INJURIES ON MECHANIZED LOGGING OPERATIONS IN THE SOUTHEASTERN UNITED STATES

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(ABSTRACT)

A random sample of injuries to employees of mechanized logging operations in the piedmont and coastal plain regions of the Southeastern U.S. was taken from the 1996-1997 claims records of three cooperating Worker's Compensation Insurance carriers. For each claim, information was gathered about the accident. Additional information on equipment, labor, and operations was gathered for each firm reporting a sample claim. All data was recorded in a spreadsheet program for sorting and analysis.

The deckhand was the crew member most frequently injured (34% of claims), followed by equipment operators (28%) and truck drivers (24%). The delimbing/topping job function resulted in 24% of injuries, followed by maintenance/repair of equipment (19%), operating equipment (15%), and mounting/dismounting equipment (9%). The injuries occurred on the log deck (41%), in the woods (29%), and at a shop (11%). Most injuries were "struck by" type (50%), but 21% were "falls". The mean claims cost was $10,920 and the median claims cost was $1,200. On fully mechanized operations, 24% of total injuries are still a result of chainsaw delimbing or felling. Equipment operator injuries occur during maintenance/repair (29%) and while mounting/dismounting the equipment (23%). One-third of injuries to truck drivers was the result of motor vehicle accidents.

Conclusions:

- A worker performing equipment maintenance or repair, or a worker felling or delimbing a tree not processed by a feller-buncher or delimbing device, has the greatest risk of injury on fully-mechanized operations.
- Mechanization of the delimbing function will reduce but not eliminate the most costly injuries, where a worker on the ground is “struck-by” a tree, limb, or log.
- Equipment maintenance or repair should be performed in the controlled environment of a shop, rather than in the field, in order to decrease injuries.
- Operating a chainsaw is still a very dangerous logging job function, even on mechanized operations. All employees that use a chainsaw should undergo extensive training, and only trained employees should use a chainsaw.

Keywords: logging, safety

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Most importantly, I thank my wife Stephanie for her patience and support throughout my academic career. Thanks go to the James Wood FFA Alumni for starting me on my college career many years ago. I am forever indebted to my parents for their continuing love and guidance. I wish to dedicate this thesis to my father who was taken from us far too early.

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CHAPTER 1. INTRODUCTION

Timber harvesting is a very dangerous profession with significant numbers of injuries and deaths every year. In 1996, the most recent data available indicated that the incident rate for reportable injuries within the logging industry was 26% higher than the overall incident rate for all private industries (Bureau of Labor Statistics 1997a). The incident rate for 1996 fatalities within the logging industry (timber cutting and logging occupations) was 30 times the overall incident rate for fatalities for all private industries (Bureau of Labor Statistics 1997b).

Because of the increasing concern about timber harvesting accidents, logging safety has been an important topic during the past several years. Safety is a top concern of logging contractors along with the American Forest & Paper Association's Sustainable Forestry Initiative (SFI), stumpage prices, and forestry best management practices. SFI requires member firms of AF&PA to establish training programs for loggers and to annually report the number of loggers trained. Training has been aimed at decreasing injuries and fatalities, increasing the profitability of the logging business, and reducing environmental impacts of harvesting. Safety is also a primary concern of organizations such as the American Pulpwood Association (APA) and state logging associations, which sponsor many logging safety-training programs.

The national incident rate for logging injuries has been steadily decreasing for the past seven years. During the past decade, logging has become increasingly mechanized and

there has been an increase in safety training provided to loggers. Even in industrial safety, few studies have been published which evaluate the effectiveness of safety training programs (Hale 1984). Sluss (1992) reported that a study that compared matched companies with low and high accident frequency found the low accident frequency group had more safety training while the high accident frequency group had less safety training (Cohen et. al. 1979).

This project is designed to enable logging safety training to be more effectively targeted to the areas with the most need. There has been much time and money spent in recent years on logger safety training materials and programs. Most of these programs have been broadly directed at chainsaw safety, equipment safety, and developing a general safety conscious attitude. These basic areas have been targeted because the limited amount of existing statistical analysis suggested these were higher risk areas. Past analyses generally were based on data from a wide range of logging systems and operating conditions. The safety training programs that resulted from those analyses were conducted on a region-wide "one-size-fits-all" basis. This report will provide a more in-depth look at exactly where, why, and to whom the more frequent and more severe accidents are occurring.

The nature and methods of timber harvesting vary across the country and even across states. Loggers operating in different regions have different safety issues to consider. This study will evaluate causes of injuries to mechanized logging operations in the Southeastern U.S. so that targeted safety training programs can be developed. The

accident claims have been analyzed according to contractor demographics such as physiographic region, size of operation, and degree of mechanization. The findings and recommendations within apply to mechanized loggers operating in the piedmont and coastal plain regions of the Southeastern U.S.

The secondary objective of this project is to develop a method for collecting data that will allow calculation of more meaningful incident rates. Incident rates are currently calculated for broad regions and nationally. There is a need to consistently measure and monitor the incident rate for mechanized loggers in the Southeastern United States. Monitoring the incident rates for this important group of contractors will enable an evaluation of the effectiveness of regionally targeted safety training programs.

CHAPTER 2. LITERATURE REVIEW

Few studies have been conducted for logging safety. Most existing studies simply compile and summarize logging injury and fatality statistics. Some of these statistics reflect actual safety concerns, others do not. Few studies closely examine data other than that available from employer's first report of accident forms. There are four studies that performed analyses on logging accident claims similar to this study. The results of those past studies will be compared to the results of this study.

BUREAU OF LABOR STATISTICS LOGGING STATISTICS

The U.S. Department of Labor and specifically the Bureau of Labor Statistics (BLS) calculates injury statistics for all industries, including logging. The BLS compiles national and regional data for Standard Industry Classification (SIC) code 2411, which includes timber cutters and loggers. The BLS statistics are based on OSHA recordable accidents. Recordable accidents include all occupational deaths, all occupational illnesses, and any occupational injury that involves loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment other than first aid. (Bureau of Labor Statistics 1997c)

The primary statistic collected by the Bureau of Labor Statistics is Total Case Incident Rates (TCIR). Incident rate is the number of occupational injuries per 100 workers. TCIR is calculated by multiplying the total number of injuries within a firm by 200,000 (40 hours/week * 50 weeks/year * 100 employees) and dividing by the actual total

number of hours worked in the firm. Fatality rates are calculated using the same method, but are reported on the basis of 100,000 workers. (Bureau of Labor Statistics 1997c)

The national incident rate for the logging industry has been decreasing in past years. This reduction is partially due to increased safety training and increased mechanization in the logging industry. The logging incident rates have been higher than the rates for all private industries for at least the past eight years. Only recently has the rate for logging become reasonably close to the national average rate. National incident rates for several industries are provided in Table 2.1 for comparison.

Table 2.1. National incident rates per 100 workers for recordable injury only cases in the logging industry and other comparable industries, 1989-1996.

Year	Logging rate	All industry rate	Construction industry	Trucking	Agricultural production
1989	19.2	8.2	14.2	13.4	11.7
1990	17.2	8.3	14.1	14.1	12.3
1991	15.6	7.9	12.8	14.4	11.1
1992	14.3	8.3	12.9	13.2	11.5
1993	13.5	7.9	12.0	13.5	10.9
1994	10.5	7.7	11.5	14.5	9.7
1995	10.0	7.5	10.4	13.6	9.9
1996	8.7	6.9	9.7	10.2	8.9

LOGGING ACCIDENT STATISTICS

All insurance carriers that provide compensation insurance for the logging industry maintain some type of statistics on their claims experience. However, this information is proprietary and closely guarded by the companies. The actuary-based data is thought to be the most complete and accurate, but this data has generally been unavailable. Most

companies use their claims experience as a guideline for developing in-house loss control programs and safety training programs.

The Bureau of Labor Statistics (BLS) published one of the most thorough reports on injuries within the logging industry in 1984. The BLS study analyzed 1,086 injuries that occurred in 1982. The analyses were performed only on accidents reported to state workers compensation agencies. Each state has its own laws that dictate when an injury has to be reported. These laws are typically linked to the number of lost workdays or the cost of the claim. They all have the same result of excluding claims for less severe injuries. The accidents in the 1984 study occurred in 12 states throughout the entire U.S.; however, some of the results were divided by western or non-western states. The eastern states involved in the study were Arkansas, Kentucky, Maine, North Carolina, Tennessee, Vermont, and Virginia. The BLS study included all injuries and illnesses, not just workers compensation claims. (BLS 1984)

Wilson (1989) reported some accident analyses for logging injuries in Virginia and North Carolina. Summaries of 1983-1985 claims from a Virginia Workers Compensation carrier were obtained. The extent of Virginia data available was nature of injury and cause of injury. The claims data obtained from the North Carolina Workers Compensation carrier were much more detailed. The 309 claims contained information on occupation, nature and cause of injury, crew size, and physiographic region. (Wilson 1989)

Sluss (1992) examined the characteristics of safety successful logging contractors. Analyses were performed on the workers compensation claims of the 26 Southeastern logging contractors that participated in the study. The results of the study were based on 91 accident claims. The investigators reported they were unable to obtain consistent information on the claims of all contractors. Also, some of the accident information could not be verified.

A study on characteristics of workers compensation injuries in Louisiana was the most recent that included an in-depth analysis of logging injuries. (Pine et. al. 1994) The study examined the same types of data as the other logging injury analyses. Data used for analyses were taken from Louisiana state worker's compensation accident reports. The data were based on reportable claims between 1985 and 1990. Reportable claims in Louisiana are defined as those involving a fatality, a permanent disability, or an injury resulting in at least eight lost workdays. Overall, claims frequency decreased from 1987 to 1990 in Louisiana. The number of workers in the logging industry increased slightly during the same time period. (Pine et. al. 1994)

The national BLS report found that 50% of all injuries occurred while workers were performing a cutting operation. Workers being struck or crushed by wood comprised 32% of the cases and workers slipping, tripping, or falling represented 17% of the cases in non-western states. Contact with a chainsaw resulted in 28% of all the injuries in non-western states. (BLS 1984)

In non-western states, the occupation named chopper, cutter, saw operator, sawhand accounted for 40% of all injuries. Truck drivers represented 5% of the total injuries while skidder operators were hurt in 8% of all accidents. (BLS 1984)

Wilson found that for North Carolina claims, tree fellers were injured in 28% of the accidents and tree toppers were injured in 26% of the accidents. Skidder operators accounted for 15% of injuries, deckhands for 10% of injuries, and truck drivers for 7% of injuries. Chainsaws were involved in 55% of the topping injuries. Over 50% of the injuries to log truck drivers were due to motor vehicle accidents. (Wilson 1989)

Part of Wilson's accident analyses focused on differences in claims by physiographic region. Injury frequency increased for deckhands and toppers from mountains to piedmont to coastal plain. Injuries to tree fellers decreased across the same gradient. There was a decrease in sprains and an increase in lacerations from mountains to piedmont to coastal plain. (Wilson 1989)

In the BLS study, employees in non-western states with less then one year of experience made up 22% of the accidents. Employees with one to five years of experience made up 23% of the accidents, and those with more than five years experience made up the other 56% of accidents. (BLS 1984)

The BLS found nature of injury statistics as follows. Lacerations made up 25% of all injuries, sprains and strains were the nature of 24% of all injuries, and contusions

represented 16% of all injuries. The nature of 13% of the injuries was fractures. (BLS 1984)

The Wilson study reported similar results in Virginia for nature of injury. The most frequent injury was lacerations (38%), followed by fractures at 19%, sprains at 14%, and contusions at 12%. (Wilson 1989)

The Sluss study found different results for the nature of injury category. Their analyses showed fractures at 40% and contusions at 20% of injuries. Lacerations, sprains, and burns each accounted 10% of total injuries. (Sluss 1992)

Part of body affected is another category that was analyzed. Injuries to the lower extremities accounted for 34% of accidents compared to upper extremity injuries, which accounted for 18% of the accidents. Injuries to the head represented 13% of the accidents, and injuries to the trunk accounted for 23% of all accidents. (BLS 1984)

Sluss found that 45% of injuries were to the lower extremities. Upper extremity injuries represented 20% of injuries. The head/neck region received 20% of injuries and the back received 10% of injuries. (Sluss 1992)

The BLS reported that one-third of all injuries in non-western states happened during felling activities. Another 32% of injuries occurred during limbing and bucking

operations. Nine percent of accidents occurred during log skidding operations. Only 4% of injuries were a result of repairing or servicing equipment. (BLS 1984)

The mechanized contractors monitored in the Sluss study found much different trends in the job function being performed when an accident occurred. Forty-five percent of injuries happened during delimbing/bucking functions. The maintenance job function claimed 30% of injuries, while felling and trimming each claimed 10% of injuries. (Sluss 1992)

The BLS study reported that in non-western states two-thirds of all accidents happened at the cutting site. Another 26% of accidents occurred either at the landing or in between the cutting site and the landing. (BLS 1984)

In the Louisiana study, truck drivers were injured in 20% of the claims. Chainsaw operators accounted for 9% of the claims and their helpers also accounted for 9% of the claims. The frequency of injuries to chainsaw operators is lower than would be expected, possibly due to increased logging mechanization in Louisiana during that time period. Workers employed for less than one year accounted for 56% of the claims. Employees with less than three years experience comprised 82% of all claims. Workers between the ages of 25 and 44 accounted for 56% of the claims. (Pine et. al. 1994)

Lacerations were the largest component of the nature of injury category with 29% of claims. Sprains made up 23% of all claims. Fractures were the nature for 15% of all injuries. (Pine et. al. 1994)

Hand tools and trees caused the most injuries with each representing 23% of all claims. Most of the hand tool injuries were caused by chainsaws. Wood objects caused 18% of the injuries. (Pine et. al. 1994)

Struck by/struck against injury types made up 61% of all the claims. Falls were responsible for 13% of claims and overexertion was responsible for 9% of all claims. (Pine et. al. 1994)

Injuries to the lower extremities accounted for about 33% of claims. Back injuries were the cause of 14% of the claims. Head injuries and upper extremity injuries each accounted for about 10% of the claims. (Pine et. al. 1994)

OTHER SOURCES

The American Pulpwood Association (APA) has been very active in providing available information on logging safety. The APA frequently publishes technical releases and other bulletins to keep members aware of current logging safety issues. The APA includes “safety alerts” in its monthly news bulletins. These safety alerts provide in-depth information about selected logging accidents each month. The alerts typically

identify the causal agents in the accident, as well as how to prevent the situation from being repeated. A sample APA "safety alert" is included in Appendix A.

CHAPTER 3. METHODS AND PROCEDURES

DATA SOURCES

The accident data used for this project were obtained solely from workers compensation insurance carriers in the Southeastern U.S. Other possible data sources were investigated, but only the insurance carriers had the required accident and demographic information on the logger. The sample of accident reports analyzed in this study was randomly selected from a population of all claims from January 1, 1996 to January 31, 1998 from each company.

Two major types of data were used in this project. The first type was related to the accident itself. Most of the accident data were gathered from first report of accident forms. These forms vary by state but they all contain the same basic information about the injured employee, the employer, and where, when, and how the injury occurred.

The second category of data gathered was what made this project unique. This category is best summarized as demographic information about the logging contractor. Demographic data collected included equipment spread, number of employees, physiographic region of operation, and degree of mechanization.

A total of 302 accident claims were analyzed for this study. All of the accidents involved either partially mechanized or fully mechanized contractors. The few accidents reported by non-mechanized contractors were excluded from the analysis. Fully mechanized

contractors were defined as those with machine-mechanical felling and delimbing/topping operations. Partially mechanized contractors were defined as using machine-mechanical felling with manual delimbing/topping operations. Contractors were assigned to physiographic regions using commonly accepted boundaries of those regions. Due to the similarities of the piedmont and upper coastal plain, contractors operating in the upper coastal plain were placed in the piedmont category and those operating in the lower coastal plain were placed in the coastal plain category.

CLASSIFICATION OF DATA

All claims were entered into a spreadsheet program for statistical analysis. The accidents were each assigned a unique identifying number to allow for accuracy checks. All information was taken from the insurance records and recorded by one person to insure uniformity in interpretation. The data were recorded by categories as follows:

Information on Injured Person – Information recorded included: age, months of experience with the contractor working for when injured, and months of experience in current occupation when injured.

Occupation – This category described the injured person's primary duty including: skidder operator, loader operator, deckhand, chipper operator, mechanic, supervisor/owner, truck driver, feller-buncher operator, bulldozer operator, other, or unknown.

Job Function – This category further described what job function the injured person was performing when the accident occurred including: dismounting, felling, hooking, idle, loading, maintenance/repair, mounting, operating, other, delimbing/topping, trimming load, unloading, walking, and unknown.

Time and Place of Accident – Information gathered included: city or county and state where accident occurred, date, day of the week, and time of accident (a.m. or p.m.), and location where the accident occurred (woods, deck, mill, shop, or other).

Type of Injury – This category described basic accident type including: struck by/struck against, caught in/on/between, fall (from above or at ground level), overexertion, fire, motor vehicle accident (MVA), and other.

Nature of Injury – This category described the injury incurred by the claimant including: fracture, contusion (bumps and bruises), laceration, sprain (strain/pull), heart attack, burn, fatal, crush, bite, other, and unknown.

Object – The machine, tool, or object causing injury. These were recorded as specifically as possible as to which object was most directly responsible for the injury (for example if a loader was swinging a log and the log struck a person, object would be recorded as loader).

Body Part – This category identified the specific body part that was injured including: ankle, arm, back, body/multiple, chest, eye, foot, hand, head, leg, shoulder, other, and unknown.

Analyses were also performed on an occupation category labeled "equipment operators". This category is simply the combination of skidder, loader, feller-buncher, chipper, and bulldozer operators. These analyses were performed because workers operating heavy equipment, whatever the type, are often exposed to the same hazards and have very similar safety concerns.

INCIDENT RATE PROCEDURES

A random sample of contractors was selected from a population of all insured loggers from each insurance carrier. The sample used for the incident rate calculation was completely separate from the previous sample used for accident analyses. For each contractor sampled, the total number of employees and the total number of compensation insurance claims for calendar year 1996 were recorded. The total sample size for the incident rate calculation was 200 contractors.

TCIR rates are computed using the total number of hours worked by all employees. As the actual number of total hours worked was not readily available, it was decided to use the industry norm of 2000 hours per worker per year (50 weeks* 40 hours per week). Thus, the TCIR for the sample was calculated as follows:

$TCIR_{1996}$ = average of 200 incident rates (one rate for each sample logger)

$$TCIR_{logger} = \frac{200{,}000 * \text{total number of claims filed in 1996 by each sample logger}}{2000 \text{ hours} * \text{total number of workers employed by each sample loggers}}$$

CHAPTER 4. RESULTS AND DISCUSSION

A total of 303 claims were examined and summarized to produce the following results. Contractors operating in the piedmont region made 62% of the compensation claims in this study. Coastal plain operators were responsible for the remaining 38% of claims. The overall median cost of the claims was $1200 dollars. Fully mechanized contractors filed 70% of claims while partially mechanized contractors filed 18% of the claims. The other 12% of claims were from contractors with an unknown degree of mechanization. CAUTION: These statistics reflect the injuries of the loggers insured by the WCI firms and are not necessarily reflective of the overall logging industry in the southeast. All overall results are summarized in Appendix B.

OVERALL RESULTS BY CATEGORY

The occupation of deckhand represented the most claims with 34% of all incidents. The next highest frequency of claims was truck drivers with 24% of all incidents. Skidder operators were involved in 11% of the claims and all other occupations were below 10% of the total. Equipment operators as a whole were claimants in 28% of the accidents in this study. The most frequently injured worker was on the ground, with a chainsaw, manually removing limbs or tops from trees. (Table 4.1)

Table 4.1. Percentage of total claims by occupation.

Occupation	Percentage of total claims
Deckhand	33.7%
Fellerbuncher	6.6%
Loader	7.9%
Skidder	11.2%
Supervisor	5.9%
Truckdriver	23.8%
Equipment operator	28.4%

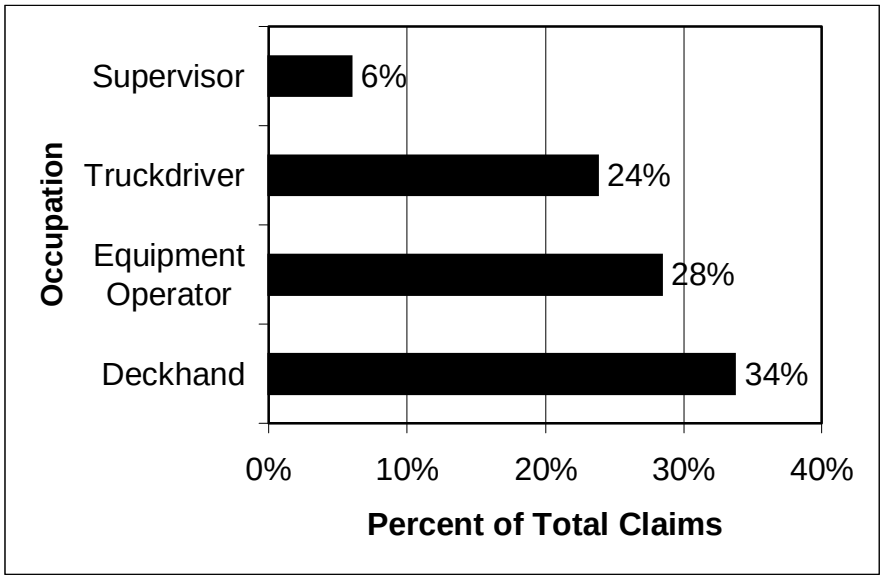

Figure 4.1. Percentage of total claims by occupation.

Job Function When Injured

Twenty-four percent of all claims occurred during the topping/delimbing job function. The maintenance and repair of equipment resulted in 19% of all claims. Workers were operating equipment, including trucks, during 15% of the accidents. Manual felling of trees accounted for 7% of total accidents for these mechanized contractors. Nine percent of accidents occurred during the mounting or dismounting of equipment.

Table 4.2. Percentage of total claims by job function.

Job function	Percentage of total claims
Dismounting	5.9%
Felling	6.9%
Idle	5.6%
Maintenance/repair	18.8%
Mounting	3.0%
Operating	14.5%
Other	5.9%
Topping/delimbing	23.8%

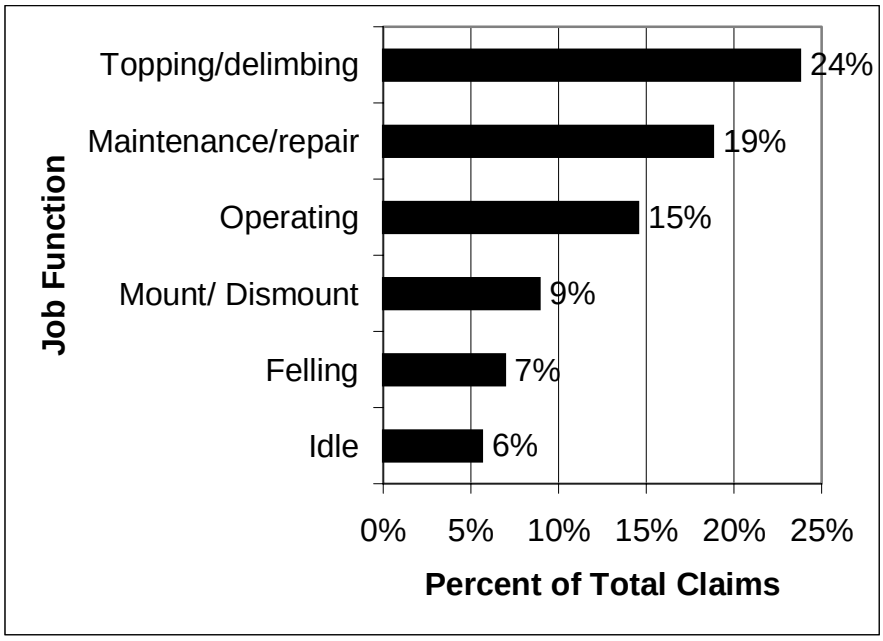

Figure 4.2. Percentage of total claims by job function.

Nature of Injury

Lacerations were the nature of injury for 29% of the claims. Contusions and sprains were equally as likely with each representing 23% of the total claims. Eighteen percent of claims were fractures. All other causes were responsible for less than 2% of injuries each. These results are comparable to what other recent studies have found. With

increased mechanization, lacerations caused by chainsaws are decreasing but those caused by contact with metal or equipment are increasing. (Table 4.3)

Table 4.3. Percentage of total claims by nature of injury.

Nature of injury	Percentage of claims
Contusion	23.1%
Fatal	1.0%
Fx	17.8%
Laceration	29.4%
Sprain	23.1%

Type of Injury

The largest proportion of injuries was "struck by/struck against" types, which accounted for 50% of total claims. The next largest category was "falls" with 21% of all claims. Motor vehicle accidents and "caught in" type injuries were each responsible for 10% of claims. Logging injuries have in the past been comprised of a large proportion of "struck by" type injuries. This study shows that this remains the case. (Table 4.4)

Table 4.4. Percentage of total claims by type of injury.

Type of injury	Percentage of total claims
Caught in	9.6%
Fall	20.8%
MVA	9.6%
Overexertion	7.9%
Struck by	50.2%

Object Causing Injury

This category was provided mainly to allow for additional description of the accident within the spreadsheet constraints. A few apparent trends are worth mentioning though. A falling limb or tree caused 15% of injuries. A log already on the ground was

responsible for 14% of the injuries. Eleven percent of injuries were caused by contact with a chainsaw. Trucks also caused 11% of the total injuries. (Table 4.5)

Table 4.5. Percentage of total claims by object.

Object causing injury	Percentage of total claims
Chainsaw	10.9%
Fellerbuncher	3.3%
Falling limb/tree	14.5%
Loader	7.9%
Log/stump	13.9%
Metal	8.9%
Skidder	8.6%
Tools	4.3%
Truck	11.2%

Costs

The mean cost of an injury claim in this study is $10,920. This number is deceivingly high because it is heavily influenced by a few very expensive claims. A better representation of the cost of the "typical" claim is the median value of $1,200. The costs ranged from zero (0) to over $500,000. The costs were arbitrarily divided into three categories. Sixty-four percent of claims had a total cost under $5,000. Claims costing between $5,000 and $20,000 represented 23% of the total. Claims costing $20,000 and above made up 12% of the total. (Table 4.6)

Table 4.6. Summary of overall cost data.

Cost Location	Results
Mean $	$10920
Median $	$1200
Ranges	**Percentage**
?	2.3%
< $5000	63.6%
$5000-$20000	22.5%
$20000 and up	11.6%

Length of Experience

Workers with less than one year of experience with the contractor were injured in 39% of claims. Workers with one to five years experience and with more than five years experience were each injured in 23% of claims. This data suggests that new employees are more likely to be injured on the job. The logging industry has typically had high employee turnover rates, which leads to a higher frequency of workers with little experience. Very few contractors provide initial safety or other training upon hire. The most common type of training in the logging industry is on-the-job training where workers learn by their mistakes or successes. (Table 4.7)

Table 4.7. Percentage of claims by employee experience.

Time employed	Percentage of total claims
?	14.2%
< 12 months	39.3%
12-60 months	23.1%
>60 months	23.4%

Time and Day of Accident

Analyses by time and day of week were performed to identify any trends. Excluding weekends, Friday showed the least number of claims with 14% of the total. Monday and

Thursday were very close, each having about 18% of total claims. Tuesday and Wednesday each were responsible for 22% of total claims. Saturday had 4% of claims and Sunday had less than 2% of claims. Part of the reason Tuesday, Wednesday, and Thursday may have higher accident rates is that loggers are more likely to be working on those days. The results of time of accident were not drastic. Fifty percent of accidents occurred before 12 p.m., 38% occurred after 12 p.m., and another 13% were unknown. (Table 4.8)

Table 4.8. Percentage of total claims by day of week and time.

Day of week	**Percentage of total claims**
Monday	17.8%
Tuesday	22.1%
Wednesday	22.4%
Thursday	18.5%
Friday	13.5%
Saturday	4.3%
Sunday	1.3%
Time of day	**Percentage**
Am	49.5%
Pm	37.6%
?	12.9%

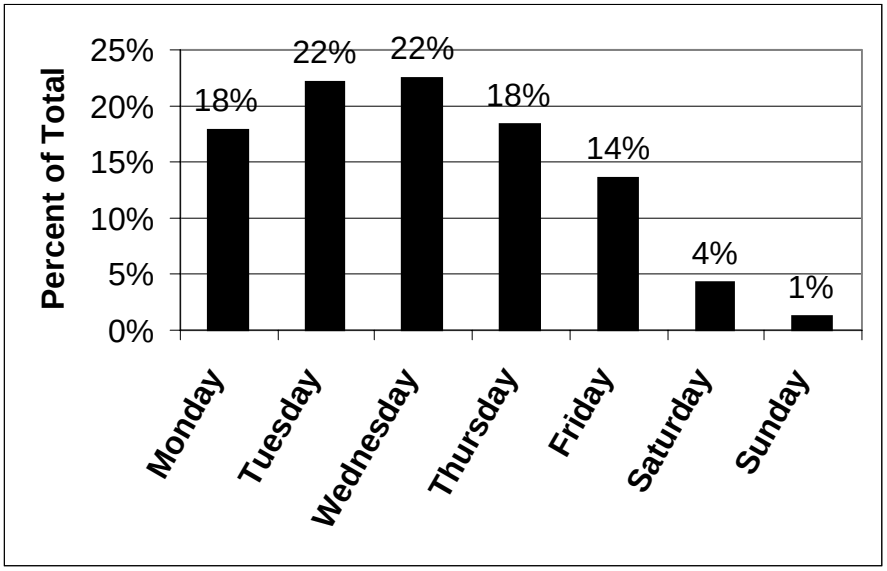

Figure 4.3. Percentage of total claims by day of week.

Location of Injury

Overall results indicated that 41% of injuries happened at a deck or pre-deck location on the job site. Twenty-nine percent of accidents occurred in the woods. Accidents at maintenance shops resulted in 10% of total claims. The remainder of accidents occurred at a mill, on the road, or at some other location. The high frequency of injuries at log decks is attributable to the topping/delimbing operation. The removal of limbs on mechanized operations is seldom done at the stump and instead is done at a pre-deck or at the main landing. (Table 4.9)

Table 4.9. Percentage of total claims by location.

Location of accident	Percentage of total claims
?	7.9%
Deck	40.6%
Mill	1.7%
Other	10.9%
Shop	10.2%
Woods	28.7%

INJURIES TO LOGGING EQUIPMENT OPERATORS

The claims of loader, skidder, chipper, dozer, and feller-buncher operators were combined into a category labeled equipment operator to allow for analyses. Equipment operators as a whole showed different injury characteristics than other workers. The equipment operator results are summarized in Appendix B.

The nature of injuries equipment operators receive show several differences from the overall results. Equipment operators have more sprains (33%), more fractures (23%), and fewer lacerations than other workers do. The increased sprains are likely a result of falling from the equipment and trying to lift heavy objects during machine maintenance and repair. Another component of the sprains is neck and back injuries caused by the jarring associated with operating heavy equipment in the woods. (Table 4.10)

Table 4.10. Percentage of equipment operator claims by nature of injury.

Nature of injury	Percentage of equipment operator injuries
Burn	2.3%
Contusion	19.8%
Fx	23.3%
Laceration	22.1%
Sprain	32.6%

A large proportion of injuries to equipment operators (28%) occurs during the maintenance or repair of machinery. There is a clear need for training in safe maintenance procedures. Injuries that occur during normal equipment operation represent 20% of claims. The injuries that occur during machine operation are usually random events that are fairly uncontrollable. Mounting and dismounting the equipment

is responsible for 23% of the claims. The mount/dismount injuries usually happen one of two ways. Accidents during mounting result from the operator accidentally slipping off of the steps. Accidents during dismounting often result from the operator purposefully jumping from the machine to avoid the steps. Machine operators need to use proper techniques when getting on or off machines, and should keep steps and platforms free from mud and obstructions. (Table 4.11)

Table 4.11. Percentage of equipment operator claims by job function.

Job function	Percentage of equipment operator injuries
Dismounting	16.3%
Felling	3.5%
Maintenance/repair	27.9%
Mounting	7.0%
Operating	19.8%
Other	9.3%
Topping/delimbing	7.0%
Walking	3.5%

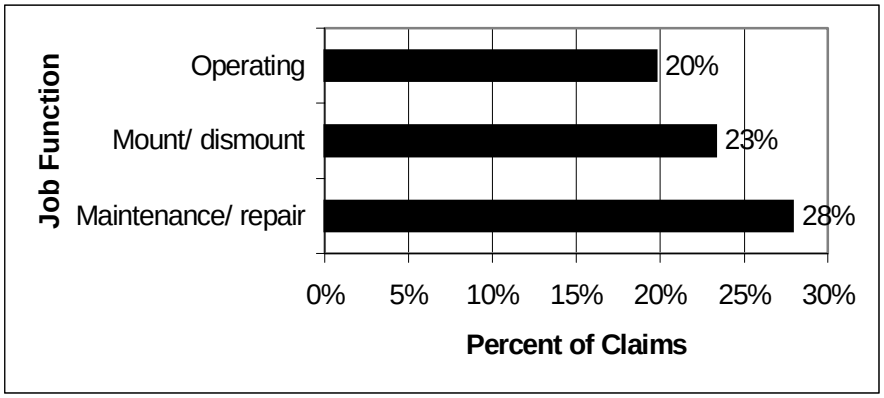

Figure 4.4. Percent of claims by job function for logging equipment operators.

The object injuring the equipment operators is most often the machinery they are responsible for operating (45%). Metal is the injuring object in 13% of the claims.

Equipment operators have fewer struck by type injuries (35%). They have more falls (29%), more "overexertion" (14%), and more "caught in" type injuries (15%). The falls are attributable to mount/dismount mishaps. The overexertions are primarily due to lifting heavy objects or being jarred in the machine. The caught in injuries are mostly related to maintenance/repair accidents. (Table 4.12)

Table 4.12. Percentage of equipment operator injuries by object.

Object causing injury	Percentage of equipment operator claims
Chainsaw	4.7%
Other Equipment	4.7%
Fb	8.1%
Falling limb/tree	9.3%
Loader	16.3%
Log/stump	5.8%
Metal	12.8%
Skidder	16.3%
Truck	7.0%

Claims by equipment operators are slightly less costly than other claims. The median cost was $1,100 and the mean cost was $5,540. A small percentage of equipment operators' claims (7%) had total costs over $20,000. These costs indicate that although equipment operators have a high frequency of accidents, the severity of those accidents is lower than other claims. (Table 4.13)

Table 4.13. Claims cost summary for equipment operator injuries.

Cost location	Cost
Cost mean $	$ 5540
Cost median $	$ 1100
Cost distribution	**Percentage of total**
?	2.3%
< $5000	67.4%
$5000-$20000	23.3%
$20000 and up	7.0%

CHAINSAW INJURIES

An analysis of injuries caused by chainsaws was performed to provide some insight into the changing nature of those types of injuries. Mechanized contractors still have 11% of all injuries caused by a chainsaw. Many studies have shown that a large proportion of chainsaw injuries occurs during manual tree felling. After removing that element by focusing on mechanized contractors, the characteristics of chainsaw injuries begin to change. All chainsaw injury results are summarized in Appendix B.

The deckhand occupation represents 70% of chainsaw injuries. Skidder operators are injured in 9% of chainsaw injuries. Supervisors and truck drivers are each injured in 6% of chainsaw injuries. It is apparent that many different employees on a logging job are using chainsaws. (Table 4.14)

Table 4.14. Percentage of chainsaw injury claims by occupation.

Occupation	Percentage of chainsaw injuries
?	6.1%
Deckhand	69.7%
Fellerbuncher	3.0%
Skidder	9.1%
Supervisor	6.1%
Truckdriver	6.1%

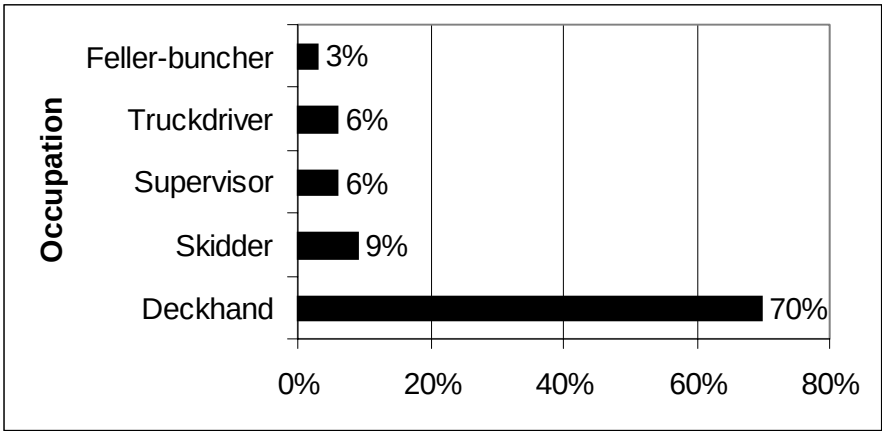

Figure 4.5. Percentage of chainsaw-related injuries by occupation.

Ninety-one percent of injuries caused by chainsaws are lacerations. Most of the remaining injuries are contusions. Chainsaw injuries were incurred equally in the woods or on the deck. The claims resulting from chainsaw injuries tend to be slightly less expensive than other claims. "Struck by" type injuries represent 91% of all chainsaw injuries. The other 9% are due to falls. (Table 4.15)

Table 4.15. Percentage of chainsaw injury claims by nature of injury.

Nature of injury	Percentage of chainsaw injury claims
Contusion	6.1%
Fx	3.0%
Laceration	90.9%

The topping/delimbing job function represents 64% of chainsaw injuries. Eighteen percent of chainsaw injuries occur while trimming a load on the truck. The manual felling of trees was responsible for 9% of chainsaw injuries for these mechanized contractors. Mechanization of the delimbing/topping job function would eliminate a great majority of chainsaw injuries. This can be seen in the next section where the injuries of fully mechanized and partially mechanized contractors are compared. (Table 4.16)

Table 4.16. Percentage of chainsaw injury claims by job function.

Job function	Percentage of chainsaw injury claims
Felling	9.1%
Operating	3.0%
Other	3.0%
Topping/delimbing	63.6%
Trimming load	18.2%
Walking	3.0%

Chainsaw injuries happen 46% of the time to workers with less than one year of experience. This is a higher proportion than for the overall results. Employees with the least seniority on logging jobs often are assigned to operate a chainsaw. Once the employee gains experience, he is often promoted to being an equipment operator. Sluss (1992) found that sawhands had the lowest average tenure of logging employees. The

other large influence is that the logging industry has typically had high turnover rates for its employees. (Table 4.17)

Table 4.17. Percentage of chainsaw injury claims by worker experience.

Length of experience	Percentage of chainsaw injuries
?	15.2%
< 12 months	45.5%
12-60 months	24.2%
>60 months	15.2%

INFLUENCE OF DEGREE OF MECHANIZATION

Comparisons were made between the accident statistics of partially mechanized (manual delimbing) contractors vs. fully mechanized contractors (mechanical delimbing). Degree of mechanization has an impact on accident statistics primarily because of exposure to chainsaws versus exposure to logging equipment. Two-sample T-tests were performed on the results to determine if the differences in proportions were statistically significant. A summary table based on degree of mechanization results is included in Appendix C.

A deckhand is almost twice as likely to be injured on a partially mechanized operation than on a fully mechanized operation (51% vs. 26%) ($P<0.001$). Fully mechanized operations should by definition have fewer deckhands. The data suggested that equipment operators were more likely to be injured with fully mechanized contractors (22% partial vs. 32% fully ($P=0.145$)). The truck driver occupation also appeared to be more dangerous under fully mechanized contractors (18% partial vs. 26% fully

(P=0.214)). The results for equipment operator and truck driver were not statistically significant, but may still be important. (Table 4.18)

Table 4.18. Occupation results by degree of mechanization.

Occupation	Percentage for partially mechanized	Percentage for fully mechanized	Statistically significant
Deckhand	50.9%	26.3%	Yes
Skidder	9.1%	12.2%	No
Supervisor	5.5%	6.1%	No
Truckdriver	18.2%	25.8%	No
Equipment Operator	21.8%	31.9%	No

Injuries were more likely to happen at a shop with fully mechanized contractors (4% partial vs. 12% fully (P=0.06)). This difference may be attributable to fully mechanized contractors being more likely to have a shop. Partially mechanized contractors may not have enough equipment to warrant the cost of a maintenance shop. The delimbing/topping job function caused 38% of injuries for partially mechanized contractors and 17% of injuries for fully mechanized contractors. The difference was statistically significant. (P<0.001) The injury analysis showed that the maintenance or repair of equipment claimed 7% of injuries for partially mechanized crews and 24% of injuries for fully mechanized crews. (P=0.007) Mechanization of the delimbing process results in injuries being shifted from the delimbing process to the maintenance/repair of equipment process. (Table 4.19)

Some other differences that were not statistically significant but should be mentioned are that manual felling caused 11% of partially mechanized injuries compared to 7% of fully mechanized injuries. Also, fully mechanized crew members are more likely to be hurt

while operating equipment (16% fully vs. 11% partially). Manual felling still makes up a significant percentage of injuries, considering the fact that all of these crews used mechanized felling. These data suggest that partially mechanized crews are more likely to be performing manual chainsaw felling. Perhaps this is due to more workers on the job having access to chainsaws and deciding to help boost production by felling trees when they are not busy. (Table 4.19)

Table 4.19. Job function and location results by degree of mechanization.

Job function	Percentage for partially mechanized	Percentage for fully mechanized	Statistically significant
Felling	10.9%	6.6%	No
Maintenance/repair	7.3%	23.5%	Yes
Operating	10.9%	16.0%	No
Topping/delimbing	38.2%	16.9%	Yes
Location			
Deck	45.5%	41.8%	No
Shop	3.6%	12.2%	Yes
Woods	32.7%	25.8%	No

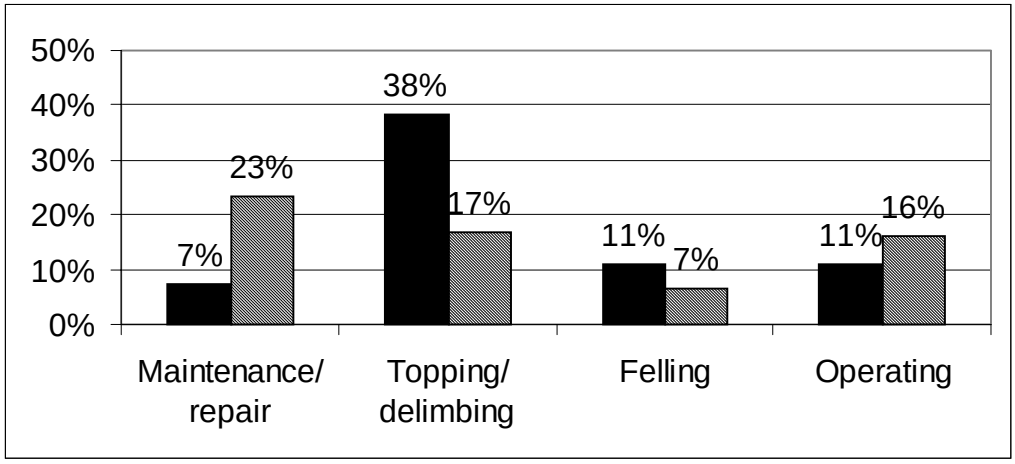

Figure 4.6. Comparison of job function results for partially mechanized (black) and fully mechanized operations (gray).

Workers on fully mechanized jobs are more likely to be injured in "caught in" machine-related type accidents type accidents (11% and 3%, respectively), while partially mechanized crewmembers are more likely to have "struck by" chainsaw-related type injuries (64% and 44% respectively). (Table 4.20)

Crew members on partially mechanized jobs are twice as likely to be injured by a falling tree or limb than those on fully mechanized jobs (26% and 12%, respectively). The difference in percentages is statistically significant (P=0.001). Workers on fully mechanized crews are more likely to be injured by metal objects (2% partially and 11% fully) and the difference is statistically significant (P=0.038). (Table 4.20)

Table 4.20. Type of injury and object results by degree of mechanization.

Type of injury	Percentage for partially mechanized	Percentage for fully mechanized	Statistically significant
Caught in	3.6%	11.3%	Yes
Struck by	63.6%	44.1%	Yes
Object			
Falling limb/tree	25.5%	11.7%	Yes
Log	16.4%	11.3%	No
Metal	1.8%	10.8%	Yes

Partially mechanized crews had 33% contusions, 27% lacerations, and 20% sprains. Fully mechanized crews had 21% contusions, 29% lacerations, and 25% sprains. The difference in contusions is statistically significant (P=0.059). Neither of the other two differences is statistically significant. Past studies have shown higher frequencies of sprains and lacerations with fully mechanized contractors. There is a suggestion of that in the data but there is no statistical proof. The higher rate of contusions for partially

mechanized contractors is most likely due to the large number of "struck by" moving log type incidents. (Table 4.21)

Table 4.21. Nature of injury results by degree of mechanization.

Nature of injury	Percentage for partially mechanized	Percentage for fully mechanized	Statistically significant
Contusion	32.7%	20.7%	Yes
Laceration	27.3%	29.1%	No
Sprain	20.0%	24.9%	No

INFLUENCE OF CONTRACTOR LOCATION

Analyses were performed on claims by contractors operating in the coastal plain (CP) compared with contractors operating in the piedmont (Pied). All results of contractor location influence are summarized in Appendix D. Of the 115 coastal plain claims that were filed, 60% were made by fully mechanized contractors and 20% were made by partially mechanized contractors (20% were "unknown"). For the 188 piedmont claims, 17% were from fully mechanized contractors, 77% were from partially mechanized contractors, and 6% were unknown. Results for the physiographic region comparison are similar to the results for degree of mechanization comparison, but there are several important differences. The loggers filing WCI claims in this study are more likely to be fully mechanized if operating in the coastal plain and more likely to be partially mechanized if operating in the piedmont. The differences are statistically significant ($P<0.001$). Again, these trends apply only to the population in this study and are not necessarily indicative of the southeastern region as a whole.

Logging employees in the coastal plain are more likely to be injured during maintenance or repair of equipment (21% CP vs. 18% Pied). The difference is statistically significant (P<0.001). Coastal plain logging employees are also statistically more likely to be injured during the delimbing/topping job function (30% CP and 20% Pied) (P<0.001). Coastal plain deckhands are more likely to be injured than piedmont deckhands (37% and 31%, respectively). The difference is statistically significant (P<0.001). Even though the majority of coastal plain loggers are fully mechanized, 20% still are partially mechanized and that 20% is more likely to be injured than piedmont deckhands. This difference may be attributable to higher turnover rates and less experience for coastal plain deckhands. There may be other differences relating to the available labor pool in each region that influences the injury rates. Piedmont equipment operators have statistically significant higher injury frequency than coastal plain operators (31% Pied and 24% CP) (P=0.006). This difference is attributable to the influence of terrain and operating conditions. Piedmont equipment operators have more mounting accidents due to mud-clogged boots and steps. Piedmont operators also have more hills and stream channels to contend with. (Table 4.22)

Table 4.22. Job function and occupation results by physiographic region.

Job function	**Percentage for coastal plain**	**Percentage for piedmont**	**Statistically significant**
Felling	4.3%	8.5%	No
Maintenance/repair	20.9%	17.6%	Yes
Topping/delimbing	30.4%	19.7%	Yes
Occupation			
Deckhand	37.4%	31.4%	Yes
Loader	4.3%	10.1%	No
Equipment operator	24.3%	30.9%	Yes

Coastal plain logging employees are statistically more likely to make claims for "caught in" machine-related type injuries (15% CP vs. 6% Pied (P<0.001)) and motor vehicle accidents (14% CP vs. 7% Pied (P<0.001)). Even though truck drivers are slightly more likely to be injured in the piedmont than in the coastal plain, they are much more likely to be involved in a wreck if they work in the coastal plain. The larger, fully mechanized operations in the coastal plain are more apt to have dedicated truck drivers, where piedmont truck drivers may perform several different job functions. Piedmont logging employees are statistically more likely to have delimbing/topping-related "struck by" and "fall" type accidents ("struck by" 54% Pied and 44% CP (P<0.001)) and ("fall" 22% Pied and 19% CP (P=0.006)). (Table 4.23)

Table 4.23. Type of injury results by physiographic region.

Type of injury	Percentage for coastal plain	Percentage for piedmont	Statistically significant
Caught in	14.8%	6.4%	Yes
Fall	19.1%	21.8%	Yes
MVA	13.9%	6.9%	Yes
Struck by	44.3%	53.7%	Yes

Logging workers in the piedmont are more likely than those in the coastal plain to be injured by a falling limb or tree (15% Pied, 13% CP (P=0.045)). Injuries caused by rolling or moving logs happened more often in the coastal plain (17% CP, 12% Pied (P<0.001)). The data suggest that piedmont loggers are slightly more likely to be injured by a chainsaw, although the difference is not statistically significant. These differences are related to piedmont loggers being more likely than coastal plain loggers to use manual chainsaw felling. The higher frequency of "moving log" caused injuries is attributable to the high frequency of deckhand-related injuries in the coastal plain. (Table 4.24)

Table 4.24. Object results by physiographic region.

Object causing injury	Percentage for coastal plain	Percentage for piedmont	Statistically significant
Chainsaw	9.6%	11.7%	No
Falling limb/tree	13.0%	15.4%	Yes
Log/stump	16.5%	12.2%	Yes
Skidder	4.3%	10.1%	No

INFLUENCE OF CONTRACTOR SIZE

Two measures of contractor size were used to determine if there were any differences in injury frequency relating to the size of the logging operation. The first measure was number of employees. The categories used for number of employees were 5 or less, six to nine employees, and ten or more employees. The second measure of contractor size was number of skidders on the job. The category breakdown used was one skidder, two skidders, and three plus skidders. The results for these two measures of contractor size were very similar. Two tables with summary of contractor size results are included in Appendix E.

Loggers in the piedmont were more likely to have either one or two skidders while coastal plain loggers were more likely to have three or more skidders. Along those same lines, piedmont loggers were most likely to have less than 5 employees while coastal plain loggers were most likely to have 10 or more employees.

Struck-by type injuries decreased as the number of employees decreased. Motor vehicle accidents increased with the number of employees. The proportion of injuries to truck drivers steadily increased as number of employees increased. Accidents during manual

felling decreased as number of employees increased. Accidents occurring during maintenance/repair, operating, and topping/delimbing all increased as the number of employees increased. The truck driver results are most likely due to large contractors being more likely to have full-time truck drivers whose only job is operating the truck. The operations with smaller employee numbers may have other employees such as loader operators that also drive a truck when needed. The operations with higher numbers of employees often have more deckhands, which explains the increased delimbing accidents. (Table 4.25)

Table 4.25. Job function, occupation, and injury type results by # of employees.

Job function	Percentage for 5 or less employees	Percentage for 5-10 employees	Percentage for 10+ employees
Felling	14.1%	7.6%	1.9%
Maint/repair	15.6%	17.6%	22.6%
Operating	10.9%	13.7%	17.0%
Topping/delimbing	18.8%	24.4%	25.5%
Occupation			
Truckdriver	17.2%	21.4%	31.1%
Equipment operator	40.6%	28.2%	20.8%
Type of injury			
MVA	3.1%	9.9%	13.2%
Struck by	56.3%	49.6%	46.2%

The analysis by number of skidders showed many of the same results. The operations with more skidders had more delimbing-related injuries. Maintenance/repair related injuries were slightly higher within the three or more skidder category, as would be expected. The two measures of contractor size end up highlighting essentially the same trends. (Table 4.26)

Table 4.26. Job function, occupation, and injury type results by # of skidders.

Job function	Percentage for one skidder	Percentage for two skidders	Percentage for 3+ skidders
Felling	7.2%	8.4%	5.0%
Maint/repair	17.4%	17.6%	21.8%
Topping/delimbing	21.7%	23.7%	24.8%
Occupation			
Truckdriver	17.4%	25.2%	26.7%
Equipment operator	37.7%	27.5%	22.8%
Type of injury			
Fall	29.0%	19.1%	17.8%
MVA	4.3%	12.2%	9.9%

TCIR RESULTS

The incident rate that was calculated from the sample of 200 mechanized southeastern loggers was close to what was expected. The incident rate was calculated two different ways yielding slightly different results. All claims were counted; even those filed as "information only" that resulted in zero (0) cost so this rate includes minor and major injuries. This incident rate is calculated using an approximation of hours worked by the sample firms. The rate that was calculated for this study is to be used only as a base for comparison in later years with a similar population; i.e. mechanized logging contractors operating in the southeast.

The first rate calculated was 9.8 claims per 100 employees. The formula used is below.

$TCIR_{1996}$ = average of 200 incident rates **(one rate for each sample logger)**

$$TCIR_{logger} = \frac{200{,}000 * \text{number of claims filed in 1996 by } \textbf{each} \text{ sample logger}}{2000 \text{ hours} * \text{number of workers employed by } \textbf{each} \text{ sample logger}}$$

The result using the second method was 10.0 claims per 100 employees. The second rate was calculated using the sum of all logger data as follows.

$$TCIR_{1996} = \frac{200{,}000 * \textbf{total number of claims filed in 1996 by all the sample loggers}}{2000 \text{ hours} * \textbf{total number of workers employed by all the sample loggers}}$$

$$10.01_{(1996)} = (200{,}000*148)/(2000*1478)$$

This rate is slightly higher than the 1996 BLS national rate for logging. However, the two rates cannot be compared because they have a completely different basis. The BLS rate includes only the more serious OSHA recordable injuries in its rate. The BLS rate is also based on actual reported hours worked by the firms, which may be more or less than the estimated actual hours used in this study.

CHAPTER 5. SUMMARY AND CONCLUSIONS

The results of this study identify some areas in logging safety training where emphasis should be considered. The results are indicative of the safety concerns of the southeast region mechanized loggers that filed WCI claims during the study period.

Chainsaw injuries still make up a significant proportion of the total injuries for these mechanized contractors. However, most of the injuries occurred during the delimbing/topping process rather than during manual chainsaw felling. Extensive chainsaw safety training should be provided to one or two crewmembers and only those people should be permitted to manually fell the occasional "oversize" or difficult-to-access tree that cannot be processed by machine. Manual felling is the most dangerous aspect of logging and the performance of that activity by inexperienced or ill-trained workers, who only perform the function sporadically, only magnifies the dangers. Deckhands need to be trained in the recognition of hazards such as spring-poles, binding and pinching of the saw. They also need to be extra cautious while cutting supporting limbs on logs, and be constantly aware of how a log will move as the limbs are being severed.

Loggers that currently use manual delimbing should consider switching to a mechanical delimbing process in order to substantially decrease chainsaw-related injuries. The frequency of delimbing related accidents is cut in half for fully mechanized contractors. The frequency of felling related accidents is also almost halved by using a mechanized

delimbing process. The logger will probably incur more equipment maintenance related accidents. This is an acceptable trade-off in order to reduce the traumatic chainsaw injuries.

Truck drivers were injured in a large percentage of total accidents as well. Truck drivers appear to be a "jack of all trades" on some logging jobs. They are injured while performing many different job functions. Drivers need to have safety training for all duties they perform. The majority of injuries to truck drivers are a result of motor vehicle accidents. A log truck driver should always drive defensively and at a reasonable speed. A pre-trip inspection of the truck and trailer should be performed habitually. The adverse off road conditions that log trucks are operated in can lead to damaged parts and unsafe vehicle conditions. Log trucks should never be loaded beyond state DOT weight limits. The higher weights can lead to premature equipment failure. Specially tailored defensive driving courses for log truck drivers may be warranted. If the truck drivers are using a chainsaw to trim the loads, they should use a "pole-saw" and be subjected to the same training that deckhands receive.

Logging equipment operators need to consistently use proper techniques when mounting or dismounting their machine. Loader operators showed the highest percentage of dismount injuries. It may be appropriate to build transportable steps for loaders that are easier to access and more likely to be used. Operators should always use the steps provided on the machines and should never jump from a machine. Skidder operators showed high percentages of mounting injuries most likely caused by slippage due to

mud-clogged boots or steps. Steps should be of a high-grip design and need to be kept clear of mud and other debris.

Significant proportions of logging workers are injured while performing maintenance and repair tasks on equipment. One of the tradeoffs of increased mechanization is that more time is spent performing maintenance to keep the equipment running. A large number of maintenance injuries happen at the logging site, where necessary tools may be unavailable and conditions are uncontrollable. If more mechanical work could be performed at a shop or other more controlled location, injuries would decrease. A training program covering safe maintenance and repair procedures seems to be warranted. The program would discuss topics as simple as proper lifting and carrying, but would also discuss the danger areas of machine maintenance and the proper use of hand tools. Encouraging the use of PPE such as safety glasses and gloves would also be beneficial in reducing the severity and/or frequency of some of these accidents.

Recommendations for Further Research

A major question that this study was unable to answer was "does converting from partial mechanization to full mechanization of the logging job decrease overall injury rates" (as measured by TCIR). We have shown that mechanization changes the characteristics of injuries, but are fully mechanized loggers truly safer overall? The data needed to calculate injury rates by degree of mechanization is available through the WCI carriers that cooperated in this study, and could be obtained in a second phase of this study.

This study has provided a "snapshot" of the work-related accidents and injuries incurred by mechanized loggers in the southeast. In order to monitor changes in logging injuries, this study should be duplicated in subsequent years. Additionally, the study should be conducted in other regions (northeast, lake states) where different logging systems and operating conditions are common.

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APPENDICES

APPENDIX A

Appendix B. Summary of overall results (n=303), equipment operator category (n=86), and chainsaw injuries (n=33) by selected characteristics.

occupation	overall	equip. opr	chainsaw only
?	5.3%		6.1%
Chipper	2.0%	XXXXXXX	0.0%
Deckhand	33.7%		69.7%
Dozer	0.7%	XXXXXXX	0.0%
Fellerbuncher	6.6%	XXXXXXX	3.0%
Loader	7.9%	XXXXXXX	0.0%
Mechanic	2.6%		0.0%
Other	0.3%		0.0%
Skidder	11.2%	XXXXXXX	9.1%
Supervisor	5.9%		6.1%
Truckdriver	23.8%		6.1%
SUM	100.0%		100.0%
equipment operator	28.4%		

nature injury	overall	equip opr	chainsaw only
?	1.0%	0.0%	0.0%
Amputation	0.3%	0.0%	0.0%
Bite	0.7%	0.0%	0.0%
Burn	1.3%	2.3%	0.0%
Contusion	23.1%	19.8%	6.1%
Crush	1.0%	0.0%	0.0%
Fatal	1.0%	0.0%	0.0%
Fracture	17.8%	23.3%	3.0%
Heartattack	0.7%	0.0%	0.0%
Laceration	29.4%	22.1%	90.9%
Other	0.7%	0.0%	0.0%
Sprain	23.1%	32.6%	0.0%
SUM	100.0%	100.0%	100.0%

where	overall	equip opr	chainsaw only
?	7.9%	7.0%	9.1%
Deck	40.6%	48.8%	45.5%
Mill	1.7%	0.0%	0.0%
Other	10.9%	4.7%	0.0%
Shop	10.2%	4.7%	0.0%
Woods	28.7%	34.9%	45.5%
SUM	100.0%	100.0%	100.0%

job function	overall	equip opr	chainsaw only
?	3.0%	2.3%	0.0%
Dismounting	5.9%	16.3%	0.0%
Felling	6.9%	3.5%	9.1%
Hooking	1.0%	2.3%	0.0%
Idle	5.6%	1.2%	0.0%
Loading	1.0%	0.0%	0.0%
Maintenance/repair	18.8%	27.9%	0.0%
Mounting	3.0%	7.0%	0.0%
Operating	14.5%	19.8%	3.0%
Other	5.9%	9.3%	3.0%
Topping/delimbing	23.8%	7.0%	63.6%
Trimming load	4.3%	0.0%	18.2%
Unloading	2.0%	0.0%	0.0%
Walking	4.3%	3.5%	3.0%
SUM	100.0%	100.0%	100.0%

time of day	overall
am	49.5%
pm	37.6%
?	12.9%
SUM	100.0%

Region	overall
coastal plain	38.0%
piedmont	62.0%
SUM	100.0%

object	overall	equip opr	chainsaw only
?	2.3%	1.2%	
Cable	0.7%	2.3%	
Cans	0.7%	2.3%	
Car	0.7%	0.0%	
Chainsaw	10.9%	4.7%	XXXXXXX
Chips	2.3%	1.2%	
Engine	1.0%	0.0%	
Other Equipment	2.6%	4.7%	
Fellerbuncher	3.3%	8.1%	
Gas	0.7%	1.2%	
Hole	1.0%	2.3%	
Hydfluid/water	0.7%	1.2%	
Insect	1.0%	0.0%	
Falling limb/tree	14.5%	9.3%	
Loader	7.9%	16.3%	
Log/stump	13.9%	5.8%	
Metal	8.9%	12.8%	
Other	2.3%	0.0%	
Skidder	8.6%	16.3%	
Tire	0.7%	1.2%	
Tools	4.3%	2.3%	
Truck	11.2%	7.0%	
SUM	100.0%	100.0%	

time employed	overall	equip opr	chainsaw only
<12 months	39.3%	32.6%	45.5%
12-60 months	23.1%	25.6%	24.2%
≥ 60 months	23.4%	20.9%	15.2%
?	14.2%	20.9%	15.2%
SUM	100.0%	100.0%	100.0%

type injury	overall	equip opr	chainsaw only
Bite	1.0%	0.0%	0.0%
Caught in	9.6%	15.1%	0.0%
Fall	20.8%	29.1%	9.1%
Fire	0.3%	1.2%	0.0%
MVA	9.6%	4.7%	0.0%
Other	0.7%	1.2%	0.0%
Overexertion	7.9%	14.0%	0.0%
Struck by	50.2%	34.9%	90.9%
SUM	100.0%	100.0%	100.0%

day of week	overall	equip opr	chainsaw only
Monday	17.8%	19.8%	21.2%
Tuesday	22.1%	23.3%	27.3%
Wednesday	22.4%	16.3%	27.3%
Thursday	18.5%	22.1%	12.1%
Friday	13.5%	14.0%	12.1%
Saturday	4.3%	3.5%	0.0%
Sunday	1.3%	1.2%	0.0%
SUM	100.0%	100.0%	100.0%

Overall	overall	equip opr	chainsaw only
Cost mean $	10920	5540	5552
Cost median $	1200	1100	1008

Cost	overall	equip opr	chainsaw only
?	2.3%	2.3%	0.0%
< $5000	63.6%	67.4%	69.7%
$5000-$20000	22.5%	23.3%	21.2%
$20000 and up	11.6%	7.0%	9.1%
SUM	100.0%	100.0%	100.0%

Time Employed	overall	equip opr	chainsaw only
?	14.2%	20.9%	15.2%
< 12 months	39.3%	32.6%	45.5%
12-60 months	23.1%	25.6%	24.2%
>60 months	23.4%	20.9%	15.2%
SUM	100.0%	100.0%	100.0%

Appendix C. Summary of results based on degree of mechanization; partially mechanized (n=55) VS. fully mechanized operations (n=213)

occupation	partially	fully
?	1.8%	6.1%
Chipper	3.6%	1.9%
Deckhand	50.9%	26.3%
Dozer	0.0%	0.5%
Fellerbuncher	5.5%	8.0%
Loader	3.6%	9.4%
Mechanic	1.8%	3.8%
Other	0.0%	0.0%
Skidder	9.1%	12.2%
Supervisor	5.5%	6.1%
Truckdriver	18.2%	25.8%
SUM	100.0%	100.0%
equipment operator	21.8%	31.9%

nature injury	partially	fully
?	0.0%	1.4%
Amputation	0.0%	0.0%
Bite	0.0%	0.5%
Burn	0.0%	1.9%
Contusion	32.7%	20.7%
Crush	0.0%	1.4%
Fatal	1.8%	0.9%
Fracture	18.2%	17.4%
Heartattack	0.0%	0.9%
Laceration	27.3%	29.1%
Other	0.0%	0.9%
Sprain	20.0%	24.9%
SUM	100.0%	100.0%

where	partially	fully
?	9.1%	6.1%
Deck	45.5%	41.8%
Mill	0.0%	1.9%
Other	9.1%	12.2%
Shop	3.6%	12.2%
Woods	32.7%	25.8%
SUM	100.0%	100.0%

job function	partially	fully
?	0.0%	3.8%
Dismounting	1.8%	7.5%
Felling	10.9%	6.6%
Hooking	0.0%	0.5%
Idle	3.6%	6.6%
Loading	1.8%	0.9%
Maintenance/repair	7.3%	23.5%
Mounting	7.3%	2.3%
Operating	10.9%	16.0%
Other	9.1%	5.6%
Topping/delimbing	38.2%	16.9%
Trimming load	1.8%	3.8%
Unloading	1.8%	2.3%
Walking	5.5%	3.8%
SUM	100.0%	100.0%

object	partially	fully
?	0.0%	2.8%
Cable	0.0%	0.5%
Cans	0.0%	0.9%
Car	0.0%	0.9%
Chainsaw	10.9%	9.4%
Chips	7.3%	1.4%
Engine	0.0%	0.9%
Other equipment	1.8%	4.7%
Fellerbuncher	1.8%	3.8%
Gas	0.0%	0.9%
Hole	0.0%	0.9%
Hydfluid/water	0.0%	0.9%
Insect	0.0%	0.9%
Falling limb/tree	25.5%	11.7%
Loader	7.3%	8.5%
Log	16.4%	11.3%
Metal	1.8%	10.8%
Other	5.5%	1.9%
Skidder	7.3%	8.9%
Tire	1.8%	0.5%
Tools	3.6%	4.7%
Truck	9.1%	12.7%
SUM	100.0%	100.0%

time employed	partially	fully
<12 months	43.6%	38.5%
12-60 months	21.8%	24.4%
≥ 60 months	23.6%	20.7%
?	10.9%	16.4%
SUM	100.0%	100.0%

type injury	partially	fully
Bite	0.0%	0.0%
Caught in	3.6%	11.3%
Fall	23.6%	21.1%
Fire	0.0%	0.5%
MVA	7.3%	10.8%
Other	0.0%	1.9%
Overexertion	1.8%	10.3%
Struck by	63.6%	44.1%
SUM	100.0%	100.0%

Cost	partially	fully
< $5000	63.6%	64.3%
$5000 to $20000	27.3%	21.1%
$20000 plus	9.1%	12.7%
?	0.0%	1.9%
SUM	100.0%	100.0%
mean	10710	11304
median	1200	1200

Appendix D. Summary of results based on physiographic region; Coastal Plain (n=115) VS. Piedmont Operations (n=188).						
occupation	**CP**	**piedmont**		**object**	**CP**	**piedmont**
?	7.0%	4.3%		?	1.7%	2.7%
Chipper	2.6%	1.6%		Cable	0.0%	1.1%
Deckhand	37.4%	31.4%		Cans	0.0%	1.1%
Dozer	0.9%	0.5%		Car	0.9%	0.5%
Fellerbuncher	5.2%	7.4%		Chainsaw	9.6%	11.7%
Loader	4.3%	10.1%		Chips	2.6%	2.1%
Mechanic	1.7%	3.2%		Engine	1.7%	0.5%
Other	0.9%	0.0%		Other equipment	6.1%	2.7%
Skidder	11.3%	11.2%		Fellerbuncher	1.7%	3.7%
Supervisor	6.1%	5.9%		Gas	0.9%	0.5%
Truckdriver	22.6%	24.5%		Hole	1.7%	0.5%
SUM	100.0%	100.0%		Hydfluid/water	0.9%	0.5%
equipment operator	24.3%	30.9%		Insect	1.7%	0.5%
				Falling limb/tree	13.0%	15.4%
nature injury	**CP**	**piedmont**		Loader	7.0%	8.0%
?	0.0%	1.6%		Log/stump	16.5%	12.2%
Amputation	0.9%	0.0%		Metal	7.0%	10.1%
Bite	0.9%	0.5%		Other	2.6%	2.1%
Burn	0.9%	1.6%		Skidder	4.3%	10.1%
Contusion	20.9%	24.5%		Tire	1.7%	0.0%
Crush	1.7%	0.5%		Tools	5.2%	3.7%
Fatal	1.7%	0.5%		Truck	13.0%	10.1%
Fracture	17.4%	18.1%		**SUM**	100.0%	100.0%
Heartattack	0.0%	1.1%				
Laceration	29.6%	29.3%		**time employed**	**CP**	**piedmont**
Other	1.7%	0.5%		<12 months	36.5%	41.0%
Sprain	24.3%	21.8%		12-60 months	21.7%	23.9%
SUM	100.0%	100.0%		≥ 60 months	27.0%	21.3%
				?	14.8%	13.8%
where	**CP**	**piedmont**		**SUM**	100.0%	100.0%
?	9.6%	6.9%				
Deck	39.1%	41.5%		**type injury**	**CP**	**piedmont**
Mill	2.6%	1.1%		Bite	1.7%	0.5%
Other	13.9%	9.0%		Caught in	14.8%	6.4%
Shop	10.4%	10.1%		Fall	19.1%	21.8%
Woods	24.3%	31.4%		Fire	0.0%	0.5%
SUM	100.0%	100.0%		MVA	13.9%	6.9%
				Other	0.9%	0.5%
job function	**CP**	**piedmont**		Overexertion	5.2%	9.6%
?	0.9%	4.3%		Struck by	44.3%	53.7%
Dismounting	6.1%	5.9%		**SUM**	100.0%	100.0%
Felling	4.3%	8.5%				
Hooking	0.0%	1.6%		**Degree of mech.**	**CP**	**piedmont**
Idle	3.5%	6.9%		?	20.0%	6.4%
Loading	0.9%	1.1%		fully	60.0%	17.0%
Maintenance/repair	20.9%	17.6%		partially	20.0%	76.6%
Mounting	1.7%	3.7%		**SUM**	100.0%	100.0%
Operating	14.8%	14.4%				
Other	7.0%	5.3%				
Topping/delimbing	30.4%	19.7%				
Trimming load	5.2%	3.7%				
Unloading	1.7%	2.1%				
Walking	2.6%	5.3%				
SUM	100.0%	100.0%				

Appendix E. Summary of results of analyses of contractor size by # of employees, 5 or less employees (n=64) vs. 6 to 9 employees (n=131) vs. 10+ employees (n=106).

occupation	5 or less	6 to 9	10 or more
?	7.8%	5.3%	3.8%
Chipper	1.6%	1.5%	2.8%
Deckhand	28.1%	38.9%	30.2%
Dozer	0.0%	0.0%	0.9%
Fellerbuncher	3.1%	9.2%	5.7%
Loader	12.5%	7.6%	5.7%
Mechanic	0.0%	0.0%	7.5%
Other	0.0%	0.8%	0.0%
Skidder	23.4%	9.9%	5.7%
Supervisor	6.3%	5.3%	6.6%
Truckdriver	17.2%	21.4%	31.1%
SUM	100.0%	100.0%	100.0%
equipment operator	40.6%	28.2%	20.8%

nature injury	5 or less	6 to 9	10 or more
?	0.0%	0.8%	1.9%
Amputation	0.0%	0.0%	0.9%
Bite	0.0%	0.8%	0.9%
Burn	1.6%	2.3%	0.0%
Contusion	20.3%	25.2%	21.7%
Crush	0.0%	0.8%	1.9%
Fatal	0.0%	1.5%	0.9%
Fracture	25.0%	13.7%	17.9%
Heartattack	1.6%	0.0%	0.9%
Laceration	32.8%	29.8%	27.4%
Other	0.0%	0.0%	1.9%
Sprain	18.8%	25.2%	23.6%
SUM	100.0%	100.0%	100.0%

where	5 or less	6 to 9	10 or more
?	7.8%	5.3%	11.3%
Deck	40.6%	41.2%	40.6%
Mill	0.0%	3.8%	0.0%
Other	4.7%	11.5%	14.2%
Shop	10.9%	5.3%	16.0%
Woods	35.9%	32.8%	17.9%
SUM	100.0%	100.0%	100.0%

job function	5 or less	6 to 9	10 or more
?	6.3%	2.3%	1.9%
Dismounting	7.8%	6.9%	3.8%
Felling	14.1%	7.6%	1.9%
Hooking	4.7%	0.0%	0.0%
Idle	4.7%	6.9%	4.7%
Loading	1.6%	0.8%	0.9%
Maintenance/repair	15.6%	17.6%	22.6%
Mounting	7.8%	1.5%	1.9%
Operating	10.9%	13.7%	17.0%
Other	0.0%	6.9%	8.5%
Topping/delimbing	18.8%	24.4%	25.5%
Trimming load	6.3%	3.1%	4.7%
Unloading	0.0%	1.5%	3.8%
Walking	1.6%	6.9%	2.8%
SUM	100.0%	100.0%	100.0%

object	5 or less	6 to 9	10 or more
?	1.6%	3.1%	1.9%
Cable	3.1%	0.0%	0.0%
Cans	0.0%	1.5%	0.0%
Car	1.6%	0.8%	0.0%
Chainsaw	12.5%	12.2%	8.5%
Chips	0.0%	2.3%	3.8%
Engine	0.0%	0.8%	1.9%
Other Equipment	1.6%	3.8%	5.7%
Fellerbuncher	1.6%	3.8%	2.8%
Gas	0.0%	1.5%	0.0%
Hole	0.0%	2.3%	0.0%
Hydfluid/water	1.6%	0.8%	0.0%
Insect	0.0%	1.5%	0.9%
Falling limb/tree	17.2%	15.3%	11.3%
Loader	10.9%	8.4%	4.7%
Log/stump	14.1%	10.7%	17.0%
Metal	12.5%	7.6%	8.5%
Other	1.6%	0.0%	5.7%
Skidder	9.4%	6.9%	8.5%
Tire	0.0%	0.8%	0.9%
Tools	4.7%	4.6%	3.8%
Truck	6.3%	11.5%	14.2%
SUM	100.0%	100.0%	100.0%

time employed	5 or less	6 to 9	10 or more
<12 months	40.6%	36.6%	41.5%
12-60 months	14.1%	29.8%	20.8%
≥ 60 months	18.8%	19.1%	31.1%
?	26.6%	14.5%	6.6%
SUM	100.0%	100.0%	100.0%

type injury	5 or less	6 to 9	10 or more
Bite	0.0%	1.5%	0.9%
Caught in	10.9%	7.6%	11.3%
Fall	20.3%	22.9%	18.9%
Fire	1.6%	0.0%	0.0%
MVA	3.1%	9.9%	13.2%
Other	0.0%	1.5%	0.0%
Overexertion	7.8%	6.9%	9.4%
Struck by	56.3%	49.6%	46.2%
SUM	100.0%	100.0%	100.0%

Mechanization	5 or less	6 to 9	10 or more
?	12.5%	9.2%	12.3%
fully	67.2%	74.8%	67.9%
partially	20.3%	16.0%	19.8%
SUM	100.0%	100.0%	100.0%

Region	5 or less	6 to 9	10 or more
CP	26.6%	35.9%	47.2%
piedmont	73.4%	64.1%	52.8%
SUM	100.0%	100.0%	100.0%

Appendix E. Summary of results based on analysis of contractor size by number of skidders; one skidder (n=69) vs. two skidders (n=131) vs. 3+ skidders (n=101).

occupation	one	two	3 plus
?	4.3%	8.4%	2.0%
Chipper	1.4%	2.3%	2.0%
Deckhand	33.3%	32.1%	35.6%
Dozer	0.0%	0.0%	1.0%
Fellerbuncher	10.1%	6.9%	4.0%
Loader	10.1%	8.4%	5.9%
Mechanic	0.0%	0.0%	7.9%
Other	0.0%	0.8%	0.0%
Skidder	15.9%	9.9%	9.9%
Supervisor	7.2%	6.1%	5.0%
Truckdriver	17.4%	25.2%	26.7%
SUM	100.0%	100.0%	100.0%
equipment operator	37.7%	27.5%	22.8%

nature injury	one	two	3 plus
?	0.0%	2.3%	0.0%
Amputation	0.0%	0.8%	0.0%
Bite	0.0%	0.8%	1.0%
Burn	1.4%	1.5%	1.0%
Contusion	20.3%	25.2%	21.8%
Crush	0.0%	0.8%	2.0%
Fatal	0.0%	0.8%	2.0%
Fracture	21.7%	13.0%	20.8%
Heartattack	0.0%	0.8%	1.0%
Laceration	29.0%	29.0%	30.7%
Other	0.0%	0.0%	2.0%
Sprain	27.5%	25.2%	17.8%
SUM	100.0%	100.0%	100.0%

where	one	two	3 plus
?	4.3%	6.9%	11.9%
Deck	47.8%	37.4%	40.6%
Mill	1.4%	1.5%	2.0%
Other	5.8%	13.7%	10.9%
Shop	7.2%	9.9%	12.9%
Woods	33.3%	30.5%	21.8%
SUM	100.0%	100.0%	100.0%

job function	one	two	3 plus
?	7.2%	2.3%	1.0%
Dismounting	8.7%	5.3%	5.0%
Felling	7.2%	8.4%	5.0%
Hooking	2.9%	0.8%	0.0%
Idle	4.3%	6.1%	5.9%
Loading	1.4%	0.8%	1.0%
Maintenance/repair	17.4%	17.6%	21.8%
Mounting	7.2%	0.0%	4.0%
Operating	11.6%	16.8%	12.9%
Other	2.9%	7.6%	5.9%
Topping/delimbing	21.7%	23.7%	24.8%
Trimming load	2.9%	5.3%	4.0%
Unloading	0.0%	0.8%	5.0%
Walking	4.3%	4.6%	4.0%
SUM	100.0%	100.0%	100.0%

object	one	two	3 plus
?	1.4%	4.6%	0.0%
Cable	2.9%	0.0%	0.0%
Cans	1.4%	0.8%	0.0%
Car	1.4%	0.0%	1.0%
Chainsaw	11.6%	9.9%	11.9%
Chips	0.0%	2.3%	4.0%
Engine	0.0%	1.5%	1.0%
Other Equipment	1.4%	5.3%	4.0%
Fellerbuncher	4.3%	3.1%	2.0%
Gas	0.0%	0.8%	1.0%
Hole	2.9%	0.0%	1.0%
Hydfluid/water	1.4%	0.8%	0.0%
Insect	1.4%	0.8%	1.0%
Falling limb/tree	11.6%	16.8%	12.9%
Loader	8.7%	9.2%	5.0%
Log/stump	17.4%	8.4%	17.8%
Metal	4.3%	10.7%	9.9%
Other	1.4%	0.0%	5.9%
Skidder	13.0%	5.3%	7.9%
Tire	0.0%	0.8%	1.0%
Tools	5.8%	4.6%	3.0%
Truck	7.2%	14.5%	9.9%
SUM	100.0%	100.0%	100.0%

time employed	one	two	3 plus
<12 months	30.4%	44.3%	38.6%
12-60 months	24.6%	21.4%	24.8%
≥ 60 months	18.8%	18.3%	32.7%
?	26.1%	16.0%	4.0%
SUM	100.0%	100.0%	100.0%

type injury	one	two	3 plus
Bite	1.4%	0.8%	1.0%
Caught in	13.0%	4.6%	13.9%
Fall	29.0%	19.1%	17.8%
Fire	1.4%	0.0%	0.0%
MVA	4.3%	12.2%	9.9%
Other	0.0%	0.8%	1.0%
Overexertion	7.2%	9.2%	6.9%
Struck by	43.5%	53.4%	49.5%
	100.0%	100.0%	100.0%

Mechanization	one	two	3 plus
?	5.8%	10.7%	14.9%
fully	76.8%	71.8%	65.3%
partially	17.4%	17.6%	19.8%
SUM	100.0%	100.0%	100.0%

Region	one	two	3 plus
CP	31.9%	32.1%	49.5%
piedmont	68.1%	67.9%	50.5%
SUM	100.0%	100.0%	100.0%

Appendix F. Summary of results for claims cost analyses;
cost under $5000 (192) VS. cost $5000-20000 (68) VS. cost $20000 and up (35)

occupation	< $5000	$5K to $20K	$20K plus
?	6.3%	4.4%	2.9%
Chipper	2.6%	1.5%	0.0%
Deckhand	31.8%	38.2%	37.1%
Dozer	0.5%	1.5%	0.0%
Fellerbuncher	6.3%	10.3%	2.9%
Loader	8.9%	4.4%	5.7%
Mechanic	3.1%	0.0%	5.7%
Other	0.5%	0.0%	0.0%
Skidder	12.0%	11.8%	8.6%
Supervisor	3.6%	4.4%	20.0%
Truckdriver	24.5%	23.5%	17.1%
SUM	100.0%	100.0%	100.0%
equipment operator	30.2%	29.4%	17.1%

nature injury	< $5000	$5K to $20K	$20K plus
?	1.0%	1.5%	0.0%
Amputation	0.0%	0.0%	2.9%
Bite	1.0%	0.0%	0.0%
Burn	1.6%	1.5%	0.0%
Contusion	29.2%	11.8%	11.4%
Crush	0.5%	1.5%	2.9%
Fatal	0.0%	0.0%	8.6%
Fracture	9.9%	36.8%	28.6%
Heartattack	1.0%	0.0%	0.0%
Laceration	30.2%	27.9%	25.7%
Other	1.0%	0.0%	0.0%
Sprain	24.5%	19.1%	20.0%
SUM	100.0%	100.0%	100.0%

where	< $5000	$5K to $20K	$20K plus
?	8.3%	7.4%	2.9%
Deck	40.6%	41.2%	40.0%
Mill	1.6%	2.9%	0.0%
Other	9.9%	13.2%	14.3%
Shop	11.5%	4.4%	8.6%
Woods	28.1%	30.9%	34.3%
SUM	100.0%	100.0%	100.0%

job function	< $5000	$5K to $20K	$20K plus
?	3.6%	1.5%	2.9%
Dismounting	6.3%	2.9%	5.7%
Felling	5.7%	8.8%	14.3%
Hooking	1.6%	0.0%	0.0%
Idle	5.7%	4.4%	2.9%
Loading	1.6%	0.0%	0.0%
Maintenance/repair	20.8%	10.3%	22.9%
Mounting	4.2%	1.5%	0.0%
Operating	12.5%	19.1%	17.1%
Other	6.8%	5.9%	2.9%
Topping/delimbing	21.4%	32.4%	20.0%
Trimming load	4.2%	5.9%	2.9%
Unloading	2.6%	1.5%	0.0%
Walking	3.1%	5.9%	8.6%
SUM	100.0%	100.0%	100.0%

object	< $5000	$5K to $20K	$20K plus
?	3.6%	0.0%	0.0%
Cable	1.0%	0.0%	0.0%
Cans	1.0%	0.0%	0.0%
Car	0.0%	1.5%	2.9%
Chainsaw	11.5%	10.3%	8.6%
Chips	2.6%	1.5%	0.0%
Engine	0.5%	0.0%	5.7%
Other Equipment	2.1%	4.4%	2.9%
Fellerbuncher	3.1%	4.4%	2.9%
Gas	1.0%	0.0%	0.0%
Hole	0.5%	2.9%	0.0%
Hydfluid/water	0.5%	1.5%	0.0%
Insect	1.6%	0.0%	0.0%
Falling limb/tree	14.1%	14.7%	20.0%
Loader	7.3%	4.4%	14.3%
Log/stump	10.9%	23.5%	8.6%
Metal	10.4%	8.8%	0.0%
Other	2.1%	4.4%	0.0%
Skidder	8.9%	7.4%	11.4%
Tire	0.5%	0.0%	2.9%
Tools	4.2%	0.0%	11.4%
Truck	12.5%	10.3%	8.6%
SUM	100.0%	100.0%	100.0%

time employed	< $5000	$5K to $20K	$20K plus
<12 months	40.6%	38.2%	31.4%
12-60 months	21.4%	23.5%	37.1%
≥ 60 months	20.8%	30.9%	17.1%
?	17.2%	7.4%	14.3%
SUM	100.0%	100.0%	100.0%

type injury	< $5000	$5K to $20K	$20K plus
Bite	1.6%	0.0%	0.0%
Caught in	9.4%	5.9%	17.1%
Fall	23.4%	16.2%	11.4%
Fire	0.0%	1.5%	0.0%
MVA	8.3%	13.2%	11.4%
Other	1.0%	0.0%	0.0%
Overexertion	8.9%	5.9%	5.7%
Struck by	47.4%	57.4%	54.3%
SUM	100.0%	100.0%	100.0%

Appendix G. Summary of results by occupation

job function	chipper(6)	deckhand(102)	FellrBunchr(20)	loader(24)	mechanic(8)	skidder(34)	supervisor(18)	truckdriver(72)	equipment opr(84)
?		2.0%		8.3%					2.4%
Dismounting			15.0%	33.3%		5.9%	5.6%	4.2%	15.5%
Felling		13.7%	5.0%			5.9%	22.2%	1.4%	3.6%
Hooking						5.9%		1.4%	2.4%
Idle	16.7%	9.8%						8.3%	1.2%
Loading								4.2%	0.0%
Maintenance/repair	50.0%	2.0%	30.0%	33.3%	100.0%	20.6%	44.4%	13.9%	28.6%
Mounting				8.3%		11.8%		4.2%	7.1%
Operating	16.7%		25.0%	4.2%		26.5%	5.6%	34.7%	19.0%
Other	16.7%	3.9%	10.0%	8.3%		8.8%	5.6%	5.6%	9.5%
Delimbing/topping		60.8%		4.2%		14.7%	5.6%	1.4%	7.1%
Trimming load		2.9%						9.7%	0.0%
Unloading								8.3%	0.0%
Walking		4.9%	15.0%				11.1%	2.8%	3.6%
SUM	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

type injury	chipper(6)	deckhand(102)	FellrBunchr(20)	loader(24)	mechanic(8)	skidder(34)	supervisor(18)	truckdriver(72)	equipment opr(84)
Bite		2.0%			12.5%				0.0%
Caught in	16.7%	2.9%	15.0%	8.3%	12.5%	20.6%	27.8%	8.3%	15.5%
Fall	16.7%	18.6%	30.0%	50.0%		14.7%	16.7%	20.8%	28.6%
Fire				4.2%					1.2%
MVA			5.0%	4.2%		5.9%		33.3%	4.8%
Other		1.0%				2.9%			1.2%
Overexertion	16.7%	2.0%	10.0%	8.3%	37.5%	20.6%	11.1%	5.6%	14.3%
Struck by	50.0%	73.5%	40.0%	25.0%	37.5%	35.3%	44.4%	31.9%	34.5%
SUM	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

object	chipper(6)	deckhand(102)	FellrBunchr(20)	loader(24)	mechanic(8)	skidder(34)	supervisor(18)	truckdriver(72)	equipment opr(84)
?		3.9%				2.9%	5.6%		
Cable						5.9%			2.4%
Cans			5.0%	4.2%					2.4%
Car							5.6%	1.4%	
Chainsaw		22.5%	5.0%			8.8%	11.1%	2.8%	4.8%
Chipper	33.3%								2.4%
Chips	16.7%	1.0%						5.6%	1.2%
Engine							11.1%	1.4%	
Other Equipment		1.0%	5.0%	4.2%		5.9%		4.2%	4.8%
Fellerbuncher			30.0%				5.6%	2.8%	7.1%
Gas		1.0%				2.9%			1.2%
Hole			10.0%					1.4%	2.4%
Hydfluid/water			5.0%					1.4%	1.2%
Insect		2.0%			12.5%				1.2%
Falling tree/Limb		24.5%	5.0%	4.2%		14.7%	11.1%	8.3%	8.3%
Loader		7.8%	5.0%	50.0%			5.6%	1.4%	15.5%
Log/stump		24.5%	10.0%	8.3%		2.9%		11.1%	6.0%
Metal	16.7%	2.0%	10.0%	20.8%	37.5%	8.8%	11.1%	11.1%	13.1%
Other					25.0%		5.6%	5.6%	
Skidder		9.8%				38.2%		2.8%	15.5%
Tire						2.9%		1.4%	1.2%
Tools	16.7%		5.0%		25.0%		16.7%	2.8%	2.4%
Truck	16.7%		5.0%	8.3%		5.9%	11.1%	34.7%	7.1%
SUM	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

VITA

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While enrolled at Virginia Tech in the Forest Resource Management undergraduate program, the author completed a forestry internship with Trus Joist MacMillan in Buckhannon, West Virginia. He graduated with a Bachelor of Science in Forestry in May 1996, and enrolled in the Industrial Forestry Operations graduate program at Virginia Tech in August 1996. The author graduated with a Master of Science in Forestry in June 1998.