

Developing Mitigation Strategies to Reduce Truck Crash Rates on Wyoming Highways

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1. Introduction:

Wyoming has one of the highest large truck crash rates in the country. This is due to a variety of reasons which include: the significant amount of through truck traffic on I-80, adverse weather conditions, and the increased oil and gas production activities in the state. These factors have caused the Wyoming Highway Patrol (WHP) to spend extensive resources on inspection of commercial vehicles and enforcement of traffic laws in the state. Because of the heavy truck traffic on Interstate 80, WHP utilizes much of their resources patrolling and performing inspections there.

Based on workload and observation, resources may or may not be addressing all the factors involved in the large truck crashes. Studies show that there are differences among states in enforcement and inspections depending on each states' priorities and resources available. Analysis of these practices and actual crash data can help identify ways to maximize the utilization of the WHP limited resources as well as determine where additional resources are needed to reduce truck crashes on Wyoming's highways. The analysis may also identify systematic safety improvements for potential WYDOT implementation and better ways to communicate with the trucking industry to reduce commercial vehicle crashes in the state.

The American Transportation Research Institute (ATRI) released a report in 2014 about trucks safety and crashes. This ATRI report was first presented by WYT²/LTAP to the Wyoming Safety Coalition. The presentation resulted in a meeting between WYT²/LTAP, WHP and WYDOT. That meeting was followed with a comprehensive discussion by the Wyoming Safety Coalition which unanimously voted to present this research proposal to the WYDOT RAC.

2. Background:

This background section will cover three recently completed studies which evaluated truck crashes and enforcement issues Wyoming.

2.1. ATRI Study

A study was prepared by the American Transportation Research Institute (ATRI) that evaluated the impact of commercial vehicle enforcement disparities have on carrier safety performance factors (Weber & Murray, 2014). In this study, four tasks were performed to investigate the impact of differing enforcement priorities across the trucking industry by looking at state matrices, relationships between violations and crash risks, state enforcement objectives and carrier case studies. The study revealed that the varying state enforcement priorities and inspections may affect the Safety Management System (SMS) scores important to the commercial carriers. The purpose of the study was to use a four task methodology to determine why the differences exist.

Task One evaluated state safety data metrics from multiple sources. Roadside Inspections (RIs) were compared with violations issued and vehicle miles traveled (VMT). RIs ranged from 3.7 to 27.9 RIs per MVMT across the county with Wyoming at 12.4 RIs/MVMT. And violations ranged from 5.8 to 52.2 Violations/MVMT with Wyoming at 22.7 V/MVMT. As shown in Table 1, truck crashes per MVMT ranged from 0.08 crashes/MVMT for New Mexico, to 0.52 crashes/MVMT for Wyoming.

When looking at RIs and Traffic Enforcements (TEs) per 1,000 dollars Motor Carrier Safety Assistance Program (MCSAP) funds expended, on average 14.8 RIs for every 1,000 dollars were conducted. An average of 2.7 TEs per 1,000 dollars were conducted. Wyoming conducted 17 RIs/1,000 dollars and 3.6 TEs/1,000 dollars. As shown in Table 2, state budget contributions showed that the median average states contributed to every federal dollar was 0.70 cents. Wyoming contributed only 0.33 cents.

Table 1. Large Truck Crashes per MVMT (Weber & Murray, 2014)

Crash Rates		
Top 10		
Rank	State	Crashes/ MVMT
1	Wyoming	0.52
2	New Jersey	0.48
3	Kansas	0.41
4	Colorado	0.40
5	Virginia	0.39
6	Montana	0.37
7	Kentucky	0.35
8	Minnesota	0.34
9	Iowa	0.32
10	Michigan	0.31
NATIONAL AVERAGE		0.26
Bottom 10		
39	Washington	0.20
40	South Dakota	0.19
41	Georgia	0.19
42	Oregon	0.18
43	Idaho	0.16
44	Pennsylvania	0.16
45	Mississippi	0.14
46	Florida	0.12
47	Utah	0.11
48	New Mexico	0.08

Table 2. State Enforcement Contributions – States Contributing Less Than Median Average (0.07 cents) (Weber & Murray, 2014)

	State	State /Federal Fund Ratio	Additional RIs	Additional TEs
1	Kentucky	\$0.66	15,876	2,850
2	Oklahoma	\$0.63	17,201	3,088
3	Georgia	\$0.62	31,031	5,571
4	Minnesota	\$0.61	19,093	3,428
5	Texas	\$0.57	128,226	23,021
6	Arkansas	\$0.52	12,302	2,209
7	Arizona	\$0.52	37,805	6,787
8	Indiana	\$0.50	25,326	4,547
9	Illinois	\$0.49	34,157	6,132
10	Iowa	\$0.46	13,528	2,429
11	North Carolina	\$0.45	25,192	4,523
12	New Hampshire	\$0.42	4,267	766
13	Kansas	\$0.39	15,523	2,787
14	Colorado	\$0.37	16,304	2,927
15	Wyoming	\$0.33	4,371	785
16	Nebraska	\$0.29	11,324	2,033
17	Wisconsin	\$0.26	18,187	3,265
18	Alabama	\$0.25	21,004	3,771
19	Rhode Island	\$0.23	4,181	751
20	Delaware	\$0.21	3,486	626
21	Montana	\$0.21	9,234	1,658
22	Vermont	\$0.20	3,830	688
23	New Mexico	\$0.18	13,359	2,398
24	North Dakota	\$0.17	8,218	1,475

Another metric used was driver fitness and Hours of Operation (HOS) compliance. On average, 5.2 drivers per 100 relevant RIs did not possess a medical certificate. Wyoming had 3.4/100 RIs. For HOS compliance, the national average was 7.1 log violations per 100 relevant RIs and Wyoming was 12.4 violations/100 RIs.

As shown in Table 3, for vehicle maintenance violations, there was an average of 2.0 violations/100 RIs across the country with Wyoming at 0.45 violations/100 RIs.

Task Two looked at the relationships between violations and crash risks. “Red Flag” (RF) violations designated by FMCSA and “Crash Predictor” (CP) violations developed by ATRI were used to relate violations to crashes. States issuing the most CP violations had high rates of TEs, whereas states that issued more RF violations had higher RIs performed. RF states had higher crash rates as well. This may indicate that the Red Flag violations should be re-evaluated and updated to reflect the crash risks.

Table 3. Vehicle Maintenance Violations by Relevant RI (Weber & Murray, 2014)

Vehicle Maintenance		
Windshield Wipers Inoperative/Defective		
Top 10		
Rank	State	Viol/100 RIs
1	Texas	12.2
2	Arizona	11.1
3	Connecticut	7.1
4	Arkansas	6.3
5	Utah	6.2
6	Minnesota	4.6
7	Colorado	3.0
8	Kansas	2.9
9	Idaho	2.7
10	Rhode Island	2.4
NATIONAL AVERAGE		2.0
Bottom 10		
39	Oregon	0.47
40	New Hampshire	0.47
41	Wyoming	0.45
42	Iowa	0.34
43	Kentucky	0.33
44	California	0.30
45	Delaware	0.30
46	South Dakota	0.28
47	Tennessee	0.26
48	North Dakota	0.19

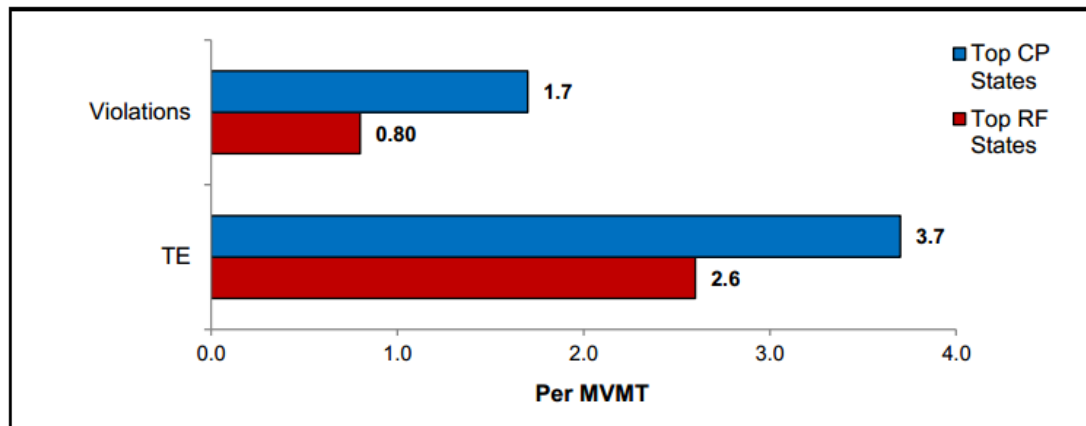


Figure 1. Average TE and Violation Rates

Task Three used a case study approach and looked at five states' enforcement objectives identified in their 2011 MCSAP Commercial Vehicle Safety Plan (CVSP) to see how these plans influence violations issued. In each of the five states, moving violations were compared to truck crash factors. As shown in Figure 2, in many instances where there were high violations, the crash factors were low. For example, there were 36.4 percent speeding violations in Minnesota but only 7.2 percent crashes related to speeding. And where 10.1 percent of truck crashes were related to improper lane change, only 1.8 percent violations were issued. A closer study of these factors would benefit the state enforcement agencies to better allocate their resources to those types of violations that most influence crashes.

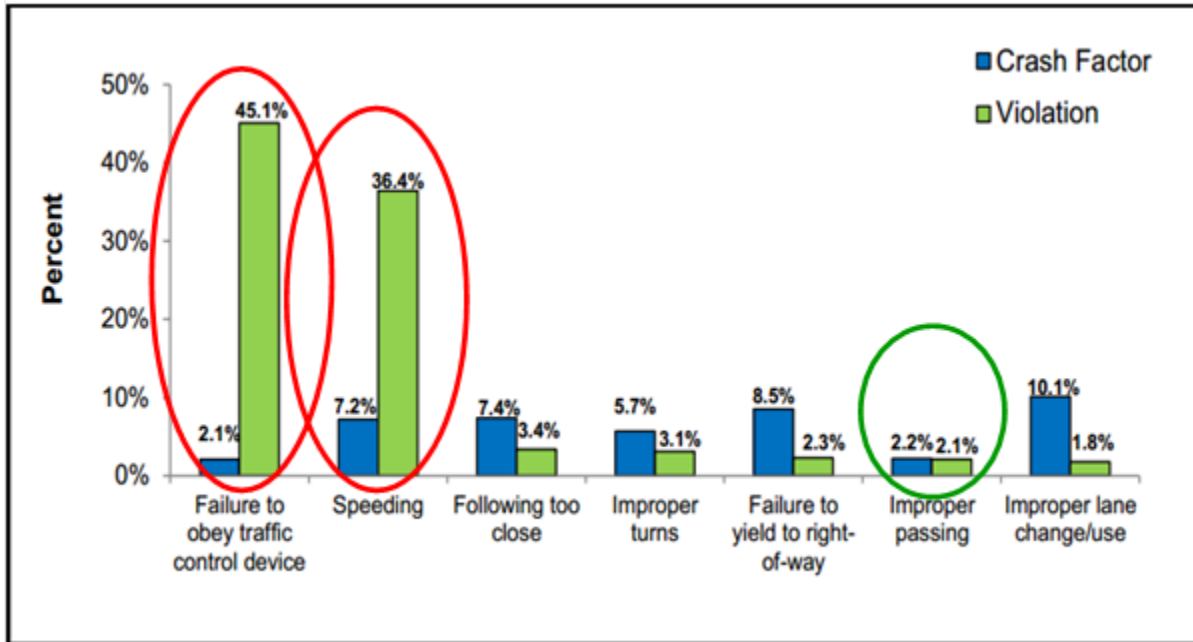


Figure 2. Minnesota Crash Factors and Violations (Weber & Murray, 2014)

The final task in the ATRI study was to look at seven carriers and analyze the impact of enforcement disparities on the ratings of the carriers. Where enforcement objectives vary across state lines, carriers are affected by their performance rating although in reality their performance should not change simply by crossing state lines.

When looking at state disparity factors, shown in Figures 3 and 4, Wyoming had the fourth highest HOS compliance violations and had the highest controlled substance/alcohol violations in the US.

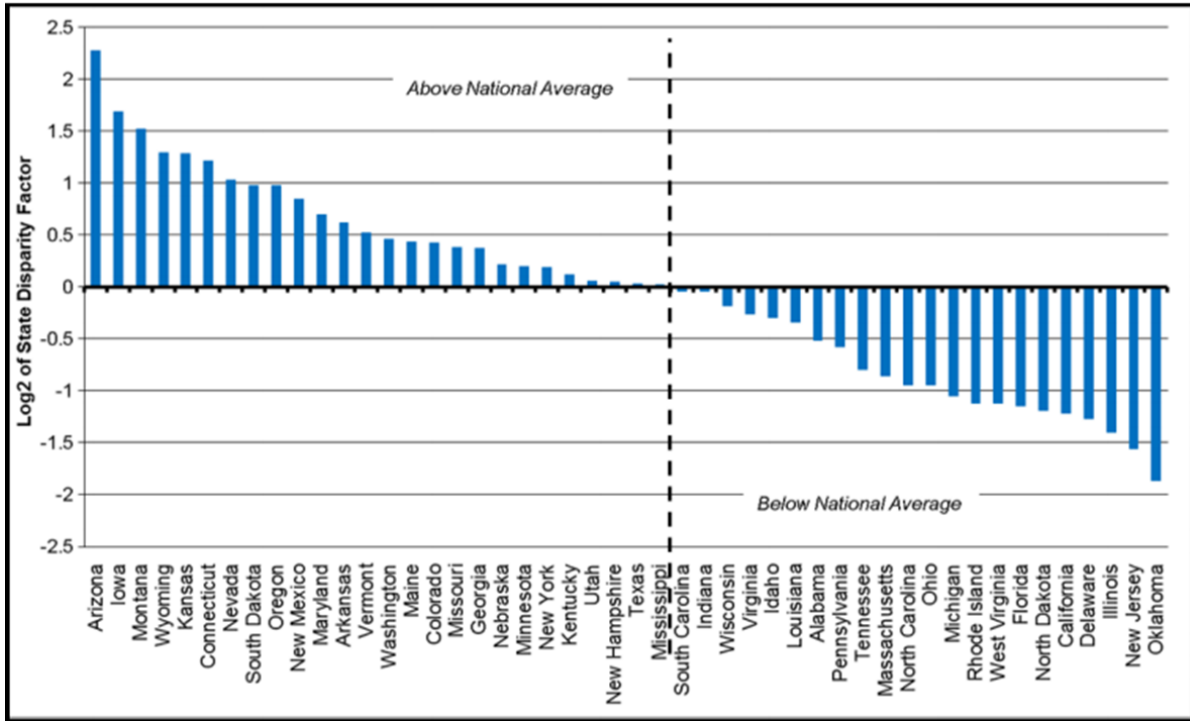


Figure 3. State Disparity Factor – HOS Compliance (Weber & Murray, 2014)

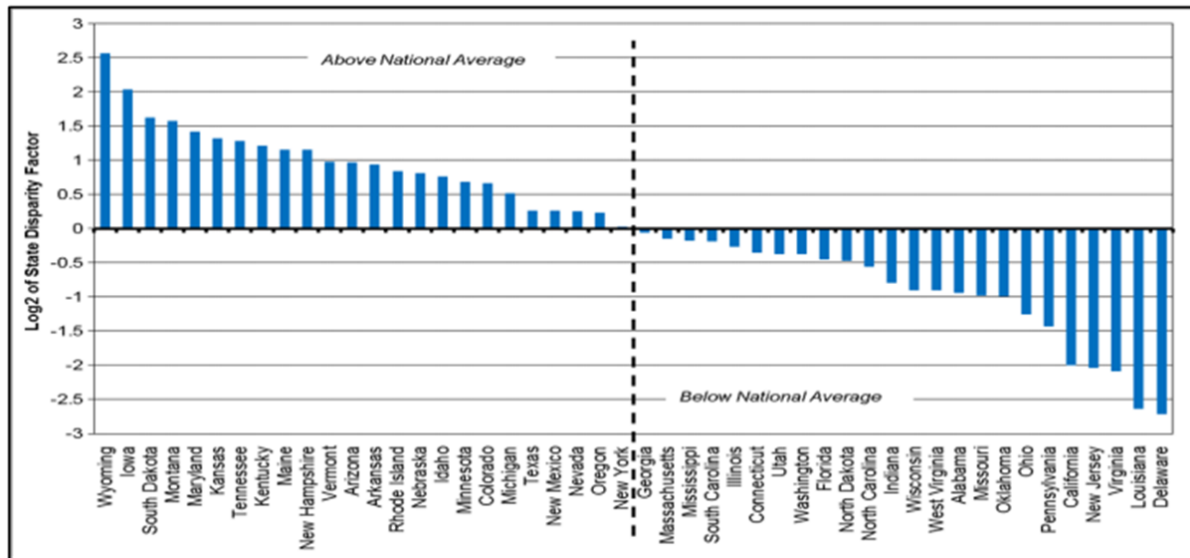


Figure 4. State Disparity Factor – Controlled Substance/Alcohol (Weber & Murray, 2014)

In summary, The ATRI study showed that Wyoming had the highest number of heavy truck crashes per MVMT in the country. In addition, Wyoming was in the bottom ten states with the lowest budget contributions to enforcement. Variation in citations issued and inspections performed occurred across the US. Many of the enforcement objectives are developed

individually by each state. In many instances, citations may be high but the crash data did not necessarily support it.

2.2. Wyoming Versus North Dakota Study

In another study (Andreen & Ksaibati, 2012), enforcement activities were compared between Wyoming and North Dakota. Although Wyoming issues more motor carrier citations than North Dakota, North Dakota spends more effort on enforcement on child restraints, seatbelt use and DUI. They also had fewer fatalities than Wyoming. Traffic law enforcement practices were compared to crash trends in each state and enforcement efforts were identified to determine their effectiveness in reducing crashes. Economic factors were also considered when comparing crash trends. Where crashes had increased, there was known increased oil and gas production.

The two states have similarities but crash rates, road miles and enforcement practices vary. The populations are comparable with Wyoming ranking 50th and North Dakota ranking 48th in the country. Wyoming and North Dakota are similar geographically and in population. North Dakota has only slightly more people with an average population of 650,000 (2000-2009).

North Dakota has approximately 56,000 more miles of local roadways than Wyoming. There are almost 60 percent more interstate miles in Wyoming than in North Dakota. A large percentage of the crashes in Wyoming happen on the interstate. Wyoming's higher severity problem may be attributed to the difference in distribution of functional classification.

Table 4. Miles of Highway by Functional Classification

STATE	INTERSTATE	OTHER PRINCIPLE ARTERIAL	MINOR ARTERIAL	COLLECTOR	LOCAL	TOTAL
North Dakota	571	3101	2812	11810	68548	86842
Wyoming	913	2204	1389	11190	12410	28106
DIFFERENCE	-342	897	1423	620	56138	58736

North Dakota began experiencing more fatalities than Wyoming after 2009. Many reasons were speculated for this sharp change in trends, but the most relevant and believable explanation was the increased drilling activity in North Dakota that began in 2008 in the Bakken formation. Figure 5 shows the fatalities in both North Dakota and Wyoming from 1992 to 2009. The idea that this change in crash trends could be due to increased drilling activities led to the notion that economic conditions could have real effects on crash rates.

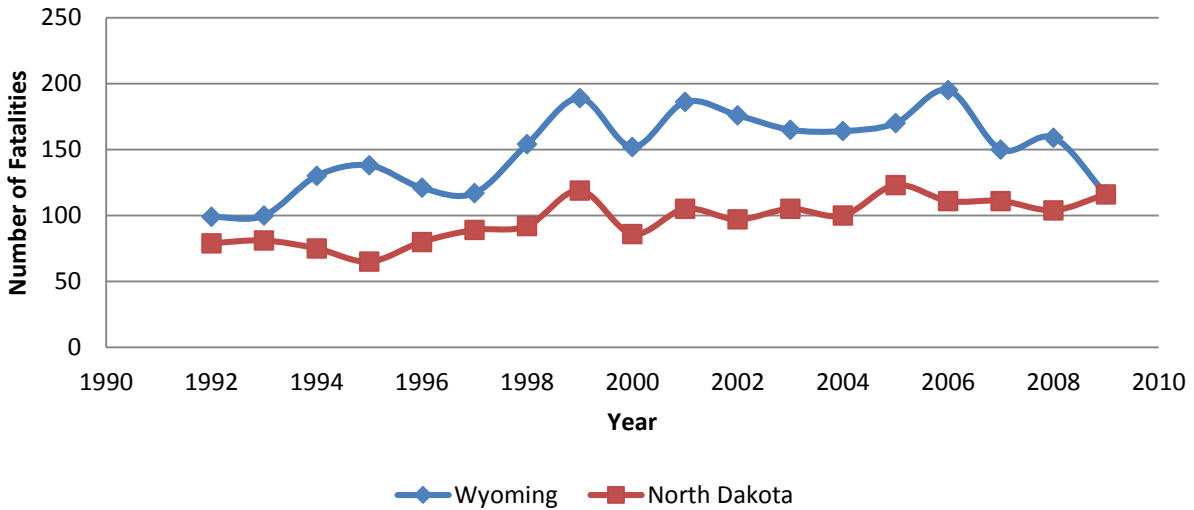


Figure 5. Wyoming and North Dakota Fatalities

The original objective of this study is to identify potential reasons for higher fatality rates in Wyoming and to develop recommendations to mitigate those fatal crashes. With the increase in fatal crashes that was discovered in North Dakota and speculation that economic factors could play a role, additional research was initiated to understand if a link existed. A closer look at fatality rates in the two states, normalized per 100 million vehicle miles of travel (MVMT) shows even more of a disparity in the trend. In 2009, Wyoming experienced 1.43 fatalities per 100 MVMT while North Dakota had 1.76 fatalities per 100 MVMT, up 28percent from 2008. Figure 6 illustrates those trends compared to the national trend for 1998 through 2009.

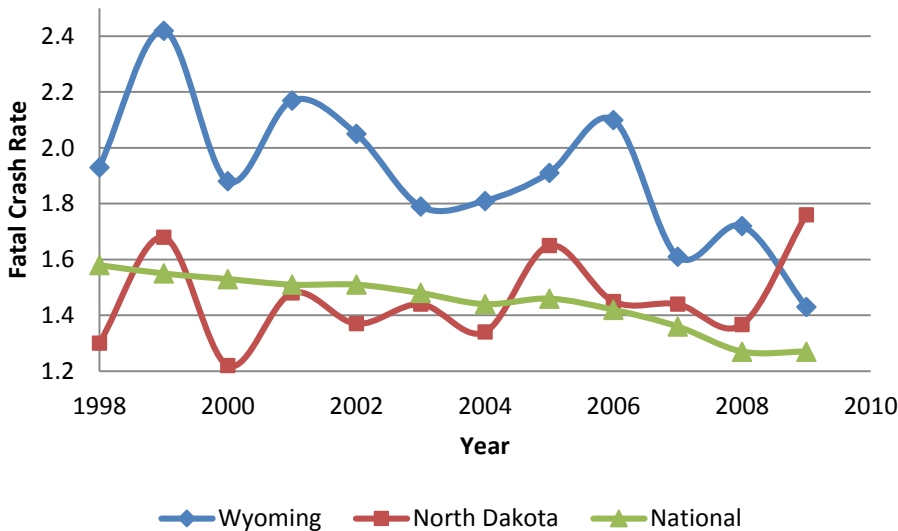


Figure 6. Fatality Rate per 100 Million Motor Vehicle Miles Traveled (MVMT)

The national fatal crash rates have been decreasing in recent years and the Wyoming crash rates have been decreasing at an even faster rate. The injury rates in both states have been decreasing

as well. Wyoming had higher injury rates than North Dakota for ten years until 2009. Figure 7 shows the injury crash trends from 1998-2009.

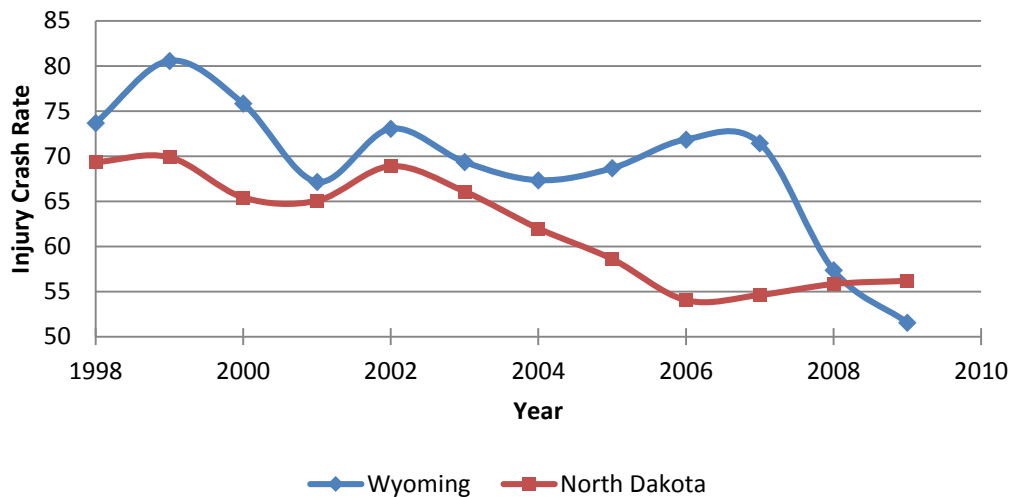


Figure 7 Injury Rate per 100 MVMT

Study Conclusions:

The traffic safety laws only differ slightly between the two states. The Wyoming Highway Patrol has specific goals in reducing fatal crashes and reducing impaired driving. North Dakota has much broader objectives which give them more flexibility in their patrolling tactics. The study concluded that enforcement techniques are necessary due to the different needs for each state. Wyoming spends more time on truck inspections and issues more motor carrier citations because of the large truck traffic especially along Interstate 80 which consumes much of their enforcement resources.

This study showed that despite the general similarities, Wyoming and North Dakota have some differences in driving habits, traffic, crashes, and enforcement. Wyoming historically has had more fatalities and a higher fatal crash rate. North Dakota has more total crashes and a higher total crash rate. There are more miles of highway in North Dakota than in Wyoming. Wyoming has more interstates and more crashes on the interstates and the number of vehicle miles traveled in Wyoming is larger than in North Dakota.

North Dakota consistently issues more citations than Wyoming for child restraints, DUIs, and seatbelts. North Dakota spends a larger percentage of its patrolman’s time on actual patrol hours rather than administrative or inspection work. Wyoming has more sworn officers and spends more hours on the road, but as a percentage of the total time in the department. Wyoming also issues more motor carrier citations and spends more time on truck inspections than North Dakota.

North Dakota has had fewer fatalities than Wyoming every year until 2009. Wyoming does have several differences from North Dakota that could be factors contributing to the higher crash severities. The higher number of interstate miles across steep grades and high mountains, weather, industry, geometrics, and roadway factors could all effect crash rates.

Construction employment and GDP show a high correlation to increased crash rates, showing that an increase in economic activity is contributing to the higher crash rates. The data shows that in Wyoming and North Dakota there are more crashes in counties where there is more mining and construction, regardless of population. Wyoming has always had high levels of employment in these fields and therefore has not seen an increase. But the correlation in the data confirms why the crashes in Wyoming have been higher. With the increase in drilling in North Dakota, there has been a corresponding increase in crashes.

Study Recommendations:

The highway patrol enforcement in Wyoming is doing excellent with the resources that they have and the large area that they must cover. Where the patrols differ in the two states is that North Dakota has a group of officers dedicated to the enforcement of motor carriers and they deal with a smaller volume of trucking within their state. The Interstate 80 corridor is the largest and heaviest used truck route in the region. No other corridor even compares to amount of truck traffic that Wyoming has to inspect and deal with on a daily basis.

Enforcement on I-80 consumes so much of the patrols budget and resources. It would be beneficial to consider additional officers and personnel to help with the burden of higher amounts of trucking, in enforcement and inspections. North Dakota has been very proactive with the development that has been happening in the Bakken formation. They have added new officer positions and attempted to keep ahead of the expansion. Wyoming would benefit from studying their strategies further.

2.3. UW Truck Crashes Study:

The University of Wyoming studied the effects of truck traffic on crash injury severity on rural highways in Wyoming (Franke, Shinstine, Ahmed, & Ksaibati, 2015). The study concluded that more truck crashes occurred when road and weather conditions were poor. This study also revealed that there is high compliance to seatbelt use and low alcohol and drug use among commercial drivers. Advanced warning systems and targeted training could improve roadway safety for trucks.

Weather and road conditions at the time of the crashes were analyzed in this study. Most crashes occurred when the weather was clear. However, snow was most common in crashes that occurred during inclement weather. In Figure 8, the analysis shows that the next most common road condition to dry roads was ice and frost. Twenty-eight percent of truck involved crashes occurred on roads with ice and frost, compared to fifteen percent of non-truck crashes occurring on ice and frost covered roads.

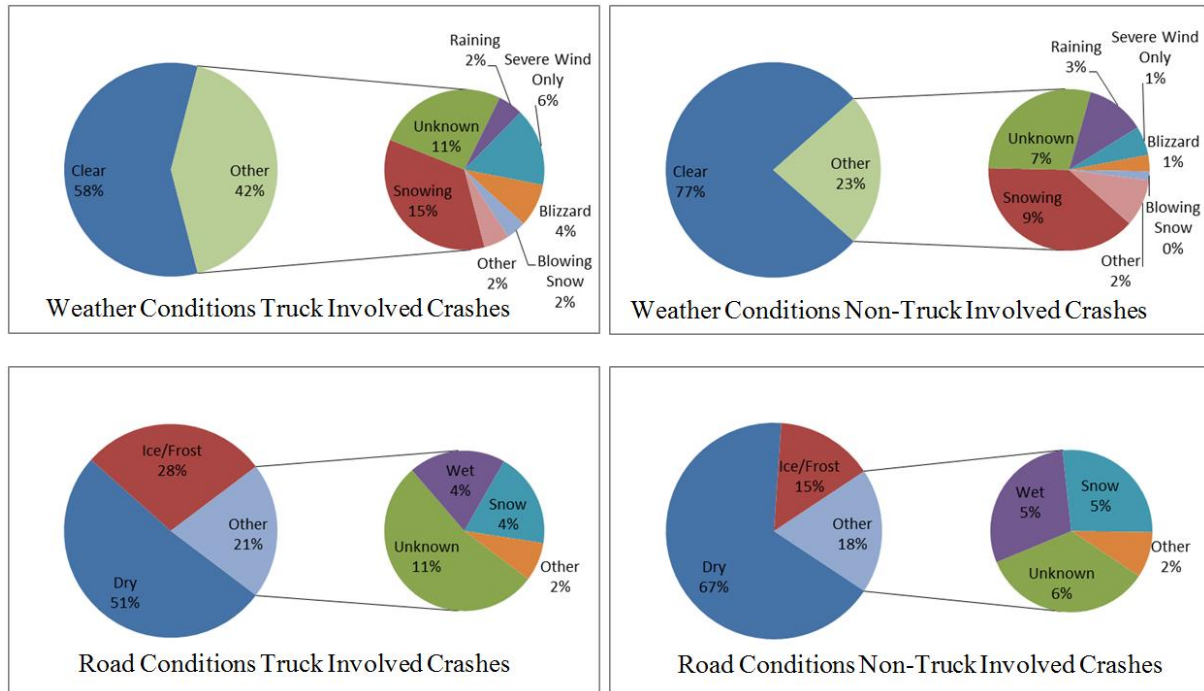


Figure 8. Weather and Road Conditions during Crashes

3. Objectives:

The main objective of this study is to identify the primary factors behind the high truck crash rates in Wyoming and then develop mitigation strategies to reduce these high crash rates. The recommended strategies might include tools which will help WHP in allocating their resources to enhance safety at locations where there are high crash rates. Recommendations will be provided to identify any additional needed resources to: enhance safety by implementing specific safety improvements, concentrate enforcement efforts, expand trucks inspection programs, and develop an outreach program for the trucking industry to reduce truck crashes.

4. Methodology:

In order to fulfill the study objective, it is important to obtain and then analyze crash data, citations, and inspection reports. The proposed methodology is describe graphically in Figure 9.

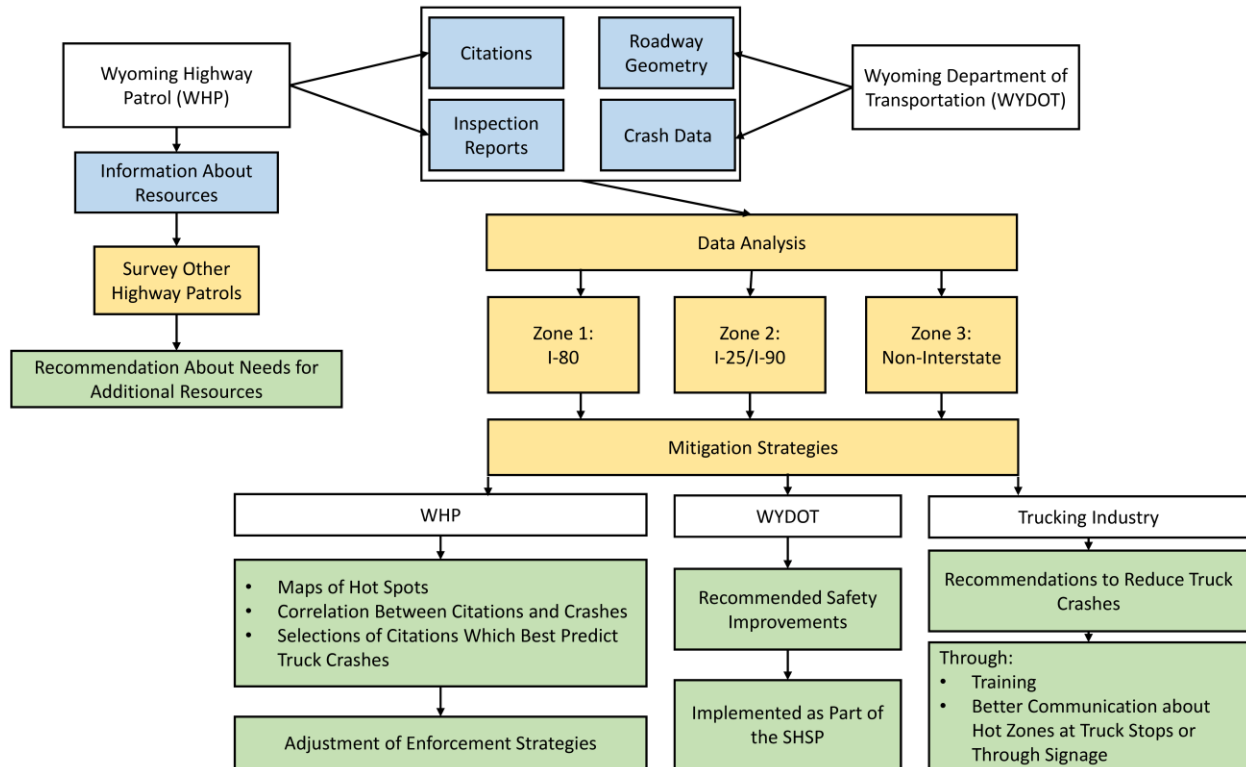


Figure 9. Research Methodology and Projected Outcome.

5. Research Tasks:

The following ten tasks will be performed in this study:

1. Perform a comprehensive literature review to identify research studies related to the causes of truck crashes and the correlations between enforcement strategies and truck crashes.
2. Collect statewide crash data and perform analysis on three zones. As shown in Figure 10, zone one includes Interstate 80, zone two includes Interstates 25/90, and zone three includes three state highways that have high truck traffic such as Wyoming Highway 59, US Highway 30, and US 26. These highways will be identified by coordinating with WYDOT and WHP. The crash analysis will include identifying: all truck crashes, equivalent property damage only truck crashes (EPDO) and critical crashes. Critical crashes include fatal and serious injury crashes. Truck crash rate per mile and per VMT will be established and various causal factors will be studied such as vehicle type, first harmful event, weather, roadway conditions, driver impairment, speed, and state driver's license issued.

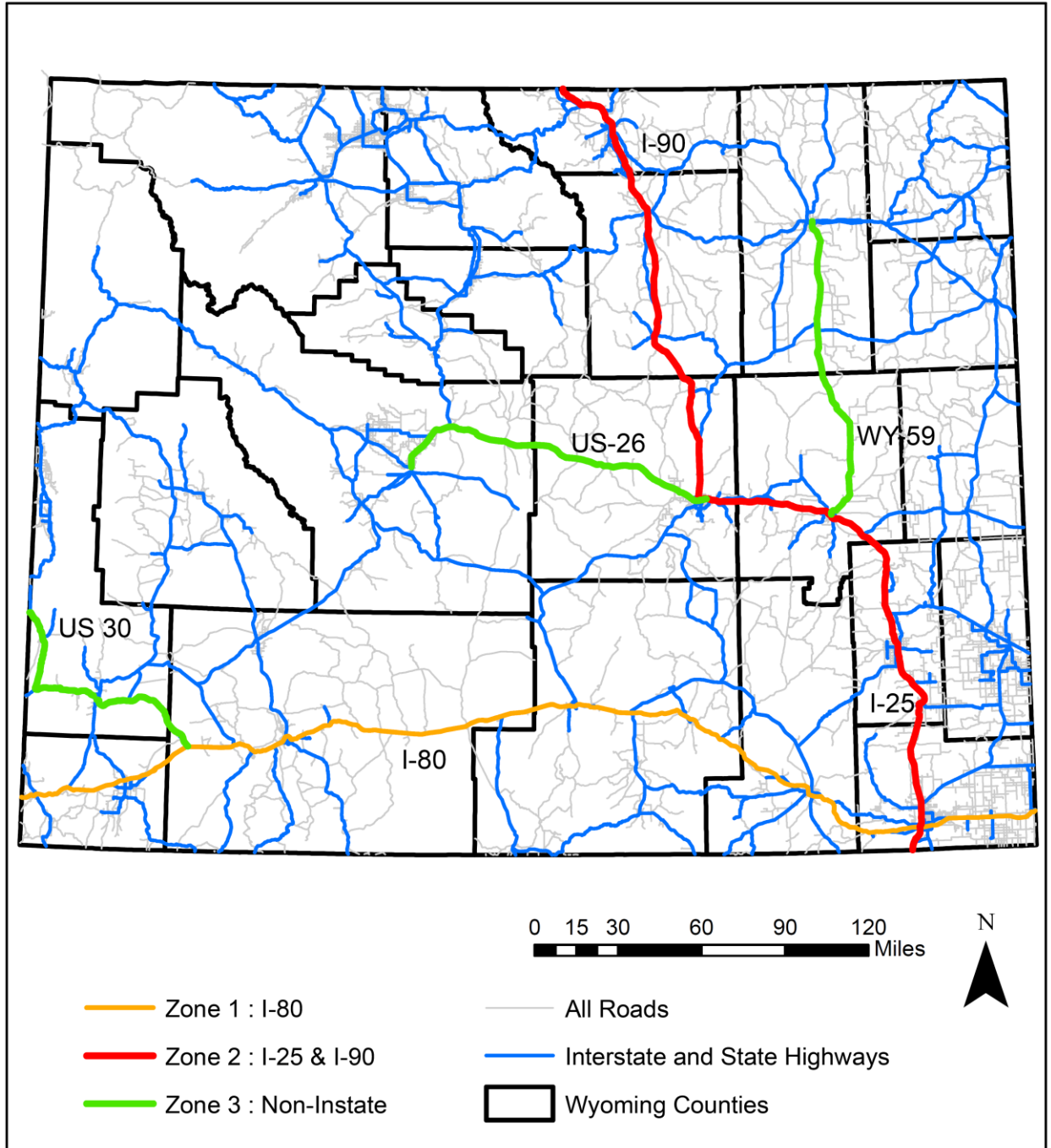


Figure 10. The Three Analysis Zones for the Crash/Citations Analysis.

3. Collect data on statewide citations issued by WHP for motor carriers. Review WHP policies and strategies for enforcement. Again, three zones will be evaluated, Interstate 80, Interstate 25/90, and a combined zone of state highways. The citations will be evaluated per mile along each system and will be grouped by type of citation such as speeding, improper passing, etc. as well as weather conditions, time of day and other factors included in the citation report.

4. Compare relevant crash data and citations issued. For commercial vehicles, driver action and driver citation will be studied. Table 5 illustrates the information available in CARE that can be analyzed directly to compare driver action in a crash to citations issued. Comparisons among the three zones will also be performed to determine if statewide trends exist and identify other problematic situations that are unique to the different zones. A statistical analysis will be performed to identify correlations between citations issued and truck crashes.

Table 5. Variables in Care for CMV Crashes

Variables in CARE	
CMV Driver Action	CMV Driver Citation
Disregarded Traffic Signs	Disregard Stop Light Disregard Stop Sign
Erratic or Reckless or Careless or Aggressive	Careless Legacy - Reckless or Careless Driving
Failed to Yield ROW	Failed to Grant ROW to MV Failed to Grant ROW to Ped
Drove too Fast for Conditions	Speed too Fast
Following too Close	Following too Close
Improper Backing	Improper Backing
Improper Parking	Improper Parking
Improper Passing	Improper Passing
Improper Turn or No Signal	Improper or No Signal Improper Turn
Speeding	Exceeding Speed Limit
Wrong Side or Wrong Way	Wrong Side of Road

5. GIS maps will be developed for crash locations and citation locations. From these maps, more refined analysis and maps will be performed to study hot spots, crash types and causes, and citation types. Color coded maps will be developed to clearly identify trouble locations. Such maps will provide the WHP with valuable information to identify where to concentrate their enforcement and inspection efforts.
6. The research team will meet with WHP representatives to discuss the collection and evaluation of truck inspection reports to determine what and if these reports could provide helpful information for the study.
7. WHP resources will be reviewed. Documentation will be collected for the past five years from WHP to determine resources such as number of officers, percent of time spent patrolling, performing inspections and issuing citations. How these relate to officer contact hours along with enforcement will be studied. Information about the budget related to direct enforcement resources will be collected and included in the study.

8. A survey will be developed and distributed other states with higher and lower funding contribution levels than Wyoming to determine if higher contribution levels would result in higher level of safety and reduction in truck crashes.
9. Review Red Flag Violations and Crash Predictor Violations as discussed in the ATRI report will be compared in relation to crashes. Determination will be made as to which might be better predictors of safety in Wyoming.
10. Prepare a final report of findings and present it to Wyoming Safety Coalition, WYDOT and WHP.

6. Study Outcomes:

This study will provide specific conclusions, recommendations, and products at the following three levels:

- Recommendations will be given to provide the trucking industry useful information about the hazard on the highways in Wyoming. Strategies to communicate this information would include posting at truck stops, adding signs at high hazard locations and recommended enhanced training for the truckers.
- Comparing crash types to citations issued will help in determining how to best utilize the efforts and resources of the Wyoming Highway Patrol (WHP). In addition, the recommendations of the study may specify additional needed resources for the WHP so that enforcement and inspection efforts can be fully utilized to reduce truck crashes around the state.
- Recommendations for systematic safety improvement maybe provided to WYDOT based on the trends of truck crashes experienced in the state.

The cooperation among WYDOT, WHP, and the trucking industry in tackling the high truck crash rates in the state will hopefully result in reducing these crash rates over time.

7. Timeline and staffing:

It is anticipated that this study will be performed in two years. WYDOT, WHP, and the Wyoming Safety Coalition will be provided with regular updates on the progress of the study. One UW faculty member, a graduate student, and several staff members of the Wyoming T2/LTAP center will contribute to this study.

8. Budget:

As shown in Table 6, the overall budget of this study is 89,181 dollars. A significant portion of the requested budget will be used to support a graduate student.

Table 6. Project Budget

Developing Mitigation Strategies to Reduce Truck Crash Rates on WY Highways		
University of Wyoming		
CATEGORY	Budgeted Amount	Explanatory Notes
Faculty Salaries	\$ 13,500	
Administrative Staff Salaries	\$ -	
Engineer Salaries	\$ 3,500	
Student Salaries	\$ 28,000	
Staff Benefits	\$ 8,518	
Total Salaries and Benefits	\$ 53,518	
Permanent Equipment		
Expendable Property, Supplies, and Services	\$ 3,500	
Domestic Travel	\$ 9,800	
Foreign Travel	\$ -	
Other Direct Costs (specify)	\$ 9,000	Student Tuition, exempt from indirects
Total Other Direct Costs	\$ 22,300	
F&A (Indirect) Costs	\$ 13,364	
TOTAL COSTS	\$ 89,181	

9. References:

- Andreen, B., & Ksaibati, K. (2012). *Comparing Crash Trends and Severity in the Northern Rocky Mountain Region*. Cheyenne: WYDOT.
- Franke, R., Shinstine, D., Ahmed, M., & Ksaibati, K. (2015). Effects of Truck Traffic on Crash Injury Severity on Rural Highways in Wyoming Using Bayesian Binary Logit Models. *TRB 94th Annual Meeting*. Washington, D.C.
- Weber, A., & Murray, D. (2014). *Evaluating the Impact of COmmercial Motor Vehicle Enforcement Disparities on Carrier Safety Performance*. Arlington, VA: American Transprotation Research Institute.