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Impact of Energy Sector Growth on Perceived Transportation Safety in the 17-County Oil Region of Western North Dakota: A Three-Year Case Study

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Impact of Energy Sector Growth on Perceived Transportation Safety in the 17-County Oil Region of Western North Dakota: A Three-Year Case Study

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ABSTRACT

The sharp increase in travel volumes, shift in traffic mix, and large increases in crashes have transformed the traffic environment in the oil region of western North Dakota. Roads once used for local access and agricultural purposes now regularly serve the energy sector. Oil companies, workers, commercial trucks, and industrial equipment associated with oil extraction use these roads to access drilling and production sites. This has led to a larger number of overweight and oversized vehicles sharing the roadway with other traffic. A survey questionnaire was sent to drivers to better understand perceptions and behaviors of road users in this region. County-level crash data were gathered to analyze changes in driving conditions during the latest oil boom – specifically between 2004 and 2014. This study addresses two goals for improving regional traffic safety: first, to examine public perceptions of traffic safety issues and priorities; and, second, to address crash trends and intervention strategies. Survey results indicate residents believe driving conditions in the region are dangerous, but ratings have improved as oil activity has decreased. Crash data reveal that crashes parallel oil production: as the number of active oil wells grew exponentially, so too did crashes – even when factoring for changes in vehicle miles traveled and population growth. Economic factors, such as the price of a barrel of oil, may be linked to the prevalence of crashes, especially those involving large trucks.

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1. INTRODUCTION

Road usage and condition in western North Dakota has changed. Interstate, highway, and low-volume unpaved roads have been used more regularly due largely to the growth in the energy sector. This evolution is prominent in a 17-county region where new extraction methods such as hydraulic fracturing, or "fracking," have improved production economics. Roads once used for local access and agricultural purposes now see high volumes of traffic to serve oil production. Oil companies, workers, commercial trucks, and heavy-duty industrial equipment associated with oil and gas development all rely on these roads to access drilling and production sites. This has led to both an increase in traffic volume and an increase in the number of overweight and oversized vehicles on the road. As such, a number of roads are now in poor condition and others are deteriorating rapidly.

The oil region of North Dakota consists of 17 counties in the western part of the state: Billings, Bottineau, Bowman, Burke, Divide, Dunn, Golden Valley, McHenry, McKenzie, McLean, Mercer, Mountrail, Renville, Slope, Stark, Ward, and Williams (Figure 1.1). Three of the largest cities in the state are located in this region: Minot (Ward County), Dickinson (Stark County), and Williston (Williams County). Because of the growing energy sector, the region has been transformed via various social, economic, and environmental changes – many of which stem from rapid population growth, an influx of labor and job-seekers, and improved economic development.

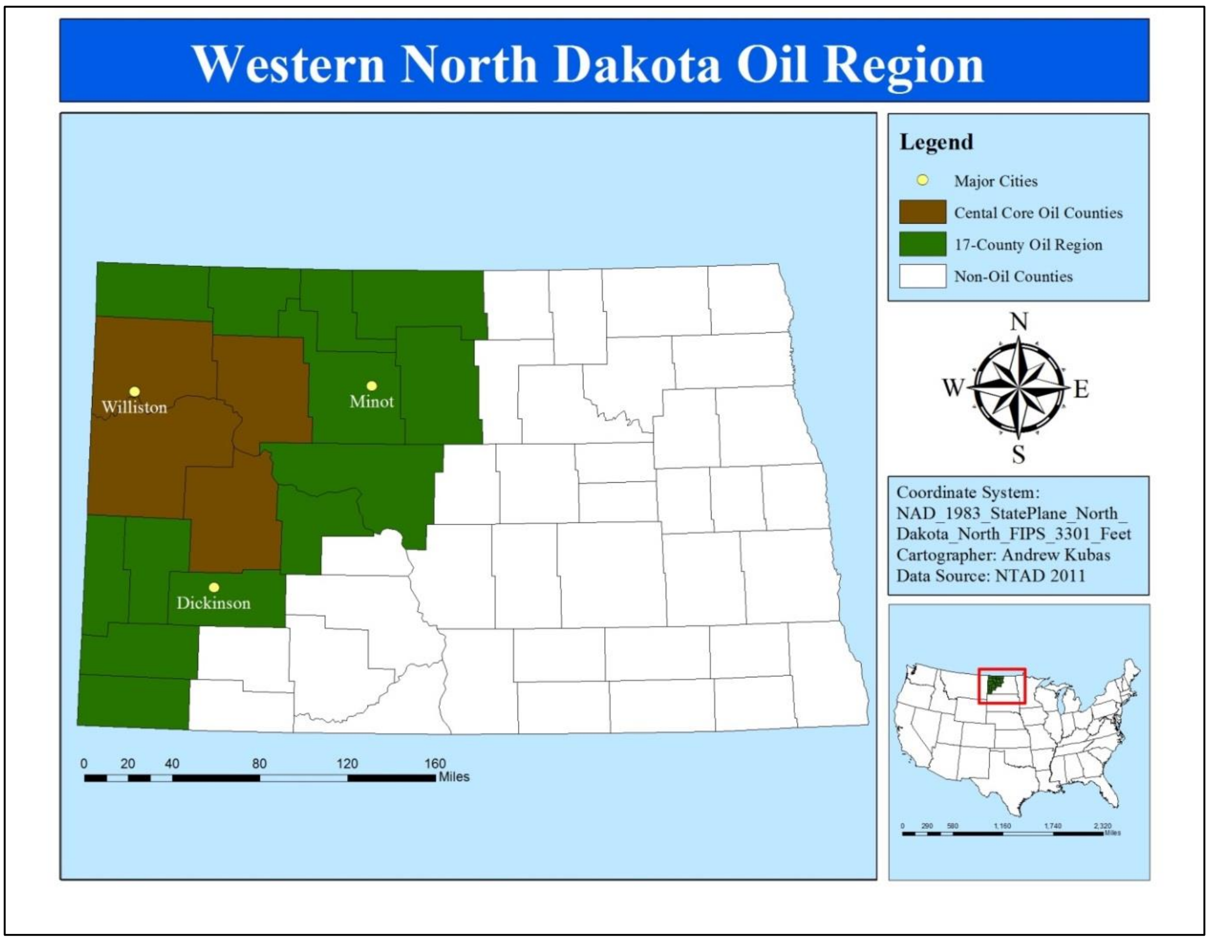

Figure 1.1 Western North Dakota Oil Region

It is undeniable that the expanding oil industry has resulted in numerous benefits. The state currently has the second-lowest unemployment rate in the nation, largely due to the success of the oil region (Bureau of Labor Statistics 2015). The oil boom also plays a direct role in North Dakota's budget surplus, although future budget forecasts are uncertain because of the declining price of oil (Bosman 2015). Despite these economic benefits, an increased public safety risk associated with greater traffic volume is evident when examining the number and severity of crashes in the area. Fatal crash incidence trends in the central core of the oil region show exponential growth (Figure 1.2). The central core consists of the four highest-producing counties as defined by the North Dakota Industrial Commission: McKenzie, Mountrail, Dunn, and Williams (Department of Mineral Resources 2015) (see Table 2.1). Vehicle miles traveled (VMT) in these counties is generally higher than in most other areas in the region. (However, in 2014, McLean, Stark, and Ward counties did have comparable VMT figures to the central core counties.) This implies that increased oil activity in these counties is amplifying the number of miles traveled. Consequently, when more miles are driven, there are more opportunities for drivers to have a crash. This may partially explain why crash rates in these four counties are considerably higher than in other parts of North Dakota.

When these four counties are compared to all other counties in North Dakota, it is apparent that driving conditions in the central core are more dangerous than in the rest of the state. Using 2004 as a baseline, the growth in fatal crashes in the central core outpaces fatal crashes elsewhere (Figure 1.2).

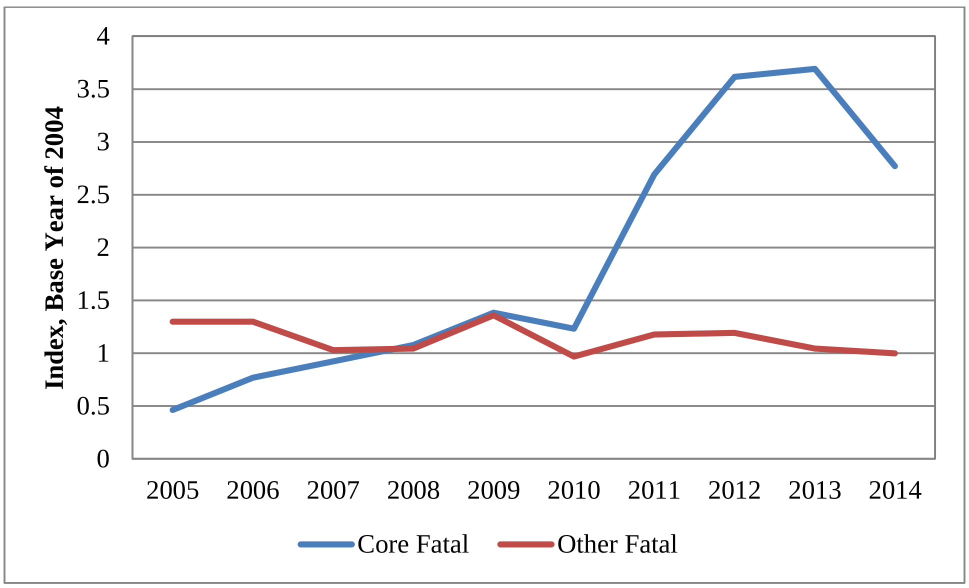

Figure 1.2 Fatal Crash Trends for Central Core Oil-Producing Counties and Other North Dakota Areas

Large truck crashes are another contributing factor that can be examined to compare and contrast counties. In all four counties the number of large trucks involved in crashes remained stable from 2004 through 2009. After 2009, however, the number of large truck crashes rose significantly (Figure 1.3). With the exception of McKenzie County, large truck crash rates have not grown as sharply since 2011, but the overall trend has clearly moved upward between 2004 and 2014.

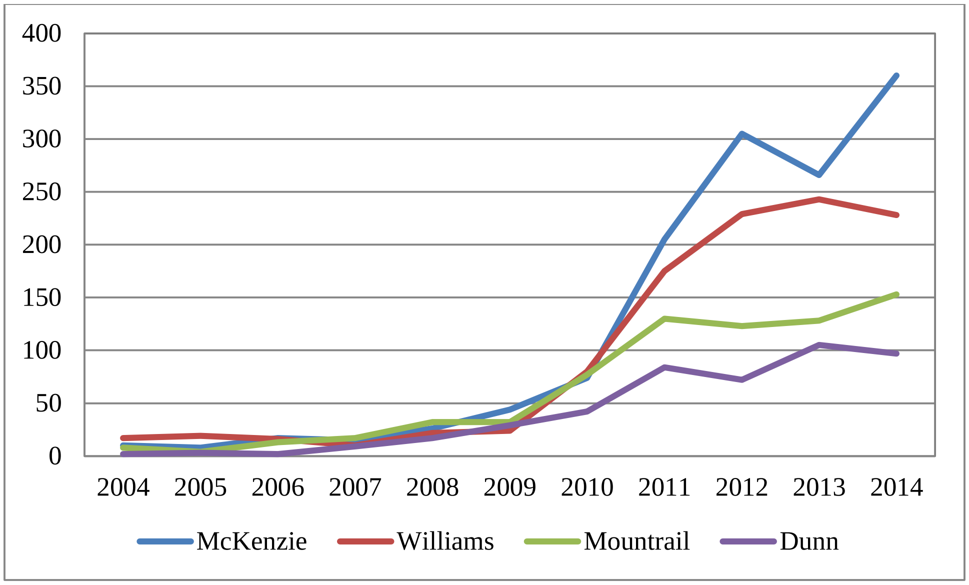

Figure 1.3 Large Truck Crash Involvement, by Central Core Counties

When factored together, the change in large truck crashes for the central core resembles an exponential growth curve (R^2=0.9535) (Figure 1.4). These counties increased from just 37 large truck crashes in 2004 to 838 in 2014, an increase of 2,164%. This increase is exaggerated due to the small number of truck crashes in the base year and a rise in VMT. Nonetheless, the rate at which truck crashes have increased outpaces the rate at which VMT has grown in these counties and is probably a contributing factor to perceptions of danger in the region. The prevalence of large truck crashes may be a factor in negative perceptions of traffic safety as heavy-duty trucks are more likely to be involved in serious crashes (Braver et al. 1992), especially when speeding (Neeley and Richardson 2009; Islam and Hernandez 2013; Vadlamani et a. 2011). Note that heavy-duty trucks are not necessarily the root cause of danger; drivers of passenger vehicles can be at-fault in a crash for unsafely attempting to pass a large truck.

Driving factors such as these have prompted stakeholders such as the North Dakota Department of Transportation (NDDOT), the North Dakota Petroleum Council (NDPC), and the North Dakota Highway Patrol (NDHP) to take action to encourage safety on the roadway. One awareness campaign – *ProgressZone: Moving Forward Safely* – was created in 2012 as an intervention strategy to improve driver safety. In 2014, the *Code for the Road* campaign was rolled out as a safety initiative. Various messages have been promoted on billboards, newspapers, radio advertisements, television broadcasts, and online advertisements to alert drivers about safe practices. Education and outreach have also been utilized, and funding has been allocated for additional safety personnel and law enforcement to patrol the oil region (Grand Forks Herald 2013).

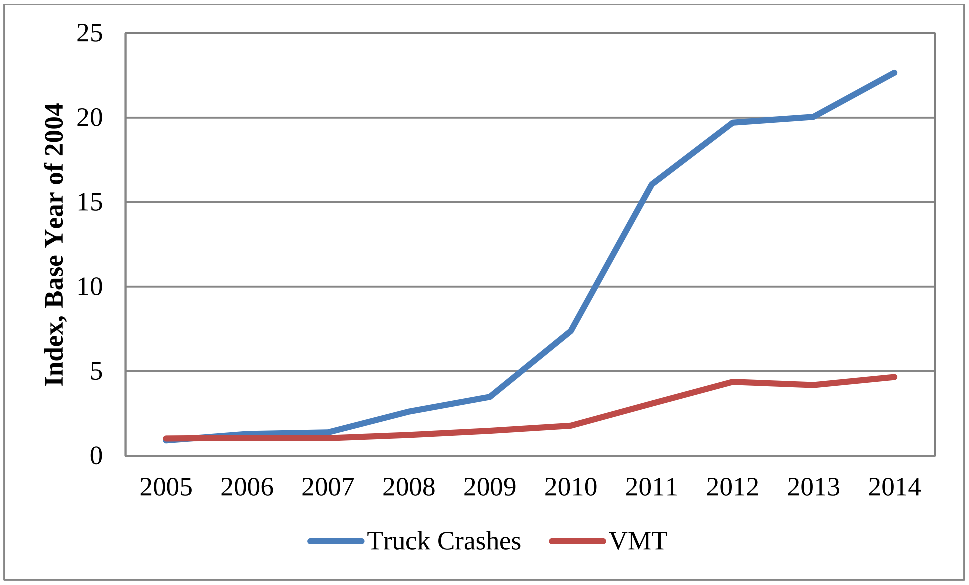

Figure 1.4 Large Truck Crash Growth Trends in Central Core Counties

This research report aims to address a few key goals related to improving traffic safety in the region: (1) to longitudinally examine public perceptions of traffic safety issues and priorities in the state's oil producing region; (2) to discover trends in large truck/passenger vehicle interaction among oil county drivers; and (3) to understand the efficacy of public education, specifically *ProgressZone: Moving Forward Safely* in 2012 and *Code for the Road* in 2014 and 2015 as safety intervention strategies focusing on large truck/passenger vehicle interaction. The following section provides context for the survey discussion presented in section five. Sections three and four highlight information on the methodology and survey response. Some crash facts related to the survey focus are given in section six. Section seven discusses the correlative relationships between economic factors of oil extraction and different crash metrics. The final sections include the conclusion and discussion for the survey.

2. BACKGROUND

2.1 Western North Dakota Oil Region Geography

The 17-county oil region is defined by its proximity to economically viable oil formations (Figure 2.1). Currently, two formations define the oil region: the Bakken and the Three Forks. The recently discovered Birdbear Formation is expected to augment oil activity further. All have different levels of drilling and production. The Bakken covers a significant portion of North Dakota, South Dakota, and Montana, and extends northward into Saskatchewan and Manitoba. It is estimated that the Bakken has a mean undiscovered volume of 3.65 billion barrels of oil (Pollastro et al. 2008). The Three Forks is directly below the Bakken, and is roughly two miles below the surface of the ground (Beitsch 2010). It has been estimated that it has two billion barrels of recoverable oil (Sonnenberg, Gantyno, and Sarg 2011). Presently, North Dakota produces just under 1.2 million barrels per day from these formations (Helms 2015), a number which was predicted by geological experts just a few years ago (St. Anthony 2011).

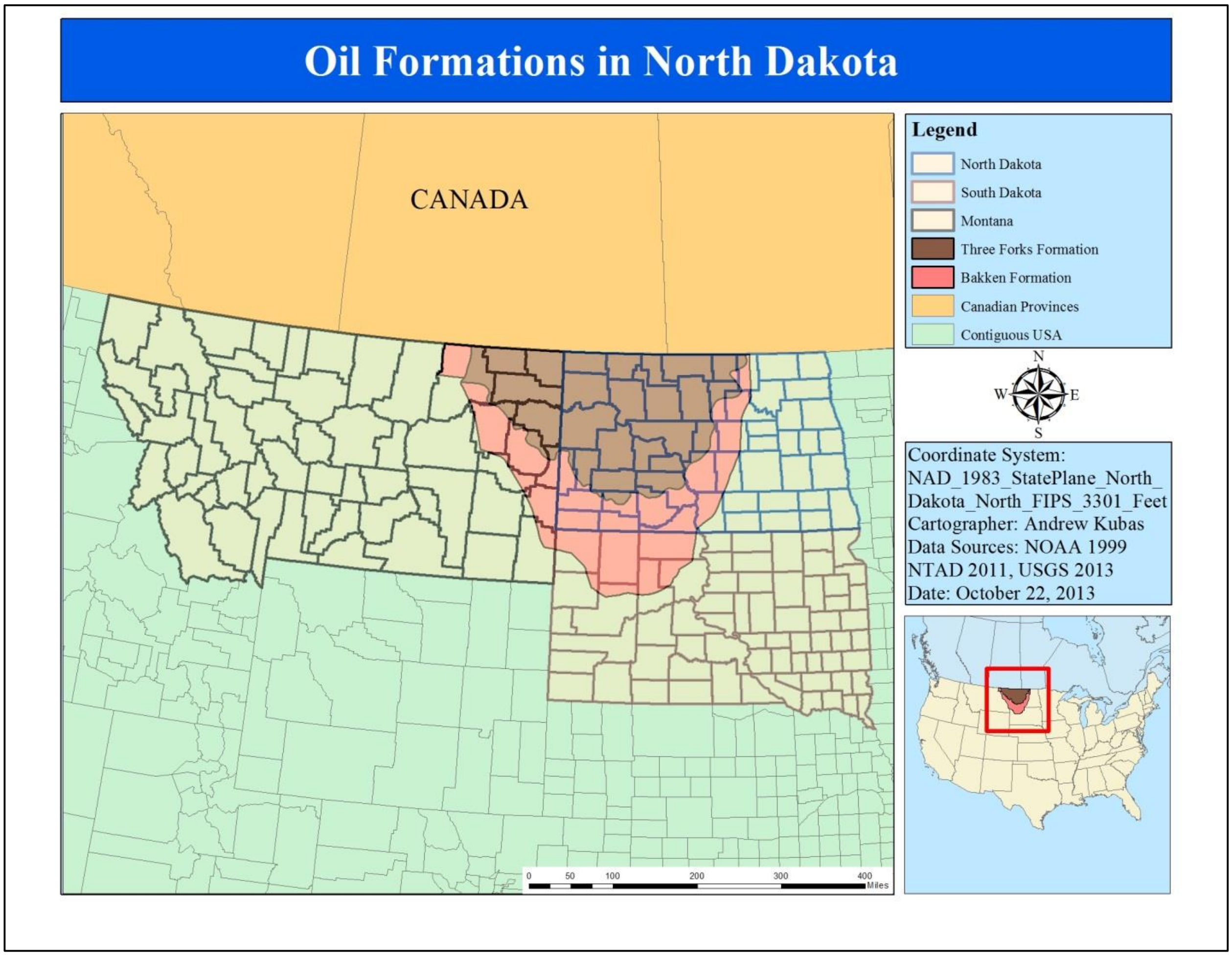

Figure 2.1 Oil Formations in North Dakota Oil Region

The Birdbear Formation lies further underground beneath the Three Forks Formation (LeFever 2009). Drilling and oil production is newer, with only 37 active wells producing as of 2010 (Yang and Kent 2010). Although the three formations share similar geographic and geologic properties, the drilling and production activity that takes place varies from formation to formation.

2.2 Growth and Development of the Oil Industry

Oil development in North Dakota has expanded rapidly, particularly since the latest "boom" in activity began in 2004 (NDIC 2015) (Figure 2.2). The North Dakota Industrial Commission's Department of Mineral Resources, Oil and Gas Division, reports that there are 12,543 actively producing oil and gas wells, a considerable spike from the 3,339 that were producing in 2004.

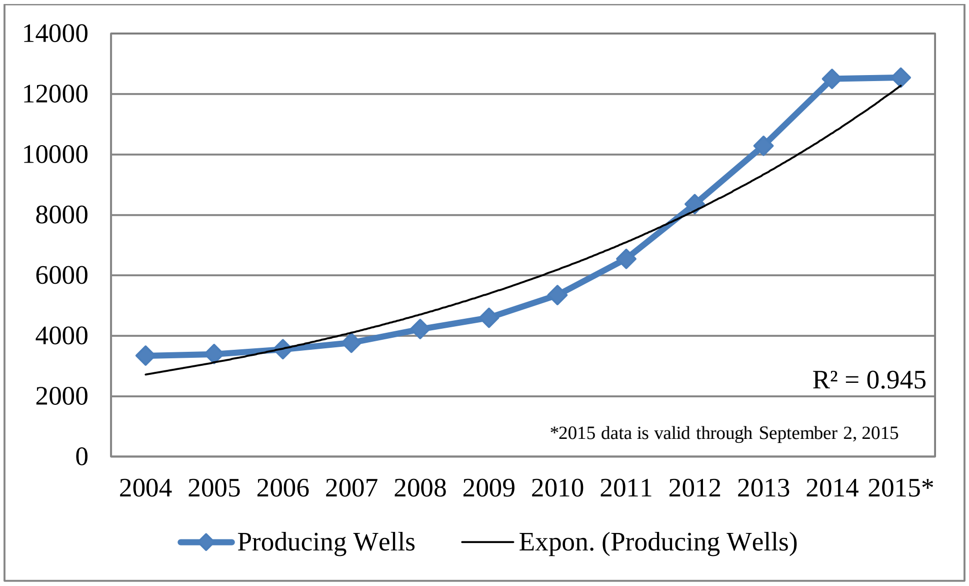

Figure 2.2 Active Oil Wells in North Dakota

The 17 western oil-producing counties vary considerably in terms of oil production (Table 2.1). McKenzie County has the highest volume of barrels of oil produced in June of 2015 (12,214,385), the greatest number of actively producing oil and gas wells (3,184), and the highest average production per well (3,836 barrels). These numbers represent a stark contrast from Mercer County, which did not have any wells producing in June of 2015. It was producing oil as recently as December of 2013.

These counties face unique impacts with regard to state and local roads because of oil development (Table 2.2, Table 2.3). As demand for oil has increased, so too has the use of local low-volume and high-volume roads. Many of these roadways were not designed for heavy truck traffic. The most common reason that infrastructure problems arise is because of the sheer volume of vehicles and weight that these vehicles place on each axle. The stressors are especially prominent in oil development (Rosendahl 2011). The NDDOT estimates that for each vertical oil well drilled, 400 truck loads are needed throughout implementation and maintenance (NDDOT 2008). Additionally, for each horizontal well drilled, anywhere from 600 to 1,000 truck loads are required (NDDOT 2008).

Based on extensive analysis of surface and base layer thickness, the materials of those layers, the amount of cracking and deterioration of the surface layer, underlying soil conditions, and the graded width of the road, a study from the Upper Great Plains Transportation Institute concluded that approximately 958 miles of paved roads and 12,718 miles of unpaved roads are impacted by oil development (UGPTI 2010). These impacts include additional maintenance costs, unforeseen maintenance costs, surface cracking, road deterioration, damages to grading, damages to drainage, and overhead expenditures (UGPTI 2010).

Table 2.1 Western North Dakota Oil Production, June 2015

County	Ranking	Barrels	Wells	Average Production per Well
McKenzie	1	**12,214,385**	**3,184**	**3,836**
Mountrail	2	7,378,427	2,362	3,124
Dunn	3	5,636,689	1,685	3,345
Williams	4	5,589,626	2,031	2,752
Divide	5	1,208,426	702	1,721
Bowman	6	602,727	373	1,616
Stark	7	464,045	251	1,849
Burke	8	443,016	522	849
Billings	9	421,379	494	853
Bottineau	10	189,403	537	353
McLean	11	83,331	42	1,984
Golden Valley	12	69,247	88	787
Renville	13	66,523	236	282
Slope	14	31,064	15	2,071
McHenry	15	5,961	13	458
Ward	16	3,039	8	380
Mercer	17	0	0	0
TOTAL		34,407,288	12,543	2,743

Bold: Leading county in category

Source: North Dakota State Industrial Commission 2015

Table 2.2 Conditions of Paved Roads Affected by Oil Development

Road Condition	Miles	Percent Miles	Cumulative Miles	Cumulative Percent
Very Good	60.8	6.3%	60.8	6.3%
Good	496.1	51.8%	556.9	58.1%
Fair	333.6	34.8%	890.5	92.9%
Poor	38.2	4.0%	928.7	96.9%
Very Poor	29.7	3.1%	958.4	100%

Source: Upper Great Plains Transportation Institute 2010

Table 2.3 Conditions of Unpaved Roads Affected by Oil Development

Road Condition	Miles	Percent Miles	Cumulative Miles	Cumulative Percent
Very Good	118.2	0.9%	118.2	0.9%
Good	4,601.9	36.18%	4,720.1	37.1%
Fair	7,374.2	57.98%	12,094.3	95.1%
Poor	574.3	4.52%	12,668.6	99.6%
Very Poor	49.3	0.4%	12,717.9	100%

Source: Upper Great Plains Transportation Institute 2010

In general, truck loads consist of heavy-duty vehicles and objects that are significantly over the size and weight limits of low-volume rural roads (NDDOT 2008) (Table 2.4). The main impacts of the overweight loads and heavy-duty vehicles on rural road networks are damages to the crown and rutting (Skorseth and Selim 2000). The weight of the vehicles gradually diminishes the crown. As the crown decreases, water accumulation and traffic can soften the crust, create a rut, develop potholes, and, eventually result in washboard conditions that make the road dangerous year round.

Table 2.4 Overweight Loads During Oil Development and Maintenance

Load Type (and number needed)	Weight (lbs.)
Generator House (3)	111,180
Shaker Tank/Pit	122,000
Suction Tank	131,000
Mud Pump (2)	164,000
Shaker Skid	111,760
Draw Works	130,880
Hydraulic Unit	127,640
Tool Room Junk Box	124,140
BOP Skip	138,680
Top Dog House	117,000
Crown Section	140,000
Derrick	159,000
VFD House	130,100
Mud Boat	114,380
Substructure	136,000
Centerpiece	139,440
Choke Manifold	126,000
MCC House	145,160
BOP Setting Machine	145,160

Source: North Dakota Department of Transportation 2008

A study by Mitra, Tolliver, and Dybing (2012) analyzed three main data sources – oil production forecasts, traffic data, and county road surveys – to assess the current situation in the state. Presently, there is greater traffic volume, an increased number of overweight vehicles, and an increased number of oversized trucks on the road because of energy sector growth. All of these variables contribute to deteriorating road conditions. The authors estimate an investment of $900 million will be needed during the next 20 years to maintain roads for transporting oil and allowing travelers to have acceptable roadway use in western North Dakota.

2.3 Community-Level Changes due to Oil Extraction and Development

Early research regarding the impacts that oil extraction has on a region shows a similar situation to that currently being experienced in North Dakota. Affolter (1976) studied the implications oil development had in Scotland factoring for ecological, planning, and general environmental considerations. There was a link between human activity and growing pressures on the built and natural environments. Oil extraction in the North Sea created noise, safety hazards, increased traffic volumes, altered landscape, construction camps, and localized changes to infrastructure – all of which are presently occurring in western North Dakota.

Near Coastal Louisiana, environmental consequences from oil extraction in the Gulf of Mexico were augmented by hurricanes and tropical storms. Laska et al. (2005) performed a social impact assessment to gauge which human activities in the region would be impacted by various proposed projects aimed at restoring barrier islands. The authors noted that such projects could threaten transportation modes such as road networks, ports, and airports; issues that would not have arisen without demand for oil extraction.

Prowse et al. (2009) discuss the implications that oil development has had in northern Canada. The researchers found that the development has led to noticeable changes to infrastructure and transportation, particularly in terms of designing pipeline networks to deliver oil and gas to market. The study sheds light into the relationship between oil extraction and transportation safety, but focuses extensively on future responses due to predicted climate change instead of present issues stemming from oil development.

A recent study from Kubas and Vachal (2014) indicates that drivers in western North Dakota do not feel safe when traveling via automobile. Residents from the region generally are fearful during large truck-passenger vehicle interactions. About three-quarters of drivers were willing to drive out of the way during a typical commute to avoid roads with heavy truck traffic or to drive on roads with better signage and surface conditions. The study also tracked crash rates noting that conditions in the western oil-producing counties were actually more dangerous than in the rest of the state.

2.4 Studies Relating to Perceived Safety

Some studies have attempted to measure perceptions of safety in various situations. Naveh, Katz-Navon, and Stern (2005) gave a questionnaire to doctors and nurses at two separate hospitals to identify patient safety within the hospital building. A major finding from the study was that when employees perceived that the safety procedures were congruent with their daily work demands and were realistic given the available resources, the priority given to safety was high and overall safety subsequently improved. This was further augmented when information flow was clear and sufficient from all employees in the hospital. In western North Dakota, it can be argued that daily travel demands have exceeded capabilities of the roadway, and this may influence how road users perceive safety.

A survey of workers at British Rail aimed to understand perceptions of the importance of safety in the organization (Clarke 1999). Three types of workers – train drivers, supervisors, and senior managers – were asked to participate. All three groups rated safety as being important, but each group varied on how they perceived other groups would rate the importance of safety. This finding parallels some of the literature on risk taking: humans tend to perceive themselves as being safer than others (see section 2.7). In general, a sense of "otherness" emerges when one is asked to compare one's self to one's peers or colleagues. In this instance, a hierarchy of transportation management officials rated the importance of safety differently compared to others at the exact same institution.

2.5 Driver Behavior as a Determinant of Roadway Safety

Driver behavior directly impacts safety. Operating a vehicle while impaired, speeding, or choosing not to wear a seat belt contributes to danger. Drivers have different underlying mechanisms that determine emotional or reckless driving violations. For example, Martinussen et al. (2013) gave a survey questionnaire to 4,335 Danish drivers in an attempt to understand behaviors while operating a motor vehicle. The study found a differentiation between how drivers with emotional violations and those with reckless violations change their driving styles. The changes stem from different underlying mechanisms, such as errors or lapses while unfocused, emotional arousal, reckless behavior, and confusion. Given the large volume of vehicles on western North Dakota roads, a lapse in judgment, loss of focus, or confusion on the roadway could be fatal.

Strayer and Drews (2007) focused on cell phone use as it related to driver distraction. The authors tested drivers by using a simulated screen to see if hands-free cell phone use resulted in any lost information while driving. Drivers who use a hands-free cell phone failed to see some information in the driving scene. According to the researchers, drivers do not encode information adequately, even when using a hands-free device. The authors indicate that the best driving scenario is one in which the driver is not distracted whatsoever.

Individuals behave differently after being in a crash (af Wahlberg 2012). A study of drivers at the bus company Gamla Uppsalabuss in Uppsala, Sweden, attempted to explain if drivers operate vehicles in a safe manner after having been in a crash. The study showed that there is no large effect on general driving behavior after a crash, but the researcher noted that drivers may change specific behaviors. For example, an individual who experienced a crash at a junction may use extra caution when at junctions in the future.

Drivers exhibit more stress, worry, and exhaustion after a crash. A survey of 124 drivers from the Atlanta area found that 42 had been in at least one crash in the previous five years. When studying differences between those that did and did not crash, Lucas (2003) showed that drivers reporting having been in at least one crash had greater personal safety concerns, worries about driving, stress, exhaustion, and negative physical symptoms. These experiences may directly relate to overall perceptions of safety on the roadway.

Although drivers who have experienced a crash exhibit more fear and worry on the roadway, these motorists nonetheless tend to have higher levels of risk-taking, even after the crash has occurred (Lin et al. 2004). A 20-month study was conducted in Taiwan in which the impact of motorcycle crash experiences was investigated. Students with prior crash involvement had higher risk-taking levels than those without a crash. However, involvement in a previous crash did not change one’s reported levels of risk-taking. This indicates that risk-taking among drivers varies individually – danger on the roadway can stem from individual behavior.

2.6 Large Truck-Passenger Vehicle Interaction

Nationally, fatalities from large truck crashes decreased from 1975 to 1999, likely due to safety improvements to trucks and passenger cars (Lyman and Braver 2005). After querying FARS data for U.S. truck crash rates and truck crash fatality rates over that time frame, the researchers found that fatalities in large truck crashes per 100 million truck miles traveled decreased. Similarly, truck driver deaths per 10,000 truck registrations also decreased over the same period. The number of fatalities in large truck crashes, however, has not changed per 100,000 population. It is hypothesized by the authors that across-the-board safety advances to truck and passenger cars may explain the overall crash rate improvement.

A study by Jermakian (2012) posits that further safety improvements such as side view assist, forward collision warning, lane departure warning, and vehicle stability control would be relevant to approximately one-fourth of all large truck crashes in the United States. The author extracted data from two sources – the National Automotive Sampling System General Estimates System (NASS GES) and FARS – to identify which safety features were relevant to different types of crashes. This was accomplished by factoring for the crash type and manner of collision and then separating individual crash events as they related to each of the four crash avoidance technologies. It was found that such technology could be applicable to tens of thousands of large truck crashes annually.

Aghabayk et al. (2011) showed that large trucks execute lane changes more smoothly on arterial roads and freeways than shorter vehicles. The researchers applied different models to lane-changing techniques by large and heavy trucks. They attributed the smoothness of large truck movements to the fact that heavy vehicles apply lower acceleration or deceleration when executing a lane change maneuver. Although the authors have a limited sample size, they also present preliminary findings suggesting that large truck driver behaviors are typically safer than drivers of passenger vehicles.

The Upper Great Plains Transportation Institute analyzed the impacts that oil and gas development have had on western North Dakota's roads (UGPTI 2010). Trucks make up a significant portion of traffic in oil-producing counties (Table 2.5). Of the 15 western North Dakota oil-producing counties studied, the mean number of trucks on the road each day is 61 (UGPTI 2010). Beyond volume, the number of trucks on the road in western North Dakota is also a significant proportion of the traffic (Table 2.6). As a whole, in the 15 counties that were studied, trucks comprised 42% of the average daily traffic (UGPTI 2010).

Table 2.5 Average Trucks per Day on Major County Roads

County	Road Segments Observed	Minimum	Mean	Maximum
Billings	9	4	31	80
Bottineau	3	48	68	86
Bowman	6	30	125	233
Burke	6	4	22	66
Divide	3	28	96	172
Dunn	10	12	61	198
Golden Valley	5	23	38	50
McHenry	4	7	21	40
McKenzie	12	14	97	253
Mercer	3	1	3	6
Mountrail	12	12	65	252
Slope	4	7	17	34
Stark	5	9	26	62
Ward	6	24	105	217
Williams	11	10	68	312
All	99	1	61	312

Source: Upper Great Plains Transportation Institute 2010

The same study from the Upper Great Plains Transportation Institute discussed a survey which analyzed 2007 truck traffic data to establish a baseline of average ADT and percent truck traffic on roads in North Dakota's oil region. The survey found that between 2008 and 2010 the percentage of trucks on collector roads – those designed to move traffic from local roads to arterial roads – increased from 18% in 2008 to 39% in the same counties by 2010 (UGPTI 2010). This is a considerable increase in a relatively short span of time, especially when considering that a majority of western North Dakota residents do not feel safe passing or being passed by heavy-duty trucks (Kubas and Vachal 2012).

Table 2.6 Percent Trucks and Multi-Unit Trucks on Major County Roads

County	Trucks as a percent of ADT	Multi-Units as a Percent of Trucks
Billings	49	23
Bottineau	24	38
Bowman	62	24
Burke	43	72
Divide	54	63
Dunn	46	46
Golden Valley	42	31
McHenry	51	52
Mercer	14	8
Mountrail	49	49
Slope	37	28
Stark	24	42
Ward	26	35
Williams	51	56
All	42	44

Source: Upper Great Plains Transportation Institute 2010

2.7 Perceived Risk on the Roadway

Drivers often perceive themselves as being safer than others. Out-of-state oil workers perpetuate the "self-versus-other" dynamic in western North Dakota. A study by DeJoy (1989) asked 106 college students to compare their risk of being involved in 10 different crash scenarios compared to other drivers at their school. Subjects consistently viewed their chances of being involved in a crash as significantly less than their counterparts. Delhomme, Verlhiac, and Martha (2009) had similar results in a study of 3,002 young French drivers. These individuals were asked to rate perceptions of one's self compared to other drivers with regard to tendencies and expectations when operating a vehicle. Like the study by DeJoy, drivers rated themselves as safer than other drivers. Additionally, this study factored for various emotional states. Drivers who exhibited comparative optimism tended to take less risk on the roadway and were safer drivers than those categorized as exhibiting comparative pessimism.

Certain demographics are more prone to taking risks on the roadway than others. In North Dakota, young male drivers are a particularly dangerous group. They are more likely to engage in dangerous driving activity, less likely to partake in safe driving behaviors, and are less likely to be positively influenced by traffic safety messages (Vachal, Benson, and Kubas 2010-2015). A study utilizing the U.S. National Household Travel Survey estimated the individual driver risk for crash involvement (Ouimet et al. 2010). Just as is in North Dakota, on a national scale the study indicated that young male drivers have the highest risk of any driver group. Additionally, young drivers with passengers in the vehicle were found to engage in high-risk activity on the roadway.

2.8 Safety Strategies/Campaigns as Intervention and Prevention Tools

Traffic safety interventions are generally formed under four approaches: policy (Shults et al. 2004), enforcement (Houston and Richardson 2006), education (Hedlund et al. 2008), and media (Nichols and Ledingham 2008). All intervention approaches have been used with varying degrees of success in addressing issues such as seat belt use, impaired driving, and speeding. These strategies are primarily associated with public education and perceptions, and have been proven in past applications.

For example, the *ProgressZone: Moving Forward Safely* campaign launched by the North Dakota Department of Transportation in 2012 utilized a combination of education and media strategies to alert drivers in western North Dakota oil-producing counties about safe behaviors (North Dakota Petroleum Council 2011a, North Dakota Petroleum Council 2011b). The campaign had four main messages displayed on large yellow billboards: "Pass With Caution," "Be Patient. Slow Down," "Buckle Up. Every Time," and "Roads Shared. Lives Spared" (Wehrman 2011). The campaign proved successful: roughly 42% of all drivers that viewed the safety messages positively changed their driving habits (Kubas and Vachal 2012). Understanding the safety impacts of this campaign is important in future traffic safety resource decisions (Donovan 2011).

The *Code for the Road* campaign is another example of education and media strategies focused on traffic safety. The safety messages target driver behavior and focus on buckling up, driving sober, and slowing down. It is a statewide initiative with commercials displayed on television, radio, and internet advertisements (Heidle, Horton, and Lerman 2014). Messages began appearing in 2014, and have been rolled out consistently in 2015.

Local, state, regional, and federal safety campaigns have been waged in an attempt to promote safer driving habits and discourage dangerous driving activity. Safety tools such as *What's the Hurry?* in northeastern Tennessee (Whittam et al. 2006), the *Hawaii Opportunity Probation with Enforcement* (Hawken 2011), the *South Dakota 24/7 Sobriety Project* (Loudenburg, Drube, and Leonardson 2010), the *Checkpoint Strikeforce* program in NHTSA's Region 3 (Lacey et al. 2008), the annual nationwide *Drunk Driving: Over the Limit, Under Arrest* Labor Day crackdown (Solomon et al. 2008), the *Target Zero Team Project* in Washington State (Cicchino 2012), the *Saving Lives* program in Massachusetts (Hingson et al. 1996), the *Strategic Evaluation States* initiative in Alaska, Georgia, and West Virginia (Syner et al. 2008), the *Better Driver Campaign* in Florida (Lee et al. 2010), and the national *Click It Or Ticket* campaign (Kim and Yamashita 2003) are geared toward improving safety on the roadway and have been studied extensively. Many of these programs emphasize preventing impaired driving, and some do so specifically targeting young males (Murry, Stam, and Lastovicka 1993).

2.9 Traffic Safety and Economic Factors

Studies have revealed a relationship between overall traffic safety and economic factors. Most link the price of petroleum and/or oil to crash patterns. In Minnesota, the price of gasoline was found to have an inverse relationship to traffic safety: as gas prices declined, the total number of crashes, property-damage-only crashes, and injury crashes rose, likely because of increased travel at more affordable prices (Chi et al. 2013a). The study found more noticeable differences in rural counties than in urban counties; rural communities generally had worse traffic safety conditions with lower gas prices. Considering the rurality of North Dakota and the recent decline in oil and gas prices, it may be expected that some traffic safety metrics will worsen.

A study in Mississippi had comparable findings: an increase in gas prices had a noticeably reduced less severe crashes (Chi et al. 2013b). However, there was a negligible effect on fatal crashes. A separate study in Mississippi linked higher gas prices with a decline in impaired driving crashes (Chi et al. 2011).

At the national level, trends mirrored those in individual states. Lower gas prices tend to result in more traffic fatalities (Grabowski and Morrisey 2014). Once again, this was not because of changes in driver behavior, but because of additional travel activity resulting in more opportunities for a crash to occur.

Hyatt et al. (2009) analyzed the effect of gas price as it specifically related to motorcyclists. The findings contrasted other studies in the literature in that higher gas prices appeared to result in more deaths to motorcycle drivers. The relationship between the price of gas and motorcyclist safety was somewhat inconclusive: higher gas prices resulted in more deaths to motorcycle drivers by volume, but when the authors factored for the rate at which vehicles were registered there was no substantive association between gas prices and motorcyclist fatalities.

Although these studies will guide the present research, none focus on areas with historically high oil extraction activity but declining petroleum prices. It is clear that economic factors such as the price one pays to enjoy vehicular travel are linked to actual traffic safety, but does a similar relationship exist when the volume of traffic declines because a substantial amount of said traffic is related to the price of oil and gas being high? It is plausible that there may be a correlative relationship between the price of oil, gas, and crash patterns, but it is uncertain if this relationship will also follow inverse patterns. For instance, as oil prices have dropped overall extraction activity has subsequently declined. As a result, drivers are able to travel more often – which increases crash likelihood – yet these same drivers may perceive travel to be safer as a product of fewer oil trucks and oil-related traffic sharing the roadway. This paper will examine possible correlative links between oil prices, crash trends, and perceptions of traffic safety.

2.10 Gaps in the Literature

These topics have been studied widely by academics and transportation safety personnel, but none have focused solely on North Dakota oil development. Moreover, none have given priority to rural road segments. The goal of this project is to measure driver behaviors, perceptions, priorities, and risk given rapidly changing road networks in western North Dakota and worsening crash trends. This will be achieved by (1) measuring public perceptions of traffic safety issues and priorities in the state's oil producing region; (2) determining perceived driver risk and its relation to danger on the roadway; and, (3) querying rural crash data to parallel it with on-road driving experiences as reported by drivers. This crash data will be compared to the non-oil-producing part of the state in an attempt to quantify if the perceptions of dangerous driving conditions are simply perceived or occurring in reality.

3. METHOD

A mail survey was used to obtain data from western North Dakota residents. A draft survey was designed by blending questions related to traffic safety, *ProgressZone: Moving Forward Safely* goals (in 2012), *Code for the Road* goals (in 2014 and 2015), and issues directly related to oil traffic and oil development. Industry partners provided input regarding questions to include in the final survey. The mailing to drivers included a cover letter which invited participation and explained the goals of the survey. The survey was first mailed to drivers on April 6, 2012, and was open to response until May 1, 2012. In 2014, the second mailing for a follow-up study was mailed to drivers on April 1, 2014, and was open to response until May 5, 2014. The 2015 mailing occurred on April 9, 2015, and was open to response until May 23, 2015.

The state driver licensing division used the 17-county oil region driver population for the sampling. Initially, the 2012 mailing list provided by the North Dakota Department of Transportation consisted of 2,700 driver addresses. Prior to mailing, 41 addresses were removed because they were in counties outside of the 17-county focus area. Thus, 2,659 addresses were verified for final mailing. Of these, 10 were flagged as addresses of individuals who had moved and had not provided a new forwarding address, 2 were flagged as “unmailable,” and 22 were flagged as “problem” addresses that were not mailed. Ultimately, 2,623 surveys were mailed. Three of the 2,623 initial surveys that were mailed were unable to be forwarded to a current address and were returned by the post office. Of the 2,620 successfully mailed, 781 responses were obtained. From these, two responses had zip codes that were either out-of-state or unverifiable. Of the useable survey responses received, 779 were verified as North Dakota responses and form the valid driver response sample used as the baseline year in the analysis.

In 2014, a slightly larger mailing list of 2,720 driver addresses was provided by the state driver licensing division. Before mailing the survey, 54 addresses were removed because they were either addressed to out-of-state drivers or North Dakotans living in counties outside of the target area. None of the remaining addresses were flagged as “unmailable,” “problem addresses,” or sent to individuals who had changed residency. A total of 2,666 surveys were mailed. Two of these were returned as undeliverable. Of the 2,664 successfully mailed, 710 responses were acquired. Of these, 14 responses had zip codes that were either out-of-state addresses, unverifiable, or from counties outside of the 17-county target region. Thus, 696 surveys comprise the final sample for the 2014 follow-up study.

The 2015 mailing consisted of 2,720 driver addresses provided by the state licensing division. Prior to mailing the survey, 64 addresses were eliminated due to being addressed to areas that were outside of the target region. None of the 2,656 remaining addresses were tagged as “unmailable,” or “problem addresses” by the post office. Of these, two were returned as undeliverable. From the 2,654 successfully mailed, 599 were returned. Three surveys did not include a zip code, one survey had an unknown zip code, and six had zip codes that were from North Dakota counties outside of the study area. A total of 589 surveys were valid and comprise the final sample for the third year of the study.

The sample sizes were based on a 95% confidence interval, with a 5% confidence level. The expected response rate was estimated at 20%. Although mail survey response is generally low – 10% is not uncommon – a slightly better response rate was expected due to the parameters used in the survey design and administration. These parameters included keeping the survey to a single page, including “Upper Great Plains Transportation Institute, North Dakota State University” letterhead, and using mail envelopes with official insignia. Given the timeliness of the topic at hand, it was expected that an above-average response would be obtained.

A proportionate stratified random sample was used to select drivers. The North Dakota driver population was stratified by county. Individuals living in the 17 oil-producing counties had no greater than a 3.5% chance of receiving a survey. The greatest number of surveys was sent to Williams, Stark, and Ward counties, respectively. This aligns with the fact that these three counties are home to the three largest cities in the oil region: Williston, Dickinson, and Minot.

Although a random sample was obtained for the survey mailing, the sample was not representative of the population (Table 3.1). Males were overrepresented in the 2012 mailing and underrepresented in the 2014 follow-up study. Whereas the adult (18+) population in the 17 western North Dakota oil-producing counties is 51 percent male and 49 percent female, the sample used in 2012 had rates that were 62 percent male and 38 percent female and the 2014 follow-up study had rates that were 42 percent male and 58 percent female. In 2015, proportions more accurately represented the balance of the North Dakota population: 48% of responses were from males and 52% were from females.

The proportion of drivers in each age cohort did not always mirror the real-life proportion of drivers in the oil-producing counties. In 2012, the sample was underrepresented in terms of drivers 44 years of age and younger. In contrast, drivers between ages 55 and 74 were overrepresented in the sample when compared to their actual proportion of the population in the counties. In 2014, a comparable situation occurred: drivers under the age of 34 were underrepresented and drivers between the ages of 55 and 74 were once again overrepresented. The same trend occurred in 2015. Some age cohorts – such as the 45-54 age group and the 75+ age cohort – were accurately represented in the mailing sample.

Table 3.1 Mailing Samples and State Driver Population by Age

Survey Information	Age Cohort						
	18-24	25-34	35-44	45-54	55-64	65-74	75+
Surveys Mailed, 2012	86	285	212	584	637	488	366
Surveys Mailed, 2014	150	249	375	609	652	358	273
Surveys Mailed, 2015	157	270	425	530	634	354	286
Percent of Sample Mailed, 2012	3.2	10.7	8.0	22.0	24.0	18.4	13.8
Percent of Sample Mailed, 2014	5.6	9.3	14.1	22.8	24.5	13.4	10.2
Percent of Sample Mailed, 2015	5.9	10.2	16.0	20.0	23.9	13.3	10.8
Oil County Population[1]	17,486	21,976	18,087	24,914	21,292	12,730	13,637
Percent of 18+ Oil County Population	13.4	16.9	13.9	19.1	16.4	9.8	10.5

[1]Source: US Census Bureau 2010 Census

Survey responses were entered into a database using SPSS Statistics 22 software (see Table 5.1 and Table 5.2 for quantitative scale definitions). Initially, a factor analysis was performed to identify possible components linked to constructs developed by the researchers. After the factor analysis was conducted, different statistical analyses – such as measures of association, Chi-Square tests, and 1-way ANOVAs – were performed to identify differences in response distributions and differences across target groups. Most of the questions on the survey were posed at ordinal levels of measurement, though some were presented and subsequently coded as dichotomous “dummy” variables. Some variables, such as length of residency, were recoded to ordinal scales based on prior studies from the literature. Key driver groups – gender, age, newcomers/long-term residents, high-risk young drivers, and those exposed to the *Code for the Road* safety campaign – were treated as independent variables in the analysis. Driver knowledge, attitudes, behaviors, and beliefs were most often treated as dependent variables in the statistical analyses.

4. RESPONSE

Survey response rate was 29.7% in 2012, with 779 valid responses from the sample mailing to 2,620 drivers. The response rate was 26.1% in 2014, with 696 valid surveys obtained from a mailing to 2,666 drivers. A smaller response rate of 22.2% was obtained in 2015, with 589 valid surveys returned from a mailing to 2,654 North Dakota drivers. As expected, the proportion of responses by age cohort increased with age: there were more responses from older (45+) drivers than there were responses from drivers under the age of 45 (Table 4.1). This was likely because a smaller proportion of younger drivers received the survey compared to the higher proportion of older drivers who received it. Note that the valid responses obtained from this study are not representative of the 17 western North Dakota oil-producing counties: a much lower proportion of drivers under the age of 45 are in the sample than are in the population. Similarly, the portion of drivers between ages 45 and 74 is much higher than the actual proportion of individuals in this age group in the 17-county oil region. The 75+ age cohort comprised 10.3% of responses in 2012, 10.6% of responses in 2014, and 12.6% of responses in 2015 – numbers that accurately reflect their proportion (10.5%) of the oil region population. Also consider that the total number of responses from the 18-24 age cohort is not large enough to be extrapolated to fit the 17 western North Dakota oil county population. In general, at least 30 valid responses are required for data to be considered representative of a particular demographic. Thus, any conclusions made for the 18-24 age cohort cannot be considered indicative of the entire 18-24 year-old population in this portion of the state.

Table 4.1 Valid Survey Responses and State Driver Population, by Age

Survey Information	Age Cohort						
	18-24	25-34	35-44	45-54	55-64	65-74	75+
Valid Surveys, 2012	12	49	55	193	220	168	80
Valid Surveys, 2014	17	40	55	186	198	124	74
Valid Surveys, 2015	8	44	59	121	192	89	74
Percent of Sample Received, 2012	1.5	6.3	7.1	24.8	28.2	21.6	10.3
Percent of Sample Received, 2014	2.4	5.7	7.9	26.7	28.4	17.8	10.6
Percent of Sample Received, 2015	1.4	7.5	10.1	20.6	32.7	15.2	12.6
Oil County Population[1]	17,486	21,976	18,087	24,914	21,292	12,730	13,637
Percent of 18+ Oil County Population	13.4	16.9	13.9	19.1	16.4	9.8	10.5

[1]Source: US Census Bureau 2010 Census
Frequency Missing 2012=2; Frequency Missing 2014=2; Frequency Missing 2015=2

When factoring for both gender and age, multiple demographic groups have less than 30 responses for their respective cohorts. Responses obtained in 2012 cannot be extrapolated to fit the entire population of 18-24 year-old males, 18-24 year-old females, 25-34 year-old females, and 35-44 year-old males (Table 4.2). A similar pattern emerges for 2014 responses. Yet again, both males and females in the 18-24 age cohort did not have at least 30 responses; thus information obtained for these groups will not be considered representative. Males in the 25-34 and 35-44-year-old age cohorts also did not have 30 responses. There were only 27 responses from females over the age of 75; this represents another group for which responses must be interpreted critically. In 2015, responses for males under the age of 44, females under the age of 34, and females over age 75 cannot be extrapolated to fit the entire North Dakota driver population. In the forthcoming statistical analyses, independent variables are not examined in such detail; therefore, considerations of only age and only gender can be considered an accurate reflection of attitudes in the target region (see sections 5.5.1 and 5.5.2 for further detail).

Table 4.2 Survey Response by Age and Gender

	2012		2014		2015	
Age	Male	Female	Male	Female	Male	Female
18-24	6 (50.0%)	6 (50.0%)	0 (0.0%)	17 (100.0%)	5 (62.5%)	3 (37.5)
25-34	30 (61.2%)	19 (38.8%)	5 (12.5%)	35 (87.5%)	20 (45.5%)	24 (54.5%)
35-44	24 (43.6%)	31 (56.4%)	24 (44.4%)	30 (55.6%)	23 (39.0%)	36 (61.0%)
45-54	113 (58.5%)	80 (41.5%)	69 (37.5%)	115 (62.5%)	41 (34.2%)	79 (65.8%)
55-64	137 (62.3%)	83 (37.7%)	86 (43.9%)	110 (56.1%)	97 (50.8%)	94 (49.2%)
65-74	104 (62.7%)	62 (37.3%)	55 (45.1%)	67 (54.9%)	49 (55.7%)	39 (44.3%)
75+	38 (47.5%)	42 (52.5%)	45 (62.5%)	27 (37.5%)	45 (61.6%)	28 (38.4%)
Total	452 (58.3%)	323 (41.7%)	284 (41.5%)	401 (58.5%)	280 (48.0%)	303 (52.0%)
	Frequency Missing=4		Frequency Missing=11		Frequency Missing=6	

5. RESULTS

Survey responses offer important insight into driver perceptions, attitudes, and behaviors regarding traffic conditions in the oil region. Simple frequency analysis of ordinal and dichotomous survey responses provides a baseline of driver views and behaviors. Quantifying responses allows for statistical testing of relationships, means, and tests of significance. Quantitative scale definitions are provided in Table 5.1 (for questions that were unchanged in survey iterations) and Table 5.2 (for unique questions on the individual annual surveys).

Table 5.1 Quantitative Scale Definitions: Identical Questions on All Three Surveys

Q#	Question	Scale	Conversion Values
1	Safety Now vs. 5 Years Ago	1-5	1=Much Less Safe to 5=Much Safer
3	Sudden Brake/Swerve	0-1	0=No, 1=Yes
4	Law Enforcement Presence	0-1	0=No, 1=Yes
5	Meet/Pass Large Trucks	1-5	1=Never to 5=Daily
6a	Safety Passing Large Trucks	1-5	1=Very Unsafe to 5=Very Safe
6b	Being Passed by Trucks	1-5	1=Very Unsafe to 5=Very Safe
7a	Extra Driving to Avoid Oil Trucks	1-4	1=No Change to 4=20+ Minutes Extra
7b	Extra Driving for Better Surface/Signs	1-4	1=No Change to 4=20+ Minutes Extra
8a	Seat Belt Use in Town	1-5	1=Never to 5=Always
8b	Seat Belt Use Over 30 MPH	1-5	1=Never to 5=Always
9	Speeding on 65 MPH Road (Over 70 MPH)	1-5	1=Never to 5=Always
13a	Signage of Traffic Rules	1-4	1=Least Important to 4=Most Important
13b	Law Enforcement Presence	1-4	1=Least Important to 4=Most Important
13c	Driver Awareness	1-4	1=Least Important to 4=Most Important
13d	Truck/Car Interaction	1-4	1=Least Important to 4=Most Important

Table 5.2 Quantitative Scale Definitions: Unique Questions

Q#	Year	Question	Scale	Conversion Values
2	2012	Message Alert System	0-1	0=No, 1=Yes
10	2014	Future Injury Crashes	0-5	0=None to 5=5 or more times
11a	2014	Safer Driver Than Others	1-5	1=Strongly Disagree to 5=Strongly Agree
10a	2015	Safer Driver Than Others	1-5	1=Strongly Disagree to 5=Strongly Agree
11b	2014	Out-of-State Dangerous	1-5	1=Strongly Disagree to 5=Strongly Agree
10b	2015	Out-of-State Dangerous	1-5	1=Strongly Disagree to 5=Strongly Agree
11c	2014	Risking My Life Driving	1-5	1=Strongly Disagree to 5=Strongly Agree
10c	2015	Risking My Life Driving	1-5	1=Strongly Disagree to 5=Strongly Agree
11d	2014	See Crash, Drive Less Often	1-5	1=Strongly Disagree to 5=Strongly Agree
10d	2015	See Crash, Drive Less Often	1-5	1=Strongly Disagree to 5=Strongly Agree
10e	2015	Fear Future Crash	1-5	1=Strongly Disagree to 5=Strongly Agree
10f	2015	Improve Road Conditions	1-5	1=Strongly Disagree to 5=Strongly Agree
12	2014	Multi-Vehicle Crash	1-3	1=No, 2=Else's Fault, 3=My Fault
11	2015	Multi-Vehicle Crash	1-3	1=No, 2=Else's Fault, 3=My Fault

The survey questionnaire was designed to measure certain constructs within transportation safety. The researchers wanted to learn about key latent variables which are not easily measured. When applied to residents living in western North Dakota, these factors include perceptions of danger, perceptions of risk, travel behavior, safety priorities, and attitudes toward large truck-passenger vehicle interaction. Factor analysis was utilized to determine which variables had similar patterns of responses. Initially each variable (with the exception of demographic information) was correlated with one another to identify variables that may be unrelated to any underlying factor. A total of 17 variables were used in the factor analysis, and six components emerged as having an Eigenvalue greater than 1. A scree plot of the components, however, visually displays that the first four components explain a significant percentage of the total variance, and that the fifth and sixth components have an Eigenvalue slightly larger than 1, and are plausibly the "beginning point" of the scree plot's plateau (Figure 5.1).

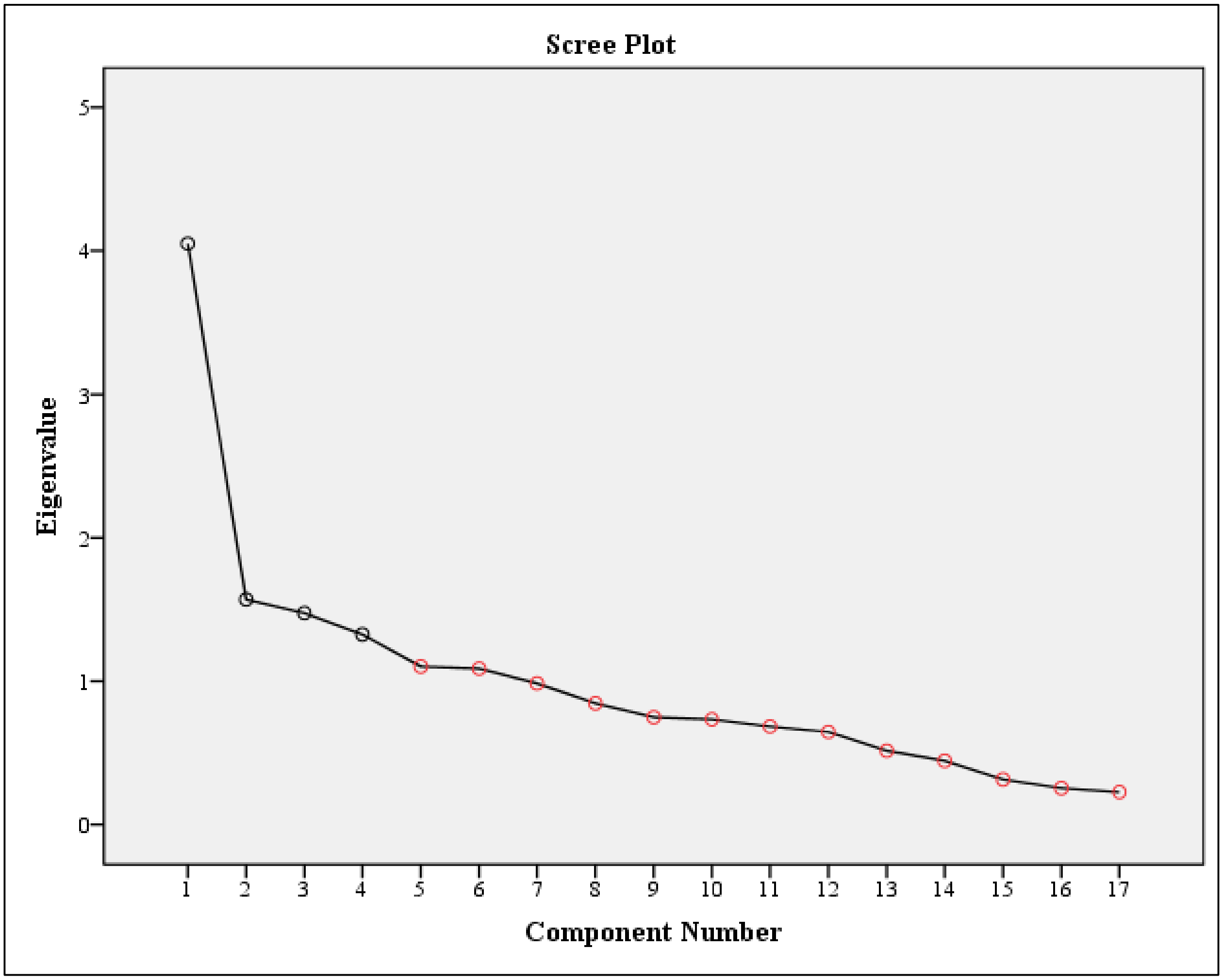

Figure 5.1 Scree Plot of Factor Analysis

These four components were subjected to a Varimax rotation with Kaiser Normalization, and factor loads were sorted by size. Only factor loads greater than 0.40 were considered. The four main components appear to be linked to the constructs identified by the researchers. The first factor relates to perceptions of danger. The second factor can be described as those choosing to avoid danger. The third factor encompasses safe driver behaviors. The fourth factor highlights large truck-passenger vehicle interaction. The relationships of driver responses to these themes will be the focal point of the following data analysis.

5.1 Perceptions of Danger

Multiple survey questions focused on safety conditions in the 17 western North Dakota oil-producing counties. Response frequencies for three of these general safety questions are provided in Table 5.3. Responses show that drivers most commonly do not feel safer driving now than they did five years ago. A majority of respondents chose the worst option on the Likert scale – "Much Less Safe" – in both 2012 and 2014. This declined to 42.4% of respondents in 2015. An independent samples t-test demonstrates that there was a statistically significant difference in how drivers rated safety in 2015. Compared to responses in 2014 ($t=-3.925$, $df=1{,}267$, $p<0.001$) and 2012 ($t=-4.475$, $df=1{,}352$, $p<0.001$) participants in 2015 believed that driving conditions were safer.

Just 1.1% of respondents in 2014 indicated that driving conditions had improved in the last five years by answering that they either feel "much safer" or "somewhat safer" when driving. This was a slight decline from the 1.4% of respondents that held this view in 2012. In 2015 the proportion of drivers holding this viewpoint more than tripled to 3.6%.

With regard to braking suddenly, treated here as a crash avoidance maneuver measure, the proportion of respondents revealing that they have had to brake or swerve suddenly to avoid a crash declined compared to the prior two iterations of the survey. This may be a contributing factor in why respondents rated driving conditions as more safe.

Table 5.3 Perceptions of Danger Responses

Question Number	Survey Question	Responses			
1	How safe do you feel driving in your area compared to five years ago?				
	Much Safer	Somewhat Safer	Same	Less Safe	Much Less Safe
2012	0.8%	0.6%	9.7%	33.2%	55.6%
2014	0.1%	1.0%	10.6%	36.2%	52.0%
2015	0.3%	3.3%	13.1%	40.9%	42.4%
3	Have you had to brake or swerve suddenly to avoid a crash in the past 3 months?				
	Yes	No			
2012	73.3%	26.7%			
2014	72.7%	27.3%			
2015	68.7%	31.3%			
11	Have you been in a multi-vehicle car crash in the past 12 months?				
	Yes, it was my fault	Yes, it was someone else's fault	No		
2014	0.0%	2.6%	97.4%		
2015	0.3%	3.2%	96.4%		

Only 17 respondents (2.6%) in 2014 and 21 respondents (3.5%) in 2015 reported that they had been in a multi-vehicle crash within the past year. Being in a multi-vehicle collision is a strong barometer of fear and danger on the roadway, and may contribute to some perceptions and behaviors. Unfortunately, these numbers are not large enough to extrapolate to fit the entire population of western North Dakota residents who have experienced a crash and will not be examined further in the analysis.

5.1.1 Danger: Perceptions of Self and Other

One common theme that emerged from the literature review was that of a "self-versus-other" complex. In general, humans perceive themselves as being safer and more responsible than others. This is also evident in situations related to transportation safety (see DeJoy 1989 and Delhomme, Verlhiac, and Martha 2009).

This theme prompted three questions on the final survey questionnaire to highlight self-versus-other perceptions as related to safety on the roadway (Table 5.4).

North Dakota drivers follow trends found in other studies: a majority rate themselves as safer than others with whom they are sharing the roadway. Similarly, a clear majority believe out-of-state drivers to be a source of danger when compared to fellow North Dakotans. This reveals that a sense of otherness exists when sharing the roadway. Despite this sense of otherness, North Dakotans in 2015 were not as critical when rating other drivers (t=3.034, df=1,277, p=0.002). The average rating for this prompt declined from a mean of 4.03 in 2014 to 3.90 in the most recent survey mailing, implying that North Dakota drivers in 2015 thought other drivers were safer than did their 2014 counterparts.

Table 5.4 Self-versus-Other Danger on the Roadway

Question	Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am safer than others	2014**	0.1%	0.7%	24.5%	45.0%	29.6%
I am safer than others	2015**	0.0%	0.7%	29.7%	48.1%	21.5%
Out-of-state drivers are more dangerous	2014	0.9%	7.2%	20.4%	38.3%	33.2%
Out-of-state drivers are more dangerous	2015	0.7%	6.3%	22.7%	40.3%	29.9%
If I see a crash, I drive that route less often	2014*	4.9%	30.4%	42.4%	17.6%	4.7%
If I see a crash, I drive that route less often	2015*	5.6%	37.2%	38.4%	14.5%	4.3%

**Statistically significant difference at 1% level for independent samples t-test
*Statistically significant difference at 5% level for independent samples t-test

A similar trend happened when rating one's propensity to drive a route after seeing a crash (t=2.323, df=1,271, p=0.020). Although responses followed somewhat of a normal distribution, in 2015 drivers were more likely to continue driving a route even in the event they had witnessed a crash on that particular road segment. This may be due to limited route availability in some rural areas of western North Dakota.

5.1.2 Danger: Risk on the Roadway

A majority of drivers in 2014 and 2015 indicated that they feel as though they are risking their lives when driving in western North Dakota, based on those who answered that they "agree" or "strongly agree" with that prompt, respectively (Table 5.5). Less than one-in-ten (9.8%) either disagreed or strongly disagreed with the belief that they were risking their lives when driving in this part of the state in 2014 and approximately one-in-eight (12.3%) held this viewpoint in 2015. Between 2014 and 2015 a statistically significant shift in viewpoints occurred and respondents became more positive (t=2.196, df=1,268, p=0.028). On average, compared to responses from 2014, western North Dakota drivers in 2015 felt less likely to think that they were risking their lives when traveling in the target study region.

Table 5.5 Risk on the Roadway

Question	Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I feel like I'm risking my life when driving in western North Dakota	2014*	2.0%	7.8%	19.0%	40.8%	30.4%
	2015*	2.1%	10.2%	21.6%	40.6%	25.6%

*Statistically significant at the 5% level for independent samples t-test

5.2 Danger Avoidance

Some drivers actively attempt to avoid danger on the roadway. Other drivers may not have this chance considering the remote, rural areas prevalent in some North Dakota counties. Drivers in the target region were asked if – during a typical 20-minute commute – they would drive out of the way to avoid large oil trucks and/or travel on roads with better surface conditions. More than two-thirds indicated they would travel at least five additional minutes for these improved conditions (Figure 5.2 and Figure 5.3).

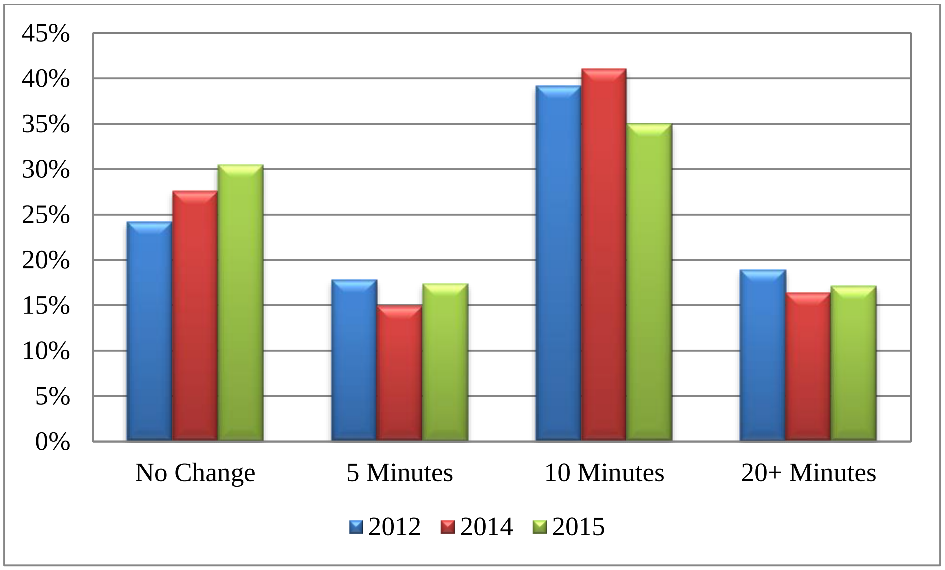

Figure 5.2 Willingness to Travel Out of the Way for Roads with Fewer Oil Trucks

In all three years of the survey, roughly one-fifth of drivers indicated that they would more than double their current commute time and add an additional 20 minutes to travel roads with better surface conditions. One's willingness to travel out of the way is linked to how safe one feels today compared to five years ago. In the 2015 iteration of the survey, those who feel less safe will drive further to avoid oil trucks ($F=9.418$, $df=4$, $p<0.001$) or for better surfaces ($F=4.841$, $df=4$, $p=0.001$).

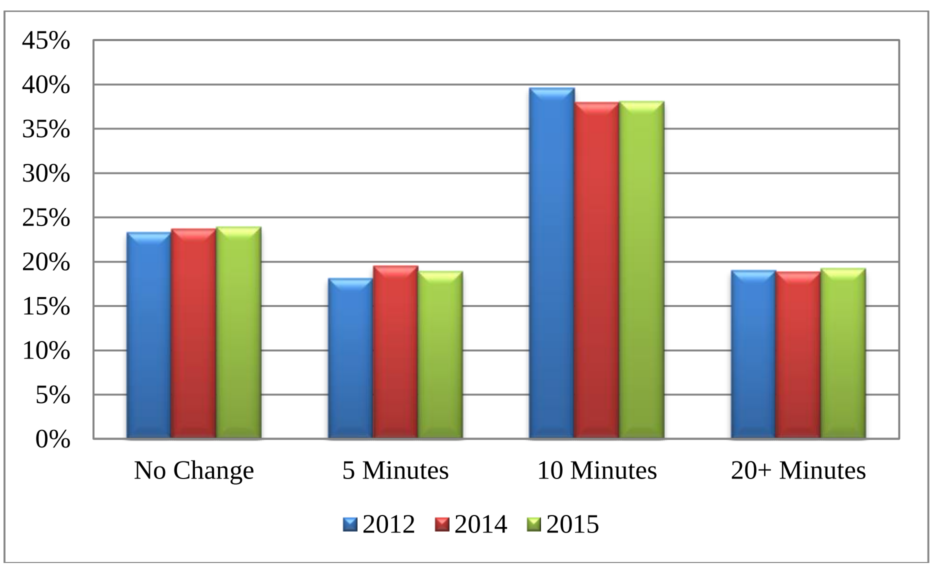

Figure 5.3 Willingness to Travel Out of the Way for Roads with Better Surface Conditions

5.3 Driver Behavior

Driver behavior behind-the-wheel directly affects safety. Drivers control some roadway safety via seat belt use, obeying the speed limit, and never choosing to operate a vehicle when impaired. External factors, such as law enforcement presence also influence driver behavior, often positively.
Two questions examined driver behavior related to seat belt use and speeding. Based on driver response indicating that they "always" or "nearly always" wear a seat belt, 87.2% use a safety belt regularly while driving in town. A higher proportion, 95.5%, either "always" or "nearly always" wear a seat belt when traveling in a vehicle going over 30 miles per hour (Figure 5.4). Only 6.5% of drivers reported "rarely" or "never" wearing a seat belt while in town, and an even smaller portion, 2.5%, "rarely" or "never" do so while driving in a vehicle traveling at least 30 miles per hour. There was a strong, positive correlation between the two seat belt use variables (Pearson Corr.=0.746, n=577, p<0.001) indicating that those who use a seat belt in town are more likely to also use a safety belt in a car going at least 30 miles per hour. This is logical as seat belt use is often habitual in nature.

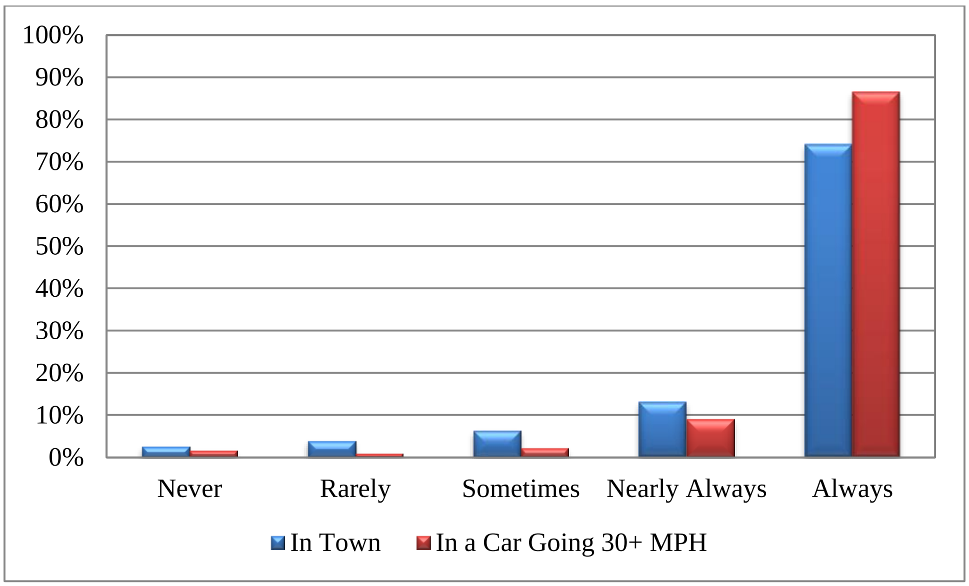

Figure 5.4 Driver Behavior Response: Seat Belt Use

Speeding tendencies have stayed consistent in all three iterations of the survey (Figure 5.5). In 2015, 5.2% of drivers reported that they "always" or "nearly always" have the dangerous driving habit of traveling at least 70 miles per hour in a 65 mile per hour zone – a slight decline from the 5.5% who reported doing so in 2014. A majority of drivers, 76.1%, reported "rarely" or "never" engaging in this dangerous habit. A contrast between seat belt use and speeding tendencies is that the median value of "sometimes" is much more prominent for speeding than for using a safety belt; roughly one-fifth of drivers "sometimes" drive more than 70 miles per hour in a 65 mile per hour zone. Based on these frequencies, in western North Dakota drivers make safer choices regarding seat belts than they do speeding.

A majority of respondents (69.7%) believed that greater law enforcement visibility helps reduce crashes on North Dakota roads. Drivers who held this viewpoint were more likely to wear a seat belt in town (F=24.227, df=1, p<0.001) and in a vehicle traveling over 30 miles per hour (F=24.872, df=1, p<0.001). An unexpected relationship occurred factoring for speeding: those believing law enforcement visibility reduces crashes were just as likely to speed on a road with a 65 mile per hour speed limit (F=1.405, df=1, p=0.236). This suggests that drivers believe law enforcement has a deterrent effect on crashes, but not on ticketing for compliance with speed laws.

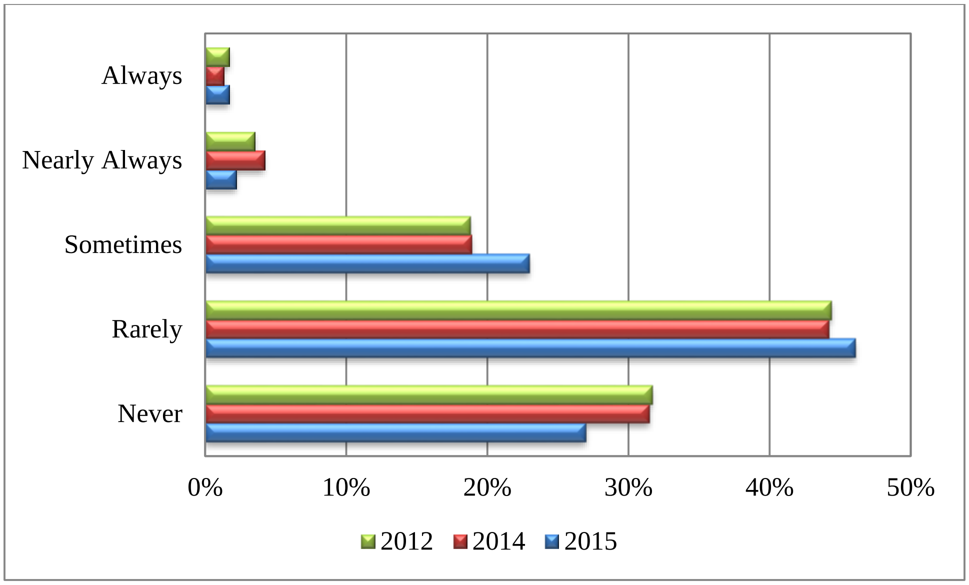

Figure 5.5 Driver Behavior Response: Speeding

5.3.1 Driver-Reported Priorities

Drivers were asked to rank their priorities for four issues that may be targeted in traffic safety: improved road signage, increased law enforcement presence, heightened driver awareness, and education for truck/passenger car interaction. Road signage is important in providing drivers information needed for navigation and vehicle control (Rasanen and Hornberry 2006). Increased law enforcement presence has been proven as a traffic safety intervention that reduces crime, reduces the fear of a crime occurring, and provides the public with a greater sense of security and safety (NHTSA 2001). Driver awareness is also a critical element in traffic safety. Driver expectations, perceptions, and distraction can create a significant risk for both the driver and others on the road. The size/mass relationship of large trucks and passenger vehicles, along with operational differences such as acceleration/deceleration times and turning radiuses heighten the risk of a crash taking place (UGPTI 2012). The survey asked drivers to rank these issues on a scale of one to four, with one being least important and four being most important.

Results show that driver awareness is clearly seen as the most important issue to drivers. Three-fifths (60.0%) ranked it as most important. Similarly, the lowest proportion, 7.9%, ranked driver awareness as least important. This congruity suggests that driver awareness is, in fact, the most important issue facing drivers in the oil region (Figure 5.6).

A majority of drivers perceived three issues to be important, based on the proportion of those who ranked the issues as a 3 or 4, respectively. Over three-fifths (63.7%) rated law enforcement presence as being either most important or second-most important. A similar proportion, 59.1%, ranked passenger vehicle/large truck interaction as their most important or second-most important issue. A clear majority, 81.6%, believed that driver awareness was a top priority.

Unlike these three issues, a majority of drivers did not think that signage related to traffic rules was of the highest priority. More than half (56.3%) of those sampled ranked signage related to traffic rules as either least important or second-least important. The proportion of individuals who ranked signage last (31.3%) was noticeably higher than law enforcement presence (13.5%), driver awareness (7.9%) and passenger vehicle/large truck interaction (22.4%).

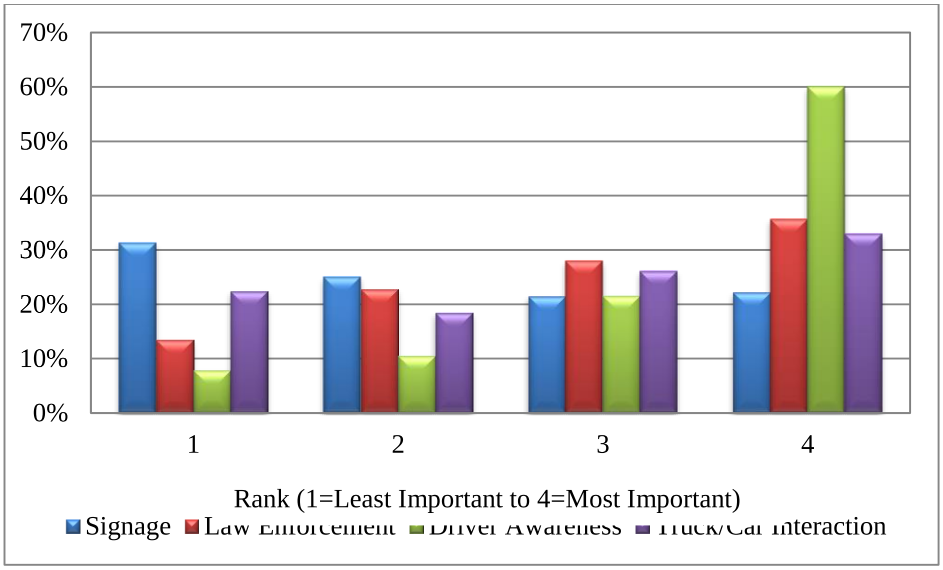

Figure 5.6 Driver Safety Priorities for Traffic Safety

5.4 Large Truck-Passenger Vehicle Interaction

Based on driver response in 2015, roughly three in four (75.3%) drivers in the 17 western North Dakota oil-producing counties meet or pass a large truck daily (Table 5.6). Only 2.3% of drivers reported meeting trucks on the roadway less than once per month or not at all. In terms of perceived safety, drivers generally felt unsafe when passing or being passed by large trucks. About half (47.8%) of all drivers indicated that they felt either "unsafe" or "very unsafe" while passing large trucks and about three-fifths (61.5%) felt the same way while being passed by large trucks. There was an obvious link between these two variables: drivers who felt safe passing large oil trucks were more likely to also feel safe when being passed by large trucks (Pearson Corr.=0.716, n=576, $p<0.001$).

Table 5.6 Responses to Large Truck/Passenger Vehicle Interaction Questions

Question #	Question	Response				
5	How often do you meet/pass large trucks while driving?					
		Daily	Few/Week	Few/Month	<1/Month	Never
	2015	75.3%	14.8%	7.5%	2.0%	0.3%
	2014	74.5%	15.2%	9.1%	0.9%	0.4%
	2012	79.4%	12.5%	6.0%	1.5%	0.5%
6a	How safe do you feel when passing large trucks?					
		V. Safe	Sw. Safe	Neutral	Unsafe	V. Unsafe
	2015	4.5%	19.7%	28.0%	33.4%	14.4%
	2014	2.8%	20.2%	26.0%	34.2%	16.9%
	2012	4.0%	20.4%	21.8%	32.4%	21.3%
6b	How safe do you feel when being passed by large trucks?					
		V. Safe	Sw. Safe	Neutral	Unsafe	V. Unsafe
	2015	2.8%	14.3%	21.4%	37.3%	24.2%
	2014	1.6%	14.6%	17.1%	38.8%	27.9%
	2012	2.8%	12.9%	18.7%	37.4%	28.3%

5.5 Driver Groups

In addition to general population insight, the potential to focus traffic safety efforts for more efficient resource use may be possible. For instance, some significant differences were found when factoring for driver groups. These driver groups – the independent variables used in this portion of the analysis – include gender, age, length of residency, and high-risk young drivers.

5.5.1 Gender

Some differences between males and females were found related to safety and behaviors (Table 5.7). Men interact with trucks more regularly than women in this sample (F=5.537, df=1, p=0.019). Despite sharing the road less often with large trucks, perceptions of safety were lower for women when rating how safe it is passing large oil trucks (F=27.985, df=1, p<0.001) and being passed by large oil trucks (F=6.010, df=1, p=0.015). This follows results from 2014 in which there were also differences in how men and women perceived safety when being passed by large oil trucks.

Women exhibit behaviors that are safer than men, especially with regard to seat belt use. Females were more likely to wear a seat belt when driving in town (F=9.649, df=1, p=0.002) and when in a vehicle traveling over 30 miles per hour (F=23,340, df=1, p<0.001). This continues a trend that initially occurred in 2012. Other studies of North Dakota driver behaviors have found similar differences between seat belt use rates among men and women (Vachal, Benson, and Kubas 2010-2015). It is possible that women choose to wear a seat melt more regularly because they have a greater fear of being injured in a crash in the future (F=6.278, df=1, p=0.012).

Table 5.7 Differences in Mean Driver Views and Behaviors, by Gender

QUESTION	SCALE[1]	ALL DRIVERS	MALE	FEMALE	SIG.
Safety Now vs. 5 Years Ago	1-5	1.79	1.85	1.73	
Read, Seen, Heard *Code for the Road*	0-1	0.33	0.37	0.30	
Changed Driving After *Code for the Road*	0-1	0.34	0.33	0.34	
Sudden Brake/Swerve	0-1	0.68	0.69	0.68	
Law Enforcement Visibility	0-1	0.70	0.66	0.73	
Meet/Pass Trucks Frequency	1-5	4.62	4.70	4.55	*
Safety Passing Trucks	1-5	2.66	2.91	2.44	**
Safety Being Passed by Trucks	1-5	2.34	2.45	2.23	*
Seat Belt Use in Town	1-5	4.52	4.39	4.64	**
Seat Belt Use 30+ MPH	1-5	4.78	4.64	4.91	**
Drive > 70 on 65 MPH Road	1-5	2.06	2.00	2.11	
Safer Driver than Others	1-5	3.91	3.97	3.85	*
Out-of-State are Dangerous	1-5	3.92	3.96	3.89	
I'm Risking My Life	1-5	3.77	3.74	3.81	
Drive Route Less After Seeing Crash	1-5	2.75	2.67	2.82	
Fear Future Injury	1-5	3.26	3.16	3.36	*
Improving Road Conditions	1-5	4.19	4.15	4.23	
Signage to Traffic Rules	1-4	2.34	2.34	2.34	
Law Enforcement Presence	1-4	2.86	2.89	2.83	
Driver Awareness	1-4	3.33	3.38	3.29	
Truck/Passenger Car Interaction	1-4	2.69	2.74	2.65	

**Significant difference at the 1% level for 1-way ANOVA
*Significant difference at the 5% level for 1-way ANOVA
[1]Nominal/Ordinal scales require different tests of significance
Please refer to Table 5.1 and Table 5.2 for quantitative scale definitions for responses

5.5.2 Age

Like results from 2012, some differences in views and behaviors exist across age groups. Table 5.8 highlights mean response values by the six age groups studied in this survey. The table suggests that extreme values tend to be associated with the youngest and oldest age cohorts, respectively. Perceptions of safety are skewed, with older drivers generally feeling safer on the roadway than those in younger age cohorts. For example, older drivers are less fearful of being injured in a future crash (F=3.149, df=5, p=0.008). This may be related to their lower likelihood of having had to brake or swerve to avoid a crash in the last three months (Chi-Sq.=50.087, df=5, p<0.001).

Traffic safety priorities tend to be viewed as more important by older drivers. Higher values are clustered near the 65-74 and 75+ age cohorts. The driver-rated importance of signage related to traffic rules (F=3.218, df=5, p=0.007) and law enforcement presence (Chi-Sq.=14.002, df=5, p=0.016) increases with age.

Younger drivers are more likely to speed (F=8.979, df=5, p<0.001), more likely to interact with trucks (F=6.981, df=5, p<0.001), and are less likely to wear a seat belt in a vehicle traveling at least 30 miles per hour (F=2.437, df=5, p=0.034). Some of these experiences may be due to how often one drives. In North Dakota, younger drivers typically travel more miles annually than their elderly counterparts (Vachal, Benson, and Kubas 2010-2015).

Table 5.8 Differences in Mean Driver Views and Behaviors, by Age

QUESTION	SCALE[1]	AGE GROUP AND CORRESPONDING MEAN VALUE					
		18-34[2]	35-44	45-54	55-64	65-74	75+
Safety Now vs. 5 Years Ago	1-5	1.85	1.88	1.70	1.71	1.84	1.88
RSH *Code for the Road*	0-1	0.37##	0.47##	0.43##	0.31##	0.24##	0.19##
Changed *Code for the Road*	0-1	0.44	0.43	0.34	0.34	0.26	0.26
Sudden Brake/Swerve	0-1	0.85##	0.80##	0.77##	0.71##	0.64##	0.36##
Law Enforcement Visibility	0-1	0.55#	0.59#	0.70#	0.71#	0.77#	0.79#
Meet/Pass Trucks	1-5	4.73**	4.78**	4.71**	4.71**	4.49**	4.22**
Safety Passing Trucks	1-5	2.85	2.66	2.62	2.67	2.65	2.63
Safety Passed by Trucks	1-5	2.35	2.40	2.23	2.34	2.28	2.56
Seat Belt Use in Town	1-5	4.21	4.56	4.58	4.52	4.60	4.59
Seat Belt Use 30+ MPH	1-5	4.54*	4.83*	4.86*	4.73*	4.87*	4.85*
Drive >70 on 65 MPH Road	1-5	2.50**	2.32**	2.13**	2.06**	1.83**	1.66**
Safer Driver than Others	1-5	3.85**	4.00**	4.06**	3.94**	3.81**	3.66**
Out-of-State Dangerous	1-5	4.10	3.86	3.78	4.02	3.82	4.00
I'm Risking My Life	1-5	3.66	3.71	3.88	3.80	3.86	3.54
Drive Route Less	1-5	2.72	2.56	2.71	2.75	2.80	2.86
Fear Future Injury	1-5	3.47**	3.36**	3.45**	3.20**	3.15**	2.99**
Improving Road Conditions	1-5	4.29	4.25	4.09	4.16	4.33	4.10
Signage to Traffic Rules	1-4	2.43**	2.07**	2.11**	2.39**	2.47**	2.67**
Law Enforcement Presence	1-4	2.63	2.61	2.90	2.85	2.94	3.11
Driver Awareness	1-4	3.20	3.37	3.26	3.32	3.54	3.34
Truck/Car Interaction	1-4	2.67	2.60	2.53	2.67	3.05	2.72

*Significant difference at the 5% level for 1-way ANOVA
**Significant difference at the 1% level for 1-way ANOVA
#Significant difference at the 5% level for Chi-Square test
##Significant difference at the 1% level for Chi-Square test
[1]Nominal/Ordinal scales require different tests of significance
[2]Due to limited sample size, the 18-24 and 25-34 age cohorts were merged

5.5.3 Newcomers and Long-Term Residents

Some studies have shown that newcomers and long-term residents have differing attitudes towards land use (Smith and Krannich 2000). This difference becomes more prominent when environmental issues are taken into consideration. Differences may stem from political ideology, urban/rural background, and the amount of time one has lived in the community. From an environmental context, oil development in western North Dakota is not without controversy. The advent of hydraulic fracturing has pushed some residents to oppose energy sector development altogether. Given the latest boom in oil development, it is prudent to investigate if attitudes towards oil traffic safety differ between long-term residents and those who have moved to the region recently.

An important question to investigate is how one should classify newcomers as opposed to long-term residents. Some studies comparing newcomer and long-term resident attitudes arbitrarily use 10 years as a cutoff point to differentiate between attitudes (Graber 1974; Fortmann and Kusel 1990). An accepted idea is that some length of residence in a community is vital for developing one's sense of social integration within the community (Kasarda and Janowitz 1974).

Other studies postulate that it is best to identify newcomers and long-term residents by examining the year in which substantial in-migration to the community began (Blahna 1985). Using that year as a baseline, one can then confidently distinguish between residents who have relocated to the community because of pull factors (newcomers) and those who had established roots in the community before a major event took place (long-term residents).

The most recent oil boom began in 2004, which creates a newcomer designation of 11 years. This closely aligns with both the arbitrary 10-year cutoff point suggested by some authors and the beginning date of in-migration to the community suggested by others. One question posed in the survey asked drivers how long they had lived at their residence. As such, anyone living in the area fewer than 11 years was coded as a "newcomer" and anyone who had been in the area for more than 11 years was identified as a "long-term resident."

Results were mixed when comparing newcomers to long-term residents (Table 5.9). Newcomers were more likely to feel safe when passing a large truck (F=5.205, df=1, p=0.023). These same drivers were more likely to speed on a 65-mile-per-hour road (F=11.178, df=1, p=0.001).

Long-term residents were more likely to think that out-of-state drivers are more dangerous than North Dakota drivers (F=4.653, df=1, p=0.031). This viewpoint could be influenced by a number of factors, but one can speculate that the influx of oil workers may create a sense of "self-versus-other" between local residents and those living in the area temporarily for the oil industry. Logically, it is plausible that many of the newcomers sampled in this survey may have moved to the region specifically because of the growth of the energy sector. As such, these individuals may be accustomed to different driving conditions, and may not be familiar with what rural driving in western North Dakota was like more than 11 years ago.

Table 5.9 Differences in Mean Driver Views and Behaviors, by Length of Residency

QUESTION	SCALE$_1$	ALL DRIVERS	NEWCOMERS	LONG-TERM RESIDENTS	SIG.
Safety Now vs. 5 Years Ago	1-5	1.78	1.84	1.75	
RSH *Code for the Road*	0-1	0.34	0.36	0.33	
Changed *Code for the Road*	0-1	0.34	0.40	0.32	
Sudden Brake/Swerve	0-1	0.69	0.75	0.67	
Law Enforcement Visibility	0-1	0.70	0.66	0.71	
Meet/Pass Trucks	1-5	4.63	4.68	4.62	
Safety Passing Trucks	1-5	2.66	2.82	2.59	*
Safety Passed by Trucks	1-5	2.34	2.45	2.29	
Seat Belt Use in Town	1-5	4.52	4.59	4.48	
Seat Belt Use 30+ MPH	1-5	4.78	4.81	4.76	
Drive > 70 on 65 MPH Road	1-5	2.06	2.24	1.98	**
Safer Driver than Others	1-5	3.91	3.87	3.92	
Out-of-State Dangerous	1-5	3.92	3.80	3.98	*
I'm Risking My Life	1-5	3.78	3.68	3.82	
Drive Route Less	1-5	2.75	2.64	2.79	
Fear Future Injury	1-5	3.27	3.29	3.26	
Improving Road Conditions	1-5	4.18	4.23	4.16	
Signage to Traffic Rules	1-4	2.34	2.37	2.32	
Law Enforcement Presence	1-4	2.85	2.77	2.89	
Driver Awareness	1-4	3.34	3.37	3.33	
Truck/Car Interaction	1-4	2.71	2.65	2.74	

*Significant difference at the 5% level for 1-way ANOVA
**Significant difference at the 1% level for 1-way ANOVA
$_1$Nominal/Ordinal scales require different tests of significance
Please refer to Table 5.1 and Table 5.2 for quantitative scale definitions for responses

5.5.4 High-Risk Young Drivers

In North Dakota, 18-34 year-old drivers exhibit explicitly different behaviors and attitudes from the rest of the driver population (Vachal, Benson, and Kubas 2013-2015). Other studies show that young drivers in North Dakota are more likely to speed, less likely to wear a seat belt, and are more likely to operate a vehicle after consuming alcohol (Vachal, Benson, and Kubas 2013-2015). These same drivers are less likely to have had recent exposure to safety messages. Interestingly, this target group generally has higher familiarity with safety campaigns targeting impaired driving, yet this group is still more likely to operate a vehicle after consuming alcohol.

In this survey of western North Dakota drivers, those between the ages of 18 and 34 were once again more likely to speed on a 65-mile-per-hour road ($F=15.549$, $df=1$, $p<0.001$). This group was also less likely to wear a seat belt in town ($F=6.456$, $df=1$, $p=0.011$) and in a car going at least 30 miles per hour ($F=7.675$, $df=1$, $p=0.006$). These changes represent a deviation from the 2014 iteration of the survey, in which there were no statistically significant differences in seat belt use.

Some studies have found that social situations, peer pressure, and the perceived invincibility of youth result in younger drivers making dangerous decisions on the roadway (Nygaard et al. 2003; NCADD 1988). This perceived invincibility is evident when young drivers rate certain driving situations. For example, these drivers were more likely to have had to brake or swerve in the last three months (Chi-Sq.=6.710, $df=1$, $p=0.010$) indicating that they may be driving recklessly more often than their 35-and-older counterparts. Another difference between high-risk young drivers and all other North Dakota drivers is the perceived value of law enforcement presence. Young drivers were less likely to think that additional law enforcement visibility reduced crashes (Chi-Sq.=6.052, df=1, p=0.014). This parallels other North Dakota studies which have found that young drivers are less likely to think that greater police presence increases seat belt use among drivers (Vachal, Benson, and Kubas 2014). It is clear that this target driver group holds explicitly different views about law enforcement than North Dakota drivers age 35 and older.

Table 5.10 Differences in Mean Driver Views and Behaviors, by High-Risk Driver Group

QUESTION	SCALE$_1$	ALL DRIVERS	HIGH-RISK	OTHERS	SIG.
Safety Now vs. 5 Years Ago	1-5	1.78	1.85	1.77	
RSH *Code for the Road*	0-1	0.33	0.37	0.33	
Changed *Code for the Road*	0-1	0.34	0.44	0.33	
Sudden Brake/Swerve	0-1	0.69	0.85	0.67	#
Law Enforcement Visibility	0-1	0.70	0.51	0.71	#
Meet/Pass Trucks	1-5	4.63	4.73	4.61	
Safety Passing Trucks	1-5	2.67	2.85	2.65	
Safety Passed by Trucks	1-5	2.34	2.35	2.34	
Seat Belt Use in Town	1-5	4.53	4.21	4.56	*
Seat Belt Use 30+ MPH	1-5	4.78	4.54	4.81	**
Drive > 70 on 65 MPH Road	1-5	2.06	2.50	2.01	**
Safer Driver than Others	1-5	3.91	3.85	3.91	
Out-of-State Dangerous	1-5	3.93	4.10	3.91	
I'm Risking My Life	1-5	3.77	3.66	3.78	
Drive Route Less	1-5	2.74	2.72	2.74	
Fear Future Injury	1-5	3.26	3.47	3.24	
Improving Road Conditions	1-5	4.19	4.29	4.18	
Signage to Traffic Rules	1-4	2.35	2.43	2.34	
Law Enforcement Presence	1-4	2.86	2.63	2.88	
Driver Awareness	1-4	3.34	3.20	3.35	
Truck/Car Interaction	1-4	2.70	2.67	2.70	

*Significant difference at the 5% level for 1-way ANOVA
**Significant difference at the 1% level for 1-way ANOVA
#Significant difference at the 5% level for Chi-Square test
$_1$Nominal/Ordinal scales require different tests of significance
Please refer to Table 5.1 and Table 5.2 for quantitative scale definitions for responses

5.6 Impact of Public Awareness as a Safety Strategy: *Code for the Road*

The survey highlighted familiarity with the *Code for the Road* safety campaign. *Code for the Road* was targeted at high-risk (18-34 year-old) males and emphasizes safety messages such as buckling up, driving sober, and slowing down. It is a statewide campaign, but given the demographic of generally young, male oil workers moving into the western part of the state for employment, it was believed that the campaign would improve road safety in the targeted area. These messages have been displayed on television, radio, and internet advertisements since 2014. Internet advertisements are optimized to play more frequently on certain websites when visited by the target demographic (Heidle, Horton, and Lerman 2014). The survey included two questions addressing exposure to the safety initiative. Drivers were first asked whether they had recently read, seen, or heard the safety messages being promoted by the *Code for the Road* initiative. Drivers were then asked if they changed their driving behavior after seeing such ads. One-third (33.3%) of respondents indicated that they had recent exposure to the advertisements – a noticeable increase from

18.6% in 2014. Of these, 46.8% reported positively improving their driving after being exposed to the safety messages –another improvement from 29.9% in 2014. Among all of the drivers within this sample, 14.9% positively changed their driving behaviors as a direct result of the *Code for the Road* ads.

Detail beyond the targeted online advertising was not available about the deployment of the *Code for the Road* safety campaign. Approximately two-thirds (64.1%) of all drivers who had seen a *Code for the Road* advertisement lived in Ward, Stark, and Williams counties. The safety initiative may have targeted those three counties, though it should be noted that they are home to the three largest cities in the oil region: Minot, Dickinson, and Williston, respectively. Moreover, if McLean and Mercer counties are included with the three aforementioned counties, the total proportion of drivers who saw the *Code for the Road* ads increases to 77.1%. In other words, approximately three out of every four drivers who saw a *Code for the Road* advertisement lived in only 5 of the 17 western North Dakota oil-producing counties.

5.6.1 Exposure as a Determinant of Views and Behaviors

Like the other driver groups highlighted in this study, it is plausible that exposure to safety messages, such as the one put forth by *Code for the Road*, may influence drivers positively to hold views that are different from those individuals who have not been exposed to safety messages. Education influence is powerful, and has been found to be linked to behavior changes among drivers in North Dakota (Vachal, Benson, and Kubas 2010-2015). A dummy variable was created based on responses to the second question of the survey. The variable categorized drivers into two groups: those who had recent exposure to the safety messages and those who did not. When these groups were compared with one another, results were mostly expected (Table 5.11).

Overall, drivers held similar viewpoints regardless of whether or not they had recently read, seen, or heard a *Code for the Road* advertisement. There were four significant differences between the two groups, though only one was significant at the 1% level. On average, drivers who had recent exposure to the *Code for the Road* safety messages were more likely to have had to brake or swerve to avoid a crash (Chi-Sq.=4.441, df=1, p=0.035). It can be argued that this is an unexpected result: those who would have been exposed to the safety messages should have driven with more caution and thus been less likely to be in situations where one may need to use such a crash avoidance maneuver.

Other results were expected. Those with exposure to the safety messages were more likely to believe that law enforcement visibility can reduce crashes (Chi-Sq.=4.038, df=1, p=0.044). This is expected as some of the messages highlight the influence of law enforcement personnel on drivers who are not abiding by legal driving standards. The advertisements also advocate that drivers adopt behaviors that follow the law.

There were two statistically significant differences between these groups factoring for truck safety. Drivers who had exposure to the safety messages were more likely to prioritize large truck/passenger vehicle interaction as a safety strategy (F=4.200, df=1, p=0.041) and rated perceptions of safety when being passed by large trucks as lower than did those who did not view the safety campaign (F=7.907, df=1, p=0.005). It is plausible that these two variables are related: drivers who feel unsafe being passed by trucks may then want to dedicate more resources to large truck/passenger vehicle interaction safety. Because the safety campaign focuses on preventing danger on the roadway, drivers may hold these attitudes based on their underlying views that large trucks are a source of danger.

Table 5.11 Differences in Mean Driver Views and Behaviors, by *Code for the Road* Exposure

QUESTION	SCALE[1]	ALL DRIVERS	SAW AD	DID NOT SEE AD	SIG.
Safety Now vs. 5 Years Ago	1-5	1.78	1.70	1.83	
Sudden Brake/Swerve	0-1	0.69	0.75	0.66	#
Law Enforcement Visibility	0-1	0.69	0.75	0.66	#
Meet/Pass Trucks	1-5	4.64	4.69	4.61	
Safety Passing Trucks	1-5	2.67	2.62	2.70	
Safety Passed by Trucks	1-5	2.35	2.17	2.44	**
Seat Belt Use in Town	1-5	4.52	4.51	4.53	
Seat Belt Use 30+ MPH	1-5	4.78	4.75	4.79	
Drive > 70 on 65 MPH Road	1-5	2.05	2.15	2.01	
Safer Driver than Others	1-5	3.91	3.99	3.87	
Out-of-State Dangerous	1-5	3.92	3.88	3.94	
I'm Risking My Life	1-5	3.77	3.84	3.74	
Drive Route Less	1-5	2.73	2.71	2.74	
Fear Future Injury	1-5	3.26	3.30	3.24	
Improving Road Conditions	1-5	4.18	4.25	4.14	
Signage to Traffic Rules	1-4	2.34	2.24	2.39	
Law Enforcement Presence	1-4	2.85	2.94	2.81	
Driver Awareness	1-4	3.34	3.29	3.36	
Truck/Car Interaction	1-4	2.69	2.83	2.62	*

**Significant difference at the 1% level for 1-way ANOVA
*Significant difference at the 5% level for 1-way ANOVA
#Significant difference at the 5% level for Chi-Square test
[1]Nominal/Ordinal scales require different tests of significance
Please refer to Table 5.1 and Table 5.2 for quantitative scale definitions for responses

6. CRASH DATA

In addition to survey data, crash reports were collected for the 17 western North Dakota oil-producing counties from 2004 to 2014. Rural road data were queried specifically to track the total number of crashes, large truck crash rates, and crash severity – including injuries, fatalities, or property-damage-only (PDO) crashes. The results of the crash data are compelling: almost every crash statistic has increased considerably since 2004, and major spikes occurred in 2009 and 2011.

6.1 Oil Counties Compared to the Rest of the State

6.1.1 Fatal Crashes

Fatal crashes rose 107.4% from 2004 (27) to 2014 (56) in the oil-producing counties and the largest number (78) occurred in 2013 (Figure 6.1). This was outpaced by a 132.9% growth in VMT in the same time period and represents the first time since 2011 that VMT change has outpaced the growth of fatal crashes. The overall trend in western North Dakota shows that fatal crashes have risen with the increase in oil development. This may explain why many respondents in the survey indicated that they felt less safe driving presently compared to five years ago.

Traffic fatality trends in the oil region differ from other North Dakota counties: statistically-based linear trend lines are included to illustrate the contrast. Whereas fatal crashes in the oil region more than doubled compared to 2004 and peaked in 2013 (R^2=0.6953), the number of fatal crashes in the rest of the state remained relatively stable, peaking in 2005 (R^2=0.4135). Beginning in 2011, there were more fatal crashes in the oil-producing counties than in the remainder of the state.

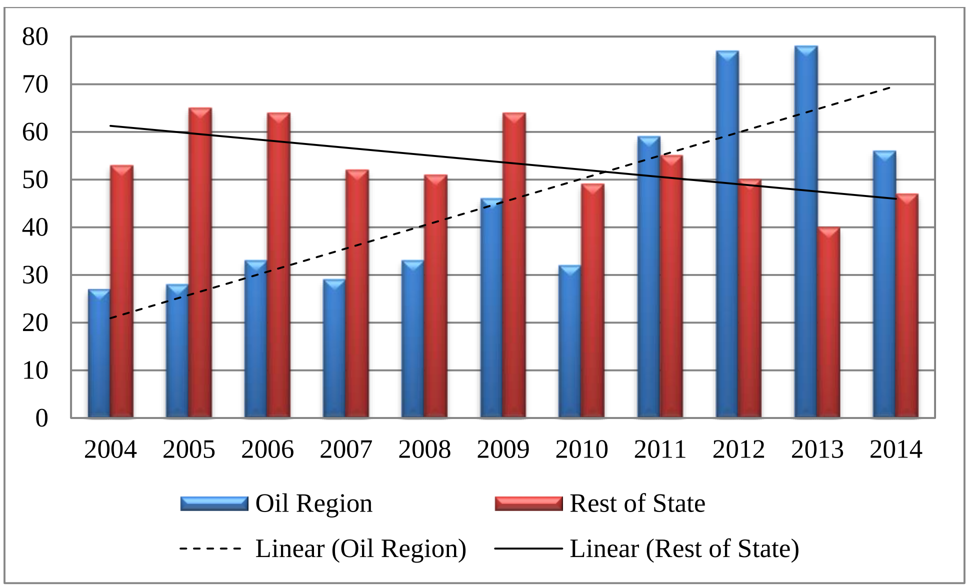

Figure 6.1 Total Number of Fatal Crashes, 2004-2014

The fact that the total number of fatal crashes in the oil region outpaced those in the rest of the state is especially alarming given the annual VMT attributed to the two groups and their respective populations. Between 2004 and 2014, the 17 oil-producing counties had a smaller share of North Dakota's annual rural VMT compared to the rest of the state, yet experienced higher rates of fatal crashes every year in the study period (Figure 6.2). For example, in 2014 the study area's rural VMT (3.768 billion miles) was smaller than the rest of the state (4.102 billion miles), yet it experienced 1.486 fatal crashes per 100 million VMT in 2014, a rate that was about 30% higher than the 1.146 fatal crashes per 100 million VMT elsewhere.

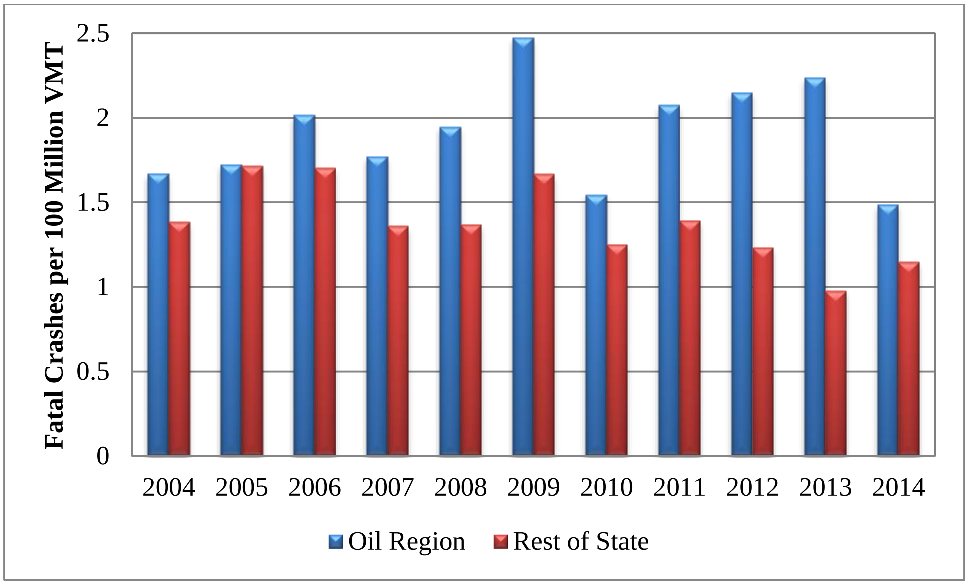

Figure 6.2 Fatal Crashes per 100 Million Rural VMT, 2004-2014

With regard to population, fatal crashes in the oil-producing counties have been higher than in the rest of the state in each year of the study period. The U.S. Census Bureau (2015) estimates the oil-producing counties have a 2014 population of 202,027, which is roughly three-eighths (37.6%) the size of the rest of the state (537,455), yet in the oil region there were 27.719 fatal crashes per 100,000 individuals, a rate that is more than three times higher than the 8.745 fatal crashes per 100,000 individuals in the rest of the state (Figure 6.3). In terms of fatal crashes, both of these metrics show that driving has been more dangerous in the oil-producing counties than in the rest of North Dakota. Note that fatal crashes are still largely episodic in nature and are difficult to use for assessing traffic safety issues and strategies.

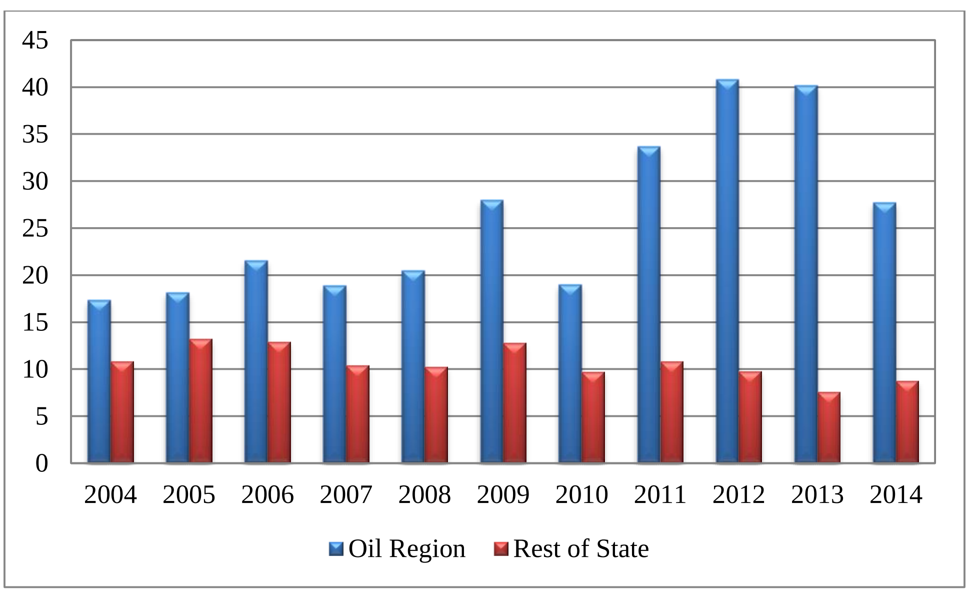

Figure 6.3 Fatal Crashes per 100,000 Population, 2004-2014

6.1.2 Injury Crashes

Crashes resulting in injuries have also increased during the study period, though the growth has been moderate by comparison (R^2=0.3922) (Figure 6.4). During the time frame studied, the total number of non-fatal injury crashes in oil-producing counties increased 33.6% from 295 to 394. Non-fatal injury crashes in the 17 western oil-producing counties increased noticeably between 2010 and 2011. The overall growth in injury crashes may be a direct factor in why some drivers feel less safe and favor increased driver awareness or more law enforcement presence as strategies to reduce crashes. In contrast, the number of non-fatal injury crashes in the rest of the state decreased noticeably (R^2=0.8745).

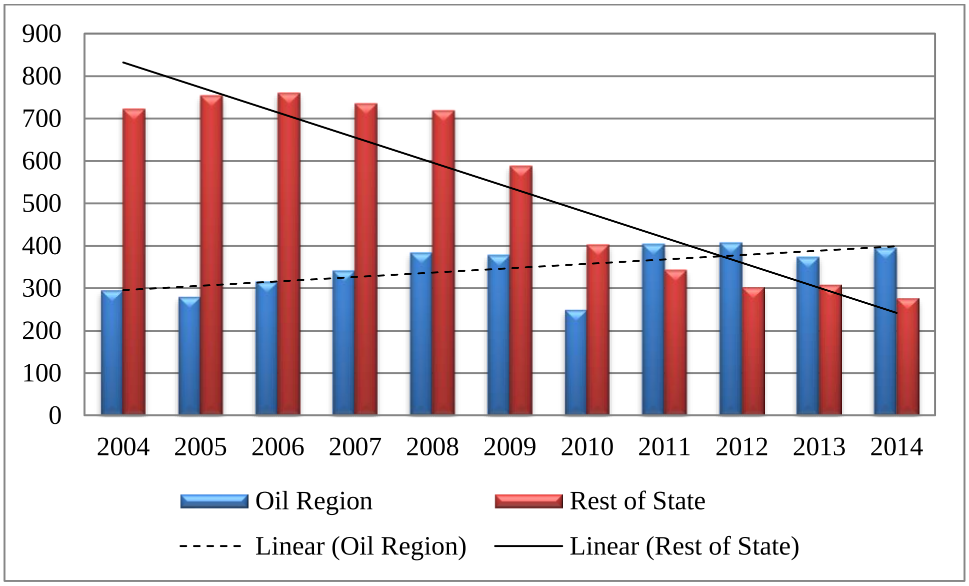

Figure 6.4 Total Number of Non-Fatal Injury Crashes, 2004-2014

Beginning in 2011, there were more injury crashes by volume in the oil region than in the remainder of the state. When injury crashes are normalized by 100 million VMT, it becomes apparent that the rates of injury crashes in the oil patch have exceeded injury rates in the rest of the state each year since 2007 and were comparable to the rest of the state near the beginning of the oil boom (Figure 6.5). In 2014, there were 10.486 injury crashes per 100 million VMT in oil-producing counties, a higher rate than in other parts of the state (6.713 injury crashes per 100 million VMT).

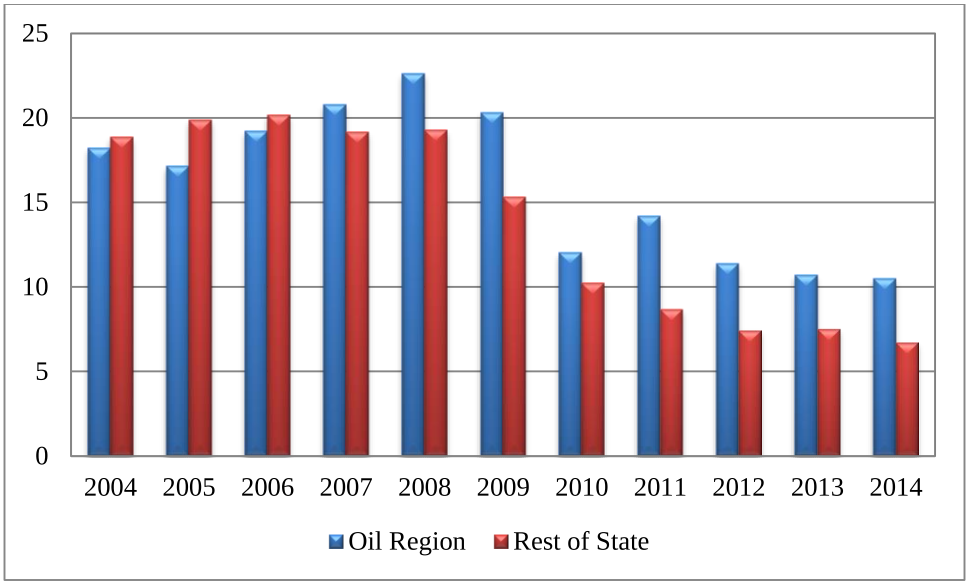

Figure 6.5 Injury Crashes per 100 Million Rural VMT, 2004-2014

When normalized by population, the rate at which injury crashes occur in the oil region have outpaced injury crashes elsewhere in North Dakota during each year of the study period (Figure 6.6). Using data from the most recent year, there were 195.023 injury crashes per 100,000 population in oil-producing counties in 2014. By comparison, there were just 51.353 such crashes per 100,000 population in the rest of the state. These numbers parallel previous statements about fatal crashes in the oil region: individuals living in this part of the state have a higher likelihood of being involved in a crash resulting in a serious injury.

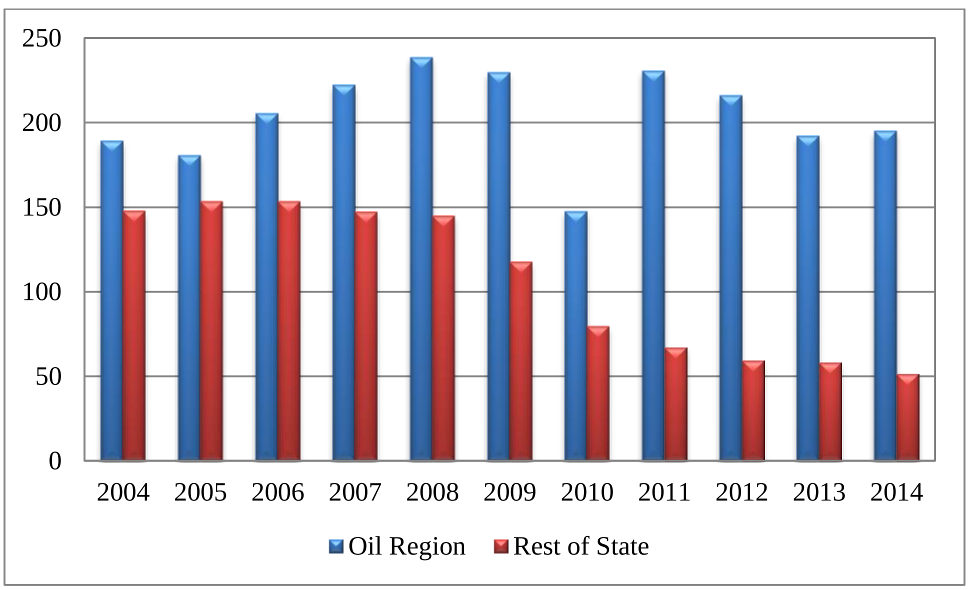

Figure 6.6 Injury Crashes per 100,000 Population, 2004-2014

6.3.3 Large Truck Crashes

With increases in oil development come growing numbers of large trucks and heavy-duty machinery required to extract and transport natural resources. This has created a higher propensity for trucks to become involved in traffic crashes; large truck crash involvement in the oil region appears to be growing exponentially (R^2=0.9447) but has less variability in the rest of the state (R^2=0.5524) (Figure 6.7). From 2004 to 2014 the total number of large trucks involved in crashes in oil-producing counties increased more than 654%. This may explain drivers' fears of passing and being passed by large trucks. Within the last five years alone there has been a 162.1% increase in the total number of trucks involved in a crash.

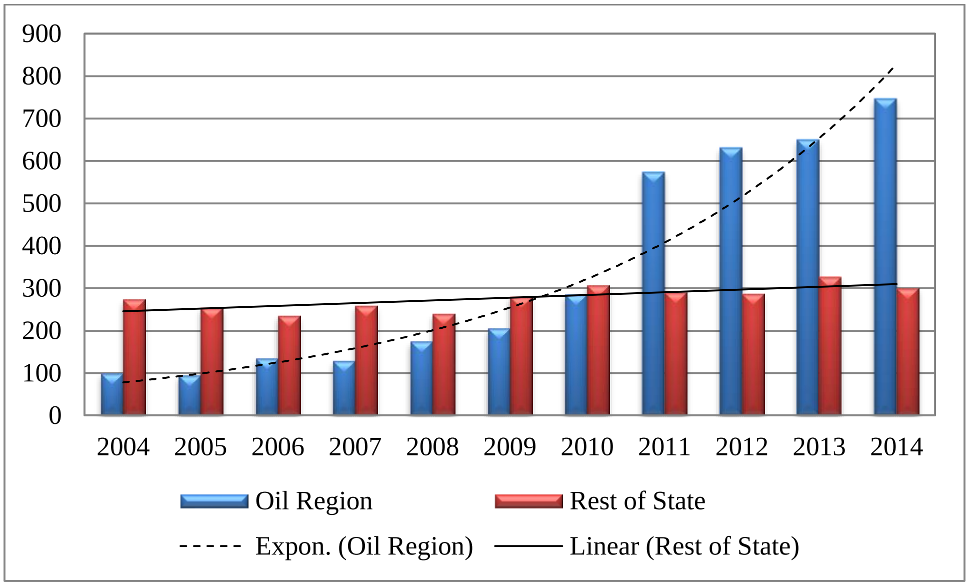

Figure 6.7 Total Number of Large Truck Crashes, 2004-2014

When normalizing large truck crash rates per 100,000 population, the oil region once again outpaced crash rates in the remainder of North Dakota (Figure 6.8). There were 369.753 crashes involving large trucks per 100,000 population in oil-producing counties and just 55.819 per 100,000 individuals elsewhere in 2014. The representation in terms of traffic exposure is not known since VMT is not reported by vehicle class for the oil counties so the population exposure measure is reported.

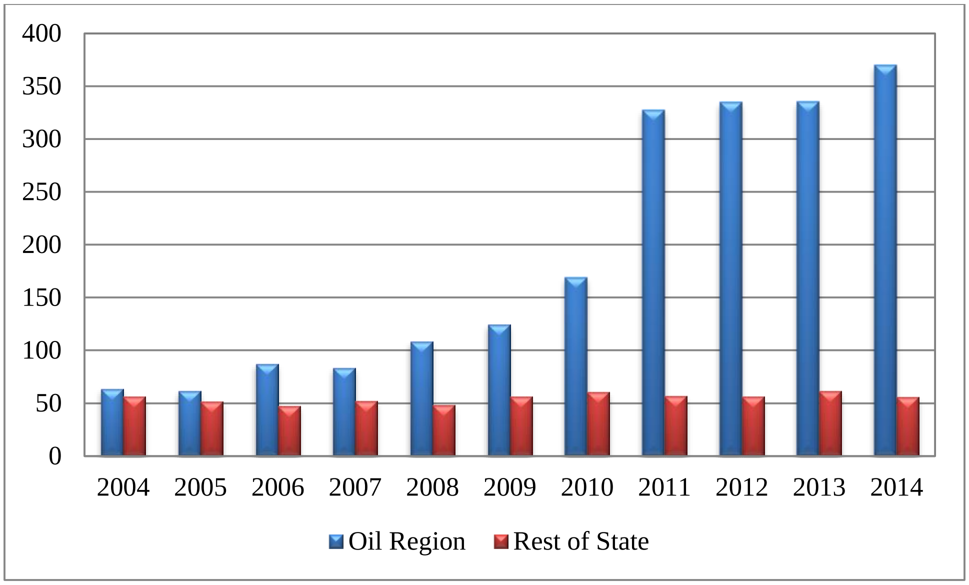

Figure 6.8 Large Truck Crashes per 100,000 Population, 2004-2014

6.2 Overall Trends in the Entire Oil Region

Using 2004 as a base year, it is obvious that one crash metric – large truck crashes – have grown at a faster pace than other crash types (Figure 6.9). For the first time in four years, the fatal crash rate in the oil region has not outpaced the VMT growth rate, suggesting that 2014 was a safer year for North Dakota drivers living in the oil region.

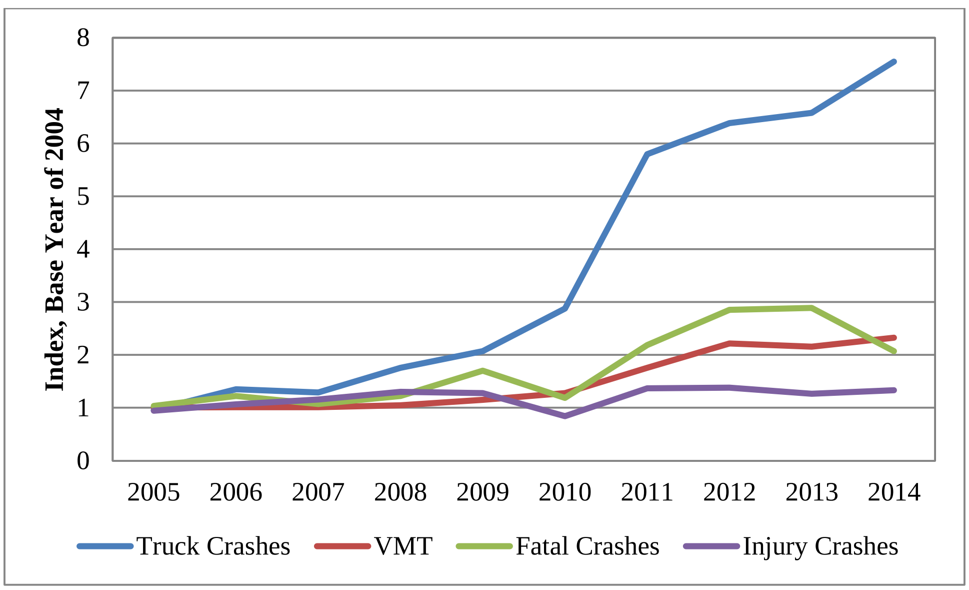

Figure 6.9 Driving Trends in Entire Oil Region, 2004-2014

Fatal crashes are perhaps more prevalent due to the type of traffic associated with the oil industry. Injury crashes in the oil region remained on par with changes in VMT until 2009, but then began to lag behind VMT growth in 2010 and beyond. Taken collectively, the crash metrics analyzed in this study are more common in the oil region than in the rest of North Dakota which indicates that driving conditions are more dangerous in these 17 counties than elsewhere in North Dakota.

7. ECONOMIC FACTORS AND TRAFFIC SAFETY

In traffic safety it is very difficult to statistically demonstrate causative relationships. This is due to the myriad factors at play when one chooses to operate a vehicle. To further clarify, factors such as wearing a seat belt, driving impaired, weather, animals on the roadway, vehicle malfunction, driving unsafe for the conditions, reckless behavior, and overcorrecting are common reasons why crashes take place. Often more than one factor may lead to a crash. Introducing a new variable – oil extraction activity – is difficult to measure empirically, especially considering the dynamic “boom-or-bust” nature of the oil industry. Demonstrating that oil activity alone is a source of danger on the roadway is impractical given the many possible dangers facing drivers. Moreover, it is possible that additional vehicles and vehicle miles traveled on the roadway due to energy production may not solely cause danger, but may instead interact with other traffic safety factors to create unsafe traveling conditions. Therefore, it is prudent to demonstrate correlative relationships between extraction activity and crash measures. Economic activity related to energy production such as crude oil price per barrel, gasoline price per gallon, and newly erected oil wells were tracked on a monthly basis over the study period. These metrics were plotted against large truck crashes, fatal crashes, and overall crashes to identify any correlative relationships (Table 7.1). These relationships help clarify some of the influence oil activity has on overall crash patterns.

Table 7.1 Correlative Relationships between Oil Extraction Activity and Crashes

Variable	Measure	Barrel of Oil Price[1]	Gallon of Gas Price[2]	New Wells[3]	Large Truck Crashes	Fatal Crashes	Total Crashes
Barrel of Oil Price	Pearson Corr.	1	**0.901****	**0.678****	**0.533****	0.363**	0.225**
	Sig.	-	**0.000**	**0.000**	**0.000**	0.000	0.009
	N	132	**132**	**132**	**132**	132	132
Gallon of Gas Price	Pearson Corr.		1	**0.831****	**0.704****	**0.506****	0.296**
	Sig.		-	**0.000**	**0.000**	**0.000**	0.001
	N		132	**132**	**132**	**132**	132
New Wells	Pearson Corr.			1	**0.862****	**0.513****	0.441**
	Sig.			-	**0.000**	**0.000**	0.000
	N			132	**132**	**132**	132
Large Truck Crashes	Pearson Corr.				1	**0.546****	**0.652****
	Sig.				-	**0.000**	**0.000**
	N				132	**132**	**132**
Fatal Crashes	Pearson Corr.					1	0.340**
	Sig.					-	0.000
	N					132	132
Total Crashes	Pearson Corr.						1
	Sig.						-
	N						132

**Pearson Correlation significant at the 1% level
Bold: Correlation and p-value indicate a substantive relationship
Note: Correlations between -0.5 and +0.5 indicate a weak relationship and are not addressed in this study
[1]Source: U.S. Energy Information Administration 2015a
[2]North Dakota ceased reporting average monthly gas prices to the U.S. Energy Information Administration in March 2011. Data from March 2011-December 2014 uses the Midwest Region averages. (Source: U.S. Energy Information Administration 2015b)
[3]New wells represents oil wells that are still active (as of September 3, 2015) and went on-line in each respective monthly cohort

Some of the statistically significant relationships depicted in Table 7.1 are expected, but indirectly related to traffic safety. For instance, there is a strong, positive relationship between the number of new oil wells and the price of a barrel of oil (Pearson Corr.=0.678, n=132, $p<0.001$) and the price of a gallon of gas (Pearson Corr.=0.831, n=132, $p<0.001$). This is likely the product of a profit-based supply/demand relationship: energy companies have a financial incentive to drill more wells to extract more resources because a greater profit is to be made.

The relationship between wells and commodity prices then has an indirect – but noticeable – effect on traffic safety. There is a clear relationship between the presence of additional new wells and an increase in large truck crashes (Pearson Corr.=0.862, n=132, $p<0.001$). Furthermore, with the introduction of additional large trucks on roadways in western North Dakota, a subsequent rise in fatal crashes is observed (Pearson Corr.=0.546, n=132, $p<0.001$). This follows research from Braver et al. (1992) which noted that large trucks are generally associated with more severe crashes. This may also explain why the presence of additional oil wells is associated with a rise in fatal crashes (Pearson Corr.=0.513, n=132, $p<0.001$). Moreover, another relationship to consider is that of total crashes increasing as the number of large truck crashes increases (Pearson Corr.=0.652, n=132, $p<0.001$). This suggests that large trucks are accounting for a growing percentage of the overall crashes in the region.

In less technical terminology, it appears as though higher oil and gas prices lead to the construction of new wells. The presence of new wells is associated with a growing number of large truck crashes (Figure 7.1), which makes sense considering the vehicles and equipment necessary for oil extraction. The presence of more large trucks on the road is associated with a rise in total crashes and fatal crashes (Figure 7.2), which suggests that North Dakota drivers in this region may not be acting safely with regard to large truck/passenger vehicle interaction. This validates findings in the survey that some North Dakotans believe traffic conditions are dangerous, particularly when sharing the road with large trucks. Although this statistical approach does not demonstrate oil activity as causing danger on the roadway, the presence of more wells – and subsequently more large trucks – does appear to have a correlational link to worsening crash metrics.

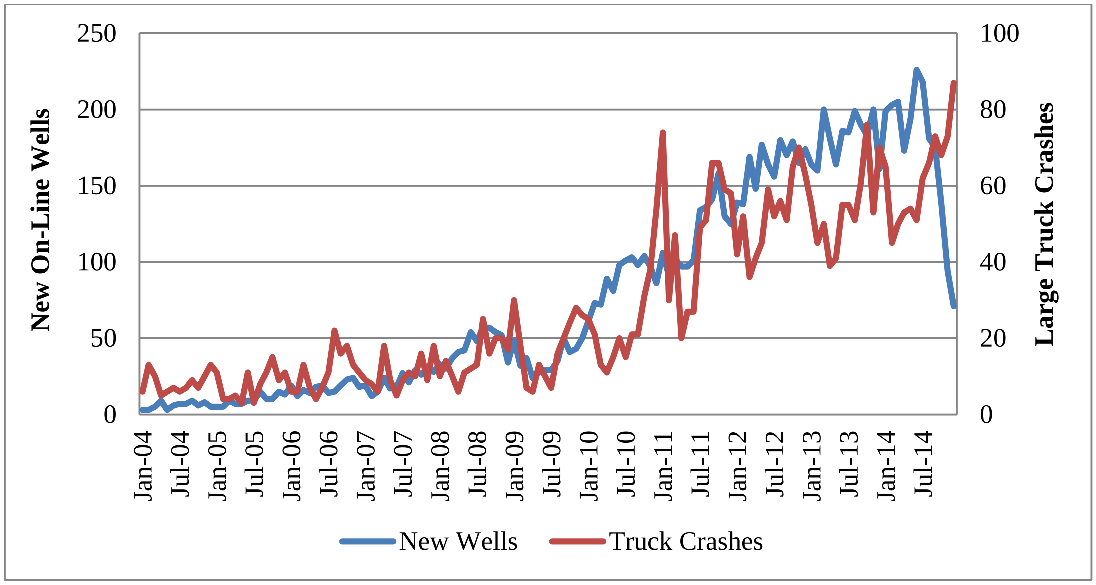

Figure 7.1 Relationship between Additional On-Line Wells and Large Truck Crashes

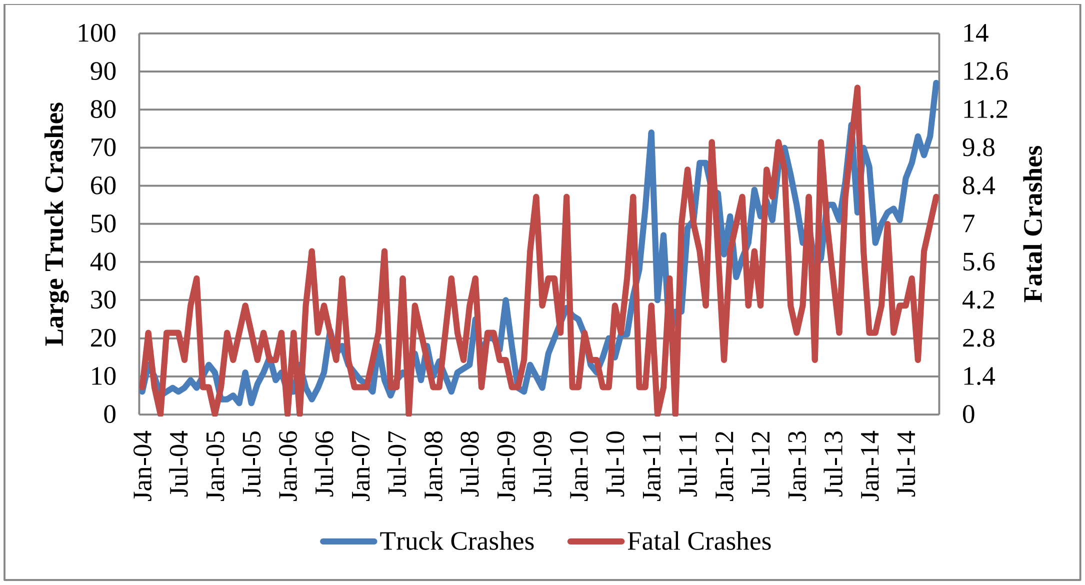

Figure 7.2 Relationship between Large Truck Crashes and Fatal Crashes

8. CONCLUSION

It is evident that the driving environment in the 17 western North Dakota oil-producing counties is noticeably different than in other parts of the state. Whereas other parts of the state have experienced traffic growth related to multidimensional factors, this particular area of the state has seen extensive growth surrounding one issue: the expansion of the oil industry. This development has coincided with drastic increases in population, job opportunities, and economic prosperity. As individuals flock to the 17 western oil-producing counties, increased traffic, including more personal vehicles, large trucks, oil trucks, and heavy-duty machinery, is being experienced.

Responses from the survey show that residents in the oil region perceive driving conditions to be unsafe. Although perceptions of safety compared to five years ago improved moderately from 2014 to 2015, most metrics studied in the survey questionnaire remained relatively unchanged between the three iterations of the survey. This reaffirms that the survey is both valid and reliable. Most drivers believed that improving safety on oil roads is contingent upon multiple factors, such as increasing driver awareness or utilizing greater law enforcement presence. Beyond perceptions, responses indicate that some behaviors, such as seat belt use and speeding, can be improved with greater compliance. It is undeniable that *Code for the Road*, an initiative geared specifically at encouraging safe driving behaviors, has had some positive influence. The safety messages were more widely recognized in 2015 and drivers did reportedly change behaviors after exposure to this safety campaign.

There were some important differences in responses when factoring for specific driver groups. Knowing these differences exist can be crucial for practitioners and safety personnel when planning future safety initiatives, intervention strategies or prevention efforts.

An examination of crash data in the 17-county oil region revealed that the total number of crashes, injuries, fatalities, PDO crashes, and the number of large trucks involved in crashes has increased substantially since 2004. Some crash patterns, such as the total number of large trucks involved in crashes, appear to be increasing at a rate comparable to that of an exponential growth curve. Moreover, every major crash statistic experienced a considerable spike, either in 2009 or 2011. This likely has a direct impact on driver views, attitudes, behaviors, and perceptions and may go hand-in-hand with why many drivers view roads in the oil region as unsafe. Crash data reaffirms results obtained by the survey, and validates that negative driving experiences reported by drivers are not just perceived, but are actually taking place on western North Dakota roadways.

Note that not all crash statistics within the oil region worsened from 2004 to 2014. This was more evident when normalizing data by 100 million vehicle miles traveled, per 100,000 population, or when using 2004 as a baseline year. Some metrics showed moderate improvements between 2013 and 2014, and some rates began to slow relative to crash rate growth in recent years. This may be the first sign of improved crash trends in the region, though it is still much too early to make this claim. Even with these moderate improvements, crash rates among North Dakota drivers are still higher in these 17 counties than in the rest of the state, especially when factoring for vehicle miles traveled and for population. For individual drivers in certain counties, it may be difficult to perceive that crash rates are improving when factoring for vehicle miles traveled and population growth as these measures are difficult to assess by firsthand observation. Local residents may be more familiar with changes in numbers and volumes of crashes as they are more easily interpreted. This may explain why responses to the survey indicate that driving conditions are dangerous and worsening, even if they are improving moderately in some individual counties when normalized by VMT and population.

Projections for continued oil drilling and extraction are difficult to quantify as they largely depend on the price of oil and a company's ability to generate profits. At the publishing of this report, crude barrel prices remained near six-year lows and extraction activity in western North Dakota slowed considerably compared to other years. The relationship between large truck crashes and new wells is undeniable; this then has a direct effect on fatal crashes as the presence of additional large trucks is associated with more fatalities. With economic uncertainty surrounding oil prices, VMT figures and population numbers may be difficult to estimate as travel may decline and workers may leave for other economic opportunities. If crude oil prices remain low, there may be a visible decline in truck crashes and a subsequent decline in fatal crashes. As of 2014, which represents the end of the study period, oil prices were still strong. Therefore, it may be prudent to continue tracking crash rates in 2015 and beyond to validate if a decline in extraction activity has a visible impact on traffic safety.

9. DISCUSSION

Future research can be improved by integrating more responses from specific groups into the survey. Although the survey was mailed to residents from all 17 western North Dakota oil-producing counties, responses varied greatly from county-to-county. Billings, Bottineau, Bowman, Burke, Divide, Dunn, Golden Valley, McHenry, McKenzie, Renville, and Slope counties all had fewer than 30 responses. Thus, the responses obtained from these areas could not be extrapolated to fit the rest of the population and should not be considered representative of the true sentiments and perceptions held by drivers from those respective counties. Similarly, there were not enough responses from the 18-24 year-old cohort to consider their responses as representative of the entire 18-24 year-old population in the region. Future research could benefit by intentionally over-sampling these groups to ensure that all demographics within the oil region are included. Focus groups with these communities or businesses may be useful in gaining additional insight and help mitigate these shortcomings.

Additionally, future research may benefit from integrating non-North Dakota residents into this survey through creel techniques or private company participation. The boom of the oil industry in western North Dakota has attracted temporary workers and businesses from Canada, Montana, South Dakota, eastern North Dakota, Minnesota, and other areas. Including non-western North Dakotans would provide an outside voice to better understand if perceptions of poor driving conditions are accurate across all residents or if they are simply a product of locals experiencing changing driving conditions firsthand.

Although new insights may be gained with future driver contact, it seems prudent to expand or discuss alternative strategies for improving travel safety in the region. Public health outreach using the *Code for the Road* platform may be one outlet for delivering the message, especially to targeted driver groups. Work with private companies in educating their workers about safe practices for maneuvering in traffic with increasing truck density may be another beneficial endeavor. If not already identified in the deployment, school and community events may also be strong venues for reaching young drivers with messages specific to oil region traffic safety issues such as how to interact with trucks safely.

Beyond public awareness and education strategies, deterrence methods may be considered based on successful experiences elsewhere. For instance, traffic surcharges may be useful in discouraging risky driving behavior such as driving too fast, tailgating, and improper passing. Some jurisdictions have successfully instituted surcharges on existing traffic fees for moving violations. The surcharges collected are generally dedicated to an associated cause such as emergency medical services or traumatic brain injury funds. An example is Douglas County, Colorado, where a Victim Assistance and Law Enforcement (VICE) surcharge is assessed on each traffic violation per Douglas County Ordinance 999-002 (Douglas County Sheriff 2012). If a driver is cited for three traffic violations on a citation, the assessment totals $30 with a surcharge of $10 applied for each violation. All surcharges collected are dispersed to local programs that provide services to crime victims. If one of the violations is speeding, an additional surcharge applies. The State of Colorado collects a $12 surcharge for each speeding citation. These funds are dedicated to the Colorado Traumatic Brain injury fund (U.S. Department of Health and Human Services 2006).

In Texas, the Driver Responsibility Program is governed by the Texas Transportation Code, Chapter 708. An annual surcharge of $100 is assessed for three years following offenses such as impaired driving, driving under an invalid license, and driving without insurance. The Trauma Center and Texas General Revenue Funds receive 99% of the funds collected; 1% is provided to the Transportation Department for Program Administration (Texas Department of Public Safety 2012). Another example of the driver responsibility assessment is found in New York where anyone convicted of an alcohol- or drug-related traffic offense must pay $250 for three years (New York Department of Motor Vehicles 2012).

Operational solutions may also be discussed. Given that more than two-thirds of drivers were willing to increase the distance driven to avoid trucks, passenger- or truck-only routes or one-way traffic may be useful in certain situations or during selected time intervals. Public education and awareness regarding this type of change would be crucial. In addition to operational interventions, increased use of roadway safety enhancements such as clear zone, intersection lighting, edge lines, and rumble strips could also be considered. The ability of counties to pool needs in contracting as a group or joining into a state services contract may accelerate these types of investments.

Lastly, the ability of counties to share best practices and supplement efforts to manage heavy trucks to maintain roads in good condition may contribute to longer-term road safety. Road degradation, both on paved and gravel roads, is widespread. Whereas enforcement efforts are led by the state, several counties have begun their own efforts. In North Dakota, state, county, and city law enforcement are currently working together to increase visibility for road maintenance and beyond. Sharing best practices and standards related to these efforts may be useful for those already engaged and for counties or locales considering similar strategies.

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