



KENTUCKY TRANSPORTATION CENTER

**CAUSES AND COUNTERMEASURES RELATED TO
MOTORCYCLE CRASHES**





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**CAUSES AND COUNTERMEASURES RELATED TO
MOTORCYCLE CRASHES**

by

Kenneth R. Agent
Transportation Research Engineer

and

Jerry G. Pigman
Transportation Research Engineer

University of Kentucky
Lexington, Kentucky

in cooperation with

Kentucky Transportation Cabinet
Commonwealth of Kentucky

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EXECUTIVE SUMMARY

The number of motorcycle crashes (especially fatal crashes) has increased substantially in Kentucky in the past several years. A detailed analysis of crashes involving motorcycles could provide insight into the characteristics and causes of these crashes and identify potential countermeasures for addressing the problem. The objectives of this study were to: a) evaluate and analyze motorcycle crashes and b) identify the causes and potential countermeasures to reduce the number and severity of the crashes.

The literature was reviewed to determine the state-of-the-art related to motorcycle crash research. An analysis of traffic crashes involving motorcycles was conducted using several years of crash data. The characteristics of motorcycle crashes were compared to all traffic crashes. A more detailed review and analysis was performed for fatal crashes involving motorcycles. Roadway locations (0.3-mile spots and one-mile sections) with the highest frequency of motorcycle crashes were identified. Motorcycle crash data were analyzed by county and city. Separate analyses of driver license and motorcycle registration data were conducted.

Contributing factors to traffic accidents can be placed into the following three general categories: a) vehicular, b) environmental, and 3) human. The environmental area, which can be addressed by a transportation agency, is the roadway. The driver is the human factor which can be addressed. Potential countermeasures in these of these areas were identified using the results of the crash analysis and review of literature.

1.0 INTRODUCTION

The number of motorcycle crashes (especially fatal crashes) has increased substantially in Kentucky in the past several years. A detailed analysis of crashes involving motorcycles could provide insight into the characteristics and causes of these crashes and identify potential countermeasures for addressing the increase in crashes.

The total number of motorcycle crashes has increased from less than 1,000 in the 1990's to about 2,000 in recent years. The number of fatal motorcycle crashes has increased even more. For example, the average number of fatal crashes involving a motorcycle has increased from 32 for the five years of 1996 through 2000 to 96 for the five years of 2006 through 2010. The average number of fatal crashes tripled in this 10-year time period.

Motorcycle crashes are a severe type of crash. For the five years of 2006 through 2010, motorcycle crashes accounted for only about 1.5 percent of all crashes compared to 4.8 percent of injury crashes and 11.9 percent of fatal crashes. This shows that, compared to all crashes, motorcycles were overrepresented by a factor of 3.2 in injury crashes and 7.9 in fatal crashes.

Since repeal of the mandatory motorcycle helmet law in 1998, the numbers of injury and fatal crashes have increased dramatically. This corresponds to a significant reduction in helmet usage. Helmet usage has decreased from more than 95 percent before repeal of the helmet law to about 60 percent for the past several years.

A factor to consider is the increased number of motorcycles being registered in Kentucky and nationally. Also, the age and skill level or training received by motorcycle riders may be factors influencing increased involvement and injuries.

The objectives of this study were to:

- evaluate and analyze motorcycle crashes and
- identify the causes of these crashes and potential countermeasures to reduce the number and severity of the crashes.

2.0 PROCEDURE

The following tasks were performed as part of conducting the study and obtaining the objectives.

- The literature was reviewed to determine the state-of-the-art related to motorcycle crash research.
- An analysis of traffic crashes involving motorcycles in Kentucky was conducted using several years of crash data. Trends over a long time period were documented. The characteristics of motorcycles crashes were summarized and compared to all traffic crashes.
- A more detailed review and analysis was performed for fatal crashes involving motorcycles. The police reports for fatal motorcycle crashes were reviewed with the objective of determining contributing factors related to categories for the vehicle, driver, and roadway. Site visits were made to several of the fatal crash locations.
- Roadway locations (0.3-mile spots and one-mile sections) with the highest frequency of motorcycles crashes were identified. A number of these locations were inspected with the objective of determining causes of the crashes and possible countermeasures.
- Motorcycle crash data were analyzed by county and city. Counties and cities having the highest rate of motorcycle crashes were identified.
- A separate analysis of driver license data was performed to determine specific characteristics of motorcycle operators and changes which have occurred in recent years.
- Motorcycle registration data were analyzed to determine if the number of motorcycles is consistent with the increase in crashes. Exposure rates were analyzed by summarizing vehicle classification data.

The completion of these tasks, as described in this report, documents the current status of motorcycle crashes in Kentucky.

3.0 RESULTS

3.1 Trends in Motorcycle Crashes

The numbers of total, injury, and fatal motorcycle crashes in Kentucky for the 19 years of 1992 through 2010 are given in Table 1. The totals for 2000 through 2009 were updated from that reported in previous annual reports using the most recent data. The total number of crashes has ranged from a low of 736 in 1997 to a high of 2,312 in 2008. The number of injury crashes ranged from 565 in 1997 to 1,452 in 2007. The number of fatal crashes ranged from 21 in 1995 to 112 in 2007.

The data in Table 1 show the increase which has occurred in motorcycle crashes over the past several years. For example, comparing the five years of 1995 through 1999 to 2005 through 2009 shows that the total number of crashes increased by 133 percent with injury crashes increasing 104 percent and fatal crashes increasing 200 percent.

The percentage of all fatal crashes involving motorcycles had increased dramatically over the past years (Table 2). This percentage has ranged from 2.5 percent in 1995 to 13.4 percent in 2007. Motorcycle crashes have accounted for more than 10 percent of all fatal crashes since 2006.

3.2 Trends in Motorcycle Registrations and Licenses

The numbers of motorcycle registrations and licenses in Kentucky for the years of 1999 through 2009 are shown in Figures 1 and 2. The increasing trend in the numbers of motorcycle registrations and licenses is evident. The number of motorcycle registrations has increased by 165 percent from 1999 to 2009 with the number of motorcycle licenses increasing by 66 percent over this 10-year time period.

A comparison of the increase in motorcycle registrations (from 1999 to 2009) was compared to area of the state using the 12 highway districts as a method of dividing the state (Figure 3). The largest increase (285 percent) was in District 11 with the smallest increase in District 6 (126 percent).

The increase in the number of motorcycle licenses in the ten years from 1999 to 2009 has varied by driver age (Figure 4). The largest increase was for drivers over 65 years of age followed by the 55 to 64 years of age category. The third highest increase was for drivers under 25 years of age.

The age and sex of individuals with a motorcycle license was compared to the total driving population. About one half of all licensed drivers are male but the percentage of motorcycle licenses issued to males is much higher (91 percent). When age is considered the largest differences are a smaller percentage of motorcyclists under 25 years of age (2.7 percent compared to 11.9 percent of all drivers) and a higher percentage between 45 and 54 years of age (33.1 percent compared to 20.3 percent for all drivers).

Crash rates were calculated in terms of crashes per 1,000 motorcycle registrations and 1,000 motorcycle licenses. The trend in total crash rates (using registrations) is shown in Figure 5 with the trend in fatal crash rates shown in Figure 6. The data show that, while numbers of crashes are increasing, the crash rate (considering registrations) has not increased. The trend in total crash rates for motorcycles (using licenses) is shown in Figure 7 with the trend in fatal crash rates shown in Figure 8. The data show that the crash rate (considering registrations) has had a slight increasing trend. These rates show that the increase in the number of motorcycle crashes is directly related to the increase in the numbers of motorcycles and drivers licensed to operate a motorcycle.

Crash rates (using motorcycle registrations as the exposure measure) by county are shown in Table 3 (for 2005 through 2009). The number of crashes per 1,000 registrations is given for each county with the counties divided into five population ranges. The counties in the five population ranges having the highest rates were: Christian, Bell, McCreary, Owen, and Bracken. The counties in each range with the lowest rates were: Bullitt, Oldham, Wayne, Green, and Nicholas.

3.3 Comparison of Motorcycle Crashes with All Crashes

A comparison of the characteristics of motorcycle crashes with all crashes is given in Table 4. Following is a discussion of the variables which were compared.

- Motorcycle crashes are more severe than all crashes. The percentage of motorcycle crashes involving an injury is 3.2 times higher than all crashes with the percentage of fatal crashes 7.8 times higher.
- For all crashes, the percentage of single vehicle crashes is much higher for motorcycles. The difference is substantially less for fatal crashes.
- For all crashes, there is a higher percentage of motorcycle crashes on KY routes and county roads with a lower percentage on interstates and city streets. This comparison is similar for fatal crashes.
- For all crashes, there is a higher percentage of motorcycle crashes in rural areas with a lower percentage in business areas and no limited access highways. The difference in land use category was less for fatal crashes with the largest difference on limited access highways.
- A higher percentage of motorcycle crashes (both all crashes and fatal crashes) occurred in curves. The percentage in curves is higher for fatal crashes compared to all crashes.
- A much lower percentage of motorcycle crashes occurred on wet or snow covered pavement. This would be related to less travel by motorcyclists during these conditions.
- A smaller percentage of motorcycle crashes occurred during non-daylight hours.
- A higher percentage of motorcycle crashes occurred on the weekend.
- As would be expected, a much higher percentage of motorcycle crashes occur during summer months when most of the travel occurs. Almost one-half occur in the three months of June, July and August.

- Motorcycle crashes have a higher percentage of male drivers. This would be related to the much higher percentage of male licensed drivers.
- There is no major difference in the driver age distribution. The percentage for motorcycle drivers was higher for drivers between 35 and 54 years of age.
- There was no consistent difference when area of the state was considered (using Area Development District as the location criteria). The largest difference was in the Louisville area with a lower percentage of all crashes for motorcycles and a higher percentage of fatal collisions.
- The largest difference in driver contributing factors was the higher percentage of the “not under proper control” factor in motorcycle crashes.
- Speeding was listed more often as a contributing factor in motorcycle crashes.
- In fatal crashes, “failure to yield” and inattention were noted more often in motorcycle crashes.
- Motorcycle crashes did not have more vehicular-related factors than all crashes.
- The major difference in environmental-related factors was the lower percentage of crashes involving a slippery surface for motorcycle crashes. This is related to less driving by motorcyclists during this pavement condition.
- Considering all crashes, there were more motorcycle crashes involving an alleged pavement defect. This would be related to the handling characteristics of motorcycles compared to other types of vehicles.

3.4 Motorcycle Helmet Use

The use of helmets by motorcyclists is included in the annual statewide survey of safety belt use. The results of this survey from 1996 through 2009 are given in Table 5. The data for 1998 includes results before and after the repeal of the mandatory helmet law which was effective that year. The data show a usage rate of about 97 percent when there was a mandatory helmet usage law. The usage rate has been steady since 2001 with an average of 58 percent for the last nine years.

The use of helmets by motorcyclists in fatal crashes is also included in Table 5. The average percentage of the use of a helmet in a fatal crash has been 37 percent for the last nine years. This percentage is about 20 points less than the helmet usage rate and illustrates the benefit for motorcyclists of the use of helmets in reducing fatal injuries.

3.5 Analysis of Fatal Motorcycle Crashes

A more detailed analysis was conducted for fatal motorcycle crashes. A copy of the police report was obtained for all of these crashes for the four years of 2007 through 2010. Specific information from each report was summarized.

A review of the data showed that 52 percent of the crashes were single vehicle. The large majority of the single vehicle crashes (73 percent) occurred in a curve. The most common type of fatal motorcycle crash involves a lane departure by the motorcycle.

The data show that 38 percent of all fatal crashes are single vehicle in which a motorcyclist lost control in a curve. A further analysis showed that an additional 12 percent of fatal crashes involve a motorcycle crossing the centerline and colliding with an opposing vehicle.

A more detailed analysis was conducted for the types of fixed objects struck. After the general category of “earth embankment/rock cut/ditch,” the most common fixed object was a guardrail, followed by a tree. The large majority of the fixed object collisions occurred in a curve (81 percent).

The most common type of multi-vehicle crash (21 percent of all fatal crashes) involved another vehicle either pulling from a side road or making an opposing left turn into the path of the motorcyclist. Almost all of this type of collision (96 percent) resulted from the driver of the other vehicle (and not the motorcyclist) failing to yield the right-of-way.

The multi-vehicle crashes were reviewed to determine which driver was primarily at fault. The analysis showed that the motorcyclist was primarily at fault in about 38 percent of these crashes. This was the result of the large number of multi-vehicles crashes in which the other driver failed to yield the right of way to the motorcycle. The most common multi-vehicle crash with the motorcyclist at fault occurred when the motorcycle crossed the centerline into the opposing lane.

Following is a summary of the most common types of multi-vehicle crashes. The numbers of crashes are given along with a description of fault.

- 64 – vehicle crossed centerline into opposing lane (motorcycle crossed centerline in 45 of these crashes)
- 46 – opposing left turn (in 44 the other driver turned into path of motorcycle)
- 35 - vehicle pulled from side road (in 34 the other driver pulled into path of motorcycle)
- 21 – rear end (motorcycle at fault in 15)
- 12 – same direction sideswipe (motorcycle at fault in five)

It should be noted that, for crashes in which the other driver failed to observe the motorcycle and turned into its path, the most common color of the motorcycle was black. About 36 percent of the motorcycles involved in this type of crash, where the lack of conspicuity of the motorcycle was a factor, were black.

The first area of contact is listed on the police report. In 67 percent of the crashes the front of the motorcycle was the first area of contact. In 28 percent of the crashes either the right or left side was the first contact.

Male motorcyclists were very overrepresented in fatal crashes with about 96 percent male. About 91 percent of all motorcycle licenses are issued to males. For all fatal crashes, 73 percent of drivers were male. There were a slightly higher percentage of motorcyclists between 35 and 54 years of age compared to all drivers.

A comparison was made by age between the percent of licensed motorcyclists and the percent involved in fatal collisions. The following ratios (percent involved in fatal collisions divided by percent of licensed drivers) decreased with age. This shows that younger motorcyclists were overrepresented in fatal collisions.

<u>Age (years)</u>	<u>Ratio (percent collision/percent licenses)</u>
Under 25	6.4
25 – 34	2.0
35 – 44	1.1
45 – 54	0.7
Over 54	0.5

The type of injury sustained by the motorcyclist was related to use of a helmet. The percentage in which a head injury occurred was much higher when a helmet was not used (26 percent when a helmet was used compared to 53 percent when no helmet was used). The fatal injury was most commonly described as “multiple” when a helmet was used while the most common injury listed when no helmet was used was a head injury.

The type and age of motorcycles involved in fatal crashes were identified. Following is a summary of the manufactures and the age of the motorcycles.

<u>Manufacturer</u>	<u>Percent</u>	<u>Year of Manufacturer</u>	<u>Percent</u>
Harley	28.0	before 1980	3.0
Honda	22.0	1980 - 1989	8.9
Yamaha	16.9	1990 – 1999	16.9
Suzuki	13.8	2000 – 2004	32.0
Kawasaki	11.4	after 2004	39.2
other mfg.	7.9		

The most common manufacturers were Harley and Honda. About 70 percent of the motorcycles were no more than 10 years old.

3.6 Analysis by County

An analysis of traffic crash data in the Kentucky is conducted annually. The most recent report used data for 2005 through 2009 (Table 6). Motorcycle crash rates were calculated using populations for each county in terms of crashes per 10,000 residents.

The counties with the highest rate in the five population categories were: Trimble, Carroll, Mason, Calloway, and McCracken. The counties with the lowest rates were: Hickman, Green, Wayne, Oldham, and Kenton. This analysis, using county population as the measure for exposure, resulted in different results than when motorcycle registrations were used for exposure.

3.7 Analysis by City

The crash rate analysis report also provides rates for cities (Table 7) in terms of crashes per 10,000 population (for five population categories). The cities with the highest rates were: Louisville, Paducah, Somerset, Pikeville, and Prestonsburg.

The city with the highest rate was Pikeville. A case study was conducted for Pikeville with a review of the 62 reported motorcycle crashes which occurred during the five years of 2005 through 2009. The most common crash involved a single vehicle (58 percent) followed by an angle crash (15 percent). Four fatal crashes occurred during these five years with two involving a driver turning into the path of a motorcycle, one with alcohol involvement and a speed too fast for a curve, and one involving a collision with a deer. Routes with the highest number of crashes were US 23 (a four-lane highway around Pikeville) and KY 3496 (a one-mile, two-lane road in a business area). Most of the crashes on US 23 were single vehicle while most on KY 3496 were angle.

3.8 High Motorcycle Crash Locations

A subset of all crashes was obtained using only motorcycle crashes. This subset was then analyzed to determine high crash locations (0.3-mile spots and one-mile sections) across Kentucky. The analysis was conducted using two different three-year periods (2006 through 2008 and 2007 through 2009).

The analysis considered both the number of crashes and the crash rate (using total traffic volume as the measure of exposure). For the three years of 2006 through 2008 at 0.3-mile spots, the highest number of motorcycle crashes was eight at one location (Table 8). This table gives the county, route, and milepoint range for each location (along with the critical rate factor (CRF)). The CRF is the actual rate at the location divided by the critical rate for that location. A CRF of one or more is a basis for more evaluation of the crashes at a location. There was one location with seven crashes, two locations with six crashes, four locations with five crashes, and 14 locations with four crashes. All of these locations had a CRF over one.

The same type of analysis for 0.3-mile spots was conducted using 2007 through 2009 data (Table 9). The highest number of crashes was two locations with seven crashes. There were three locations with five crashes, and 28 locations with four crashes. There were 10 spots identified on both lists.

For the three years of 2006 through 2008 at one-mile sections, the highest number of motorcycle crashes was 14 at one location (Table 10). There was one location each having ten, nine, and eight crashes. There were four locations with seven crashes and 13 locations with six crashes. All but a couple of these one-mile sections had a CRF over one.

The same analysis was used for one-mile sections with 2007 through 2009 data (Table 11). The highest number of crashes occurred at one location with 12 crashes. This was

followed with one location each with 11 or nine crashes. There were four locations with eight crashes, seven locations with seven crashes, and 14 locations with six crashes. There were 14 sections on both lists (at least a portion of the one-mile section was on both lists).

Case studies were evaluated for the one-mile sections with the highest number of crashes. Following is a summary of the types of crashes at the eight sections which had seven or more crashes in 2006 through 2008.

<u>County</u>	<u>Location</u> <u>Route</u>	<u>Milepoint</u>	<u>Number</u> <u>Crashes</u>	<u>Description</u>
Kenton	I-75	183.5-184.5	14	11 of 14 were single vehicle crashes on the ramp from KY 236 eastbound to I-75 northbound; one fatal crash
Fayette	US 27	2.0-3.0	10	urban area; four were rear end or same direction sideswipe and five were angle
Bullitt	KY 44	8.1-9.1	9	all were single vehicle; westbound in series of curves on a downgrade; involving impact with a guardrail
Warren	US 231	9.1-10.1	8	urban area; straight and level; five were rear end or same direction sideswipe
Hardin	US 31W	24.4-25.4	7	three were angle involving an entrance (two fatal); four were rear end or same direction sideswipe
Hardin	US 31W	26.2-27.2	7	straight road; three single vehicle; three rear end of same direction sideswipe; one angle at entrance
Christian	US 41A	1.4-2.4	7	straight road; urban area; three angle crashes
Boone	KY 18	14.3-15.3	7	straight road; four rear end or same direction sideswipe

There were 14 locations which had seven or more crashes in a one-mile section in the three years of 2007 through 2009. Six of these locations were on both lists. Following is a summary of crashes for the eight locations which had seven or more crashes in 2007 through 2009 and were not on the previous list. The three locations in Warren County are in Bowling Green.

<u>County</u>	<u>Location</u> <u>Route</u>	<u>Milepoint</u>	<u>Number</u> <u>Crashes</u>	<u>Description</u>
Jefferson	US 31W	13.1-14.1	9	three single vehicle and rear end; straight
Kenton	KY 8	5.7-6.7	8	four single vehicle; one head-on; curves
Warren	US 68	10.8-11.8	8	central business district; three angle; two rear end; one sideswipe
Warren	US 31W	12.1-13.1	8	urban bypass; four angle; two rear end; straight road
Boyle	US 127	4.7-5.7	7	four angle; straight road
Campbell	KY 8	0.3-1.3	7	three angle; two rear end; straight road
Fayette	US 68	2.2-3.2	7	five single vehicle; straight road
Warren	US 231	12.8-13.8	7	four rear end; straight road

It would not be necessary for the spots and sections to have a high number of crashes to have a CRF over one if they occurred on a low volume road. Locations having a CRF over two for the three-year periods of 2006 through 2008 or 2007 through 2009 are shown in Figure 9 for 0-3 mile spots and Figure 10 for one-mile sections. There were a few clusters of these spots and sections in various parts of the state. For example, there were several in the three adjacent northern Kentucky counties of Boone, Kenton, and Campbell. There were several locations in the boundary area of Fayette and Madison Counties. Other counties having high numbers of locations include McCracken, Warren, and Bullitt Counties.

Considering 0.3-mile spots for both three-year periods, the counties with the highest numbers of spots with a CRF over two (for either 2006 through 2008 or for 2007 through 2009) were:

- Campbell – 13
- Boone – 10
- Fayette – 8
- Warren – 8
- Bullitt – 7
- Clark – 7
- McCracken – 7
- Pendleton – 6
- Kenton – 5
- Madison – 5

Considering one-mile sections for both three-year periods, the counties with the highest numbers of sections with a CRF over two for these periods were:

- Boone – 13
- Campbell – 11
- McCracken – 7
- Kenton – 6
- Bullitt – 5
- Marshall - 5

There were several spots and sections which occurred in both of the three-year periods. There were 47 spots and 22 sections on both lists. Campbell County had the highest number of spots on both lists with five (with three spots on KY 915) while Boone County had the highest number of sections on both lists with four (with two on KY 338).

Spots and sections having high CRFs could be compared to identify potential high crash locations. For example, a review of the locations in Campbell County with a high CRF found several spots and sections on KY 915. An inspection of this section of road found it consisted of a series of curves with substantial grades with some issues with cracks in the pavement.

3.9 Fatal Motorcycle Crash Locations

Locations of the fatal motorcycle crashes for the 10 years of 2000 through 2009 were identified. The county, route or street, and milepoint (if applicable) of the 744 fatal crashes which could be plotted were placed on a map with the objective of identifying sections of road with the highest number of fatal crashes. The locations of these crashes across the state are shown in Figure 11.

Of the 775 fatal motorcycle crashes in this 10-year period, the highest number was 109 in Jefferson County. The next highest numbers were 26 in Fayette and Warren Counties and 21 in McCracken and Pike Counties. Only five counties had no fatal crashes in these 10 years. Another 19 counties had one fatal crash.

The county and road combinations which had the highest number of fatal crashes in this 10-year period were identified. The following 12 “county and route combinations” had three or more fatal crashes.

<u>County</u>	<u>Route</u>	<u>Number</u>
Jefferson	KY 1934	6
Jefferson	US 31E	5
Jefferson	US 60	5
Jefferson	River Road	4
Jefferson	I-264	4
Boone	I-75	4

<u>County</u>	<u>Route</u>	<u>Number</u>
Daviess	US 60	3
Marshall	US 62	3
Hardin	US 31W	3
Scott	US 460	3
Jefferson	KY 1020	3
Jefferson	KY 1230	3

The crash reports at several of these locations were reviewed. Five of the six fatal crashes on KY 1934 in Jefferson County were multi-vehicle and typically involved a vehicle turning into the path of the motorcycle. All four of the crashes on River Road in Jefferson County were single vehicle.

3.10 Fatal Crash Locations Case Studies

Locations of a sample of fatal motorcycle cases which occurred in 2010 were inspected. A total of 47 inspections at fatal crash locations were conducted in rural and urban areas in 28 counties across the state. The objective of the site visits was to review the existing traffic control, roadway cross-section, and roadway geometrics and determine the contributing factors to the crash.

Several crash locations were at curves in both rural and urban areas. Possible changes which could be made at these locations include more advance warning signs (with advisory speeds) and positive guidance through the curve (signs and pavement markings). Possible warning signs at and through the curve include a supplemental “combination horizontal alignment/advisory speed sign” and chevrons. Guidelines developed for the use of centerlines and edge lines could be used to determine the appropriate markings as well as guidance given in the Manual on Uniform Traffic Control Devices (MUTCD). Placement of signs and markings through a curve will reduce, but not eliminate this type of crash, since all of this traffic control was present at some of the curves.

Inspections of several locations where the driver of another vehicle turned into the path of a motorcycle showed that limited sight distance was typically not a problem. This confirmed the need for taking measures to increase the conspicuity of motorcycles. Some locations had small restrictions in line of sight which would not be a problem with most vehicles. Having a clear line of sight is especially important for motorcycle due to their lack of conspicuity.

The condition of the pavement was a potential issue at a very few locations. The condition of the pavement is more important for motorcycles than other types of vehicles due to their relative instability compared to other vehicle types.

3.11 Related Board of Claims Cases

Cases in which a claimant alleges that the roadway contributed to a traffic crash are brought through the Board of Claims. These claims have been analyzed to determine the most common basis of claims. The investigation of many of these claims found that several involved a motorcycle. A review of these cases shows that the following two areas of alleged contributing factors relating to the roadway occurred several times.

- lack of traffic control warning of a curve
- pavement defect caused loss of control

These areas are consistent with the analysis of motorcycle crashes which found a high percentage occurred at curves and several of the crash reports listed pavement defect as a contributing factor. These cases confirm the potential countermeasures for motorcycle crashes of warning and delineation of curves and maintenance of the pavement surface.

3.12 License Class

The crash reports in 2009 and 2010 listed license class for the operator. The data were summarized for motorcyclists having a Kentucky address involved in fatal crashes in those two years. There were 156 motorcyclists in this category. Of these, 10 percent did not have any license.

Data were available for 118 motorcyclists which had a Kentucky driver license. Almost one half (47 percent) had a motorcycle endorsement on their license. Adding the motorcyclists with no license resulted in 41 percent with a valid license with a motorcycle endorsement.

A higher percentage of motorcyclists who were wearing their helmet had a motorcycle endorsement (61 percent compared to 38 percent). The percentage with an endorsement increased with driver age. Following is a summary of the percentage of drivers (by age) with a motorcycle endorsement.

<u>Age (years)</u>	<u>Percent</u>
Under 25	25
25 to 34	41
35 to 44	45
45 to 54	48
Over 54	68

The data shows that many drivers obtain a motorcycle permit but do not take the steps necessary to obtain a motorcycle endorsement on their license.

4.0 COUNTERMEASURES

Factors contributing to traffic accidents can be placed into the following three general categories: a) vehicular, b) environmental, and 3) human. The environmental area which can be addressed by a transportation agency is the roadway. The driver is the human factor which can be addressed. Following are potential countermeasures in each of these areas. They were identified using the results of the crash analysis and review of literature as having the potential to reduce the number and/or severity of motorcycle crashes.

4.1 Vehicle Countermeasures

A common cause of angle collisions involving a motorcycle is the driver of another vehicle turning into the path of the motorcycle. This is due to the lack of conspicuity of motorcycles. Any method which can improve the visibility of the motorcycle and motorcyclist would be a countermeasure for this type of crash. For example, motorcycles are designed such that their headlights remain on at all times to improve their visibility. Following is a list of other methods which could be used to increase the conspicuity of the motorcycle and its rider.

- wear high-visibility clothing (such as bright-color jacket or reflective safety vest)
- use a white or other bright colored helmet
- avoid riding a black motorcycle or the use of black clothing
- use reflective tape (on helmet, clothing, and motorcycle)
- use auxiliary running lights
- use a headlight modulator
- keep headlights clean
- use high beam headlight when possible
- consider placement of a small flag on the rear of the motorcycle

4.2 Roadway Countermeasures

Most countermeasures related to the roadway which would be considered for motorcycle crashes would also benefit other drivers. They are listed since they would have a direct affect on motorcycle crashes.

A high percentage of motorcycle crashes are single vehicle and occur at curves. Possible countermeasures for this type of crash include the following.

- provide advance warning signs (with advisory speeds when appropriate)
- provide positive guidance (pavement markings and signs) through the curve
- ensure that the proper cross-slope is provided through the curve
- adapt guardrail design to provide a more crashworthy design for motorcyclists

Guidelines have been developed for the placement of a centerline and edge lines related to pavement width.

The lack of stability of motorcycles (as compared to other types of vehicles) increases the importance of the riding surface (pavement). The ride quality and pavement friction are factors to be considered in this area. Following is a list of countermeasures which could affect this type of crash.

- maintain the pavement surface to reduce differences in elevation (minimize surface irregularities and discontinuities)
- use full-width patching (do not patch portions of lanes)
- install warning signs where there is uneven pavement (with a supplemental warning plaque for motorcycles)
- pave the apron of gravel approaches to minimize gravel on the adjacent pavement
- remove roadway debris

Line of sight at intersections is important for all vehicles. It is of increased significance for motorcycles due to their lack of conspicuity compared to other types of vehicles.

This study identified spots and sections with high numbers of motorcycle crashes and also spots and sections with the highest critical rate factor (CRF). The analysis of crashes at these locations should be reviewed to determine if any countermeasures are appropriate at specific locations.

Safety audits are conducted on sections of road identified as high crash locations. Issues related to motorcycles should be considered as part of the audit. The use of motorcycle specific signs should be considered when appropriate.

4.3 Driver Countermeasures

The increase in motorcycle fatalities corresponded to the decrease in the use of helmets which occurred when the mandatory helmet law was repealed. Education concerning the benefits of use of a helmet should be continued. The law requiring the use of helmets while riding a motorcycle (for all riders) should be reenacted.

Proper training for motorcyclists must be attained. Training would include the process necessary to obtain a motorcycle permit and a motorcycle license. Following are suggestions to consider for this process.

- limit the time that a permit can be used before a license is obtained to one year
- require a more comprehensive skills test to obtain a motorcycle license (such as including driving on various types of roads)
- contact registered motorcycle owners who do not have a motorcycle license
- update the motorcycle manual to include relevant crash data and recommendations contained in this study
- add a “daylight riding only” restriction to driving with only a permit
- after six months contact individuals who obtained a permit but have not attempted to obtain a license

A common type of crash involves a driver turning into the path of the motorcyclist. The motorcyclist could consider the following methods to alleviate crashes where the other driver did not observe the motorcycle.

- avoid driving in the “blind spots” of other drivers
- use the horn
- use hand signals
- maintain safe following distances
- watch and anticipate the movement of other drivers
- tap brakes

Safety campaigns related to motorcycles should be used to education both motorcyclists and other drivers of the cause of motorcycle crashes. For example, the lack of conspicuity of motorcycles can be emphasized.

Several rear-end fatal crashes have occurred where the motorcycle collided with the rear of another vehicle. Motorcyclists must be informed of the frequency of this type of crash and the need to maintain a safe following distance (considering the braking and stability characteristics of motorcycles).

Table 1. Number of Motorcycle Crashes

Year	Total Crashes	Injury Crashes	Fatal Crashes
1992	1,014	778	32
1993	928	713	31
1994	926	733	33
1995	852	677	21
1996	747	581	25
1997	736	565	29
1998	835	647	26
1999*	1,033	774	42
2000	1,208	849	40
2001	1,383	958	61
2002	1,393	966	42
2003	1,564	1,046	58
2004	1,680	1,144	73
2005	1,924	1,230	83
2006	1,900	1,232	94
2007	2,256	1,452	112
2008	2,312	1,441	96
2009	2,066	1,289	85
2010	2,088	1,287	92

*First year after repeal of mandatory helmet law

Table 2. Percent of Fatal Motorcycle Crashes

Year	Fatalities (All crashes)	Motorcycle Fatalities	Percent
1992	819	32	3.9
1993	875	31	3.5
1994	791	33	4.2
1995	856	21	2.5
1996	846	27	3.2
1997	865	29	3.4
1998	869	27	3.1
1999	819	44	5.4
2000	823	41	5.0
2001	843	62	7.4
2002	915	43	4.7
2003	928	60	6.5
2004	964	77	8.0
2005	985	90	9.1
2006	913	97	10.6
2007	864	116	13.4
2008	826	96	11.6
2009	791	88	11.1
2010	759	97	12.8

Table 3. MOTORCYCLE CRASHES PER REGISTRATION BY COUNTY (2005-2009)

COUNTY	NUMBER CRASHES	NUMBER OF REG.	CRASHES PER 1,000 REG.
Population Over 50,000			
Christian	203	1,482	137
Jefferson	1,564	11,508	136
Fayette	639	4,902	130
Madison	244	1,882	130
Warren	316	2,545	124
McCracken	247	2,204	112
Boone	287	2,584	111
Campbell	173	1,573	110
Daviess	225	2,095	107
Laurel	151	1,446	104
Pike	218	2,101	104
Kenton	297	2,988	99
Hardin	246	2,809	88
Pulaski	140	1,640	85
Bullitt	148	2,093	71
Population 25,000 - 50,000			
Bell	54	355	152
Boyle	88	650	135
Jessamine	128	978	131
Franklin	122	949	129
Calloway	117	954	123
Boyd	167	1,460	114
Henderson	121	1,080	112
Graves	109	977	112
Whitley	76	759	100
Harlan	51	511	100
Shelby	91	925	98
Marshall	93	965	96
Nelson	90	942	96
Clark	87	917	95
Letcher	51	575	89
Meade	62	716	87
Muhlenberg	72	848	85
Scott	111	1,309	85
Barren	101	1,267	80
Knox	64	803	80
Logan	57	722	79
Greenup	78	994	78
Floyd	87	1,129	77
Carter	49	705	70
Hopkins	109	1,586	69
Perry	59	871	68
Oldham	59	1,284	46
Population 15,000 - 24,999			
McCreary	44	246	179
Clay	48	334	144
Rowan	67	467	143
Woodford	71	528	134
Bourbon	55	432	127
Mason	66	522	126
Simpson	47	384	122
Hart	42	364	115
Knott	39	347	112
Breathitt	35	317	110
Casey	27	253	107
Union	54	508	106
Johnson	54	532	102
Anderson	60	597	101
Montgomery	75	754	99
Russell	29	309	94
Allen	40	430	93
Rockcastle	35	379	92

COUNTY	NUMBER CRASHES	NUMBER OF REG.	CRASHES PER 1,000 REG.
15,000 - 24,999 cont.			
Taylor	56	625	90
Harrison	44	501	88
Henry	32	365	88
Estill	32	372	86
Lincoln	56	673	83
Mercer	56	676	83
Marion	32	390	82
Grant	56	692	81
Grayson	53	673	79
Ohio	43	651	66
Lawrence	21	375	56
Breckinridge	24	442	54
Adair	20	399	50
Wayne	22	472	47
Population 10,000 - 14,999			
Owen	41	240	171
Pendleton	54	320	169
Carroll	44	367	120
Magoffin	18	153	118
Powell	31	277	112
Todd	33	298	111
Butler	32	303	106
Leslie	22	222	99
Metcalfe	23	233	99
Morgan	29	298	97
Jackson	26	276	94
Washington	23	255	90
Monroe	18	211	85
Garrard	42	494	85
Bath	21	248	85
Martin	20	249	80
Trigg	31	413	75
Larue	23	350	66
Fleming	23	352	65
Spencer	30	480	63
Caldwell	25	442	57
Edmonson	13	232	56
Lewis	10	205	49
Webster	11	426	26
Green	6	251	24
Population Under 10,000			
Bracken	28	179	156
Menifee	18	119	151
Wolfe	27	181	149
Elliott	20	158	127
Fulton	13	105	124
Livingston	38	307	124
Trimble	38	315	121
Lyon	27	228	118
Gallatin	24	207	116
Carlisle	11	123	89
Crittenden	23	285	81
Ballard	21	261	80
Robertson	5	72	69
Lee	12	173	69
McLean	16	236	68
Hancock	18	269	67
Clinton	14	212	66
Cumberland	11	194	57
Owsley	5	105	48
Hickman	5	117	43
Nicholas	7	211	33

Table 4. Comparisons of Motorcycle Crashes with All Crashes (2007-2009)

	Category	Percent	
		All	Motorcycles
Severity	Injury	20.5	65.7
	Fatal	0.6	4.7
Type of collision (All)	Collision with moving vehicle	64.4	45.1
	Collision with fixed object	20.6	24.7
	Non-collision	3.8	23.1
	Parked Vehicle	6.4	2.5
	Animal	4	4.3
	Pedestrian	0.8	0.3
Type of collision (Fatal)	Collision with moving vehicle	39.3	43.5
	Collision with fixed object	40.4	34.2
	Non-collision	12.5	18.8
	Parked Vehicle	0.9	1.1
	Animal	0.4	2.1
	Pedestrian	6.5	0.3
Type of Roadway (All)	Interstate/Parkway	9.5	4.8
	US route	24.8	23.8
	KY route	34	40.9
	County road	6.1	11.3
	City road	23.3	17.8
	other	2.3	1.4
Type of Roadway (Fatal)	Interstate/Parkway	12.4	3.4
	US route	23.7	22.6
	KY route	49.1	55.2
	County road	9.4	12.3
	City road	4.6	5.8
	other	0.8	0.7
Land Use (All)	Rural	23.8	39.3
	Business/Industrial	41.8	31.7
	Residential/School	23.8	22.8
	Limited Access	10.5	6.1
	Unknown	0.1	0.1
Land Use (Fatal)	Rural	60.9	62.1
	Business/Industrial	13	16.7
	Residential/School	12.1	14.3
	Limited Access	13.8	6.9
	Unknown	0.2	0
Roadway Characteristics (All)	Straight/Level	57.4	44.6
	Straight/Grade	17	14.2
	Straight/Hillcrest	3.9	3.8
	Curve/Level	9.7	16.2
	Curve/Grade	9.8	16.9
	Curve/Hillcrest	2.2	4.2
	Curve(all)	21.7	37.3
	Other	0	0.1

Table 4. Comparisons of Motorcycle Crashes with All Crashes (2007-2009) (cont.)

	Category	Percent	
		All	Motorcycles
Roadway Characteristics (Fatal)	Straight/Level	36.7	29.5
	Straight/Grade	16.8	14
	Straight/Hillcrest	4.2	3.4
	Curve/Level	18.6	18.5
	Curve/Grade	20.3	29.5
	Curve/Hillcrest	3.4	5.1
	Curve(all)	42.2	53.1
	Other	0	0
Roadway Condition (All)	Dry	73.9	94.9
	Wet	21.6	4.3
	Snow/ice	4.2	0.1
	Mud/Other	0.3	0.7
Roadway Condition (Fatal)	Dry	79.3	96.2
	Wet	17.9	3.5
	Snow/ice	2.4	0.3
	Mud/Other	0.4	0
Light Conditions (All)	Day	71.4	76.8
	Dark	23.5	18.4
	Dawn/Dusk	5.1	4.8
Light Conditions (Fatal)	Day	56.5	64.4
	Dark	38.5	30.8
	Dawn/Dusk	5	4.8
Day of Week (All)	Sunday	9.8	17.4
	Monday	14.6	12.5
	Tuesday	15.2	11.1
	Wednesday	15	11.2
	Thursday	15.2	12.4
	Friday	17.6	14.2
	Saturday	12.6	21.2
Day of Week (Fatal)	Sunday	13.5	19.5
	Monday	14.1	15.1
	Tuesday	13.5	9.2
	Wednesday	12.9	6.2
	Thursday	13.4	12.3
	Friday	15.3	16.8
	Saturday	17.3	20.9
Month (All)	January	8.1	0.9
	February	7.9	1.2
	March	7.8	5.7
	April	8.1	9
	May	8.5	13.3
	June	8	14.2
	July	7.9	14.7
	August	8	15.2
	September	8.1	12.1
	October	9.4	8.1
	November	8.9	4.2
	December	9.3	1.4

Table 4. Comparisons of Motorcycle Crashes with All Crashes (2007-2009) (cont.)

	Category	Percent	
		All	Motorcycles
Month (Fatal)	January	7.2	1.4
	February	6.3	1.4
	March	8	7.5
	April	8.5	7.9
	May	9	11.3
	June	9.1	15.8
	July	8.8	15.4
	August	8.4	14
	September	9.2	11.6
	October	8.4	9.9
	November	9	3.1
	December	8.1	0.7
Sex (All)	Male	55.7	81.4
	Female	44.3	18.6
Sex (Fatal)	Male	73	85.1
	Female	27	14.9
Age (All)	Under 25	25	20.6
	25-34	20.8	20.1
	35-44	18.1	20.2
	45-54	16	20.7
	55 and Older	19.4	17.9
	Not Stated	0.7	0.5
Age (Fatal)	Under 25	20.7	20.4
	25-34	19.2	18.4
	35-44	19.7	22.7
	45-54	16.6	19.5
	55 and Older	23.7	18.8
	Not stated	0.1	0.2
Area of State (All)	Purchase	4.4	6.2
	Pennyrile	4.6	5.8
	Green River	5	4.7
	Barren River	6.2	7.1
	Lincoln Trail	5	5
	KIPDA	25.1	20
	Northern Kentucky	10.9	10.3
	Buffalo Trace	1.1	1.4
	Gateway	1.8	1.9
	FIVCO	2.9	3.6
	Big Sandy	3.1	3.8
	Kentucky River	2	2.5
	Cumberland Valley	4.4	5
	Lake Cumberland	3.4	3.6
Bluegrass	20.1	19.1	

Table 4. Comparisons of Motorcycle Crashes with All Crashes (2007-2009) (cont.)

	Category	Percent	
		All	Motorcycles
Area of State (Fatal)	Purchase	6.3	5.1
	Pennyrile	5.9	4.8
	Green River	4.6	6.2
	Barren River	8.1	7.9
	Lincoln Trail	7.8	4.1
	KIPDA	13	17.9
	Northern Kentucky	6.8	8.9
	Buffalo Trace	2.1	3.4
	Gateway	2.8	2.7
	FIVCO	3.4	2.7
	Big Sandy	5.6	5.5
	Kentucky River	5.1	5.5
	Cumberland Valley	9.2	6.5
	Lake Cumberland	5.8	5.1
	Bluegrass	13.5	13.7
Contributing Factors (All)	Speeding	1.1	4.8
	Failure to Yield	11.4	11.9
	Following to close	5.4	2.9
	Improper Passing	0.9	1.6
	Improper Backing	1	0.5
	Disregard Traffic Control	3	1.6
	Turning improperly	1.5	1.4
	Alcohol	4.1	6.8
	Drug/Medication	1.2	1.2
	Sick/Emotional/Fatigue	1.1	0.5
	Fell asleep	1	0.1
	Misjudge clearance	5.2	2.6
	Driver Inattention	39.6	32.1
	Distraction	3.9	3
	Physical disability	0.2	0.2
	Cell Phone	0.8	0.2
	Lost Consciousness	1	0.7
	Not Under proper control	13.4	27.6
	Over Steering	3.1	2.8
	Too Fast for Conditions	4.7	3.5
	Weaving In Traffic	0.1	0.2
Other	6.3	8.1	
None Detected	78.6	61	
Contributing Factors (Fatal)	Speeding	8.1	14.4
	Failure to Yield	9.9	15.4
	Following to close	0.4	0
	Improper Passing	0.6	1.4
	Improper Backing	0.1	0.3
	Disregard Traffic Control	3.3	2.4
	Turning improperly	0.4	0.3
Alcohol	15.1	16.1	

Table 4. Comparisons of Motorcycle Crashes with All Crashes (2007-2009) (cont.)

	Category	Percent	
		All	Motorcycles
Contributing Factors cont. (Fatal)	Alcohol	15.1	16.1
	Drug/Medication	3.5	3.8
	Sick/Emotional/Fatigue	2.1	0
	Fell asleep	1.9	0.7
	Misjudge clearance	1.1	2.1
	Driver Inattention	17.2	27.4
	Distraction	1.8	1.7
	Physical disability	0.3	0.3
	Cell Phone	0.8	0.3
	Lost Consciousness	1	0.7
	Not Under proper control	29	44.5
	Over Steering	11	5.1
	Too Fast for Conditions	6.2	5.8
	Weaving In Traffic	0.2	0.3
	Other	9.1	12
	None Detected	38.2	48.6
Vehicular Factors (All)	Brakes Defective	1.1	0.9
	Lighting Failure	0.1	0.2
	Steering Failure	0.3	0.4
	Tire Failure	0.7	0.7
	Load Failure/Problem	0.5	0.2
	Other	1.8	3.3
	None Detected	98	96.4
Vehicular Factors (Fatal)	Brakes Defective	0.6	1
	Lighting Failure	0.4	0.3
	Steering Failure	0	0.3
	Tire Failure	1.1	0
	Load Failure/Problem	0.7	0.3
	Other	2.9	4.1
	None Detected	97.4	97.3
Environmental Factors (All)	Animals	3.9	4.9
	Glare/View Obstructed	2.9	3.4
	Debris	0.6	3
	Bumps/Holes/Defective Shoulder	0.4	1.3
	Construction/Maintenance	0.5	0.4
	Improperly Parked vehicle	0.3	0.1
	Fixed object	0	0.1
	Slippery Surface/Water Pool	13	3.9
	Other	2.2	3.4
	None Detected	83.9	83.9
Environmental Factors (Fatal)	Animals	0.8	2.4
	Glare/View Obstructed	3.1	4.5
	Debris	1.3	1
	Bumps/Holes/Defective Shoulder	0.9	0.7
	Construction/Maintenance	0.7	0.3
	Improperly Parked vehicle	0.2	0
	Fixed object	0.1	0.3
	Slippery Surface/Water Pool	11.6	2.4
	Other	3.2	2.4
	None Detected	83.9	91.8

Table 5. Motorcycle Helmet Use

Year	Survey (Percent)	Fatal Crashes (Percent)*
1996	98	**
1997	97	**
1998 (before repeal)	97	**
1998 (after repeal)	76	**
1999	65	**
2000	70	53
2001	56	33
2002	57	37
2003	56	**
2004	58	34
2005	59	36
2006	60	36
2007	56	40
2008	58	35
2009	64	43

*Use of helmets by motorcyclist in fatal crashes

**No data available

Table 6. Motorcycle Crash Rates by County and Population Category (in order of Decreasing Percentages)(2005-2009)

County	Number of crashes	Annual crash rate (crashes per 10,000 pop.)	County	Number of crashes	Annual crash rate (crashes per 10,000 pop.)
Population Category under 10,000			Population Category 15,00-24,999		
Trimble	38	9.4	Mason	66	7.9
Livingston	38	7.8	Union	54	6.9
Wolfe	27	7.6	Montgomery	75	6.7
Bracken	28	6.8	Anderson	60	6.3
Lyon	27	6.7	Woodford	71	6.1
Gallatin	24	6.1	Rowan	67	6.1
Elliot	20	5.9	Bourbon	55	5.7
Menifee	18	5.5	Simpson	47	5.7
Ballard	21	5.1	Mercer	56	5.4
Crittenden	23	4.9	McCreary	44	5.2
Robertson	5	4.4	Grant	56	5.0
Hancock	18	4.3	Taylor	56	4.9
Carlisle	11	4.1	Harrison	44	4.9
Fulton	13	3.4	Hart	42	4.8
McLean	16	3.2	Lincoln	56	4.8
Cumberland	11	3.1	Johnson	54	4.6
Lee	12	3.0	Allen	40	4.5
Clinton	14	2.9	Knott	39	4.4
Nicholas	7	2.1	Grayson	53	4.4
Owsley	5	2.1	Breathitt	35	4.3
Hickman	5	1.9	Rockcastle	35	4.2
Population category 10,000-14,999			Estill	32	4.2
Carroll	44	8.7	Henry	32	4.2
Owen	41	7.8	Clay	48	3.9
Pendleton	54	7.5	Ohio	43	3.8
Garrard	42	5.7	Russell	29	3.6
Todd	33	5.5	Marion	32	3.5
Spencer	30	5.1	Casey	27	3.5
Trigg	31	4.9	Lawrence	21	2.7
Butler	32	4.9	Breckinridge	24	2.6
Powell	31	4.7	Adair	20	2.3
Metcalfe	23	4.6	Wayne	22	2.2
Washington	23	4.2	Population Category 25,000-50,000		
Morgan	29	4.2	Calloway	117	6.8
Jackson	26	3.9	Boyd	167	6.7
Caldwell	25	3.8	Scott	111	6.7
Bath	21	3.8	Jessamine	128	6.6
Leslie	22	3.5	Boyle	88	6.4
Larue	23	3.4	Marshall	93	6.2
Fleming	23	3.3	Graves	109	5.9
Martin	20	3.2	Shelby	91	5.5
Monroe	18	3.1	Henderson	121	5.4
Magoffin	18	2.9	Barren	101	5.3
Edmonson	13	2.2	Clark	87	5.2
Webster	11	1.6	Franklin	122	5.1
Lewis	10	1.4	Nelson	90	4.8
Green	6	1.0	Hopkins	109	4.7
			Meade	62	4.7
			Muhlenberg	72	4.5
			Logan	57	4.3
			Greenup	78	4.2
			Whitley	76	4.2
			Floyd	87	4.1
			Perry	59	4.0
			Knox	64	4.0
			Letcher	51	4.0
			Carter	49	3.6
			Bell	54	3.6
			Harlan	51	3.1
			Oldham	59	2.6
			Population Category Over 50,000		
			McCracken	247	7.5
			Madison	244	6.9
			Warren	316	6.8
			Boone	287	6.7
			Pike	218	6.3
			Laurel	151	5.7
			Christian	203	5.6
			Bullitt	164	5.4
			Hardin	246	5.2
			Pulaski	140	5.0
			Daviess	225	4.9
			Fayette	639	4.9
			Jefferson	1,564	4.5
			Campbell	173	3.9
			Kenton	297	3.9

Table 7. Motorcycle Crash Rates By City and Population Category (in Order of Decreasing Percentages)(2005-2009)

City	Number of crashes	Annual crash rate (crashes per 10,000 pop.)	City	Number of crashes	Annual crash rate (crashes per 10,000 pop.)
Population Category over 200,000			Population Category 2,500-4,999		
Louisville	1,414	11.0	Prestonsburg	22	12.2
Lexington	639	4.9	Calvert City	13	9.6
Population Category 20,000-55,000			Carrrollton	17	8.8
Paducah	142	10.8	Russell	15	8.2
Bowling Green	198	8.0	Hazard	19	7.9
Florence	92	7.8	Scottsville	17	7.9
Ashland	82	7.5	Paintsville	16	7.7
Elizabethtown	83	7.4	Stanford	13	7.6
Richmond	99	7.3	Springfield	10	7.6
Henderson	83	6.1	Greenville	14	6.4
Hopkinsville	92	6.1	Cold Spring	12	6.3
Frankfort	77	5.6	Marion	9	5.6
Owensboro	141	5.2	Barbourville	10	5.6
Radcliff	57	5.2	Tompkinsville	7	5.3
Covington	95	4.4	Grayson	10	5.2
Jeffersontown	37	2.8	Benton	11	5.2
Population Category 10,000-19,999			Williamstown	8	5.0
Somerset	50	8.8	Columbia	9	4.5
Danville	58	7.5	Stanton	6	4.0
Murray	54	7.2	Dawson Springs	6	4.0
Shively	53	7.0	Mount Vernon	5	3.9
Shelbyville	35	6.9	Hartford	5	3.9
Glasgow	42	6.5	Fulton	5	3.6
Nicholasville	60	6.1	Southgate	6	3.5
Newport	52	6.1	Beaver Dam	5	3.3
Bardstown	29	5.6	Lancaster	6	3.2
Erlanger	45	5.4	Morganfield	5	2.9
Campbellsville	27	5.1	Providence	4	2.2
Georgetown	43	4.8	Hodgenville	3	2.1
Winchester	40	4.8	Irvine	3	2.1
Independence	32	4.3	Vine Grove	4	1.9
Mayfield	22	4.3	Ludlow	4	1.8
Madisonville	39	4.0	Park Hills	2	1.3
Middlesboro	14	2.7	Cumberland	1	0.8
Fort Thomas	13	1.6	Hickman	1	0.8
Population Category 5,000-9,999			Lakeside Park	1	0.7
Pikeville	58	18.4			
London	40	14.1			
Shephardsville	48	11.5			
Mount Sterling	23	7.8			
Maysville	32	7.1			
Harrodsburg	28	7.0			
Fort Wright	20	7.0			
Berea	32	6.5			
Franklin	23	5.8			
Paris	26	5.7			
Morehead	17	5.7			
Versailles	21	5.6			
Central City	16	5.4			
Leitchfield	16	5.2			
La Grange	13	4.6			
Russelville	16	4.5			
Corbin	17	4.4			
Williamsburg	11	4.3			
Mount Washington	18	4.2			
Princeton	13	4.0			
Monticello	12	4.0			
Lawrenceburg	16	3.6			
Cynthiana	11	3.5			
Taylor Mill	11	3.2			
Bellevue	10	3.1			
Lebanon	9	3.1			
Flatwoods	11	2.9			
Villa Hills	11	2.8			
Dayton	8	2.7			
Alexandria	11	2.7			
Fort Mitchell	11	2.7			
Highland Heights	7	2.1			
Edgewood	6	1.3			
Elsmere	5	1.2			
Wilmore	1	0.3			

Table 8. 0.3-Mile Spots with Highest Number of Motorcycle Crashes (Three-Year Period)(2006-2008)

Number of Crashes	County	Route	Milepoint Range	CRF
8	Fayette*	US 27	2.6-2.9	2.21
7	Kenton*	I-75	183.5-183.8	2.36
6	Campbell	KY 1998	0.6-0.9	5.35
6	Hardin	US 31W	24.4-24.7	2.68
5	Warren	US 31W	16.9-17.2	2.45
5	Hardin*	US 31W	26.2-26.5	2.12
5	Christian	US 41A	1.4-1.7	1.98
5	Jefferson*	KY 61	3.1-3.4	1.96
4	Kenton	KY 8	0.5-0.8	3.52
4	Bullitt	KY 44	8.1-8.4	3.48
4	Bullitt	KY 44	8.5-8.8	3.44

Number of Crashes	County	Route	Milepoint Range	CRF
4	Kenton	US 25	12.9-13.2	2.79
4	Jefferson	KY 1142	1.0-1.3	2.39
4	Boyd*	US 23X	1.4-1.7	2.20
4	Jessamine*	US 68	7.3-7.6	2.17
4	Campbell	I-471	4.7-5.0	1.90
4	Warren*	US 231	8.7-9.0	1.82
4	Warren	US 231	9.4-9.7	1.72
4	Boone*	US 25	10.8-11.1	1.68
4	Kenton	US 25	5.7-6.0	1.49
4	Kenton*	US 25	5.0-5.3	1.48
4	Henderson*	US 41A	16.7-17.0	1.41

*Locations also on list for 2007 through 2009

Table 9. 0.3-Mile Spots with Highest Number of Motorcycle Crashes (Three-Year Period)(2007-2009)

Number of Crashes	County	Route	Milepoint Range	CRF
7	Kenton	I 75	183.5-183.8	2.25
7	Fayette	US 27	2.6-2.9	1.69
5	Hardin	US 31W	26.2-26.5	1.99
5	Fayette	US 68	2.9-3.2	1.75
5	Franklin	US 60	10.9-11.2	1.58
4	Bell	KY 66	14.7-15	5.06
4	Logan	KY 591	3.7-4.0	4.93
4	Bullitt	KY 61	12.4-12.7	3.19
4	Jefferson	I-264	0.0-0.3	2.57
4	Christian	US 41	12.4-12.7	2.56
4	Boyle	US 150	13.5-13.8	2.35
4	Bullitt	KY 61	14.6-14.9	2.33
4	Warren	US 68	11.3-11.6	2.25
4	Boyd	US 23X	1.4-1.7	2.25
4	Mercer	US 127	3.4-3.7	2.22
4	Jessamine	US 68	7.3-7.6	2.12
4	Warren	US 68	9.3-9.6	1.88

Number of Crashes	County	Route	Milepoint Range	CRF
4	Warren	US 31W	9.6-9.9	1.85
4	Warren	US 231	8.7-9.0	1.67
4	Warren	US 31W	12.1-12.4	1.63
4	Fayette	US 27	9.4-9.7	1.58
4	Warren	US 231	9.7-10.0	1.57
4	Boone	US 25	10.9-11.2	1.5
4	Jefferson	KY 1747	12.6-12.9	1.46
4	Fayette	US 25	14.4-14.7	1.37
4	Jefferson	KY 61	3.4-3.6	1.34
4	Kenton	US 25	5.1-5.4	1.34
4	Boone	KY 18	14.6-14.9	1.3
4	Kenton	I 75	183.8-184.1	1.27
4	Henderson	US 41A	16.7-17.0	1.27
4	Jefferson	US 31W	15.0-15.3	1.25
4	Jefferson	US 31W	13.7-14	1.18
4	Fayette	KY 4	0.2-0.5	1.08

Table 10. One-Mile Section with Highest Number of Motorcycle Crashes (Three-Year Period)(2006-2008)

Number of Crashes	County	Route	Milepoint Range	CRF	Number of Crashes	County	Route	Milepoint Range	CRF
14	Kenton*	I-75	183.5-184.5	2.41	6	Bullitt*	KY 61	14.0-15.0	2.17
10	Fayette*	US 27	2.0-3.0	1.25	6	Campbell*	KY 8	0.3-1.3	1.89
9	Bullitt*	KY 44	8.1-9.1	5.04	6	Fayette	US 27	9.4-10.4	1.43
8	Warren*	US 231	9.1-10.1	1.78	6	Jefferson	I-65	135.6-136.6	1.37
7	Hardin	US 31W	24.4-25.4	1.69	6	Fayette	US 25	13.3-14.3	1.35
7	Hardin*	US 31W	26.2-27.2	1.59	6	Warren*	US 31W	12.7-13.7	1.34
7	Christian*	US 41A	1.4-2.4	1.45	6	Fayette	KY 44	9.9-10.9	1.12
7	Boone*	KY 18	14.3-15.3	1.28	6	Jefferson*	KY 1747	11.9-12.9	1.09
6	Campbell	KY1998	0.6-1.6	3.52	6	Jefferson*	US 31W	13.7-14.7	0.95
6	McCracken	US45X	1.6-2.6	2.66	6	Fayette*	US 27	0.8-1.8	0.73
6	Kenton*	KY 8	5.7-6.7	2.27					

*Locations also in list for 2007 through 2009

Table 11. One-Mile Section with Highest Number of Motorcycle Crashes (Three-Year Period)(2007-2009)

Number of Crashes	County	Route	Milepoint Range	CRF	Number of Crashes	County	Route	Milepoint Range	CRF
12	Kenton	I-75	183.5-184.5	1.94	6	Campbell	US 27	21.2-22.2	2.3
11	Fayette	US 27	1.8-2.8	1.14	6	Christian	US 41	12.1-13.1	2.25
9	Warren	US 231	9.0-10.0	1.85	6	Bullitt	KY 61	13.8-14.8	2
8	Kenton	KY 8	5.7-6.7	2.86	6	McCracken	US 60	10.1-11.1	1.48
8	Warren	US 68	10.8-11.8	2.61	6	Jefferson	US 31E	13.6-14.6	1.12
8	Warren	US 31W	12.1-13.1	1.64	6	Calloway	US 641	7.5-8.5	1.09
8	Jefferson	US 31W	13.1-14.1	1.18	6	Franklin	US 60	10.1-11.1	1.07
7	Bullitt	KY 44	8.2-9.2	3.85	6	Christian	US 41A	1.4-2.4	1.07
7	Boyle	US 127	4.7-5.7	2.57	6	Fayette	US 25	14.2-15.2	1.06
7	Campbell	KY 8	0.3-1.3	1.9	6	Kenton	KY 17	18.3-19.3	0.93
7	Hardin	US 31W	26.2-27.2	1.47	6	Fayette	US 27	6.4-7.4	0.92
7	Fayette	US 68	2.2-3.2	1.22	6	Jefferson	KY 1747	11.7-12.7	0.89
7	Warren	US 231	12.8-13.8	1.21	6	Jefferson	US 31W	14.1-15.1	0.78
7	Boone	KY 18	14.3-15.3	1.14	6	Fayette	US 27	0.8-1.8	0.63

Figure 1. **Motorcycle Registration Trend**

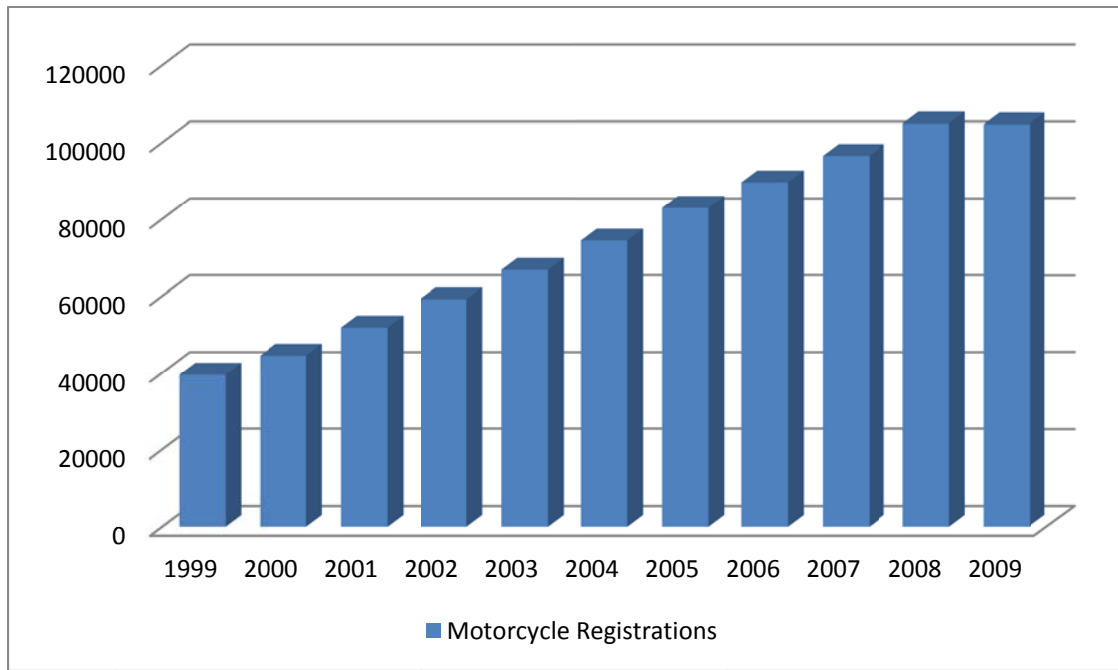


Figure 2. **Motorcycle License Trend**

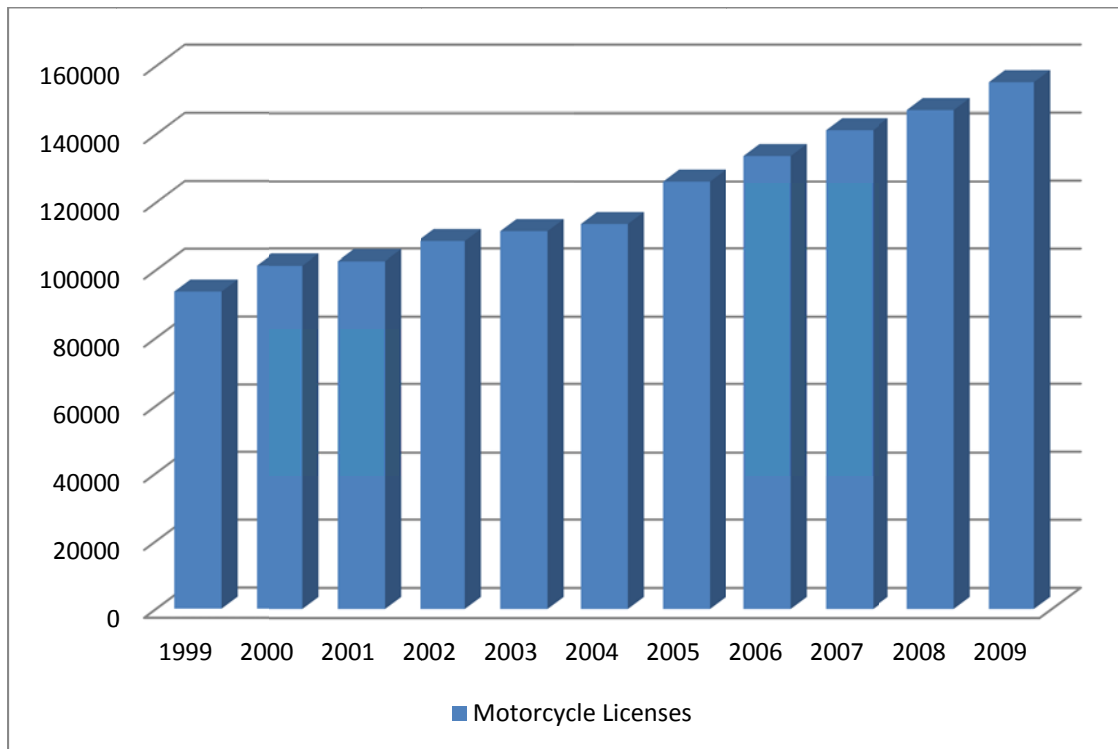


Figure 3. Motorcycle Registration Change by District from (1999 to 2009)

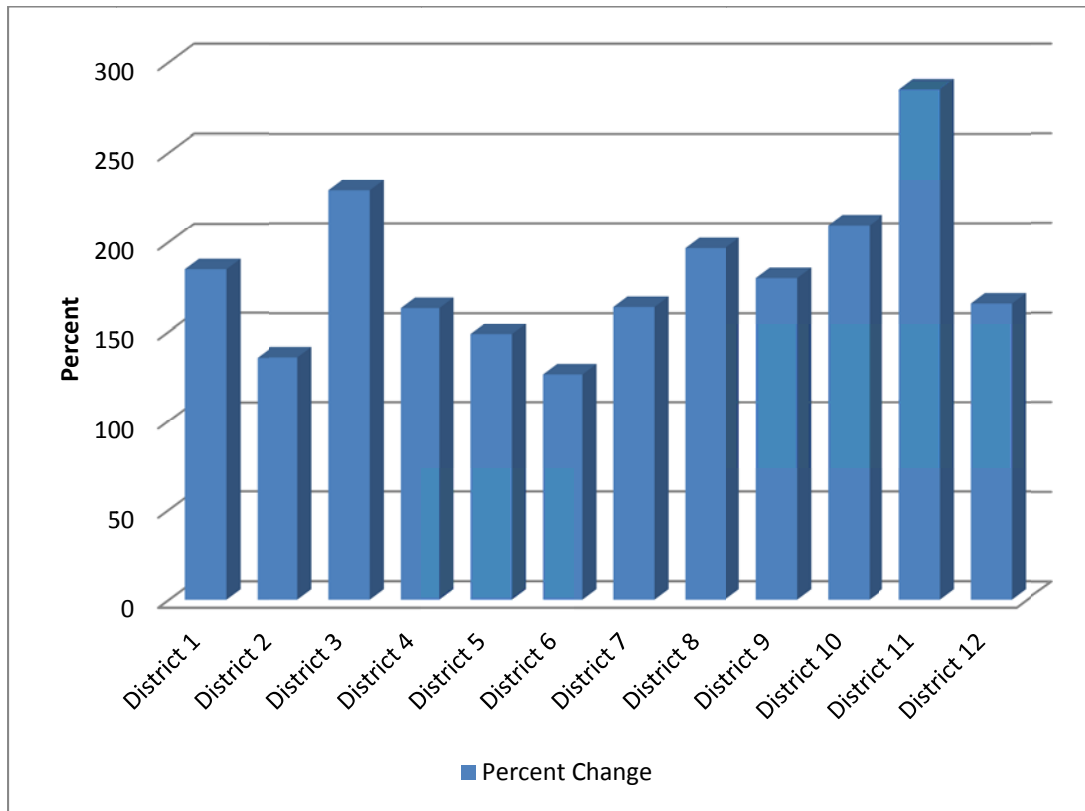


Figure 4. Motorcycle License Change by Age (1999 to 2009)

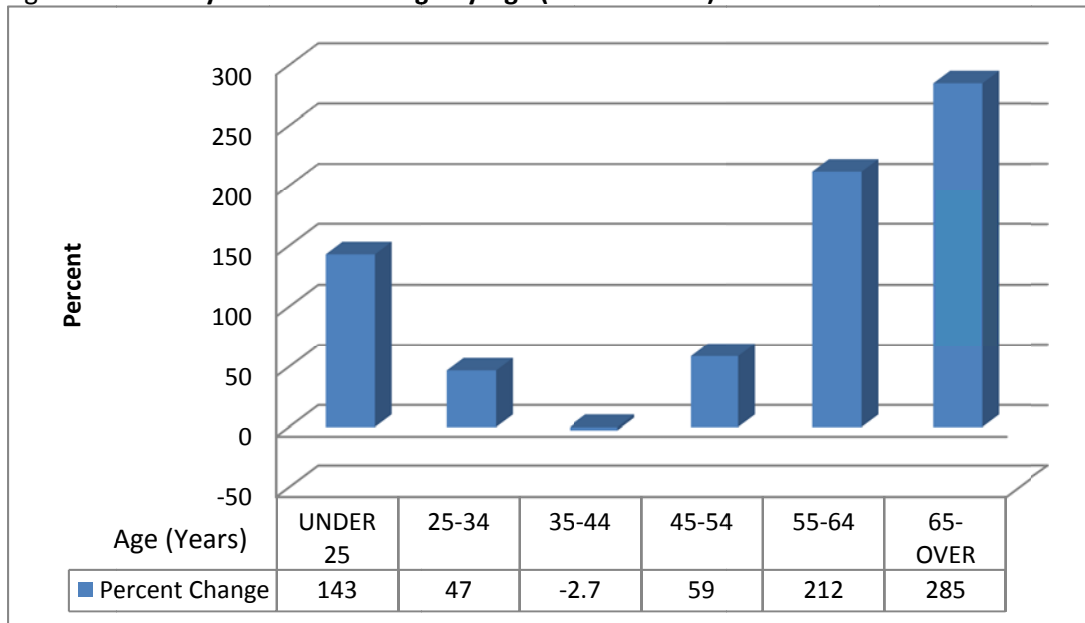


Figure 5. Total Motorcycle Crash Rate (by Registration)

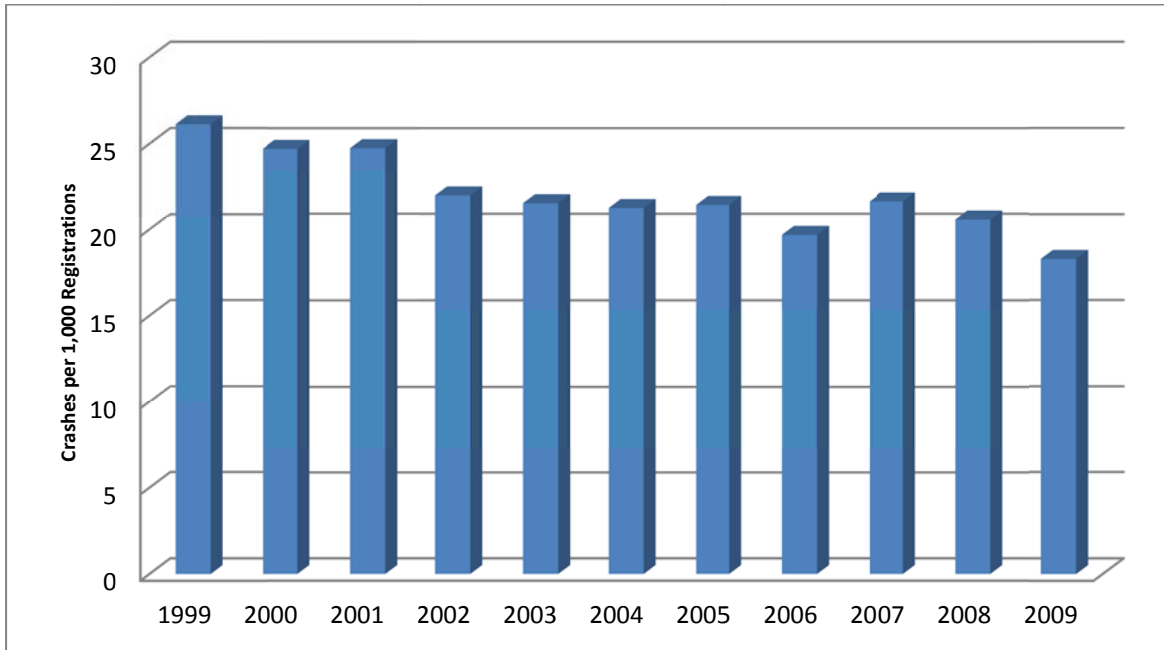


Figure 6. Fatal Motorcycle Crash Rate (by Registration)

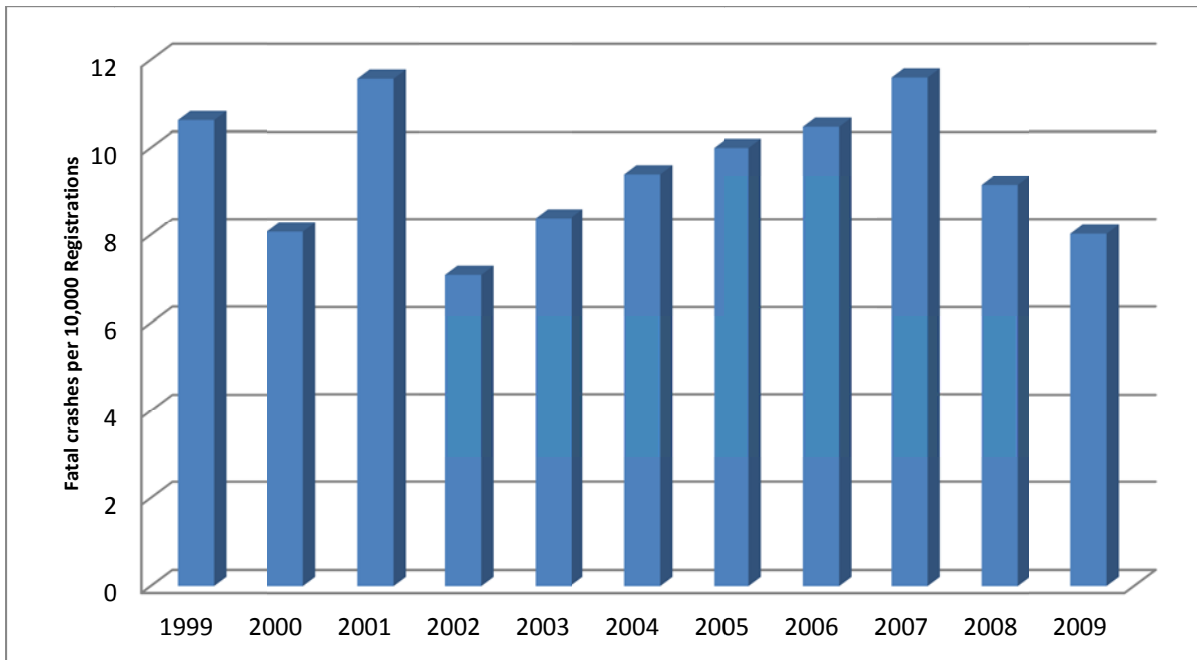


Figure 7. Total Motorcycle Crash Rate (by License)

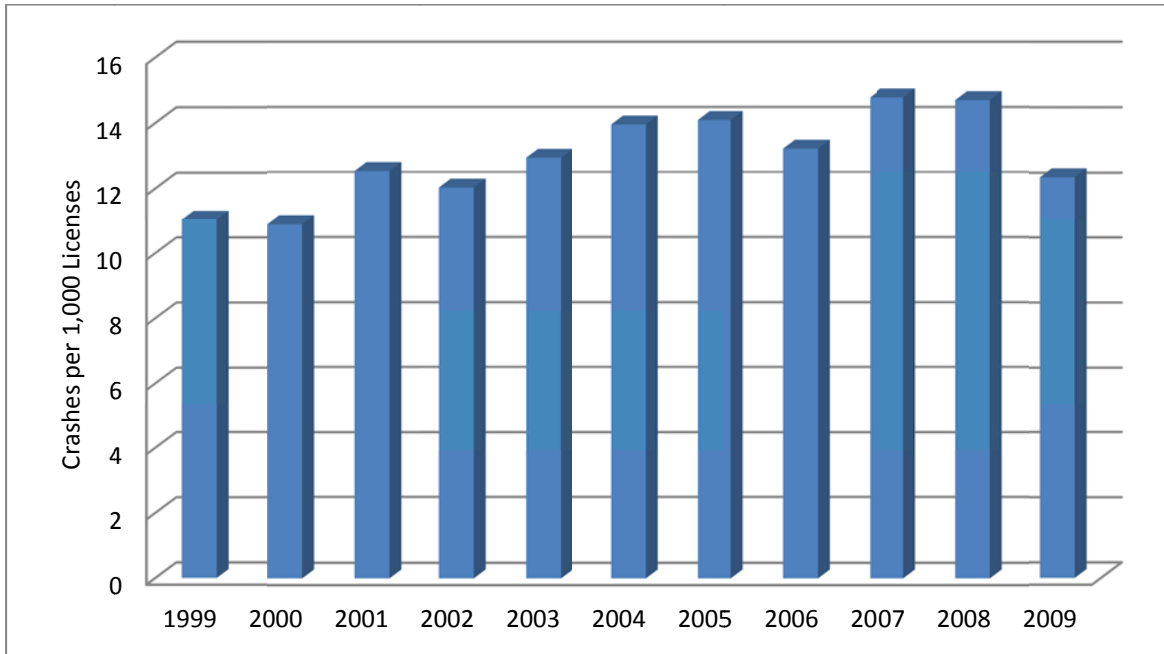
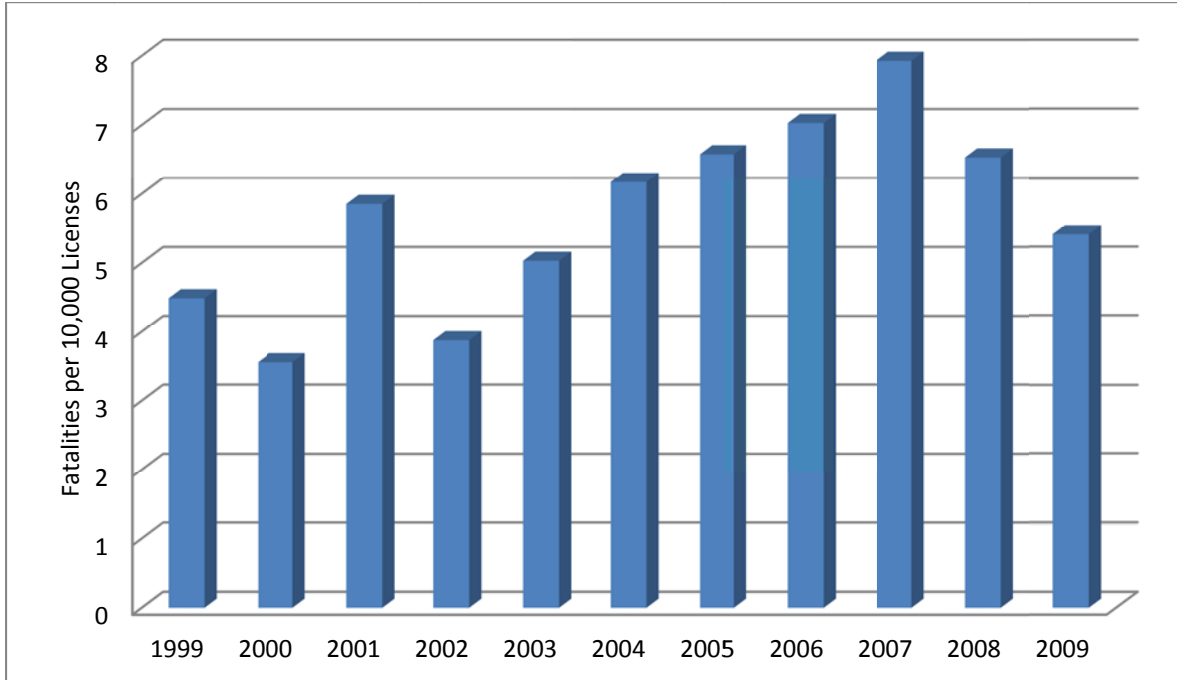
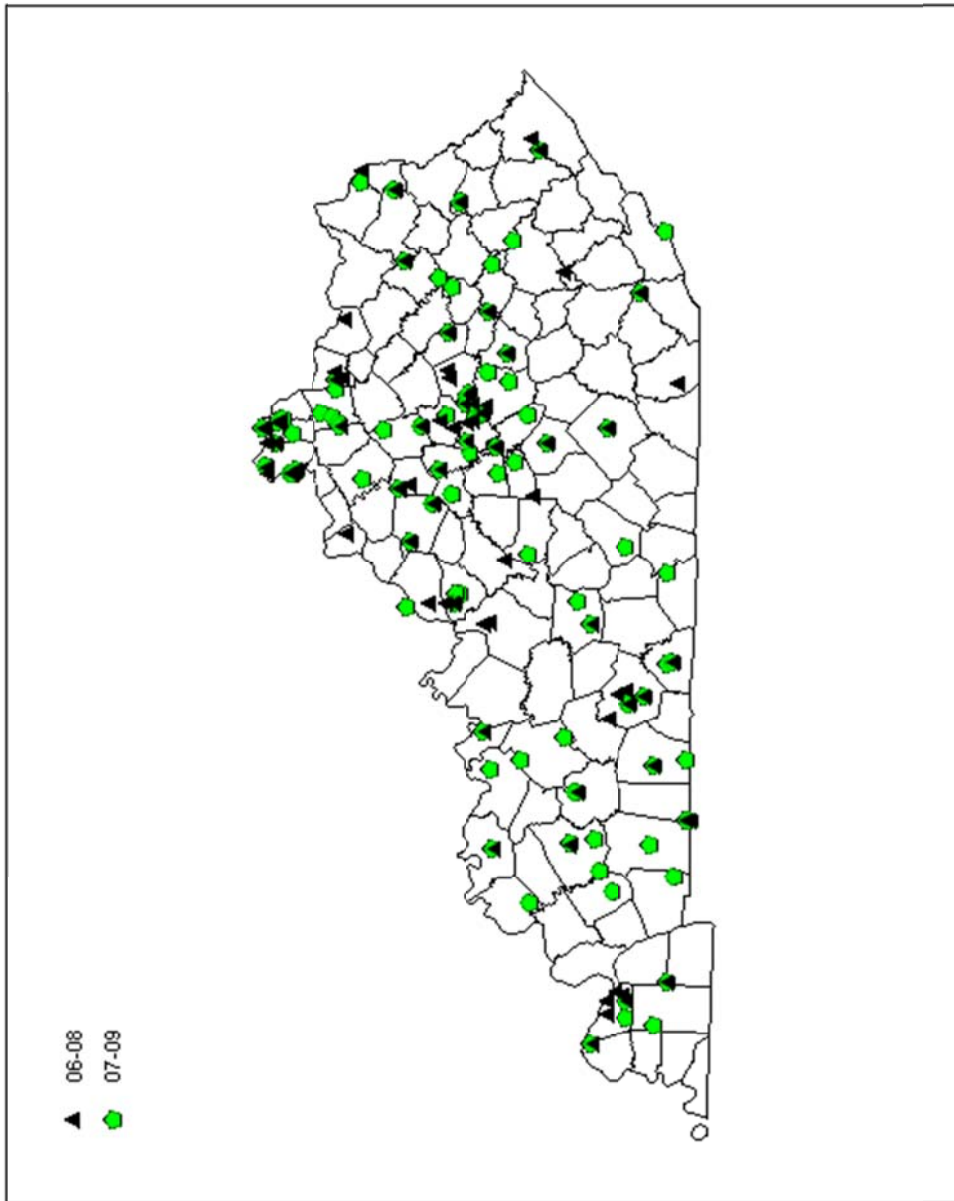
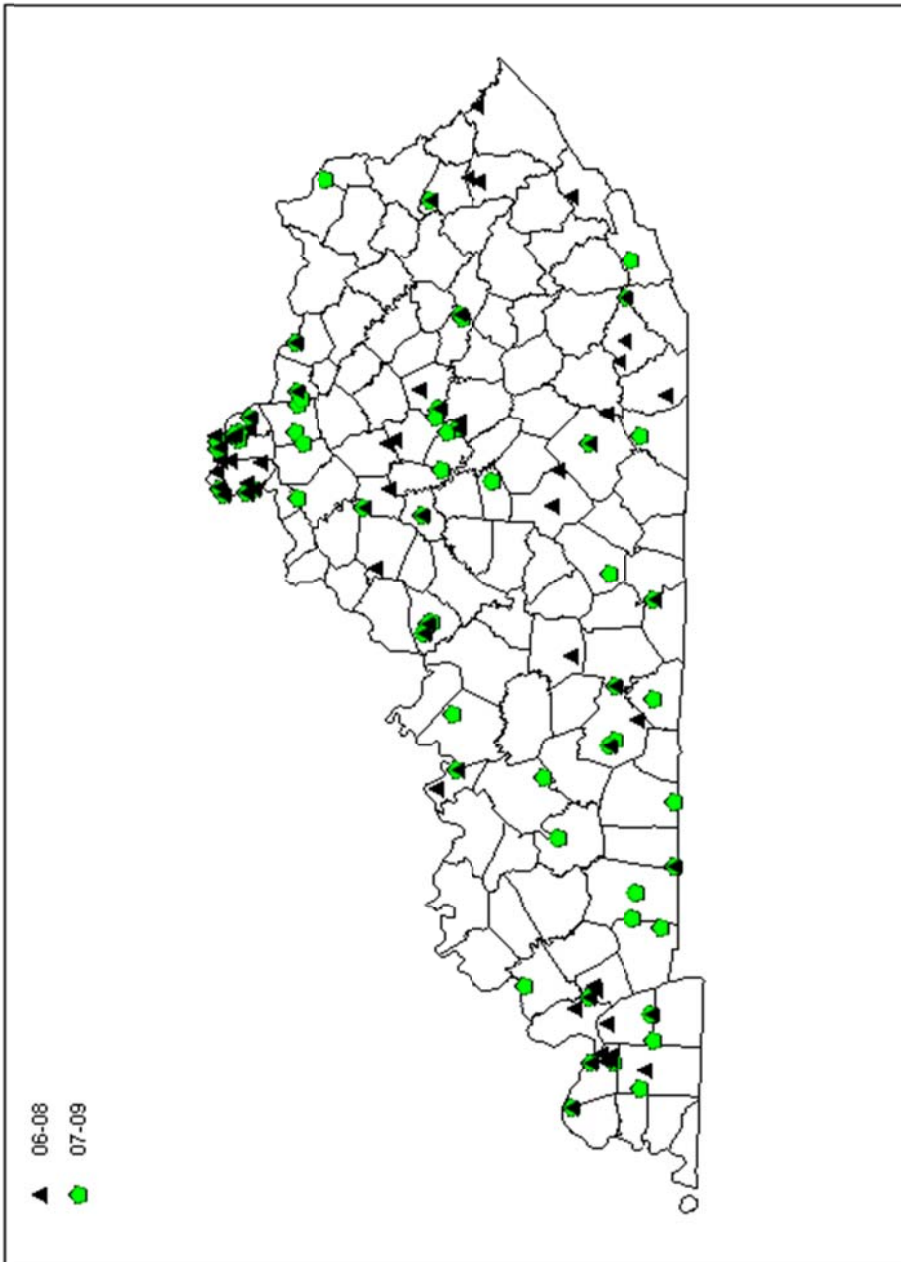
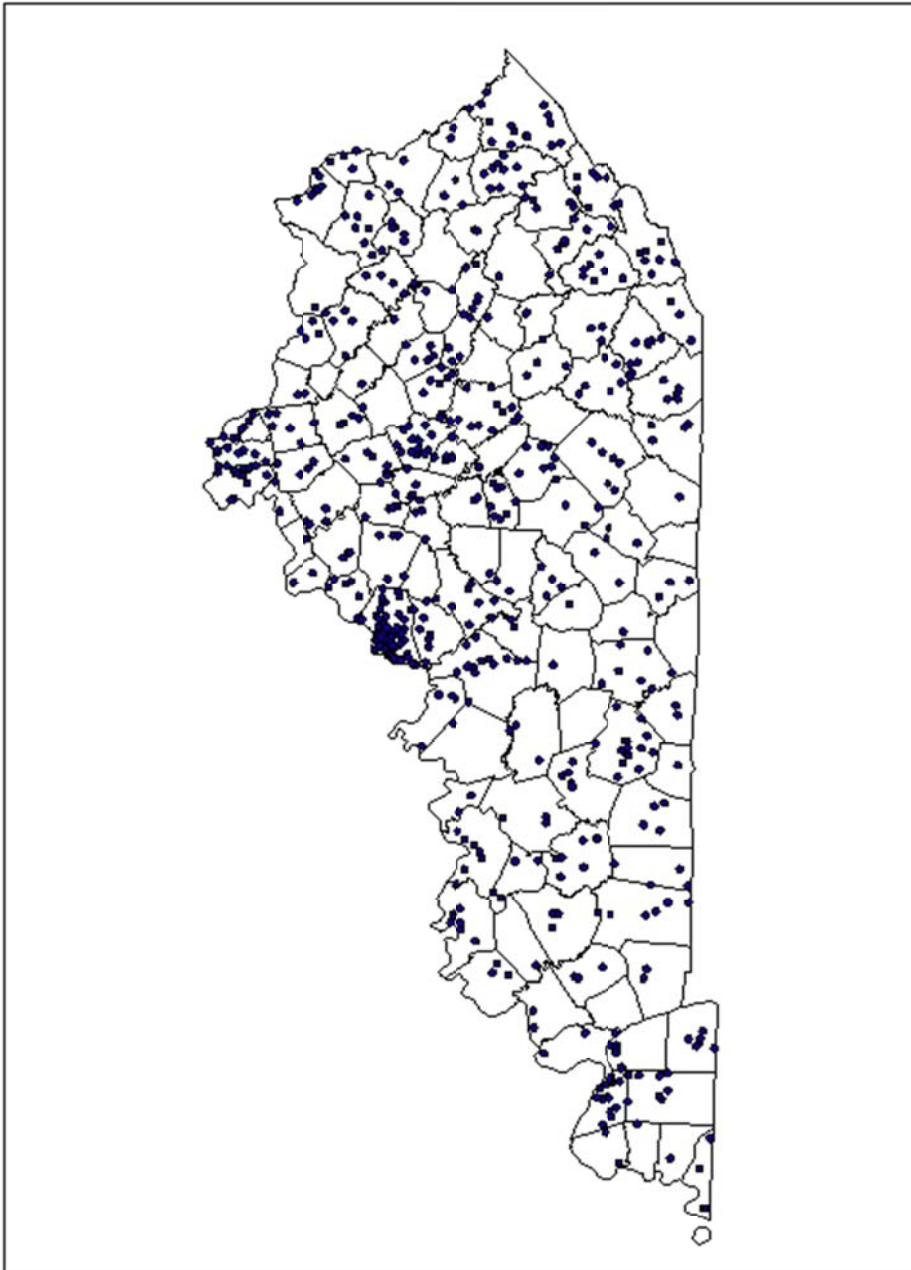


Figure 8. Fatal Motorcycle Crash Rate (by License)









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KENTUCKY TRANSPORTATION CENTER

176 Raymond Building
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ktc@engr.uky.edu

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