

Applying Successfully Proven Measures in Roadway Safety to Reduce Harmful Collisions in SC



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16. Abstract <p>The overall goal of this research was to identify proven successful safety programs used in other states and assess the potential for safety improvement if similar programs were implemented in South Carolina. The research team not only sought out engineering solutions, but also expanded the search to include programs for enforcement, education, licensing, emergency services, and partners—therefore incorporating a wide range stakeholder groups. South Carolina has, for many years, had one of the highest mileage death rates of any state in the nation – far exceeding the national fatality rate. While SCDOT has a federal requirement to develop and maintain the Strategic Highway Safety Plan, which identifies the state's key safety needs and guides investment decisions toward strategies and countermeasures with the most potential to save lives and prevent injuries, South Carolina legislation and state policies have effectively blocked many paths to safety improvements. Tree protection ordinances, limited policies for graduated drivers licensing, bans on camera enforcement, and lack of universal helmet laws will continue to undermine efforts to improve safety in the state. Using a data driven approach to safety program selection will yield support for changes in programs, policies, and standards, and have positive impacts on safety, operational, and economic aspects of the South Carolina roadway system. Further, the implementation of a data-driven safety management program will help to assure that the most appropriate strategies are implemented. The successful implementation of this research will likely result in a substantial reduction in loss of life and injuries associated with motor vehicle crashes in the state of South Carolina.</p>			
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1. Executive Summary

The overall goal of this research was to identify proven successful safety programs used in other states and assess the potential for safety improvement if similar programs were implemented in South Carolina. The search for proven safety programs began with an evaluation of existing crash problems, population characteristics, and driving environment. The research team not only sought out engineering solutions, but also expanded the search to include programs for enforcement, education, licensing, emergency services, and partners—therefore incorporating stakeholder groups such as SCDOT, South Carolina Department of Public Safety (SCDPS), Department of Motor Vehicles (DMV), Fire/Emergency Management Services (EMS), local transportation agencies (Metropolitan Planning Organization's (MPO's) and Council of Government's (COG's)), and private entities as necessary. In most instances, it was necessary to review policies and legislation for South Carolina in comparison to the model program state, as these could potentially be barriers to successful implementation of safety programs.

The term roadway safety refers to the data driven methods and measures used to prevent road users from being killed or seriously injured. South Carolina has consistently been among the top ten states for numerous safety problems including but not limited to road departure crashes, failure to use safety belts, impaired driving, and excessive speed. By reviewing successful initiatives in other states, South Carolina can learn from those successes and prioritize safety programming for substantial safety improvements on its own surface transportation system.

In 2015, there were 911 fatal collisions, 37,861 injury collisions, and 95,189 property damage only collisions in South Carolina. On average, fatal traffic crashes in South Carolina result in over \$7 billion in economic loss each year. South Carolina has, for many years, had one of the highest mileage death rates of any state in the nation – far exceeding the national fatality rate. While SCDOT has a federal requirement to develop and maintain the Strategic Highway Safety Plan, which identifies the state's key safety needs and guides investment decisions toward strategies and countermeasures with the most potential to save lives and prevent injuries, South Carolina legislation and state policies have effectively blocked many paths to safety improvements. Tree protection ordinances, limited policies for graduated drivers licensing, bans on camera enforcement, and lack of universal helmet laws will continue to undermine efforts to improve safety in the state. SCDOT, along with other safety partners in the state, have continued efforts to reduce fatalities, but there are significant gains to be made. The following represent a few key program adoptions/changes that could bring about significant reductions in fatal crashes in South Carolina with notable benefit/cost ratios:

- **Tree-related Fatalities** (2015 - 191 Fatalities, 24.9%) - South Carolina ranked 1st in the nation for the highest fatality rate (0.32 per 100,000 population) for crashes involving trees. The national average tree-related fatality rate is 0.12 per 100,000 pop., thus SC is 165% above the national rate. Extensive research has been conducted nationally to determine the effect of allowing trees to re-establish in areas that were intended for clear zones. A prior SCDOT research study surveyed 131 randomly selected sites to determine if recommended clear zones (or safe recovery areas) were provided. Of these, only 12 sites met the recommended criteria, and researchers determined that the odds of a site having a tree-related crash are 42 times higher if the minimum clear zone is not met. Severe crash reductions range from 27% to 60% by reclaiming up to 50% or 75% of the recommended clear zone, respectively. Considering the magnitude of the roadside hazard problem, and the deficiency of the clear zones, it appears that

by providing recommended clear zones for motorists who leave the roadway, South Carolina could realize a notable decrease in roadway fatal and injury crashes. Further, clear zone reclamation also has potential benefits of decreased tree removal and reduced hazards accrued during natural disasters. For every dollar invested in tree clearing, \$26-\$38 will be saved.

- **DUI Fatalities** (2015 - 301 fatalities, 30.7%) - South Carolina has some of the weakest laws in the United States relating to DUI offenders. A driver's license is suspended for refusal to take a test for alcohol; however, a driver may obtain a temporary alcohol license or a route-restricted license upon release from jail. Emma's Law, passed in 2014, increased the penalties for DUI convictions, requiring first-time convicted offenders with a BAC of 0.15% or greater to complete the state's Ignition Interlock Device Program. The same law removed the hard suspension period for second and subsequent convictions, allowing drivers to get their licenses back sooner by completing an Alcohol and Drug Safety Action Program. A 2016 Impaired Driving Assessment (2016) refers to this SC statute as "...poorly drafted and archaic...and mandates unsafe roadside practices endangering the public and the officer making the stop" Further, South Carolina is one of only two states in the nation where police officers prosecute their own DUI cases. Nebraska and Arizona have implemented some of the strictest laws requiring first-time offenders and repeat offenders to install ignition interlock systems. Before the program was enacted in Arizona in 2007, DUI fatalities comprised 54% of the total fatalities. By 2012, DUI fatalities in Arizona had dropped to 28% of the total fatalities. This along with many programs (DUI courts, beverage server training, and solicitor case handling) could be implemented to reduce DUI-related factors in South Carolina. For every dollar invested in DUI courts, \$49 will be saved.
- **Speed-related Fatalities** (2015 - 361 fatalities, 36.9%) - Almost 40% of the fatalities on South Carolina roadways were speed-related. Speed-related is defined as: exceeding authorized speed limit, and/or driving too fast for conditions. This is the 2nd highest rate in the nation. Speed is a behavioral issue that is must be managed through enforcement activities, and the reality is that drivers far outnumber enforcement officers. Auto-enforcement with cameras has the potential to expand speed management programs and reduce crashes - not only speed-related crashes, but all crashes. Unfortunately, in 2010, South Carolina banned the use of red light cameras and speed cameras in the state. Camera enforcement began for the first time in 1987 in Arizona. Since then, speed cameras have been used in 12 states and the District of Columbia and have lowered fatal crashes up to a 25% at fixed camera sites and up to almost 50% with mobile camera operations. An added benefit is that they also foster better traffic flow with more uniform speeds. For every dollar invested in camera speed enforcement, \$13 dollars will be saved.
- **Teen Driver Fatalities** (2015 - 40 fatalities, 6%) - In 2015, there were 37 fatal crashes among 15-17 year-old drivers, which produced a crash cost of \$347.8 million in South Carolina. Traffic fatalities are the leading cause of death of teens, greater than homicide, suicide, and disease combined. Graduated Drivers Licensing programs have reduced teen crashes by 10-40% on average in the US through a three-stage criterion for granting young drivers full driver's license privileges. The three stages are: a supervised learning period, a restricted intermediate licensing stage, and a full license stage, in which the driver is granted an unrestricted license after

fulfilling all requirements. The purpose of the GDL programs are to maximize experience while minimizing common risks that teens face while driving. Estimates by the Insurance Institute of Highway Safety indicate that at least 10 states, including South Carolina, could reduce their rate of teen driver related fatal crashes by nearly 50% or more by adopting the strictest GDL provisions. For South Carolina, a 45% reduction could be realized by adopting three stricter GDL criteria including: raising the permit age to 16 and the unrestricted licensing age to 17, raising the minimum number of practice hours to 70, and restricting teen passengers during the intermediate driving phase. For every dollar invested in adopting strict GDL provisions, \$156 will be saved.

To make significant gains, all partners must have a complete vision of their role and responsibilities in the priority programs and seek collective efficacy through collaboration across the state. The development of this comprehensive safety program assessment, along with identification of funding sources, will enable forward movement on all fronts. Using a data driven approach to safety program selection will yield support for changes in programs, policies, and standards, and have positive impacts on safety, operational, and economic aspects of the South Carolina roadway system. Further, the implementation of a data-driven safety management program will help to assure that the most appropriate strategies are implemented.

The successful implementation of this research will likely result in a substantial reduction in loss of life and injuries associated with motor vehicle crashes in the state of South Carolina. This research is expected to have significant benefits for SCDOT and the motoring public. These benefits fall into several categories, and are related to reduced numbers of crashes and the resulting deaths and injuries, improved system operations and reduced delay, decreased fuel consumption and emissions, as well as potential cost savings for SCDOT and other stakeholder agencies.

2. Introduction

The term roadway safety refers to the data driven methods and measures used to prevent road users from being killed or seriously injured. Roadway safety, by its very nature, must be a fundamental objective of our state's transportation system; however, statistics reveal that South Carolina's surface transportation systems face substantial safety challenges. For a number of years, South Carolina has been among the top ten states for numerous safety problems including road departure crashes, failure to use safety belts, drinking and driving, excessive speed, among others.

To achieve comprehensive roadway safety in South Carolina, we must gather and examine appropriate data, integrate human factors with infrastructure use, understand the sociology and safety cultures, and implement safety prediction tools and best practices. While the South Carolina Department of Transportation (SCDOT) has a large role in safety of the transportation system, it only represents one branch of the four E's responsible for management of overall roadway safety: Engineering, Enforcement, Education, and Emergency Medical Services. To achieve significant gains in the safety of our roadway system, SCDOT and other potential stakeholders must seek collective efficacy to successfully drive down crashes, injuries, and fatalities. Progress has been made toward addressing many of our state's safety challenges, thanks in part to research, education, and legislative actions, but there remains much work to be done.

The overall goal of this research was to identify proven successful safety programs used in other states and assess the potential for safety improvement if similar programs were implemented in South Carolina. The search for proven safety programs began with an evaluation of existing crash problems, population characteristics, and driving environment. The research team not only sought out engineering solutions, but also expanded the search to include programs for enforcement, education, licensing, emergency services, and partners— therefore incorporating stakeholder groups such as SCDOT, South Carolina Department of Public Safety (SCDPS), Fire/Emergency Management Services (EMS), local transportation agencies (Metropolitan Planning Organization's (MPO's) and Council of Government's (COG's)), and private entities as necessary. In most instances, it was necessary to review policies and legislation for South Carolina in comparison to the model program state, as these could potentially be barriers to successful implementation of safety programs. Involving all stakeholders in the safety of the roadway system will result in collective efficacy and reduction of crashes, injuries, and fatalities on South Carolina roadways. It is anticipated that implementation of the findings of this research will result in long-term safety improvements, as well as economic benefits and improved traffic flow.

The research team was led by Clemson University, and the following work was completed in collaboration with faculty from the University of South Carolina (USC) and the Citadel. SCDOT, SCDPS, and Federal Highway Administration (FHWA) supported the research with current Strategic Highway Safety Plan (SHSP) Emphasis Area data and statistics. Prior roadway safety research conducted by Clemson for SCDOT has focused on the contributions of the road network on safety - such as fixed object crashes and lane widths. This research expanded the focus to include driver behavior, safety education, legislation, and enforcement in addition to potential engineering measures.

Research began with a national search for proven successful safety programs that have resulted in significant reductions in fatal and serious injury collisions in each of the problem areas defined by the steering committee (e.g., serious crash types, high risk drivers, special vehicles, vulnerable roadway users, etc.). The research team reviewed these programs with the steering committee and selected a portion of the programs for in-depth review and analysis. During the reviews, researchers sought information on the effectiveness of the safety programs in reducing fatal and serious injury collisions, as well as costs and other programmatic requirements. The potential for safety improvement in South Carolina was assessed on several factors including:

- the magnitude of the problem in the state,
- geographic boundaries of problem areas,
- demographic trends,
- present legislative statutes,
- state regulations,
- agency policies, and
- other factors that contributed to the success of the program

Given the background on prior implementations and comparison with South Carolina conditions, the research team estimated the costs and benefits of the particular programs, as well as legislative and SCDOT policy changes that would be necessary to implement the evaluated programs in this state. Prior research has shown that sociodemographic characteristics play a part in crash involvement – specifically in more severe crashes. For instance, Oliver and Kohen (2009) cited lower income level as a significant factor for individuals involved in fatal and injury crashes in Canada. Such information, as available in South Carolina, was examined in an attempt to identify priority program areas to provide the largest return on investment for these safety improvement programs.

The South Carolina Department of Transportation is searching for ways to reduce the consistently high rate of severe and fatal crashes, in collaboration with other stakeholder groups around the state. Clemson University, in conjunction with USC and the Citadel, researched extensively for safety programs that other states have used to effectively reduce the number of severe and fatal crashes. The outcome of the research is presented here and includes a review of potential state-specific programs/legislative/policy changes for consideration by SCDOT and partner agencies in roadway safety. In addition, the research team tried to elaborate on any specific requirements that will enable the state to showcase successful safety program implementations. The sections that follow provide background on the process, a brief overview of crash statistics and trends in South Carolina, safety program assessments, and a sociodemographic evaluation related to traffic safety.

Further, the new Federal Aid Highway Bills beginning with the Moving Ahead for Progress in the 21st Century (MAP-21) Act (2012) and continuing in the Fixing America's Surface Transportation (FAST) Act (2015) emphasis on performance based measures to qualify for funding in most transportation programs. Much attention is given to prioritize safety measures throughout the bill. With that in mind, SCDOT seeks to implement highway safety improvements based on factual data with indications of positive expectations for the improvements. Recommended safety programs identified by this research

project focus on not only satisfying the requirements of the new highway funding bills, but also achieving the ultimate goal of reducing severe crashes, their consequences, and the resulting economic burden in South Carolina.

3. Research Approach

The overall goal of this project was to reduce the number of fatal and serious injury vehicular crashes in South Carolina by seeking out proven successful safety programs used in other states and evaluating them to determine the likelihood of similar outcomes given conditions in South Carolina. Several tasks were undertaken to accomplish the research goals and objectives. Each task is defined as follows:

Task A – Project Commencement and Strategy Session

A kickoff meeting was held in the beginning stage of the research project. The meeting served as a scoping session and included the research team, steering committee, and stakeholder partners. The steering committee and research team discussed the ongoing development of the new South Carolina Strategic Highway Safety Plan (SC SHSP) and Emphasis Areas were provided to help direct the safety program research. The research team obtained the most recent three years of crash and traffic data for use in cost/benefit analysis tasks.

Task B – Identify Potential Safety Programs for Review

The research team conducted a national/international search for effective safety programs based on the safety Emphasis Areas identified in South Carolina Strategic Highway Safety Plan. Research was conducted through a variety of resources, such as National Highway Traffic Safety Administration's (NHTSA's) safety assessments, best-practices safety awards, reviews of the Strategic Highway Safety Plan implementations, commercial literature, peer-reviewed journals, and interviews with DOT personnel. Researchers also consulted with the steering committee to identify any potential programs of interest to stakeholder groups that may not have been noted during the initial review.

While South Carolina has experienced reductions in fatal crashes until 2013, there are twenty states which had greater reductions on their roadways in the preceding years. Using historical data to determine a 10-year level of success for other states in reducing their overall number of fatal crashes, the research team developed Table 3.1. In doing so, the research team reviewed each of the top twenty fatal crash reduction states and their respective Governor's Office of Highway Safety (GOHS) web sites to determine the level of involvement in state safety planning/operations, as well as their organizational structure. A state name presented in bold italics indicates that the GOHS was independent of typical stakeholder agencies (Department of Public Safety, Department of Transportation, Highway Patrol, and the Department of Motor Vehicles), whereas regular text indicates that the GOHS representative is an employee within one of the stakeholder agencies. It was found that of all five of the states with GOHS that operated independently of stakeholder agencies were all among the top 16 highest crash reduction states; many of the top programs were actively operating in these top fatal crash reduction states. While this independency was not required to achieve success in reducing fatalities, it points to the overall effectiveness of a strong commitment by the state legislative branch to drive safety improvement in the state. This structure had a clear advantage that no one agency was responsible for safety, but all

agencies in the state have an important role in reducing deaths and injuries on our transportation system. This list of states will also be highlighted in the respective safety program assessments.

Table 3.1 Top Twenty States with Largest 10-year Fatal Crash Reductions

State*	2012 Fatal Crashes	2002 Fatal Crashes	10 Year Difference in Fatal Crashes
<i>California</i>	2632	3654	-1022
Florida	2247	2810	-563
Illinois	886	1273	-387
Texas	3021	3348	-327
<i>New York</i>	1085	1411	-326
Missouri	762	1082	-320
Michigan	873	1173	-300
Mississippi	507	769	-262
Ohio	1024	1285	-261
Pennsylvania	1211	1462	-251
Colorado	433	677	-244
<i>Arizona</i>	742	984	-242
Minnesota	349	590	-241
<i>Georgia</i>	1126	1362	-236
North Carolina	1222	1427	-205
<i>Washington</i>	409	586	-177
Wisconsin	549	721	-172
Louisiana	652	816	-164
Maryland	456	604	-148
New Jersey	553	698	-145

*Note: state names presented in bold italics indicates that the GOHS was independent of typical stakeholder agencies.

Task C – Select Programs for Review with Steering Committee

From the list of successful safety programs identified through the national/international search, safety programs were selected by the research project steering committee for further review and in-depth analysis. This selection incorporated input from the steering committee representatives of various stakeholders in the state.

Task D – Conduct Safety Program Assessments

The research team conducted in-depth program assessments of successful prior safety program implementations in other states across the nation. A significant amount of information was obtained for each safety program, including: 1) the type of action (engineering, enforcement, education, and EMS); 2) the parameters of implementation (before and after conditions- crash statistics, demographics, traffic

levels, socioeconomics, policy/legislative factors, and environmental factors); 3) cost to implement (low, moderate, and high); 4) the level of effectiveness and expected benefit (low, moderate, high); and 5) any known implementation risks and mitigation factors. The information obtained in this task was used to determine if the potential safety program would likely be successful in South Carolina, and subsequently to determine if the return on investment would be an efficient use of resources.

Task E – Investigate Legislative/Policy Barriers

For each program, the research team investigated potential legislative or policy barriers to successful implementation of the proposed programs in South Carolina. Often times, there were agency policies or state legislation in place that contradicted with new or different programs. In cases where barriers were identified, the research team sought legislation or policy information from the state that successfully implemented the program as an example. While policy and legislative changes may be required for successful implementation of a program, it is understood that this can take a considerable amount of time. Thus, the research team also tried to identify programs that could be implemented with little or no policy or legislative actions needed. Unfortunately, many of the most successful programs required legislative or regulatory action.

Task F – Conduct Sociodemographic Analysis

For this task, researchers took existing census block/block group sociodemographic data and merged it with crash data to determine the demographic and socioeconomic characteristics most commonly associated with crash involved drivers for various safety problems in the state. The primary benefit of this task is to identify geographic areas with the highest risk. The characteristics of the drivers in this area will provide valuable information for decision makers to leverage resources to implement safety programs in areas where the safety benefit will be greatest.

Task G – Complete Cost/Benefit Analysis

The project team evaluated the benefits and costs of potential safety program implementations to justify the effectiveness of the program in South Carolina. The team estimated the cost-benefit ratio for each program based on information obtained from states that have successfully implemented the program and given the magnitude of the problem in South Carolina. The research team in conjunction with the steering committee developed thresholds for the magnitude of the expected benefits with categories of high, medium, and low to allow for easy consideration during the prioritization process.

In calculating the actual benefit cost ratio, the following US Department of Transportation (2015) crash costs valuations for 2015 were used:

- Death/fatal injury cost \$9,400,000
- Incapacitating/serious injury cost \$650,000
- Non-incapacitating injury cost \$130,000
- Possible injury/complaint of injury cost \$68,000
- Property Damage Only (PDO) cost \$6,500

Task H – Define Program Parameters

All programs selected for implementation should allow measurement of progress toward the fatality and injury reduction goals stated in the SHSP. The most important part of research is to provide programmatic information to enable the stakeholders to make informed strategy decisions, resource decisions, and goal setting decisions.

Task I – Compile Program Summaries and Rankings

The research team compiled program summaries for the evaluated safety programs to facilitate the implementation of programs across the various stakeholder agencies. All ingredients necessary for success were outlined in the comprehensive safety assessment, including: human resources, financial resources, educational efforts, legislation, and agency policy changes. The summaries will consist of the following:

- Location for the action (statewide, local, etc.)
- Implementation timeframe (short-, mid-, and long-term)
- Type of action (engineering, enforcement, education, and EMS)
- Implementation conditions (crash statistics, demographics, traffic levels, socio-economics, etc.)
- Action to be conducted from what level (State and/or local)
- Cost to implement (low, moderate, and high)
- Expected benefit (low, moderate, or high)
- SHSP strategies supported by the action

4. South Carolina Crash Statistics

For many years, South Carolina has had one of the highest mileage death rates of any state in the nation and far exceeding the national fatality rate (see Figure 4.1 Mileage Death Rate from 1975 to 2014). On average in 2015, almost three people were killed in a crash every day in South Carolina, and a traffic crash was reported roughly every four minutes. Traffic collisions are responsible for billions of dollars in economic loss to South Carolina each year. Economic loss includes property damage, medical costs and lost productivity, but does not include intangible costs such as grief and suffering. On average, fatal traffic crashes in South Carolina result in over \$7 billion in economic loss each year. (SCDOT Crash Data, 2015)

In 2015, there were 911 fatal collisions, 37,861 injury collisions, and 95,189 property damage only collisions in South Carolina. Traffic fatalities increased 19% between 2014 and 2015. There were 3.684 million licensed drivers, 4.163 million registered vehicles, and a total population of 4.896 million in South Carolina in the same period. As shown in the following national fatality rate rankings, South Carolina is consistently in the top-ten worst states for motor vehicle fatalities. (NHTSA 2015 Traffic Safety Fact Book, 2017)

- **Mileage-based Fatality Rate – 1st**

In 2015, South Carolina had the highest fatality crash rate in the US with 1.89 fatalities per 100 million vehicle miles traveled. Montana (1.81) and Mississippi (1.70) follow in second and third

place, respectively. The national average fatality rate is 1.13 fatal crashes per 100 million vehicle miles of travel (NHTSA, 2017).

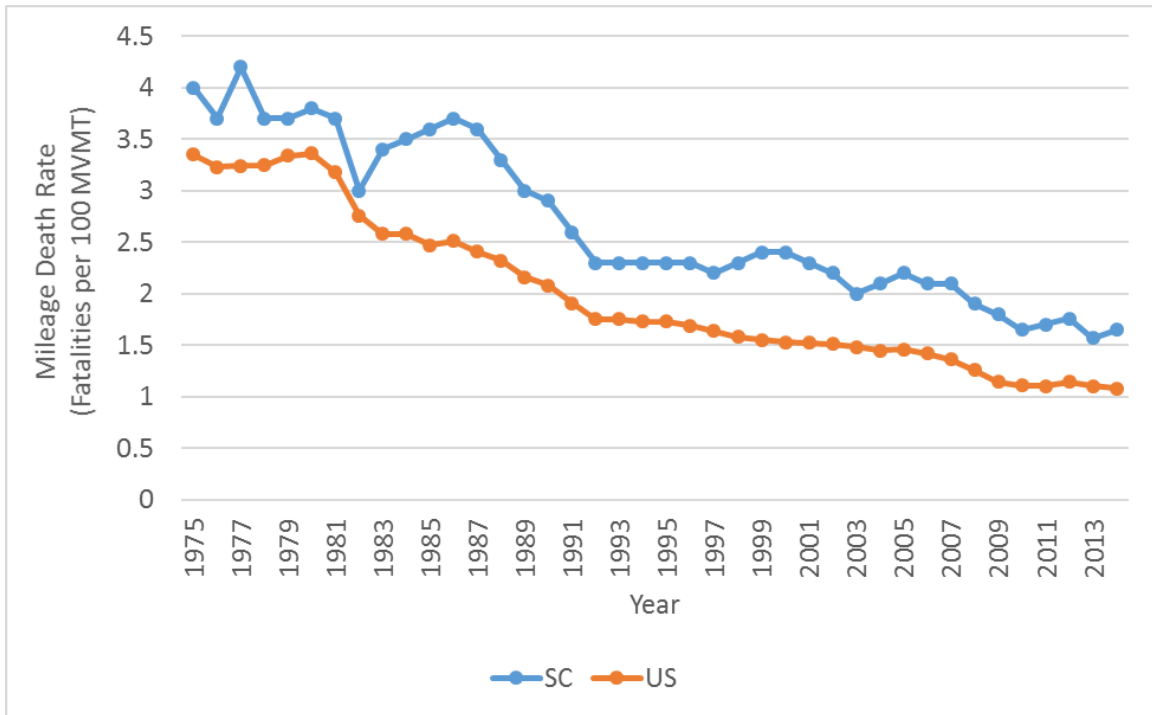


Figure 4.1 Mileage Death Rate from 1975 to 2014 (fatalities per 100 million vehicle miles travelled) for South Carolina versus the United States

- **DUI Fatality Rate – 2nd**

In 2015, 35% of total fatalities (343 fatalities) in South Carolina involved a driver with a positive, non-zero blood alcohol concentration (BAC). Of these, 301 fatalities (30.7% of total fatalities) involved a driver with BAC over 0.08, which is considered legally impaired by alcohol. South Carolina still ranks second in the nation for DUI fatality rate, despite the fact that the number of DUI fatalities dropped 24% between 2014 and 2015. Nationally, BAC = 0.08+ accounts for 29% of drivers involved in fatal crashes. (NHTSA, 2017).

- **Motorcycle Fatality Rate – 2nd**

A total of 140 motorcyclists were killed in South Carolina in 2015, which is 14.3% of all occupants killed that year. Overall, 74% of South Carolina motorcycle riders killed in crashes in 2015 were not wearing a helmet (SCDOT Data, 2015). South Carolina ranks second in nation in motorcycle fatalities with 3.8 fatalities per 100,000 population, following Wyoming at 4.2 fatalities per 100,000 population. The national statistics include both motorcycle and moped riders.

- **Pedalcycle Fatality Rate – 4th**

In 2015, South Carolina had 16 pedalcyclist fatalities, for a rate of 3.3 pedalcyclist fatalities per million population. This is the 4th highest rate in the nation behind Louisiana, Florida, and Vermont. The national average is just over 2 pedalcyclist fatalities per million population (NHTSA, 2017).

- **Pedestrian Fatality Rate – 3rd**

South Carolina ranked 3rd in the nation in pedestrian fatality rates per 100,000 population with a total of 123 pedestrian fatalities. Delaware has the highest rate, with Florida having the second worst rate of pedestrian fatalities per 100,000 population. The national rate is 1.60 pedestrian fatalities per 100,000 population (NHTSA, 2017).

- **Speed-related Fatality Rate – 2nd**

Better than one-third (361 or 36.9%) of the fatalities on South Carolina roadways were speed-related. Nationally, speed-related traffic fatalities account for 27.2% of total traffic fatalities (NHTSA, 2017). South Carolina ranks second in the nation in speeding-related crashes with 6.9 fatalities per million vehicle miles of travel, following Montana with 7.3 fatalities per million vehicle miles of travel.

- **Population Fatality Rate – 4th**

Per population, South Carolina ranked 4th in the nation in 2015 for highest number of fatal crashes per 100,000 population with a rate of 19.95. The highest fatality rate per 100,000 population belongs to Wyoming at 24.74, followed by Mississippi and Montana. The national average is 10.92 fatalities per 100,000 population (NHTSA, 2017).

- **Tree-related Fatality Rate – 1st**

South Carolina ranked 1st in the nation for the highest fatality rate (0.32 per 100,000 population) for crashes involving trees in 2015. The national average tree-related fatality rate is 0.12 per 100,000 population, thus SC is 165% above the national rate. South Carolina must eliminate 98 tree-related fatalities each year to reach the national average rate.

- **Road Departure Fatality Rate – 3rd**

The road departure fatality rate in South Carolina for 2015 is 1.08 per 100,000 population. Nationally South Carolina has the 3rd highest fatality rate, whereas Montana and Wyoming have the 1st and 2nd highest road departure fatality rates, respectively. The National average road departure fatality rate is 0.89 per 100,000 population; therefore, 97 roadway departure fatalities need to be eliminated in SC to reach the national average rate.

- **Fixed Object Fatality Rate – 1st**

It has already been mentioned that South Carolina ranked 1st in the nation for the highest tree-related fatality rate per 100,000 population. Further, in South Carolina the rate of fatalities

involving fixed objects on a roadside is 0.46 per 100,000 population. The national average fixed object fatality rate is 0.24. SC is 90% above national average rate and would need to eliminate 108 fixed object fatalities to reach the national average rate.

5. South Carolina Strategic Highway Safety Plan (SC SHSP)

The SC SHSP (2015) is the product of a multi-Agency Steering Committee comprised of members from the Education, Enforcement, and Engineering sectors. While agreeing to utilize a data-driven approach to identify the nine Emphasis Areas, priority categories may have differed among the Agencies, due to their respective overall missions. For the SCDPS, the focus is centered around enforcement and education; while, SCDOT is focused on engineering solutions to eliminate the number of roadway fatalities and reducing severe injuries. To achieve the goal of zero traffic fatalities, reductions in the number of fatal and severe injury collisions must be achieved in each of the priority Emphasis Areas. The Emphasis Areas presented in 2015 SHSP were identified using a data-driven process consisting of extensive analysis of fatal and severe injury collision data from 2008 to 2012. This analysis revealed the following areas to be addressed in the updated SHSP (bolded areas are addressed in this research):

1. **Roadway Departure**
2. **Unrestrained Motor Vehicle Occupants**
3. Age Related
 - Young Drivers
 - Older Drivers
4. **Speed Related**
5. Vulnerable Roadway Users
 - **Motorcyclists**
 - Pedestrians
 - **Moped Operators**
 - Bicyclists Intersection and Other
6. High-Risk Roadway Locations
 - **Intersections**
 - Work Zones
 - Railroad Crossings
7. **Impaired Driving**
8. Commercial Motor Vehicles
9. Distracted Driving
10. Safety Data Collection, Access, and Analysis

Table 5.1 provides the fatal and severe injury collision statistics for the first eight Emphasis Areas. Roadway-departure crashes were the leading type of fatal and injury crashes. The second-most occurring crash type included unrestrained motor vehicle occupants, which was about 41% of all fatal and injury crashes. Young drivers were the most likely to be involved in a crash. Motorcyclists, pedestrians, and moped users are at a higher risk to be injured or killed in a crash. Intersections were

where a large portion of the crashes occurred, and impaired driving has been proven to be one of the leading causes for crashes. (SC SHSP, 2015).

Table 5.1 Target Zero Emphasis Area Statistics from SC SHSP (2008-2012) (Source: SC SHSP 2015)

South Carolina 2008-2012	Fatalities		Severe Injuries		Fatal & Severe Injury Collisions	
	# of People	% of Total	# of People	% of Total	# of Collisions	% of Total
Roadway Departure	2,133	49.4%	6,437	37.9%	7,454	42.6%
Unrestrained MV Occupants*	1,723	55.5%	3,469	26.6%	5,179	41.3%
Age Related	1,808	41.9%	6,537	38.5%	6,314	36.1%
Young Drivers	1,208	28.0%	4,849	28.5%	4,163	23.8%
Older Drivers	600	13.9%	1,688	9.9%	2,151	12.3%
Speed Related	1,684	39.0%	5,775	34.0%	6,102	34.9%
Vulnerable Roadway Users	1,198	27.8%	4,104	24.2%	4,833	27.6%
Motorcyclists	497	11.5%	2,060	12.1%	2,407	13.8%
Pedestrians	515	11.9%	1,073	6.3%	1,288	7.4%
Moped Operators	115	2.7%	618	3.6%	715	4.1%
Bicyclists	71	1.6%	353	2.1%	423	2.4%
Intersections & Other High Risk Roadway Locations	890	20.6%	7,819	46.0%	4,539	25.9%
Intersection	830	19.2%	7,629	44.9%	4,358	24.9%
Work Zone	43	1.0%	158	0.9%	154	0.9%
Railroad Crossing	17	0.4%	32	0.2%	27	0.2%
Impaired Driving	1,794	41.6%	3,759	22.1%	4,521	25.8%
CMV/Heavy Trucks	426	9.9%	818	4.8%	1,011	5.8%
Total**	4,315		16,986		17,503	

*Number and percent based on occupants who had access to restraints.

**More than one factor is commonly involved in fatal and severe injury collisions. Therefore, each fatality and severe injury tallied in "Total" may be represented in multiple factors in the table.

6 Safety Program Assessments

6.1 Emphasis Area 1: Roadway Departure (Treatment: Clear Zone Reclamation)

Roadway departure crashes are classified as a vehicle leaving the lane and going either into the opposite lane or onto the shoulder of the road or the surrounding environment. As a result, the vehicle hits either oncoming traffic or fixed objects, such as trees, guardrails, poles, embankments, bridge walls, or columns/piers. The main goal is to create a clear zone that allows for drivers to go back into their lane without hitting any fixed objects from the roadside environment. Safety features, such as edge lines, centerline rumble strips, and wider shoulders, may help prevent fatalities by roadway departure (SCDOT, 2014).

6.1.1 Roadway Departure Crashes in South Carolina

In 2015, there were 240 fatal tree-related crashes, which accounts for 25% of total fatal crashes (SCDPS, 2014). In a prior study conducted for SCDOT (Ogle et. al., 2009), researchers analyzed more than 60,000 crashes involving fixed objects (trees, utility poles, culverts, bridge piers, etc.) located within South Carolina roadsides between 2004 and 2006. These fixed object crashes accounted for 20% of all crashes

in South Carolina, and nearly 50% of all fatal crashes. In comparison, only 30% of fixed-object crashes result in fatalities nationally. Trees along the roadside cost South Carolina over \$1 billion per year, including crash costs, injury and property damage.

An analysis of the primary contributing factors in fatal fixed object crashes both nationally and in South Carolina showed a striking difference between the two in terms of the involvement of trees – 50% in South Carolina, yet only 21% nationally. Almost 50% of tree-related crashes occurred on secondary roads, with another 25% on primary roads, and approximately 15% on Interstates. Interstate 26 topped the list for tree related fatalities, and Interstate 95 followed closely behind in the ranking.

Using a combination of crash data, SCDOT roadway inventory data, and geographic information system analysis tools the research team identified 287 sites of interest in 14 counties across the state. Clemson researchers surveyed the sites with an instrumented van to identify exact parameters for roadside slopes and distances to obstacles in the clear zones. Of the 287 sites surveyed, 131 were randomly selected and analyzed for clear zone requirements. Of these, only 12 met the criteria using automated software processing. The research team also analyzed 58 control sites. Control sites are areas that have no instances of fixed object crashes within the three-year study period. For these 58 control sites, 47 met the minimum clear zone requirements, and only 11 did not. Using an odds ratio test for this sample, researchers determined that the odds of a site having a fixed object crash are 42 times higher if the minimum clear zone is not met. (FHWA, 2009)

Considering the magnitude of the roadside hazard problem, and the deficiency of the clear zones in these areas, it appears that by providing recommended clear zones (or safe recovery areas) for motorists who leave the roadway, South Carolina could realize a notable decrease in roadway fatal and injury crashes. This is particularly significant realizing that many times it is for reasons other than driver error (i.e. blown tire, struck by another vehicle, avoiding an accident, avoiding deer, etc.).

6.1.2 Vegetation Control for Safety (FHWA, 2008)

In 2008, FHWA published, Vegetation Control for Safety, providing the following statement, “All trees within the clear zone should be cut while they are still small saplings rather than small trees. At that time, they are easy to cut off at ground level and cause no stump problems. Also, no one will be tempted to try to save a beautiful, but hazardous, tree in the roadway clear zone.” This statement succinctly summarizes the problems associated with allowing vegetation regrowth on the roadside.

Some of the main goals of controlling vegetation include: allowing roadway signs to be seen by drivers (see Figure 6.1); removing any vegetation or trees from the roadside that could cause a severe crash if a vehicle went off the road (see Figure 6.2); and improving the abilities to deal with winter road maintenance without having vegetation in the road. Trees along the roadside are one of the most common causes of injury and fatal crashes. The closer the trees are to the edge of the road, the more likely they are to be struck by a vehicle that leaves the road. The recommendations for removing trees are as follows:

1. Remove all trees in the clear zone; and
2. If you must prioritize, remove trees in the following areas:
 - a) Trees closest to the road,
 - b) Trees in critical locations (curves, intersections),
 - c) Trees that have been struck,
 - d) Dead and leaning trees in the ROW, and
 - e) Potentially hazardous trees outside the ROW. (FHWA, 2009).



Figure 6.1 Sign visibility and roadside clear zone before and after clear zone reclamation in Georgia



Figure 6.2 Fatal crash due to a roadway departure and impact with roadside trees

6.1.3 Washington State DOT Clear Zone Safety Improvements

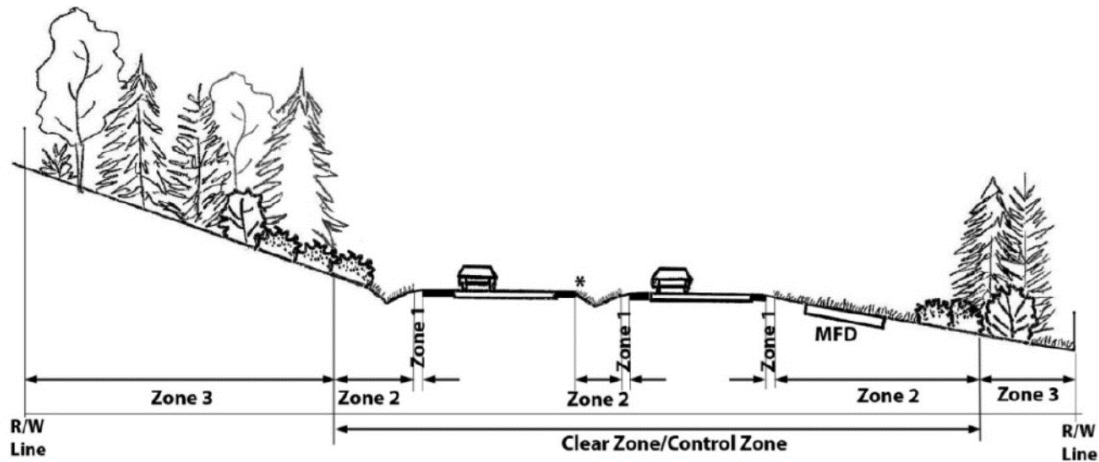
In comparing South Carolina and Washington, both have dense forest vegetation. As such, the Washington State Department of Transportation (WSDOT) has initiated several programs to deal with the negative effects of trees in the clear zone from crashes, as well as natural disasters. In 2009, King county, Washington had the highest number of roadway departure crashes in the state. There were 76 fatalities, coming from single crash vehicles. These crashes involved speeding, and roadway departure

crashes. WSDOT instituted a two phase program: 1) Phase one included installing guide posts, reflectors on existing guardrails and barriers, shoulder and centerline rumble strips, and improving the clear zone at a cost of \$2.2 million; 2) Phase two focused on low cost improvements, primarily through clear zone reclamation at a cost of \$0.6 million (NHTSA, 2009).

The state of Washington paid a \$10 million settlement to a family because of a fatal tree accident. Many trees had fallen around the road, yet no move was made to close the road (see Figure 6.3). Even after this fatal crash, the road remained open until another crash occurred. Both parents were killed and three out of the four children were disabled when a tree fell onto their passing vehicle from the roadside due to the weight of the frozen precipitation. Trees along roadways are susceptible to snow, ice, and wind loads and can create hazardous conditions for motorists and ultimately cost the DOTs if not properly managed. The costs of clean-up and settlements could better be used on proactive management.



Figure 6.3 WSDOT involved in tort liability suit for a dead tree in the right-of-way



* Zone 1 may or may not be present on both sides of the median
MFD = Media Filter Drain

Figure 6.4 WSDOT Roadside Zones

Vegetation is intended to have a positive impact on the drivers using the road. The WSDOT Roadside Policy Manual, as of June 2014, coordinates with the Integrated Vegetation Management (IVM) Plans and the Management Manual to create a safe, positive environment. The IVM allows vegetation to grow in locations where it is not harmful to motorists, however, removes it from locations where it could cause harm to the traveling public. It also recommends using methods other than chemicals to control vegetation as to not negatively impact the surrounding environment. Vegetation is only to be removed as much as necessary for highway purposes (WSDOT, 2015). The manual defines three distinct zones as portrayed in Figure 6.4, with specific activities and vegetation growth allowed in each zone as specified in Table 6.1.

Table 6.1 WSDOT activities and allowable vegetation in each zone

	Zone 1	Zone 2	Zone 3
Definition	The vegetation-free or routinely mowed zone adjacent to the pavement	Clear Zone as defined in the <i>Design Manual</i> ; also includes Zone 1- Control zone as defined in the <i>Utilities Manual</i> ; also includes Zone 1	Area beyond the clear zone up to the right of way line- Typically contains native or naturally occurring vegetation
Activities and Features		Errant vehicle recovery	
	Guideposts and buried utilities	Signs and buried utilities	
	Sight distance	Sight distance, sign visibility	
	Erosion control	Erosion control	Erosion control
	Noxious weed control	Noxious weed control	Noxious weed control
	Pavement preservation	Slope stabilization	Slope stabilization, provides carbon sequestration
	Level spreader and filter for stormwater leaving the pavement	Stormwater conveyance and treatment, such as filter strips and swales	Stormwater conveyance, treatment, and storage, such as natural dispersion areas and ponds
		Corridor continuity	Corridor continuity
		Scenic enhancement, screening, and blending	Screening and blending; Scenic enhancement
	Guardrail	Signs	Walls and other structures
	Mechanical or chemical control of vegetation	IVM techniques to preserve sign visibility/sight distance, and provide weed control	Minimal intervention using IVM techniques to encourage desirable self-sustaining plant communities
	Zone 1 has no stream and wetland buffer functions	Zone 2 has limited stream and weather buffer functions	

6.1.4 Clear Zone Safety Improvements by Connecticut Department of Transportation

After the 2011 Tropical Storm Irene and October Nor’easter caused over \$1 billion in damages, Connecticut created a Two Storm Panel to review the storm response to determine what they could have done better and how they could be better prepared in the future. They determined that 90% of the over 800,000 power outages that occurred in both storms were caused by fallen trees (see Figure 6.5). Some residents went without power and clean water for up to 12 days. The storm panel also recommended that the CTDOT increase the budget for tree maintenance to remove potentially dangerous trees more quickly, both dead, decaying, and dying trees and trees within the clear zone. Not only does the removal of trees decrease the risk of a fatal or injury crash, it also allows for sunlight to help melt snow and ice during winter storms reducing the risk of injury and death and decreases the cost needed for winter maintenance (CTDOT, 2008).



Figure 6.5 Clear Zone Reclamation after Tropical Storm Irene (2011)

The Connecticut General Statute 13a-140 gives authority to the DOT Commissioner with regards to roadside trees. This enables them to cut trees, remove or prune any tree, shrub, or other vegetation located within the highway right-of-way, whenever necessary, for the safe convenient travel by the public, and reclaim clear zones by removing trees and brush, both healthy and unhealthy, that exist within the “clear zone.”

As of August 2013, they had trained tree wardens employed in each of four districts. They reported to a State Licensed Arborist, and they were responsible for identifying dead, dying, and decaying trees and establishing tree management priorities. The budget is about \$1.5 million per year, with the four tree wardens.

6.1.5 North Carolina Department of Transportation Clear Zone Safety Improvements

The North Carolina Department of Transportation created and implemented a Clear Zone Improvement Program (CZip) for state roadways. The program has provided significant benefits, which include a decreased number of injuries and fatalities caused by vehicles hitting trees, improved highway traffic sign visibility, improved sight distance around curves, the elimination of the possibility of trees falling across the roadway during inclement weather, and the re-establishment of drainage ditches. In the CZip area (see Figure 6.6), they replaced the infrangible trees with native grasses and wildflowers. The resulting roadside landscape only requires maintenance every three years to remove unwanted vegetation (NCDOT, 2012).

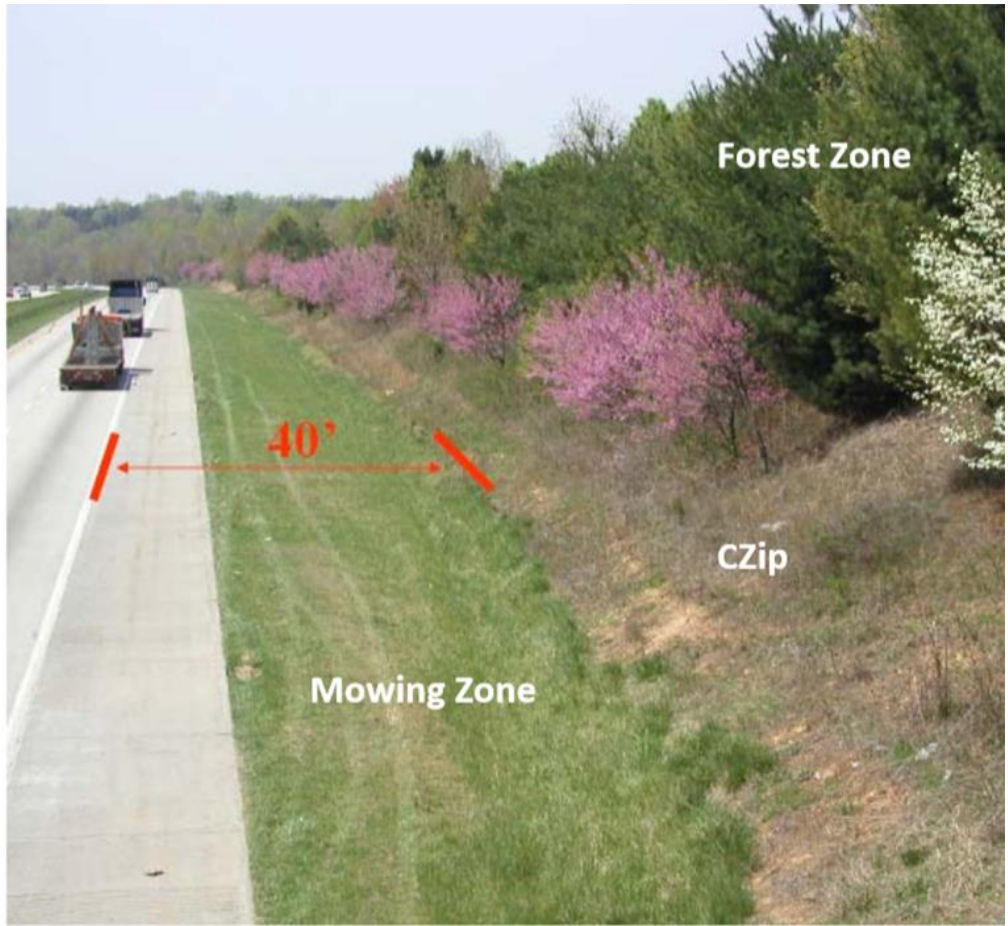


Figure 6.6 NCDOT Clear Zone Improvement Program Guidelines

6.1.6 Crash Modification Factors

A good deal of research has been conducted to determine the effect allowing trees to re-establish in areas that were intended for clear zones. The FHWA CMF Clearinghouse contains several Roadside Clear Zone studies. An Australian study by Jurewicz and Pyta in 2010 (see Table 6.2) indicates that crashes increase significantly when trees reestablish in the intended clear zone areas. A regression cross-section was used to determine the increase in crashes along roads with speed limits above 60 mph. When a clear zone of 26 feet is present, a loss of one to 13 feet to regrowth increases crashes by 27%, and a loss of 13 to 19 feet to regrowth increases crashes by 60%. Reestablishment of trees greater than 19 feet in an intended 26' clear zone can increase crashes over 100%. This research suggests that having a larger clear zone requirement could positively impact a reduction in fatal and severe crashes (Jurewicz and Pyta, 2010).

Table 6.2 Results of Vegetation Regrowth in the Clear Zone

CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference
Countermeasure: Change clear zone from greater than equal to 26' to between 7' and 3' (loss of 13-19 feet)						
1.6	-60	3 stars	Run off road	Fatal, Serious injury, Minor injury	Rural	Jurewicz and Pyta, 2010
Countermeasure: Change clear zone from greater than equal to 26' to between 13' and 26' (loss of 1-13 feet)						
1.27	-27	3 Stars	Run off road	Fatal, Serious injury, Minor injury	Rural	Jurewicz and Pyta, 2010
Countermeasure: Change clear zone from greater than or equal to 26' to less than or equal to 7' (loss of 19 or more feet)						
2.19	-119	3 Stars	Run off road	Fatal, Serious injury, Minor injury	Rural	Jurewicz and Pyta, 2010

6.1.7 The Return on Investment

In 2014, there were 191 fatalities in South Carolina that were tree-related, with a total estimated crash cost of \$2.26 billion.

The assumptions used in this return on investment analysis include:

1. There is only a reduction in fatalities. Although some fatalities may actually convert to injuries, this estimate is conservative because no crash savings for reductions in injury crashes were considered.
2. The re-establishment of vegetation in the clear zone is less than 50% of the intended clear zone distance; therefore, a 27% reduction in fatal crashes can be obtained for reclaiming up to 50% of the intended clear zone
3. This estimate does not consider the potential benefits of decreased tree removal and reduced hazards accrued during natural disasters.
4. The cost of clearing was taken from a recent Interstate-26 clearing project, where 56 acres were cleared for \$5 million. Therefore, clearing is estimated at \$11,000 per linear foot-mile with traffic control.
5. Treatment sites are estimated as one mile in length.
6. The average clear zone regrowth distance was taken from the FHWA-SC-09-01 as shown in Table 6.3
7. Cost to clear = Average clear zone regrowth * Number of sites * \$11,000 per linear foot-mile
8. Crash saving benefits = 2014 fatal crashes involving trees * \$9.4 million fatal crash costs * 27% reduction
9. B:C Ratio = Crash saving benefits / Cost to Clear

The total crash cost savings are estimated as:

191 fatal crashes x 27% crash reduction x \$9,400,000 = \$484,758,000 (\$484 million)

Table 6.3 Average Clear Zone Regrowth Distances and B:C Calculations

Rate Category	Average Clear Zone Regrowth	2014 Fatal Crashes Involving Tress	Crash Saving Benefit	Cost to Clear	B:C Ratio
Interstate	8	31	\$78,678,000	\$2,728,000.00	29:1
US Primary	7	17	\$43,146,000	\$1,309,000.00	33:1
SC Primary	6	38	\$96,444,000	\$2,508,000.00	38:1
Secondary	9	93	\$236,034,000	\$9,207,000.00	26:1

6.2 Emphasis Area 2: Unrestrained Occupants

(Treatment: Night-time Safety Belt Enforcement)

Lap and shoulder safety belts, along with air bags, are one of the most effective countermeasures for reducing the number of fatal and severe injury crashes. Despite this, in 2015, 50% of those in fatal crashes in South Carolina were not wearing safety belts. Safety belts can reduce injury by up to 50%, and the USDOT imposes sanctions for states that do not have primary belt laws to aid in behavioral changes. In response to the threat of losing millions in federal highway transportation funding, South Carolina enacted a primary safety belt law in 2005. Since its enactment, safety belt usage has increased from 69.7% in 2005 to 91.6% in 2015. The methods to prevent fatal and severe injury crashes include the education of the public and enforcing safety belt usage laws. According to a study conducted in 2014, 49% of the fatal and severe injury crash reports indicated that backseat occupants were unrestrained. (NHTSA, 2014)

6.2.1 Unrestrained Night Time Fatalities

Nationwide, 61% of the crashes that occur during the nighttime are unrestrained compared to the 43% unrestrained during the daytime. Figure 6.7 shows the percent of unrestrained drivers by time of day and vehicle type (passenger car or pickup). Pickup trucks have significantly higher percentages of unrestrained fatalities (~15% higher on average as indicated in Figure 6.7) than passenger cars. Further, other behavioral trends also tend to be present in these disproportionate nighttime unbelted crashes, such as driving under the influence (DUI) (see Figure 6.8) and speeding. Similarly, in South Carolina, 57% of the crashes during the nighttime are unrestrained (see Figure 6.9). Pickup trucks in South Carolina also had a larger percent of unrestrained deaths.

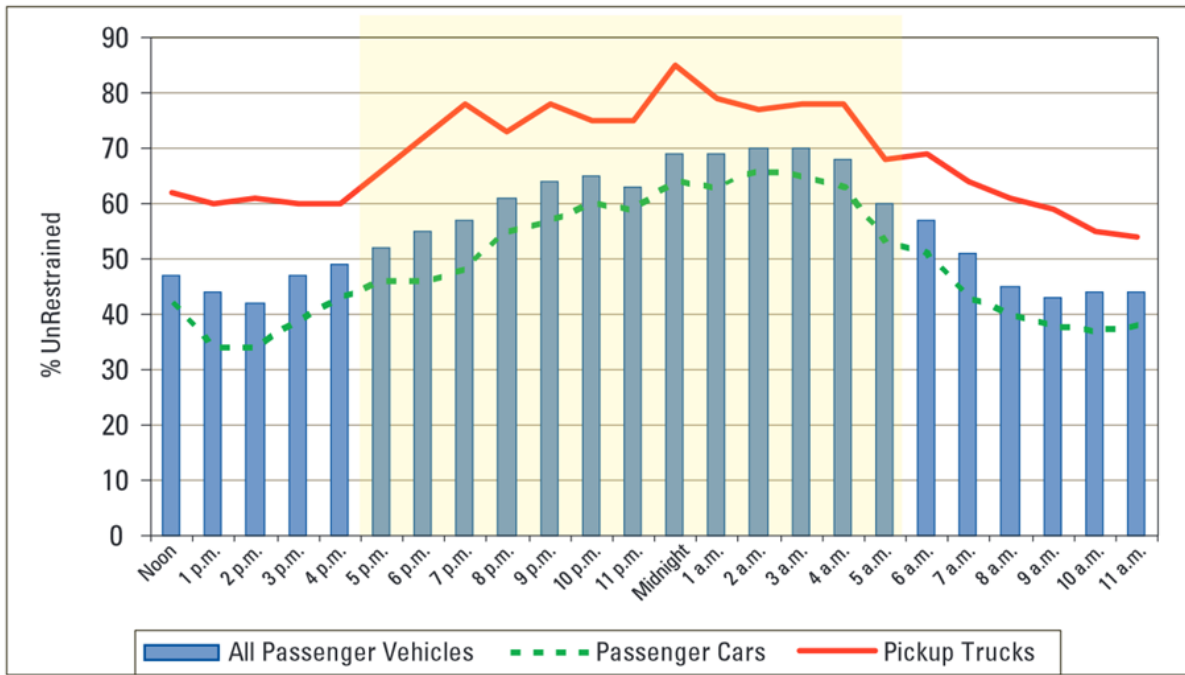


Figure 6.7 Percent of unrestrained deaths in the US based on time of day and vehicle type

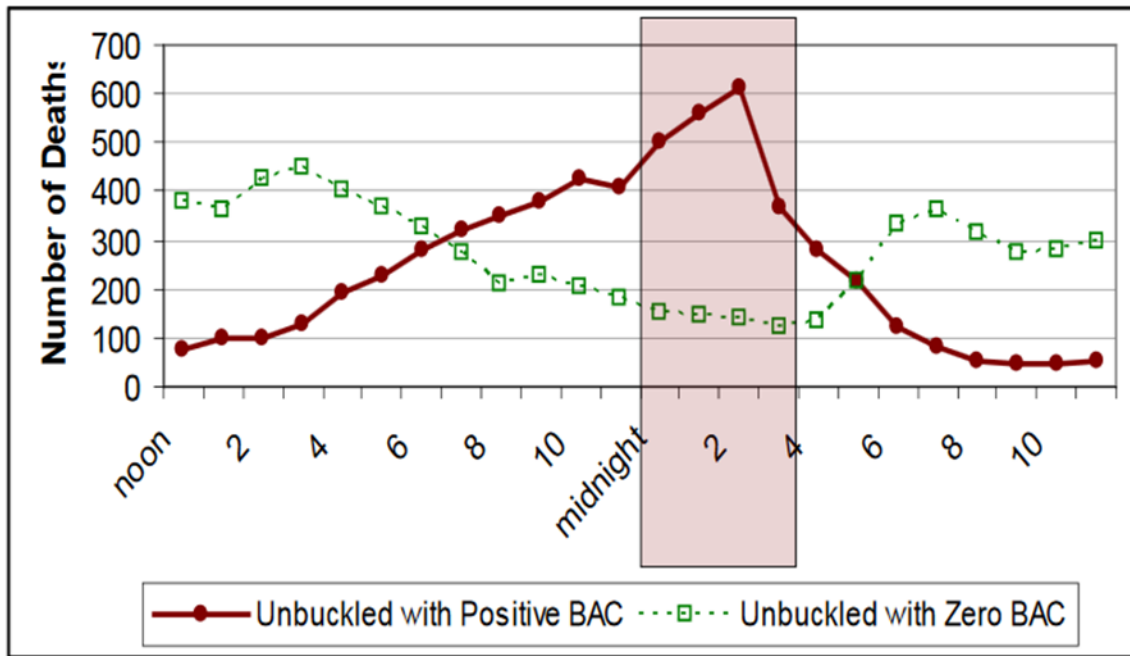


Figure 6.8 Number of unrestrained deaths by time of day and blood alcohol content

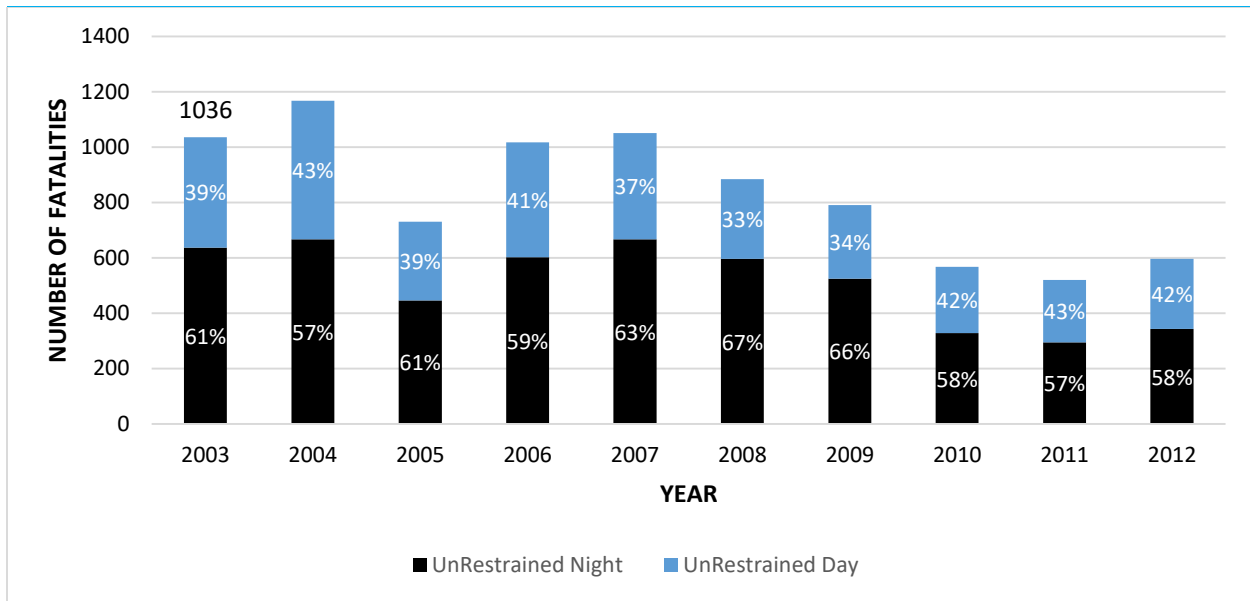


Figure 6.9 South Carolina fatalities and restraint use for night and day conditions (Source: FARS, 2005)

6.2.2 The Washington State Night Time Seat Belt Enforcement Project

The primary purpose of the Night Time Seat Belt Enforcement (NTSBE) Project in Washington was to encourage seat belt use through increased enforcement and public awareness campaigns. The enforcement message indicated that, “extra seat-belt-focused law enforcement patrols are taking place at night because the death rate at night is four times higher than it is during the day.” The latter part was included to send an important message to the law-compliant population about why the project is taking place. Nighttime was defined as 7 PM to 4:59 AM in the project.

In the first year of the Nighttime Seat Belt Enforcement (NTSBE) Program, a total of \$1.7 million was spent. Advertising and media (see Figure 6.10), which was offered at a half-price discount, took up nearly half (\$865,000) of the \$1.7 million budget, and the remaining \$877,000 was expended on law enforcement at 40 sites in five counties. The law enforcement hours per year increased by 12,000 hours. These hours were used in both stationary observation and roving patrols. The components of the program included: observations of seat belt use at sample roadway and gas station locations; interviews of passer-by attitudes and self-reported behaviors; surveys at Department of Licensing (DOL) on awareness and exposure; collection of citation data; focus groups with the police; and collection of driving and criminal records of belted and unbelted drivers.

One of the components of the study was a survey on awareness of the media campaign. For this survey, nearly 10,000 individuals who were waiting in line at the Department of Licensing in Washington completed a questionnaire. The majority of respondents indicated that they had seen the NTSBE messages, as well as the increased nighttime enforcement activities. The message had been targeted to 18 to 34-year old males, who were found to be the most egregious violators of nighttime belt use as well as participation in risky behaviors, and the messaging was successful.



Figure 6.10 Advertisements for the Washington NTSBE Program

One of the components of the study was a survey on awareness of the media campaign. For this survey, nearly 10,000 individuals who were waiting in line at the Department of Licensing in Washington completed a questionnaire. The majority of respondents indicated that they had seen the NTSBE messages, as well as the increased nighttime enforcement activities. The message had been targeted to 18 to 34-year old males, who were found to be the most egregious violators of nighttime belt use as well as participation in risky behaviors, and the messaging was successful.

Before “Click it or Ticket” (CIOT) ¹was created (1998-2002), the state of Washington had 221 unrestrained deaths per year, representing a 31% usage rate of safety belts in fatal crashes. In the time between when CIOT was created and before NTSBE was created (2003-2006), there were 200 unrestrained deaths a year, which was a 9.5% decrease. After NTSBE was created (2007-2008), the unrestrained death toll decreased 12.5% to 175 deaths per year. The study showed that the changes in belt use over time for day and night were statistically significant.

The study team was also interested in studying those who do and do not wear safety belts in both day and night conditions. At gas station observation sites, drivers were observed to determine belt usage upon arrival. Interviewers at the gas stations approached drivers and asked them to participate in a safety survey which was designed to collect self-reported seat belt usage, purpose of trip, perceptions of law enforcement actions observed, and alcohol consumption. Additionally, interviewers collected vehicle type, vehicle make, license plate number, gender, and estimated age. This information allowed correlation with driver and criminal records, and interesting differences between the groups were identified. Unrestrained drivers at night had significantly more citations, criminal charges, and crashes than did their belted counterparts. These relationships were even more significant for males between the ages of 18 and 34.

A total of 4,516 seat belt citations were issued during NTSBE activities in May 2007. A total of 3,822 seat belt citations were issued in November 2007, and 5,194 in May 2008. The NTSBE campaigns also

¹ It is important to note that in South Carolina, the state slogan for the national CIOT campaign is: ‘Buckle Up, South Carolina!’.

resulted in the issuance of a wide variety of other citations, such as DUI and speeding that added to the value of the activity. Finally, the drivers who were cited during the study for not wearing safety belts had similarly high citations and criminal histories as did those in the gas station observations.

Other NTSBE programs have also shown a significant increase of seat belt use (see Table 6.4). In most cases, the change is larger in areas primary belt law, as well as in areas where initial usage rates are lower. Based on these findings, a NTSBE program in South Carolina is expected to increase safety belt usage by 7% at nighttime.

Table 6.4 Effectiveness of NTSBE Programs in Various Areas

Region	Before	After	Change	Year
State of Illinois	84%	90%	6%	2007
Reading, PA	50%	56%	6%	2004
Binghamton, NY	35%	49%	14%	2000
Moncton, Nova Scotia	58%	66%	8%	1987
Halifax, Nova Scotia	54%	62%	8%	1987

6.2.3 The Return on Investment

In 2015, there were 306 unrestrained fatalities in South Carolina, which produced a crash cost of \$2.8 billion.

The assumptions used in this return on investment analysis include:

1. There is only a reduction in fatalities. Although some fatalities may actually convert to injuries, this estimate is conservative because no crash savings for reductions in injury crashes were considered.
2. Approximately 26% of fatalities occur during the nighttime.
3. The National Highway Traffic Safety Administration (NHTSA) indicates that safety belts are 48% effective in saving lives. (NHTSA, 2014)
4. South Carolina would see a 7% increase in safety belt use if a similar program was implemented.

The total crash cost savings are estimated as:

306 unrestrained fatal crashes x 26% fatalities occur at night x 7% increase in belt use x 48% safety belt effectiveness in reducing fatalities x \$9,400,000 = \$25,128,230 (25 million).

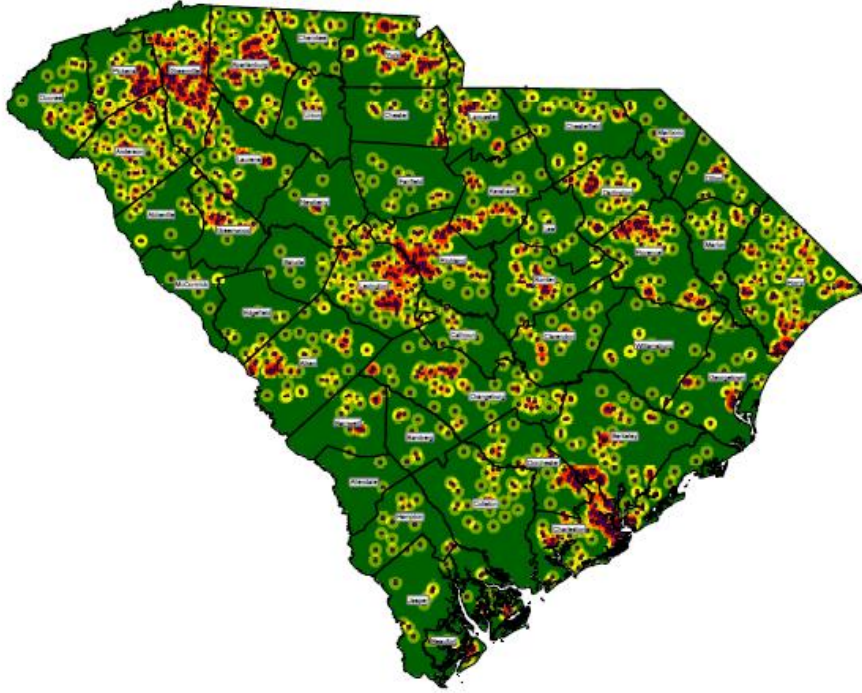


Figure 6.11 Unrestrained Drivers in Fatal Crashes by Block Group

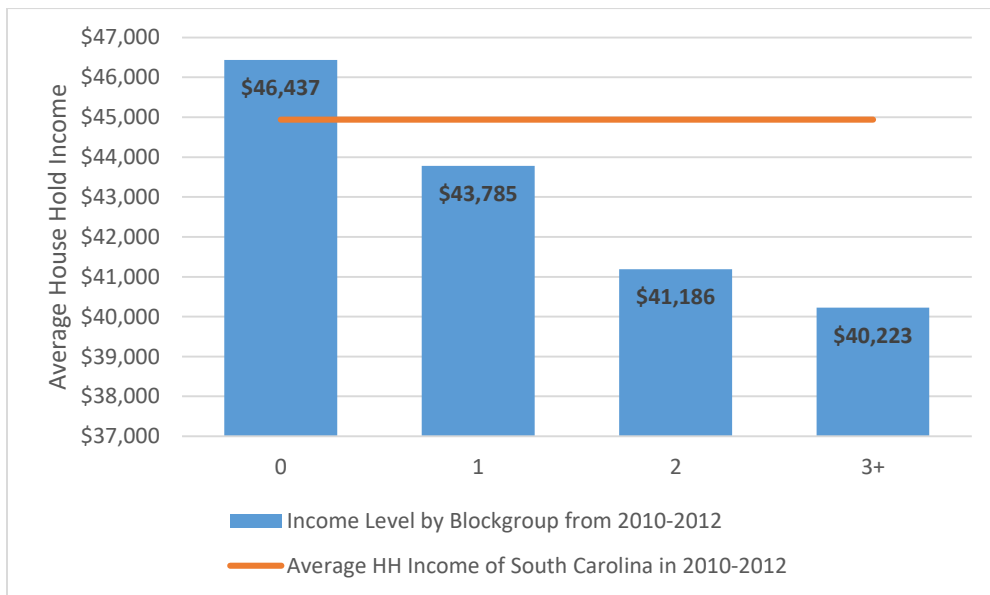


Figure 6.12 South Carolina unrestrained fatalities/ severe injury crashes vs. income level by block

The overall effect of the NTSBE program is a 3.5% reduction in unrestrained fatalities. The crash cost savings are \$25,703,059, with the program cost equaling about \$50 thousand for each phase of the enforcement campaign times the number of areas. With most behavioral programs, it is often difficult

to determine which areas should be targeted and this can greatly impact the benefit/cost analysis. In this study, the research team also collected information on driver residential location involved in all crashes. The driver's residence was then associated with sociodemographic characteristics of the Census block group. Figure 6.11 shows a heat map of the areas with the highest concentrations of nighttime unbelted drivers by block group. Using this information, enforcement campaigns could be more effectively targeted across the state. Another important characteristic of unrestrained drivers is associated with household income levels. Where the number of unrestrained fatal and severe injury crashes per block group are the highest, the household income levels are the lowest (see Figure 6.12). Thus, improving driver education in lower income school zones could also have a greater impact on roadway safety.

6.3 Emphasis Area 3: Young Drivers

(Treatment: Stricter Graduated Drivers Licensing Provisions)

Motor vehicle crashes cause the most deaths among people from 15 to 24 years of age in South Carolina. Young people make up 14.9% of licensed drivers in South Carolina, yet they account for 22.9% of fatal and severe injury crashes (SC SHSP, 2015). Along with other safety measures, Graduated Drivers Licensing (GDL) is the most comprehensive program in place and aimed at reducing the number of fatal crashes among young drivers. Increasing the knowledge and awareness of young drivers through educational programs, such as "Alive at 25," also help to reduce the number of fatal and severe injury crashes.

6.3.1 Graduated Drivers Licensing (GDL) Effectiveness

Traffic fatalities are the leading cause of death in US teens, more than homicide, suicide, and disease combined (NSC). Per 100 million miles of travel, the 16-19 age group has the highest crash rate among all age groups (IIHS). Graduated Drivers Licensing programs have reduced teen crashes by 10-40% on average through programs with the National Institute of Health (NIH), the Insurance Institute for Highway Safety (IIHS), and the National Highway Traffic Safety Administration (NHTSA). The GDL programs include a three-stage criterion for granting young drivers full driver's license privileges. The three stages are: a supervised learning period, in which young drivers go through a qualifying test and can only drive with an adult in the car, generally one who is over the age of 21, for a minimum number of hours before he/she is able to move to the next stage; an intermediate stage, in which a driver is granted a license and can drive without supervision, but under restricted conditions, like no cellphone usage, limited night time driving, a limited number and age group passengers in the car, etc., which vary from state to state; and a full license state, in which the driver is granted an unrestricted license after fulfilling all requirements. The purpose of the GDL programs are too maximize experience while minimizing common risks that teen face while driving (NSC). Other restrictions are put into effect that help lower fatal and injury crashes, such as teen drivers and passengers must wear a safety belt, and teen driver are not allowed to text or talk on the phone while driving. South Carolina has one of the most lenient GDL programs.

Some of the effective requirements of GDL programs are a minimum age of 15.5 to obtain a learner's permit; a waiting period of at least three months, after obtaining a learner's permit, before applying for

an intermediate license; a minimum of 30 hours of supervised driving; a minimum age of at least 16 years to obtain an intermediate license; a minimum age of 17 years to obtain a full license; and night time driving restrictions. States with the strictest policies in each of these areas can be found in Table 6.5. South Carolina currently meets the strictest requirements for night time driving (See Table 6.6). However, the limited ability to identify teen drivers on the road after hours reduces the effectiveness of this provision.

Table 6.5 States that have adopted the strictest GDL provisions as of June 2016

Permit age of 16	70 Supervised Practice Hours	Licensing age of 17	8pm Night Driving Restriction	No Teen Passengers	
Connecticut	Maine	New Jersey	Idaho (Sunset to Sunrise)	Alaska	California
New York & D. C.				Colorado	Connecticut
New Jersey				D.C.	Georgia
Pennsylvania				Indiana	Maine
Rhode Island			Maryland	Massachusetts	
Delaware			Nevada	Oregon	
Kentucky			Utah	Vermont	
Massachusetts			Washington	West Virginia	
			South Carolina (6pm EST)		

Table 6.6 Current and Proposed (Strictest) Provisions

GDL Component	Current SC Provisions	Strictest Provisions
Minimum Age	15 years old	16 years old
Learner Stage Duration	6 months	1 year
Required Supervised Driving Hours	40 hours (10 of those at night)	70 hours
Night-time Driving Restriction	EST: 6pm to 6am EDT: 8pm to 6am	No Change
Passenger Restriction (Family members are exempt unless otherwise noted)	No more than 2 passengers under 21 years old unless going to or from school	None
Minimum Age for Full-Privilege Driving	15 years 6 months old	17 years old

Studies have shown that U.S. states and Canadian provinces that have put some level of GDL laws into effect have reduced crashes by 20-40%. The stricter GDL laws can reduce fatal crashes by up to 30%. Nighttime restriction is the most effective in reducing fatal crashes. In the US, enforcing a 9 PM driving restriction can reduce fatal crashes by up to 17% (McCartt, 2012).

In California, after the GDL laws went into effect, Thomas Zwicker and his associates used Auto-Regressive Integrated Moving Average time series analysis to study the resulting change. They discovered a 23% decrease in 16 year olds involved in fatal and injury crashes. They also estimated that 8,052 fatal and injury crashes involving 16 year olds were prevented after 66 months of the GDL laws. There was a 38% reduction in fatal and injury crashes (or about 3,953 fewer fatal and injury crashes) among 16 year olds with injured teen passengers (Zwicker et. al., 2006).

6.3.2 GDL Enhancement Estimates by Insurance Institute for Highway Safety

GDL laws have been proven to be effective in preventing fatal crashes. However, GDL laws are decided on by states. The Insurance Institute of Highway Safety created a calculator to determine how much each state could benefit from enforcing the strictest GDL laws. The calculator uses research to determine which aspects of GDL laws are most productive in limiting fatal crashes. The five key provisions included in the model are: the age allowed to get a permit; the number of practice hours required before getting the intermediate license; the minimum age allowed before getting a full license; the night time driving restrictions; and the allowance of teen passengers. IIHS studied the rate of fatal crashes per 100,000 teenage drivers in every state and used the GDL laws in all of the states to determine how much each provision of the GDL law would reduce the rate of fatal crashes. Figure 6.13 shows the individual components of GDL that would produce the greatest reductions in collision claims and fatal crashes. Overall, the calculator estimates a 45% reduction in fatal crashes and a 22% reduction in collision claims. The main fatality reducing provisions include raising the permit age to 16, raising the unrestricted licensing age to 17, and restricting teen passengers during the intermediate driving phase. Figure 6.14 shows an example of the graphical user interface portion of the online GDL calculator interface with results for South Carolina.

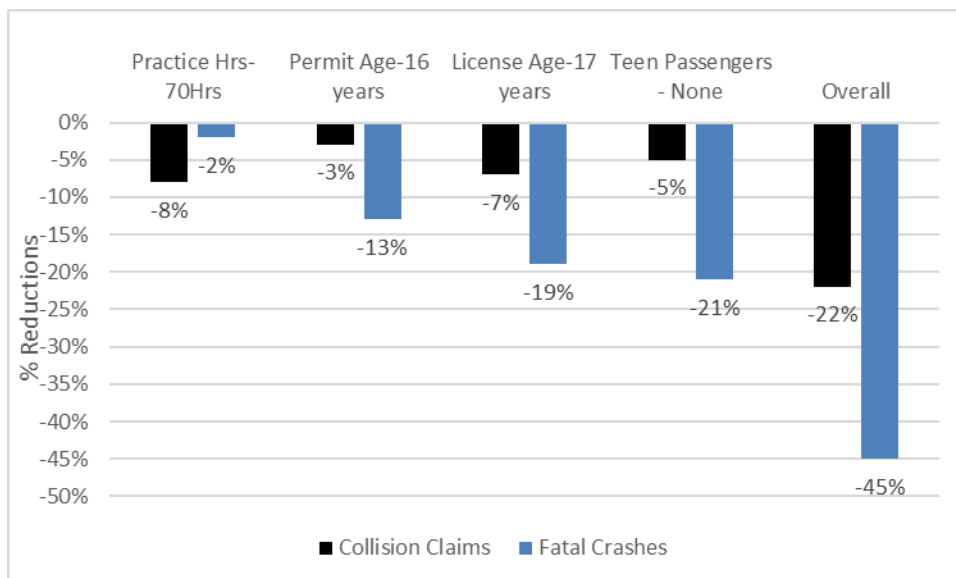


Figure 6.13 Effects of adopting the best practices in South Carolina for drivers age 15-17 years

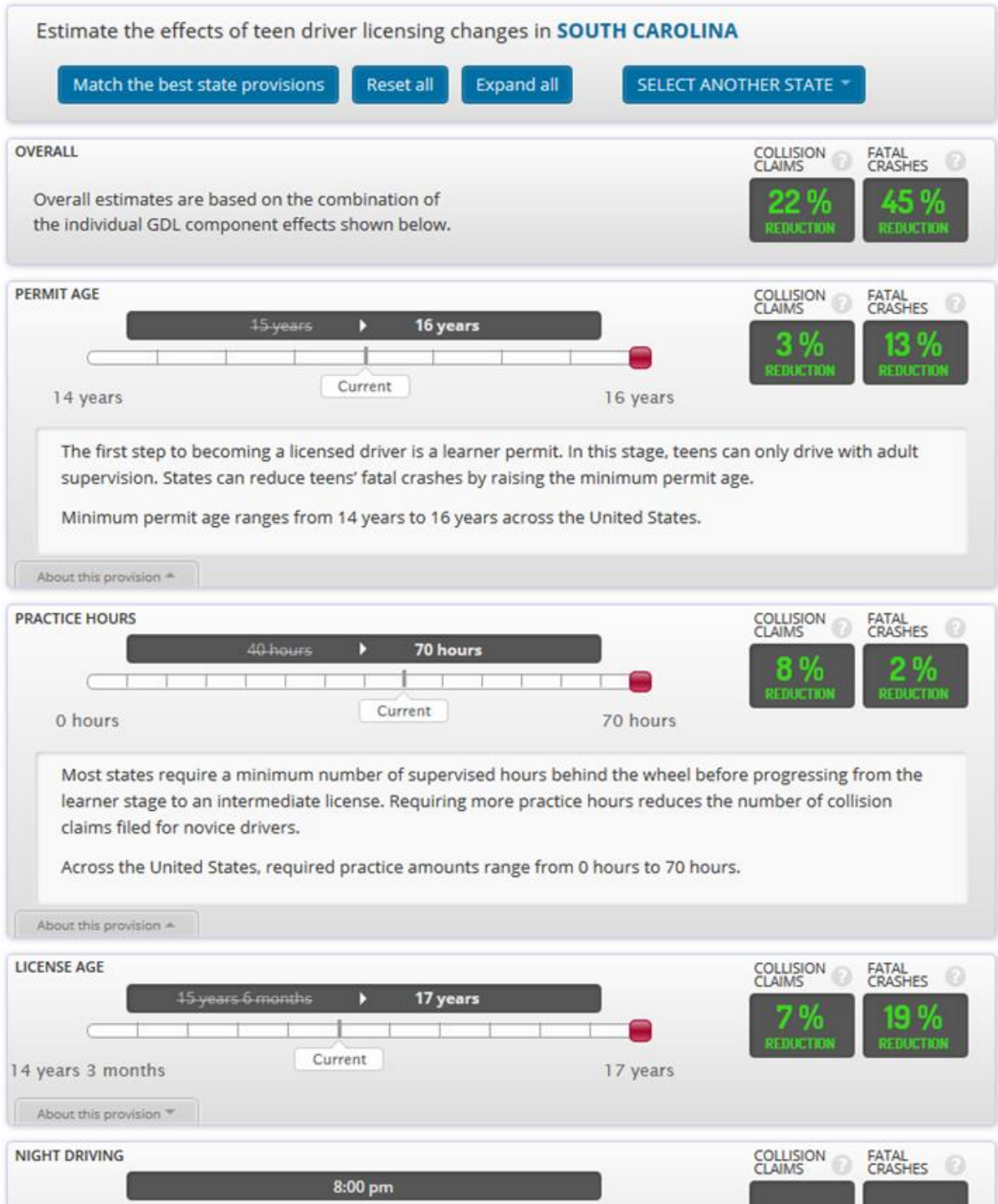


Figure 6.14 Example of the GDL Calculator User Interface

Adopting some of the stricter provisions can make a significant impact on the rate of fatal crashes every year. Since the 1990s when GDL laws were first put into effect, states have been constantly upgrading their laws. However, since 2012 the progress has slowed to almost no improvement among most states even though estimates by the Insurance Institute of Highway Safety (IIHS) show that at least ten states (see Figure 6.15), including South Carolina, could reduce their rate of fatal crashes by nearly 50% or more by adopting the strictest GDL provisions (IIHS, 2016).

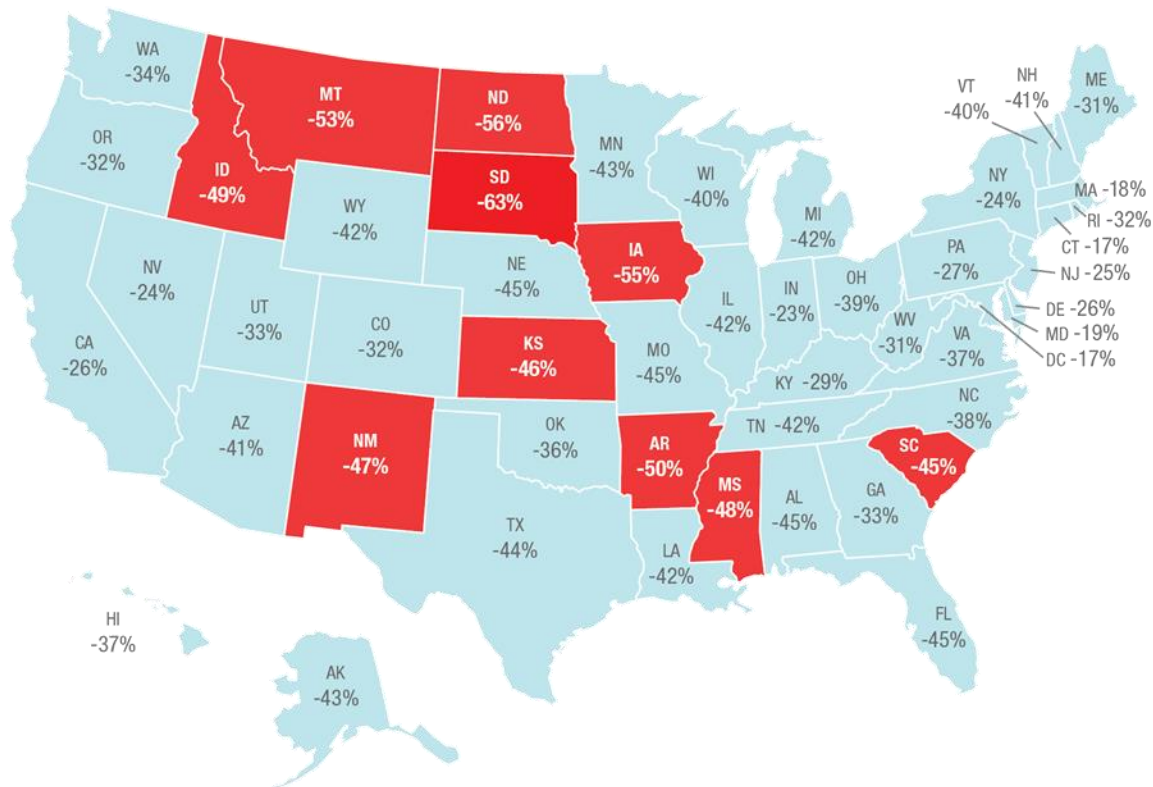


Figure 6.15 Ten states with the most room to improve by enhancing GDL laws

A few states are touted as having the strictest GDL laws in the country including Connecticut, District of Columbia, and New Jersey. Connecticut’s laws on passengers and permit age are the strictest that have been adopted. Connecticut requires parents of drivers under the age of 18 attend a 2-hour class that explains the laws for teen drivers and related issues, before the teen can take the test to get their intermediate license. The District of Columbia follows the strictest provisions for permit age and the number of teen passengers. However, they require everyone go through the intermediate stage until they are 21 years old. They also require drivers under 18 obey the laws regarding nighttime driving and passengers, even if they have their full license. Still yet, IIHS estimates that the District of Columbia can achieve a 17% reduction in fatal crashes and a 14% reduction in collision crashes (IIHS 2015). New Jersey has a law that requires all teenagers on a learner’s permit and all drivers on probation to have a decal on their license plate, so the police can more easily identify if a law is being broken – especially at night

(McCartt, 2012). New Jersey could have a 25% reduction in fatal crashes if they enacted the strictest laws (IIHS, 2015).

South Dakota is the state with the most potential for improvement, because they have the youngest age allowed for teenagers to get a license. In fact, they have the most lenient provisions for all GDL components except nighttime driving. This means that teenage drivers can get a permit at the age of 14 and intermediate license at the age of 14.5, do not have to complete any supervised driving time, and have no passenger limits. Because of this, South Dakota has a potential 63% reduction in fatal crashes and a 38% reduction in collision crashes if they enacted the strictest GDL laws. (IIHS, 2015)

The IIHS Crash Reduction Calculator uses Institute research to show how changes to state provisions might affect collision claims and fatal crash rates among young drivers. For every state and D.C., the Institute has estimated the effects of strengthening or weakening five key graduated driver licensing provisions: permit age, practice driving hours, license age, night driving, and passenger restrictions.

6.3.3 The Return on Investment

In 2015, there were 37 fatal crashes among 15-17 year-old drivers, which produced a crash cost of \$347.8 million in South Carolina. In addition, there were 2,637 injury crashes and 9,763 property damage only crashes among this age group.

The assumptions used in this return on investment analysis include:

1. Using the estimate of fatal crash reductions from the Insurance Institute for Highway Safety GDL calculator, a stricter GDL program could lead to a 45% reduction in fatal crashes.
2. Three provisions would be adopted in full including: raising the permit age to 16, raising the unrestricted licensing age to 17, raising the minimum number of practice hours to 70, and restricting teen passengers during the intermediate driving phase.
3. There is only a reduction in fatalities. Although some fatalities may actually convert to injuries, this estimate is conservative because no crash savings for reductions in injury crashes were considered. A 22% reduction in overall crash claims is expected and could be applied to injury and PDO crashes.

The total crash cost savings are estimated as:

37 fatal crashes among 15-17 year-old drivers' x 45% fatal crash reduction x \$9,400,000 = \$156,510,000 (156 million).

The benefits of the program include crash cost savings of \$156 million, and the cost of the program GDL program with these changes is essentially negligible. Thus the benefit-to-cost ratio exceeds 156:1.

Years ago, most high schools nationally began to cut drivers education from the curriculum either because of budget constraints or increased emphasis on college entrance requirements. However, in recent years, high schools with support from law enforcement have taken a proactive role in helping educate students on roadway safety with emphasis on the dangers of distracted and impaired driving

and proper belt usage. In South Carolina for example, 109 of 189 public high schools participate in the 'Alive at 25' program. For the majority of these schools, completion of the 'Alive at 25' program is a prerequisite for obtaining a parking permit on campus. According to the SC 'Alive at 25' program statistics, the traffic fatalities among 15 to 24-year-old drivers have been reduced by 37% since 2007, when the program began.

A geospatial analysis of the effects of Alive at 25 was conducted using the crash-involved driver residence database and SC high school attendance zones. A query of teen drivers involved in crashes from 2007 to 2012, returned 122,905 drivers aged 15-19 with 31,644 of those young drivers being involved in fatal or injury crashes. For this analysis, the subset of drivers aged 15-19 who were involved in fatal or injury crashes between 2007 and 2012 will be referred to as at-risk young drivers. Pairing the residence location of at-risk drivers with the school attendance zones allowed the high schools to be sorted based on risk level (See Figure 6.16). The grouping of high schools was based on the average number (over the 6-year analysis period – 2007 to 2012) of at-risk young drivers per 100 students enrolled. The 189 high school zones were grouped into thirds (63 high school attendance zones each). The risk groupings were classified as low at-risk enrollment (1.0 - 2.6 at risk young drivers/100 enrollment), moderate at-risk enrollment (2.6 - 3.3) and high at-risk enrollment (3.3 - 9.0). Summary descriptive statistics based the three risk groupings are shown in Table 6.7.

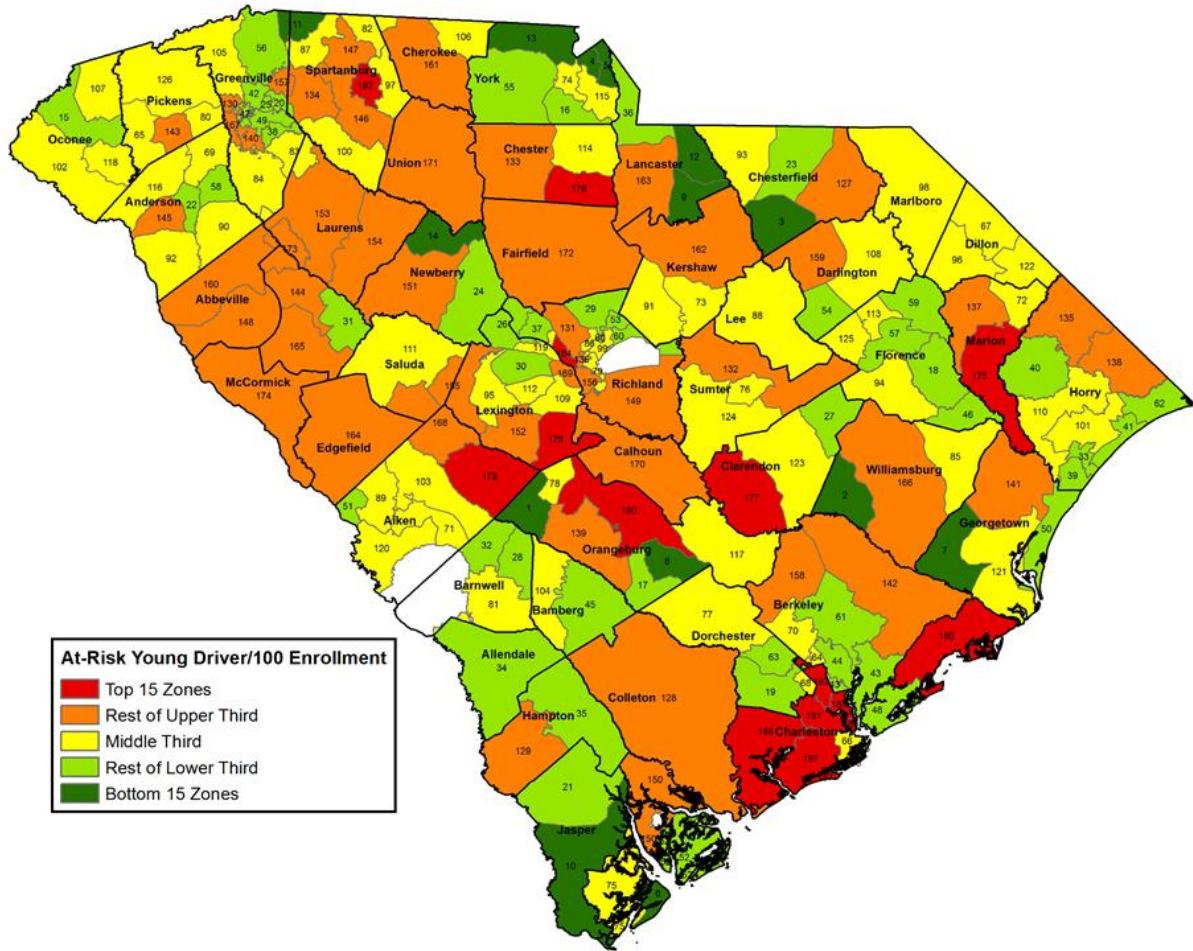


Figure 6.16 South Carolina Public High School Attendance Zone Groupings by At-Risk Young Drivers/100 Enrollment.

Table 6.7 High school attendance zone average summary statistics for three groupings of fatal crash at-risk young drivers (based on at-risk (15-19)/100 enrollment)

Categories	Fatal Crash At-Risk 15 to 19 Year Old Drivers per 100 Enrollment in the Attendance Zone (189 high school attendance zones, 63 zones each)		
	Lower Third Fatal Crash At-Risk/ Enrollment	Middle Third Fatal Crash At-Risk/ Enrollment	Upper Third Fatal Crash At-Risk/ Enrollment
Fatal Crash At-Risk Young Drivers (15-19)	9,310	11,912	12,454
Fatal Crash At-Risk (15-19)/100 Enrollment	2.04	2.93	4.33
Fatal Crash At-Risk (15-19)/100 Pop (15-19)	1.10	1.26	1.30
Enrollment/100 Pop (15-19)	81.84	62.06	46.76
School Rating (0-5)	3.58	3.29	3.01
Poverty Index (0-100)	59.91	68.90	80.50
Dollars Spent Per Student (\$)	7,673	7,679	9,287
Graduation Rate (%)	80.81	76.98	72.77
Dropout Rate (%)	2.34	2.88	3.81

From the analysis, nine of the 15 schools in the lower third risk category run a mandatory ‘Alive at 25’ program, while only two of the 15 highest-risk schools offer the mandatory program. While recommending the ‘Alive at 25’ program for implementation in zones with the highest risk may contribute to the overall preparedness of teen drivers and their safety, the compliance with and effectiveness of this training may hinge on the financial status of the households in these higher risk attendance zones. The higher risk group had an average poverty index of 80.5 - indicating that on average 80.5% of the students attending in that zone are either Medicaid eligible or qualify for a free- or reduced-price lunch program.

The findings of this research also imply that working to improve overall high school education to achieve improvements in characteristics (i.e. enrollment rate and on-time graduation rates), could potentially influence young driver behavior in a positive way. The highest risk group had an enrollment rate of 46.7 – indicating that on average less than half of the eligible high school age population were enrolled. Of those enrolled, the graduation rate is 72.8% - indicating that over a quarter of those who were enrolled do not graduate. As is often the case in lower income settings, students may have no other options than to leave school early to seek employment. The regression analysis determined that on-time graduation rate, dollars spent per student (surrogate to poverty index), and enrollment per 100 population (15-19 years old) were the most influential categories in determining at-risk young drivers per 100 enrollment from the available array of data. Note that these are the most influential variables from those available with regard to the characteristics and possible contributions of high schools to young driver safety. While the models presented here are not predictive, they are descriptive of historical data.

Another supplementary program is Drive-it-HOME™, which is an initiative of the National Safety Council, designed by and for parents of newly licensed teen drivers. Drive-it-HOME™ offers free resources parents can use to help their teen build experience to become safer drivers. They offer free resources, such as a New Driver Deal for both parents and children to encourage safe driving, a Digital Driving Coach, which sends out emails with lessons and tips for driving every week, and many media sources, such as videos, blogs from parents and new drivers, and infographics. They offer numerous guidelines and suggestions to parents on how to make young drivers safer and more experienced (Drive It Home, 2016).

6.4 Emphasis Area 4: Impaired Driving

(Treatment: DUI Courts)

Every day, approximately 30 people are in fatal crashes in the United States that involve a driver under the influence (DUI) of alcohol. On average, almost one-third (31%) of the fatal crashes involved an alcohol-impaired driver. Once a person reaches a blood alcohol concentration (BAC) of 0.08%, he/she is seven times more likely to cause a traffic collision. DUI crashes typically occur between the hours of 9 PM to 6 AM (IIHS 2014). There are 112 million self-reported cases of driving while being impaired by alcohol every year. Young people have approximately a one in three (34%) chance of being involved in a fatal crash involving alcohol compared to other ages. Drivers who have been previously convicted of driving while under the influence are four times more likely to be involved in a fatal crash involving alcohol. Some of the most effective measures in reducing injury and fatal crashes include, enforcing zero tolerance in alcohol under 21, using sobriety checkpoints, educating the community on the dangers of drunk driving, and requiring substance abuse assessment and treatment for DUI offenders. Other possible measures that are still being researched include, reducing the maximum BAC to 0.05% and requiring BAC testing when a crash results in an injury.

6.4.1 South Carolina DUI Crashes

In 2015, South Carolina had 301 fatalities (30.8% of total fatalities) involved a driver with BAC over 0.08, which is considered legally drunk, the highest percentage in the country. Trends for the prior 5-year period are shown in Figure 6.17. South Carolina also has some of the weakest laws in the United States relating to DUI offenders. A driver's license is suspended for refusal to take a test for alcohol; however, a driver may obtain a temporary alcohol license or a route-restricted license upon release from jail. Emma's Law, passed in 2014, increased the penalties for DUI convictions, requiring first offenders with a BAC of 0.15% or greater to complete the state's Ignition Interlock Device Program. The same law removed the hard suspension period for second and subsequent convictions, allowing drivers to get their licenses back sooner by completing an Alcohol and Drug Safety Action Program. Additional legislative shortcomings are mentioned in the state's 2016 Impaired Driving Assessment: "South Carolina laws contain provisions that prevent effective enforcement" (South Carolina Impaired Driving Assessment Final Report, 2016, p. 49). For example, law enforcement officers are statutorily mandated (SC § 56-5-2953) to video record all stages of a traffic stop, from the time the officer activates the blue lights and conducts the field sobriety test to the breath test site, if a breathalyzer is administered. The legislation is structured in such a way that if an officer misses one step in the process, or if the driver takes a single step outside the video, the video evidence can easily be dismissed during trial. The

Assessment (2016) refers to this statute as “...poorly drafted and archaic...and mandates unsafe roadside practices endangering the public and the officer making the stop” (p. 49). A priority recommendation from the Assessment (2016) was to “repeal the statutory videotaping requirements of the entire traffic stop, including the field sobriety testing and advice of rights” (p. 9). By comparison, Nebraska has one of the strongest laws for prosecuting DUI offenders. Administrative licenses are suspended for 180 days and only given back if an ignition interlock system is installed. They also require first time offenders and repeat offenders to install an ignition interlock system, regardless of BAC content (IIHS, 2016).

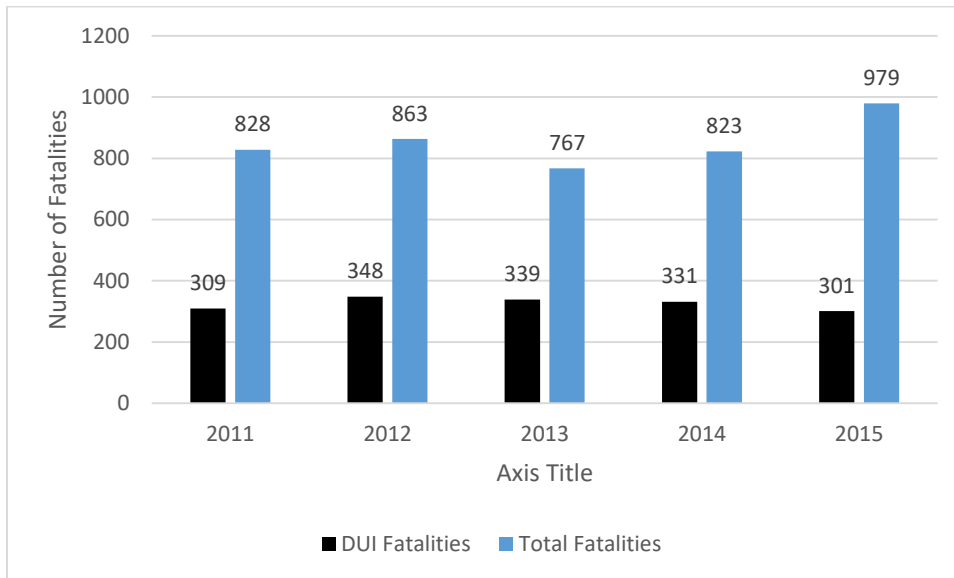


Figure 6.17 Total fatalities in SC versus DUI-related fatalities

In South Carolina from 2008 to 2012, drivers ages 25 to 34 had the highest number of DUI incidents and the highest percentage of crashes out of any age group. There were 1,576 incidents of DUI among 15 to 19-year-old drivers, all of which are illegal under state law. By gender, males had the highest incidence of driving while intoxicated. In a five-year span, South Carolina had over 900 people with at least two DUI offenses. Many programs could either be implemented or enforced better, such as zero tolerance, DUI/DWI courts, etc., that could reduce all of the DUI-related factors in South Carolina (Brown, 2016). South Carolina’s most recent Impaired Driving Assessment lends further support to this statement, citing Alli’s Law – proposed legislation that would require responsible beverage server training as a condition of business liquor licensure (2016, p. 9). Recent data released by the South Carolina Department of Public Safety show a significant number of DUI arrests are made in the state each year. However, due to legislative loopholes in DUI statutes, prosecution has become increasingly difficult. Another recommendation proposes increasing the number of Solicitors to handle DUI cases (p. 55). South Carolina is one of only two states in the nation where police officers prosecute their own DUI cases. Solicitors could assist officers, particularly in cases held in higher court, by making appropriate motions and responding to motions made by the defense

Geospatial analysis was conducted to determine residential areas within the state with an overrepresentation of drivers involved in DUI crashes. Information was taken from six years of crash data (2007 to 2012) and the residential locations of drivers involved in crashes. While many of the highlighted areas are in densely populated urban areas, there are some pockets of higher numbers of drivers involved in severe DUI crashes in relatively rural areas (Figure 6.18). Knowledge of problem areas will allow more effective targeted enforcement near areas where problems are known to exist.

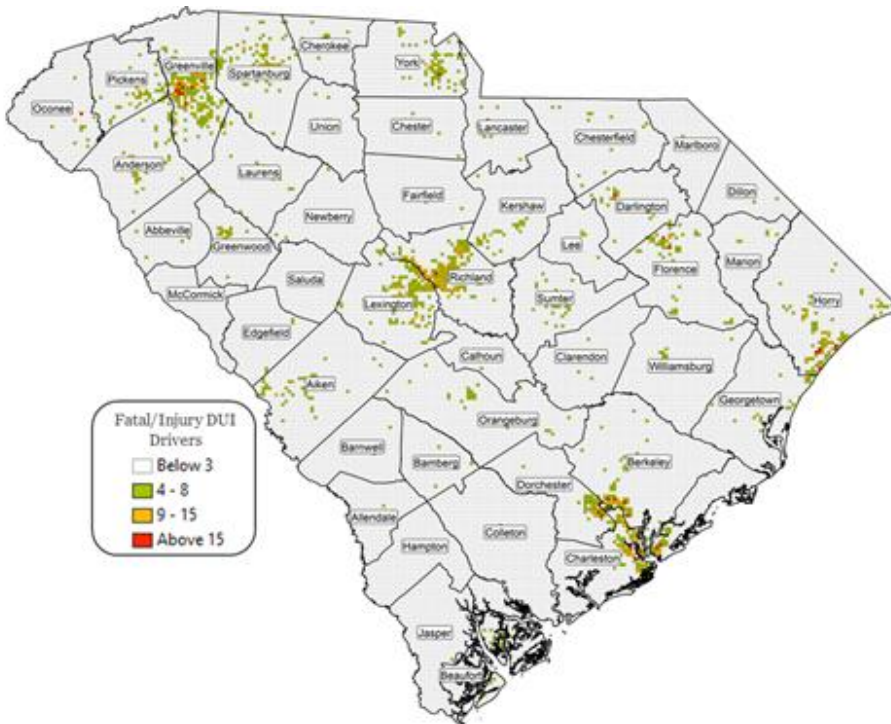


Figure 6.18 Heat map of fatal and injury DUI driver residences in South Carolina by block group

6.4.2 Statewide Impaired-Driving Prevention Task Forces

Statewide Impaired-Driving Task Forces assemble the key leaders in education and enforcement of impaired-driving from around the state and bring them together to address issues with legislature, enforcement, and prosecution. These task forces are generally comprised of legislators, law enforcement, health officials, victims, citizen activists, researchers, public relations, judges, among others. By January 2006, 16 states had these task forces in operation, including South Carolina. Currently the SC Impaired Driving Prevention Council operates within the confines of the law, and could be more effective with modifications to DUI legislation. More and more states are starting to create statewide task forces to lower the rate of fatalities and injuries from drunk driving (NHTSA, 2009).

6.4.3 Arizona Ignition Interlock Systems

When a driver is charged for driving under the influence in Arizona, whether they are a repeat offender or not, they are prohibited from plea bargain negotiation. Offenders are also required to install an ignition interlock for one year. The ignition interlock requires the driver to breathe into it before he/she

may start the car to ensure that he/she is not intoxicated. This test is also required every 15 to 20 minutes while the vehicle is in motion. If the driver does not comply, lights will flash and an alarm will sound until the test is completed or the car is turned off. Data relating to the tests and compliance is stored in the car for driver monitoring. Before this program was enacted in 2007, DUI fatalities comprised 54% of the total fatalities in Arizona. By 2012, DUI fatalities had dropped to 28% of the total fatalities. For comparison, Table 6.8 shows the relative laws in both Arizona and South Carolina.

Table 6.8 Comparison of Arizona’s and South Carolina’s DUI Laws

		Arizona	SC
Refusal to Test			
1st	1 year suspension of license		6 month suspension of license
2nd	2 year suspension of license		9 month suspension of license
3rd	2 year suspension of license		1 year suspension of license
DUI			
1st Charge			
Total Fine Minimum	\$1,500.00		\$400.00
Jail/Prison Time	Minimum 24 hours up to 10 days		Minimum 48 hours up to 30 days
License Suspension	90-360 days		90 days
Other	Court <i>may</i> order installation of ignition interlock device at the expense of the convicted DUI offender.		Public service may be ordered in lieu of jail.
2nd Charge			
Total Fine Minimum	\$3,500.00		\$2,100.00
Jail/Prison Time	Minimum 30 days up to 90 days		Mandatory five days to one year in jail
License Suspension	One year		One year
Other	Complete alcohol or other drug screening, education or treatment program		Complete alcohol or other drug screening, education or treatment program.
	Court ordered ignition interlock device		Court may suspend fine to lower amount.
	Community restitution - minimum 30 days		
3rd Charge			
Total Fine Minimum	\$4,000.00		\$3,800.00
Jail/Prison Time	Minimum 120 days		Mandatory 60 days to 3 years in jail
License Suspension	One year		Two years
Other	Use of an ignition interlock device for a minimum of 12 months.		Enrollment in, and completion of, a drug/alcohol program.
			Court may suspend fine to lower amount.

Ignition interlock systems have been approved in some form of legislature in every state because they offer an effective method of preventing drunk driving. They also have a relatively low cost, averaging

from \$3 to \$7 a day depending on the type of data and monitoring that is done. They also prevent tampering and monitor almost everything about the vehicle and device (NHTSA, 2014).

6.4.4 Georgia DUI Courts

In 2003, the Georgia Governor’s Office of Highway Safety (GOHS) awarded an 18-month grant of \$474,138 to establish three DUI courts that specialized in treating and managing cases of multiple DUI offender cases. The goal of these courts is to ensure abstinence from drugs and alcohol for all participants. In 2004, the program was continued for an additional 12 months at a cost of \$247,387 from GOHS. All three of the courts that were established included: a judge; a DUI court coordinator; and a case management clerk. The three original DUI courts were Hall County in Gainesville, Clarke County in Athens, and Chatham County in Savannah.

By May 2006, 1,053 offenders had been referred to the DUI courts in Georgia. 301 people (29%) graduated from the program, 532 people (51%) were active participants in the DUI courts, and 220 people (21%) were either not in compliance or had been removed from the program. Those who graduated the program generally have a reduced jail sentence. The majority of DUI court participants (95%) were addicted to alcohol and have had at least three lifetime DUIs. Over the four-year period, there was a 79% participant retention rate. This indicates that once in the program, most participants had a motivation to complete it. Georgia now has 19 DUI courts. Graduates of the Georgia DUI court program are four times less likely (see Figure 6.19) to have a repeat DUI arrest and 20% less likely to be arrested for a felony within 24 months after graduation from the program (Judicial Council of Georgia, 2012).

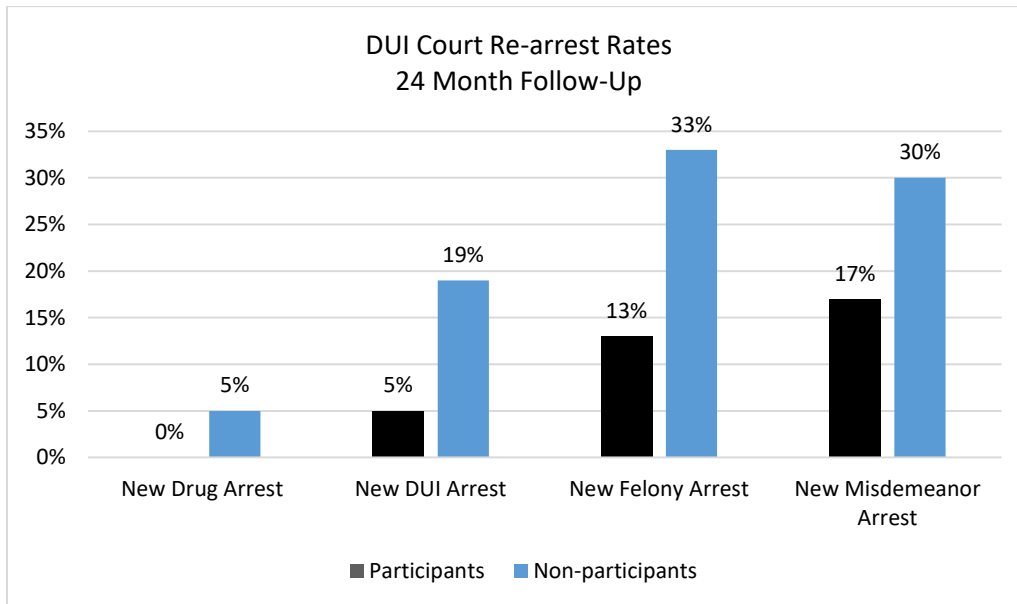


Figure 6.19 Georgia DUI Court Graduate Re-Arrest Rate

During the initial testing for the new DUI court program, 270 of the DUI court participants came from within their own counties (either Chatham, Clarke, or Hall), and 450 participants came from counties

that were similar to those three. Those in Bibb County went to Chatham County, those in Bulloch County went to Clarke County, and those in Whitfield County went to Hall County. Those who went to their own counties were labeled as the retrospective group, and those who went to the other county were labeled the contemporary group. The retrospective group was found to have a greater reduction in recidivism rates than the contemporary group. Thus, programs within the county of residence were found to be more effective. (NHTSA, 2011).

In Georgia from 2001 to 2005, the parents of approximately 65,000 children were incarcerated for offenses related to drugs or alcohol. DUI courts present a better situation for the children by allowing parents to stay in the home, and thus reducing the possibility of recidivism. Recidivism is a tendency to relapse into a previous condition or mode of behavior.

Incarceration costs about four times more than utilizing DUI Court for these offenses (see Figure 6.20). They are also less likely to be incarcerated in the future after graduating from a DUI court. As of 2009, Georgia had 47 courts which have resulted a reduction in recidivism, drug and alcohol abuse, and crime (Judicial Council of Georgia, 2009).

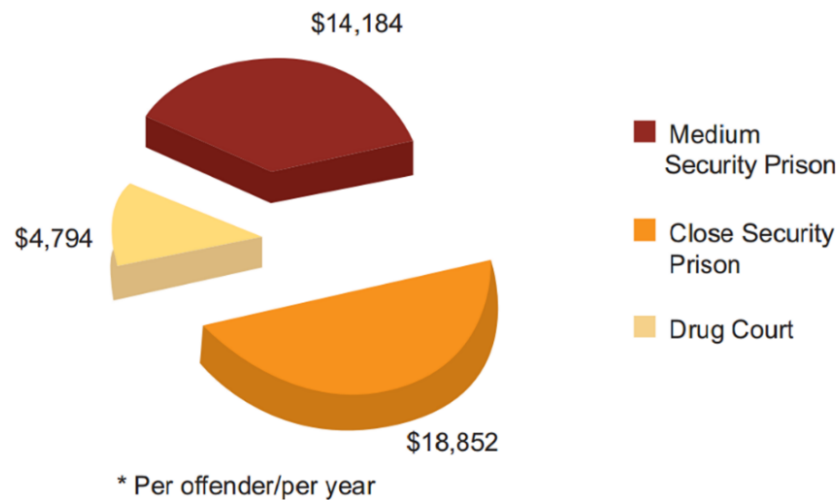


Figure 6.20 Relative Cost of DUI Courts vs. Prison in Georgia (2009)

6.4.5 Effective Principles for DUI Courts

DUI Courts have been created to prevent future DUI behavior and to reduce current behavior. Those who are enrolled in the program are required to undergo random testing for drugs and alcohol, attend a court hearing, and receive treatment for substance abuse. There are ten established principles, which must be followed when creating DUI courts. DUI courts must:

1. **Determine the population.** The court population should include those with previous DUI records, and especially offenders which have had a significant negative impact in their community. Positive change within this population is the goal. If the resources are limited and the DUI offenders outnumber available resources, then the program will not be as successful.

2. **Perform a clinical assessment.** The assessment is to ensure that participants are eligible for the program. It also determines the level of need for such a program and the type of treatment plan each person needs. Without the assessment, the treatment plan would be less effective.
3. **Develop a treatment plan.** The treatment plan should not only address the drinking itself, but the reasons for drinking and any long-term side effects, such as depression or anxiety that can accompany heavy or repetitive drinking. There are many types of treatment plans, and many people require a combination of treatment plans.
4. **Supervise the offender.** Because of the type of crime committed, supervision is required. Drinking and driving under the influence is a significant danger to the public. Supervision is best accomplished with a team. The court, supervision staff, and treatment staff all help supervise the participants through testing, court orders, and physical supervision.
5. **Forge agency, organization, and community partnerships.** When more groups and people support the DUI court program, it is more likely to be successful because there will be support from all facets of the community, and it will be enforced by everyone. Overall, it also increases the likelihood of long-term success.
6. **Have a judicial leadership role.** The judge will be the team leader; he/she will be the one publicly enforcing all of the precedents set up by the organization.
7. **Develop case management strategies.** These strategies will help all of the organizations contributing to the larger goal work effectively.
8. **Address transportation issues.** DUI court programs have to help the participants learn how to live without being able to drive while in the program, since almost all participants have lost their licenses. Because of this, after they have gotten out of the program when they still do not have their license, they know how to cope with not having one, instead of resorting to driving without a license.
9. **Evaluate the program.** The program needs to be evaluated, so others can implement it if effective. It is also important to make sure that it is as efficient as possible. The necessary things to evaluate include: jurisdictional variables: participant risk factors; supervision variables; and treatment variables.
10. **Ensure a sustainable program.** To ensure a sustainable program, a continuous source of funds should be present. Further, program partners should seek out any future obstacles that could hinder progress, and encourage unity in goals. (DWI Courts, 2010).

6.4.6 The Return on Investment

In 2012, there were 5,974 DUI-related crashes in South Carolina, which produced a total crash cost of \$4,285,731,500 as shown in Table 6.9.

Table 6.9 DUI crash cost calculations for 2012

Injury Level	Number of 0.08+ BAC (2012)	Unit Cost	Resulting Crash Cost by Injury Level	Cost Saving from 1.7% Reduction in DUI Crashes with DUI Counts
Property Damage Only	3035	\$6,500	\$19,727,500	\$335,367.50
Complaint of Injury/ Possible Injury	553	\$68,000	\$37,604,000	\$639,268.00
Non-incapacitating Injury	875	\$130,000	\$113,750,000	\$1,933,750.00
Incapacitating/Serious Injury	1153	\$650,000	\$749,450,000	\$12,740,650.00
Death/Fatal Injury	358	\$9,400,000	\$3,365,200,000	\$57,208,400.00
Total Crashes (All Levels)	5974	--	\$4,285,731,500	\$72,857,435.50

The assumptions used in this return on investment analysis include:

1. The programs would initially operate in counties where the highest number of DUI fatalities have occurred as per Figure 6.21. In 2012, South Carolina had 358 fatalities involving an alcohol-impaired driver with a blood alcohol concentration (BAC) 0.08% or greater. Over 33% of the fatal crashes occurred in five counties, which are selected for the cost benefit analysis.

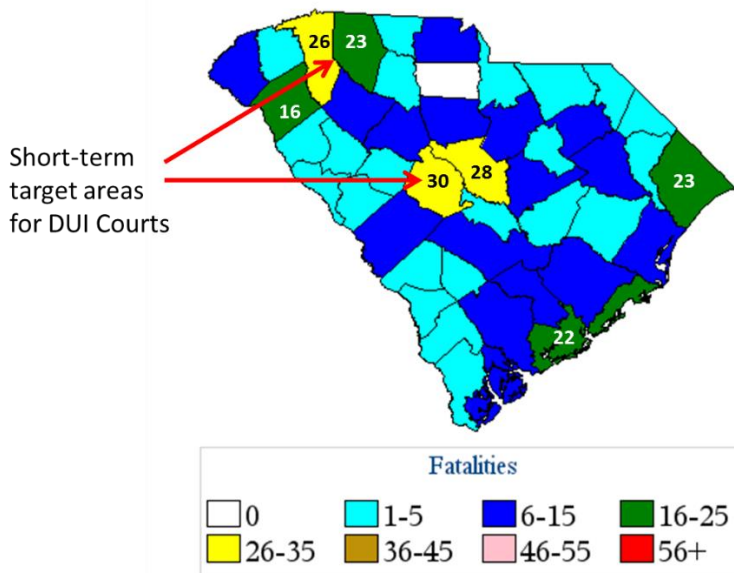


Figure 6.21 Fatalities in Crashes Involving an Alcohol-Impaired Driver (BAC = 0.08+%) in

2. 9% of all DUI offenders are repeat offenders (NHTSA).
3. There is an 80% retention from the DUI court program (GA DUI Court).

4. There is a 71% reduction in recidivism (GA DUI Court).
5. The result of the programs that are implemented is a 1.7% reduction in DUI crashes (GA DUI Courts).
6. The cost of the program is \$930,000 for three courts or \$1,500,000 for five courts (GA DUI Courts).

The total crash cost savings are estimated as shown in Table 6.9 with a 1.7% reduction in DUI crashes of all levels resulting in a savings of approximately \$73 million (\$72,857,435).

The benefits of the program include crash cost savings of nearly \$73 million, and the cost of three DUI Courts estimated at \$1.5 million. Thus, the benefit-to-cost ratio approaches 49:1. While South Carolina does have active drug courts, they have struggled to obtain and keep funding in certain counties, and limited resources could prove to reduce the effectiveness of DUI courts in South Carolina. Note that the benefit cost analysis above does not take into consideration the savings associated with housing DUI offenders in our jail facilities.

6.5 Emphasis Area 5: Speeding (Treatment: Speed Camera Installations)

The United States is the only developed country to still allow increases in their speed limits. In 1973, the national speed limit in all 50 states was set to 55 miles per hour on the Interstates, which was set as the national maximum speed limit during the oil embargo. Roughly four decades later, Texas has the highest speed limit at 85 miles per hour, and the majority of states now allow either 70 or 75 miles per hour on Interstate facilities (See Figure 6.22). Studies have shown that as speeds increase, so do fatal crashes. (Lund, 2015).

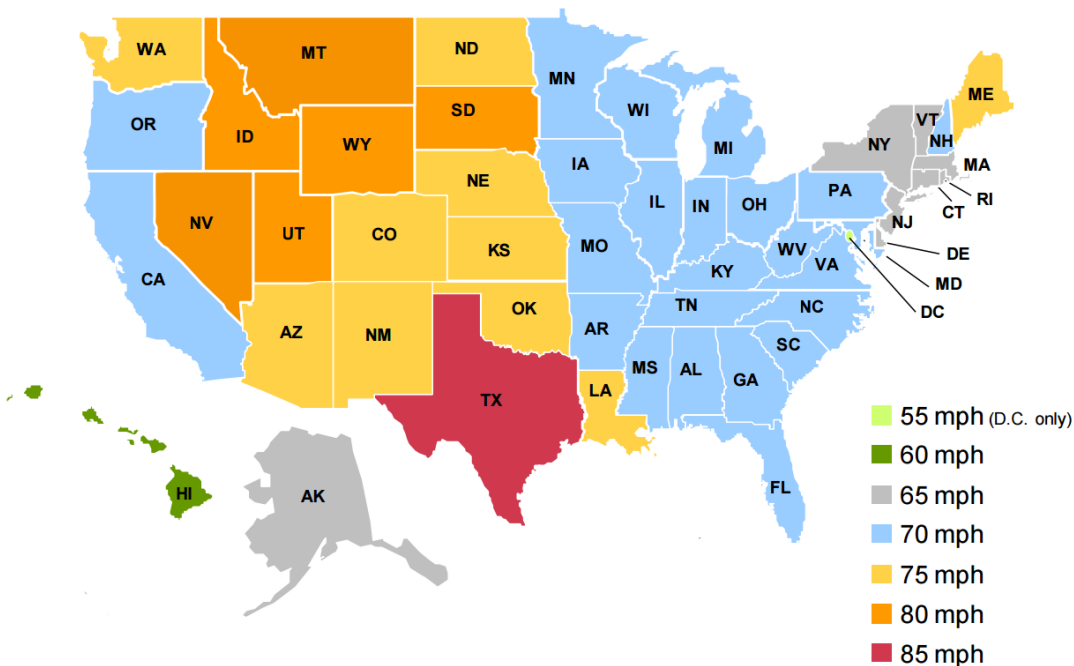


Figure 6.22 Maximum Speed Limits as of August 2015

Almost 40% of the fatalities on South Carolina roadways were speed-related. Speed-related is defined as: exceeding authorized speed limit, and/or driving too fast for conditions. South Carolina has the 2nd highest rate in the nation. Speed is a behavioral issue that is must be managed through enforcement activities, and the reality is that drivers far outnumber enforcement officers. Auto-enforcement with cameras has the potential to expand speed management programs and reduce crashes - not only speed-related crashes, but all crashes. Camera enforcement began for the first time in 1987 in Arizona. Since then, speed cameras have been used in 12 states and the District of Columbia and have lowered fatal crashes up to a 25% at fixed camera sites and up to almost 50% with mobile camera operations. An added benefit is that they also foster better traffic flow with more uniform speeds.

6.5.1 South Carolina Prohibition on Automated Enforcement

In 2010, South Carolina Governor Mark Sanford signed a law banning the use of red light cameras and speed cameras in the state. The legislation was unanimously approved in both the South Carolina House and Senate. The law does allow photo ticket use during emergencies declared by the governor or president, however, the ticket must be personally delivered by an officer within one hour. The lawmakers acknowledged that they saw no practical way that a photo enforcement system could be used under these conditions. While a number of other states have also banned photo enforcement, over a dozen others allow its use and have found it to be quite effective (see Figure 6.23). (IIHS, 2016).

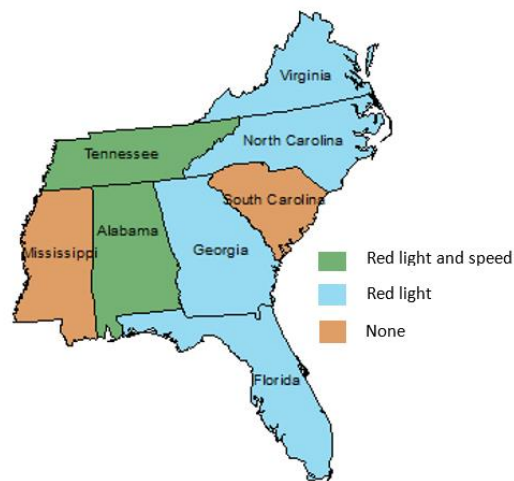


Figure 6.23 Southeastern States with Red Light and/or Speed Cameras

Camera enforcement began for the first time in 1987 in Arizona. Since then, it has spread across the United States in two forms: red light cameras and speed cameras. Red light cameras have been more widely used. However, speed cameras have a positive effect on lowering fatal crashes with up to a 25% reduction at fixed camera sites (Decina et. al., 2007). It also allows for better traffic flow (Van Winkle, 2008). Speed cameras work by using a photo radar to determine when a vehicle exceeds a set limit, and then it takes a picture of the vehicle. This allows law enforcement to identify the offender and ticket them. Thus far, speed cameras have been used in 12 states and the District of Columbia; however, not all of them are still in use because many states have encountered problems with support from the

public, which is why many of the states either do not have speed cameras or do not have running systems anymore. (CDC, 2015).

6.5.2 Alabama and Tennessee Red Light/Speed Camera Programs

Tennessee and Alabama are a couple of the states that have both red light cameras and speed cameras. Speed cameras are used in numerous areas in Tennessee including: Bluff City, Bradford, Chattanooga, Graysville, Huntington, Jackson, Jonesborough, among many others. In Alabama, state laws allow photo enforcement in certain cities, and photo enforcement is currently operating in Center Point and Midfield.

In Tennessee, speed cameras are located in school zones and on continuously curvy roads (see Figure 6.24). The laws also include a fine for traffic violations, and up to an eight-point violation on the registered owner's license. In Chattanooga, the Hixson Pike S-shaped curves were used to test the effectiveness of speed cameras as photo enforcement. The purpose of putting photo enforcement on S-shape curves is to prevent speeding on roads where it is difficult to see the entire stretch of road (see Figure 6.25 for driver's view). Four separate systems were installed (see Figure 6.26): two on the northbound lanes and two on the southbound lanes. For one month, warning tickets were given and regular enforcement began after that.



Figure 6.24 Overhead View of Hixson Pike Curves in Chattanooga, Tennessee



Figure 6.25 Driver's View of Hixson Pike S- Curves in Chattanooga, Tennessee

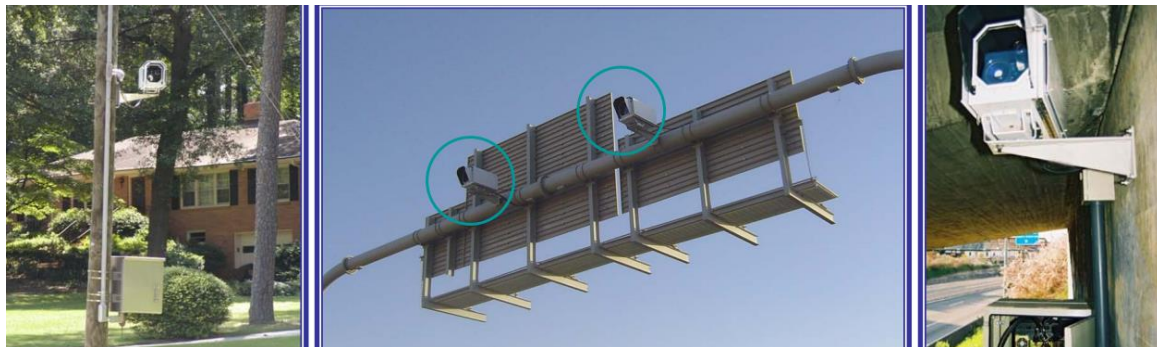


Figure 6.26 Images of the fixed speed cameras on Hixson Pike

In a study of the effectiveness of the speed cameras on Hixson Pike, lasers were used to measure vehicle speeds, and determine if the passing vehicles were traveling over the set speed. If so, a camera would take a picture of the license plate. The cameras were connected to the vendor's offices, where the data could be sent. They were mounted on a pole and operated 24 hours a day. For this test, a \$50 fine was given with no points on a license. Both citations and fatal and injury crashes decreased. Between 2000-2001, there were five deaths and 32 injuries on S curves; however, after installation between 2004-2005, there were no deaths and only 12 injuries (see Figure 6.27).

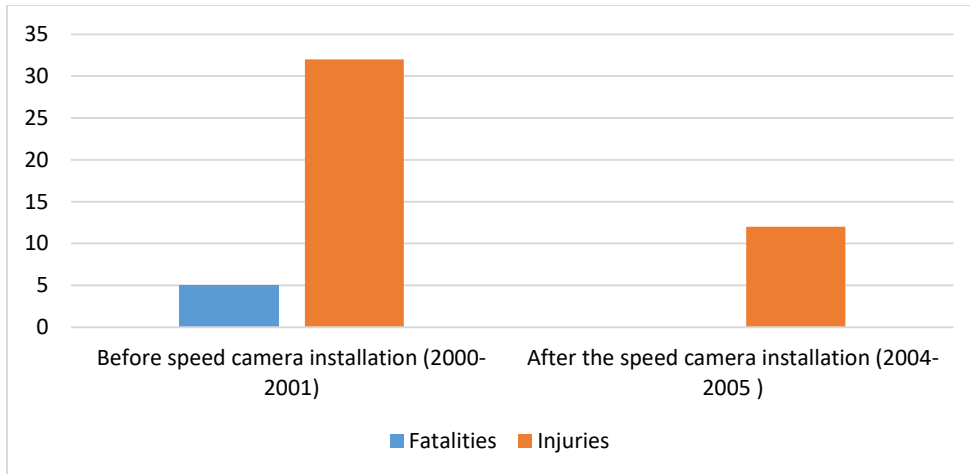


Figure 6.27 Change in fatalities and injuries on Hixson Pike with speed camera installation

Another method of photo enforcement is through mobile vans (See Figure 6.28). The City of Chattanooga has two vans that carry speed cameras, which operate the same way as the fixed cameras. They allow for a wider range of operation because they can be moved wherever there is a need for them (Van Winkle, 2008).



Figure 6.28 Mobile Van with Cameras and Sensors for Photo Enforcement, Chattanooga, TN

As shown in Figure 6.29, the initial citation rate is high, but tapers off to a relatively stable amount after the first month to six weeks into the speed camera implementation. The number of citations issued by the automated system far exceed that which can be written by hand in the field by officers. Further, automated enforcement would allow scarce police resources to be used more effectively for other important tasks that cannot be handled by a computer system.

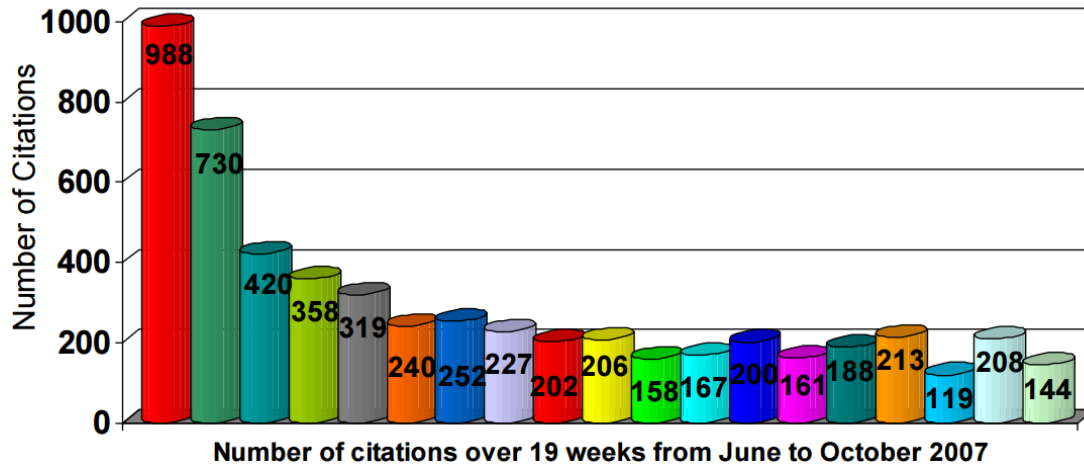


Figure 6.29 Change in Citation within Four Months of Installing Speed Cameras (June to October 2007), Chattanooga, TN

6.5.3 Maryland Speed Camera Program

Montgomery County in Maryland is another example of success by speed cameras. By 2014, they had in use 56 fixed cameras, 30 portable cameras, and six mobile vans. All of the cameras are used in either residential areas or school zones. There is a \$40 fine for the citation and no points on the license. Within six months of the implementation of the speed cameras, the proportion of drivers traveling ten miles over the speed limit or higher dropped significantly on streets with speed cameras. Seven years after the program was implemented, there is a 59% reduction in the chance that a driver will drive ten or more miles over the speed limit. There was also a 19% reduction in the probability that a fatality or severe injury would occur as a result of a crash on roads with speed cameras.

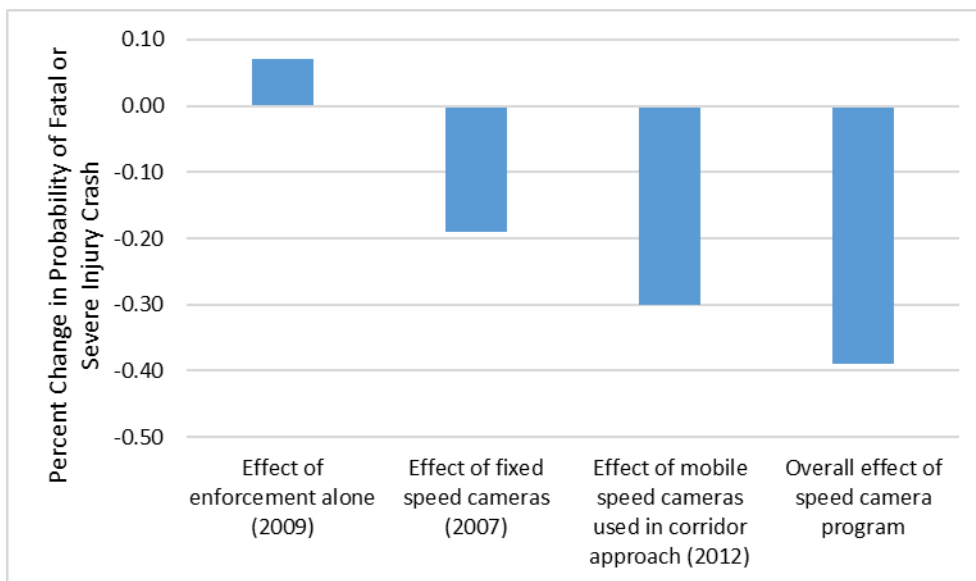
In 2012, Montgomery County found that implementation of speed-camera corridors (see Figure 6.30) reduced the likelihood of crashes even more. Instead of using fixed camera locations, the cameras on the speed-camera corridor were moved around within the corridor, so motorists did not know the specific location within the corridor where speeds were monitored. The resulting effect was that drivers reduced their speed for the entire length of road because they were uncertain where the cameras would be operating. The speed-camera corridor approach helped reduce the likelihood of fatal or severe injury crashes by an additional 30% from the original 19% (see Figure 6.31). As an advantage for having speed cameras elsewhere in the county, researchers found that drivers also tended to drive slower on roads that were not advertised as speed-camera corridors. This phenomenon is referred to as bleed-over effect. Over 75% of the drivers in Montgomery County said that they had slowed their speed

due to the speed cameras, and 62% of drivers said they supported the use of speed cameras in residential areas (IIHS, 2015).

Figure 6.30 Speed camera corridor sign in Montgomery County, MD



Figure 6.31 Percent change in probability of fatal or severe injury crash with 25-35 mph speed limit



6.5.4 The Return on Investment

In 2015, there were 361 fatal crashes on South Carolina roadways involving speed, which produced a fatal crash cost well over \$3 billion (\$3,393,400,000).

The assumptions used in this return on investment analysis include:

1. There is only a reduction in fatalities. Although some fatalities may actually convert to injuries, this estimate is conservative because no crash savings for reductions in injury crashes were considered. The literature indicates a 12% overall crash reduction with the use of speed cameras.

2. The reduction in fatal crashes with speed camera implementation is estimated at 19%.
3. The cameras cost about \$50,000 to purchase and \$25,000 to install. Monthly operating costs are about \$5,000 [per camera system] ([Maccubbin, Staples, and Salwin, 2001]).
4. Each fatal crash site is an individual site.
5. 50 cameras will be purchased to install at 50 fixed sites in close proximity to 50 fatal crash sites.

The total crash cost savings are estimated as:

50 fatal crashes x 19% fatal crash reduction x \$9,400,000 = \$89,300,000.

The benefits of the program include crash cost savings of over \$89 million, and the cost of the 50 fixed site camera systems and operation for one year is \$6,750,000. Thus the benefit-to-cost ratio exceeds 13:1. However, if portable camera systems were purchased, the equipment could be rotated through more sites, generating almost double the impact and the return on investment. Finally, the cost of the cameras will provide multiple years of crash cost savings which was not considered here.

6.6 Emphasis Area 5: Vulnerable Road Users (Treatment: Universal Helmet Law)

Following the prohibition of speed cameras in South Carolina, and a ban on red light camera enforcement, another notable safety crippling legislation in South Carolina is the lack of a universal helmet law. While SCDOT has a federal requirement to develop and maintain the Strategic Highway Safety Plan which identifies the state's key safety needs and guides investment decisions toward strategies and countermeasure with the most potential to save lives and prevent injuries, South Carolina legislation and state policies have effectively blocked many paths to safety improvements. One law that has been studied in great detail is the universal helmet law. In 1967, states were required to enact helmet laws in order to qualify for certain federal safety programs and highway construction funds. South Carolina enacted the universal helmet law on July 1, 1967. However, in 1976, several states successfully lobbied Congress to stop the USDOT from assessing financial penalties on states without the universal helmet law. On June 16, 1980, the South Carolina legislature had reduced the helmet law coverage to those 20 and younger. A decade later, Sosin, Sacks, and Wilson (1990) conducted a study of motorcycle fatalities from 1979 through 1986. They found that over half of the motorcycle fatalities were associated with head injuries, and rates per population for motorcycle fatalities associated with head injury (adjusted by age, sex, and race) were almost twice as high in states without universal helmet laws as in states with universal helmet laws. In the two states that dropped universal coverage during the study period, motorcyclist fatalities per population rose substantially: by 184% in South Carolina and by 73% in Wyoming.

On July 1, 2000, Florida repealed the legal requirement that all motorcyclists wear protective helmets. Similar to South Carolina, the Florida helmet law only requires riders aged 20 and younger to wear helmets. However, the law also requires older riders who do not have a minimum of \$10,000 medical insurance coverage to wear helmets. NHTSA Traffic Safety Facts (2005) indicate a substantial increase in

According to results from the National Occupant Protection Use Survey (NOPUS), the overall rate of DOT-compliant motorcycle helmet use in the United States was 60% in 2013. Helmet use continued to be significantly higher (approaching 90%) in States that required all motorcyclists to be helmeted than in other States. In States without universal helmet laws, 59% of motorcyclists killed in 2013 were not wearing helmets, as compared to 8% in States with universal helmet laws. Per vehicle mile traveled in 2013, motorcyclist fatalities occurred 26 times more frequently than passenger car occupant fatalities in motor vehicle traffic crashes. NHTSA estimates that helmets saved the lives of 1,630 motorcyclists in 2013. If all motorcyclists had worn helmets, an additional 715 lives could have been saved. Helmets are estimated to be 37% effective in preventing fatal injuries to motorcycle riders and 41% for motorcycle passengers. In other words, for every 100 motorcycle riders killed in crashes while not wearing helmets, 37 of them could have been saved had all 100 worn helmets.

6.6.1 The Return on Investment

In 2015 there were 135 fatal motorcycle crashes (140 fatally injured riders), with 74% occurring without a helmet. In South Carolina, the current partial helmet law only applies to those 20 and under. Motorcycle crashes produced a fatal crash cost of over \$1 billion (\$1,269,000,000).

The assumptions used in this return on investment analysis include:

1. There is only a reduction in fatalities. Although some fatalities may actually convert to injuries, this estimate is conservative because no crash savings for reductions in injury crashes were considered.
2. The reduction in fatal crashes with universal helmet law implementation is 37%.
3. In South Carolina 74% do not wear a helmet, and would be affected by the universal helmet law.
4. Based on national statistics, the universal helmet law would induce an 87% compliance rate with helmet usage.

The total crash cost savings are estimated as:

135 fatal motorcycle crashes x 74% without helmet x 87% compliance with helmet laws x 37% fatal crash reduction with universal helmet law x \$9.4 M fatal crash cost= \$243,473,912.

Much like safety belt enforcement, a new helmet law would require some waves of enforcement. Assuming similar costs to NTSBE for enforcement over 40 sites and media campaigns at a cost of \$1.5M, the resulting benefit/cost ratio would be 162:1.

7. Conclusions

Under federal law, SCDOT has been charged with leading the statewide implementation effort to effectively deploy strategies outlined in the South Carolina Strategic Highway Safety Plan. Many of the potential strategies identified in the prior SC SHSP have already been implemented in South Carolina, but many more have not. By reviewing successful initiatives in other states, South Carolina can learn from those successes and prioritize safety programming for substantial safety improvements on its own surface transportation system.

In 2015, there were 911 fatal collisions, 37,861 injury collisions, and 95,189 property damage only collisions in South Carolina. On average, fatal traffic crashes in South Carolina result in over \$7 billion in economic loss each year. South Carolina has, for many years, had one of the highest mileage death rates of any state in the nation – far exceeding the national fatality rate. While SCDOT has a federal requirement to develop and maintain the Strategic Highway Safety Plan, which identifies the state's key safety needs and guides investment decisions toward strategies and countermeasures with the most potential to save lives and prevent injuries, South Carolina legislation and state policies have effectively blocked many paths to safety improvements. Tree protection ordinances, limited policies for graduated drivers licensing, bans on camera enforcement, and lack of universal helmet laws will continue to undermine efforts to improve safety in the state. SCDOT, along with other safety partners in the state, have continued efforts to reduce fatalities, but there are significant gains to be made. The following represent a few key program adoptions/changes that could bring about significant reductions in fatal crashes in South Carolina with notable benefit/cost ratios:

- **Tree-related Fatalities** (2015 - 191 Fatalities, 24.9%) - South Carolina ranked 1st in the nation for the highest fatality rate (0.32 per 100,000 population) for crashes involving trees. The national average tree-related fatality rate is 0.12 per 100,000 pop., thus SC is 165% above the national rate. Extensive research has been conducted nationally to determine the effect of allowing trees to re-establish in areas that were intended for clear zones. A prior SCDOT research study surveyed 131 randomly selected sites to determine if recommended clear zones (or safe recovery areas) were provided. Of these, only 12 sites met the recommended criteria, and researchers determined that the odds of a site having a tree-related crash are 42 times higher if the minimum clear zone is not met. Severe crash reductions range from 27% to 60% by reclaiming up to 50% or 75% of the recommended clear zone, respectively. Considering the magnitude of the roadside hazard problem, and the deficiency of the clear zones, it appears that by providing recommended clear zones for motorists who leave the roadway, South Carolina could realize a notable decrease in roadway fatal and injury crashes. Further, clear zone reclamation also has potential benefits of decreased tree removal and reduced hazards accrued during natural disasters. For every dollar invested in tree clearing, \$26-\$38 will be saved.
- **DUI Fatalities** (2015 - 301 fatalities, 30.7%) - South Carolina has some of the weakest laws in the United States relating to DUI offenders. A driver's license is suspended for refusal to take a test for alcohol; however, a driver may obtain a temporary alcohol license or a route-restricted license upon release from jail. Emma's Law, passed in 2014, increased the penalties for DUI convictions, requiring first-time convicted offenders with a BAC of 0.15% or greater to complete

the state's Ignition Interlock Device Program. The same law removed the hard suspension period for second and subsequent convictions, allowing drivers to get their licenses back sooner by completing an Alcohol and Drug Safety Action Program. A 2016 Impaired Driving Assessment (2016) refers to this SC statute as "...poorly drafted and archaic...and mandates unsafe roadside practices endangering the public and the officer making the stop" Further, South Carolina is one of only two states in the nation where police officers prosecute their own DUI cases. Nebraska and Arizona have implemented some of the strictest laws requiring first-time offenders and repeat offenders to install ignition interlock systems. Before the program was enacted in Arizona in 2007, DUI fatalities comprised 54% of the total fatalities. By 2012, DUI fatalities in Arizona had dropped to 28% of the total fatalities. This along with many programs (DUI courts, beverage server training, and solicitor case handling) could be implemented to reduce DUI-related factors in South Carolina. For every dollar invested in DUI courts, \$49 will be saved.

- **Speed-related Fatalities** (2015 - 361 fatalities, 36.9%) - Almost 40% of the fatalities on South Carolina roadways were speed-related. Speed-related is defined as: exceeding authorized speed limit, and/or driving too fast for conditions. This is the 2nd highest rate in the nation. Speed is a behavioral issue that must be managed through enforcement activities, and the reality is that drivers far outnumber enforcement officers. Auto-enforcement with cameras has the potential to expand speed management programs and reduce crashes - not only speed-related crashes, but all crashes. Unfortunately, in 2010, South Carolina banned the use of red light cameras and speed cameras in the state. Camera enforcement began for the first time in 1987 in Arizona. Since then, speed cameras have been used in 12 states and the District of Columbia and have lowered fatal crashes up to a 25% at fixed camera sites and up to almost 50% with mobile camera operations. An added benefit is that they also foster better traffic flow with more uniform speeds. For every dollar invested in camera speed enforcement, \$13 dollars will be saved.
- **Teen Driver Fatalities** (2015 - 40 fatalities, 6%) - In 2015, there were 37 fatal crashes among 15-17 year-old drivers, which produced a crash cost of \$347.8 million in South Carolina. Traffic fatalities are the leading cause of death of teens, greater than homicide, suicide, and disease combined. Graduated Drivers Licensing programs have reduced teen crashes by 10-40% on average in the US through a three-stage criterion for granting young drivers full driver's license privileges. The three stages are: a supervised learning period, a restricted intermediate licensing stage, and a full license stage, in which the driver is granted an unrestricted license after fulfilling all requirements. The purpose of the GDL programs are to maximize experience while minimizing common risks that teens face while driving. Estimates by the Insurance Institute of Highway Safety indicate that at least 10 states, including South Carolina, could reduce their rate of teen driver related fatal crashes by nearly 50% or more by adopting the strictest GDL provisions. For South Carolina, a 45% reduction could be realized by adopting three stricter GDL criteria including: raising the permit age to 16 and the unrestricted licensing age to 17, raising the minimum number of practice hours to 70, and restricting teen passengers during the

intermediate driving phase. For every dollar invested in adopting strict GDL provisions, \$156 will be saved.

To make significant gains, all partners must have a complete vision of their role and responsibilities in the priority programs and seek collective efficacy through collaboration across the state. The development of this comprehensive safety program assessment, along with identification of funding sources, will enable forward movement on all fronts. Using a data driven approach to safety program selection will yield support for changes in programs, policies, and standards, and have positive impacts on safety, operational, and economic aspects of the South Carolina roadway system. Further, the implementation of a data-driven safety management program will help to assure that the most appropriate strategies are implemented.

The successful implementation of this research will likely result in a substantial reduction in loss of life and injuries associated with motor vehicle crashes in the state of South Carolina. This research is expected to have significant benefits for SCDOT and the motoring public. These benefits fall into several categories, and are related to reduced numbers of crashes and the resulting deaths and injuries, improved system operations and reduced delay, decreased fuel consumption and emissions, as well as potential cost savings for SCDOT and other stakeholder agencies.