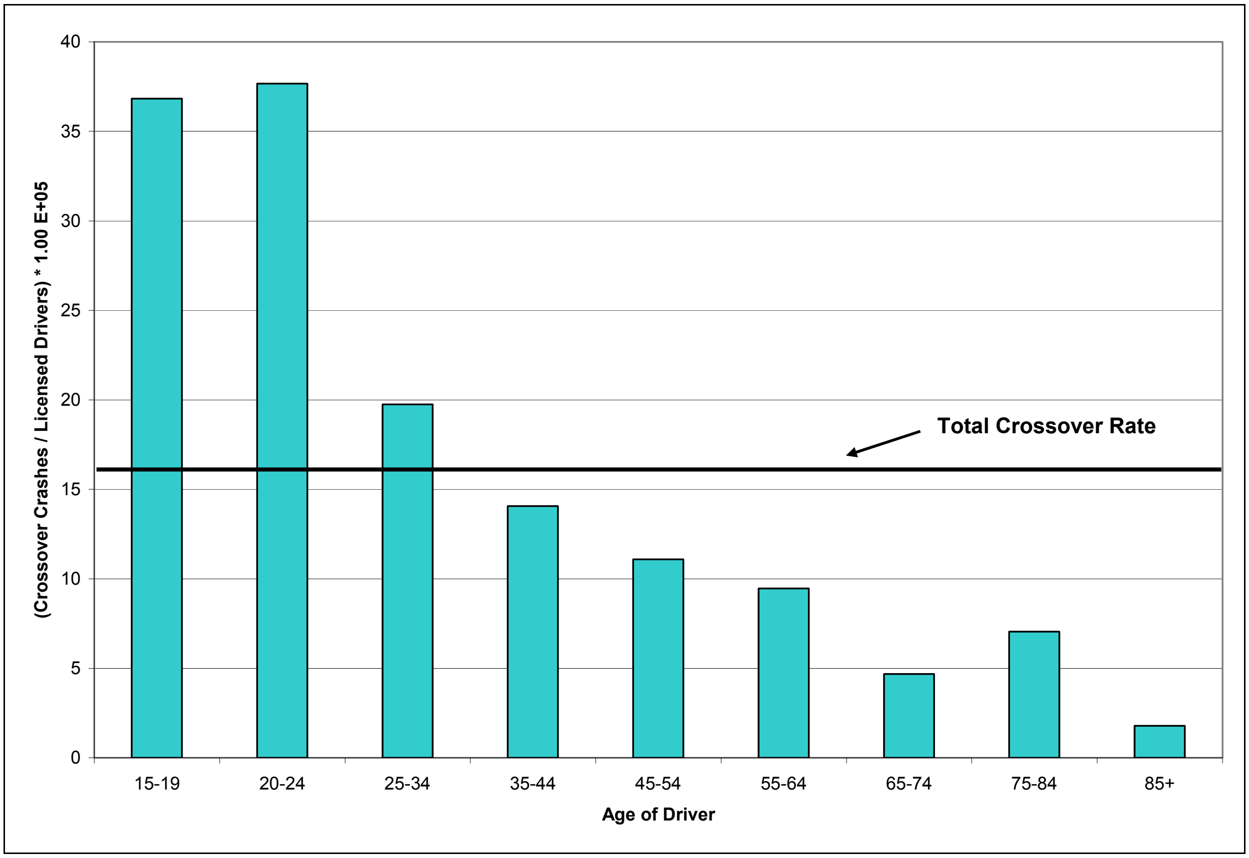


**FIGURE 16 Median Crossover Crash Rate by Age of Driver.**

## Mapping Median Crossover Crashes

Median crossover crash locations were mapped using GIS coordinates to more easily identify "hotspots," i.e., locations where a significantly high amount of crashes are occurring in close proximity to one another. All 631 median crossover crashes were plotted on the Wisconsin state highway network, illustrated in Figure 17.

Examination of the map reveals several counties where crash frequency clusters have formed. Two of these spots are quite apparent: I-39/I-90/I-94 in Dane and Columbia Counties and USH 41 in Fond du Lac and Winnebago Counties. Using the median barrier warrant criteria of 0.5 median crossover crashes per mile per year for at least three years of a five year period, Figure 18 presents the crossover crashes that meet this median barrier requirement.

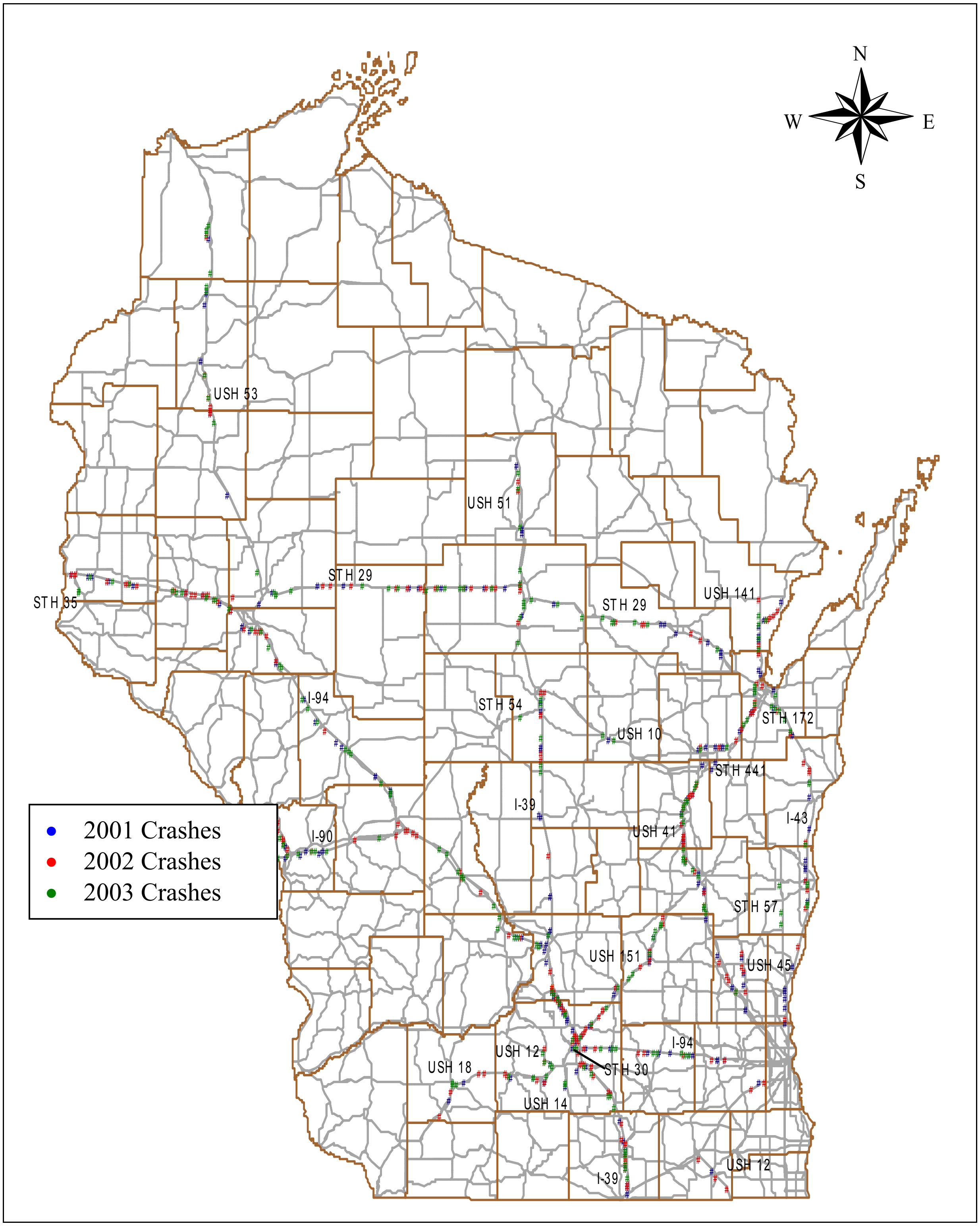


**FIGURE 17 Median Crossover Crashes (2001 – 2003).**

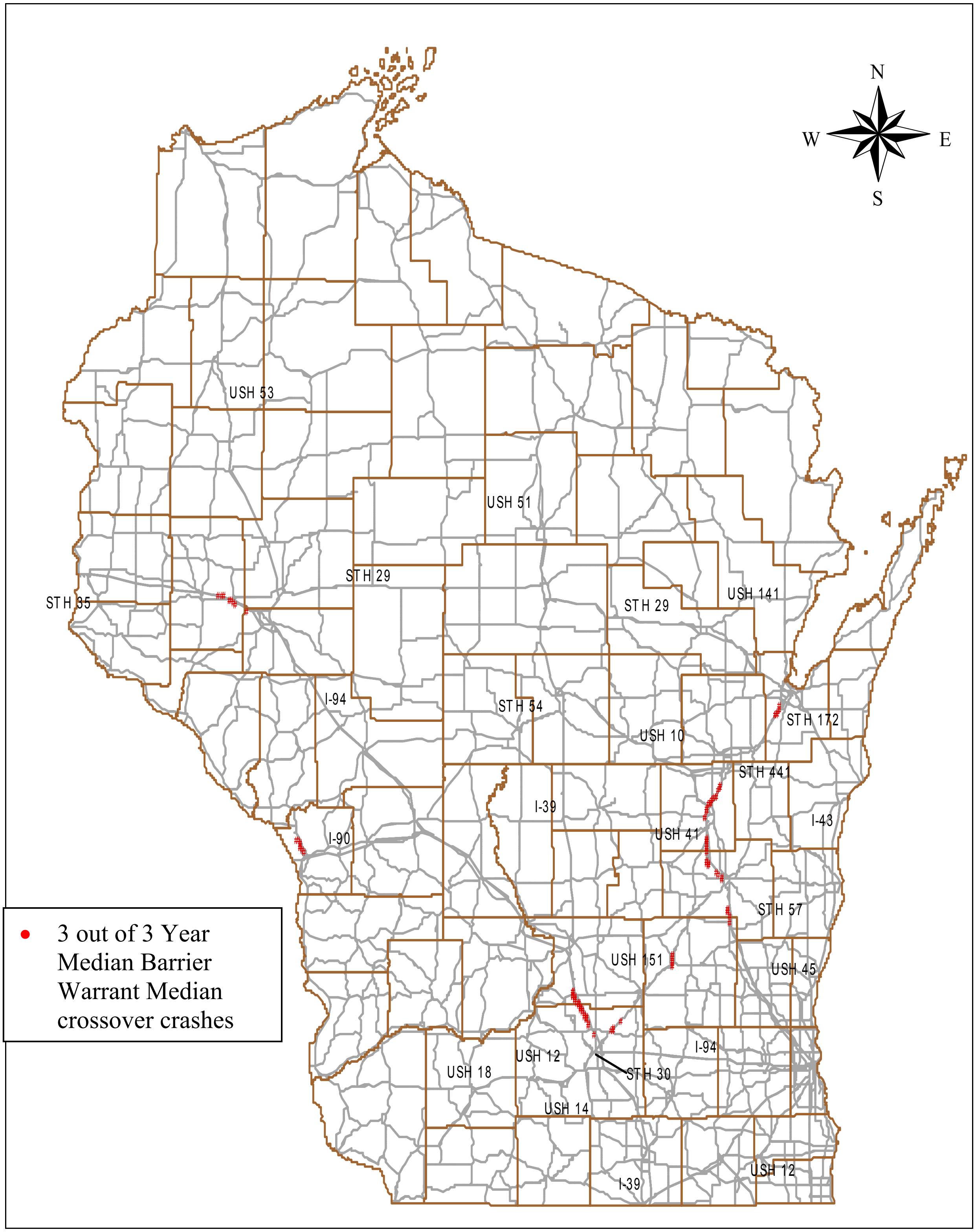


**FIGURE 18 Median Barrier Warranted Median Crossover Crashes (3 Out Of 3 Years).**

## CONCLUSIONS

The following conclusions were determined in this research:

- It is clear that median crossover crashes are a significant problem in Wisconsin. Five roadway segments in Wisconsin exceeded the benchmark of 0.5 crashes/mile/year in all three years analyzed. One site exceeded the 0.12 fatalities/mile/year benchmark for all three years analyzed.

- Median crossover crashes and median width are not strongly correlated with each other. There does not appear to be a combination of ADT and median widths that lead to higher frequencies of median crossover crashes.

These results suggest that the current median barrier standards in the state of Wisconsin should be re-evaluated. Approximately 82 percent of the selected median crossover crashes occurred on roadways with median widths that did not warrant a median barrier. Of these crashes, many occurred on roadways with typical median widths of 50 or 60 feet and common cross-slopes. Additionally, the benchmarks used for identifying high frequency median crossover locations should also be evaluated, given that most use the California standard. Median barrier applied to the frequent crossover locations and improvements in barrier warranting can be effective in reducing the growing median crossover crash problem.

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