Regional Analysis of Log Truck Crashes in the United States between 2011 and 2015

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ABSTRACT (ACADEMIC)

Safe and efficient transportation of fiber is an essential component of the forest products supply chain, yet log truck crashes are believed to have increased across the United States. We examined two federally maintained databases to explore crash characteristics. Study objectives were to characterize log truck crashes nationally and regionally, and to compare log trucks to other similar trucks and assess differences. An analysis of 383 crashes involving log trucks across the U.S. were divided into four geographic regions for regional assessment. Results indicate that log trucks were significantly more likely to experience a rollover *($p<.0001$)* as compared to other large trucks types. The average age of log trucks involved in fatal crashes (13 years) was significantly older (*$p=.0109$*) than overall average age for other large trucks (7.6 years). Log truck driver age was significantly different between region (*$p=.0269$*) with the highest average age in the Western region (53.4) and the lowest average age in the Midwest region (45.5). Calculations of crash rates revealed that the national average was 0.7 fatal log truck crashes per 100 million ft^3 of wood harvested. The highest rate of log truck crashes occurred in the Southeast with 0.9 fatal crashes per 100 million ft^3 of wood harvested. Between 2011 and 2015 fatal log truck crashes increased by 41%. Log tractor-trailer crashes increased 33% while all tractor-trailer crashes increased by 16%. Our findings reveal sufficient differences between log trucks and other large trucks to justify additional research regarding causation of crashes.

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ABSTRACT (GENERAL AUDIENCE)

Safe and efficient transportation of raw materials to a processing facility is important to any industry, including the transportation of logs, pulpwood, and chips to forest products processing facilities. Although information regarding log truck crashes is clearly important, few studies have examined crashes specific to log trucks. Study objectives were to characterize log truck crashes nationally as well as regionally, and to compare log trucks to other similar trucks and assess differences. Analysis of data obtained from two federally maintained crash databases revealed that 383 crashes occurred over a 5-year period from 2011 to 2015 involving log trucks. Log trucks are more likely to experience a rollover during a crash with occurrences in 78% of fatal crashes. Both truck age and driver age differ significantly by region. Crash rates by state and region were calculated by comparing number of fatal crashes to the amount of wood harvested. The national average crash rate is 0.7 fatal log truck crashes per 100 million ft^3 of wood harvested. The highest rate of log truck crashes is the Southeast with 0.9 fatalities per 100 million ft^3. Log tractor-trailer crashes increase by 33% between 2011 and 2015, while other large trucks increased by 16%. Log trucks are the oldest vehicles involved in fatal crashes, with an average age of 13 years, compared to the overall average for all trucks of 7.6 years. Our findings reveal sufficient differences between log trucks and other log truck to justify additional research regarding causation of crashes.

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1.0 INTRODUCTION AND LITERATURE REVIEW

1.1 The Need for Research Related to Log Truck Crashes

The safe and efficient transportation of wood is an essential component of the supply chain of the forest product industry. Available and reliable truck transport of wood from landing to mill is critical to processing facility production. Trucking is often one of the most publicly visible components of logging operations. Factors that impact safety and costs for log trucking can threaten the sustainability of the log trucking sector. Log transportation can be considered risky by some insurers, therefore insurance companies willing to write policies for log trucks are limited. Currently, only 5 companies nationally are willing to write log truck vehicle insurance (FRA 2017). Similarly, in Michigan an interview of insurance companies indicated that most will not insure log trucks. Of 16 companies interviewed, only 6 carriers wrote policies for log trucks (MDOT 2005). Crashes are a major factor that can affect insurance costs of log trucks. Identifying characteristics of crashes involving log trucks can help to target areas of concern and identify where to implement log truck safety training with the goal of improving safety while simultaneously reducing costs.

While heavy vehicle crash rates overall have steadily declined over the past several decades (Knipling 2009), it is not known whether log trucks follow this trend nationally. Conrad (2017) determined that log truck crashes increased by 24% in Georgia from 2012 to 2016 and insurance premiums for log trucks were an average of 19% higher for log trucks than for other trucks over the past decade. Overall, little specific data are available regarding crashes related to log transportation. Lefort (2003) completed a study of forestry related workers compensation claims in Louisiana and determined that 8% of claims are transportation related. Additionally, the proportion of transportation related injuries had the highest increase over a 12-year period as compared to all injury types (Lefort 2003).

Minimal research has been done of log truck crashes nationally. State specific studies of log truck crashes have been completed in Michigan and Georgia and Washington (MDOT 2005, Greene 2007, Mason 2008). Greene et al. (2007) determined that log truck crashes caused by mechanical failure decreased from 13% of crashes to 4% from 1988 to 2004 in the state of Georgia. From 1988 to 1991 the most cited contributing factor involving a logging tractor-trailer was mechanical failure, while from 2001 to 2004, the most cited contributing factor was following too closely (Greene et al 2007). A study in the Upper Peninsula of Michigan compared log truck crashes to other crashes that occurred in the same area. Based on the total number of crashes, log truck crashes in the Upper Peninsula appear to be relatively infrequent and account for a small percentage of all truck and bus crashes and an even smaller percentage of the total crash records. Mason et al (2008) found that crashes involving log trucks declined by 11% from 2004 to 2006 while crashes involving all commercial carriers increased by 15% (Mason 2008) in the state of Washington. Although some regional analyses have been conducted, there have been no analyses on vehicle crashes specific to forestry transportation issues on a nationwide scale.

Large truck crashes are a problem for any industry involving truck transportation and are also a safety concern for all drivers. In 83% of crashes between a large truck and a passenger vehicle the truck driver survives but the car driver does not (Knipling 2009). Characterizing log truck crashes can aid safety managers in effectively focusing resources in needed areas. Reducing log truck crashes could have a positive fiscal impact for the logging industry and improve overall safety for all drivers.

1.1.1 Large Trucks Crashes: General Characteristics

Motor vehicle crashes create a significant monetary impact on society. In 2014, the total cost of motor vehicle crashes was estimated by the National Highway Traffic Safety

Administration (NHSTA) to be $242 billion (Blincoe 2015). Based on NHSTSA guidelines, a large truck is classified as a truck weighing greater than 10,000 pounds (NHTSA 2015). As of 2014 large trucks accounted for 8 percent of all vehicles involved in fatal crashes and 4 percent of all vehicles involved in injury and property damage only crashes. Large trucks also accounted for 4 percent of all registered vehicles, but 9 percent of the total vehicle miles traveled (NHTSA 2015). This higher mileage exposure increases the likelihood of potential crashes. Truck drivers' interview responses regarding common unsafe driving acts in the vicinity of large trucks indicated that the most common act seen on roadways is changing lanes abruptly in front of a truck, often to make an exit (Stutser 1999). More recent data suggests that many crashes are a result of distracted driving. In 2015 it was reported that 3,477 people were killed because of distracted driving practices (National Center for Statistics and Analysis 2015).

Many studies have been done on large truck crash trends, yet little research has focused on characteristics of specific cargo body types of large trucks, such as log trucks. Atypical of other large trucks, log trucks often travel over private, county, state, and federal road systems with dirt, gravel, and pavement. They encounter a variety of unique conditions that other trucks may not. The cargo a truck carries could be related the conditions it operates in such as gravel roads and time spent in rural areas. These unique characteristics make further assessment of log truck crashes important.

1.1.2 Large Truck Crash Causation Study

The Large Truck Crash Causation Study (LTCCS) (FMCSA 2007) is a project conducted by the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) that collected data on fatal and serious injury crashes involving large trucks over a three-year period, with the goal of using the data to develop safety countermeasures. For each crash one "Critical Reason" and one "Critical Event" is assigned as the main reason the crash occurred, to inform a "cause" of the crash. Per this study, 75% of all crashes recorded involved 1 or more vehicle (FMCSA 2007). In crashes that resulted in a fatality, trucks were determined to be at fault 23% of the time. In crashes resulting in an incapacitating injury the large truck was assigned fault 37% of the time, and in crashes with no incapacitating injuries fault was assigned to the truck in 46% of instances. Overall, 40% of the time error was assigned to the truck driver compared to 60% of the time that error was assigned to another vehicle involved. This implies that more than half the time fault was not assigned to the truck driver (FMCSA 2007). Eighty-nine percent of these crashes had a critical reason attributed to human error, mainly recognition error, decision error, and critical non-performance such as falling asleep at the wheel. The major critical events assigned to at-fault truck crashes included: running out of the travel lane or off the road (32%), loss of control due to speed, cargo shift, vehicle failure or other problem (29%) and colliding with the rear end of another vehicle (22%) (FMCSA 2007).

1.1.3 Log Truck Crash Studies

A study of 96 log truck crashes over a 3-year period in the Upper Peninsula of Michigan was completed in 2005. This study indicated that 25 percent involved a log truck only, 64.6 percent involved a log truck and another vehicle, and 10.4% involved a log truck and an animal (MDOT 2005). In this study, log truck involvement appears very similar to the overall heavy truck and bus crash trends in the Upper Peninsula. Of the three fatal crashes present in this data, fault was assigned to the other driver, and no citations were issued to the drivers of log trucks (MDOT 2005). Of the crashes, 56 percent were within 150 feet of an intersection and 69 percent occurred on a state highway (MDOT 2005). A study by Lefort et al. (2003) looked at injuries in Louisiana and determined that 8 percent of logging injuries from 1986 to 1998 were transportation related. Suggested improvements included minimizing distances to the mill, implementation of defensive driving training, and increasing public awareness of trucks on the road (Lefort et al. 2003).

There is abundant evidence that most crashes are caused by human error (FMCSA 2007), but not all crashes are caused by drivers. In the large truck crash causation study, cargo shift was identified as a contributing factor in 7 percent of cases, and brake failure was identified in 3 percent of cases. A study in Georgia indicated that from 2005-2008 brake failure was a contributing factor in 4.5 percent of log truck crashes (Cutshall 2010). Mechanical failures have declined significantly from 15.9 percent before 1990 to half that in 2008. Tire failure was also reduced from 1.47 percent to 0.67 percent of crashes, a 75 percent reduction between 1990 and 2008 (Cutshall 2010). This reduction is attributed to an increase in roadside inspections which helped improve safety and lower mechanical failure rates overall. In a survey given to log truck drivers regarding what they perceive to be the most dangerous part of their jobs, 69% reported "traffic conditions" to be most dangerous aspect of their job (MDOT 2005). A similar study given to log truck drivers in the state of Washington found that 89% of respondents indicated traffic and road conditions to be the most dangerous part of their jobs (Mason et al 2008).

Specifying crash causation is often difficult. Safety experts postulate that a specific "cause" of a crash may not exist, rather that multiple short term and long-term factors contribute to a crash (Knipling 2009). Identifying crash factors is important so that a more complete description of the crash can aid in identification of risk factors. Although there may be multiple reasons for a crash, the LTCCS identified one "critical event" that caused the crash (FMCSA 2007). Both FARS and LTCCS analysis indicate that approximately 75 percent of fatal crashes involving a heavy truck are related to errors of other motorists (Knipling and Bocanegra 2008). "Associated contributing factors" include driver physical factors, driver recognition factors, driver decision factors, driver emotional factors, driver experience factors, relation with carrier or employer, traffic flow, vehicle condition, environment, or a combination these factors (LTCCS 2007). Some of these factors are subjective in nature and are subject to the discretion of the crash investigator. This can be especially difficult in fatal instances, as the fatally injured driver's motives cannot be determined. The complexity of interacting factors at every crash scene renders it difficult to identify a single cause (Knipling 2009).

1.2 Objectives

The literature clearly indicates that additional information and examination of log truck safety are warranted for both safety and economic reasons. Thus, this project examined existing national databases for truck crashes in order to achieve the following objectives:

Objective 1 was to characterize log truck crashes across the United States.

Objective 2 was to estimate the rate of log truck crashes per unit of wood production to facilitate a comparison of the relative frequency of log truck crashes by region.

Objective 3 was to compare log truck crashes to other large trucks in order to assess differences and similarities.

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2.0 LOG TRUCK CRASHES BY U.S. GEOGRAPHIC REGIONS IN YEARS 2011-2015

2.1 Abstract

Log truck crashes have increased across the United States. The reported number of log trucks involved in a fatal crash increased 41% from 2011 to 2015. Although concerning, few studies have characterized these crashes by region. Data was obtained from two federally maintained crash databases: the Fatality Analysis Reporting System and the Motor Carrier Management Information System. An analysis of 383 crashes involving log trucks was performed nationwide and divided into four geographic regions to assess crash characteristics regionally. Log trucks experienced rollover in 78% of fatal crashes. In multiple vehicle crashes another vehicle directly contributed to the crash over half (53.2%) of the time. Crashes vary by day of week and month in different regions. We calculated a rate of crashes using reported crash data and the US Forest Service harvest data for each state. Overall, the US had an average rate of 0.7 fatal log truck crashes per 100 million ft^3 of wood harvested. The southeast region had more total crashes, and the highest rate of log truck crash fatalities with 0.9 fatalities per 100 million ft^3 of wood harvested. Our findings reveal sufficient differences between log trucks crashes by region to justify additional research regarding causation of crashes.

2.2 Introduction

Transportation is an essential component of the forest products industry in the United States. Trucks supply wood fiber and logs to processing facilities. As of 2015 transportation for natural resources and mining contributed approximately 38 billion dollars to the US economy (BLS 2017). Safe and efficient transportation of products from woods to mill is an essential part of the forest product supply chain and is often the most expensive phase of a timber harvesting operation with 40-60 percent of total logging cost going towards trucking (Shaffer 1998). An increase in frequency of log truck crashes could contribute to a rise in insurance premiums, as the rates are determined by perceived risk to the insurance company. Increases in insurance premiums could further increase trucking costs. A recent survey of loggers in Georgia indicated that 25% of loggers experienced a premium increase of at least 50% over a five-year period (Conrad 2017). Premium increases can put financial stress on logging businesses. The American Transportation Research institute estimated that insurance represents just under 8% of the operating costs of specialized trucking (Torrey 2016).

Motor vehicle crashes create a negative fiscal impact on society. In 2014, the total cost of motor vehicle crashes was estimated by the National Highway Traffic Safety Administration (NHSTA) to be $242 billion (Blincoe 2015). In 2014 large trucks accounted for 4 percent of all registered vehicles, but 9 percent of the total vehicle miles traveled (NHTSA 2015). In the same year, large trucks accounted 8 percent of all vehicles involved in fatal crashes and 4 percent of all vehicles involved in injury and property-damage-only crashes (NHTSA 2015). While overall large truck crash rates have steadily declined over the past several decades (Knipling 2009), log trucks are a small sector of this sample that operate in conditions unique from other trucks. Harvests often occur in remote locations and require travel on unpaved roads and rural state roads and change the conditions in which the trucks operate. A survey of logging crews and supervisors indicated that log truck drivers were believed to be at greatest risk, and more likely to suffer a fatality than other crew members (Conway et. al 2016). They also perceived drivers as the biggest liability and most company owners indicated that they contract out trucking to mitigate risk of legal liability (Conway et al.2016).

Assessing log truck crashes separately from other crashes could provide insight into unique characteristics of log truck crashes, and possibly enable creation of industry specific safety training in the future. Previous studies have analyzed crashes involving large trucks (Mcknight 2009, Knipling et al.2008, Braver et al.1996), and the Federal Motor Carrier Safety Administration (FMCSA) has also completed the Large Truck Causation Study which analyzed trends of large truck crashes in the US over a three- year period. None of these studies specifically focus on log hauling vehicles. There have been studies that characterized industry specific injuries on logging jobs in the Southeast (Roberts 2005, Lefort 2003, Shaffer 1998), but none specifically focus on the transportation sector. One study looking at workers compensation claims in the state Louisiana determined that 8% of forest industry crashes are transportation related (Lefort 2003). Additionally, of all injuries in the study the proportion of transportation related injuries had the highest increase compared to other types of injury over a 12-year period (Lefort 2003). In the forest products industry, log truck driving was determined to be the third most frequent job classification cited on worker's compensation claims when an injury occurred (Roberts 2005), with 35% of all injuries occurring while driving on a road (Shaffer 1999). Logging is acknowledged as a dangerous profession. In a 2015 Bureau of Labor Statistics survey, logging workers had the highest fatality rates of any other occupation including miners, fisherman and construction workers (BLS 2016). This is concerning and indicates there is a need to identify factors contributing to high fatality rates.

There have been state specific log truck crash studies in Georgia (Greene et al. 2007) as well as Michigan (MDOT 2005). A study of 96 log truck crashes over a three-year period in the Upper Peninsula of Michigan was completed in 2005. This study indicated that 25% of crashes involved a log truck only, 64.6% involved a log truck and another vehicle, and 10.4% involved a log truck and an animal (MDOT 2005). In this study, log truck involvement appears very similar to the overall heavy truck and bus crash trends in the Upper Peninsula. Of the three fatal crashes present in this data, fault was assigned to the other driver, and no citations were issued to the drivers of log trucks (MDOT 2005). Of the located crashes, 56% were within 150 feet of an intersection. Sixty-nine percent of these crashes occurred on a state highway (MDOT 2005). A study by Lefort et al. (2003) looked at logging injuries in the Louisiana logging industry and made suggestions to mitigate trucking related crashes which included, minimize distance to the mill if possible, implementing defensive driving trainings, and making the public aware of the truck on the road.

A study in Georgia indicated that from 2005-2008 brake failure was a contributing factor in only 4 percent of log hauling vehicle crashes (Greene et al. 2007). Mechanical failures have declined from being the most cited contributing factor to a crash in 1990 to the least cited factor in 2004. Tire failure as a percentage of mechanical failures of log trucks was also reduced from 2.7% to 1.5% of crashes during the same period (Greene et al. 2007). This reduction was attributed to an increase in roadside inspections which helped improve safety and lower mechanical failure rates overall.

These studies are insightful, but no similar studies have been performed on a national scale and such information could provide a basis for improving safety programs in the log trucking industry. Therefore, the objective of our investigation was to characterize crashes that resulted in debilitating vehicle damage, injuries and fatalities in the forest transportation sector.

2.3 Methods

2.3.1 Federal Crash Databases

An assessment of log truck crashes was completed using the two federal crash databases. Fatality Analyses Reporting System (FARS) (https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars), as well as the Motor Carrier Management Information System (MCMIS) (https://www.fmcsa.dot.gov/app/mcmiscatalog/c_chap1). The FARS contains data on crashes in the United States that result in at least one fatality and occur on a roadway generally open to the public. The goal of the database is to identify potential safety problems and potentially suggest solutions. This is a comprehensive dataset, though not all states report crashes into the FARS System. In the US, 41 states report into the FARS system, and 9 states which do not. These states are: Arizona, Pennsylvania, Hawaii, Maryland, Michigan, Nebraska, North Dakota, and South Dakota. States that report in have FARS analysts who obtain documents such as police crash reports, vehicle registration files, driver licensing files, death certificates and medical reports, and enter coded data into the FARS system. The FARS database contains 143 different coded data elements which characterize the crash, vehicle, and people involved. Vehicle configurations (Figure 2.1) as well as characteristics such as the gross vehicle weight rating and cargo body type (Figure 2.2) of all large trucks is recorded during this process. Starting in 2010 “log” cargo body types were recorded as one of the categories, as determined by the investigating officer at the scene. This study analyzed all trucks with “log” cargo body types recorded in the database. In some regions of the US forest products may be hauled in a carrier other than a log trailer. Situations where products are hauled on pole trailers or in chip vans would not be captured by this dataset. Additionally, this dataset will not include trucks moving logging equipment to and from harvesting operations.

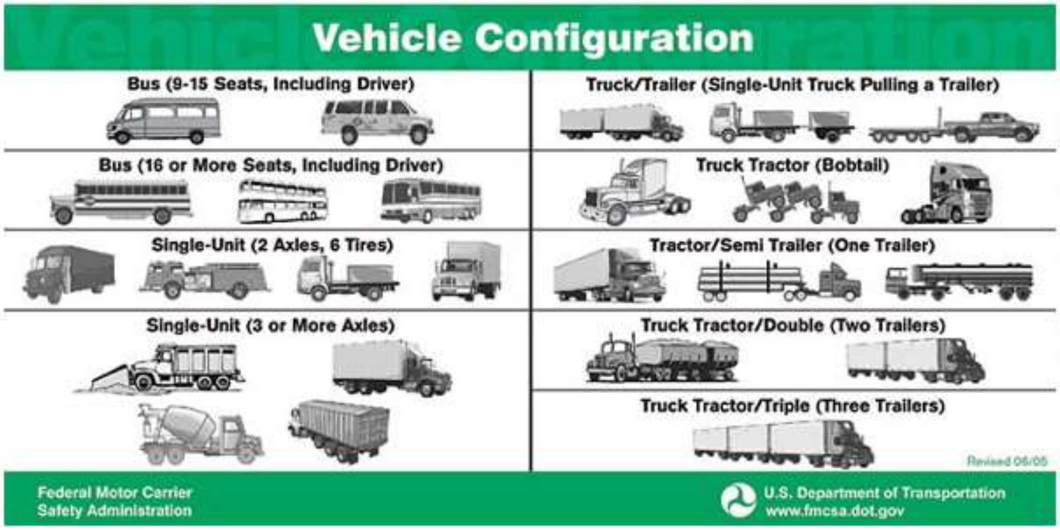


Figure 2.1: Federal Motor Carrier Safety Administration vehicle configuration classifications.

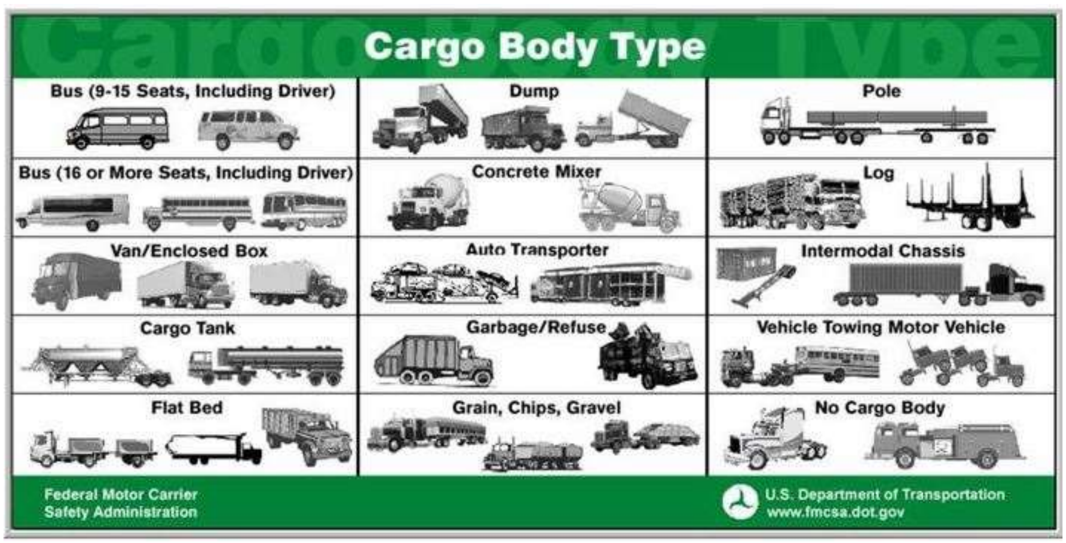


Figure 2.2: Federal Motor Carrier Safety Administration cargo body classifications.

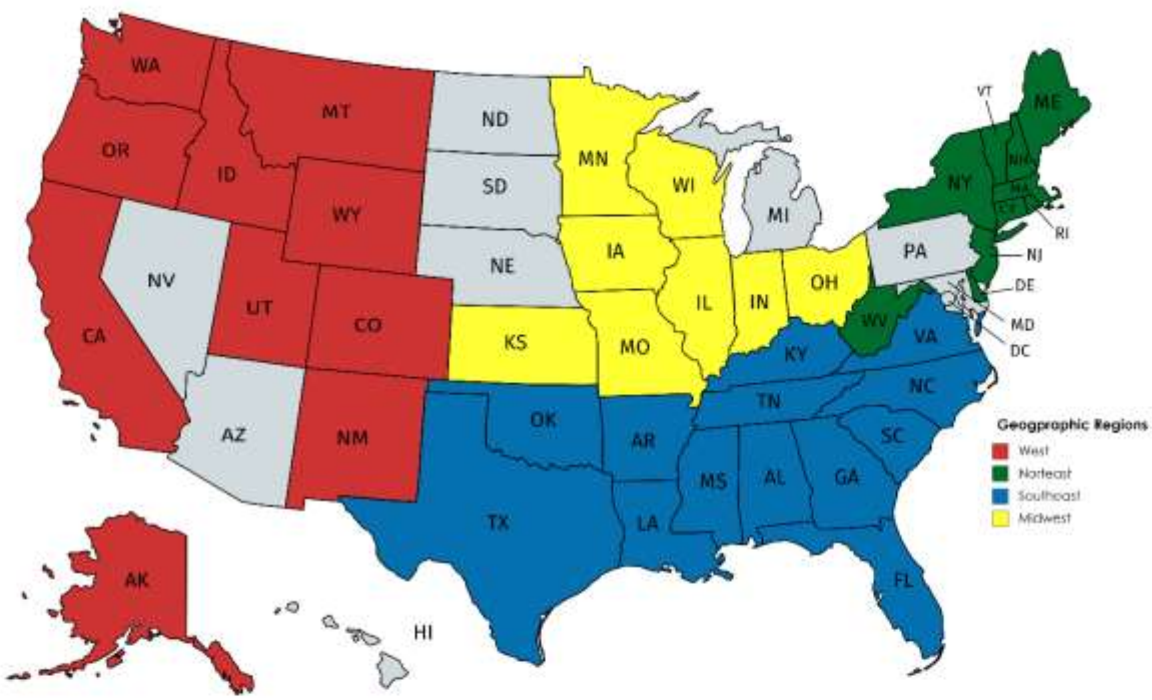
The FARS database has the most detailed crash information, however is limited to the relatively small proportion of all crashes involving fatalities. To evaluate a wider range of crashes, we also utilized another dataset known as the Motor Carrier Management Information System (MCMIS) crash file. The MCMIS crash data is maintained by the Federal Motor Carrier Safety Administration (FMCSA). To be included in the MCMIS crash data, a crash must result in at least one fatality, at least one injury involving immediate medical attention away from the crash scene, or at least one vehicle disabled because of the crash and transported away from the crash scene. Unlike the FARS, the MCMIS database includes only commercial vehicles which are defined as all vehicles with a gross vehicle weight rating of >10,000 pounds, buses, and any vehicles displaying a hazmat placard. This dataset provides less detail than FARS for each individual crash, however it provides information on injury crashes, and property damage crashes, whereas the FARS only reports fatality crashes. Combining the data from these two sources enables a more comprehensive examination of log truck crashes.

2.3.2 Data Compilation and Analysis

Data from FARS and MCMIS data sets were compiled using Microsoft Access$_{tm}$. With a relatively small number of fatal crashes annually involving log trucks, we combined data over a 5-year period. The years 2011 through 2015 were selected as 2015 was the most recent year available for FARS data. To be consistent the same period was chosen for both datasets. Crashes involving log trucks were selected from the larger dataset, the records were transferred to Microsoft Excel$_{tm}$ and JMP (SAS Institute Inc., 2016) for data analysis, where descriptive statistics were performed. Comparisons were made using descriptive statistics, as well as ANOVA for comparison of means, and Tukey’s Least Significant Difference test.

2.3.4 Regional Assessment

Characteristic of log trucks crashes were analyzed nationally and regionally. Four regions were compared: Northeast, Midwest, Southeast and Western regions (Figure 2.3). These regions were chosen in part on differences in physiography, and partially to mimic US Forest Service regions. The Southeast region includes the 13 states in the US Forest service Region 8 (USFS 2017). The Western region encompasses 11 states located in multiple USFS regions, however because of the small sample size of log truck crashes, all states west of Texas were assigned to the Western region. The Northeast region extends from Maine to West Virginia encompassing nine states. The Midwest region, approximately delineated form the Northeast by the Appalachian Mountains, extends from Ohio to Kansas, and encompasses 8 states (Figure 2.3). These four regions will allow for comparison of similarities and differences on a national scale.



States in gray do not report into Fatality Analysis Reporting System

Figure 2.3: States that report into Fatality Analysis Reporting System grouped by geographic region.

2.3.5 Log Truck Crash Rate

The number of crashes is complicated by regional differences in the quantity of log truck traffic. Therefore, we calculated rates of crashes per unit of wood produced so that comparison of regional differences would be more meaningful. The US Forest Service Timber Products Output (TPO) database (USFS TPO 2012) was used to estimate wood harvested for each state. The most recent data available for all states was 2012, so harvest volumes for all states were generated for this year. This volume was compared to the five-year average (2011-2015) of fatality, injury, and tow-away crashes from the FARS and MCMIS databases. Harvest volumes from the USFS TPO were reported in million ft^3. Log truck crash rates were reported as crashes per 100 million ft^3 of wood produced.

2.4 Results and Discussion

2.4.1 Overview

From 2011-2015 there were 389 logs trucks involved in a fatal crash (Table 2.1). There were instances where several log trucks were involved in the same crash, therefore the number of total crashes is 383 during that period. There were two crashes in 2015 that included two log trucks, one crash in 2014 that involved two log trucks, one in 2012 that included two log trucks. In 2013 there was one crash involving three log trucks in total. There were 385 log truck drivers involved in these crashes, in four instances the log truck involved in the fatal crash was unoccupied at the time.

Table 2.1: Number of fatal crashes, log trucks and log truck drivers from 2011-2015 in the United States as reported by the Fatality Analysis Reporting System.

	Crashes	**Trucks**	**Drivers**
2011	66	66	66
2012	70	71	70
2013	82	84	83
2014	72	73	73
2015	93	95	93
Total	383	389	385

Fatal log truck crashes increased by 41% during this period with the majority of log truck crashes involving multiple vehicles and only 17% involving a log truck only. Of these crashes, 70% involved the log truck and one other vehicle, most often a passenger vehicle. Few of the crashes involved more than two vehicles with 12% involving three or more vehicles (Table 2.2).

Table 2.2: Number of vehicles involved in fatal crashes involving log trucks from 2011-2015 in the United States as reported by the Fatality Analysis Reporting System.

Number of vehicles involved in crash	**Count**	**Percent**
1	68	17.8
2	269	70.2
3	34	8.9
4	8	2.1
5	1	0.3
6	1	0.3
7	1	0.3
16	1	0.3
Total	**383**	**100**

Most crashes (91.7%) resulted in one fatality (Table 2.3), though 7% of crashes resulted in two or more fatalities. Fatal crashes involving a log truck most often occurred on state highways (46.1%) followed by US highways approximately 1/3 of the time (Table 2.4).

Interstate roadways accounted for only 3.6 percent of crashes. The infrequency of crashes on Interstate roadways could be a result of weight limits on most interstate routes that are lower than state weight limits and may restrict log trucks from traveling along these roads.

Table 2.3: Number of fatalities in fatal crashes involving log trucks in the United States from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Number. of fatalities	**Count**	**Percent**
1	351	91.7
2	28	7.3
3	4	1.0
Total	**383**	**100**

Table 2.4: Roadway classification where fatal log truck crash occurred in United States from 2011 to 2015 as reported by fatality analysis reporting system.

Roadway	**Count**	**Percent**
State highway	176	46.0
US highway	129	33.7
County road	44	11.5
Interstate	14	3.7
Local street municipality	10	2.6
Other	8	2.1
Local street-township	1	0.3
Unknown	1	0.3
Total	**383**	**100**

In relation to a junction where the crash occurred, 66% of the time the crash was not at a junction or interchange area (Table 2.5). In 23% of cases the crash was at an intersection or was intersection related. This is less than a similar study in Michigan evaluated 96 log truck crashes in the Upper Peninsula and found that 56% of crashes happened within 150 feet of an intersection (MDOT 2005). The same study found that a crash occurred when a vehicle was entering or exiting a driveway in 23% of cases. This is specifically relevant to log trucks as they are frequently entering and exiting rural back roads. In these cases, it would be beneficial for drivers to exhibit greater due diligence when entering and exiting the roadway to ascertain the roadway is clear.

Table 2.5: Relation to junction where fatal crash occurred in United States from 2011 to 2015 as reported by fatality analysis reporting system.

Relation to Junction	**Count**	**Percent**
Non-Junction	252	65.8
Intersection	88	23.0
Driveway access related	30	7.8
Entrance/exit ramp	4	1.0
Railway grade crossing	3	0.8
Crossover related	3	0.8
Through roadway	3	0.8
Total	**383**	**100**

In recorded crashes, the event indicated as causing the most injury to the log truck was another motor vehicle in transport either striking the log truck or being struck by the log truck 63% of the time (Table 2 6). Within the sample 78% of all log trucks in a fatal crash experienced a rollover at some point during the event. A rollover was attributed as the first injury or damage producing the event in 7.2 percent of crashes (Table 2.7).

Table 2.6: The most harmful event for log trucks involved in a crash in the US from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Most Harmful Event	Count	Percent
Motor vehicle in transport (MVIT)	245	63.0
Not reported	71	18.3
Rollover/overturn	31	8.0
Pedestrian	11	2.8
Tree	9	2.3
Fire/ explosion	6	1.5
MVIT set in motion by other MVIT	3	0.8
Cargo loss or shift	3	0.8
Train	3	0.8
Pedal cyclist	2	0.5
Embankment	2	0.5
Immersion	1	0.3
Guardrail	1	0.3
Utility pole	1	0.3
Total	**389**	**100**

Table 2.7: First event that caused injury or harm for crashes involving log trucks in the US from 2011 to 2015 as reported by Fatality Analysis Reporting System.

First Harmful Event	**Count**	**Percent**
Motor Vehicle in Transport(MVIT)	301	78.6
Rollover	27	7.0
Pedestrian	11	2.9
Tree	10	2.6
Ditch	5	1.3
Guardrail	4	1.0
Pedal cycle	3	0.8
Railway vehicle	3	0.8
Embankment	3	0.8
Live animal	3	0.8
Utility pole	2	0.5
MVIT set in motion by another MVIT	2	0.5
Cargo loss	2	0.5
Cargo equipment loss/shift	1	0.5
Cable barrier	1	0.3
Bridge rail	1	0.3
Concrete traffic barrier	1	0.3
Wall	1	0.3
Bridge rail	1	0.3
Guardrail end	1	0.3
Total	**383**	**100**

The most common event occurring immediately before the crash involved another vehicle encroaching into the lane from the opposite direction over the center line, which occurred 29% of the time. Another vehicle in the same lane traveling at a different speed was indicated 9% of the time, and another vehicle encroaching into the path by crossing street was indicated 5.9% of the time (Table 2.8). In 30% of cases the impact occurred an angle, and with 21% of impacts being front-to front (Table 2.9). This is consistent with another study that analyzed two vehicle crashes between large trucks and passenger cars which found that 28.3 percent of crashes occurred head-on (Blower 1998). Overall, almost all critical pre-crash event assignments given by the FARS analysts involve a motor vehicle whether it be a log truck, a passenger vehicle or both.

These critical pre-crash event findings are consistent with both the "First Harmful Event" and the "Most Harmful Event" attributed to the crashes. These two categories are different in the fact that the "First Harmful Event" applies to the crash and the "Most Harmful Event" applies to each individual vehicle. In 63% of cases a moving vehicle was the most harmful event to the crash (the event that caused the most damage), and in 79% of cases it was the most harmful event specific to the log truck. This data helps answer the questions as to what happened and critical pre-crash event points to how it happened. While it is impossible to find an exact cause, as cause is a series of long-term and short-term risk factors interacting simultaneously (Knipling 2009), this data indicates that most fatal crashes involve an interaction with a log truck and at least one other vehicle. In total the critical event was attributed to another vehicle encroaching into the log trucks' lane from some direction 53.2% of the time. While this indicates fault was assigned to someone other than the log truck driver more than half the time, the truck driver is also at fault at times. A study by FMCSA (2007) analyzing large truck crash trends indicated that fault was assigned to the truck driver in 40% of crashes. In the FARS dataset fault was attributed directly to the log trucks in 29.3 % of crashes, which is less than the overall average for large trucks. Human error appears to be a common factor in vehicle crashes. The Large Truck Crash Causation Study found human error to be the largest contributing cause to large truck crashes occurring 89% of time (FMCSA 2007). Very rarely is the event assigned to some factor such as an animal or object in the road.

Table 2.8: Critical event that made fatal crashes imminent for crashes involving log trucks in the United States from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Pre-Crash Event	Count	Percent
Other motor vehicle encroaching into lane from opposite direction over left lane line	113	29.0
Other vehicle in lane traveling in same direction with higher speed	45	11.6
Other vehicle encroaching into lane from crossing street across path	25	6.4
This vehicle traveling off edge of road on right side	24	6.2
This vehicle traveling over the lane line on left side of travel lane	16	4.1
This vehicle traveling off the edge of road on left side	14	3.6
Other cause of control loss	14	3.6
This vehicle crossing through intersection	12	3.1
Other motor vehicle in lane travelling in opposite direction	12	3.1
This vehicle turning left at junction	10	2.6
Other vehicle stopped in lane	10	2.6
Pedestrian in road	10	2.6
Other vehicle encroaching into lane from crossing street, turning into opposite direction	9	2.3
Traveling too fast for conditions	8	2.1
Other motor vehicle encroaching into lane from adjacent lane (same direction) over right lane line	8	2.1
Other vehicle in lane in crossover	7	1.8
Other vehicle in lane traveling in same direction with lower steady speed	6	1.5
Other vehicle in lane traveling in same direction while decelerating	6	1.5
This vehicle traveling over the lane line on the right side of the travel lane	5	1.3
Pedal cyclist in road	4	1.0
Other motor vehicle encroaching into lane from adjacent lane (same direction) over left lane line	3	0.8
Animal in road	3	0.8
Disabling vehicle failure (e.g., wheel fell off)	2	0.5
Unknown cause of control loss	2	0.5
This vehicle turning right at junction	2	0.5
This vehicle travelling in unknown direction	2	0.5
Other motor vehicle encroaching into path from driveway, across path	2	0.5
Other motor vehicle encroaching into lane from driveway, turning into opposite direction	2	0.5
Other motor vehicle encroaching into lane from driveway, intended path unknown	2	0.5
Non- disabling vehicle failure (e.g., hood flew up)	1	0.3
Other cause of control loss	1	0.3
This vehicle ending departure	1	0.3
This vehicle decelerating	1	0.3
Other vehicle in lane traveling in unknown direction	1	0.3
Other vehicle encroaching into lane from opposite direction over right lane line	1	0.3
Other vehicle encroaching into lane from parking lane, median, shoulder, or roadside	1	0.3
Other vehicle encroaching into lane from crossing street, turning into same direction	1	0.3
Other vehicle crossing street, intended path unknown	1	0.3
Encroachment by another vehicle, details unknown	1	0.3
Object in road	1	0.3
Total	**389**	**100**

Table 2.9: Orientation of crash involving log trucks when involved in the “first harmful event” of a fatal crash from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Manner of Crash	Count	Percent
Angle	115	30.0
Front-to-front	82	21.4
Not a crash with motor vehicle in transport	80	20.9
Front-to-rear	65	17.0
Sideswipe-opposite direction	26	6.8
Sideswipe-same direction	9	2.3
Other	6	1.6
Total	**383**	**100**

2.4.2 Driver Related Factors

The FARS analyst uses the police report and any other supporting materials to determine driver-related factors for each crash. This is a factor that may have contributed to the crash, which is then assigned to a driver if a factor is identified. Instructions in the FARS *Coding and Validation Manual* (FARS 2016) are to "code information provided in the narrative by the investigating officer." Items coded here are primarily, but not always, factors that contributed to the crash. A driver related factor was assigned to log truck drivers involved in a crash 21% of time.

Table 2.10: Log truck driver related factors when factor was identified for fatal crashes in United States from 2011to 2015 as reported in “Driver Related Factor” file in Fatality Analysis Reporting System.

Driver Related Factor	**Count**	**Percent**
Failure to keep in proper lane	17	20.7
Careless driving	12	14.6
Failure to yield right of way	9	11.0
Failure to obey traffic signs/ traffic control devices	6	7.3
Driver has record or license from more than one state	6	7.3
Operating without required equipment	4	4.9
Operating vehicle in erratic, careless, reckless or negligent manner	3	3.7
Unknown	3	3.7
Leaving vehicle unattended in engine running	2	2.4
Following improperly	2	2.4
Improper or eccentric lane changing	2	2.4
Starting or backing improperly	2	2.4
Making improper turn	2	2.4
Stopping in roadway	2	2.4
Swerving due to ice, water, snow etc.	2	2.4
Towing for pushing vehicle improperly	1	1.2
Passing where prohibited	1	1.2
Passing with insufficient distance/inadequate visibility	1	1.2
Driving on wrong side of road	1	1.2
Overcorrecting	1	1.2
Driver has not complied with imposed restrictions	1	1.2
Swerving due to tire blow out/flat	1	1.2
Non-traffic violation charged	1	1.2
Total	**82**	**100**

Where driver factors were identified, the most common factors assigned were the failure to keep in the proper lane (21%), careless driving (15%), failure to yield right of way (11%), and failure to obey traffic signs (7%) (Table 2.10).

2.4.3 Single Vehicle Log Truck Crashes

While most of crashes involve more than one vehicle 68 (17%) crashes involved the log truck only. In these instances, it is important to look at what factors may be different compared to multiple vehicle crashes. The most common harmful event for log trucks was rollover occurring 32.4% of the time (Table 2.11). It appears that in single vehicle crashes rollover is a much larger contributor than in multiple vehicle crashes where it is the most harmful event in 8% of cases (Table 2.6). Rollovers appear to be more prevalent for heavy trucks, than for other vehicles. An NHTSA study of fatal crashes compared heavy truck rollover to non-rollovers and saw a 6-fold increased risk of rollover on curves (Moonsinghe et al. 2003). Almost half of truck rollover crashes result from failure to adjust to an adequate speed to keep control around a curve (McKnight 2009). Additionally, the same study indicated that two-thirds of trucks involved in a rollover were tractor-trailers (McKnight 2009). While rollover is a very situation specific risk, awareness of situations that have the highest potential risk of rollover could be included in driver safety trainings to heighten awareness.

Table 2.11: Most harmful event that occurred during crashes that involved a log truck only from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Harmful Event	**Count**	**Percent**
Rollover	22	32.4
Pedestrian	11	16.2
Tree	10	14.7
Ditch	5	7.4
Pedal cycle	3	4.4
Train	3	4.4
Embankment	3	4.4
Animal	2	2.9
Guardrail	2	2.9
Utility pole	2	2.9
Parked motor vehicle	1	1.5
Concrete traffic barrier	1	1.5
Guardrail end	1	1.5
Traffic sign support	1	1.5
Cargo loss/shift	1	1.5
Total	**68**	**100**

2.4.4 Weather and Light Condition

Only a small proportion of crashes occurred during inclement weather or poor visibility. In 74% of fatal crashes, clear weather was reported by the investigating officer. In some instances, rain (5%) and fog (2%) was reported, but this was less common. Similarly, 76% of crashes occurred during daylight hours implying poor visibility was not a contributing factor. In 15 % of cases it was reported as being dark with no lighting, so it is possible in these cases lack of visibility could have contributed. Inclement weather and daylight hours often restrict logging operations, therefore log truck traffic may be less likely to occur during these conditions.

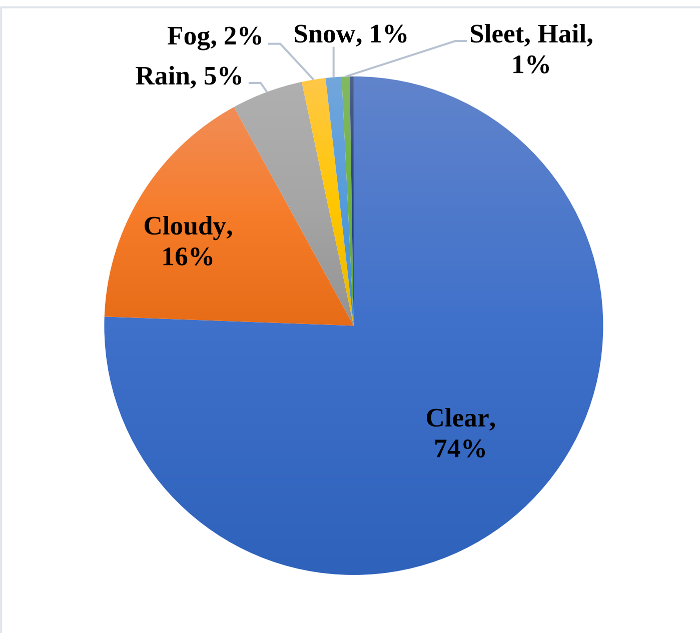


Figure 2.4: Weather condition at time of fatal crash involving log trucks from 2011 to 2015 according to Fatality Analysis Reporting System.

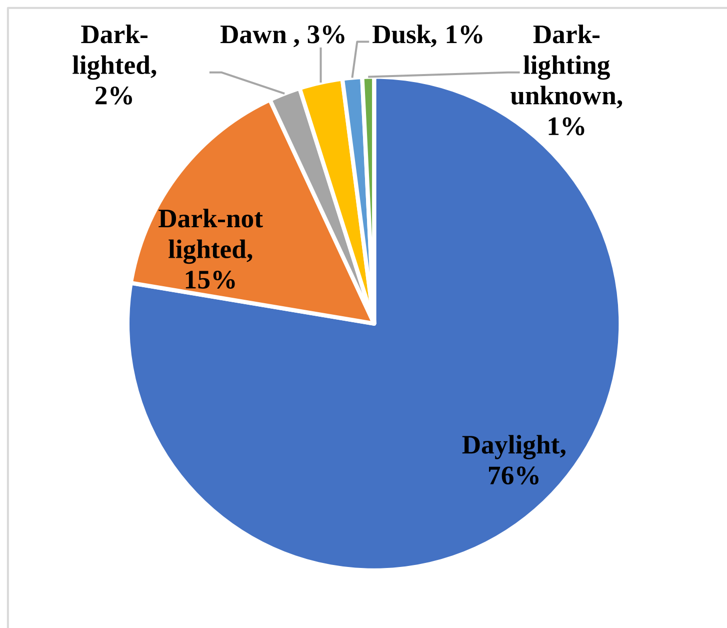


Figure 2.5: Light condition at time of fatal crash involving log trucks from 2011 to 2015 according to Fatality Analysis Reporting System.

2.4.5 Crash Characteristics by Region

An assessment of national crash characteristics is important but differences by region are also important for assessment of crash characteristics. Of the 383 fatal crashes, 297 occurred in the Southeast, 25 in the Northeast Region, 22 in the Midwest, and 39 in the West. All four regions have the lowest number of crashes on Saturdays and Sundays (Figure 2.6). This is to be expected, as not as many trucks would be on the roads on weekends. In the Southeast most crashes occur in the first half of the week, declining on Thursdays and Fridays. This is likely a result of the fact that many of the loggers have met their weekly mill quotas, so there is less wood being delivered during the latter part of the week.

In the Northeast most of the crashes occur on Mondays, with a slight increase again on Fridays. The West also has most crashes occurring on Mondays and Thursdays, with a notable decrease in the middle of the week. This is exactly opposite from the Midwest region, which has most crashes occurring on in the middle of the week on Wednesdays.

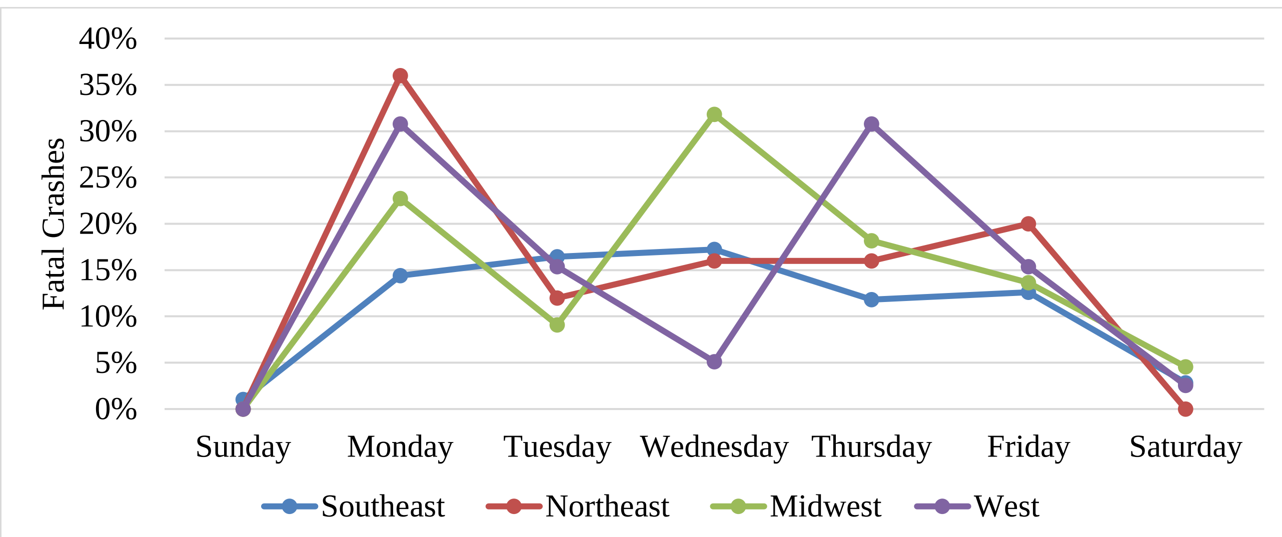


Figure 2.6: Log truck crashes by region and day from week from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Crashes also vary by region regarding the month when most crashes occur. The Southeast has smallest number of crashes in January with consistent increase throughout the year. Most crashes occur in the fall (October-December), which is often a relatively dry time of year and favors logging operations. Trends in the south appear to be different from crash trends in the Northeast region. In this region crashes often occur in the winter months with many crashes occurring in the month of January. Most of the harvesting in this region occurs during the winter months when the ground is frozen which is likely a contributing factor to a larger percentage of crashes in the northeast occurring at the beginning of the year. Most crashes in the West occur in the summer (Jun-August). Crashes in the Midwest have no apparent trend, with an apparent drop in crashes in the months of June-July. In general, it appears that crash frequency tends to follow the harvesting patterns of the different regions.

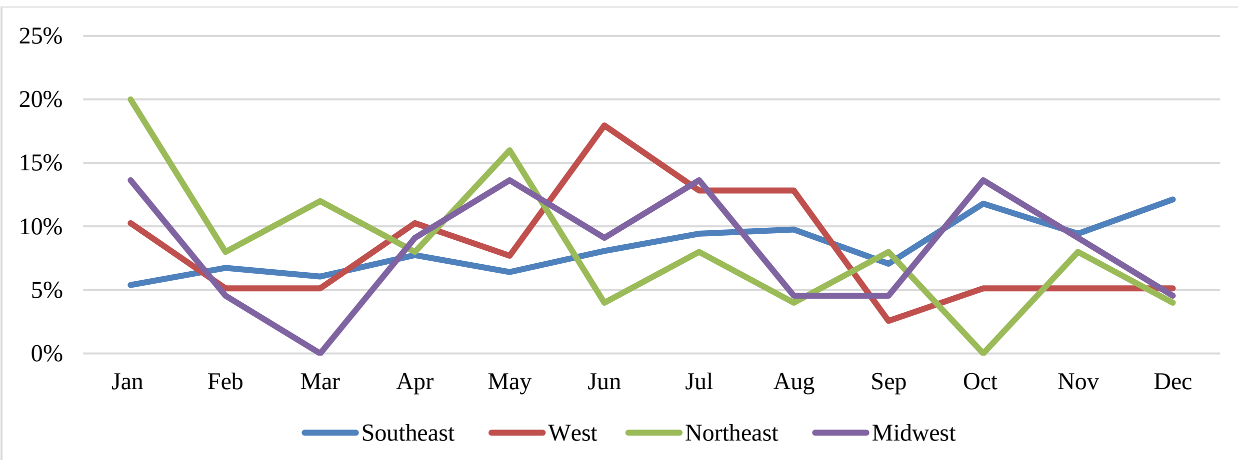


Figure 2.7: Log truck crashes by region and month from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Truck configurations also vary by region. The Northeast and the West are more variable in their truck configurations. In the West 56% of trucks are tractor- trailer, but approximately one third of crashes involve a single-unit truck pulling a trailer (Figure 2.1). The Northeast is also variable and less than half of log trucks involved in a fatal crash were tractor-trailers, with 1/3 being a single-unit truck pulling a trailer, and 15% being a single unit truck. The Northeast and the West appear quite similar and are different from the Southeast where 91%

of crashes involved a tractor-trailer. Overall tractor-trailers appear to be the most common vehicle configuration involved in fatal crashes.

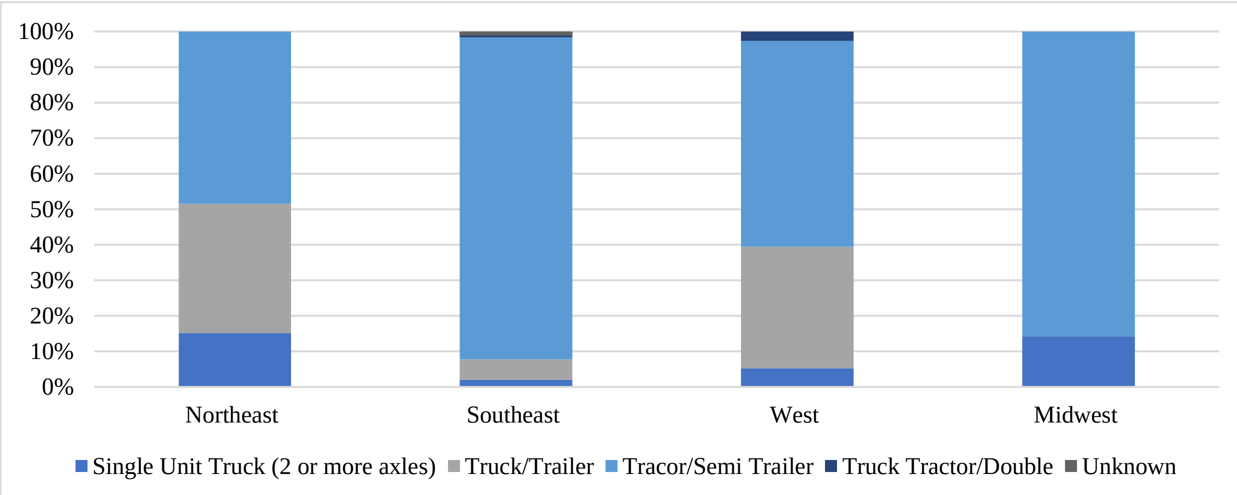


Figure 2.8: Log truck vehicle configuration (see configurations in Figure 2.1) by region from 2011 to 2015 as reported by Fatality Analysis Reporting System.

2.4.6 Log Trucks and Drivers by Region

Two hypotheses were tested using Tukey LSD, comparing difference in truck age by region and driver age by region. Both truck age ($p=.0109$) and driver age ($p=.0269$) were significantly different between regions. The West had the oldest average log truck involved in a fatal crash at 16.4 years old followed by the Northeast at 13.5, the Southeast at 12.6 years, and the Midwest at 11.4. It does not appear that truck age has obvious impacts on crash rates. The West also has the oldest drivers with the average being 53.4 years. These results are similar to a comprehensive log truck study completed in Washington state which found the average driver age to be 55 years old (Mason 2008). The overall average driver age in this study was found to be 48.8 years with a range from 18 to 80. While the western region had the oldest average age, drivers in the other regions were younger than the national average. The average age in the

Southeast was 48.5 years, the Northeast was 46 years, and the Midwest was the youngest at 45.5 years old.

2.4.7 Crash Rate by Region

The Southeast region of the United States is considered the wood basket and harvests the most wood of the 4 regions. While 77 % of the crashes occurred in the Southeast, it is unclear whether that is solely because there is more forestry activity, or whether there are additional factors at play that could contribute to an increasing number of crashes annually. We developed a rate to enable comparison of crashes between regions

Table 2.12: Estimated crash rates by state and region based on 5-year average of reported crashes (2011-2015). Fatal crashes as reported by FARS and injury/towaway crashes as reported by MCMIS. Roundwood volume attained from 2012 USFS TPO. Rate of crashes per 100 million cubic feet of wood produced.**

		Fatality		Injury		Towaway	
	Roundwood produced	Crashes	Rate	Crashes	Rate	Crashes	Rate
AL	8	9.6	1.2	119.4	14.9	226.6	28.2
AR	4.9	6.2	1.3	39	8	91.4	18.7
FL	4.8	3.8	0.8	39	8.2	45.6	9.6
GA	10.5	5.2	0.5	36.8	3.5	56.8	5.4
KY	1.4	0.4	0.3	18.8	13.8	34.8	25.5
LA	6	3.8	0.6	78.8	13.1	94.4	15.7
MS	6.9	7.8	1.1	90	13.1	155.8	22.7
NC	5.9	4.6	0.8	128	21.9	168.2	28.7
OK	0.7	0.6	0.9	4.6	7	12.8	19.3
SC	5.6	7.4	1.3	109	19.3	136	24.1
TN	2.3	2.6	1.2	26.4	11.7	52.2	23.2
TX	4.8	3.2	0.7	13.8	2.9	23.8	5
VA	4	3.8	0.9	0	0	1.2	0.3
Southeast	**65.7**	**59**	**0.9**	**703.6**	**10.7**	**1099.6**	**16.7**
CT	0	0	0	7	0	0.2	7.4
DE	0	0	0	1	27	1.2	32.4
MA	3.6	0.2	0.1	0.4	7.3	1.4	25.5
ME	3.6	2.8	0.8	36.8	10.2	45.8	12.6
NH	0.5	1.6	3.1	4.2	8.2	6.2	12.1
NJ	0	0	0	0.2	18.2	0.2	18.2
RI	0	0	0	0.2	50	1	250
VT	0.5	0.6	1.2	1.2	2.4	2	4
WV	1.9	1.6	0.9	0.2	0.1	36.8	19.7
Northeast	**10.2**	**6.8**	**0.7**	**51.2**	**5**	**94.8**	**9.3**
AK	0.5	0.2	0.4	0	0	0.4	0.8
CA	3.2	1.8	0.6	8.4	2.7	22.8	7.2
CO	0.2	0.4	2.1	0.8	4.3	1.4	7.5
ID	2.5	2.6	1	8.4	3.3	17.2	6.8
MT	1.1	0.6	0.6	2.6	2.4	6.2	5.8
NM	0	0	0	0.8	7.7	1.2	11.5
OR	8.6	1.6	0.2	9	1	21	2.4
UT	0.1	0	0	1.2	16	2.2	29.3
WA	7.1	0.4	0.1	7.8	1.1	41.8	5.9
WY	0.1	1.6	32	0.2	3.7	1.4	25.9
West	**23.4**	**9.2**	**0.4**	**39.2**	**1.7**	**115.6**	**4.9**
IA	0.1	0.2	1.4	0	0	0.6	4.4
IL	0.3	0	0	0.8	2.8	2.8	9.9
IN	0.6	0.8	1.3	7	11.2	13.2	21.1
KS	0	0	0	0.2	11.8	0.2	11.8
MN	2	0.2	0.1	1.2	0.6	3	1.5
MO	1	0.2	0.2	6	5.9	13.4	13.2
OH	0.8	0	0	9	11	14.6	18.2
WI	2.9	1	0.3	0.2	0.1	0.8	0.3
Midwest	**7.8**	**2.4**	**0.3**	**3.2**	**3.3**	**6.8**	**7**
USA	**107**	**77.4**	**0.7**	**818.4**	**7.6**	**1358.6**	**12.7**

*** Data attained from NHTSA's MCMIS may not include full reporting of injury and towaway crashes from some states.*

According to the available data, the US had an overall five-year average of 77.4 fatalities involving a log truck, 818 injuries and 1359 towaway crashes. The national rate of log truck crashes per 100 million cubic feet of wood produced is 0.7 fatalities, 7.6 injuries, and 12.9 towaway crashes. The estimated rates allow for comparison of individual states to the national average and to make comparisons by region.

The Southeast had on average 59 fatalities, 704 injuries and 1099 crashes resulting in a towaway per year which is substantially higher than the other regions (Table 2.12). The Southeast region also had the highest rate with an average of 0.9 crashes per 100 million $ft^3$of roundwood production. This is higher than the national average of 0.7 fatal crashes per unit of wood produced. The Northeast had the same rate as the national average with 0.7 fatal crashes per 100 million ft^3 of wood produced. The three states with the highest average number of fatalities are all located in the Southeast. These states are: Alabama with a yearly average of 8.8 fatalities, Mississippi with 7.8 and South Carolina with 7.4. The states in the Southeast with the highest overall rate of 1.3 fatalities per 100 million cubic feet of wood produced was Arkansas and South Carolina. The state with the lowest rate is Kentucky which only had an average of 0.3 fatalities per unit of wood produced. They also produced the least amount of wood (1.4 Million ft^3) of all the states in the Southeast in the year 2012.

The Midwest and the Western region have relatively low rates of fatalities with 0.3 (Midwest) and 0.4 (West) per 100 million cubic feet of wood produced. These are both lower than the national average of 0.7. The West has the second highest roundwood production, but the second lowest crash rate. The Southeast region produced the most roundwood but also has the highest crash rate of 0.9 fatal crashes per 100 million ft^3 harvested. This implies that total wood harvested alone is not an index of the amount of crashes that will occur, but there are other factors at play. The age of vehicles does not appear to influence crash rates. For example, even though the Western region has the oldest vehicles, it has the second lowest crash rate. Comparing the different operating conditions and safety procedures by region could help shed light on why the crash rates vary by region, and what can be done to reduce crash rates in the future. The factors contributing to log truck crashes are complicated. The FARS and the MCMIS provide a comprehensive dataset, however there are some shortcomings of this data. A large section of the fiber transportation sector is comprised of chip vans that haul pre-chipped fiber to mills. The configuration of chips vans made it impossible to separate out in the federal datasets, so this study focused on log trucks. Additionally, the dataset only records data on roads open to the public. This may not capture crashes that occurred on landings or private gravel roads where many harvesting operations occur. To fill these gaps, a separate study could focus on gathering crash data/claims data directly from insurance companies. This could allow for comparison with the federal datasets and help determine proportion of all crashes occurring in the logging industry that are captured in the publicly available datasets.

2.5 Conclusions

This study uniquely analyzes log hauling vehicle crashes on a nationwide scale and compared crashes across geographic regions. Transportation of fiber from the woods to the mill is an essential part of the forestry supply chain, and this study has shown that the number log truck crashes are increasing. Our study indicates that the biggest threat to log trucks on the road is another vehicle traveling into their path, most often (29%) from the opposite direction across the center line. While most of the drivers (79%) in this study were not assigned a factor indicating fault, when a factor was assigned the most common factor assigned was failure to keep in the proper lane (20.7%), followed by careless driving (14.7%). According to Blower

(1998), during a fatal crash between a car and large truck, the car driver's behavior was more than three times as likely to contribute to the fatal crash than was the truck driver's behavior. In addition, the car driver was solely responsible for 70 percent of the fatal crashes, compared to 16 percent for the truck driver (Blower 1998). In these crashes the truck driver survived 98% of the time, while the passenger vehicle driver was killed 83% of the time (Blower 1998). An increase in log truck crashes is dangerous for all vehicles on the road. Education of the public on their own safety around large trucks could also help increase overall awareness of log trucks.

This study also showed that the crash rate varies by region. The national average is 0.7 crashes per 100 million ft^3 of wood produced. The Southeast had the highest rate with .9 and the Midwest region had the lowest with 0.3. It is unknown why these rates are different. Future research is needed to continue to explore why these rates vary by both state and geographic region.

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3.0 A COMPARISON OF FATAL LOG TRUCK CRASHES TO OTHER LARGE TRUCK CRASHES FROM 2011-2015

3.1 Abstract

Log trucks are a critical component of the forest products supply chain in the United States. The ability to identify factors that contribute to log truck crashes could help inform future research and safety trainings. Comparison of fatal tractor-trailer crashes were made between different truck cargo body types over a 5-year period (2011-2015). A dataset of fatal log truck crashes was attained from the Fatality Analysis Reporting System (FARS). Overall, fatal log truck crashes appear to follow similar trends to other heavy trucks. Both logging tractor-trailer and other tractor-trailer crashes increased over a five-year period. Large truck crashes increased 16% while log truck crashes increased more than 33%. Log trucks are the oldest vehicles involved in fatal crashes, with an average age of 13.0 years, which was significantly higher (*p<.0001*) than the overall average for all trucks of 7.6 years. During a fatal crash log trucks experienced a rollover 21% of the time, which is significantly higher (*p<.0001*) than the overall average of 12% rollovers for other large trucks. Our findings reveal sufficient differences between log trucks and other log truck to justify additional research regarding causation of crashes.

3.2 Introduction

Transportation of commodities by truck is a crucial component to the supply chain throughout the United States and contributes greatly to the economy. In 2016, truck transportation made the largest transportation contribution to Gross Domestic Product (GDP), contributing approximately 180 billion dollars to the economy (BTS 2016). Motor vehicle crashes cause human deaths and injuries and create a huge fiscal impact on society. Thus, motor vehicle crashes involving truck transportation are important considerations. In 2014, the total cost of motor vehicle crashes was estimated by the National Highway Traffic Safety

Administration to be $242 billion (Blincoe 2015). In the same year, large trucks accounted for 4 percent of all registered vehicles, but nine percent of the total vehicle miles traveled (NHTSA 2015). This higher mileage exposure that trucks encounter elevates the risk of potential crashes while in transport. This risk of a crash not only effects the cost of transportation, but also puts the lives of all drivers on the road at risk. Large truck crash studies can help identify factors attributed to crashes and suggest ways to decrease instances in the future.

Based on NHTSA guidelines, large trucks are vehicles with weights greater than 10,000 pounds (NHTSA 2015). Little research has focused on characteristics of specific types of large trucks, and how different cargo types may affect the driver's interaction with the surrounding environment, as well as other drivers. Comparing crash characteristics of different cargo body types could allow managers to identify industry specific issues and direct safety trainings accordingly. This study specifically assessed the log transportation sector, which is unique because log trucks often encounter different conditions than other types of trucks based upon their operating environment. Therefore, crash characteristics may be different than other cargo body types.

Previous studies have analyzed heavy truck crash trends (McKnight 2009, Knipling et al. 2008, Braver et al. 1996). The most prominent of these studies is the Large Truck Crash Causation Study (LTCCS) (FMCSA 2007) undertaken by the Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA). The LTCCS is based on a national sample of injury and fatal crashes involving large trucks that occurred over approximately a two-year period from 2001 to 2003. The data collected provide a description of the physical events of each crash, with additional details about all the vehicles and drivers, as well as weather and road conditions, to provide a comprehensive description of each crash (FMCSA 2007).

The LTCCS determined that a crash with another vehicle in motion is the most frequent first harmful event for large truck crashes. Crashes with parked vehicles and persons outside the vehicle were relatively infrequent. The most prevalent non-crash harmful event for trucks was rollover (FMCSA 2007). Of the 166 large trucks assessed in the study, 108 were determined to be tractor-trailers, tractors hauling multiple trailers, and bobtail trucks. Cargo body type was also recorded, and it was determined that dump trucks and enclosed vans were involved in the most crashes during the study period. A vehicle hauling logs or poles was cited in 2 incidents (FMCSA 2007).

The raw forest products transportation sector is unique from many other sectors of the transportation industry. Trucks transporting logs most likely spend more time in rural areas and often operate on gravel or woods roads built to a lower standard, which could result in more wear and tear on vehicles. Trucking represents a substantial cost to timber harvesting operations and truck drivers were the third most frequent job classification cited on worker's compensation claims when an injury occurred on a logging job (Roberts 2005). While heavy truck crash rates have steadily declined over the past several decades (Knipling 2009), there is limited data on whether log trucks follow the trends of other large trucks. Forest industry professionals have expressed concern about an increase in log truck crashes over time, as well as increased insurance rates. A study of log trucking crashes in Georgia indicated that crashes have increased 24% from 2012 to 2016, and liability insurance premiums have increased 50% since 2012 (Conrad 2017). If premiums continue to rise, increased financial strain could inhibit the vitality of the transportation sector, which could ultimately affect the whole forest products supply chain.

Although, little research regarding log trucks has been conducted, some state specific studies exist. A study of 96 log truck crashes over a three-year period in the Upper Peninsula of Michigan was completed in 2005 and indicated that 25% of crashes involved a log truck only, 64.6% involved a log truck and another vehicle, and 10.4% involved a log truck and an animal (MDOT 2005). Overall log truck involvement appears very similar to the overall heavy truck and bus crash trends within the Upper Peninsula. There were three fatal crashes present in the data, where fault was assigned to the other driver all three times, with no citations were issued to the drivers of log trucks (MDOT 2005).

A study in Georgia indicated that from 2005-2008 brake failure was a contributing factor in only 4 percent of log truck crashes (Greene et al. 2007). Overall, mechanical failures have declined from being the most cited contributing factor to a crash in 1990 to the least cited factor in 2004. This decrease was thought to be a result of an increase in random roadside inspections in the state.

Log truck transportation is a crucial element of the wood products industry, yet log truck accidents are increasing. Such increases can have negative effects on society and the wood supply chain. Thus, it would be beneficial to examine the crashes to determine potential causes and solutions for crashes. The objective of this study was to compare cargo body types independently, specifically trucks hauling logs, to see how they compare to other trucks on the road.

3.3 Methods

3.3.1 Federal Crash Data: Fatality Analysis Reporting System

To assess and compare log truck crashes to other heavy truck crashes, a federal database known as the Fatality Analysis Reporting System (FARS) was utilized. This database is maintained by the Federal Motor Carrier Safety Administration (https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars) and contains publicly available data on all crashes resulting in a fatality within the United States that occur on roadways generally open to the public. States provide information on fatal crashes, and reports into the national FARS database. Each state has FARS analysts who obtains documents such as police crash reports, vehicle registration files, driver licensing files, death certificates and medical reports which are then coded into the FARS system. The FARS database contains 143 different coded data elements which characterize the crash, vehicle, and people involved. Vehicle configurations as well as characteristics such as the gross vehicle weight rating (GVWR), and cargo body type of all large trucks is recorded during this process.

3.3.2 Data Compilation and Analysis

This study compared all heavy trucks in the FARS database with a GVWR (Gross Vehicle Weight Rating) of greater than 26,000 pounds. Vehicles with this rating are assigned both a vehicle configuration (Figure 3.1), and a cargo body type (Figure 3.2). Cargo body types were compared using descriptive statistics, as well as ANOVA and Tukey's Honest Significant Difference (HSD) test, and a Chi Square Goodness of Fit test. A Levine normality test determined that the data were not normally distributed so, non-parametric tests were required. Since driver age and vehicle age is numerical and cargo body type is categorical, a one-way ANOVA was tested. Tukey's HSD compares all potential pairs to find out which specific groups means are significantly different. In the FARS dataset 15 different cargo body types (Figure 3.2) were compared to identify differences in vehicle age and driver age by cargo body type. To compare categorical data a Chi-Square goodness of fit test was used to compare rollover occurrences between cargo body types. Both tests were completed using α=0.05.

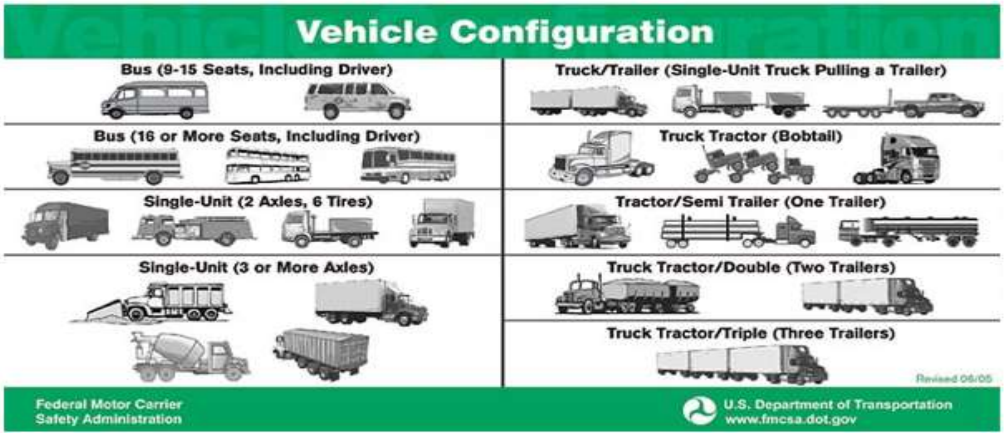

Figure 3.1: Federal Motor Carrier Safety Administration vehicle configuration classifications.

3.3.3 Comparison of Log Truck Tractor-Trailer to Other Tractor-Trailers

Comparing trucks that are similar in physical structure will allow for a better comparison between the different truck types. Greene et al (2007) indicated that the majority of log hauling vehicles on the road in Georgia were configured to be tractor-trailer or semi-trailer. Additionally, truck tractors pulling semi-trailers accounted for 70% of large trucks involved in fatal crashes in 2006 (Knipling 2009). As a result, all tractor trailer crashes were queried from the FARS dataset for comparison. A cargo body type was assigned by the FARS analyst, based upon the structure of the vehicle as well as its apparent use as determined by the investigating officer. While all trucks analyzed in this study are tractor-trailers, they may be referenced as “log trucks” or “log hauling vehicles” during this study.

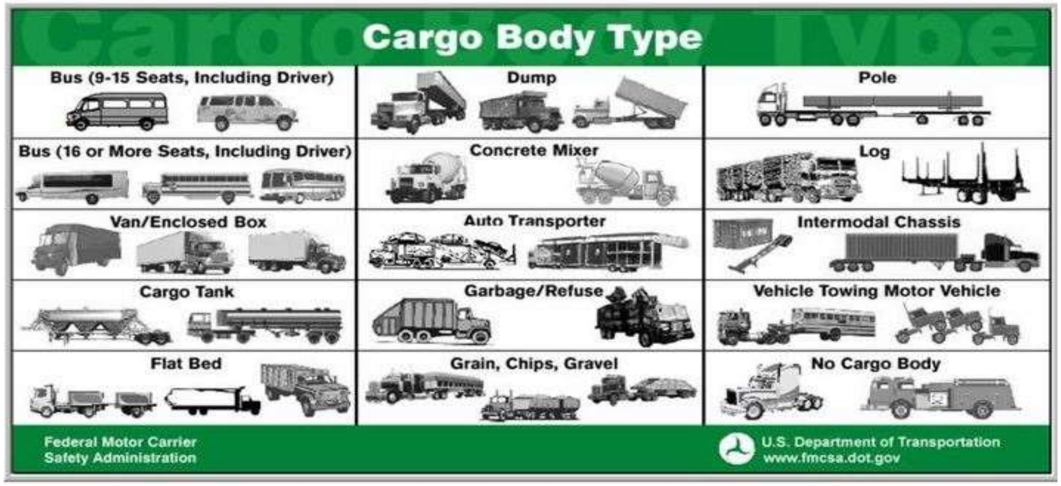

Figure 3.2: Federal Motor Carrier Safety Administration cargo body classifications.

3.4 Results and Discussion

3.4.1 Comparison of Crash Rates Between Truck Types

During the study period from 2011-2015 there were a total of 389 log trucks involved in a fatal crash. Of the 389 log trucks in the dataset 326 (84%) were indicated as tractor-trailer configuration. These 326 logging tractor-trailers represent 2.7 percent of the 9597 tractor-trailers involved in a fatal crash over the same period. These results are similar to a study completed by FMCSA which indicated that log trucks represent 2% of all large trucks involved in fatal crashes in the year 2014 (FMCSA 2016).

Both logging tractor-trailer and other tractor-trailer crashes have increased over a five-year period (Figure 3.3). Large truck crashes overall had an increase of 16% with 2219 crashes in 2011 increasing to 2469 in 2015. During the same period log truck crashes increased from 59 fatal crashes in 2011 to 79 crashes in 2015 resulting in an increase of more than 33%. Log trucks appear to follow the national trend of increased heavy truck crashes but are increasing at a higher rate. It is unclear as to why these truck crashes are increasing.

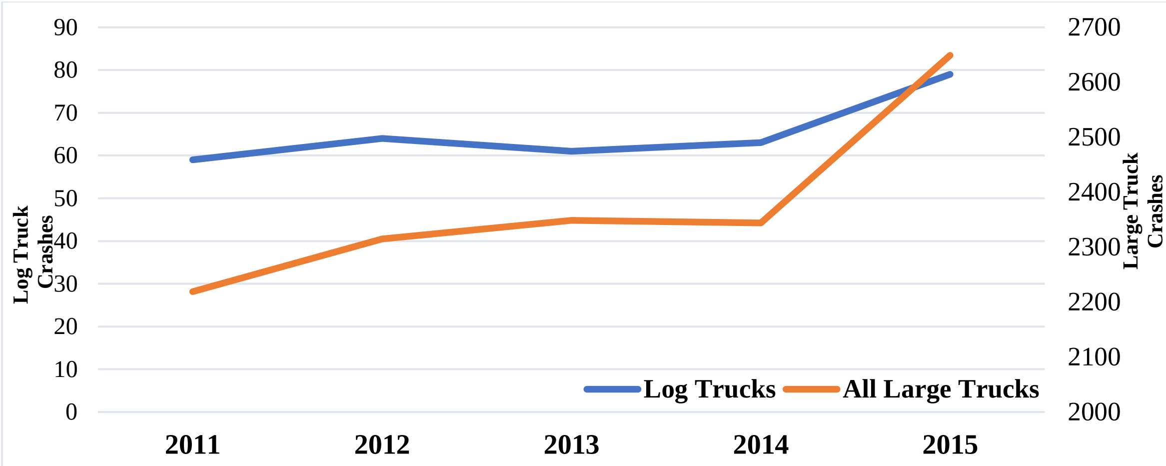

Figure 3.3: Fatal log tractor-trailer crashes (left axis) and other tractor trailer-crashes (right axis) in the United States from 2011-2015 as reported by Fatality Analysis Reporting System.

3.4.2 Truck Age by Cargo Body Type

Log trucks are the oldest vehicles involved in fatal crashes (Table 3.1), with an average age of 13 years, compared to the overall average for all trucks of 7.6 years. The difference in age is significant between log trucks and all other truck types except for pole-trailers and concrete mixers (Table 3.1). Overall vehicle age is significant between cargo body types *(p<.0001)*. Milauskas and Wang (2006) found average age for log trucks in West Virginia to be 8.8 years old. In Georgia in the 1990's the average age of log trucks involved in crashes was 10 years old (Greene et al. 1996), indicating that the average age today is older than it has been previously.

Table 3.1: Average age of vehicle involved in fatal crashes by cargo body type (2011-2015) as reported by Fatality Analysis Reporting System.

Cargo Body Type								Mean Age
Log	A							13.0
Dump truck		B						11.5
Pole-trailer	A	B	C	D				11.0
Grains, chips, gravel		B		D				10.4
Flat bed			C		E			9.1
Garbage truck		B	C	D	E	F	G	9.0
Other			C		E			8.3
Intermodal container chassis			C		E	F		8.1
Auto transporter					E	F	G	7.5
Not reported			C	D	E	F	G	7.2
Van/ enclosed box						F	G	6.4
Cargo tank							G	6.3
Concrete mixer	A	B	C	D	E	F	G	5.5

3.4.3 Driver Age by Vehicle Cargo Body Type

Drivers of the log trucks are slightly older than other truck drivers. However, truck drivers are not the oldest drivers on the road which is reserved for pole trailers followed by grain, chip, and gravel trucks. The five-year average age of log truck drivers is 48.7 years old. Mason (2008) found the average log truck driver age to be 55 years in the state of Washington. Log truck driver age is not significantly different from other cargo body types except for cargo tanks (Table 3.2).

Table 3.2: Average age of driver involved in a fatal crash by cargo body type (2011-2015) as reported by Fatality Analysis Reporting System.

Cargo Body Type			Mean Age
Pole-trailer	A	B	50.2
Grains, chips, gravel	A		48.8
Log	A	B	48.7
Not reported	A	B	47.3
Dump truck	A	B	47.3
Van/enclosed box	A	B	46.7
Other	A	B	46.5
Flat bed	A	B	46.3
Intermodal container chassis	A	B	46.1
Cargo tank		B	45.8
Auto transporter	A	B	45.6
Garbage truck	A	B	45.2
Concrete mixer	A	B	38.7

It is also worth noting that among the grain, chip and gravel category, some of these trucks may be hauling forest products, as many logs are chipped on site and the chips then hauled to a mill. This is also possible for pole trailers as an empty log truck could easily be mistaken for a pole trailer by investigating officers. While it was not possible to analyze chip trucks separately or determine if any pole trailers hauled logs, the ability to incorporate those could skew the average age drivers in the logging industry slightly older.

3.4.4 Rollovers

Rollovers account for only 10% of large truck crashes (McKnight 2009), yet it is important to investigate whether log trucks have similar rollover rates. The weight distribution of log trucks can be different than other cargo body types which could potentially result in a different rate of rollover crashes. Additionally, log trucks often operate in more rural areas which could put them on smaller state highways or backroads which can be more difficult to maneuver.

Table 3.3: Rollover occurrences of large trucks during fatal crashes by cargo body type (2011 to 2015) as reported by Fatality Analysis Reporting System.

Truck Type	**Rollovers**	**Total Trucks**	**Percent**
Cargo tank	267	1172	23
Log truck	68	326	21
Garbage truck	8	44	18
Pole-trailer	8	46	17
Grains, chips. gravel	67	449	15
Dump truck	72	486	15
Intermodal container chassis	13	110	12
Flat bed	136	1159	12
Not reported	4	35	11
Van/ enclosed box	469	5048	9
Other	52	625	8
Auto transporter	2	93	2
Concrete mixer	0	4	0
Total	**1166**	**9597**	**12**

For all large trucks, on average a rollover occurred in 12% of crashes. Log trucks specifically had a much higher proportion of rollovers during fatal crashes (21%). This is nearly twice the overall average and is a significantly higher ($p<.0001$) rate of rollovers than other cargo body types. McKnight and Bahouth (2009) found that most rollovers are a result of human error, including excessive speed, speed in curves, or misjudging the appropriate speed. An NHTSA study of fatal crashes compared large truck rollover to non-rollovers and found a 6-fold increased risk of rollover on curves (Moonsinghe et al. 2003).

3.4.5 Comparison of Crash Characteristics

The amount of damage sustained appears similar between log trucks and other trucks. Most of the damages were rated as disabling, with a smaller percentage receiving some functional or minor damage (Figure 3.4).

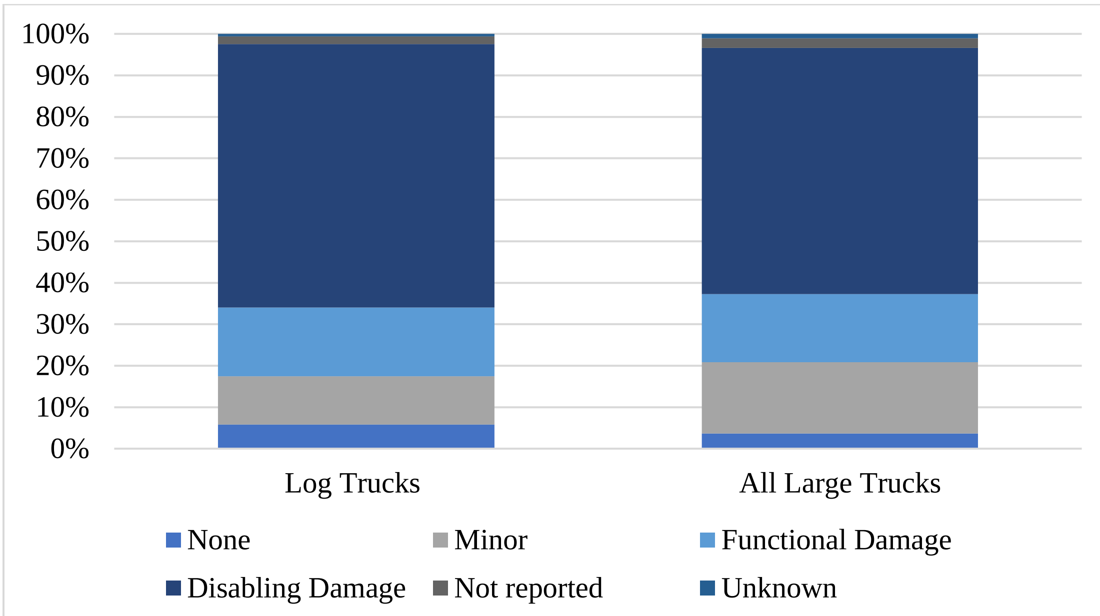

Figure 3.4: Amount of damage sustained during fatal crash for log trucks compared to others from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Overall, large trucks had a slightly more crashes resulting in only minor damage, but generally log trucks appear to follow the same trends as other truck types on the road. Even though log truck crashes have been shown to be increasing at higher rate, there does not appear to be significantly more disabling damage during the crashes. Most large truck crashes involve at least two vehicles (Knipling 2009). This appears to be true for all large trucks, including log trucks. Table 3.4 indicates that almost all crashes involved more than one vehicle with a relatively minor proportion (16%) of crashes involving the truck only. Multiple vehicle crashes are dangerous for the passenger vehicles and the truck drivers. In a study of fatal crashes between heavy trucks and passenger cars the truck driver survived 98% of the time, while the passenger vehicle driver survived 17% of the time (Blower 1998). While the same study indicated that passenger vehicle drivers contribute disproportionately to fatal truck-passenger vehicle crashes (Blower 1998), these crashes put everyone at risk. An increase in distracted driving resulting from in-vehicle cell phone use, could be contributing to this increase. The NHTSA acknowledges a safety threat from distracted driving practices. In 2015 it was reported that 10 % of all fatal crashes were affected by distracted driving, with 3,477 people killed (National Center for Statistics and Analysis 2015). This added threat is important for truck drivers to acknowledge as it not only affects their personal safety and the safety of others, but the risk of financial impacts associated with crashes.

Table 3.4: Proportion of log trucks compared to other large trucks in single vehicle vs. multiple vehicle crashes (2011-2015) as reported by the Fatality Analysis Reporting System.

Crash Type	**Log Trucks**	**Other Large Trucks**
Multiple Vehicle	82.5%	84.0%
Single Vehicle	17.5%	16.0%

By examining the event that occurred during the moments before the crash, insight into why the crash may have happened can be derived. Pinpointing a single cause for a crash is almost impossible as crashes are a series of long-term and short-term risk factors working together, in a unique scenario (Knipling 2009). However, examining the pre-crash events provide a timeline leading up to the point of the crash. To see if risk factors are shared a comparison was made between log truck and other trucks looking at the most common critical events.

Table 3.5: Comparison of critical event that made the crash imminent, between log trucks and all trucks in the United States from 2011 to 2015 as reported by Fatality Analysis Reporting System.

Critical Pre-Crash Event	**Percent of all Large Trucks**	**Percent of Log Trucks**
Other motor vehicle encroaching into lane from opposite direction over left lane line	20.5	29.1
Other vehicle in lane traveling in same direction with higher speed	13.1	12.6
Other vehicle encroaching into lane from crossing street across path	7.4	6.1
Pedestrian in road	5.3	3.1
Other vehicle stopped in lane	4.9	2.1
This vehicle traveling off edge of road on right side	4.5	6.2
Other motor vehicle encroaching into lane from adjacent lane (same direction) over left lane line	3.7	2.1
Other motor vehicle in lane travelling in opposite direction	3.4	3.7
Other vehicle in lane traveling in same direction with lower steady speed	3.2	1.8
This vehicle crossing through intersection	2.9	2.8
This vehicle traveling off the edge of road on left side	2.9	3.4
Other motor vehicle encroaching into lane from adjacent lane (same direction) over right lane line	2.9	2.1
This vehicle turning left at junction	2.8	3.1
This vehicle traveling over the lane line on left side of travel lane	2.5	3.7
Other vehicle in lane traveling in same direction while decelerating	2.0	0.0
Other vehicle encroaching into lane from parking lane, median, shoulder, or roadside	1.7	1.2
Traveling too fast for conditions	1.7	1.5
Other vehicle encroaching into lane from crossing street, turning into opposite direction	1.4	2.1
This vehicle traveling over the lane line on the right side of the travel lane	1.1	1.5
Pedal cyclist in Road	1.0	0.6
Other	11.8	11.7

For all tractor-trailers the most common pre-crash event occurs when another vehicle travels into the trucks' lane from the opposite direction over the left lane line. However, it does appear to be more prevalent for log trucks, occurring almost one third of the time, compared to others where it occurs in approximately one-fifth of cases. A possible explanation for this could be that log trucks travel more on rural backroads as opposed to Interstate highways, or other divided highways where traffic is only traveling one direction. This increases log trucks' risk of head on crashes with passenger vehicles in the opposite lane. Additionally, log trucks have higher occurrences of running off the road (9.6 %) compared to other tractor-trailers (7.9%). Other notable differences include a higher prevalence of pedestrians in the roadway for heavy trucks (5.3%) compared to log trucks (3.1%). A lower amount of pedestrian related crashes could be explained by the fact that log trucks typically operate in more rural areas with fewer pedestrians.

3.5 Conclusions

In this work we sought to highlight differences between log trucks and other large truck cargo types on the road to provide insight into factors affecting forest products transportation. Tractor-trailer crashes were compared over a 5-year period (2011-2015) by cargo body type. Overall, fatal log truck crashes follow similar trends to other heavy trucks on the road, but the increase over a five-year period was greater for log trucks (33%) versus large trucks (16%). The greater increase in fatal crashes for log trucks could possibly be attributed to differences in vehicle age, operating conditions, or cargo characteristics. Log trucks are the oldest cargo body type with an average age of 13 years compared to an average of less than 7.6 years for all large trucks. Older trucks suggest that general machine conditions could be less than optimal, especially for log trucks that routinely operate in more adverse road conditions and may not be equipped with the latest safety features.

This study also found that log trucks have a higher occurrence of rollovers during fatal crashes than other cargo body types. This could be attributed to differences in weight distribution or center of gravity for loaded log trucks compared to other trucks. Additionally, rural backroads where forest harvesting often take place can be narrow and harder to navigate. Moonsinghe et al. (2003) completed a study of fatal crashes and compared heavy truck rollover to non-rollovers and saw a 6-fold increased risk of rollover on curves (Moonesinghe et al. 2003). McKnight (2009) determined half of truck rollover crashes result from failure to adjust to an adequate speed to keep control around a curve (McKnight 2009). More research is needed to determine why logging truck have more rollover occurrences but it is possible that a failure to keep control around curves on rural roads where log trucks often navigate may contribute to these crashes.

Research has shown that most truck crashes involve multiples vehicles (Knipling 2009). Literature also indicates that fault is more likely to be attributed to car drivers than to truck drivers in fatal crashes. Blower (1998) found that fault tends to fall to the passenger vehicle more often than the truck in two-car crashes (Blower 1998). Our results show that another vehicle crossing the center line into the opposite lane is the most common factor contributing to a crash for both large trucks (20.5%) and log trucks (29.1%). Stutser et al determined that the most common unsafe driving act in the vicinity of large trucks is "driving inattentively" which includes talking on cell phones while driving, reading, and fatigue. Training which focuses on increased awareness through defensive driving for both truck drivers and the general public could potentially improve safety and help to reduce crashes in the future.

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4.0 Summary and Conclusions

The goal of this study was to provide insight into crashes involving log trucks. Log truck crashes have increased across the United States, which can increase the challenges associated with efficient and affordable production of forest products. The reported number of log trucks involved in a fatal crash has increased 41% from 2011 to 2015. When comparing logging tractor-trailers to all tractor trailers involved in fatal crashes, logging vehicles saw an increase of 33% compared to 16%. These are concerning statistics, and little has been reported about the characteristics of these crashes. An analysis of 383 crashes involving log trucks was performed nationwide and divided into four geographic regions to assess crash characteristics and compare them regionally. Data was obtained from two federally maintained crash databases, the Fatality Analysis Reporting System and the Motor Carrier Management Information System and analyzed to identify distinguishing crash characteristics.

This study determined that log trucks experienced a rollover (21% of the time) more often than other truck types (12% overall). It was also determined that cargo body type is statistically significant when determining rollover over occurrence. While most of the crashes (82.2%) in this study involved more than one vehicle, in instances where a crash involved only a log truck, rollovers were the first event to cause harm in 32 percent of single vehicle crashes, compared to 8 percent of multiple vehicle crashes. In multiple vehicle crashes another vehicle directly contributed to the crash over half (53.2%) of the time. Tractor-trailer is the most common (83%) vehicle configuration for log trucks. This study has shown general characteristics of log truck crashes. It is unclear why log truck crashes have increased but there is a need for more research on factors related to log truck crashes.

To compare crashes in different geographic regions of the US, we calculated a rate of crashes using reported crash data and the US Forest Service harvest data for year 2012 for each state. Overall, the US had an average rate of 0.7 fatal log truck crashes per 100 million ft^3 of wood harvested. The Southeast region had more total crashes, and the highest rate of log truck crash fatalities with 0.9 fatalities per 100 million ft^3 of roundwood production. The region with the lowest crash rate was the Midwest with 0.3 crashes per 100 million ft^3 of wood harvested.

When comparing logging tractor-trailer vehicles to other types of tractor-trailers it appears that fatal log truck crashes overall follow similar trends to other heavy trucks. Both logging tractor-trailer and other tractor-trailer crashes have increased over a five-year period. Heavy tractor-trailer crashes overall had an increase of 16% over the five-year period. Log trucks were determined to be the oldest vehicles involved in fatal crashes of all truck types, with an average age of 13 years, compared to the overall average for all trucks of 7.6 years. The difference in age is significant between log trucks and all other truck types. The five-year average age of log truck drivers is 48.7 years and was not significantly different from driver age of other truck types.

While many of the traits between log truck and other trucks are similar it does appear that rollover occurrences as well as older average ages of trucks are distinguishing elements in log truck crashes. It has been shown that log truck crashes increased 41% from 2011-2015. It was a goal of this study to highlight these distinguishing features and help inform and direct industry specific safety trainings in hopes of halting this increase. Focused safety training using videos and other education resources could possibly help improve driver awareness and hopefully reduce the incidence of crashes. This study has shown that many crashes directly involve another vehicle. Education toward the public on their own safety around large trucks could also help increase overall awareness of log trucks. According to Blower (1998) during a fatal crash between a car and large truck the car driver's behavior was more than three times as likely to contribute to the fatal crash than was the truck driver's behavior. In addition, the car driver was solely responsible for 70 percent of the fatal crashes, compared to 16 percent for the truck driver (Blower 1998).

Additionally, focusing on enforcing policies restricting cell phones which contribute to distracted driving in both trucks and passenger vehicles could help improve safety. Talking on a cell phone diverts a driver's attention from the road, which can be dangerous. Strayer et al (2008) determined that impairments associated with using a cell phone while driving can be as profound as driving intoxicated (Strayer et al 2008). Lastly, an emphasis on industry specific defensive driving practices could potentially help with driver safety in the future. These strategies once implemented over a period of time could hopefully reduce the frequency of log truck crashes. Reducing the frequency of crashes would not only improve safety but also reduce the financial impacts associated with log truck crashes.

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