Moving to Vision Zero: Road Safety Strategy Update and Showcase of Innovation in British Columbia

Photo Credit: British Columbia Ministry of Transportation and Infrastructure

Ministry of Public Safety and Solicitor General
RoadSafetyBC
Research and Data Unit
Policy and Strategic Initiatives Branch

Authors: Dotan Amit, Neil Arason, Linda Mussell, and Danielle Woolsey.

January 2016

Table of Contents

Acknowledgements

Moving to Vision Zero: Road Safety Strategy Update and Showcase of Innovation in British Columbia updates and builds from the document *British Columbia Road Safety Strategy: 2015 and Beyond* (2013)[1], which brought together the efforts of over 40 British Columbia road safety stakeholder groups. These groups include government, the insurance sector, crown entities, researchers, enforcement agencies, the health sector, local government and others.

RoadSafetyBC would like to acknowledge all partners who contributed to the development of the strategy:

Abbotsford Police
Canadian Traffic Safety Institute
BC Cycling Coalition
BC Emergency Health Services
BC Forest Safety Council
BC Injury Research and Prevention Unit
BC Trucking Association
BC Automobile Association (*BCAA*)
Canadian Council of Motor Transport Administrators
Canadian Traffic Safety Institute
Central Okanagan Traffic Services
Centre for Addictions Research of BC and School of Health Information Science
City of Chilliwack
City of Dawson Creek
City of Kelowna
City of Nanaimo
City of Surrey
City of Vancouver
Doctors of BC
Fraser Health Authority
HUB Cycling
Insight Driving Solutions
Insurance Corporation of British Columbia *(ICBC)*
Interior Health Authority
Metro Vancouver Transit Police
Ministry of Health – *Population and Public Health*
Ministry of Public Safety and Solicitor General – *BC Coroners Service*
Ministry of Public Safety and Solicitor General – *Police Services Division*
Ministry of Public Safety and Solicitor General – *RoadSafetyBC*
Ministry of Transportation and Infrastructure – *Commercial Vehicle Safety and Enforcement*
Ministry of Transportation and Infrastructure – *Highways Division*
Mothers Against Drunk Driving
New Car Dealers Association
Northern Health Authority
Office of the Provincial Health Officer
RCMP – *Lower Mainland District*
RCMP – *Collision Analysis*
RCMP – *Island District Traffic Services*
RCMP Traffic Services – *E Division*
Saanich Police Department
SafetyDriven – *Trucking Safety Council of BC*
Tahltan First Nation
Town of Smithers
TransLink
TranSafe Consulting
Trauma Services BC
Union of British Columbia Municipalities
University of British Columbia Okanagan
University of the Fraser Valley
University of Northern British Columbia
University of Victoria
Vancouver Coastal Health Authority
Vancouver Island Health Authority
Victoria General Hospital
WorkSafeBC

RoadSafetyBC would also like to thank the following agencies for data contributions used in analysis for this report:

ICBC
BC Transit
TransLink
BC Ministry of Health – *Hospital and Ambulatory Analytics*
BC Emergency Health Services

Finally, RoadSafetyBC would like to thank a number of individuals who provided especially thoughtful and specific feedback during the review process: Jerome Atherton, Adrian Bell, Raheem Dilgir, Dr. Bonnie Henry, Mavis Johnson, Dr. Gordon Lovegrove, Nam Nguyen, Arno Shortinghuis, and Shannon Tucker.

Message from the Minister of Public Safety and Solicitor General

Road safety is an important and evolving public health issue that impacts all citizens of British Columbia. We all have a vested interest in keeping British Columbia's roads and communities safe. Whether driving a car, truck or motorcycle, riding a bicycle, taking public transit, or walking, we all participate as road users.

Just last year, 290 people died and another 2,631 were seriously injured in motor vehicle crashes in British Columbia. Although there have been improvements in the past decade, these numbers are as shocking as they are tragic. Speed, distraction, and impairment are still a significant concern.

Motor vehicle fatalities and serious injuries are preventable. This is why British Columbia has been working toward the ultimate goal of zero traffic fatalities and serious injuries. In fact, we want to have the safest roads in North America by 2020.

Time is short for such a lofty goal: less than five years to go and much work still to do. I also recognize this is not a goal government can reach on our own. That's why we will continue working closely with stakeholders and road safety partners to address all aspects of the problem, including a focus on safe road users, safe vehicles, safe roadways, and safe speeds.

Moving to Vision Zero provides an update for *British Columbia Road Safety Strategy: 2015 and Beyond*, which was the product of close collaboration between government, the insurance sector, Crown entities, the health sector, law enforcement agencies, non-profit organizations, road safety groups and partners, and academic researchers.

This report re-affirms our way forward. Embracing new road safety innovations, continued and vigilant enforcement, being responsive to population and demographic shifts, and changing the way citizens use the road will all be essential to our continued success.

Together, our government – led by RoadSafetyBC – and partners will continue delivering quality research, policy development, program evaluation, and public education, and with hard work, collaboration and innovation, we will move closer toward the ultimate goal of zero traffic fatalities and serious injuries.

The Honourable Mike Morris
Minister of Public Safety and Solicitor General

Introduction: Achieving the British Columbia Vision

British Columbia road safety partners have aligned themselves with *Canada's Road Safety Strategy 2015*, and have adopted its goal of continuing to reduce fatalities and serious injuries caused by motor vehicle crashes. According to the national strategy, each province and territory will take ownership of its own individual strategy, while cooperating and collaborating with all levels of government, as well as with other stakeholders. The national strategy provides a framework of best practices, but each jurisdiction must identify its own needs and seek its own specific targets.

British Columbia's goal is to have the safest roads in North America by 2020. In line with the *Vision Zero* movement, the ultimate goal is to eliminate motor vehicle crash fatalities and serious injuries. The British Columbia vision will be achieved by: targeting key areas of concern; advancing the *Safe System Approach*; continuing with the implementation of the BC Road Safety Strategy; and enhancing road safety research capacity in the province. Improved communication and engagement with all British Columbia citizens, particularly local communities, stakeholders, and First Nations, is essential for moving toward *Vision Zero*.

Better road safety is not achieved by accident; it is *create*d through deliberate, innovative, and evidence-driven practices. Step by step, kilometre by kilometre, British Columbia's roads can be made safer for everyone.

Structure of the Report

This report is divided in three parts. Part I outlines the theory, principles, and practices guiding the BC Road Safety Strategy. It explains the concepts of a *Safe System Approach* and a public health perspective, discusses their significance to road safety, and lays out the BC Road Safety Strategy's purpose, which is to move toward its *Vision Zero* goal. Finally, it describes some of the policies and projects led by the Government of British Columbia that have either helped to improve road safety, or are envisioned to reduce the number of deaths and serious injuries on the province's roads.

Part II of this report provides an update of statistics on fatalities and serious injuries caused by motor vehicle crashes in the province. This part focuses on the most recent data and highlights areas in need of added attention, including: reducing the number of crashes that result in either fatalities or serious injuries; addressing dangerous driving behaviours; improving the safety of vulnerable non-motorized road users, namely pedestrians and cyclists; understanding the impact of changing road user age demographics; and addressing differences in regional rates of fatality and injury.

Part III is a showcase of road safety innovations and evidence-based practices newly employed in British Columbia.

Executive Summary

This executive summary gives an overview of the three parts of *Moving to Vision Zero: Road Safety Strategy Update and Showcase of Innovation in British Columbia*. These three parts address the theory, principles, and practices of the strategy, provide an update of road safety trends in British Columbia, and present a showcase of innovative road safety efforts in the province.

Theory, Principles, and Practices of the British Columbia Road Safety Strategy

Road safety is a major public issue. Each year, thousands of people in the province are either killed, sustain long-term injuries, or are the family members or friends of motor vehicle crash victims. In addition to the direct consequences experienced by some, all British Columbians are indirectly affected by the economic costs of motor vehicle crashes. Transport Canada estimates that the total annual social cost of traffic crashes for British Columbia is between 2-3% of the provincial Gross Domestic Product – an amount that is roughly consistent with the social cost of motor vehicle crashes in other Canadian provinces. Every dollar that is lost to the consequences of motor vehicle crashes cannot be spent by governments and households for other purposes.

In order to better address the problem of motor vehicle crashes, the Province joined with over 40 road safety partner organizations in 2013 to develop the BC Road Safety Strategy, which was first embodied in the document *British Columbia Road Safety Strategy: 2015 and Beyond*. In particular, the strategy highlighted the importance of encouraging innovation and flexibility, and this continues to be emphasized in this current report.

The BC Road Safety Strategy's goal is for British Columbia to have the safest roads in North America, measured in terms of having the lowest rates of fatalities and serious injuries per 100,000 population. The strategy is also aligned with *Vision Zero* thinking, which holds that *all* motor vehicle deaths and serious injuries are preventable. British Columbia's ultimate target is the elimination of fatalities and serious injuries on the province's roads.

A cornerstone of *Vision Zero* is the *Safe System Approach*. In the context of road safety, the *Safe System Approach* maintains that traditional road safety efforts have targeted low-hanging fruit, for example: a high prevalence of irresponsible behaviours like speeding or impaired driving; high-crash locations; or the most common types of lethal crashes (e.g., errant vehicles driving off the side of the highway). Efforts focused on these areas have done a great deal to address risks and have saved many lives, but the same sets of interventions can only ever achieve so much progress because many of the remaining serious crashes are diffused across the entire road system, where multiple and varied causes are at play, including ordinary human error.

Indeed, a central tenet of the *Safe System Approach* is that human error is an unavoidable aspect of reality, and that even the most responsible and prudent drivers can, and do, cause serious crashes. The *Safe System Approach* enables more ambitious progress by treating the road system as a product of numerous components. These components are: safe road users who are well-trained, knowledgeable of driving challenges and risks, and who are respectful of traffic rules; safe vehicles, which are equipped with proven and effective safety designs and

technologies; safe roadways, road designs, and land-use planning that reduce the risk of crashes as well as the risk of death and serious injury when crashes do occur; and safe speeds, including setting safe speed limits, and adequately enforcing those limits.

Each individual component is vital, but also has limitations inherent in it. The strength of the *Safe System Approach* is in integrating the strengths of all components such that they complement one another. According to the *Safe System Approach*, a fatality or serious injury can only occur when the gaps and weaknesses in the components line up in such a way as to allow an error to result in a fatality or serious injury. A road system designed according to the *Safe System Approach* ensures that one component or more is always in place to prevent a serious injury consequence.

The *Safe System Approach* has been successfully implemented in other transport systems, such as aviation and rail networks, both of which experience human error on a regular basis. For example, the International Aviation Safety Reporting System records 60,000 incidents per year of mistakes made by air and ground crews, but this only rarely leads to serious consequences for people because the aviation transport system has been designed to be forgiving of human error. Through deliberate and thoughtful efforts, the same can be done for British Columbia's road networks.

A well-designed road system provides obvious benefits to safety by reducing the burden of crashes, but it can also generate other benefits to human well-being by improving population health and lifestyle. According to a public health perspective, doing things such as building better infrastructure to protect cyclists or improving public transit systems does not only benefit the people who currently use those modes, but also encourages more people to choose cycling or public transit to commute and run errands. This can reduce the volume of vehicle traffic, which reduces the risk of crashes. It also increases physical activity among the population and contributes to reducing air pollution and greenhouse gas emissions. By adopting a public health perspective coupled with a *Safe System Approach*, the BC Road Safety Strategy takes a holistic a view of the road system.

The Government of British Columbia continues to introduce new road safety measures. These efforts include: legislative tools, such as the Immediate Roadside Prohibition program and the continued strengthening of distracted driving penalties; education and awareness, such as the *Shift into Winter Campaign* and the Driver Information System; infrastructure, such as investments in highway safety improvements; and new technologies, such as variable speed limits and wildlife detection systems. The full descriptions of these and other policies and programs are included in this report.

Finally, the BC Road Safety Strategy stresses that, because many areas of expertise are necessary for improving the road network, effective road safety efforts must be collaborative. In order to cultivate the professional networks and knowledge sharing that improve cooperation, RoadSafetyBC led the 2015 BC Road Safety Strategy Conference, which brought together over 100 road safety partners, and included over 25 presenters who shared their

recent work and research. At the conference, the five working committees of the BC Road Safety Strategy reported on the initiatives that they undertook in 2014 and 2015. The committee reports and conference presentations are described in more detail in Part I of this report.

Data Update on Road Safety in British Columbia Today

The 10-year period spanning 2005 to 2014 saw overall progress in road safety. The total number of motor vehicle crash fatalities in British Columbia decreased by 36% during this time. The total number of serious injuries (i.e., injuries requiring overnight hospitalization) declined by 15% over the same period. The number of ambulances dispatched to motor vehicle crashes decreased by 23% between 2005 and 2014.

The year 2014 saw an increase in fatalities, serious injuries, and ambulance calls compared to 2013. There were 290 fatalities in 2014 compared to 269 in 2013, an 8% increase. Serious injuries increased from 2,464 in 2013 to 2,631 in 2014, a 7% rise. The number of ambulances dispatched to motor vehicle crashes increased from 26,550 in 2013 to 27,471 in 2014, a 4% rise. It is crucial that effective road safety measures be sustained, and that additional ones are found or created, and implemented.

Statistics from the last decade reveal that although there were significant overall improvements made in road safety over time, this progress has not been shared equally between different types of road users, regional populations, and population demographics. The BC Road Safety Strategy stresses that all road users should benefit from safer roads.

Vulnerable non-motorized road users, namely pedestrians and cyclists, have not experienced improvements in road safety outcomes. In absolute numbers, pedestrians and cyclists had about the same number of fatalities in 2014 as they did in 2005. These road users sustained more serious injuries in absolute numbers in 2014 than in 2013, and the 10-year trend from 2005 to 2014 has been relatively flat. As a proportion of all motor vehicle-related serious injuries, road safety outcomes for pedestrians and cyclists have worsened; pedestrians had 15% of all motor vehicle-related serious injuries in 2005 and 19% in 2014, and cyclists had 5% of all serious injuries in 2005 and 7% in 2014.

Road safety outcomes are also unevenly distributed between different regions of the province. The Southern Interior had the most fatalities in 2014, despite the fact that it is more sparsely populated than some of the other parts of the province. Greater Vancouver and the Fraser Valley together had a fatality rate of 3.25 per 100,000 population in 2014, and Vancouver Island had 3.58 fatalities per 100,000 population the same year. This was close to half the provincial average that year, which was 6.26 fatalities per 100,000 population. The North Central region had the highest rate of fatalities in 2014, at 18.93 per 100,000 population – about triple the provincial average. The Southern Interior also had a high fatality rate of 15.71 per 100,000 population in the same year. This gap is a result of risk factors associated with rural areas, including, for example: longer driving distances; faster rural roads; more inclement weather; longer response times for emergency services; and lower seatbelt usage rates. These deaths,

however, are not inevitable, and solutions must be found and applied that benefit road users in all regions of the province.

Road fatalities and serious injuries are also unevenly distributed across population demographics. Different age groups have seen unequal gains in road safety. The youngest driver age group, spanning from 16-25 years of age, has seen a marked decline in absolute numbers of crash fatalities between 2005 and 2014, despite the fact that this group has grown in size. Older age groups, including those aged 56-65 years, 66-75 years, and 76 years and older have either remained flat or sustained more fatalities each year from 2005 to 2014.

First Nations sustain a disproportionate burden of motor vehicle crash consequences. This is partly because many First Nations individuals live in rural areas of the province, which increases driving risks. Other factors include generally lower socio-economic status, which can impact the ability to own newer cars with more advanced safety features, and the ability to keep one's vehicle in an adequate state of repair. Individuals in the First Nations populations are also more likely to be victims of alcohol-related motor vehicle crashes.

Overall, British Columbia has made significant improvements in road safety over the last decade. But far too many people are still dying and sustaining long-lasting injuries from crashes, and certain groups are not benefitting from the added safety measures put in place. The *Safe System Approach*, coupled with a public health perspective, can guide efforts and generate results, while also contributing to overall population health. This will be achieved through stronger efforts and newer approaches.

Showcase of Innovation in British Columbia

Moving to Vision Zero takes the opportunity to present innovative efforts that go beyond the traditional road safety approach. This report includes a showcase of innovation, which presents newly introduced road safety measures that have been proven to reduce the risk of crashes, fatalities, and serious injuries. The BC Road Safety Strategy is a collaborative endeavour that includes all road safety partners, including those within and outside the provincial government. Many of the measures showcased were introduced by non-provincial government organizations, including municipalities and ICBC. Several of these measures are relatively low-cost and easy to implement, and benefit vulnerable road users in addition to vehicle occupants.

The showcased innovations are the following:

1. Burrard Street and Cornwall Avenue intersection in Vancouver;
2. Pedestrian Scramble in Richmond;
3. Yield Here to Pedestrian (Advanced Stop Line) in Kamloops;
4. Leading Pedestrian Intervals in Surrey;
5. Narrowed Lanes in Surrey;
6. Protected Bike Lane Median Extension in Vancouver;
7. Child Seat Legislation in British Columbia;

8. Cariboo Connector;
9. Malahat Safety Improvements;
10. Clearwater Roundabout; and
11. Cable Tension Barriers throughout British Columbia.

More efforts of the kind presented in the showcase of innovation will help British Columbia move toward *Vision Zero*. In the process, more lives will be saved, fewer people will have to live with the long-term or life-time consequences of serious injuries, and every British Columbian will benefit from the reduced economic burden that accompanies safer roads.

Part I: Theory, Principles, and Practices of the British Columbia Road Safety Strategy

Vancouver, British Columbia
Photo credit: Carl Sundstrom, www.pedbikeimages.org

Ministry of Public Safety and Solicitor General
RoadSafetyBC

RAD 2015-098
January 2016

Guiding Theory and Principles

Moving to Vision Zero follows *British Columbia Road Safety Strategy: 2015 and Beyond* by adopting a *Safe System Approach* coupled with a public health perspective. This joint approach has been embraced by all leading road safety jurisdictions. However, this was not always the case in the past. The next section details the historic approach to road safety, followed by an explanation of the theories and approaches currently used, and an overview of British Columbia's *Vision Zero* goal.

The Historic Approach

Since the invention of motor vehicles and the rise in popularity of motor vehicle transportation through the twentieth century, the historic approach to road safety would, at times, focus on the role and responsibilities of the individual road user in isolation. Efforts worked to refine enforcement techniques and deterrence strategies, educate and train road users, and generate social pressures, for example by stigmatizing drinking and driving. While efforts aimed at road users' behaviours have been successful in many ways, such an approach can only ever achieve so much because even the most cautious road users will always be subject to the inescapable reality that humans are fallible and mistakes can happen to anyone. Indeed, evidence shows that the majority of vehicle crashes and resulting deaths and injuries arise from basic human error, rather than from reckless behaviour on the part of drivers or other road users.[2]

At other times, road safety efforts undertaken within the historic approach have focused on building better vehicles and better roadways. This approach was based on the idea that road and vehicle designs could help prevent collisions by anticipating and factoring in the possibility of human error, and could be made to be more forgiving of error when mistakes did occur. Vehicle technologies like airbags and crumple-zones, and road design elements like rumble strips, clear zones, and median barriers could be implemented to either help prevent crashes, or reduce the injury consequences of crashes for all road users.

Safe System Approach

The historic approach has helped make significant progress in road safety. However, added progress has sometimes been obstructed by the fact that each type of intervention, whether it was focused on driver behaviours, vehicle design, or on specific road features, was dealt with in an isolated manner that overlooked possible synergies between different types of interventions. The *Safe System Approach* responds to this by taking a holistic and comprehensive view of the entire road system. Each intervention can produce improvements in multiple elements of the road system in such a way that the total effectiveness exceeds the sum of the individual parts. In other words, improvements will interact to create safe situations; road users, vehicles, roadways, and safe travel speeds are all necessary components for improving safety.[3]

The *Safe System Approach* has been successfully adopted in other types of transport systems, such as the aviation and railway industries, well before its introduction into road safety practices.[4] It was adopted by British Columbia in 2013 and is envisioned to contribute to

significant progress in reducing the number of road fatalities and serious injuries in the province.

The ultimate focus of the *Safe System Approach* is to reduce and then eliminate motor vehicle fatalities and serious injuries. Safe system design focuses on building better roads, improving vehicle safety technologies, and managing kinetic energy to reduce the physical forces on humans when motor vehicle crashes inevitably occur. Design elements like those featured in Part III of this report contribute to safe systems by helping to reduce the risk of occurrence and the severity of injuries.

Figure 1 provides a visualization of the components that comprise the *Safe System Approach*.

Safe System Components

1. *Safe Road Users*

   This component of the *Safe System Approach* focuses on reducing unsafe behaviours including: drinking and driving, drug use and driving, distracted driving, speeding, and failing to use occupant restraints; targeting high-risk drivers and chronic offenders; and protecting vulnerable road users such as pedestrians and cyclists.

2. *Safe Vehicles*

   The safe vehicles component of the *Safe System Approach* requires working with partners such as corporate consumers, Transport Canada, the automotive industry, and researchers to assess and raise awareness about the next generation of safety technologies. Vehicle safety is improved by monitoring issues across British Columbia and ensuring that safety concerns are communicated to federal authorities responsible for Canadian motor vehicle regulation.

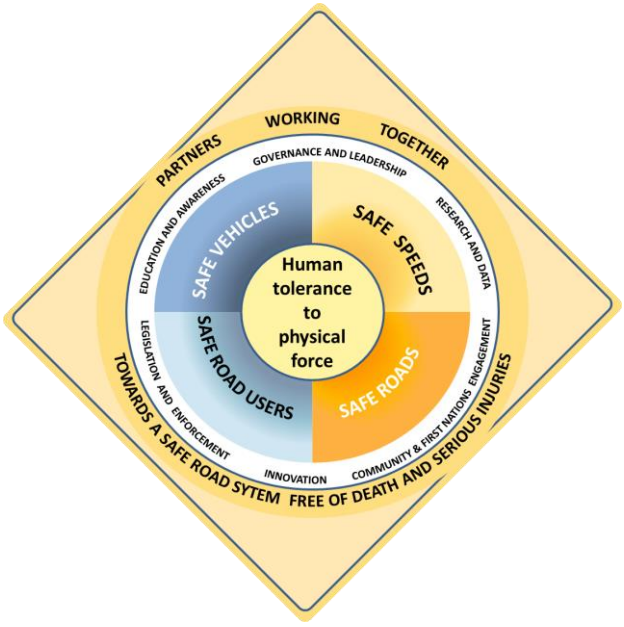
3. *Safe Roadways*

   The safe roadways component of the *Safe System Approach* focuses on the role of road project development, and on land use and neighbourhood planning. This component encourages the explicit consideration of safety for innovations in road design. Areas for work include identification and improvement of high-risk locations, and better road designs that benefit vulnerable road users.

4. *Safe Speeds*

   The safe speeds component of the *Safe System Approach* promotes setting safe

Figure 1. *Safe System Approach*



speed limits, greater compliance with speed limits, vehicle-speed management technologies, and educating road users.

All stakeholders of the road system contribute to the *Safe System Approach* through legislation, education, enforcement, road design, collaboration, licensing programs, research, innovation, and communication.

The Safe System Approach *strives to create road system designs that anticipate human error, and which are more forgiving when errors are made.*

Public Health Perspective

The public health perspective is a scientific and systematic approach to disease and injury control. This perspective highlights that public health comes from many angles, and that each effort can have beneficial impacts in multiple spheres. The public health perspective on road safety is unique in that it emphasizes that road safety need not be narrowly focused on preventing crashes, but can also contribute to citizens' health through the encouragement of non-motorized modes of transportation such as walking and cycling. A public health perspective on public transit also holds that this transport mode offers benefits to health and well-being by increasing the amount that people walk, by reducing air pollution, and by reducing the number of vehicles on the road and therefore the risk of motor vehicle crashes.

Collaboration with the public health sector is crucial to advancing road safety. For example, the health sector collects data on injury severity and characteristics, and offers insight into how to prevent and reduce the severity of injuries. Integrating and including this perspective in road safety analysis is imperative. The health sector is also on the frontline when it comes to responding to motor vehicle injuries and providing emergency health services. By adopting the public health perspective, *Moving to Vision Zero* embraces a broad view of progress made across different areas of intervention.

Vision Zero

Vision Zero thinking emphasizes that no loss of life in road transport is acceptable.[5] The adoption of an integrated *Safe System Approach* and public health perspective is meant to advance British Columbia's progress toward the *Vision Zero* target.

The *Vision Zero* approach to road safety was founded in the Netherlands in 1992, and has since been adopted by many of the world's leading road safety jurisdictions. This approach was first initiated in countries like Sweden, Norway, and the United Kingdom, and has since gained momentum in many other countries.[6] These countries, each of which has adopted a *Safe System Approach* to road safety, have the lowest rates of motor vehicle crash fatalities in the world.[7]

Vision Zero is currently spreading throughout North America. The American Association of State Highway and Transportation Officials, among other United States organizations, recently joined the National Strategy on Highway Safety's *Toward Zero Deaths* vision. This means that *Vision*

Zero is now being embraced in the United States at a national level, in addition to many individual city efforts, such as in New York City, Portland, San Francisco, Chicago, Los Angeles, and Seattle.[8]

Initiatives in New York include reducing the default speed limits, establishing a permanent *Vision Zero* task force, a new focus on pedestrian safety, increased police enforcement, engineering improvements at a number of intersections and corridors, and enhanced street lighting, among many others.[9] After adopting *Vision Zero* and committing to road safety improvements, New York City's traffic fatalities decreased 15%. Pedestrian fatalities decreased 27%, making 2014 the safest year for pedestrians in New York City since 1910.[10]

Vision Zero has also been recognized by the World Health Organization as an effective road safety policy, and is recognized for its ability to significantly reduce traffic fatalities and serious injuries.[11]

The British Columbia Road Safety Strategy

In alignment with *Canada's Road Safety Strategy 2015,*[12] RoadSafetyBC led British Columbia road safety partners in the development of the BC Road Safety Strategy in 2013. Having adopted a *Safe System Approach*, the strategy emphasizes the need for shared responsibility and collaboration across all areas affecting roads. Leading road safety experts argue that an interdisciplinary approach produces efforts that reinforce and complement one another.[13]

The BC Road Safety Strategy involves over 40 road safety organizations and over 100 individuals. Its governance framework, which is based on a review of best practices from around the world, includes a partnership made up of a 14-member province-wide Road Safety Steering Committee comprising the Superintendent of Motor Vehicles in RoadSafetyBC, Crown entity stakeholders, Assistant Deputy Ministers from ministries with road safety responsibilities, senior executives, and a special advisor. The Steering Committee meets regularly to review priorities and progress, and to help set the agenda for future road safety efforts.

In addition, RoadSafetyBC coordinates the activities of five working committees that include government and non-governmental stakeholders. The working committees identify priorities and opportunities for collaboration, suggest solutions, and provide expertise in the areas of:

1. Safe Vehicles;
2. Safe Roads and Communities;
3. Research and Data;
4. Safe Road Users; and
5. Education and Awareness.

The strategy also strives to promote public awareness on the issue of road safety. In order to enlist British Columbians in road safety efforts, it is vital to engage and inform them about efforts being made in the province and to incorporate their feedback.

Four Guiding Principles of the British Columbia Road Safety Strategy

The strategy is based on four principles that guide the work of road safety stakeholders:

1. Adopt a comprehensive *Safe System Approach* coupled with a public health perspective;
2. Envision road safety as a collaborative effort with a focus on results;
3. Sustain successful measures and focus on new areas that require attention; and
4. Encourage innovation and flexibility among partners.

Measuring Success and Reporting on Progress

The BC Road Safety Strategy measures success through the reduction in the number of motor vehicle fatalities and serious injuries per 100,000 population per year. With an estimated population of 4,631,302 people in 2014, British Columbia had a rate of 6.26 motor vehicle fatalities per 100,000 population, and 56.81 serious injuries per 100,000 population that year.[14,15,16] These 2014 rates serve to mark the current state of progress compared to previous years, and are a baseline for assessing the progress to be made in the future.

Government of British Columbia Safety Initiatives

The Government of British Columbia plays a major role in the leadership and implementation of road safety legislation, regulation, policies, programs, and infrastructure projects. The statistics contained in Part II of this report are used to inform these actions. This section highlights a number of provincial government initiatives that have helped reduce the number of crashes, fatalities, and serious injuries, as well as some newly implemented ones that will add to the effort of making the province's roads safer.

Distracted Driving Consultation

The Government of British Columbia held a distracted driving consultation over the summer of 2015. Led by RoadSafetyBC, the purpose of the consultation was to gauge the level of concern over distracted driving, and to assess the range of opinions on what further sanctions could be appropriate. This public consultation generated a great deal of media interest, and collected over 12,000 responses in the form of poll responses, discussion forum comments, emails, and stakeholder letters.

RoadSafetyBC reviewed and analyzed the submissions, and concluded that an overwhelming majority of online-survey respondents viewed distracted driving as the most serious danger on the province's roads. It was also clear from the input of British Columbians that there is a good deal of support for strengthening the sanctions currently in place.

New Approach to Combatting Drinking and Driving

RoadSafetyBC, in the Ministry of Justice, led the development and implementation of a new approach to combatting drinking and driving in British Columbia. In September 2010, the Province introduced Immediate Roadside Prohibitions (IRPs) for alcohol-affected drivers. The IRP program provides enforcement officers with the necessary tools and legislative provisions to issue up to a 90-day licence suspension and up to a 30-day vehicle impoundment to drivers

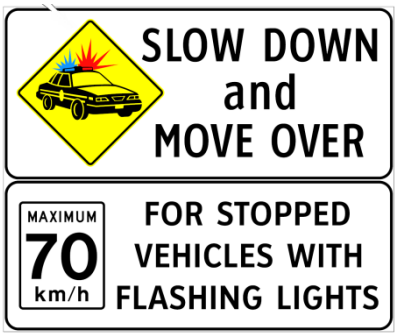
who fail a roadside breathalyzer test or who refuse to provide a breath sample. This new approach is estimated to have saved 260 lives in under five years.[17]

A recent development that advanced RoadSafetyBC's efforts was the Supreme Court of Canada's October 16, 2015 rulings on the Wilson v. British Columbia and the Goodwin v. British Columbia appeals. In the first case, the Supreme Court confirmed that a 'warn' reading on a breathalyzer test (defined as a blood alcohol content reading between 0.05 and 0.08) provides sufficient evidence that driving ability is affected. In the Goodwin appeal, the Supreme Court upheld the constitutionality of the IRP program. The Minister of Justice applauded the decision, and reaffirmed that British Columbia's plan is "to have one of the toughest drinking driving laws in the country and to protect public safety by getting these drivers off the roads."[18]

This legislation gives police the tools they need to get alcohol-affected drivers off the province's roads.

Slow Down and Move Over Regulation Change

In order to make conditions safer for roadside workers and emergency personnel, the Province modified its *Slow Down Move Over* rule. Since January 1, 2015, the *Slow Down Move Over* rule requires drivers to slow down for all roadside workers and vehicles with flashing lights stopped on the side of a roadway. Drivers must reduce speeds to 70 km/h when in an 80 km/h or over zone, and 40 km/h when in an under 80 km/h zone. If travelling on a multi-lane road, the driver must move into another lane to pass where safe to do so.



Previously, the rule applied only when there were vehicles with a flashing light, which are considered "official vehicles." Official vehicles include: police, fire, ambulance, tow trucks, Commercial Vehicle Safety Enforcement vehicles, park rangers, and conservation officers. The amended regulations simplified the "official vehicles" definitions in the *Slow Down, Move Over* rule to include any emergency or maintenance vehicle displaying a flashing red, blue, or yellow light.[19]

The new regulations will make it safer for all people working on the side of the road.

Winter Tire Legislation and *Shift into Winter* Campaign

In October 2015 the Province introduced regulations which specifically define a winter tire as either an M&S (Mud and Snow) tire or a Snowflake/Mountain branded tire. The new regulations also modernized the definition and requirements for chains, studs, and other traction devices.


Photo Credit: BC Ministry of Transportation and Infrastructure

British Columbia winters, which generally stretch from October to March, pose unique travel and road

maintenance challenges. The Ministry of Transportation and Infrastructure, as part of the Winter Driving Safety Alliance, sponsors the *Shift into Winter* Campaign, which raises awareness about winter driving risks. In 2014, the campaign was expanded beyond the original areas of focus, which were Kamloops, Kelowna, and Prince George, and now also includes the northeast and southeast parts of the province.

Driver Information System

Introduced in 2005, DriveBC is the province's traveller information system, designed to inform motorists of highway conditions, travel advisories, weather information, and incident information along the provincial highway network. Other information found on DriveBC includes inland ferry schedules, border wait times, as well as access to BC HighwayCams. DriveBC is accessible via the Internet (www.drivebc.ca) and by calling the three-digit number (511).

Striving to adopt technological advancements, DriveBC is meeting user needs by enabling users to self-subscribe to receive information through email, Twitter, and Rich Site Strategy (RSS) feeds. This service provides timely and accurate traveller information, enabling the public, families, tourists, commercial vehicle operators, and emergency service providers to make more informed decisions before travelling. DriveBC is one of the most widely-accessed government websites in British Columbia, with 14 million visits annually.

Traffic Control for Work on Roadways

The Ministry of Transportation and Infrastructure has been working on updating practices for traffic control for when construction or maintenance work is being carried out on provincial roads. The upcoming Traffic Management Manual for Work on Roadways (TMM) will consolidate Ministry traffic manuals and publications into one document to ensure that all relevant information necessary for establishing a safe zone for workers and motorists is available in one place.

Some improved features of the new manual include more:

- Graphics and sample layouts;
- Options for devices and usage information;
- Information for Traffic Control personnel; and
- User-based tools and templates.

This manual is the product of a great deal of hard work and participation of a number of Ministry staff and stakeholder groups such as WorkSafeBC, the BC Road Builders and Heavy Construction Association, and the BC Municipal Safety Association, to name only a few. The 2015 Interim Traffic Management Manual for Work on Roadways has been released.

Highway Safety Improvements

Investing in highway improvements is critical to improving safety and increasing the reliability of the highway system. Since 2001, the Province has invested $17 billion to:

- Construct 190 kilometres of new, modern 4- and 6-lane highway;
- Add 33 new passing lanes, providing safe, assured passing zones;
- Replace intersections with 27 new interchanges;
- Improve 400 intersections;
- Add 4,000 kilometres of rumble strips and 300 kilometres of roadside/median barriers; and
- Improve or replace 500 bridges.

Variable Speed Limits

Variable speed limits (VSL) use changeable light emitting diode (LED) signs, allowing speed limits to be adjusted based on local road and weather conditions.

A VSL system uses pavement and traffic sensors to measure weather, pavement condition, and traffic flow. This information is then processed centrally and used to determine an adjusted speed limit for the current conditions that is then posted on variable speed signs along the corridor. Motorists are informed of an upcoming active VSL system and inclement weather ahead by an overhead changeable message sign installed at the start of each zone.

The Province's 2014 Rural Highway Safety and Speed Review Report recommended piloting VSL systems on three provincial corridors to improve safety and mobility in adverse weather conditions, during incident responses, or for special events. Installation of the pilot system has been completed on corridors along Highway 5 (Coquihalla), Highway 99 (Sea to Sky), and Highway 1 near Revelstoke, and is now in the testing phase.

Variable speeds will help drivers to better adapt to changing weather and traffic conditions and reduce the number of vehicles driving at speeds that are inappropriate for road conditions.

Wildlife Detection System

Wildlife on rural highways presents a serious potential hazard to drivers. Approximately 5,500 wildlife collisions are reported each year. Large animals such as deer, elk, and moose present the greatest danger to vehicle occupants due to their mass.

Wildlife collision statistics show that Highway 3 between Cranbrook and the Alberta Border has one of the highest rates of deer and elk collisions in the province. This makes it an ideal site for testing new initiatives to reduce wildlife collisions. As a pilot, two high-incident locations along Highway 3 were selected:

- Michel: a 5-kilometre segment on Highway 3 east of Sparwood, British Columbia; and
- Elko: a 3-kilometre segment on Highway 3 east of Elko, British Columbia.

As of October 2015, installation is underway and the wildlife detection system is expected to be fully functional by winter 2016.

A successful pilot will result in a reduced number of wildlife incidents in the immediate area, and provide a better understanding of how this technology could be used in other parts of the province.

Improved Cycling and Pedestrian Facilities

As part of the Ministry of Transportation and Infrastructure's *BC on the Move: A 10-Year Transportation Plan*, $18 million is being invested to improve cycling facilities across the province over the next three years.

One such project is the Stanley Park Causeway pedestrian and bicycle pathway. This project includes widening the sidewalks and installing bicycle fencing on both sides of the Causeway, which is a 2.2 kilometre segment of Highway 99 and is a popular cycling route connecting Vancouver with the North Shore. This is an important safety project, and also provides more transportation options for people travelling in Metro Vancouver.

Image credit: BC Ministry of Transportation and Infrastructure

Inspection of Commercial Vehicles

Annually, over 1 million trucks cross to and from the United States via the British Columbia's three Lower Mainland border crossings.

Commercial Vehicle Safety and Enforcement (CVSE) has over 200 officers operating throughout the province to monitor commercial carriers, with a focus on road safety performance. CVSE undertakes approximately 25 focused inspection campaigns annually, each targeting a specific safety issue such as brakes, load securement, etc.

Through a network of fixed inspection stations and mobile inspectors, CVSE completes 30,000 vehicle inspections annually on average.

The October 2015 British Columbia Road Safety Strategy Conference Summary

A *Safe System Approach* emphasizes that improvements in road safety are the result of numerous interactive elements, and that various areas of knowledge and expertise are required in order to link the various parts of a safe road system. The BC Road Safety Strategy calls for a regular assembly of road safety stakeholders as a means to connect, share knowledge and learn together, and identify areas for possible collaboration. Road safety partners should take account of areas outside their fields of expertise with a view to complementing their own projects and programs.

To this end, RoadSafetyBC led a conference in Vancouver on October 15 and 16, 2015. The conference brought together all provincial road safety partners to engage one another around the theme: "What Causes Safety?" The conference promoted dialogue and exchanges between the various working committees, agencies, and researchers working to foster safer roads in British Columbia. Over 25 presenters offered unique disciplinary perspectives on the issue of

road safety; these perspectives came from the areas of research, policy, engineering, infrastructure, technology, and law enforcement. This section lays out the major points made by each of the presentations.

Reports of the British Columbia Road Safety Strategy Working Committees

At the conference, the five BC Road Safety Strategy working committees reported on their activities over 2014 and 2015, and outlined their next steps. This section summarizes the reports of each of the five working committees.

Education and Awareness Working Committee

Over the course of 2015, this committee, which was chaired by Steven Roberts, who is the Deputy Superintendent of Motor Vehicles at RoadSafetyBC, decided to focus on the following priorities: the development of a sector-wide provincial road safety calendar of education and awareness initiatives; the development of a best practices toolkit for education and awareness events; the creation of a provincial road safety logo; and the building of a network for distributing education and awareness campaigns.

Research and Data Working Committee

This committee, chaired in 2015 by Dr. Jeff Brubacher of the University of British Columbia, worked to improve road safety data completeness, quality, and access. To this end, the committee reported on its progress in developing an inventory of relevant data sources, establishing a data dictionary, specifying data requirements, identifying data gaps, recommending data collection protocols, and recommending improvements to data collection forms. This work will enhance road safety research capacity in the province. The committee also contemplated the potential for developing a road safety research center.

Safe Vehicles Working Committee

This committee, chaired by Diane Mackay of ICBC and Philip Choi of SafetyDriven, conducted a survey of commercial and passenger vehicle safety stakeholders in 2015 in order to identify opportunities for joint projects involving multiple agencies. Analysis of the survey uncovered a number of obstacles for promoting vehicle safety, including a lack of financial and human resources, difficulties in identifying specific issues in need of attention, a lack of direct links between stakeholders and commercial vehicle drivers, and inconsistencies in the definition of commercial vehicles. The identification of these obstacles is the first step in overcoming them. The survey results also indicated some positive results, namely that many organizations already collaborate on commercial vehicle safety issues, and that there is a good deal of support for continued collaboration on the issue of safe vehicles.

Safe Road Users Working Committee

This committee, chaired by Sergeant John Teague and Jan Staples, both from the Ministry of Justice, considered options for introducing newer approaches to traffic enforcement, including higher driver penalties for violations that impact vulnerable road users specifically. It also looked into the use of new technologies such as touch-based alcohol detection systems that prevent an alcohol-affected driver from starting his or her vehicle. Finally, it has begun

considerations for a pilot project on automated speed enforcement, including considerations related to current research, the strategic context in the province, an overview of suitable technology, policy and legislation implications, and governance and oversight.

Safe Roads and Communities Working Committee

In 2014, this committee, chaired by Mavis Johnson of the Canadian Traffic Safety Institute and Raheem Dilgir of TranSafe Consulting, carried out a survey on road safety issues, challenges, and opportunities for British Columbia communities, and began preparing a report of the survey results. Among the most notable findings of the survey was that the majority of small municipalities in the province did not have a formally expressed mandate for improving road safety. Based on this and other findings from the survey, the Safe Roads and Communities Committee is looking into developing a toolkit of road safety management resources to make it easier for communities to begin addressing this important issue.

Provincial Health Office Report on Road Safety

Dr. Perry Kendall, the Provincial Health Officer, and Dr. Bonnie Henry, the Deputy Provincial Health Officer, delivered a presentation outlining the main parts of an upcoming report by the Provincial Health Office. They highlighted some of the major road safety trends in the province, while pointing to areas requiring greater attention. An important finding was that while motor vehicle fatality and injury rates have declined significantly over the last decade, the number and rate of people actually involved in motor vehicle crashes has not decreased substantially. Another finding was that there are age and sex differences in the incidence of human factors contributing to crashes. For example, men were found more likely than women to be in a fatal crash involving speeding or alcohol or drug impairment, while women were found more likely to be in a fatal crash involving distraction. Also, speeding and substance-impairment as contributing factors decrease with age, but distraction tends to increase. These findings can inform new measures.

The Express Section: Five Featured Projects

The conference's Express Section presented five current projects related to the provincial government's road safety efforts. These projects are described below.

Ministry of Transportation and Infrastructure

Norm Parkes, Executive Director of Highway Operations at the Ministry of Transportation and Infrastructure presented *BC on the Move: A 10-Year Transportation Plan*. Among the 12 objectives outlined in the plan were dedicated highway safety improvement plans that include: a $25 million per year safety improvement program; $10 million per year for intersection improvements; enhancements to DriveBC; and strategies to improve roadside worker safety. During its first year, the safety program will focus on installing pilot variable speed zones, pilot wildlife detection systems, and community safety projects. *BC on the Move* also contains objectives to keep the highway system in good repair and to expand its capacity and reliability, thus improving safety and supporting economic development.

RoadSafetyBC

Kathy Kirby, Director of Policy and Strategic Initiatives at RoadSafetyBC, discussed some of the preliminary findings of the British Columbia Distracted Driving Consultation that took place over the summer of 2015. An overwhelming majority of online-survey respondents in the consultation viewed distracted driving as a serious issue on the province's roads. British Columbians also expressed a great deal of support for strengthening the sanctions currently in place. British Columbia currently has the fourth smallest fine out of all Canadian provinces and territories.

An overwhelming majority of online-survey respondents in the consultation viewed distracted driving as a serious issue on the province's roads.

British Columbia Coroners Service

Michael Egilson, Chair of the Child Death Review Unit at the British Columbia Coroners Service (BCCS), presented on a recent child death review inquiry by the BCCS that looked at how and why teenage drivers die, discussed the social and institutional measures currently in place that help keep them safe, and looked at ways to prevent more teenage driver deaths. The presentation outlined the three recommendations made in the report, which were to: 1) review the Graduated Licensing Program (GLP) to identify ways to increase its effectiveness; 2) improve data collection methods in order to help identify areas for intervention; and 3) call on ministries in the provincial government to review requirements for conducting a pilot project on automated speed enforcement, and ensure that safety is the primary criterion used to review speed limits.

External Review of the Province of British Columbia's 2008 Child Seat Legislation

Dr. Jeff Brubacher, from the Department of Emergency Medicine at UBC presented on a study that evaluated the Government of British Columbia's update of its child and booster seat laws in 2008. The presentation laid out the dangers that inappropriate restraints pose to children in a motor vehicle crash, including lesions, muscular-skeletal injuries, and spinal injuries. This study is showcased in more detail in Part III of this report.

Dr. Brubacher advocated for the importance of closing the gap between scientific knowledge and policy implementation when it comes to informing public safety in general and seatbelt use regulations in particular. British Columbia adopted legislation in 1977 that made it a requirement to vehicle occupants to wear seatbelts, but strong evidence showing seatbelts were highly effective was available at least a decade earlier. Dr. Brubacher pointed out that many lives could have been saved if seatbelts were made mandatory when they were first known to be so effective. The history of seatbelt legislation in British Columbia contains important lessons about using available knowledge to improve road safety today.

Policing and Security Branch, Road Safety Unit

Jesse Ross, from the Road Safety Unit, Policing and Security Branch of the Ministry of Justice, outlined the results of a study on the effects of enhanced enforcement on speeding in Surrey from March 2014 to August 2014. The initiative focused on police efforts dedicated solely to enforcing speed limits along specific travel corridors. The study found that there was a reduction in the proportion of speeding as police spent more enforcement hours, though this had less effect on "non-enforcement days".

While enhanced enforcement reduces speeding when it is applied, it may be less effective for producing fundamental and lasting behavioural changes. Enhanced enforcement is still a viable tool, but it should be improved through a better understanding of *when* it is most effective, and through examining this type of intervention when it is accompanied by a public awareness campaign. This study adds to the extensive existing literature which demonstrates overall that police enforcement is proven to improve road safety outcomes.

Rapid Fire Presentations

The conference's Rapid Fire Presentations gave road safety researchers and practitioners a venue to share their recent studies and projects with the road safety community. The presenters were affiliated with British Columbia universities, Crown Corporations, and government agencies. The presentations are summarized below.

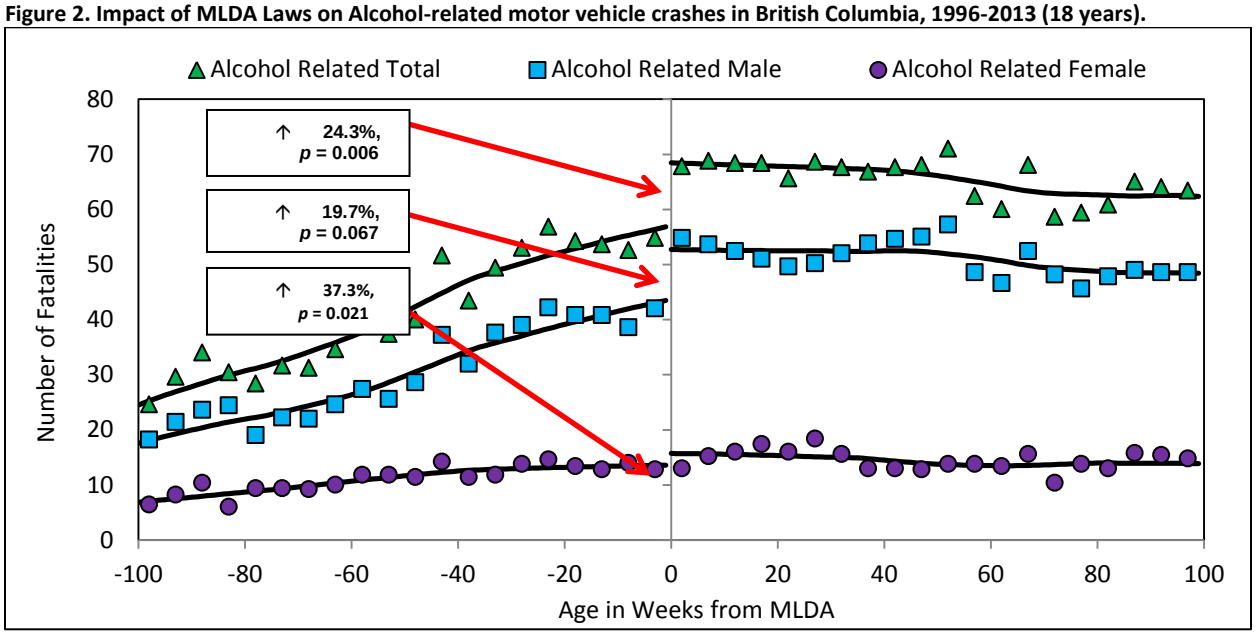
Dr. Callaghan argued that extending a 0% BAC restriction for drivers beyond the age of release from the MLDA may help reduce motor vehicle crashes involving young drivers.

Dr. Russell Callaghan, the University of Northern British Columbia

Dr. Russell Callaghan from the Northern Medical Program at the University of Northern British Columbia presented on the impact of minimum legal drinking age (MLDA) laws on crash fatalities for young drivers. His research shows that at the time that a population group reaches the MLDA, there is a significant and abrupt increase in the rate of inpatient hospital admission, alcohol-related crash fatalities, and alcohol-impaired driving crimes. The fatality rate due to alcohol-impaired driving crashes does not decrease until after the age of 25 years. Additionally, research suggests that drivers younger than 21 years with any positive blood alcohol content (BAC) demonstrate a significantly higher risk of being in a crash compared to adults over the age of 21, even when the BAC is below the legal limit.[20]

Based on this knowledge, Dr. Callaghan argued that extending a 0% BAC restriction for drivers beyond the age of release from the MLDA may help reduce motor vehicle crashes involving young drivers. Numerous jurisdictions have done this, including Ontario, Manitoba, New Brunswick, Nova Scotia, Prince Edward Island, and Quebec.

Figure 2. Impact of MLDA Laws on Alcohol-related motor vehicle crashes in British Columbia, 1996-2013 (18 years).



Source: Russell Callaghan et al. Drinking Age Laws and the Safety of Young People. BC Road Safety Strategy 2015 Conference.

Dr. Jeff Brubacher, University of British Columbia

A presentation by Dr. Jeff Brubacher showed that driving while under the influence of recreational drugs is common in British Columbia. Even more prevalent is the practice of driving while simultaneously using sedating medications. Most efforts to combat drugged driving, however, focus on the problem of recreational drugs. Dr. Brubacher concluded that police require better training and tools to identify drivers who are under the influence of each of these types of drugs.

Dr. Amanda McCormick, University of the Fraser Valley

Figure 3. Automated Licence Plate Recognition Technology.

Dr. Amanda McCormick from the University of the Fraser Valley's Centre for Public Safety and Criminal Justice Rese arch discussed the use of Automated Licence Plate Recognition (ALPR) technology. This camera technology, which is mounted on police vehicles, electronically reads licence plates in order to check the status of vehicles' registration against a controlled database. This technology provides police with the ability to match a high volume of licence plates against a secure database comprised of licence plates associated with stolen vehicles, prohibited or suspended drivers, individuals with outstanding warrants and uninsured drivers. ALPR assists police officers in their ability to identify and recover stolen vehicles, as well as remove unlawful drivers from the roadways.

Dr. Irwin Cohen, University of the Fraser Valley

Dr. Irwin Cohen from the Centre for Public Safety and Criminal Justice Research at the University of the Fraser Valley presented on the Data Driven Approach to Crime and Traffic

Safety. He discussed evidence that the areas with high crime rates and high collision rates in parts of Vancouver overlap considerably. This knowledge can contribute to a more effective and efficient use of policing resources, and to the development of strategies that improve neighbourhood safety overall.

Dr. Tarek Sayed, University of British Columbia

Dr. Tarek Sayed from UBC's Department of Civil Engineering presented on automated safety analysis using computer vision techniques. Dr. Sayed uses Bayesian safety models, automated safety analysis using computer vision techniques, traffic conflicts techniques, pedestrian and cyclist modeling, and Intelligent Transport System (ITS) in order to make safety evaluations. He recognizes that in the world of road safety, we are "data rich and understanding poor" and therefore his work is focused on helping to correct that.

Dr. Sayed's transportation engineering research has been focused within three main areas: 1) to improve road safety analysis and evaluation techniques, 2) to improve the level of knowledge associated with the safety implications of traffic operations and highway design, and 3) developing and evaluating ITS to increase the efficiency of traffic.

Dr. Paul de Leur, ICBC Road Improvement Program

Dr. Paul de Leur of ICBC's Road Improvement Program advocated for a proactive approach that targets risky low-crash locations. He called for methods that prevent collisions, and do not simply reduce them at "collision hot-spots". Rather than assess risk only on the basis of historical data, he pointed to the potential use of a Road Safety Risk Index (RSRI) which is a function of exposure to hazards, the probability of encountering roadway hazards, and the consequence or severity if the hazard is encountered. This new risk assessment framework can equip road safety actors to identify new areas for intervention.

Dr. Gord Lovegrove, University of British Columbia Okanagan

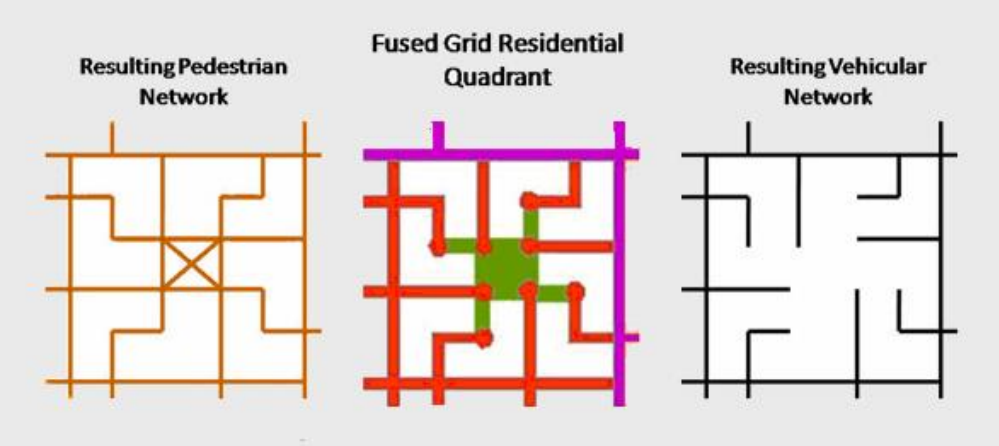
Dr. Gord Lovegrove from UBC Okanagan's School of Engineering focused on land use strategies that improve road safety. Traditionally, land use planners have largely relied on one of two general types of road network patterns – the grid network, and loops and cul-de-sacs.

Research indicates that zones built along the fused grid pattern have lower rates of traffic collisions compared to other land use patterns

The grid network is easy for all road users to navigate, but often uses up more land and increases the cost of infrastructure. Grid networks are also often less safe, as they are associated with higher speeds, larger differences in speed between vehicles and other road users, and tend to increase shortcutting from major arterials, which increases traffic on roads that are less equipped to deal with large traffic volumes. The loops and cul-de-sacs pattern has a traffic-calming effect and is more suitable for irregularly shaped land. The cul-de-sacs pattern, however, offers less accessibility for pedestrians and cyclists, thus increasing the number of vehicle trips, which increases exposure as more vehicle-kilometres are travelled.

The "fused grid" land use pattern reconciles the features of a grid and cul-de-sac system by placing easily-accessed and continuous arterial road segments for district and regional connectivity next to pockets of discontinuous streets and continuous foot and bike paths. This makes it so individuals are more likely to walk or cycle, while reducing opportunities for shortcutting by motor vehicles. Indeed, research indicates that zones built along the fused grid pattern have lower rates of traffic collisions compared to other land use patterns. While they may reduce accessibility for emergency services and utility vehicle access, this may be offset by taking into account possible service vehicle routes and planning ahead of the construction of fused grid neighbourhoods.[21]

Figure 4. Road User Travel Options in the Fused Grid Network.

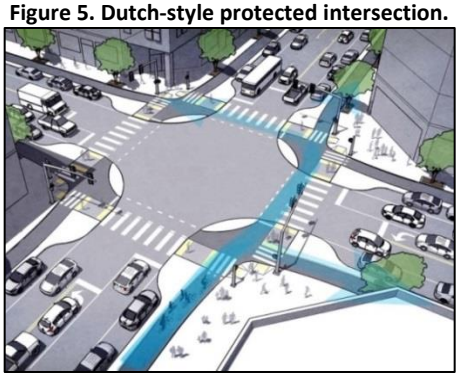


Source: Dr. Gordon Lovegrove. Sustainably Safer Neighbourhood Development Patterns. BC Road Safety Strategy 2015 Conference – Rapid Fire Presentation.

Dr. Kay Teschke, University of British Columbia

Dr. Kay Teschke from UBC's School of Population and Public Health discussed how urban design for cycling routes can both increase cyclists' safety and encourage more cycling. Some proven design principles implemented in safer jurisdictions were highlighted: mixed traffic where motor vehicle speeds and volumes are low, but clear physical separation of bike lanes where traffic speeds and volumes are high. An intersection design example was raised crossings where major and minor streets meet; these increase the visibility of cyclists and pedestrians and act as speed humps right at the crossing. Dutch-style protected intersections where two major streets meet were also highlighted. This feature works in several ways: increasing cyclists' visibility by positioning them further forward as they wait to cross; decreasing intersection crossing distance; and allowing cyclists to execute right turns without entering motor vehicle lanes.

Figure 5. Dutch-style protected intersection.



Dr. Fred Wegman, Conference Keynote Speaker

While acknowledging the need to identify and act against the greatest risks reflected in road safety data, Dr. Fred Wegman, from the Delft University of Technology in the Netherlands,

advocated for a major paradigm shift when it comes to road safety approaches in general. Traditional road safety efforts focus resources on addressing individual behaviours and human factors such as speeding, impaired driving, or outright negligence. This approach was effective in addressing low-hanging fruit, but led to diminishing returns because the majority of road crashes are not caused by dangerous or irresponsible driver behaviours, but by human error arising from the fundamental fact of human fallibility.

Today's road systems, he argued, are inherently unsafe because they rely too heavily on the ability of all individuals to make perfect decisions all the time – something that is not realistic. Calling for a *Safe System Approach*, he argued that road systems should be designed to reduce harm caused by human error. This amounts to a reconceptualization of what "high-risk" means in the context of road safety, and in the way road safety practitioners perceive and relate to data and statistics. A *Safe System Approach* demands good decisions and a level of commitment and investment, but that level of commitment and investment can be reasonable and prudent.

While acknowledging the need to identify and act against the greatest risks reflected in road safety data, Dr. Fred Wegman advocated for a major paradigm shift when it comes to road safety approaches in general.

Part II: Data Update on Road Safety in British Columbia Today

Vancouver, British Columbia
Photo credit: Sree Gajula, www.pedbikeimages.org

Ministry of Public Safety and Solicitor General
RoadSafetyBC

RAD 2015-098
January 2016

Introduction

British Columbia has realized a number of road safety successes in recent years. These achievements include a reduction in the overall number of motor vehicle fatalities from 452 in 2005, to 364 in 2010, and to 290 in 2014.[22] Measured improvements in road safety are not mere statistics – they reflect lives saved and suffering prevented.

Long-term successes are a reflection of road safety efforts in British Columbia. However it is imperative not to allow improvements to lead to complacency. If British Columbia's figures remain at their 2014 numbers, another 26,310 people in British Columbia will be seriously injured and 2,900 will be fatal crash victims in the next decade.

To further improve road safety, road safety partners must also focus attention on trends and issues requiring attention, including: safety improvements for vulnerable road users, which are pedestrians, cyclists, and motorcyclists; the increasing number of vehicles on British Columbia's roads; the increasing age of drivers and the related medical challenges for those individuals; the continued prevalence of speeding, distracted driving, and alcohol-affected driving; and the large regional disparities in motor vehicle fatalities and serious injuries per 100,000 population, among others.

Measures to protect all road users, in all age groups, including where numbers may appear small, is also imperative. As a compelling essay in the *American Journal of Public Health* pointed out, prevailing approaches to public health in many jurisdictions have tended to apply blanket measures targeted at the largest population groups. Many "niche" groups, each of which constitutes a small proportion of the total population, often have different needs that are not met by such generalist measures. Yet, as a proportion of the total population, the sum of many individual niche groups can rival or outweigh the few large groups. Small numbers add up to large numbers, and targeted strategies must be found that can address the particular needs of myriad groups in the province to ensure that disparities in road safety benefits are not created or worsened.[23]

Finally, it is important to remember that even when speaking of larger groups, the representation of some data may obscure significant dynamics in road safety trends. For example, evidence from the United States shows that not only are aggregate reductions in motor vehicle fatalities not shared equally by all socio-economic groups, but that populations with lower socio-economic status have experienced increases in the rate of crash fatalities per 100,000 population.[24] This dynamic is likely due to the higher tendency for individuals with lower incomes to use travel modes with higher mortality risks (e.g., motorcycling, walking, and bicycling), and because they are more likely to drive older vehicles that have fewer advanced safety features.[25] Further research in British Columbia would reveal if a similar dynamic is occurring in the province.

This part is organized around two themes. First is the "big picture" data that examine overall motor vehicle crashes, fatalities, and injuries. Second is a more detailed look at contributing factors, road user types, age demographics, and regional differences.

Big Picture Data

The following big picture data subsections report on the number of insured vehicles, driver population, driver demographics, motor vehicle crashes, fatalities, injuries, hospitalizations, the burden of injuries, and regional figures in British Columbia. These data are useful in focusing attention to significant trends and issues.

It is important to note that there are some limitations with most common sources of provincial road safety data. The most commonly used resource for road safety data are police reports (reported in the Traffic Accident System [TAS] database). This information can be incomplete, as police reports are not designed to rigorously collect motor vehicle crash data, or to determine the multi-variability of injury causation. Furthermore, the determination of injury and contributing factors are only an estimate. Finally, as of 2008, police in British Columbia are not required to attend all motor vehicle crashes. This has led to an underreporting of less severe crashes and injuries.

Other resources, such as hospitalization and ambulance data, are useful to help complement police data. There are some difficulties with these data as well, including ambiguity with defining and measuring "serious injury". For the purposes of this report "serious injury" is defined as injuries requiring overnight hospitalization.

Data Sources Used in the Report

The data used in this report were drawn from the following sources:

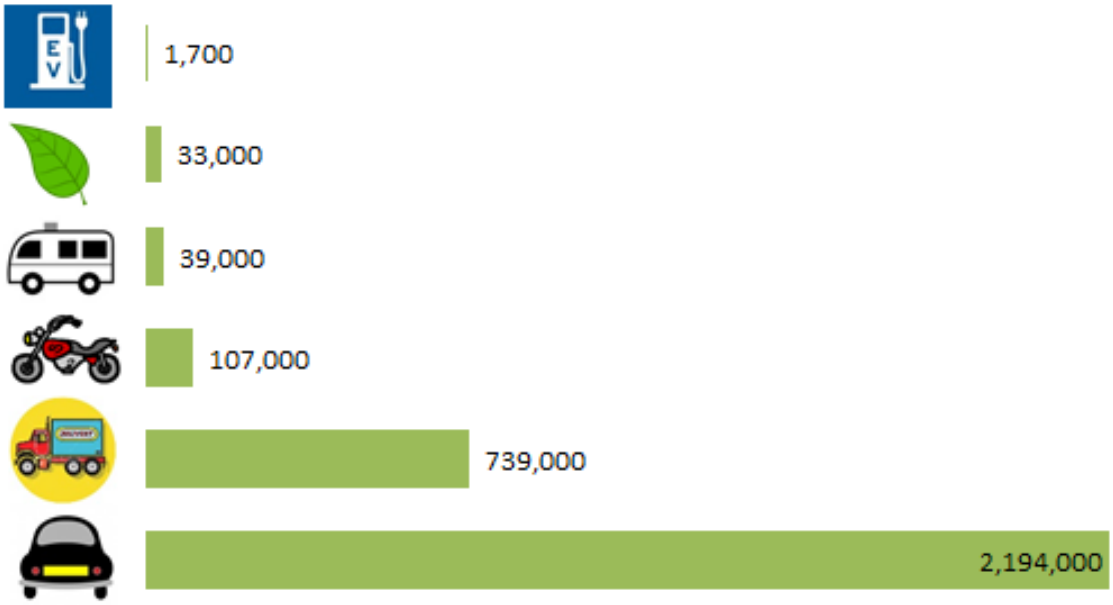
- The Traffic Accident System (TAS) Database;
- The Discharge Abstract Database (DAD);
- British Columbia Emergency Health Services (EHS);
- ICBC; and
- TransLink and BC Transit.

Population and Driver Demographics

The demographics of road users in British Columbia are changing. The population in British Columbia, at approximately 4.66 million people, is increasing at a rate of approximately 1% per year.[26] The population of drivers, pedestrians, cyclists, motorcyclists, and heavy vehicle drivers is rising as well. This means there will be a continuous increase in traffic volumes and risk of motor vehicle crashes over the coming years. The average age of drivers in British Columbia is also increasing, which may create new challenges related to senior drivers' medical fitness and ability to drive safely.

Figure 6, below, shows that the total fleet of insured vehicles in British Columbia was 3,113,700 in 2014, an increase of 63,730 vehicles from 2013.[27] 2,194,000 insured vehicles – the vast majority – are passenger vehicles; 739,000 are commercial vehicles; 107,000 are motorcycles or mopeds; 39,000 are motor homes; 33,000 are hybrids; and 1,700 are electric vehicles.[28]

Figure 6. Insured Vehicles by Vehicle Type in British Columbia, 2014.



Source: ICBC (April 2015) Quick Statistics. Retrieved July 30, 2015 from: http://www.icbc.com/about-icbc/newsroom/Documents/population.pdf.

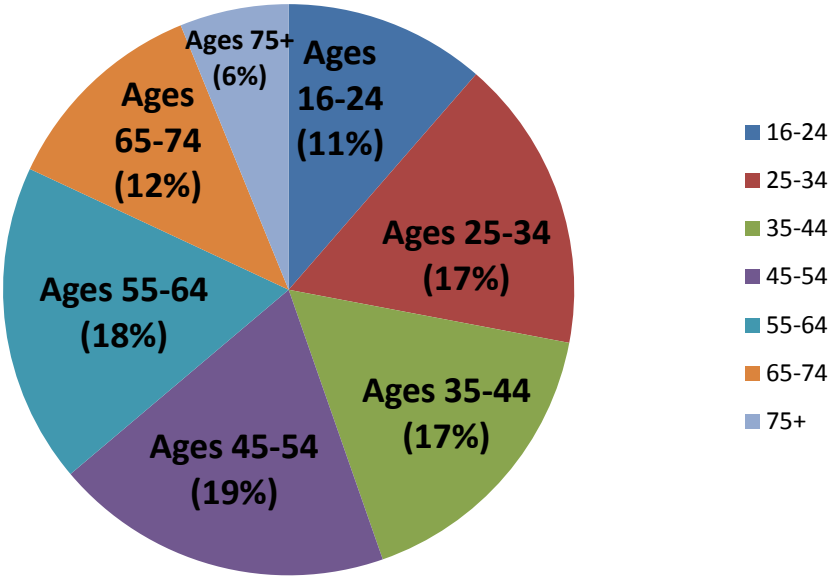
In 2014 there were approximately 3.3 million active driver's licences in British Columbia: an increase of 137,000 licences since 2010. Of the total number of licences, 1,920,000 (58%) were held in the Lower Mainland; 578,000 (18%) on Vancouver Island; 527,000 (16%) in Southern Interior; and 228,000 (7%) in North Central.[29]

The average age of drivers in British Columbia is also increasing, which may create new challenges related to senior drivers' medical fitness and ability to drive safely.

From 2010 to 2014, the average age of licensed drivers increased slightly. Steady increases were seen in the three older age categories. The number of drivers aged 55-64 increased by approximately 46,000 drivers over this period; the number of drivers aged 65-74 increased by approximately 66,000; and the number of drivers aged 75 and over increased by approximately 24,000. Meanwhile, the number of drivers aged 16-24 decreased by approximately 1,000 during this period, while the number of drivers aged 25-34 increased by 20,000.[30] The senior driver population is expected to continue to grow, which will have implications for road safety in British Columbia. Some older drivers experience age-related visual, cognitive, and physical impairments that can impact driving ability.[31]

Figure 7 shows the relative proportion of different age groups of licensed drivers in British Columbia in 2014.

Figure 7. Licensed Drivers by Age Category in British Columbia, 2014.



Source: ICBC Quick Statistics. Retrieved July 30, 2015, from: http://www.icbc.com/about-icbc/newsroom/Documents/population.pdf.

Motor Vehicle Crashes

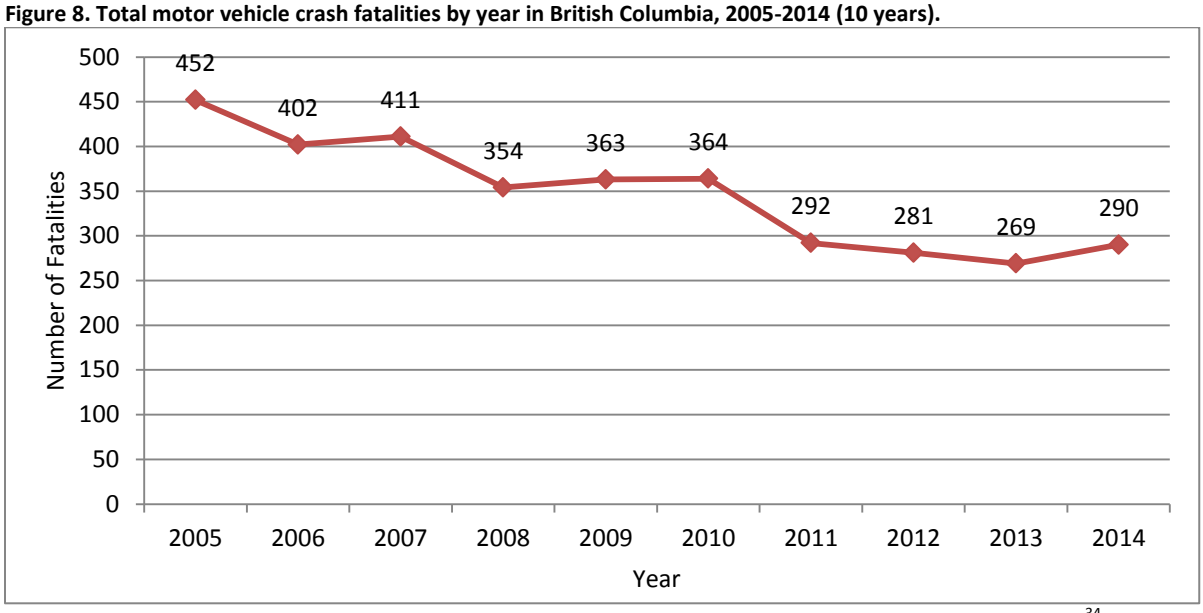
Crashes include motor vehicle collisions occurring on provincial highways and municipal roads, as well as in parking lots with both moving and parked vehicles. It does not include private roads, industrial roads, or forest service roads. In 2013, there were a total of 260,000 crashes reported to ICBC.[32] This illustrates the large scope of crashes occurring in British Columbia, and helps provide context for the number of motor vehicle collisions that result in fatalities and injuries.

In 2014 there were approximately 3.3 million active driver's licences in British Columbia: an increase of 137,000 licences since 2010. Of the total number of licences, 1,920,000 (58%) were held in the Lower Mainland.

Motor Vehicle Crash Fatalities

Motor vehicle crash fatalities have major social and economic impacts on British Columbia residents. A "fatal crash", as defined by police data in the TAS database, refers to a crash involving a motor vehicle where a road user died within 30 days after the date when an injury was sustained. Figure 8, below, illustrates that from 2005 to 2014, there was a decrease from 452 crash fatalities to 290 fatalities, a 36% decline. However, more lives can be saved through further efforts.[33]

Figure 8. Total motor vehicle crash fatalities by year in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[34]

Motor Vehicle Injuries

Motor vehicle crash-related fatalities are often the focus when considering road safety. However, the serious and lasting impacts of motor vehicle crash-related injuries should not be underplayed. Australian researchers have found that for every road crash death there are about twelve seriously injured victims, a quarter of whom suffer catastrophic injuries that carry life-long impacts.[35] The burden of injury can be drastic. Injury can undermine one's quality of life dramatically, last for decades, and have a ripple effect impacting family members, friends, and peers.

Injuries with long-term impacts are often diagnosed as impairments, functional limitations, and disabilities. Examples include orthopaedic and limb injuries (e.g., losing limbs), spinal cord and neck injuries (e.g., paralysis), neurological injuries (e.g., memory or speech disorders), cognitive disabilities (e.g., learning skills), and psychological disorders (e.g., post-traumatic stress disorder).[36]

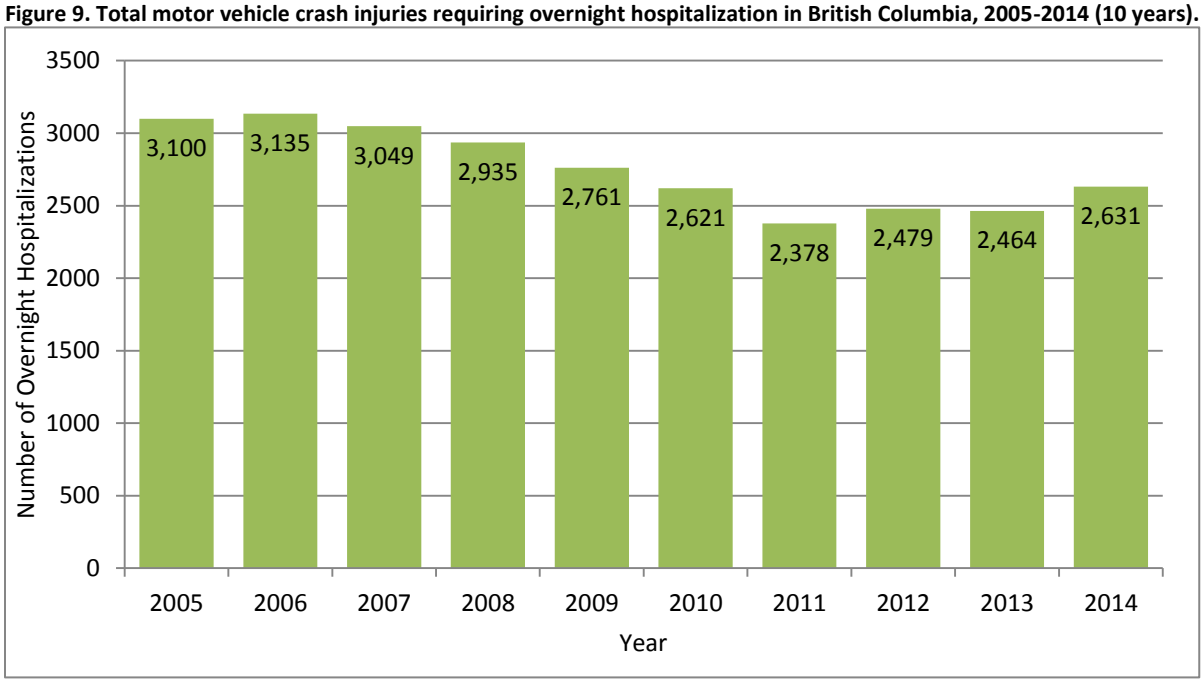
Non-fatal injuries are a main cause of reduced Health-Related Quality of Life (HRQOL). HRQOL is recognised as an important marker of population health. A United States population-based study published in 2015 found that long-term (over a year) implications of traffic injuries for adults are significant and impact self-care, depression/anxiety, mobility, pain/discomfort, and activity. The study found that although injured individuals' HRQOL may improve over time, it still remains lower compared to the general population after motor vehicle injuries are sustained.[37]

Motor Vehicle Hospitalizations

Hospitalization data are another resource that can help to understand casualties involving motor vehicles. Injuries resulting in at least one overnight hospital stay, although not a perfect

measure, can be used to indicate a "serious" injury. The total number of motor vehicle injuries requiring overnight hospitalization has declined between 2005 and 2014, reflecting overall successes in improving road safety. Figure 9 shows that the number of motor vehicle injuries requiring overnight hospitalization dropped from 3,100 in 2005, to 2,631 in 2014, a 15% reduction. There has, however, been an increase in serious injuries resulting from motor vehicle crashes in recent years. Between 2011, which marks the lowest point for serious injuries resulting from motor vehicle crashes in the province, and 2014, there was an 11% increase.

Figure 9. Total motor vehicle crash injuries requiring overnight hospitalization in British Columbia, 2005-2014 (10 years).

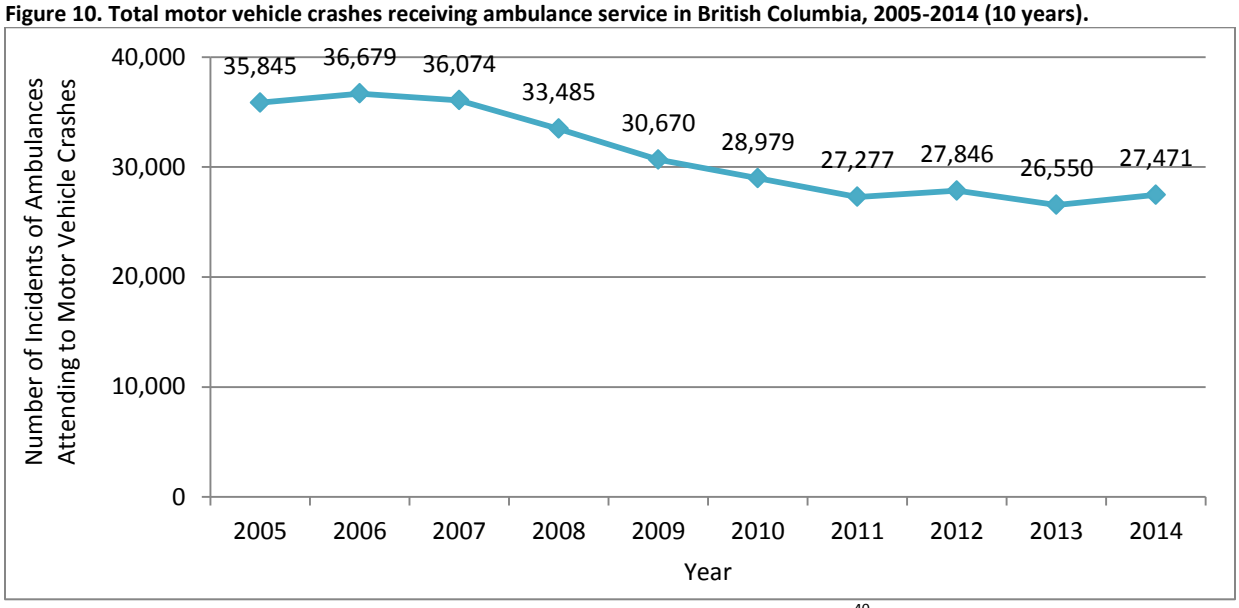


Source: Discharge Abstract Database, British Columbia Ministry of Health. Data for 2005 to 2011 drawn from: RAD-E 2015-009.[38] Data for 2012 to 2014 drawn from: RAD-E 2015-004.[39]

Motor Vehicle Ambulance Events

The number of motor vehicle emergencies requiring an ambulance provides another perspective to help understand road safety trends, as well as injuries sustained from motor vehicle crashes. Figure 10, below, shows that the total number of ambulance calls for motor vehicle crashes has declined significantly over the past decade. Between 2005 and 2014, there was a 23% decrease in the total annual number ambulances dispatched to motor vehicle crashes. The reduction can likely be attributed to improved vehicle safety technologies, improved road design, and the use of innovative road safety policies and practices.

Figure 10. Total motor vehicle crashes receiving ambulance service in British Columbia, 2005-2014 (10 years).



Source: Data extracted July 11, 2015 from British Columbia Emergency Health Services.[40] RAD-E 2015-005.

Motor Vehicle-Related Economic Burden

Motor vehicle crash injuries can have long-term impacts on income earnings. There is a significant relationship between the effects of injuries and the productivity, income potential, lost earnings, and socio-economic status of injured victims.[41] This can place severe social and emotional burdens on individuals.

It may also help to think, however, of the costs of motor vehicle collisions on society. The "social cost" is an estimation that attempts to quantify, in a dollar amount, the societal impact of preventable injuries. Calculations of the social cost of motor vehicle crashes include health care costs, property damage, the loss of human potential as measured by years of life lost, and the loss of potential productivity and earnings in the labour market. These calculations help explain the scope of the problem of injuries for society, aside from the immediate impacts on injured victims, their family, and friends.

As with other Canadian provinces, British Columbia's estimated social cost of motor vehicle collisions in 2010 was between 2-3% of the provincial annual Gross Domestic Product.[42] The heavy economic cost of collisions means that in addition to minimizing the physical and emotional suffering of road users, there is a case to be made that increasing road safety measures makes economic and financial sense.

International and National Comparisons on Road Safety Performance

Despite an overall trend toward decreased road crash fatalities in British Columbia, there are leading international jurisdictions with fewer people killed from road crashes per 100,000 persons in the population. According to the most recently available data, in 2013 the countries with the safest roads were Sweden and the United Kingdom, which had motor vehicle fatality rates of 2.7 and 2.8 per 100,000 inhabitants, respectively.[43] With an estimated population of

4,582,625, and a total of 269 motor vehicle crash fatalities in 2013, British Columbia's motor vehicle fatality rate was 5.87 per 100,000 people that year.[44,45]

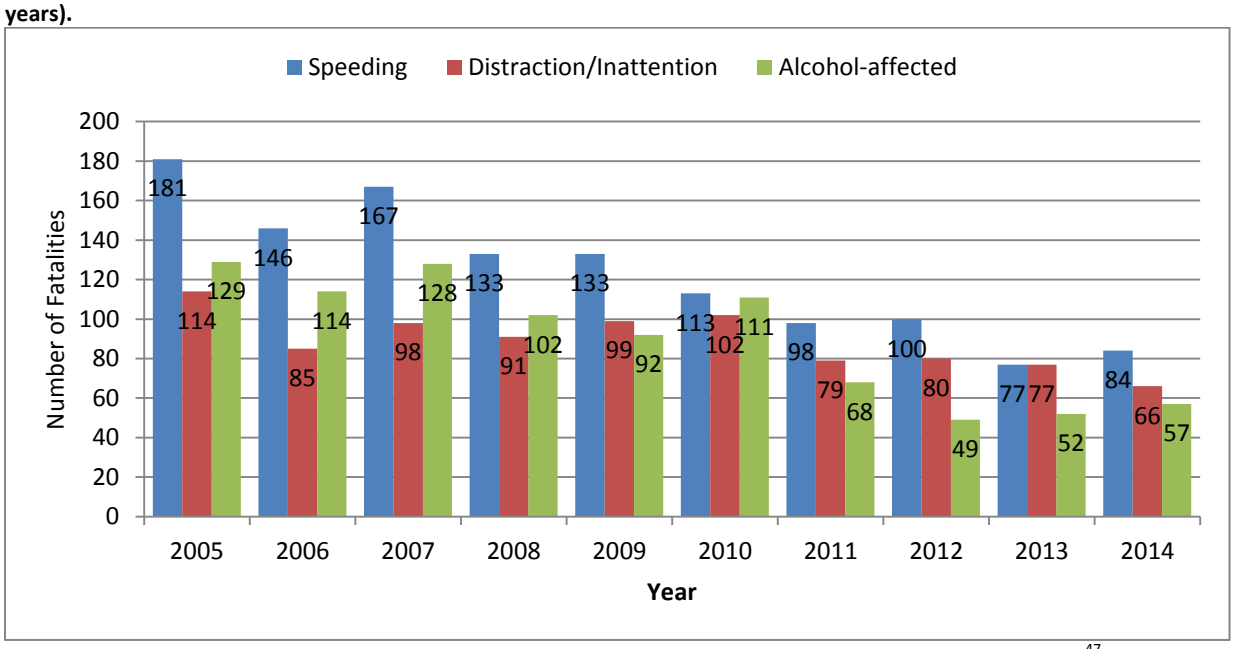
Among jurisdictions in Canada, British Columbia ranked as having the fourth lowest rate of vehicle crash fatalities in 2013 (the most recent data). The best-performing Canadian jurisdiction is Ontario, which had rate of 3.5 motor vehicle crash fatalities per 100,000 population in 2013.[46]

Among jurisdictions in Canada, British Columbia ranked as having the fourth lowest rate of vehicle crash fatalities in 2013.

Motor Vehicle Crash Contributing Factors

Efforts made under the BC Road Safety Strategy must take account of the prevalence of various factors that affect safety. This section looks at contributing factors affecting risks for crashes, fatalities, and serious injuries. The top police-reported contributing behavioural factors in fatal crashes are speeding, distraction, and alcohol-affected driving.

Figure 11. Fatalities in motor vehicle crashes involving each of the top three contributing factors in British Columbia, 2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[47]

Figure 11 shows that from 2005 to 2014, the total number of crash fatalities involving these three factors has decreased.[48] Figures 12, 13, and 14 repeat these data, but compare them to the number of crash fatalities where the contributing factor was not present. It is important to note that although unsafe behaviours can contribute to motor vehicle crashes, most crash deaths and injuries are not the result of an individual purposefully breaking the law or behaving recklessly.[49] As a consequence, gains in road safety cannot be pursued by only combatting

unsafe behaviours and illegality, even though these areas remain an important concern. The *Safe System Approach* enables road safety practitioners to address all types of road risks.

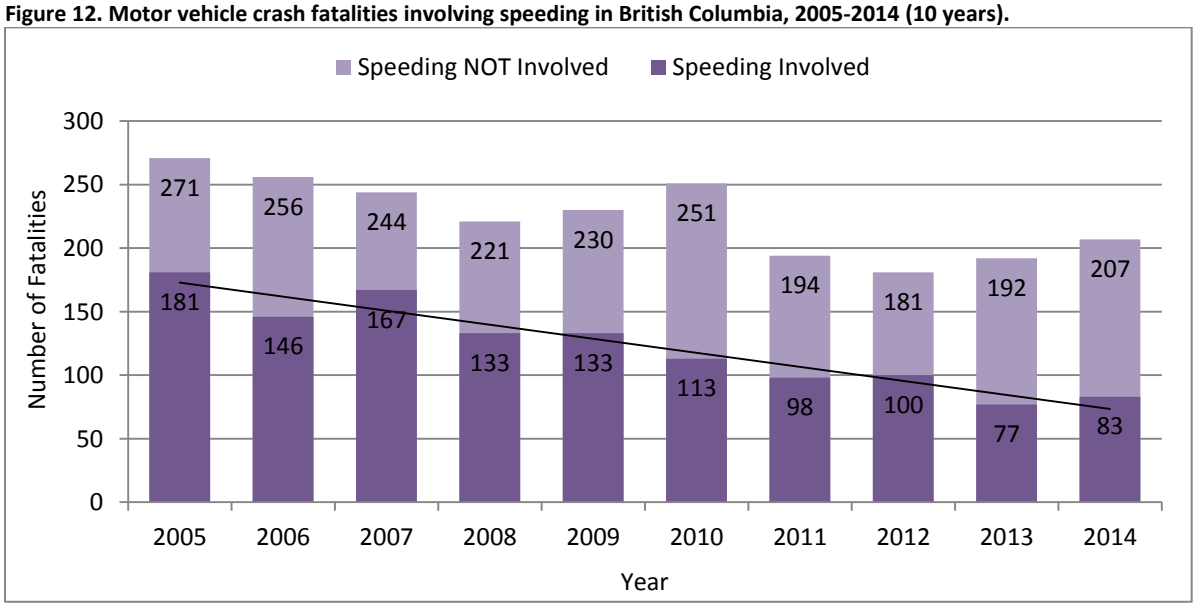
Speeding

Speeding includes driving at an unsafe speed, exceeding the speed limit, excessive speed (defined as exceeding the posted speed limit by more than 40 km/h), and driving too fast for conditions. A vehicle's speed has a major impact on both the likelihood and severity of a crash. Higher speeds mean drivers have less time to process information and react before a collision occurs; the danger of having less time to react is further amplified because braking distances required to stop a vehicle are longer at higher speeds.[50] Finally, the raw amount of kinetic energy released in a crash is an exponential function of speed. In other words, small differences in speed equal large differences in the amount of moving energy released in a crash.[51]

A vehicle's speed has a major impact on both the likelihood and severity of a crash.

In 2014, police identified speeding as a contributing factor in 83 crash fatalities (29% of total). Figure 12 shows that between 2005 and 2014 there was a general decline in fatal victims of speeding-related crashes. In 2005 there were 181 fatal victims in speeding-related crashes, while in 2014 there were 83 fatal victims, a decline of 54%.[52]

Figure 12. Motor vehicle crash fatalities involving speeding in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[53]

Driver Distraction

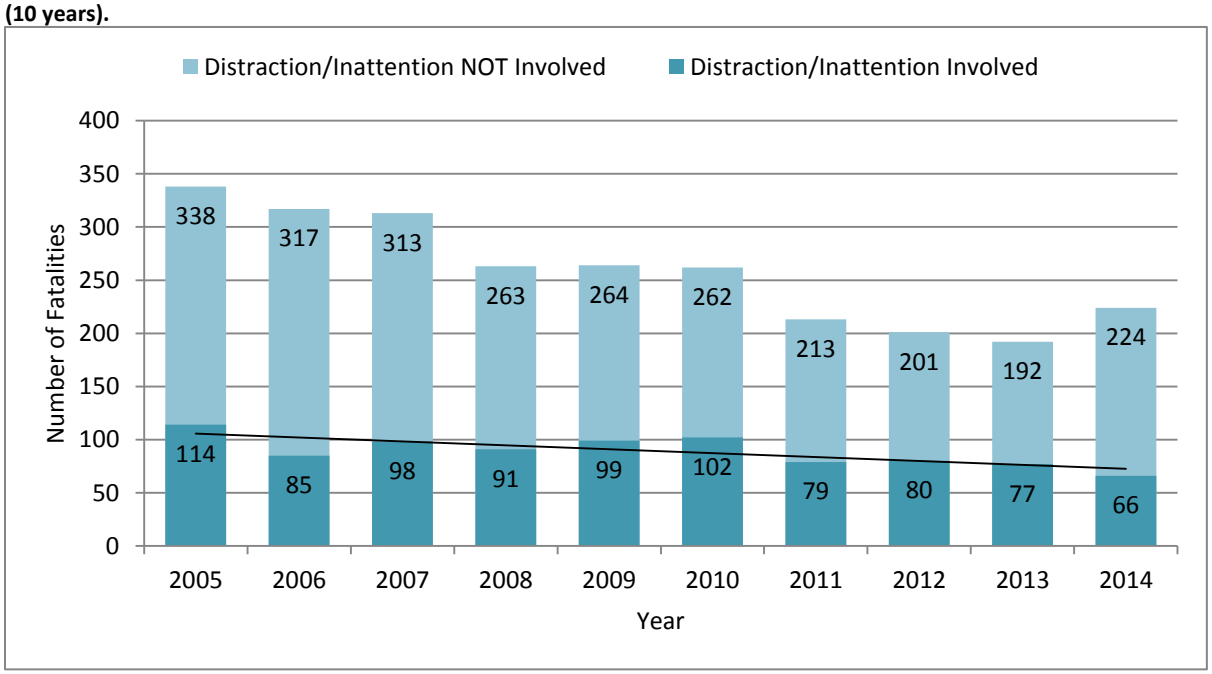
Distraction includes the use of communication and video equipment, driver inattention, and other internal or external disturbances that divert a driver's concentration from the road. The use of electronic devices such as cell phones, including both speaking and texting, is particularly impactful given its prevalence; in 2013, 51,000 tickets were issued for distracted driving.[54] The

use of electronic devices has been found in studies to reduce critical brain activity needed for driving by up to 50%, drastically increasing the risk that drivers will fail to see and process critical information in their driving environment.[55]

The use of electronic devices such as cell phones, including both speaking and texting, is particularly impactful given its prevalence.

In 2014, police identified all forms of distraction/inattention as a contributing factor in 66 crash deaths (23% of total), as shown in Figure 13. From 2005 to 2014 there was a decline from 114 to 66 fatal victims of crashes where distraction/inattention was a contributing factor, a 42% decrease. It is important to note, however, that distraction is a greater contributing cause to motor vehicle injuries and deaths than alcohol-related crashes, and must continue to be addressed.

Figure 13. Motor vehicle crash fatalities involving all forms of driver distraction/inattention in British Columbia, 2005-2014 (10 years).

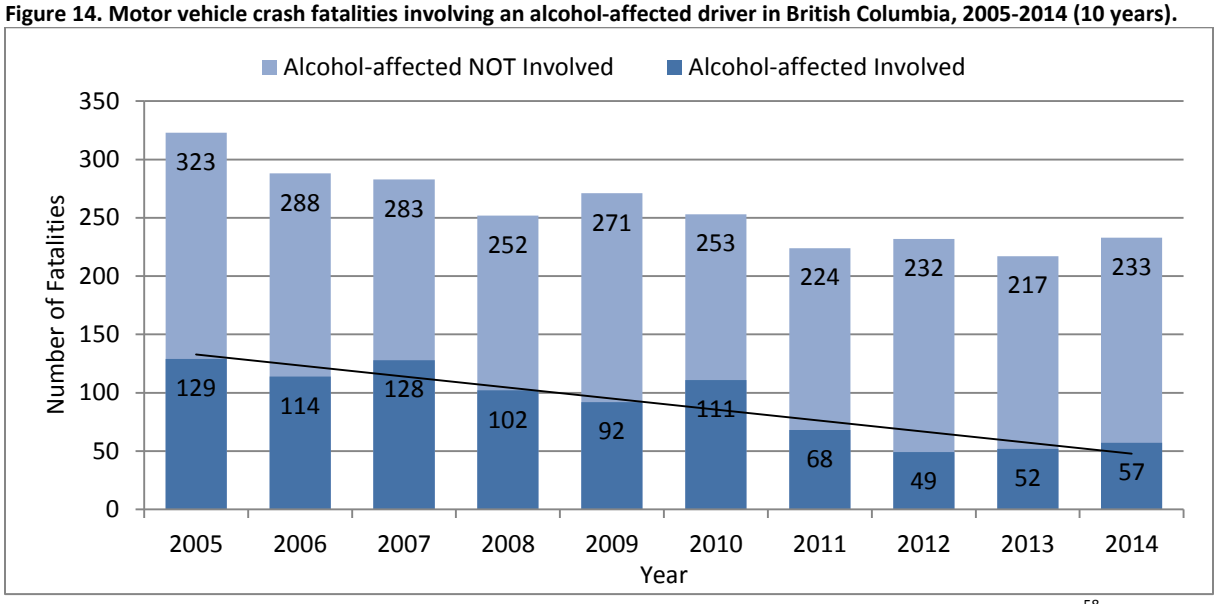


Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[56]

Alcohol-affected Driving

The use of alcohol and drugs can affect driving ability by impacting judgment, reaction time, coordination, and visual function, among other abilities.[57] It is against the law in British Columbia to drive while affected by alcohol (defined as having blood alcohol content at or above 0.05 mg/100 ml).

Figure 14. Motor vehicle crash fatalities involving an alcohol-affected driver in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[58]

Alcohol-affected driving was a contributing factor in crashes claiming 57 fatal victims in 2014 (20% of total). Figure 14 shows that between 2005 and 2014 there was a 56% decline in crash fatalities involving alcohol. Between 2010 and 2011 specifically, there was a 39% decrease in the number of crash fatalities involving an alcohol-affected driver. This decrease is associated with the implementation of the Immediate Roadside Prohibition (IRP) program that was introduced in September 2010.[59]

Another issue related to impaired driving is the use of drugs, which includes both recreational drugs and sedating medications that can impair a person's driving ability in ways similar to alcohol. Data on drug-affected drivers are collected by police, but it is hard to produce an accurate picture of its impacts on road safety because, compared to alcohol, less is known about the impairing effects of drugs at different concentrations in a person's body. Drug-use also is more difficult to detect than alcohol-use, and oftentimes the only reliable way to determine concentrations of the drug is through invasive techniques such as blood samples which cannot be easily administered at the roadside.[60]

Driver Fatigue

Although it is a part of police data collection on contributing factors in crashes, fatigue is frequently under-reported. As a consequence, the true magnitude of the problem is often underestimated. Driving while fatigued has many similar effects and outcomes as driving while under the influence of alcohol or drugs; individuals who are tired experience drowsiness, losses in concentration, and slower reactions, which impacts driving ability.[61] Research has found that drivers who have stayed awake for long periods of time, work more than one job, or work irregular were at far greater risk of having a crash than drivers who have been awake for a normal period of time.[62] The risk is also considerably higher, however, for drivers who have missed only a few hours of sleep. For example, one study found that drivers who slept 5 or

fewer hours per night on average were 7 times more likely to be involved in a crash than those who had a full night's sleep.[63]

Vulnerable Road Users (Pedestrians, Cyclists, and Motorcyclists)

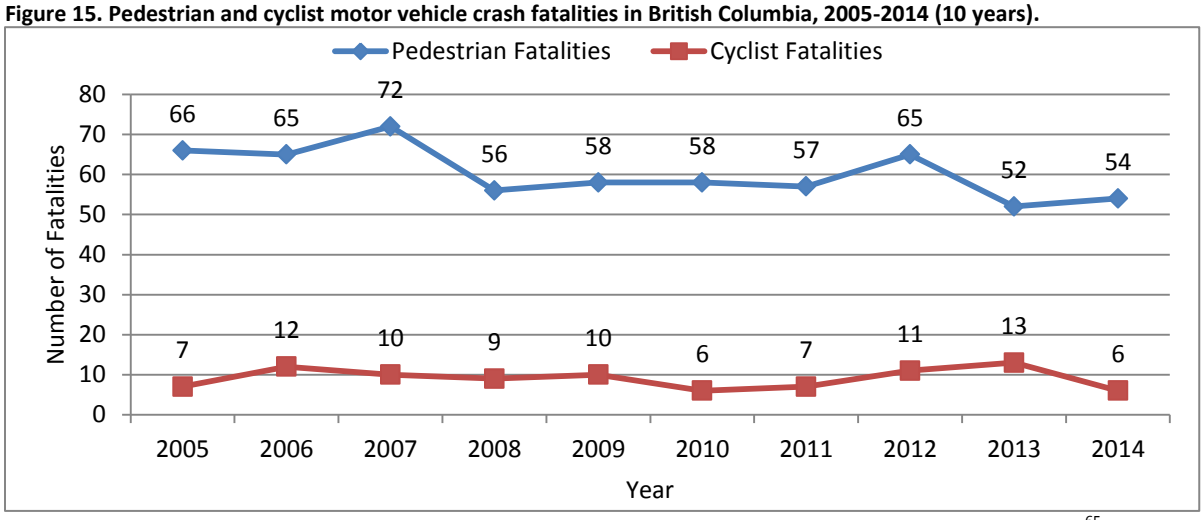
Informed and effective efforts to reduce crashes, deaths, and injuries must address the needs and experiences of all of the different types of road users. Such an approach will ensure that not only are policies and programs more effective in reducing the total number of fatalities and serious injuries, but that road safety improvements benefit all road users.

Pedestrians and Cyclists

Pedestrians and cyclists are very vulnerable road users, and advances in safety for these groups are needed. There were 2,200 incidents involving one or more pedestrians in 2013, resulting in 52 pedestrian fatalities and 2,300 total pedestrian injuries.[64]

Figure 15 shows that since 2005, annual pedestrian fatalities have not improved in terms of absolute numbers. In terms of proportions of total crash fatalities, pedestrians account for an increasingly greater share. In 2014, pedestrian had 19% of total crash fatalities, compared to 15% in 2005.

Figure 15. Pedestrian and cyclist motor vehicle crash fatalities in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[65]

Crashes involving pedestrians vary by region. In 2013, the greatest number of crashes involving pedestrians occurred in the more densely populated and urban areas of the province. The Lower Mainland had 1,600 incidents involving at least one pedestrian, resulting in 35 fatalities and 1,600 total injuries for pedestrians. Vancouver Island had 300 incidents involving pedestrians, resulting in 8 fatalities and 310 total injuries for pedestrians. In rural areas such as the interior of the province, there were fewer crashes involving pedestrians. In the Southern Interior, there were 9 pedestrian fatalities and 240 total motor vehicle crash injuries for pedestrians, while in the North Central, there were no pedestrian fatalities and a total of 64 motor vehicle injuries for pedestrians.[66]

Fatalities for cyclists have also remained fairly constant between 2005 and 2014. Given that annual numbers of total motor vehicle crash deaths has been declining over the last 10 years, cyclists actually suffer a greater proportion of fatalities compared to other road users.

Crashes involving cyclists also vary according to region. There were a total of 1,500 motor vehicle related injuries for cyclists and 13 cyclist fatalities in British Columbia in 2013. The majority were in the Lower Mainland, with a total of 1,000 injuries and 7 fatalities for cyclists involved in crashes with motor vehicles. On Vancouver Island, there were 280 injuries for cyclists and 4 fatalities in 2013. In the Southern Interior, there were 130 crash injuries for cyclists and 2 fatalities, and in North Central there were 31 crash injuries for cyclists and no fatalities that year.[67]

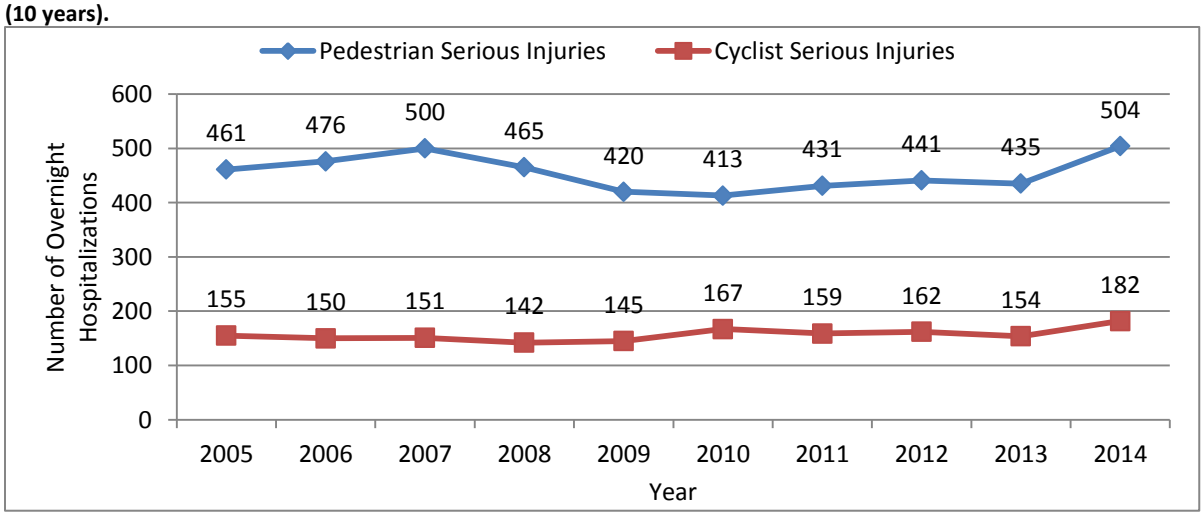
Pedestrians and cyclists are very vulnerable road users, and advances in safety for these groups are needed.

There are a number of factors influencing the regional variation in crashes for cyclists including differences in populations, infrastructure, geography, and weather. These factors all have an influence on the number people who choose to cycle, which in turn has an impact on levels of physical activity among the population, on human health, and on the number of people involved in crashes

Figure 15, above, also shows that the number of pedestrian and cyclist crash fatalities has not demonstrated clear improvement over the last 10-year period.

Figure 16 shows that the number of serious injuries for pedestrians has not improved between 2005 and 2014. While there is a small decrease after 2007, no improvements have been gained since then.

Figure 16. Motor vehicle crash-related overnight hospitalizations for pedestrians and cyclists in British Columbia, 2005-2014 (10 years).



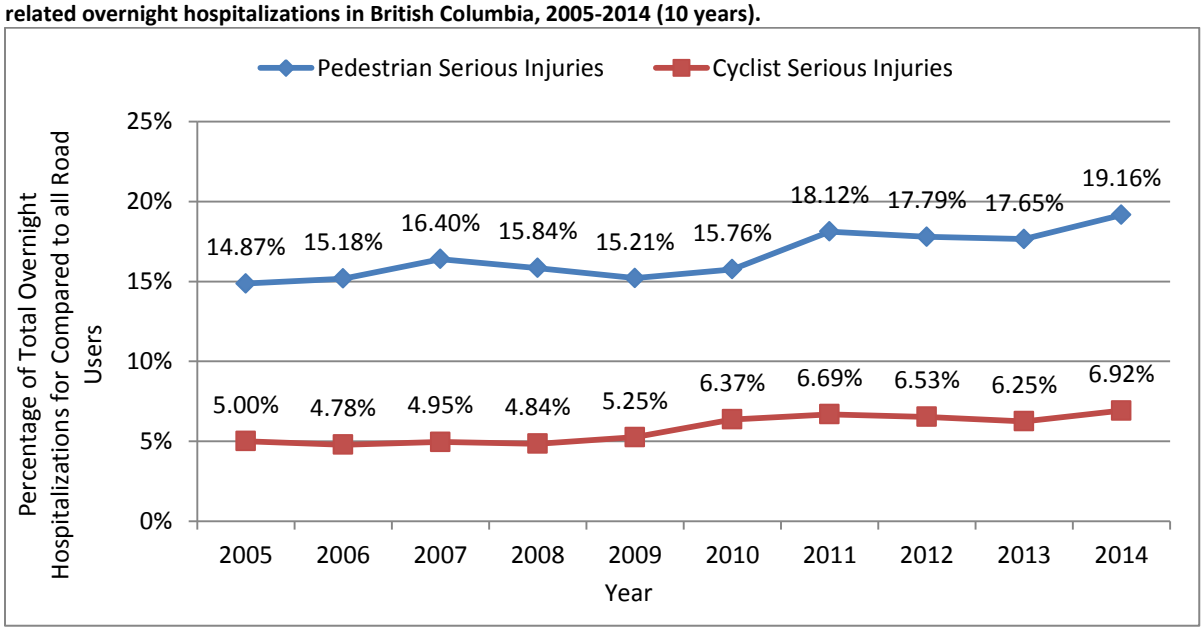
Source: Discharge Abstract Database, British Columbia Ministry of Health. Data for 2005 to 2011 drawn from: RAD-E 2015-009.[68] Data for 2012 to 2014 drawn from: RAD-E 2015-004.[69]

Also shown in

Figure 16, above, is that the amount of serious injuries for cyclists has also not shown improvement between 2005 and 2014.

Figure 17 shows serious injuries for pedestrians and cyclists as a percentage of all serious injuries caused by motor vehicle crashes. Relative to the total serious injuries for all road users, pedestrians have a greater share today than in the past. In 2005, pedestrians had close to 15% of the total serious injuries sustained by road users. In 2013, the proportion was approximately 18%, and in 2014, it was over 19%. A similar trend can be seen for cyclists. As a proportion of total serious injuries involving motor vehicle crashes, cyclists actually constitute an increasingly greater share; while in 2005 cyclists had 5% of serious injuries caused by motor vehicle crashes, these road users sustained over 6% of total serious injuries in 2013, and almost 7% in 2014.

Figure 17. Motor vehicle crash-related overnight hospitalizations for pedestrians and cyclists as a percentage of total crash-related overnight hospitalizations in British Columbia, 2005-2014 (10 years).



Source: Discharge Abstract Database, British Columbia Ministry of Health. Data for 2005 to 2011 drawn from: RAD-E 2015-009.[70] Data for 2012 to 2014 drawn from: RAD-E 2015-004.[71]

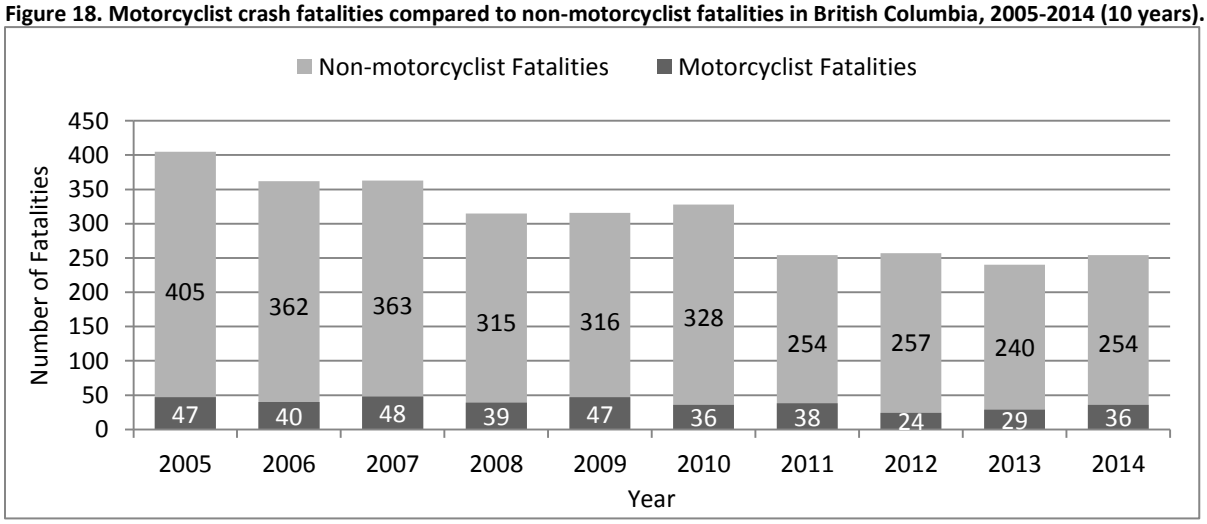
Motorcyclists

Motorcyclists are vulnerable road users for a number of reasons: they are highly exposed to impact during a crash; motorcycling requires more skill and control than driving motor vehicles; motorcycles are sometimes difficult for other drivers to see;[72] and this group is increasingly aging, making them more vulnerable to injury. Research in British Columbia has shown that older male motorcyclists in particular have increasing rates of hospitalization and injury.[73] Nonetheless, all motorcyclists, across all age groups and sexes, are very vulnerable.

Figure 18 shows that there were 36 motorcyclist fatalities in 2014. When adjusting as a proportion of total motor vehicle fatalities, they represented fewer than 12% of total deaths in 2005, while in 2014 they represented over 14%. Motorcycles comprised only 3% of registered vehicles in British Columbia in 2014. Motorcyclists are another group that has seen limited improvements in road safety compared to other road users.

Motorcyclists are another group that has seen limited improvements in road safety compared to other road users.

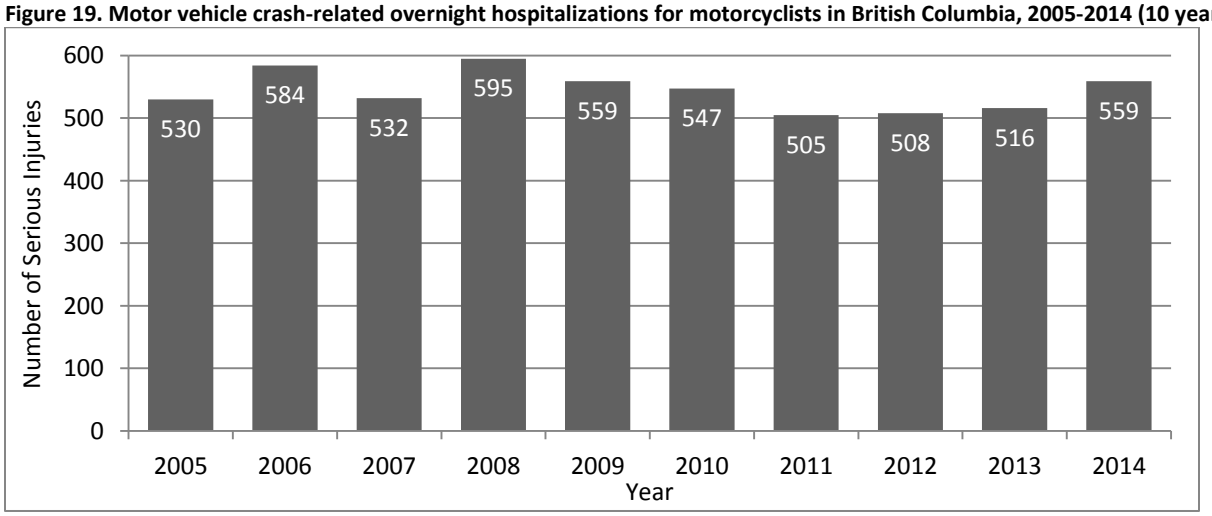
Figure 18. Motorcyclist crash fatalities compared to non-motorcyclist fatalities in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[74]

Figure 19 shows the annual number of serious injuries sustained by motorcyclists in British Columbia. These numbers have fluctuated over the 10-year period from 2005 to 2014, with no clear improvement. In 2014, there were 559 serious injuries for motorcyclists, which is close to the last 10-year average of 544 motorcyclist serious injuries.

Figure 19. Motor vehicle crash-related overnight hospitalizations for motorcyclists in British Columbia, 2005-2014 (10 years).



Source: Discharge Abstract Database, British Columbia Ministry of Health. Data for 2005 to 2011 drawn from: RAD-E 2015-009.[75] Data for 2012 to 2014 drawn from: RAD-E 2015-004.[76]

Demographics

This section covers fatality and serious injury statistics for road user age demographics, road user by sex, and First Nations.

Road User Age

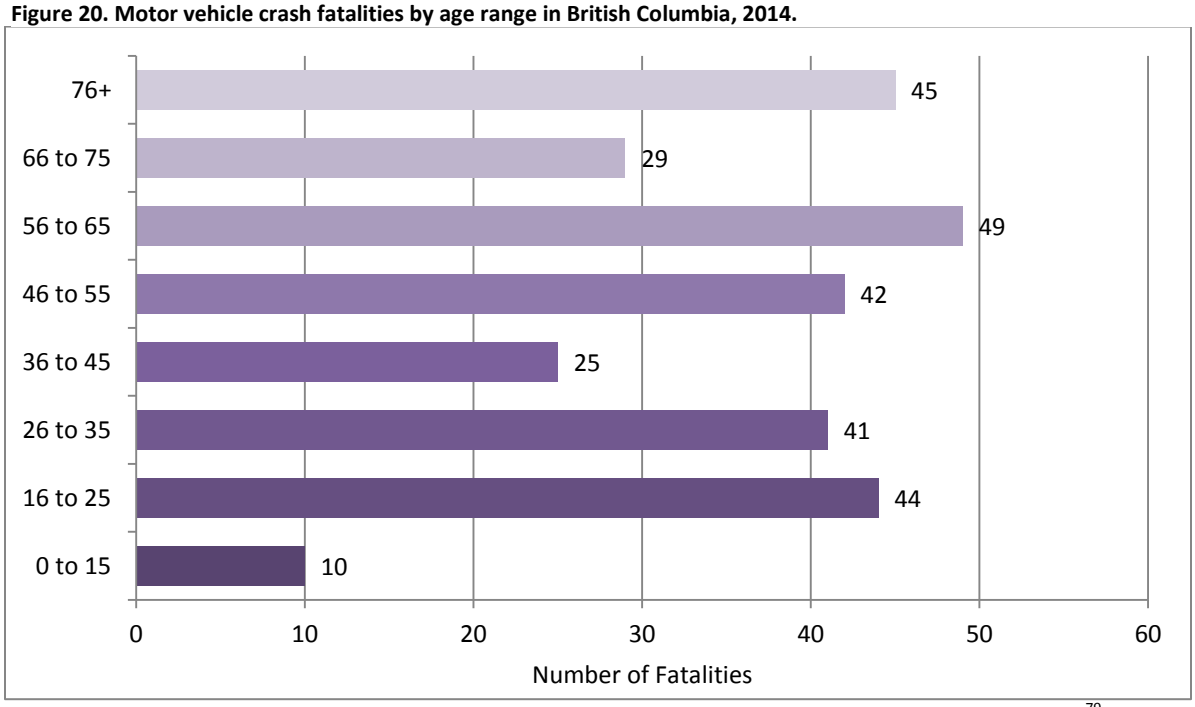
Age is important for understanding motor vehicle incidents. Younger drivers are typically less experienced, and evidence indicates they are likelier to participate in unsafe driving behaviours. Research has found that younger drivers more often speed, tailgate other vehicles, fail to obey traffic rules, and drive impaired.[77]

Older drivers, on the other hand, generally have more experience, but they are more likely to have health difficulties that can contribute to motor-vehicle crashes. Research indicates that, per distance traveled, fatal crash rates increase markedly after the age of 70 due to the increased risk of crashing, as well as to the decreased physical ability to survive and recover from crashes.[78] British Columbia's aging demographic means issues like older driver fitness will be increasingly important as factors in road safety policies and programs.

Research has found that younger drivers more often speed, tailgate other vehicles, fail to obey traffic rules, and drive impaired.

Figure 20 shows the total number of crash fatalities for each age group in British Columbia for 2014.

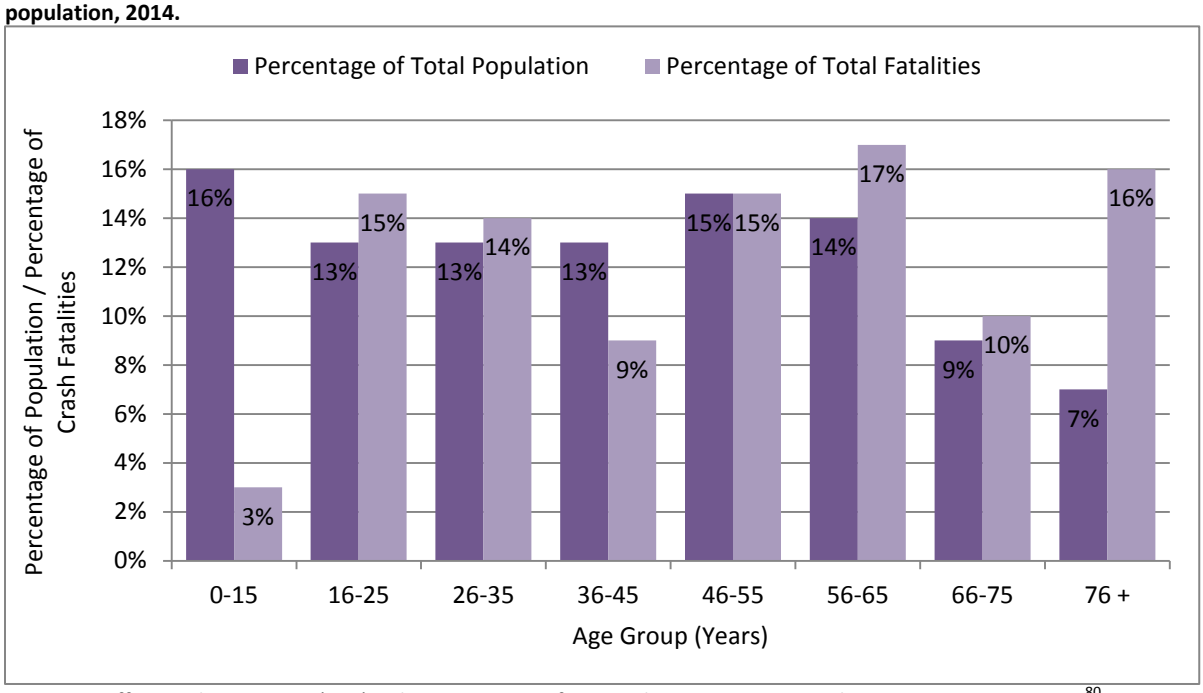
Figure 20. Motor vehicle crash fatalities by age range in British Columbia, 2014.



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[79]

Figure 21 shows each age cohort's share of motor vehicle deaths, compared to the cohort's proportion of the total provincial population.

Figure 21. Percentage of total motor vehicle crash fatalities by age group compared to group as percentage of total provincial population, 2014.

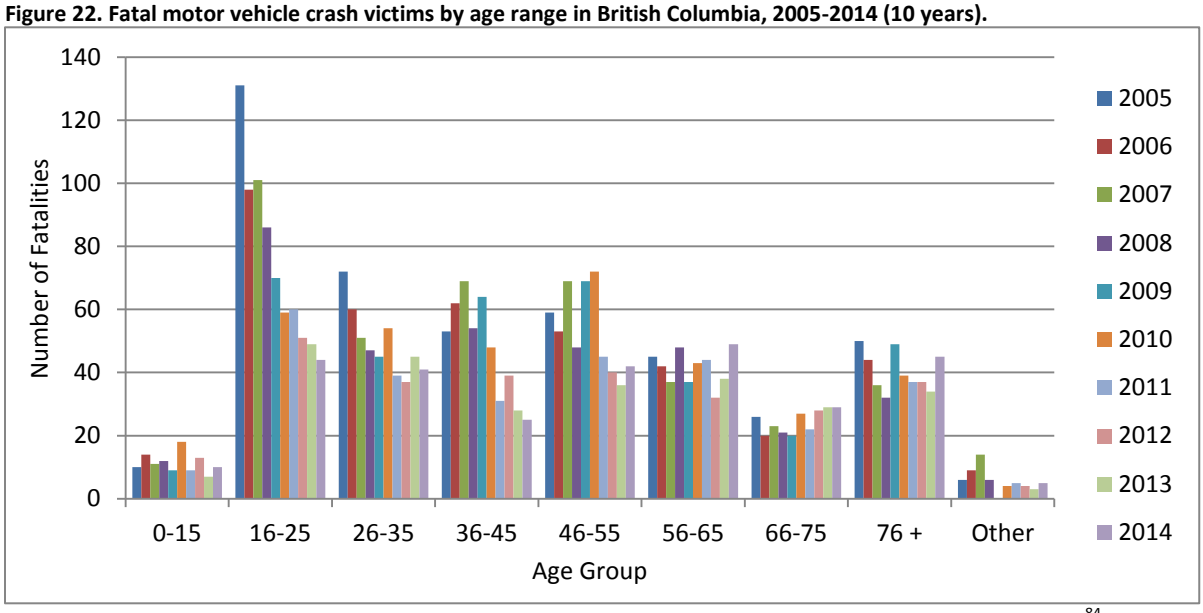


Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[80]
BC Stats. Population Estimates. Estimates as of July 1, 2015.[81]
Note: Percentages are rounded.

The 16-25 years age group accounted for 13% of the province's total population in 2014 and had 15% of all motor vehicle fatalities. The 26-35 years age group constituted 13% of the population, and had 14% of all fatalities. The 36-45 years group had a relatively low share of crash fatalities compared to its proportion of the provincial population; this group made up 13% of the province's 2014 population, and had 9% of total crash fatalities. The 46-55 years group constituted 15% of British Columbia's population, and accounted for 15% of total deaths. The 56-65 years group made up 14% of the population, and had 17% of all motor vehicle deaths that year. The 66-75 years group constituted 9% of the total provincial population in 2014, while accounting for 10% of total crash fatalities. Finally, those aged 76 years and older made up 7% of the province's total population and had 16% of crash fatalities in the same year – a disproportionately high number.[82,83]

Those aged 76 years and older made up 7% of the province's total population and had 16% of crash fatalities in the same year – a disproportionately high number.

Figure 22. Fatal motor vehicle crash victims by age range in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[84]

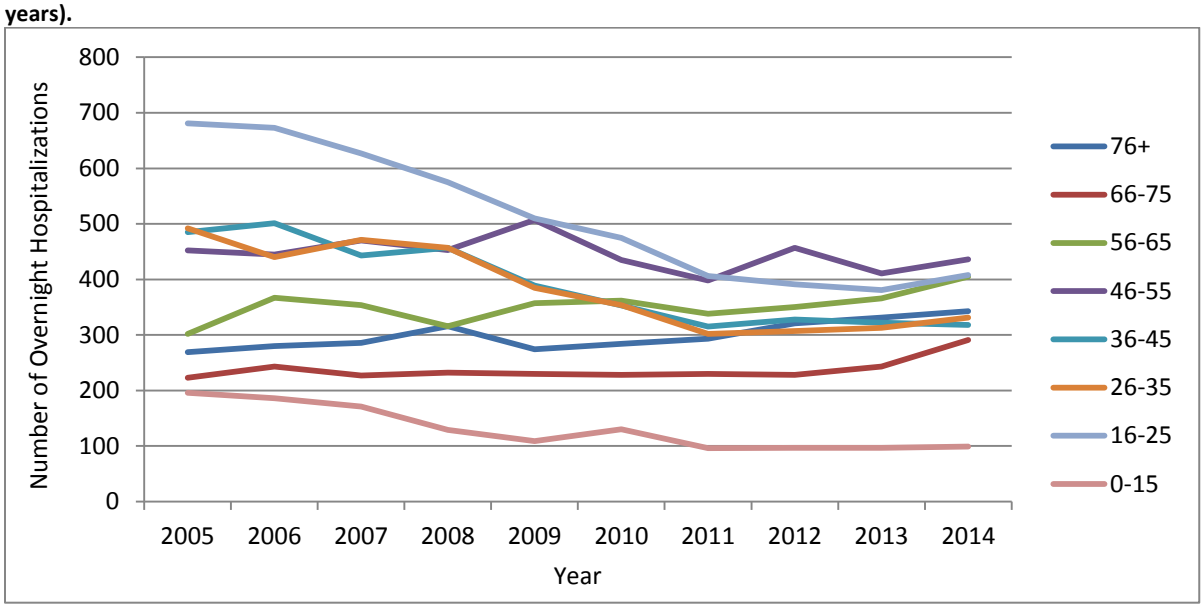
Figure 22 shows the amount of crash fatalities, both driver and passenger, for each age group in British Columbia from 2005 to 2014. The 16-25 years age group has seen significant reductions in crash fatalities year-by-year, despite the fact that this population group has grown during since 2005. The 26-35 years, 36-45 years, and 46-55 years groups have also each been experiencing overall decreases in the number of crash fatalities; the 36-45 years age group is the only age cohort of those three that has also decreased in population size between 2005 and 2014. Fatalities for the 56-65 years group has remained fairly steady between 2005 and 2014. The 66-75 years age group has experienced slightly more crash fatalities in those years. Finally, the number of fatalities for the 76 years and over group has fluctuated, and shows no clear improvement. These data show that improvements in road safety have not been shared equitably by road users of different age demographics. At the same time, it is important to remember that even where numbers may appear small, such as for non-driving-age groups, focused efforts are still required because the only acceptable number of deaths and serious injuries for any age group is zero.

The 16-25 years age group has seen significant reductions in crash fatalities year-by-year, despite the fact that this population group has grown since 2005.

The reduction in younger driver crash fatalities is likely a result of British Columbia's GLP and other efforts targeting the safety of younger drivers. GLPs that place restrictions on new drivers – such as limiting night time driving and restricting the number of passengers – are proven to reduce the rate of young driver fatal crashes.[85]

The average age of road crash victims suffering serious injuries is increasing. Figure 23 provides a visualization of motor vehicle crash injuries requiring overnight hospitalization. This trend is partially a result of the success of the GLP program, but it is also due to the increasing proportion of older-age demographics, which means more people in this demographic will be involved in crashes. Older people also tend to be more vulnerable to the physical forces sustained in a crash, and are therefore more likely than younger people to have a serious injury.

Figure 23. Motor vehicle crash-related overnight hospitalization by victim age groups in British Columbia, 2005-2014 (10 years).



Source: Discharge Abstract Database, British Columbia Ministry of Health Data. Data for 2004 to 2011 drawn from: RAD-E 2015-009.[86] Data for 2012 to 2013 drawn from: RAD-E 2015-004.[87]

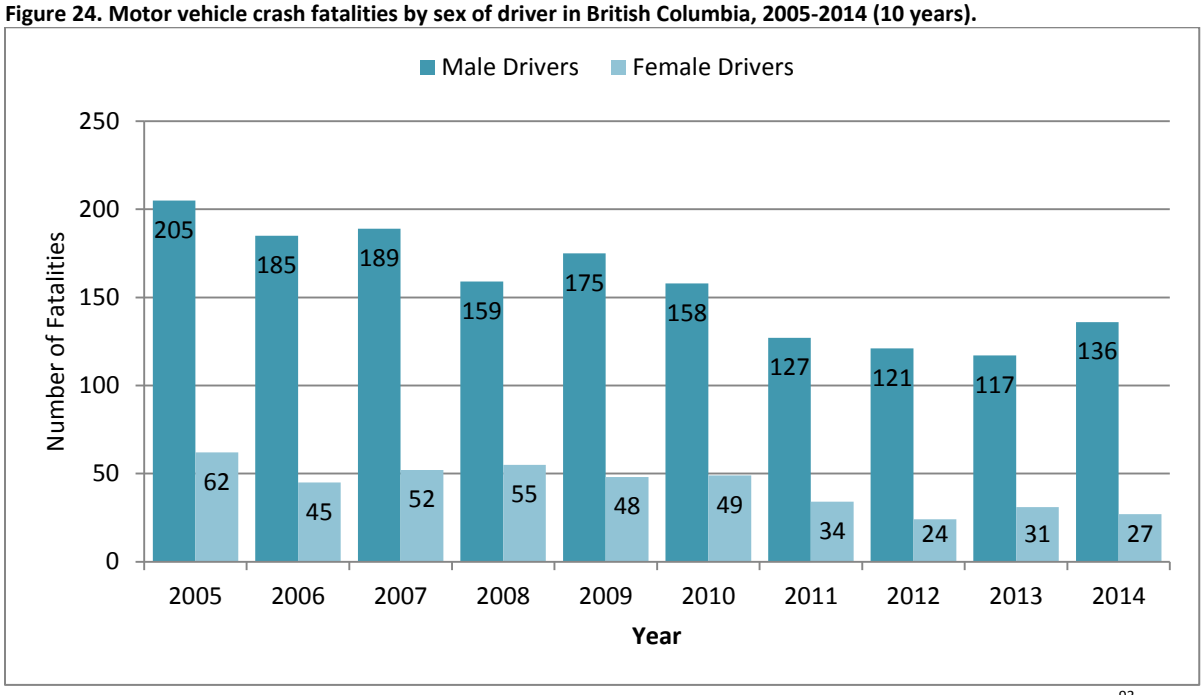
Road User by Sex

There are some differences with regard to the sex of road users in motor vehicle crash, injury, and fatality statistics. Studies suggest that male drivers are more likely to engage in risky behaviours, such as speeding, on-road aggression, and not wearing seatbelts.[88] Males also tend to drive longer distances than females, which further increases their exposure and risk.[89] Studies have found that male pedestrians are also more likely to be fatal victims and to sustain serious injuries in motor vehicle crashes, and that this is associated with high-risk behaviours more often displayed by males, including disobeying traffic laws and signals.[90,91,92]

The majority of driver crash fatalities in 2014 were for male drivers. A total of 136 motor vehicle fatalities were for male drivers, and 27 were for female drivers. This means that in 2014, there were about 5 male driver fatalities for every 1 female driver fatality. Figure 24, below, illustrates the consistent gap between the number of motor vehicle fatalities for male and female drivers for the years 2005 to 2014.

The majority of driver crash fatalities in 2014 were for male drivers. A total of 136 motor vehicle fatalities were male drivers, and 27 were female drivers.

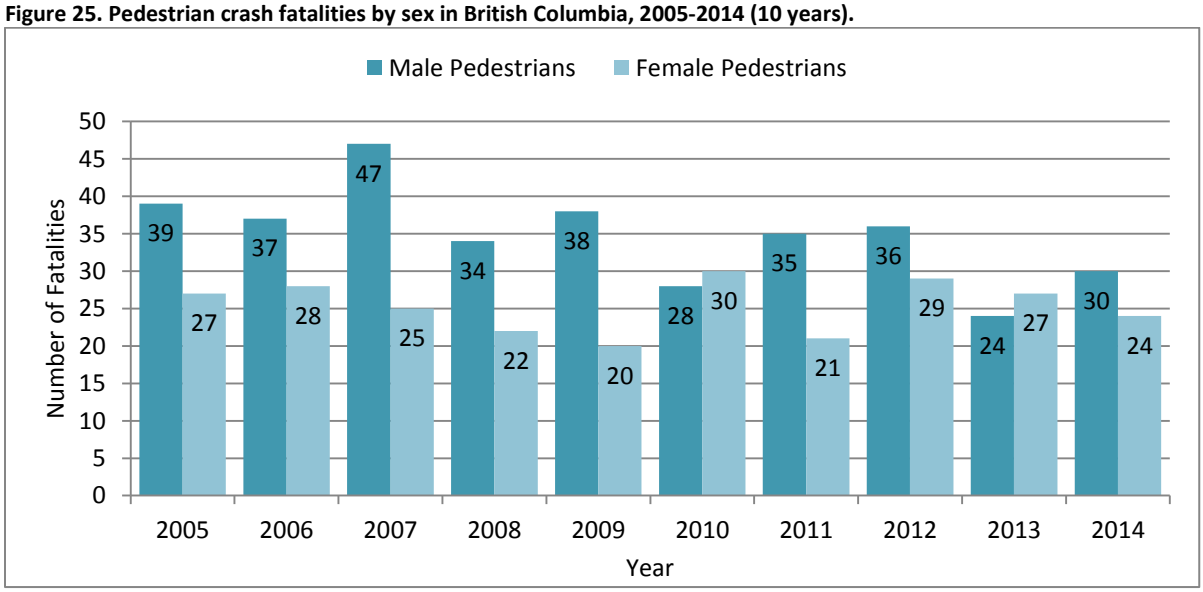
Figure 24. Motor vehicle crash fatalities by sex of driver in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[93]

The number of pedestrian fatalities also demonstrates differences in risk between males and females, as demonstrated in Figure 25. Of the 601 pedestrian fatalities in the 10-year period from 2005 to 2014, 348 (58%) were male, and 253 (42%) were female. Male pedestrians had more fatalities than females in all but two of the years in this period.

Figure 25. Pedestrian crash fatalities by sex in British Columbia, 2005-2014 (10 years).

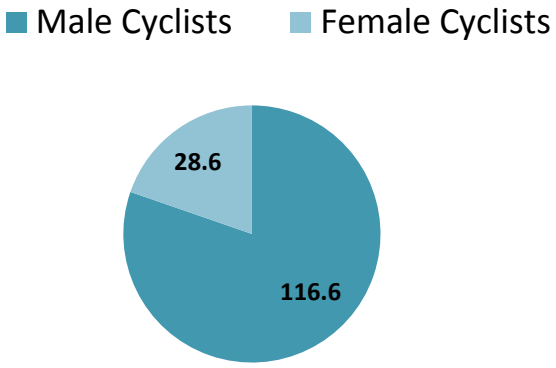


Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[94]

Male cyclists in British Columbia also sustain more deaths and serious injuries compared to female cyclists. This is partly because females in the general provincial population are about half as likely to cycle for purposes such as going to work and running errands.[95] Studies have also found that male cyclists are likelier to display high-risk behaviours such as disobeying traffic rules.[96] Between 2005 and 2014, there were, on average, 8 male cyclist deaths and 2 female cyclist deaths per year.[97]

Between 2008 and 2012, there were 582 (80%) serious injuries suffered by male cyclists and 143 (20%) by female cyclists in British Columbia. Figure 26 shows that over this 5-year period, the average annual number of serious injuries sustained by male and female cyclists was 116 and 29, respectively.[98]

Figure 26. Average annual number of motor vehicle crash-related overnight hospitalization for cyclists by sex, 2008-2012 (5 years).



Source: Discharge Abstract Database, British Columbia Ministry of Health. RAD-E 2015-009.[99]

Strategies for building support for interventions, or for changing risk perception/concern for behaviors should be tailored by sex to maximize the potential for behavior change. There are attitude-related explanations that contribute to explaining the differences of fatalities among road users. These explanations include overconfident assessments of ability and lower motivation to comply with social norms. Male road users may be both more likely to choose risky behaviors compared to females, and fail to perceive the risks involved in those behaviors.[100]

First Nations Road Users in British Columbia

The First Nations populations in the province have higher rates of motor vehicle crash fatalities and serious injuries than the rest of British Columbians. Motor vehicle crashes are the greatest cause of premature deaths for First Nation individuals, as measured by the Potential Years of Life Lost (PYLL) indicator, which estimates the years of life lost when a person dies before a baseline age (in this case, before the age of 75 years). One study found that between 1991 and 2001, the PYLL rate due to motor vehicle deaths for First Nation populations was as much as 248% higher than for the rest of the population.[101] A report from the Provincial Health Officer also found that between 2002 and 2006, the rate of motor vehicle fatalities was approximately

2.5 times higher for the province's First Nations populations than it was for other British Columbians.[102]

There are a number of reasons for this difference. First Nations individuals are more likely to have a lower level of income which, when it is below a certain point, impacts the ability to own a car with more advanced safety technologies and to maintain the vehicle to an adequate level. In the case of a crash, this increases the likelihood of having a serious injury, or dying. Geography is also an important factor. Many First Nations communities are located in rural parts of the province, which have higher rates of motor vehicle fatalities. People in rural areas tend to have to drive longer distances, which increases their exposure, are more likely to encounter weather-related hazards, and are more likely to be further away from a hospital, which increases the response time of emergency services when a crash occurs. Alcohol-affected driving deaths are also more common in First Nations populations; between 2002 and 2006, 41% of motor vehicle deaths for First Nations populations were alcohol-related, compared to 19% for other residents.[103]

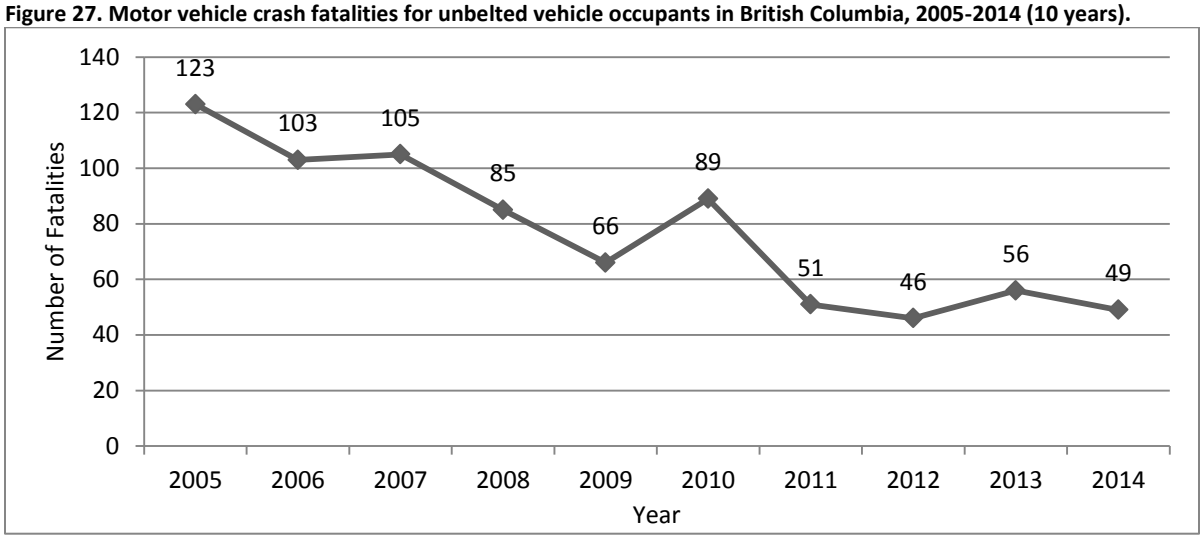
Unbelted Fatalities

Seatbelts work by holding individuals in their seats, which, in the event of a crash, prevents their bodies from colliding with the interior of the vehicle, with occupants next to them, or even being ejected from the vehicle through its windows. Research has estimated that, in a crash, seat belts reduce the risk of fatality for vehicle occupants by 37% to 48%, depending on a number of factors including: the speed at which the collision occurred; the design of the vehicle; the age and physical condition of the occupant; and the position where a vehicle was struck.[104] Legislation in British Columbia requiring vehicle occupants to wear seatbelts, as well as awareness campaigns on the benefits of wearing seatbelts, have increased rates of seatbelt usage. Legislation requiring the use of infant and booster seats for children who are too small and light for adult belts has also increased parents' and guardians' usage of these devices for children in their care. However, seatbelt non-usage continues to be much too common in the province.

Research has estimated that, in a crash, seat belts reduce the risk of fatality for vehicle occupants by 37% to 48%, depending on a number of factors.

Figure 27, below, shows the number of crash fatalities where the victim was not wearing a seatbelt. These numbers only count instances where a person had the possibility of wearing a seatbelt. In other words, it does not count fatalities for pedestrians, pedal cyclists, motorcyclists, and bus occupants. In 2005, there were 123 fatalities where a person could have worn a seatbelt, but did not. This has decreased to 49 in 2014, a 60% decline. Unrestrained deaths as a proportion of all deaths where a restraint was available have declined by approximately 10% between 2005 and 2014.

Figure 27. Motor vehicle crash fatalities for unbelted vehicle occupants in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[105]

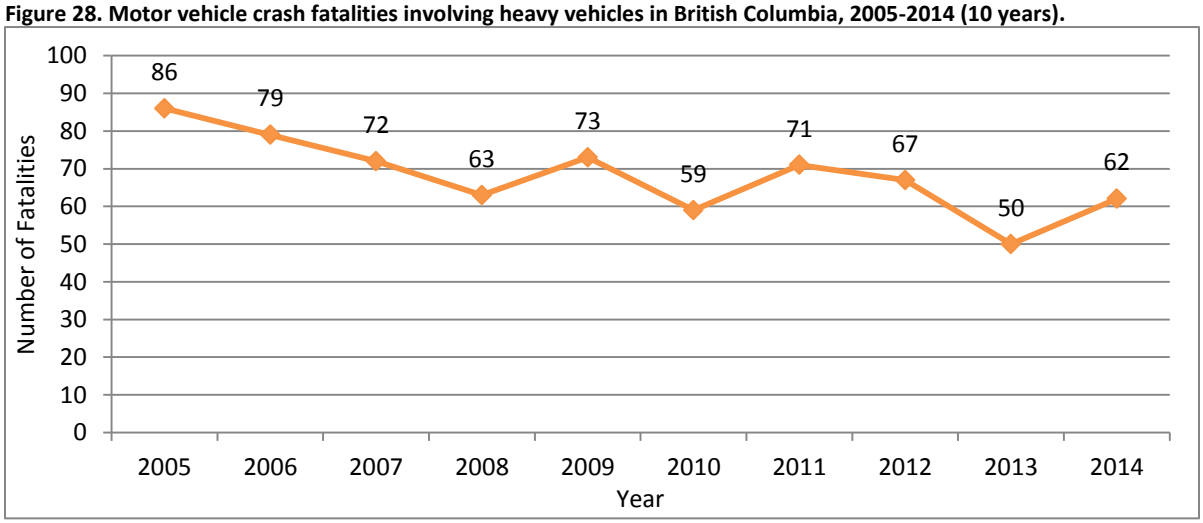
Heavy Vehicles

Heavy vehicles, defined as having a licensed gross vehicle weight of 10,900 kg or more,[106] pose a number of unique road safety risks. Large heavy vehicles require significant braking distances, more space to turn, have larger blind spots than small vehicles, and release a huge amount of kinetic energy in a crash due to their weight and speeds.

Additionally, drivers of commercial vehicles who spend long hours on the road may experience fatigue, which adversely affects driving ability.[107]

Figure 28 shows that the number of crash fatalities involving heavy vehicles has fluctuated somewhat between 2005 and 2014, but overall numbers have decreased. From 2005 to 2014, there was a 28% reduction in the number of crash fatalities involving a heavy vehicle.

Figure 28. Motor vehicle crash fatalities involving heavy vehicles in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[108]

Public Transit Users

It is important to account for public transit when considering road safety. It is widely recognized that public transit offers a more environmentally sustainable transportation option. Less often explored is that it may also offer a safer alternative. The use of public transit reduces the number of drivers on the road, and therefore reduces the rate of motor vehicle collisions. Transit buses in general have a lower risk of collisions than other road vehicles,[109] and have very low passenger fatality and injury rates.[110] Nonetheless, public transit users do experience road trauma just the same. Figure 29 shows the number of injuries per 1 million boarded passengers on the various public transit services operated by TransLink.

Figure 29. Injuries per 1 million boarded passengers on TransLink services, 2010-2014 (5 years).

	2010	2011	2012	2013	2014
Coast Mountain Bus Company	3.5	3.7	3.5	3.5	3.8
British Columbia Rapid Transit Company	5.5	5.9	5.5	5.3	5.5
Access Transit	33.7	29.8	32.8	23.7	16.2

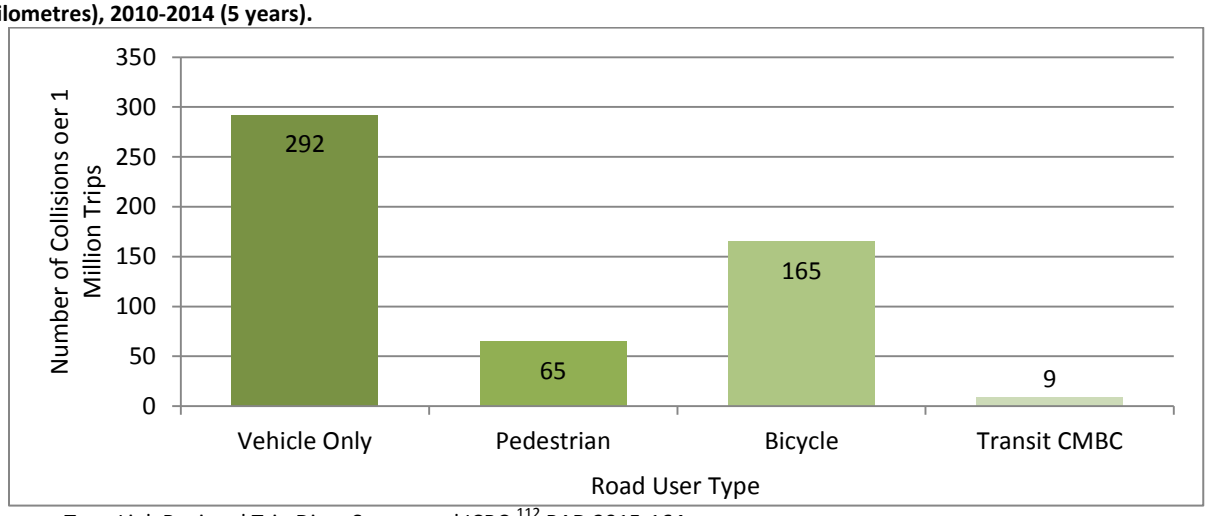
Source: TransLink and South Coast British Columbia Transportation Authority. RAD-E 2015 012.[111]

These three public transit service providers are all part of TransLink. Coast Mountain Bus Company operates over 96 percent of Metro Vancouver's public bus services as well as the SeaBus service. BC Rapid Transit Company maintains and operates two SkyTrain lines – the Expo Line and the Millennium Line – as well as the West Coast Express service. It also manages the agreement with InTransit BC for the operation and maintenance of the Canada Line. Access Transit operates the HandyDART service, and was established to ensure that accessible transit is integrated into all of TransLink's services.

Because of the different nature of trips made by public transit compared to private vehicles, walking, and cycling, it is difficult to directly compare the scale of risks. Nevertheless, it is possible to indicate which form of transport is safer. Figure 30, below, shows the average number of collisions per 1 million passenger trips for private vehicles, pedestrians, and cyclists in Metro Vancouver. Vehicles have the greatest risk of being involved in an accident, with an average of 292 collisions for every 1 million trips. Cyclists have a smaller risk of being involved in an accident, with 165 collisions per 1 million trips. Pedestrians have an even lower risk of 65 collisions occurring for every 1 million trips. Collisions for Coast Mountain Bus Company (CMBC) buses have been calculated based on the distance travelled; CMBC buses have an average of 9 collisions for every 1 million vehicle kilometres travelled.

It is important to account for public transit when considering road safety. It is widely recognized that public transit offers a more environmentally sustainable transportation option. Less often explored is that it may also offer a safer alternative.

Figure 30. Average Number of Collisions per 1 Million Trips (Transit average number of collisions per million vehicle kilometres), 2010-2014 (5 years).



Source: TransLink Regional Trip Diary Survey and ICBC.[112] RAD 2015-164.

Figure 31 shows data from two public transit companies in British Columbia: CMBC serving Metro Vancouver, and BC Transit, which serves many areas all across the province.

Figure 31. Bus collisions by collision type and year in Metro Vancouver and Greater Victoria, British Columbia, 2012 to 2014 (3 years).

Transit Company and Region	Collision type	2012	2013	2014	2013 Regional Comparison
Coast Mountain Bus Company, Metro Vancouver	All collisions	2,441	2,531	2,424	170,000
	Pedestrian collisions	95	81	73	1,600
	Cyclist collisions	35	37	43	1,000
BC Transit, British Columbia	All collisions	677	843	828	86,000
	Pedestrian collisions	21	22	11	588
	Cyclist collisions	7	14	11	441

Source: BC Transit (RAD-E 2015-011), and Coast Mountain Bus Company (RAD-E 2015-010).
Note: due to recording protocols, transit sources may capture a higher rate of vehicle interactions than other sources (i.e., other sources may only capture more severe incidents).

In 2013, there were 2,531 CMBC bus collisions in Metro Vancouver, which is a small proportion (only 1.4%) of the total 170,000 collisions for all vehicle types reported to ICBC in the region.[113] According to the latest data available from ICBC, there were 1,600 reported motor vehicle collisions involving pedestrians and 1,010 reported motor vehicle collisions involving cyclists in Metro Vancouver in 2013. By comparison, there were a total of 81 pedestrian-CMBC bus collisions and 37 cyclist-CMBC bus collisions. This means that CMBC vehicles accounted for only

5% of all reported pedestrian collisions and fewer than 4% of all reported cyclist collisions in Metro Vancouver in 2013.

In 2013 there were 843 collisions involving BC Transit vehicles in British Columbia.[114] By comparison, in 2013 there were a total of 86,000 motor vehicle collisions reported to ICBC in the Vancouver Island, Central Interior, and North Central regions, which means that BC Transit buses accounted for less than 1% of all vehicle collisions in these areas. In the same year, there were 22 BC Transit vehicle collisions with pedestrians and 14 collisions with cyclists. By comparison, there were 588 motor vehicle collisions involving pedestrians and 441 motor vehicle collisions involving cyclists reported to ICBC overall in these regions, which means that BC Transit vehicles were involved in fewer than 4% of pedestrian collisions and 3% of all cyclist collisions.

It is worthwhile to consider that collisions between private motor vehicles and vulnerable road users are under-reported. There is a case to be made, then, that in comparison to travel by private motor vehicle, public bus transit in Metro Vancouver and the rest of the province is even safer than is represented in these data.

Motor Vehicle-Related Workplace Injuries and Fatalities

Motor vehicle crashes are the leading cause of workplace injuries and deaths in British Columbia, with 37% of on-the-job deaths resulting from crashes. There are approximately 23 fatalities and 1,290 injuries resulting from at-work motor vehicle crashes every year in British Columbia. Aside from the human impacts, workplace injuries resulting from motor vehicle crashes has economic consequences as well; every year, 460 workers on average miss time from work due to a work-related crash, and in 2013, $63 million in claims was paid out by WorkSafeBC.[115]

Fatalities and Serious Injuries in All British Columbia Regions

The regional distribution of motor vehicle crash fatalities and serious injuries is important for understanding road safety in British Columbia. There are a number of factors influencing the regional variation in crashes, including: differences in population, infrastructure, geography, climate, and road-use behaviours. While total crashes and injuries in British Columbia are higher in densely populated regions, rural areas have higher rates of fatalities and serious injuries. Factors such as having non-divided traffic streams can lead to an increase in head-on crashes, and faster average speeds on higher-speed highways can lead to an increase in the severity of injuries. Vehicle occupants in rural areas are also less likely to wear seatbelts, and emergency services can be further away, leading to increased fatality rates.[116]

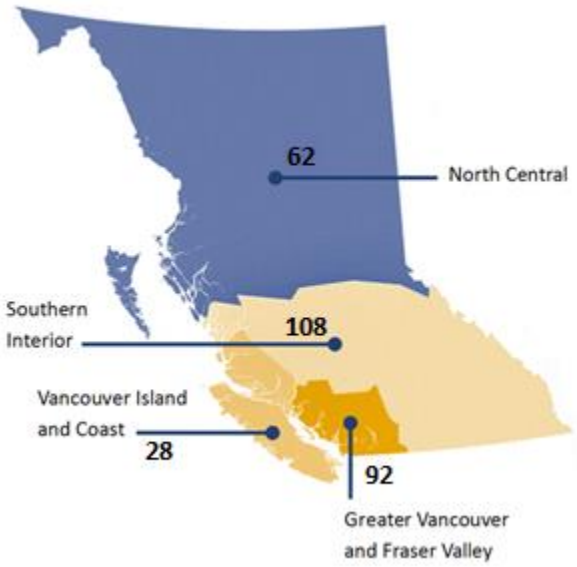
In 2013, the total number of motor vehicle crashes reported to ICBC varied by region. A total of 170,000 crashes occurred in the Lower Mainland; 34,000 occurred in the Vancouver Island region; 36,000 occurred in Southern Interior; and 16,000 occurred in North Central.[117]

Casualty crashes (motor vehicle crashes resulting in a fatality or injury) vary according to region as well. The majority of casualty crashes were concentrated in the Lower Mainland, a total of 39,000 in 2013. In the Vancouver Island region there were 6,700 crashes resulting in casualties; Southern Interior had 6,300 casualty crashes; and North Central had 2,000 casualty crashes.[118]

Figure 32 shows that the ICBC region with the highest total number of motor vehicle deaths is Southern Interior, with 108 crash fatalities in 2014 (37% of total). The region with the second most crash fatalities is Greater Vancouver and Fraser Valley with 92 deaths (32% of total). The region with the third highest number of crash fatalities is North Central with 62 deaths (21% of total). The region with the fewest motor vehicle fatalities is Vancouver Island, with 28 deaths (10% of total).

Injured victims vary according to region. ICBC reported 61,000 injuries (73% of total) resulting from a motor vehicle crash in the Lower Mainland in 2013. There were 10,000 injuries on Vancouver Island (12% of total), 9,700 in Southern Interior (11% of total), and 3,200 in North Central (4% of total).[119]

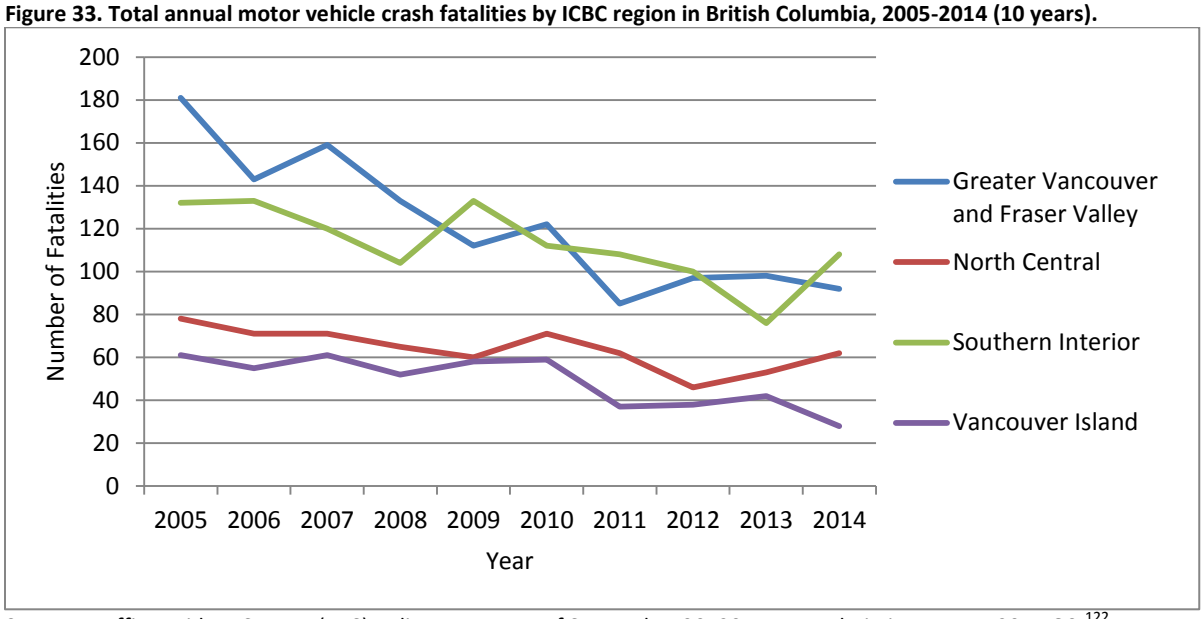
Figure 32. Total motor vehicle crash fatalities for ICBC regions in British Columbia, 2014.



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[120]
BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015.[121]

Some of the province's regions have seen greater relative gains in road safety compared to others over time. Greater Vancouver and Fraser Valley as well as Southern Interior have seen the greatest relative decrease in crash fatalities. Figure 33, below, presents a visualization of regional trends.

Figure 33. Total annual motor vehicle crash fatalities by ICBC region in British Columbia, 2005-2014 (10 years).



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[122]

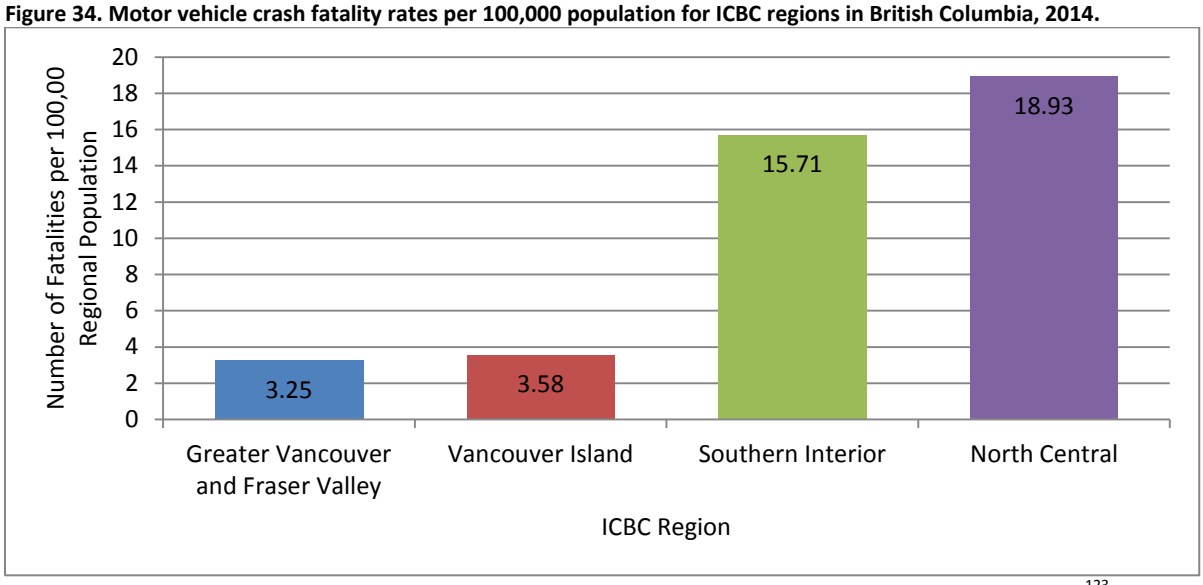
Apart from the more general road safety risk factors mentioned above, it should be noted that British Columbia's rural regions have their own characteristics which influence rate presented in this report. For example, a large volume of heavy and commercial vehicles move through the Southern Interior, and many travellers from both inside and outside the province go to this region for recreational purposes. This means that there may be more vehicle traffic and collision risks relative to the population.

Adjusting for Regional Population

Adjusting for regional population size, the Southern Interior and North Central regions have the highest rate of motor vehicle crash fatalities and serious injuries per 100,000 population. Figure 34, below, shows that when adjusting for regional population numbers, North Central had the highest rate of fatalities, with 18.93 deaths per 100,000 population in 2014. The Southern Interior also had a high motor vehicle fatality rate of 15.71 deaths per 100,000 population. The Lower Mainland (Greater Vancouver and Fraser Valley) and Vancouver Island had lower fatality rates, measured at 3.25 and 3.58 per 100,000 population, respectively. Both of these regions are well below the 2014 provincial average of 6.26 road fatalities per 100,000 people.

A large volume of heavy and commercial vehicles move through the Southern Interior, and many travellers from both inside and outside the province go to this region for recreational purposes. This means that there may be more vehicle traffic and collision risks relative to the population.

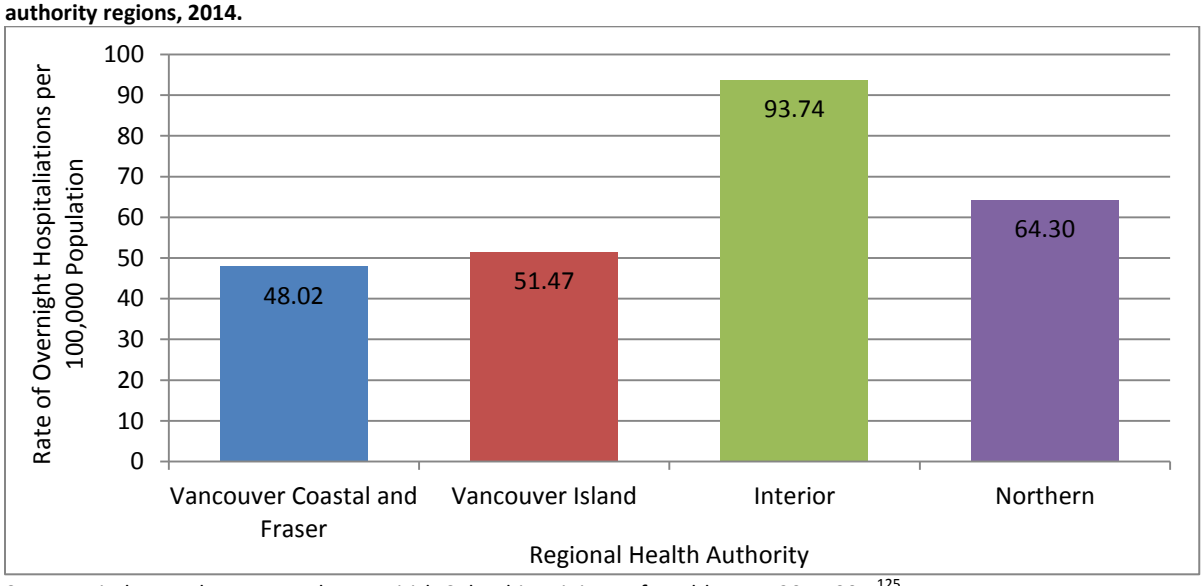
Figure 34. Motor vehicle crash fatality rates per 100,000 population for ICBC regions in British Columbia, 2014.



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[123]
BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015.[124]

Figure 35 shows the rate of serious injuries due to motor vehicle crashes in each Regional Health Authority region by adjusting for population. Southern Interior had the highest rate, with 93.74 serious injuries per 100,000 population in 2014. North Central also had a high rate of serious injury, with 64.30 serious injuries per 100,000 population. Vancouver Coastal and Fraser and Vancouver Island had almost half the rate of serious injuries of the Interior region, with 48.02 and 51.47 cases per 100,000 population, respectively, in 2014. By comparison, the rate of serious injuries due to crashes for the province as a whole in 2014 was 56.81 per 100,000 population.

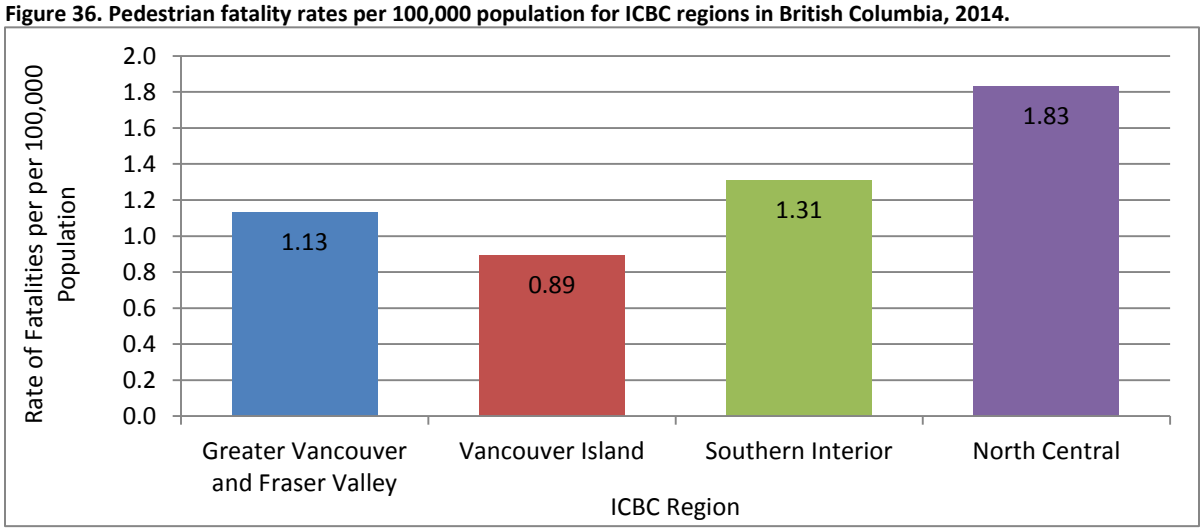
Figure 35. Motor vehicle crash-related overnight hospitalizations: rates per 100,000 population in British Columbia for health authority regions, 2014.



Source: Discharge Abstract Database, British Columbia Ministry of Health. RAD-2015-004.[125]
BC Stats. Population Estimates. Estimates as of July 1, 2015.[126]

Figure 36 shows the number of pedestrian fatalities per 100,000 population for ICBC regions in 2014. Regional differences in pedestrian fatality rates that year were smaller than was the case when all motor vehicle-related crash fatalities were counted. The difference between Vancouver Island, which had the lowest rate, and North Central, which had the highest rate, was less than one pedestrian fatality (0.94) per 100,000 population. The fatality rate for pedestrians in the province as a whole was 1.17 deaths per 100,000 population in 2014.

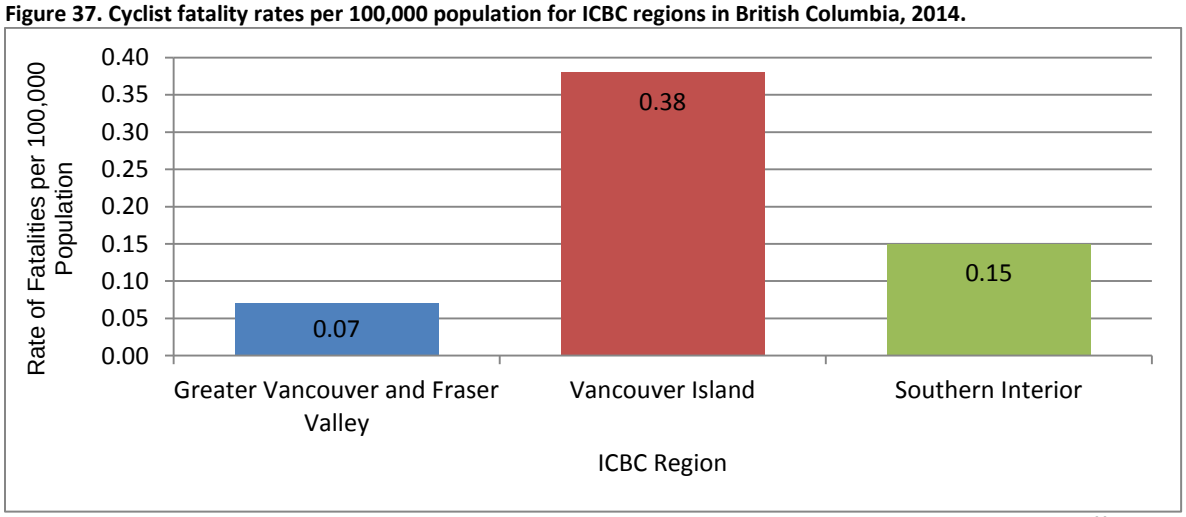
Figure 36. Pedestrian fatality rates per 100,000 population for ICBC regions in British Columbia, 2014.



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[127]
BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015.[128]

Figure 37 shows that the difference in regional fatality rates for cyclists is also small. Between Vancouver Island, which had the highest fatality rate for cyclists, and Greater Vancouver and Fraser Valley which had the second lowest rate, the difference was 0.31 fatalities per 100,000 population. The North Central did not have any cyclist fatalities in 2014. The fatality rate for cyclists in the province as a whole was 0.13 per 100,000 population in 2014.

Figure 37. Cyclist fatality rates per 100,000 population for ICBC regions in British Columbia, 2014.



Source: Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3.[129]
BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015.[130]

Data Summary and Conclusion

Overall Road Safety Update

- There were 290 fatalities in 2014 according to the TAS database.
- There were 2,631 serious injuries caused by motor vehicle crashes in 2014 according to the DAD.
- In 2014 there were 83 crash fatalities where speeding was a contributing factor, 65 fatalities where driver distraction/inattention was a contributing factor, and 57 fatalities where alcohol-affected driving was a contributing factor according to TAS. In some cases, more than one of these factors contributed to a given crash.
- Between 2005 and 2014, the youngest driver age groups have seen a decline in the number of crash fatalities annually, according to TAS. The 56-65 years, 66-75 years, and 76 years and over age groups have either seen stagnancy, or increases in the annual number of crash fatalities.

Pedestrian Safety is an area in need of attention as this group has not benefitted from improvements in road safety to the same extent as vehicle occupants.

- In 2014 pedestrian victims accounted for 19% of all crash fatalities. The number of pedestrian crash fatalities has not shown improvement based on the last 10-year average.
- When adjusting as a proportion of all deaths, pedestrian victims have actually increased from fewer than 15% of total crash fatalities in 2005, to a decade-long high of 23% of all crash fatalities in 2012, and 19% in 2014.
- Since 2005, pedestrians have had an increasingly greater share of serious injuries compared to vehicle occupants. In 2005, pedestrians sustained 15% of total serious injuries resulting from motor vehicle crashes. In 2010, pedestrians endured 16% of serious injuries, and in 2014, they had 19% of all serious injuries caused by motor vehicle crashes.

Cyclist Safety calls for greater focus based on the 2005 to 2014 10-year average.

- In absolute numbers, fatalities for cyclists have not improved from 2005 to 2014. As a percentage of total crash deaths for all road users, cyclists' share of fatalities has increased.
- Serious injuries for cyclists have also remained flat in absolute numbers since 2005. In terms of the proportion of total serious injuries caused by motor vehicle crashes, which has declined from 2005 to 2014, cyclists' share of serious injuries has also increased.[131]

Motorcycle Safety is another area which requires attention.

- The annual number of motorcycle injuries has remained stagnant at 1,500 from 2009 to 2013.[132] There were 36 motorcyclist fatalities in 2014, which is 12% of total crash fatalities that year. Motorcycles accounted for only 3% of vehicles registered in the province in 2014.

- Motorcycle safety legislation in 2012 has strengthened safety standards for helmets and seating, but considering recent trends, more needs to be done.[133] The motorcyclist population is older than in the past, and improvements in this area will require new approaches aimed at this group.

Heavy Vehicle Safety has generally improved, though fatal crashes involving heavy vehicles are concentrated in certain parts of the province.

- Between 2005 and 2014, there was a 28% reduction in the number of crash fatalities involving heavy vehicles.
- Within the Southern Interior and North Central regions in 2014, roughly 29% of motor vehicle fatalities involved a heavy vehicle, compared to 11% for the other parts of the province.[134]
- Heavy vehicle collisions account for a smaller share of total crash fatalities in relation to the proportion of heavy vehicles registered in British Columbia. However, given the high risk of injury and death when heavy vehicle crashes do occur, it is important to continue improving heavy vehicle safety.

Motor Vehicle-related Workplace Incidents is still a leading cause of workplace fatalities and serious injuries, and changing this will require improved programs and focus.

The Lower Mainland had the highest number of casualty crashes in the province in 2013 at 39,000, which is more than double the total number of all other regions combined.

The North Central Region, when adjusted for regional population, had a fatality rate of 18.93 per 100,000 population in 2014. This is roughly three times the rate of British Columbia as a whole, which stood at 6.26 fatalities per 100,000 population.

The Southern Interior had the highest rate of motor vehicle crash-related serious injuries in 2014, which stood at 93.74 per 100,000 people. This is almost double the rate of serious injury for Vancouver and Fraser Valley and Vancouver Island.

Concluding Comments

With British Columbia's increasing population and changing demographics comes the need to re-focus road safety efforts. Different regions within the province have differing priorities that should be taken into account. For example, greater risks of dangerous driving conditions and adverse weather in rural parts of the province should continue to be addressed by efforts outlined in Part I of this report, which include variable speed limits, wildlife detection systems, and the *Shift into Winter Campaign*. Programs such as DriveBC will also help drivers make safer travel and route decisions. As always, provincial road safety partners and stakeholders should seek to find new strategies and opportunities to make roads safer for everyone.

British Columbia's cities pose different challenges and offer different opportunities. Improvements to cycling infrastructure can improve safety for cyclists, as well as contribute to

the prevalence of cycling as a mode of transportation, which can reduce the number of vehicles on the road and the rate of motor vehicle collisions. This will also help to increase the environmental sustainability of the province's cities, and contribute to a healthier population. Cities must also emphasize road safety programs and policies, such as better public transit, that improve safety for other vulnerable road users including pedestrians.

Part III: Showcase of Innovation in British Columbia

Ministry of Public Safety and Solicitor General
RoadSafetyBC

RAD 2015-098
January 2016

Introduction

Numerous innovative, evidence-based programs and initiatives are being implemented in British Columbia, which contribute to creating a safe road system. Many of these road safety practices are low cost, relatively easy to implement, and can result in lives saved and injuries prevented.

The following programs and initiatives were chosen from a number of submissions by various road safety partners for their evidence-based and innovative approach to road safety.

RoadSafetyBC is excited to showcase the following excellent projects:

1. Burrard Street and Cornwall Avenue Intersection, City of Vancouver;
2. Pedestrian Scramble, City of Richmond;
3. Yield Here to Pedestrians (Advanced Stop Lines), ICBC and City of Kamloops;
4. Leading Pedestrian Interval, City of Surrey;
5. Narrowed Lanes, City of Surrey;
6. Protected Bike Lane Median Extensions, City of Vancouver;
7. Effect of 2008 Provincial Child Seat and Booster Seat Legislation;
8. Cariboo Connector, Ministry of Transportation and Infrastructure;
9. Malahat Safety Improvements, Ministry of Transportation and Infrastructure;
10. Clearwater Roundabout, Ministry of Transportation and Infrastructure; and
11. Cable Tension Barriers, Ministry of Transportation and Infrastructure.

RoadSafetyBC thanks all the organizations who submitted projects for consideration in this showcase.

Burrard Street Bridge at Cornwall Avenue Intersection
Vancouver, British Columbia
City of Vancouver

Photo credit: Kathleen Corey and Brian Gould.

The south end of the Burrard Street Bridge was reconstructed between August 2013 and the summer of 2014. The new reconfiguration is a simplification of the complex intersection, which aims to improve safety for vehicle occupants, cyclists and pedestrians. The old intersection required pedestrians and cyclists to cross 16 lanes of traffic in five stages. The new design features:

- A Dutch-style protected intersection for bicycle traffic;
- Fully separate and protected bike lanes;
- A maximum of two stages for pedestrians to cross rather than five; and
- Completely dedicated signal phases which prohibit vehicles from turning when pedestrians and cyclists are crossing.

Protected intersections, like at the Burrard intersection, contribute to the high cycling volume and low cycling fatality rates of many Dutch cities. Burrard Street Bridge monthly bicycle volumes have increased by up to 30% compared to previous years. Protected signal phases have also improved the safety of this intersection by removing all turning conflicts between people driving, cycling, and walking through the intersection (i.e., by eliminating the overlaps between when cyclists, pedestrians, and cars may proceed).

Pedestrian Scramble
Richmond, British Columbia
City of Richmond

Photo credit: City of Richmond

A pedestrian scramble is a crosswalk feature that was introduced in Richmond at the intersection of No.1 Road and Moncton Street in December of 2011. The intersection features:

- Raised and distinct intersection pavement textures and markings;
- A signal providing pedestrians with crossing priority in any direction, including diagonally; and
- Prohibited vehicle left and right turns during pedestrian crossing.

Raised and patterned crosswalks help define and bring attention to the area and signal to drivers that the area is pedestrian-focused, leading to reduced speeds. One study found that the risk of hitting a pedestrian at a pedestrian scramble is one-third the risk of traditional intersection signal phasing.[135] Prohibiting drivers from turning left while pedestrians are crossing prevents confusion that can arise from having to monitor both traffic and crossing pedestrian. A high proportion of all crashes involving pedestrians occur during left turns; as one study found, 4% to 7% of the time, drivers do not even register the presence of pedestrians before turning.[136] The pedestrian scramble safety feature is relatively inexpensive and is proven to reduce pedestrian collisions and injuries.

Yield Here to Pedestrians (Advanced Stop Lines)
Kamloops, British Columbia
ICBC and City of Kamloops

Photo location: 500 block of Columbia Street
Photo credit: City of Kamloops

In 2007 ICBC helped fund the City of Kamloops' *Yield Here to Pedestrians* pilot program, which included new pedestrian yield signs and advanced stop lines in three locations within Kamloops—two along Westsyde Road on the North Shore, and one in the Central area on Columbia Street. The project was initiated to help improve safety by increasing the distance between motorists and pedestrians. The "Yield Here to Pedestrians" signs place motorists at least 10 metres from the crosswalk stop line, the effect of which is to:

- Increase the visibility of pedestrians;
- Increase the amount of visual scanning that drivers must do;
- Increase the likelihood of the driver coming to a stop; and
- Decrease the likelihood of hitting crossing pedestrians in the case of a rear end crash.

All three projects in Kamloops have successfully increased the distance that vehicles yield to pedestrians, thus improving safety for crossing pedestrians. Advanced stop lines a relatively inexpensive safety feature that can help save lives and prevent crash injuries.

Leading Pedestrian Intervals
Surrey, British Columbia
City of Surrey and the University of British Columbia

Photo location: LPI at University Drive and Old Yale Road, Surrey
Photo credit: City of Surrey

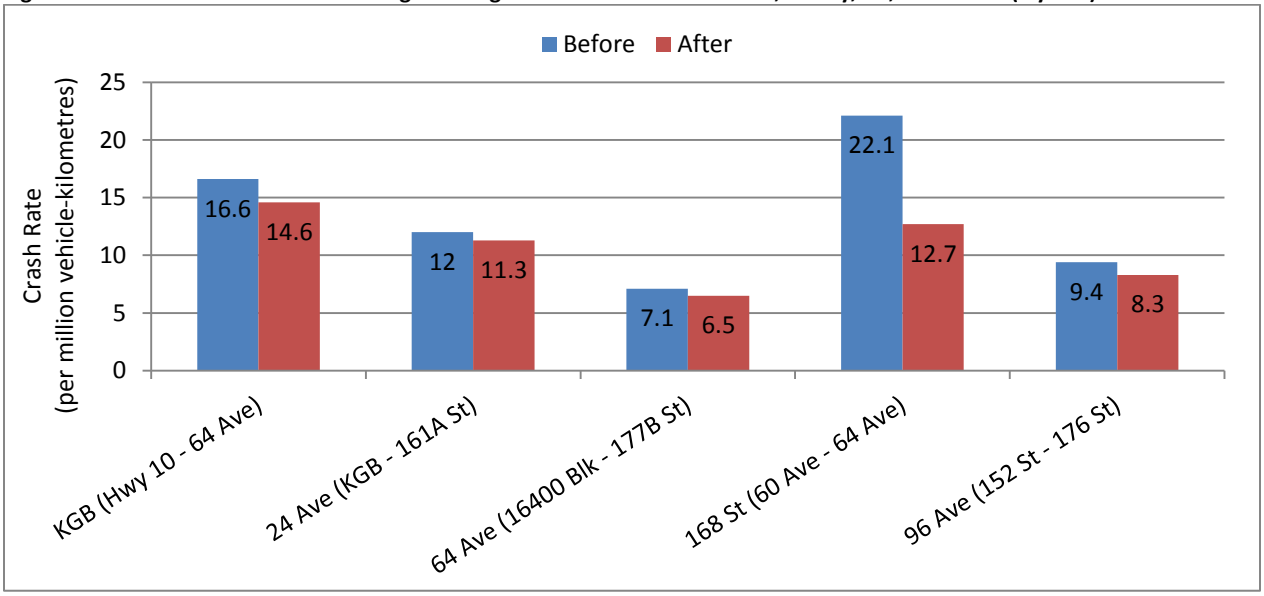
In order to protect pedestrians at two T-intersections from left turning vehicles, the City of Surrey partnered with the University of British Columbia to conduct a before-and-after study on the effectiveness of introducing a Leading Pedestrian Interval (LPI). The locations of the study were the intersections of Fraser Highway and 166th Street, and Old Yale Road and University Drive. A 4-second LPI was introduced at the two intersections. LPI works by giving pedestrians a head-start before vehicles are presented with a green light. The effect is to:

- Increase the visibility of pedestrians to left turning vehicles;
- Decrease the interactions between pedestrians and vehicles; and
- Reduce crash frequency and severity.

The results of both studies were highly encouraging, with each location showing a considerable decrease in pedestrian-vehicle conflicts. Conflict rates at Fraser Highway and 166th Street for pedestrians crossing north to south decreased by 17% while the severity of the conflicts decreased by 26%. The City of Vancouver also installed an LPI at the intersection of Burrard Street and Davie Street, and found that the overall number of conflicts decreased after its introduction.

Narrowed Lanes
Surrey, British Columbia
City of Surrey

Figure 38. Motor vehicle crash rate along road segments with narrowed lanes, Surrey, BC, 2006-2013 (8 years).



Source: Petrovic, Mirjana & Klimet Kuzmanavoski (2015).Travel Lanes Modification – Safety Study. *Commissioned by the City of Surrey*.

The City of Surrey successfully reduced motor vehicle collision rates along several segments of its high-volume arterials by reducing the width of travel lanes from 4.3 metres, to between 3.3 and 3.0 metres.

Research studies elsewhere have found that reducing the width of travel lanes causes a decrease in driving speed by lowering drivers' perceived margin for error. As a result, both the frequency and severity of collisions is reduced.[137] One study also found that narrowing lanes to 3.0 metres does not reduce traffic capacity, and therefore has no negative effect on congestion.[138]

A study commissioned by the City of Surrey found a considerable effect of the narrowed lanes on driving speeds. On average, vehicles travelled at 31 km/h over the posted speed limit prior to the lane width reduction and only 11 to 18 km/h over the speed limit after the reduction. Analysis of video footage also revealed that vehicles continued to have proper lane control where lanes had been narrowed.[139] Consequently, cyclists are not placed at greater danger by the risk of vehicles drifting into bicycle lanes.

The lane width reduction translated into a 6% to 12% reduction in collision rates along different roadways, and a 43% reduction in the rate of collision along 168th Street between 60th Avenue and 64th Avenue specifically. These results are consistent with findings from other jurisdictions that have employed this strategy.[140,141]

Protected Bike Lane Median Extensions
Throughout Vancouver, British Columbia
City of Vancouver

Photo Location: Dunsmuir Street at Hornby Street
Photo Credit: City of Vancouver

In 2015, the City of Vancouver responded to collisions at three locations along the downtown protected bike lane network by extending concrete medians to prevent illegal right turns. While other jurisdictions may have used median extensions or other treatments to limit certain motor vehicle turns, this is the first time this has been applied to bike-related infrastructure.

These three locations were each experiencing about 10 illegal turns per weekday peak hour:

1. Hastings Street at Burrard Street;
2. Dunsmuir Street at Hornby Street; and
3. Dunsmuir Street at Seymour Street.

In addition to median extensions, improvements on Dunsmuir Street at Seymour Street included increased sidewalk space, reconstructed curb ramps, and upgraded bicycle signals. The intersection of two protected bike lanes at Dunsmuir Street and Hornby Street also gained a sheltered bicycle turning box in an improved position.

These changes were based on a successful experimental intervention at Burrard Street and Pacific Avenue at the north side of the Burrard Bridge. An analysis of available data, feedback, complaints, and site conditions indicated that particular problems were associated with illegal right turns across a downhill protected bike lane. The changes in the experimental intervention included installation of green paint in mid-May 2012 and 'Elephant's Feet' in early June 2012, which reduced the number of illegal right turns by 40%. However, collision performance remained relatively unchanged. From that point, the median extension installed at the end of October 2012 resulted in a further 40% decrease in illegal turns, while collisions began to trend downward. Only 4 bicycle collisions were tallied in 2013, compared to 13 in 2011.

Effect of 2008 Child Seat Legislation and Regulations in British Columbia

The Province of British Columbia

Photo credit: © Can Stock Photo Inc. / Mark2121

Most vehicle seat belts are designed to protect adults. In a motor vehicle collision, seat belts can cause a range of injuries and death if used by children. There are four stages of passenger restraint: rear-facing infant seat, forward-facing child seat, booster seat, and adult seat belt. Advances in technology and science, however, mean that laws require occasional updating.

In 2008, the Province of British Columbia updated its 1985 legislation on the requirements for restraining small children riding in motor vehicles. Changes included new infant restraint configurations, booster seat requirements for children until they are 4'9" tall (145 centimetres) or age 9, and removed several driver exemptions related to these requirements. Other changes include that children over age one and between 20-40 lbs (9-18 kg) must be secured in a child seat, regardless of who is driving the vehicle; rear-facing infant seats must be used for children under age one and 20 lbs; seats must be placed away from active frontal airbags; and rental cars and passenger vans are no longer exempt from these requirements. Exemptions for buses will be removed; if a seat belt on a bus is available, it must be used with an appropriate restraint.

A soon to be published study, led by Dr. Jeff Brubacher, found that between 2008 and 2012, there was a 10.8% decrease in the monthly injury rate for children aged 4-8 years, and a 13% reduction for children aged 0-3 years as a result of the 2008 laws. In addition, the proportion of children aged 4-8 years involved in a motor vehicle crash that were reported to be using booster seats increased by 24 percent compared to pre-2008 levels.[142]

The study concluded that child seat legislation, coupled with ongoing awareness campaigns, can be highly effective in reducing the incidence of motor vehicle crash injuries for children.

Cariboo Connector
Highway 97 - Cache Creek to Prince George
Ministry of Transportation and Infrastructure

Photo credit: BC Ministry of Transportation and Infrastructure

The Cariboo Connector program is a long-term strategy by the Province to widen the 440 kilometre portion of Highway 97 between Cache Creek and Prince George to a modern 4-lane standard.

The first phase, valued at $240 million, consisted of 18 projects spread along the entire corridor. Construction began in 2005 and was completed in 2011. These projects added 40 kilometres of new divided 4-lane highway, providing assured passing, improving safety and reducing travel time by 10 minutes.

Work on the second phase, valued at $200 million, began in 2012. Nine projects will add another 30 kilometres of divided 4-lane highway, improving safety and reducing travel time by an additional 5 minutes. Five of the nine projects, totalling 16 kilometres, were complete as of October 2015, two are under construction, and two are nearing completion of design. The final two projects will be under construction by 2017.

This highway is an example of the safety benefits of modern highway design. Over the last decade there have been no fatal crashes on any of the newly constructed 4-lane sections of Highway 97.

Malahat Safety Improvements
Highway 1 – Vancouver Island
Ministry of Transportation and Infrastructure

Photo credit: BC Ministry of Transportation and Infrastructure

The Malahat Safety improvement project is a multi-phase project with the goal of reducing the number of serious crashes on this busy section of Highway 1 on Vancouver Island.

The first phase, completed in 2013, included 5.4 kilometres of new median barrier, intersection improvements at Shawnigan Lake Road, Finlayson Arm Road, and Goldstream Park Access, as well as construction of two new U-turn facilities at the top of Tunnel Hill and Aspen Road.

The second phase, completed in 2015, included highway widening to allow for an additional 2.3 kilometres of median guardrail, a 1 kilometre extension of the southbound passing lane, a 400 metre extension of the northbound passing lane, construction of two new U-turn facilities, and intersection improvements at Whittaker Road and Holker Place intersection.

With completion of Phase Two, 50% of the Malahat is protected with median barrier. Since installation there have been no fatal crashes in any section with a median barrier. There are a number of sections where the barrier has been hit, resulting in minor crashes - these could easily have been fatal collisions if the barrier had not been installed.

Design is underway for a third phase.

Clearwater Roundabout

Highway 5 at Clearwater Valley Road in Clearwater
Ministry of Transportation and Infrastructure

Photo credit: BC Ministry of Transportation and Infrastructure

Installed in 2013, the Clearwater roundabout offers improved safety and mobility for long haul traffic, traffic going to and from the local school and businesses, as well as traffic going to and from Wells Grey Provincial Park. Roundabouts such as this one reduce the number of fatalities and serious injuries that are due to rear-end, T-bone, and head-on collisions that more typically occur at signalized intersections.

Highway 5 is a major north-south route linking British Columbia with Alberta and is a designated heavy haul corridor, carrying a significant number of large trucks. With this in mind, the roundabout was also specifically designed to accommodate the large commercial vehicles that use the Highway 5 corridor, including extraordinary wide loads.

Pedestrian safety has also been improved. By separating traffic flow on the highway and providing large islands, pedestrians can safely cross Highway 5 in two stages rather than having to cross all five lanes in one go.

Since its completion, overall crashes have decreased by 50% and there have been no fatal collisions at this intersection.

Cable Tension Barriers
Throughout British Columbia
Ministry of Transportation and Infrastructure

Photo credit: BC Ministry of Transportation and Infrastructure

Cable Tension Barrier systems function by absorbing impact energy during a crash and minimizing forces on vehicle occupants, which reduces the probability and severity of injury. Such barriers have been proven to prevent median cross-over crashes and off-road crashes, including even for large trucks. All highway barriers help reduce motor vehicle fatalities and injuries. Cable tension barriers, however, often have a lower cost to install, and have been found in studies to be more forgiving than traditional metal or concrete medians.[143]

The cable tension barrier feature includes:

- 3- or 4-strand high tension cables installed in median or shoulder of road lanes; and
- The capacity to contain and redirect vehicles that leave the road.

In British Columbia, the first cable barrier was installed along Harrison Lake in 2005. As of 2015, a total of approximately 60 kilometres of median cable barriers have been installed on Highway 1 near Chilliwack, in Abbotsford, and on Highway 99 south of the George Massey Tunnel, to reduce median cross-over collision.[144,145]

Concluding Remarks

Road safety is an issue that impacts everyone. It is essential to protect all motor vehicle drivers, passengers, motorcyclists, pedestrians, and cyclists of all ages, in all demographics, and in all regions of British Columbia. The Province is committed to having the safest roads in North America by 2020, and is working toward the ultimate *Vision Zero* goal of having no traffic fatalities or serious traffic injuries.

Through research, collaboration, and program implementation, British Columbia's road safety partners are continuing to implement the *Safe System Approach* and to use the BC Road Safety Strategy to generate innovative and proven life-saving improvements.

References

[1] Lacombe, C. & Neil Arason (2013). British Columbia Road Safety Strategy 2015 and Beyond. 16. Retrieved from: http://www.pssg.gov.bc.ca/osmv/shareddocs/RoadSafetyStrategy.pdf

[2] Arason, Neil (2014). Review of *Eliminating Serious Injury and Death from Road Transport: A Crisis of Complacency*. Retrieved from: http://neil.arason.ca/?p=442

[3] Government of New Zealand (2015). The Safe System Approach. Retrieved from: http://www.saferjourneys.govt.nz/about-safer-journeys/the-safe-system-approach/

[4] Wegman, F., & Aarts, L. (2005). Advancing sustainable safety. *A national exploration of traffic safety for the years 2005*, *2020*.

[5] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[6] Ibid.

[7] OECD/ITF (2015). "Road safety performance in 2013 and 2014", in Road Safety Annual Report 2015. *OECD Publishing, Paris*. Retrieved from: http://www.oecd-ilibrary.org/docserver/download/7515011ec005.pdf?expires=1449602927&id=id&accname=guest&checksum=2C9E3339A124B888C8B6C7245EEF1D4A

[8] American Association of State Highway and Transportation Officials (AASHTO) (2015). *AASHTO Introduces Toward Zero Deaths Plan to Reduce Roadway Fatalities.* Retrieved from: http://www.aashtojournal.org/Pages/NewsReleaseDetail.aspx?NewsReleaseID=1440

[9] Arason, Neil (2014). *New York City is serious about Vision Zero.* Retrieved from: http://neil.arason.ca/?p=405

[10] City of New York (2015). Mayor de Blasio and Commissioner Trottenberg Announce Completion of More Than 50 'Vision Zero' Street Design Projects Making NYC Safer. Retrieved from: http://www1.nyc.gov/office-of-the-mayor/news/035-15/mayor-de-blasio-commissioner-trottenberg-completion-more-50-vision-zero-

[11] Public Health Agency of Canada (2013). Canadian Best Practices Portal. *Vision Zero*. Retrieved from: http://cbpp-pcpe.phac-aspc.gc.ca/interventions/vision-zero/

[12] Canadian Council of Motor Transport Administrators (CCMTA) (2011). *Canada's Road Safety Strategy 2015.* Retrieved from: http://ccmta.ca/crss-2015/_files/road_safety_strategy_2015.pdf

[13] Bahar, G., Masliah, M., Mollett, C., & Persaud, B. (2003). Integrated safety management process. NCHRP report 501. Washington, DC: Transportation Research Board. Retrieved from: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_501.pdf

[14] BCStats (2015). Quarterly Population Highlights. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography.aspx

[15] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. A fatality refers to a road user who dies within 30 days after an injury sustained in a crash involving at least one motor vehicle on a 'highway' as defined in the *Motor Vehicle Act* (largely any public roadway). The *Motor Vehicle Act* does not apply to forest-service roads, industrial roads and private driveways. Fatal victims of off-road snowmobile crashes, homicides, and suicides are excluded from this report.

[16] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. Data calculated based on the following filters: Length of stay: overnight. Death outcome: no. 3-wheel motor vehicle occupants: excluded. Residents of B.C. treated out of province are excluded. Non-BC residents are included.

[17] Government of British Columbia (2015). News release: Saving lives on B.C. roads. Retrieved from: http://www2.news.gov.bc.ca/news_releases_2013-2017/2015JAG0253-001719.htm

[18] British Columbia Ministry of Justice (2015). Justice Minister's statement on drinking driving law rulings. *BC Government News Archive.* October 16, 2015. Retrieved from: http://archive.news.gov.bc.ca/

[19] British Columbia Ministry of Transportation and Infrastructure (2015). Slow Down Move Over regulation protects roadside workers. Retrieved from: https://news.gov.bc.ca/stories/slow-down-move-over-regulation-protects-roadside-workers

[20] Peck, R. C., Gebers, M. A., Voas, R. B., & Romano, E. (2008). The relationship between blood alcohol concentration (BAC), age, and crash risk. *Journal of Safety Research*, *39*(3), 311-319.

[21] Sun, J., & Lovegrove, G. (2013). Comparing the road safety of neighbourhood development patterns: traditional versus sustainable communities. *Canadian Journal of Civil Engineering*, *40*(1), 35-45.

[22] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[23] M. W. Kreuter, P. Hovmand, D. J. Pfeiffer, M. Fairchild, S. Rath, B. Golla, and C. Casey (December 2014). The "Long Tail" and Public Health: New thinking for addressing health disparities. *American Journal of Public Health*, Vol. 104, No. 12, P. 2271-78.

[24] Deborah C. Girasek & Taylor, B. (2010) An Exploratory Study of the Relationship Between Socioeconomic Status and Motor Vehicle Safety Features, *Traffic Injury Prevention*, 11(2), 151-155.

[25] Harper, S., Charters, T. J., & Strumpf, E. C. (2015). Trends in Socioeconomic Inequalities in Motor Vehicle Accident Deaths in the United States, 1995–2010. *American Journal of Epidemiology*, 182(7), 606-614.

[26] BCStats (2015). Quarterly Population Highlights. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx

[27] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf

[28] Ibid.

[29] Ibid.

[30] Ibid.

[31] Huisingh, Carrie, Gerald McGwin Jr., Katherine A. Orman, Cynthia Owsley (January 2014). Frequent Falling and Motor Vehicle Collision Involvement of Older Drivers. *Journal of the American Geriatrics Society*. Volume 62, Issue 1: 123-129.

[32] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf.

[33] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[34] Ibid.

[35] Citation: I. Johnston, C. Muir, & E. Howard (2014). Eliminating Serious Injury and Death from Road Transport: A crisis of complacency, Boca Raton, FL., CRC Press.

[36] Diedericks, J.C. (2014). The effects of motor vehicle accidents on careers and the work performance of victims. *SA Journal of Industrial Psychology*, Volume 40, Issue 1: 1078-1088.

[37] Alghnam, Suliman, Stephen T. Wegener, Kavi Bhalla, Elizabeth Colantuoni, and Renan Castillo (2015). Long-term outcomes of individuals injured in motor vehicle crashes: A population-based study. *Injury* Volume 46, Issue 8: 1503-1508.

[38] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. See note in endnote 16.

[39] Ibid. RAD-E 2015-004. Residents of B.C. treated out of province are excluded. Non-BC residents are included.

[40] British Columbia Emergency Health Services. Data extracted July 11, 2015. RAD-E 2015-005. Each event counts the MVA only once, regardless of the number of patients or ambulances dispatched. Patient events count each individual patient only once, regardless of the number of ambulances that attended to that person. Pre-hospital calls are coded using the Medical Priority Dispatch System (MPDS).

[41] Diedericks, J.C. (2014). The effects of motor vehicle accidents on careers and the work performance of victims. SA Journal of Industrial Psychology, Volume 40, Issue 1: 1078-1088.

[42] Transport Canada (2010). Social Cost of Collisions in British Columbia – Jurisdictional Factsheet. RAD-E 2015 013

[43] OECD/ITF (2015). "Road safety performance in 2013 and 2014", in Road Safety Annual Report 2015. *OECD Publishing, Paris*. Retrieved from: http://www.oecd-ilibrary.org/docserver/download/7515011ec005.pdf?expires=1449602927&id=id&accname=guest&checksum=2C9E3339A124B888C8B6C7245EEF1D4A

[44] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[45] BCStats (2015). Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx.

[46] Transport Canada (2013). Canadian Motor Vehicle Traffic Collision Statistics 2013. Retrieved from: https://www.tc.gc.ca/media/documents/roadsafety/cmvtcs2013_eng.pdf

[47] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[48] Police can assign up to 4 contributing factors per entity (entities are drivers, pedestrians or cyclists), therefore an incident may be included more than once. For example, if speed, alcohol and driver inattentive were contributing factors in an incident, the incident would be counted in the Speed section, Alcohol Section, and Driver Inattentive section. Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[49] Arason, Neil (2014). Review of *Eliminating Serious Injury and Death from Road Transport: A Crisis of Complacency*. Retrieved from: http://neil.arason.ca/?p=442

[50] Ibid.

[51] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[52] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[53] Ibid.

[54] The Globe and Mail (2014). "B.C. to Crack Down on Distracted Driving as Statistics Paint Grim Picture of Death Toll." Retrieved on September 30th, 2015 from http://www.theglobeandmail.com/news/british-columbia/distracted-driving-claimed-81-lives-in-bc-in-2012-surpassing-impaired-driving-deaths/article17780087/

[55] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[56] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[57] ICBC (2015). Impaired Driving Fact Sheet. Retrieved from: http://www.icbc.com/road-safety/crashes-happen/Documents/impaired-driving.pdf

[58] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[59] Government of British Columbia (2015). Immediate Roadside Prohibition Factsheet. *Ministry of Justice, RoadSafetyBC*. Retrieved from: http://www.pssg.gov.bc.ca/osmv/shareddocs/Immediate_Roadside_Prohibition_Fact_Sheet.pdf

[60] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[61] Canada Safety Council (2009). Driver Fatigue: Falling Asleep at the Wheel. LIII: 2. Retrieved from: https://canadasafetycouncil.org/safety-canada-online/article/driver-fatigue-falling-asleep-wheel/

[62] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[63] Stutts, J. C., Wilkins, J. W., & Vaugh, B. V. (1999). Why do people have drowsy driving crashes? Input from drivers who just did. AAA Foundation for Traffic Safety, Washington DC.

[64] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf

[65] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[66] Ibid.

[67] Ibid.

[68] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. See note in endnote 16.

[69] Ibid. RAD-E 2015-004. See note in endnote 39.

[70] Ibid. RAD-E 2015-009. See note in endnote 16.

[71] Ibid. RAD-E 2015-004. See note in endnote 39.

[72] RoadSafetyBC (2015). Motorcycle Safety—the Rider and the Gear. Retrieved from: http://www.pssg.gov.bc.ca/osmv/road-safety/motorcycles.htm

[73] Brussoni, M., Wong, K., Creighton, G. & Lise Olsen (2014). Rise in injury rates for older male motorcyclists: An emerging medical and public health concern. *Volume 56, Issue 8*: 386-390. Retrieved from: http://bcmj.org/articles/rise-injury-rates-older-male-motorcyclists-emerging-medical-and-public-health-concern

[74] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[75] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. See note in endnote 16.

[76] Ibid. RAD-E 2015-004. See note in endnote 39.

[77] Shope, JT. (2006). Influences on youthful driving behaviour and their potential for guiding interventions to reduce crashes. Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1592526/

[78] Insurance Institute for Highway Safety: Highway Loss Data Institute (2014). Older drivers. Retrieved from: http://www.iihs.org/iihs/topics/t/older-drivers/fatalityfacts/older-people

[79] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[80] Ibid.

[81] BCStats (2015). Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx. Population percentages were rounded to zero decimal points.

[82] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[83] BCStats (2015). Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx. Population percentages were rounded to zero decimal points.

[84] 4-Fatal Victim Report_2015 Q3.

[85] U.S. Department of Health and Human Service: National Institutes of Health (2011). Graduated drivers licensing programs reduce fatal teen crashes. Retrieved from: http://www.nih.gov/news/health/nov2011/nichd-04.htm

[86] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. See note in endnote 16.

[87] Ibid. RAD-E 2015-004. See note in endnote 39.

[88] The Social Issues Research Centre (2004). Sex differences in driving and insurance risk: An analysis of the social and psychological differences between men and women that are relevant to their driving behaviour. Retrieved from: http://www.sirc.org/publik/driving.pdf

[89] Insurance Institute for Highway Safety. General statistics: Gender. Retrieved from: http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/gender

[90] Fontaine, H., & Gourlet, Y. (1997). Fatal pedestrian accidents in France: A typological analysis. *Accident Analysis & Prevention*, *29*(3), 303-312.

[91] Holubowycz, O. T. (1995). Age, sex, and blood alcohol concentration of killed and injured pedestrians. *Accident Analysis & Prevention*, *27*(3), 417-422.

[92] Yagil, D. (2000). Beliefs, motives and situational factors related to pedestrians' self-reported behavior at signal-controlled crossings. Transportation Research Part F: Traffic Psychology and Behaviour, 3(1), 1-13.

[93] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15. Note: 3 fatalities were excluded from these statistics due to the victim's sex being unknown in the data.

[94] Ibid. Note: 2 fatalities were excluded from these statistics due to the victim's sex being unknown in the data.

[95] Winters, M., Friesen, M. C., Koehoorn, M., & Teschke, K. (2007). Utilitarian bicycling: a multilevel analysis of climate and personal influences. *American Journal of Preventive Medicine*, *32*(1), 52-58.

[96] Johnson, M., Newstead, S., Charlton, J., & Oxley, J. (2011). Riding through red lights: The rate, characteristics and risk factors of non-compliant urban commuter cyclists. Accident Analysis & Prevention, 43(1), 323-328.

[97] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[98] British Columbia Ministry of Health, Discharge Abstract Database. See note in endnote 16.

[99] Ibid.

[100] Butters, Jennifer, Robert E. Mann, Christine M. Wikens, Paul Boase (2011). Gender differences and demographic influences in perceived concern for driver safety and support for impaired driving countermeasures. *Journal of Safety Research*, Volume 43, Issues 5-6: 405-411.

[101] Bridges, F. S., & Kunselman, J. C. (2005). Premature Mortality Due to Suicide, Homicide, and Motor Vehicle Accidents in Health Service Delivery Areas: Comparison of Status of Indians in British Columbia, Canada, with all Other Residents. *Psychological reports*, *97*(3), 739-749.

[102] Kendall, P. (2009). Pathways to health and healing: 2nd report on the health and well-being of Aboriginal people in British Columbia. *Office of the Provincial Health Officer. Victoria: British Columbia Ministry for Health Living and Sport*. The Office of the Provincial Health Officer (OPHO) report presents data on health trends for the entire Aboriginal population of British Columbia (First Nations, Métis, and Inuit). The data on motor vehicle fatalities show fatalities only for Status Indians as defined in the *Indian Act* which, at the time of the publication of the OPHO report cited here, did not include Métis or Inuit. For this reason, this BC Road Safety Strategy document is concerned only with First Nations road safety data. The data in OPHO report are also limited to First Nations individuals who have Indian Status.

[103] Ibid.

[104] Seat belts, air bags and child protection devices. SWOV Factsheet. *Institute for Road Safety Research*. Retrieved from: https://www.swov.nl/rapport/Factsheets/UK/FS_Seatbelts.pdf

[105] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[106] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf.

[107] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. 7. Waterloo Ontario: Wilfred Laurier University Press. Print.

[108] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[109] Cafiso, Salvatore, Alessandro Di Graziano, and Giuseppina Pappalardo (2013). Road safety issues for bus transport management. *Accident Analysis and Prevention*. Volume 60: 324-333.

[110] Savage, Ian (2013). "Comparing the Fatality Risks in United States Transportation across Modes and Over Time." *Research in Transportation Economics*, Vol.43, No. 1, pp. 9-22.

[111] TransLink and South Coast British Columbia Transportation Authority. RAD 2015-012. The difference in injury rates between Access Transit (HandyDART) and the conventional operators is largely due to the type of passenger they carry and the business model they operate.

[112] TransLink Regional Trip Diary Survey and ICBC. RAD 2015-014.

[113] Coast Mountain Bus Company. RAD 2015-010. The data represented here do not identify if either buses or other road users were at-fault.

[114] BC Transit. RAD 2015-011. Total number of pedestrian and cyclist collisions includes "BCT Hit Pedestrian", "Pedestrian Hit BCT," "BCT Hit Cyclist", and "Cyclist Hit BCT". The data represented here do not identify if either buses or other road users were at-fault.

[115] Road Safety at Work. The Case for Road Safety. Retrieved from: http://roadsafetyatwork.ca/why-road-safety-matters/the-case-for-road-safety/

[116] Zwerling, C., Peek-Asa, C., Whitten, PS., Choi, S-W., Sprince, BL. & MP Jones (2005). Fatal motor vehicle crashes in rural and urban areas: decomposing rates into contributing factors. *Injury Prevention*, Volume 11, Issue 1: 24-28.

[117] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf

[118] Ibid.

[119] Ibid.

[120] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[121] BCStats (2015). BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx.

[122] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[123] Ibid.

[124] BCStats (2015). BC Stats. Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx. ICBC region populations are not represented in BC Stats. Raw population estimates for ICBC regions were determined by cross-referencing TAS data on crash fatalities in BC municipalities (1-Victims by Traffic Section and District_2015 Q3) with BC Stats estimates of municipal populations located on the BC Stats website (refer to link in this endnote).

[125] British Columbia Ministry of Health, Discharge Abstract Database. RAD-E 2015-009. See note in endnote 16.

[126] BCStats (2015). Population Estimates. Estimates as of July 1, 2015. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx

[127] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[128] BC Stats (2015). Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015 retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx. See note in endnote 127.

[129] Traffic Accident System (TAS) police-reports as of September 30, 2015. 4-Fatal Victim Report_2015 Q3. See definition in endnote 15.

[130] BCStats (2015). Municipalities, Regional Districts and Development Regions. Estimates as of July 1, 2015. Retrieved from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx. See note in endnote 127.

[131] Ibid.

[132] ICBC (2015). Quick Statistics. Retrieved from: http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf

[133] RoadSafetyBC (2015). Motorcycle Safety—the Rider and the Gear. Retrieved from: http://www.pssg.gov.bc.ca/osmv/road-safety/motorcycles.htm

[134] ICBC (2015). Quick Statistics. Retrieved from http://www.icbc.com/about-icbc/newsroom/Documents/quick-statistics.pdf

[135] Arason, Neil (2014). No Accident: eliminating injury and death on Canadian roads. Waterloo Ontario: Wilfred Laurier University Press. Print.

[136] Hurwitz, D. & Monsere, C. (2012). Improved Pedestrian Safety at Signalized Intersections Operating the Flashing Yellow Arrow. Transportation Research and Education Center. Retrieved from: http://trec.pdx.edu/research/project/484/

[137] Harwood, Douglas W (1990). Effective Utilization of Street Width on Urban Arterials. *No. 330. Transportation Research Board.*

[138] Petritsch, T. (2013). *The Influence of Lane Widths on Safety and Capacity: A Summary of the Latest Findings.* Sprinkle Consulting Inc, FL, USA.

[139] Petrovic, Mirjana & Klimet Kuzmanavoski (2015).Travel Lanes Modification – Safety Study. *Commissioned by the City of Surrey.*

[140] Wood, Jonathan S., Jeffrey P. Gooch, & Eric T. Donnell (2015). Estimating the safety effects of lane widths on urban streets in Nebraska using the propensity scores-potential outcomes framework. *Accident Analysis and Prevention*. Volume 82: 180-191.

[141] World Health Organization (2008). "Speed management: a road safety manual for decision-makers and practitioners." Retrieved from: http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiarcHTstTJAhUH6mMKHR8iD0MQFggcMAA&url=http%3A%2F%2Fwhqlibdoc.who.int%2Fpublications%2F2008%2F9782940395040_eng.pdf&usg=AFQjCNF-iCSDFTLpf3yRp5cWPZT7NW57fw&sig2=KIwGDGP-7R84VWjIIUn3Dw

[142] Brubacher, Jeffrey R., Ediriweera Desapriya, Shannon Erdelyi, & Herbert Chan (In press). The impact of child safety restraint legislation on child injuries in police-reported crashes in British Columbia: An interrupted time series analysis. *Department of Emergency Medicine/Faculty of Medicine, University of British Columbia, Vancouver General Hospital. Center for Clinical Epidemiology and Evaluation.*

[143] U.S. Federal Highway Administration (2015). Cable Median Barriers. Retrieved from: https://www.fhwa.dot.gov/research/deployment/cable.cfm

[144] Nyland, Dirk (2010). Road Improvement Program: 20 years of improving communities in British Columbia: 1990-2010. *ICBC*.

[145] British Columbia Ministry of Transportation and Infrastructure (2007). News Release: Cable Barrier Improves Highway Safety. Retrieved from: http://www2.news.gov.bc.ca/news_releases_2005-2009/2007TRAN0011-000318.htm