DISSERTATION

OCCUPATIONAL INJURY PREVENTION AMONG PROFESSIONAL LOGGERS IN THE INTERMOUNTAIN REGION OF THE UNITED STATES

Submitted by

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ABSTRACT

OCCUPATIONAL INJURY PREVENTION AMONG PROFESSIONAL LOGGERS IN THE INTERMOUNTAIN REGION OF THE UNITED STATES

Despite advances in harvesting techniques, commercial logging continues to be one of the most dangerous occupations in the United States (US). In 2015, logging workers had the highest rate of fatal work injuries of all US industries (Bureau of Labor Statistics, 2017). In 2016, the nationwide fatality rate for the logging industry was 100.1 per 100,000 full-time equivalent workers (FTE), almost 30 times higher than the nationwide fatality rate for all occupations combined (U.S. Bureau of Labor Statistics, 2017).

Logging in the Intermountain (Montana and Idaho, USA) region is especially dangerous due to steep terrain, weather conditions, and remote work locations. To date, there are very few studies which provide an analysis of logging safety and none which focus on the specific challenges and risks present in the Intermountain region.

The specific aims and objectives of this proposal are consistent with the recommended strategic goals outlined in the National Occupational Research Agenda (NORA). Strategic goals six and seven in the NORA are to reduce the number, rate and severity of traumatic injuries and deaths involving hazards of forestry and to improve the health and well-being of forestry workers by reducing occupational causes or contributing factors to acute and chronic illness and disease (NORA Agricultural Forestry and Fishing Sector Council, 2008).

The Systematic Approach to Training provided the overall model for this project. Several other models and methodology were also used to create an intervention program focused on logging workers operating in the Intermountain region of the United States. The intervention program consisted of an emergency first-aid training program that provided didactic instruction, relevant examples, and practical skills to respond to emergencies, which commonly occur in the logging industry.

The justification of the need for an emergency first-aid training program in the logging industry was primarily based mixed methods analysis of five-years of workers' compensation data and focus groups with 63 professional loggers (Study 1). We then investigated the demographics and self-reported work-related musculoskeletal symptoms among a cohort of 743 loggers in Montana (Study 2). We also conducted a study to quantify safety climate and identify the determinants of safety climate (Study 3). A Systematic Approach to Training was then used to develop, implement, and evaluate an emergency first-aid training program that specifically addresses the challenges and hazards of the logging industry (Study 4). Approximately 7-months following the emergency first-aid training a qualitative analysis was conducted to evaluate the longer-term effects of the training program and identify curriculum improvements (Study 5).

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Chapter 1: Dissertation Overview

1.1. Project Introduction

The long-term goal of this research program is to reduce the injury rate and severity of injuries among professional loggers in the Intermountain region of Montana and Idaho, USA. While the long-term research goal is beyond the scope of this dissertation, as a first step, we developed and evaluated an emergency first-aid training program utilizing The Systematic Approach to Training. The Systematic Approach to Training provided the overall model for this project, but several other models and methods were combined to create an intervention focused specifically on workers operating in the Intermountain region of the United States. Collection of a combination of qualitative and quantitative data provided a deeper understanding of the injuries and hazards of the logging industry, which was used to create a training program with specific and relevant examples. Although the emergency first-aid training program focused on secondary and tertiary levels of injury prevention, the results of this research assisted in the identification of intervention strategies focused on primary injury prevention and set the framework for the continuous improvement of safety training in the Montana logging industry.

The methods contained in this dissertation are novel in the context of the logging industry and research is desperately needed due to the high rates of injuries and fatalities among professional loggers. While prior researchers have measured training effectiveness in the logging industry, there are no intervention-based studies which measure the effectiveness and reception of a training program based on end-user perspectives. This was first study to use the Systematic Approach to Training to evaluate an existing training system and needs of the logging industry with specific attention to the challenges present in the Intermountain region, and then develop, implement, and evaluate a refined training program. During the development of the emergency first-aid training program, analysis and data collection was performed for workers' compensation claims, focus groups, and surveys of worker demographics, work-related musculoskeletal symptoms, and organizational safety climate. These analyses were used to assess hazards and possible training topics and resulted in a more complete understanding of the injuries and hazards of the logging industry.

Based on the initial needs analysis of the industry, as well as gaps in current research and training, an emergency first-aid training program was developed for use by the logging industry. After implementing the training program, an evaluation plan was developed using a mixed-methods approach. Evaluation of the emergency first-aid training program included pre- and post-training examinations, surveys, and follow-up examinations and focus groups at approximately seven months post-training. Follow-up focus groups provided unique and novel insights into the relevancy of first-aid training, changes in job performance resulted from the learning process, capabilities to perform the newly learned skills, the absence of necessary skills or knowledge, and barriers to transfer of knowledge to skills in the field.

1.2. Dissertation Aims

According to the 2008 National Institute of Occupational Safety and Health (NIOSH) National Occupational Research Agenda (NORA), strategic goals for increasing the safety and furthering research in the forestry operations should be focused around … outreach, communications and partnerships (NORA Agricultural Forestry and Fishing Sector Council, 2008). The 2008 NORA related to Agriculture, Forestry, and Fishing (AgFF) included nine strategic goals, two of which were specific to the forestry industry. Strategic goal number six was to …reduce the number, rate and severity of traumatic injuries and deaths involving hazards of forestry (NORA Agricultural Forestry and Fishing Sector Council, 2008). The seventh strategic goal was to improve the health and well-being of forestry workers by reducing occupational causes or contributing factors to acute and chronic illness and disease (NORA Agricultural Forestry and Fishing Sector Council, 2008). Additionally, the specific aims and objectives of this project focused on the recommended action steps of NORA, specifically within strategic goals six and seven that include Steps 6.1.1, 6.1.2, 6.1.3, 7.1.2, 7.1.3 (NORA Agricultural Forestry and Fishing Sector Council, 2008).

In pursuit of the overall research goal of reducing the injury rate and severity of injuries among loggers the following specific aims were initially proposed:

Specific Aim 1: Conduct a descriptive analysis of workers' compensation claim data from all logging injuries and fatalities that occurred in Montana and Idaho from July 2010 through June 2015.

Objectives:

1. Partner with the Montana Logging Association and Idaho Logging Associations and their respective workers' compensation carriers to obtain workers compensation claim data.
2. Identify age, gender, and experience of workers injured, type and frequency of injury, and medical and indemnity costs of injuries.

Specific Aim 2: Conduct focus groups with professional loggers regarding the contributing factors to the types of injures described in workers' compensation claim data as well as identify possible barriers and facilitators to injury prevention interventions.

Objective:

1. Conduct focus groups with 63 professional loggers from Montana and Idaho to gain their perspective on causation and prevention of incidents identified in the workers'

compensation data.

Specific Aim 3: Determine the 12-month period prevalence of musculoskeletal symptoms (MSSs) among professional loggers in Montana.

Objective:

1. Use a validated survey (Nordic Musculoskeletal Questionnaire) to conduct an analysis of musculoskeletal symptoms (MSSs) among professional loggers working in Montana (Appendix I).

Specific Aim 4: Quantify the safety climate of the logging industry in Montana at baseline and at one year follow up.

Objective:

1. Use a validated safety culture survey to assess safety climate among professional loggers (Appendix I).

Specific Aim 5: Using the Systematic Approach to Training, develop an emergency first-aid training program to be used by the MLA at their annual training sessions (Appendix III, IV, V, VI).

Objectives:

1. Use an interdisciplinary team to develop a refined video-based training program based on the results of the analysis and design phases of the systematic approach to training.
2. Perform a gap analysis to determine if the training program is compliant with OSHA standards (Appendix VII).
3. Develop an examination to evaluate recall of necessary knowledge and skills (Appendix III).
4. Perform a gap analysis to determine if questions presented during the examination are

consistent with training objectives (Appendix IX).

Specific Aim 6: Conduct a follow-up evaluation of the emergency first-aid training program through use of training reaction surveys, examinations, and focus groups with logging crews.

Objectives:

1. Conduct a training reaction survey to evaluate the new training program and obtain suggestions for the improvement of future training. Suggestions for improvement should include topics covered, applicability, course format, etc. (Appendix II).
2. Administer a pre- and post- examination to evaluate recall of information presented during training program (Appendix VII).
3. Conduct focus groups with 100 professional loggers who attended the emergency first-aid training program in the spring of 2017. Focus groups will be centered on questions regarding the relevancy of first-aid training, changes in job performance resulted from the learning process, capabilities to perform the newly learned skills, the absence of necessary skills or knowledge, and barriers to transfer of knowledge to skills in the field.
4. Administer an examination during the follow-up period to evaluate retention of information presented during the training program.

Table 1.1: List of Original Studies

Study	Location in Dissertation	Article	Authors	Status	Study Purpose	Specific Aim	Systematic Approach to Training Phase
Workers Compensation and Focus Groups	Chapter 2	"A mixed-methods analysis of logging injuries in Montana and Idaho" *American Journal of Industrial Medicine*	Lagerstrom Magzamen Rosecrance	Published	The objective of this study was to implement a mixed-methods approach to identify injury prevention strategies for the logging industry in this region. This research integrates an analysis of workers' compensation data and focus group results to better understand injuries and fatalities. The goal of the analysis is to inform the future direction of logging safety and training in the Intermountain West region.	1 & 2	Analysis
Musculoskeletal Symptoms	Chapter 3	"Work-Related Musculoskeletal Symptoms among Professional Loggers in Montana" *International Journal of Occupational and Environmental Health*	Lagerstrom Magzamen Brazile Rosecrance	In Review	The purpose of this study was to determine the 12-month period prevalence of musculoskeletal symptoms (MSS) among professional loggers in Montana and differentiate the prevalence based on logging system types while accounting for demographic and workplace covariates. This information is needed to identify the current MSS symptom status of the logging population and to identify opportunities for occupational safety interventions.	3	Analysis
Safety Climate	Chapter 4	"Safety Climate in the Montana Logging Industry" *Safety Science*	Lagerstrom Magzamen Kines Brazile Rosecrance	In Review	The purpose of this cross-sectional study was to quantify safety climate in the logging industry of Montana and identify determinants of safety climate based on surveys of worker demographics, workplace factors, and musculoskeletal symptoms.	4	Analysis

Training Evaluation and Follow-Up	Chapter 5	"A Case Study in the Application of The Systematic Approach to Training in the Logging Industry" *Journal of Safety Research*	Lagerstrom Magzamen Brazile Stallones Ayers Rosecrance	In Review	The purpose of this research was to use the Systematic Approach to Training to develop, implement, and evaluate a refined training program that specifically addresses the challenges and hazards of the logging industry. The objectives of this study were to demonstrate recall and retention of key concepts included in the training program and to test if the program was received more positively by the intended audience than previous year's training programs.	5 & 6	Design Development Implementation Evaluation
Training Evaluation and Follow-Up	Chapter 6	"Evaluation of a Safety Training for the Logging Industry: A Qualitative Approach" *International Journal of Forest Engineering*	Lagerstrom Stallones Magzamen Brazile Ayers Rosecrance	In Preparation	The purpose of this study was to assess the effectiveness of a safety training program and to identify the current safety perceptions among Montana loggers utilizing qualitative assessment methods.	5 & 6	Evaluation

Project Plan

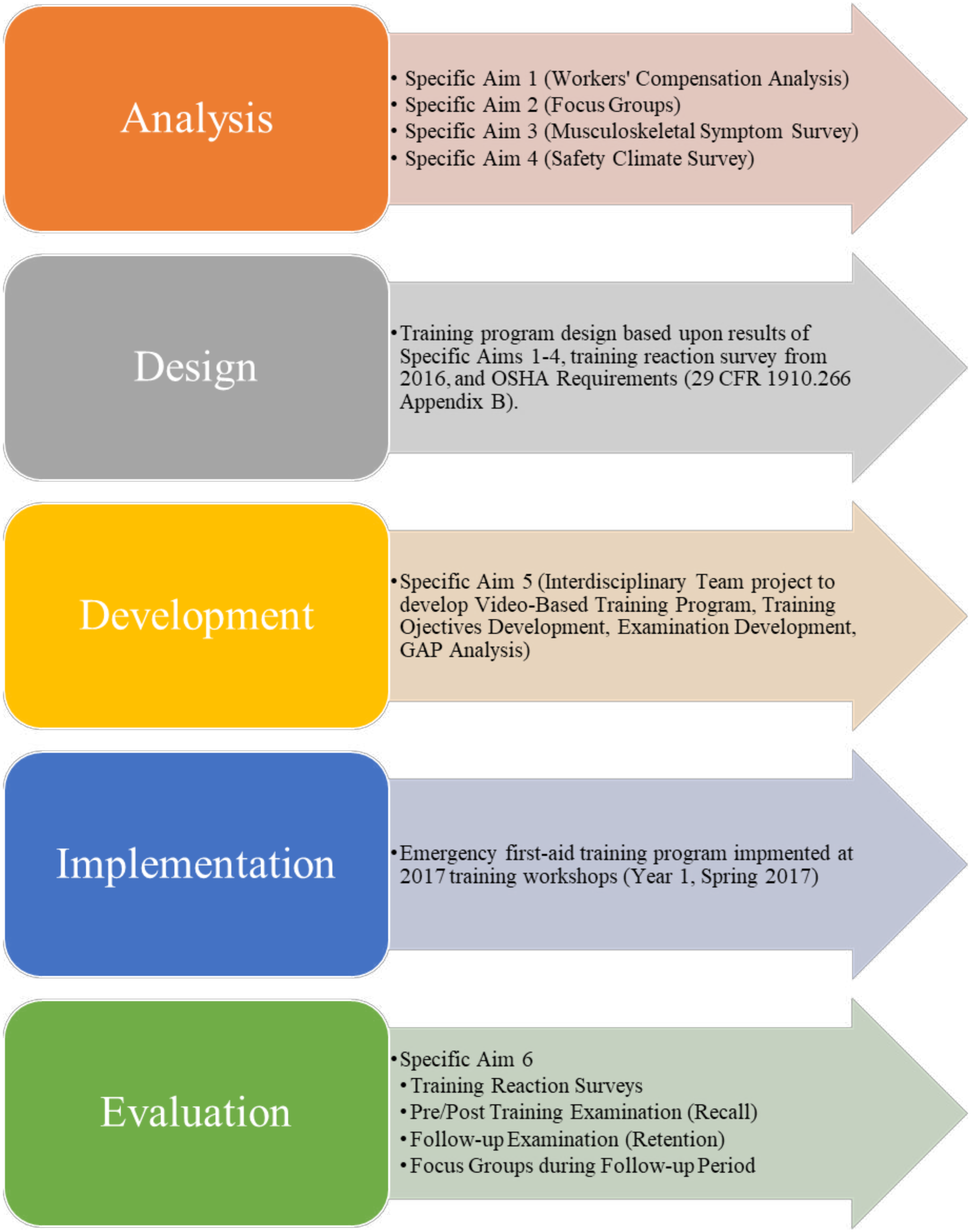

Figure 1.1: Project Plan

1.3. Literature Review

Occupational Injuries and illnesses account for nearly 170 billion in spending in the United States every year (United States Department of Labor, 2016). The logging industry is one of the most dangerous industries in the United States. The occupational fatality rate for US workers across all occupations was 3.6 per 100,000 Full-Time Equivalent Workers (FTE), while loggers had an occupational fatality rate of 100.1 per 100,000 FTE (Bureau of Labor Statistics, 2017).

While the logging industry is dangerous worldwide, logging in the Intermountain (Montana and Idaho) region is especially dangerous due to steep terrain, weather conditions, and remote work locations. In addition to the inherent dangers of the logging industry, recently, in the Intermountain region, logging companies face economic challenges. As a result of the recession, demand for timber decreased when the housing market crashed. In response to the decreased demand for timber, mills closed. While the economic challenges have a direct impact on the workers psychosocially, they also have an indirect impact on the safety of the workplace. As demand for timber decreased, lumber sale prices also decreased. Logging companies are facing decreasing profit margins as the cost to harvest the timber has not changed (and in some cases increased), while sale prices have decreased. In addition, closing mills had, and continues to have, an immediate and tangible impact to the timber haulers. Timber haulers must now drive further distances, often past mills which have closed, to unload at operational mills. The increase in time and fuel necessary for the hauling process continues to eat at the already shrinking profit margins.

According to antidotal opinions from loggers, to remain profitable during times of economic hardship, safety may be sacrificed for productivity. For example, to harvest near an operational mill, companies may accept contracts on terrain which has previously been passed over due to steepness. Similarly, companies may choose to operate and harvest during periods of extreme weather or harsh conditions, when in past years they may have taken the week off. Log haulers may violate regulations on number of driving hours and distance to maintain the same number of loads hauled per day as they did before many mills closed. Finally, safety training, equipment maintenance, and the availability of PPE may be foregone for more days in the woods or more money in the company's account.

Job Types and Associated Risk

Within the logging industry, there are different levels and types of risk based on job task and logging system. The forestry and logging industry subsector is divided into the following jobs by the United States Department of Labor: fallers, supervisors, logging equipment operators, and truck drivers (United States Department of Labor, 2015). The logging system type determines the number of workers in each of these different job tasks as well as the configuration of equipment. There is a wide range in the possible configurations of machines and processes used in harvesting (i.e. logging system). The logging system of choice is dependent on the terrain and region of the harvest, as well as the resources of the contracted logging company. There are two main logging systems for felling trees (conventional chainsaw logging and mechanical logging) and four main systems for transporting felled trees (skidder, horse logging, line skidding, and helicopter logging) (Montana Logging Association, 2008). In conventional chainsaw logging systems, trees are felled, delimbed and cut to length by sawyers using a chainsaw (Montana Logging Association, 2008). In contrast, mechanical logging systems use feller-bunchers to fell, delimb, and cut the log to the desired length (Montana Logging Association, 2008). Horse logging, line skidding, and helicopter logging systems are three methods of removing the cut logs from the stand to an area where the logs can be loaded onto a logging truck. In each of the previously mentioned methods, a worker (the hooker/choke setter) is responsible for attaching cables to the logs to be hauled from the site. These three methods are used when a skidder is unavailable or unable to operate due to terrain, weather conditions, or environmental conditions. The terrain and the availability of resources determine the method in which the logs are removed and staged for loading onto the log truck.

There are many risk factors contributing to injuries in the logging industry. Previous research on logging injuries and fatalities on a national scale they found regional differences in the fatality rates. Specifically, fatality rates were highest in the central U.S. and lowest in the Great Lakes region of the country (Myers & Fosbroke, 1994). The authors concluded that regional differences may be attributed to timber type, terrain, and logging system. In addition, this study found a significant difference in the fatality rate of general logging labor in comparison to machinery operators. General logging labor includes fellers, limbers, buckers, and choke setters and had an occupational fatality rate of 371.8 per 100,000, while machinery operators had an occupational fatality rate of 48.5 per 100,000 (Myers & Fosbroke, 1994).

There are challenges to conducting research in the logging industry for a number of reasons, two of which are rapid mechanization and industry variation across the nation and world. Variation within the industry is based on range of factors that include degree of mechanization, terrain, weather conditions, and worker demographics. Differences in the aforementioned factors may have an impact on the prevalence, type, and severity of occupational injuries and fatalities (Myers & Fosbroke, 1994).

Logging Mechanization

Degree of mechanization, terrain, weather conditions, and worker demographics within the logging industry contribute to the heterogeneity of injury and fatality rates within in the United States (Myers & Fosbroke, 1994). Some researchers suggested that increasing mechanization of the industry may decrease the number of injuries and fatalities associated with logging (Bordas, Davis, Hopkins, Thomas, & Rummer, 2001). For example, Myers and Fosbroke (1994) found a significant difference in the fatality rate of general logging labor in comparison to machinery operators (Myers & Fosbroke, 1994). General logging labor (i.e. fellers, limbers, buckers, and choke setters) had an occupational fatality rate of 371.8 per 100,000, while machinery operators had an occupational fatality rate of 48.5 per 100,000 (Myers & Fosbroke, 1994). Further, an analysis of injury claims data before and after mechanization indicated a significant decrease in injury claims when companies transitioned from conventional (i.e. chainsaw) logging to feller-buncher tree harvesting (Bell, 2002). However, with modernization and mechanization comes an effort and ability to raise productivity (Bordas et al., 2001).

In addition to higher yield, new technology and equipment has allowed loggers to harvest on extreme terrain, previously impossible with conventional logging methods. Earlier research on logging injuries and fatalities has identified differences in fatality rates by region (Myers & Fosbroke, 1994). The authors concluded that regional differences may be attributed to timber type, logging system, and terrain. Specifically, mechanization has allowed logging in the Intermountain West (which includes Montana and Idaho) to expand to previously remote areas with higher elevation, steeper slopes, extreme weather, and longer transportation times to processing plants. Previous logging injury research is not readily generalizable to this region due to these factors.

There are differences in injury type and rate based upon the degree of mechanization used during logging. Some researchers suggest that increasing mechanization of the industry should decrease the number of injuries and fatalities associated with logging (Axelsson, 1998; Bordas et al., 2001; Nieuwenhuis & Lyons, 2002). Injures common to conventional logging practices include acute injuries due to being struck-by trees and lacerations due to chainsaw use. In addition, manual felling systems are associated with chronic injuries such as hearing impairment and vibration-related problems (Nieuwenhuis & Lyons, 2002). An analysis of injury claim data before and after mechanization indicated a significant decrease in injury claims when companies transitioned from conventional to feller-buncher tree harvesting (Bell, 2002). However, this transition has now been linked to an increase in repetitive strain injuries (Nieuwenhuis & Lyons, 2002).

With modernization and mechanization comes an effort and ability to raise productivity (Bordas et al., 2001). Increased productivity can be accomplished through longer working hours and progressing technology. In addition to higher productivity, new technology and equipment has allowed loggers to harvest on extreme terrain, which would have been impossible if relying on conventional methods. Loggers working on mechanized operations in Ireland have identified increased pressure of work and excessive shift length as stressors that have resulted after the transition from conventional to mechanized logging (Nieuwenhuis & Lyons, 2002).

Psychosocial Work Conditions

The psychological stressors of decreasing profit margins (Nieuwenhuis & Lyons, 2002) , long working hours (Axelsson, 1998; Lilley, Feyer, Kirk, & Gander, 2002; Nieuwenhuis &

Lyons, 2002), and perceived workplace dangers (Nieuwenhuis & Lyons, 2002) are all present in the logging industry. In many areas throughout the world, payment in the logging industry is based upon productivity (i.e. piece rate). Use of piece rate payment has been identified as a barrier to safe work practices (Nieuwenhuis & Lyons, 2002). In addition, a survey of loggers revealed that over 60% of respondents believed that the financial restrictions and payment were a barrier to workplace health and safety (Nieuwenhuis & Lyons, 2002). There is seasonal and regional variance in the working hours in the logging industry and studies have analyzed the association between workplace fatigue and injuries. A survey conducted with logging workers in New Zealand found that almost 80% of respondents worked over 45 hours per week, with 26% working more than 60 hours per week, and 8% working more than 60 hours per week (Lilley et al., 2002). In addition to the workplace stressors of productivity concerns and working hours, in a study of health and safety perceptions in Ireland, over half of logging workers surveyed believed that forest harvesting work should be described as dangerous (Nieuwenhuis & Lyons, 2002). The combination and interaction between these psychosocial stressors may contribute to the increased injury and fatality rate of the logging industry. In studies relating workplace psychosocial stressors to occupational injury rates, jobs with "compromised psychosocial qualities, especially high job demands/workload… reported more occupational injuries" (Nakata et al., 2006).

Gaps in Existing Research and Training Programs

Research in the logging industry has focused on the annual rate and characteristics of injuries (Bell & Helmkamp, 2003; Jack & Oliver, 2008; Lefort, de Hoop, Pine, & Marx, 2003; Lynch, Smidt, Merrill, & Sesek, 2014; Priscah Mujuru, Singla, Helmkamp, Bell, & Hu, 2006; Myers & Fosbroke, 1994; Nieuwenhuis & Lyons, 2002), the effects of mechanization (Axelsson, 1998; Bell, 2002; Bordas et al., 2001; National Institute for Occupational Safety and Health, 2005; Roberts, Shaffer, & Bush, 2005), worker's perceptions of the occupational risk (Bordas et al., 2001; Nieuwenhuis & Lyons, 2002), as well as the development of training strategies (Bell & Grushecky, 2006; Egan, 2005; P. Mujuru, Helmkamp, Mutambudzi, Hu, & Bell, 2009). Industry characteristics vary greatly by country and region, due to terrain, standards, environmental conditions, and workforce demographics. Due to these differences, additional research is needed to quantify and compare injury and fatality analysis with regard to region of employment. The Intermountain region is lacking current research and has unique risks due to the weather conditions, mountainous terrain, wild animals (grizzly and black bears) and remoteness that the loggers experience. Additionally, as technology and mechanization in the logging industry becomes more pervasive, research is needed to determine emerging safety threats and trends in order for the development of training and intervention strategies.

Currently, OSHA defines training requirements for the logging industry in Appendix B of 29 CFR 1910.266 (United States Department of Labor). However, research has documented a gap between training and preparing loggers for work in the forests. Because of this gap, research has been, and continues to be, conducted to determine the needs and best methods of training new, as well as seasoned workers, on safe work practices. To develop a training program to best meet the needs of the end-user, research must be conducted to understand the population of interest. As discussed above, population demographics, risks, and logging systems vary by region. Due to this variance, training attitudes, needs, and preferences also vary by region. However, previous and non-local research can be used as a starting point and proxy for overall industry preferences.

A study conducted on the training preferences of loggers in New England found that the majority of loggers surveyed believed that they learned valuable safety information during safety trainings and that having logging certification programs available was a valuable resources (Egan, 2005). The same study also identified that there was a need to ensure that the training being administered matched the needs of the end-user in order to resist “becoming irrelevant or fostering negative attitudes toward training among the logging community” (Egan, 2005). The authors make a suggestion for future research: due to “the diversity of the logging business” any surveys on training attitudes and preferences should be separated as much as possible into different cohorts (such as by logging system type or job title), to ensure that training can be as specific as possible to the audience’s needs and interests (Egan, 2005).

One of the major barriers facing the logging industry is making safe work practices cost-productive. In the south, a survey of logging training preferences found that although safety training is useful, it is believed to be impractical and detrimental to productivity (Bordas et al., 2001). However, in a study evaluating a training intervention implemented in West Virginia, during a survey follow-up six months post intervention, 90% of loggers believed that the information that was covered during the safety training program was useful and had an impact on their work (Helmkamp, Bell, Lundstrom, Ramprasad, & Haque, 2004).

Research demonstrates that training programs on safe felling technique alone is not enough to reduce the injury rate in manual felling operations. A retrospective cohort study comparing the injury rates of fallers who received a training intervention versus fallers who did not receive a training intervention found no significant difference between fallers who attended and passed the course and fallers who did not attend (McLeod, Sarkany, Davies, Lyons, & Koehoorn, 2015). The authors suggest that training may not be enough to reduce the risk to manual fellers and that training on technique should be paired with interventions to behavior or organizational aspects of the job (McLeod et al., 2015). Despite mixed findings on the practicality and ability for training to decrease injury and fatality rates, when surveyed, loggers throughout the world hold the opinion that training is useful and should be more readily available (Nieuwenhuis & Lyons, 2002).

The Systematic Approach to Training

The Systematic Approach to Training (SAT) uses a participatory approach and was developed with the goal of training workers to " do their jobs safely, efficiently, and effectively , and to protect the workforce, the public and the environment" (United States Department of Energy, 2014). The SAT is described in detail in The Department of Energy (DOE) handbook, *DOE-HDBK-1 078-94.*Key features of ensuring the development of a successful training program, which are stressed in the handbook, include insuring frequent communication with subject matter experts and management commitment to the development and ongoing implementation and improvement of the program (Dhawan, 2016; United States Department of Energy, 2014).

The SAT is comprised of a five-step process, which is designed to train workers to be able to accomplish the necessary work tasks associated with their position. The first step, analysis, outlines and describes the necessary work tasks for the position the training is being created for. The DOE recommends identifying training needs through a variety of different processes. One of the first methods to identifying training needs is to review regulatory requirements and existing training programs for the position or task of interest (United States Department of Energy, 2014). The DOE suggests that requirements from a regulatory source, such as OSHA, may be sufficient to complete the first step in the SAT (United States

Department of Energy, 2014). In addition to reviewing regulatory requirements, other suggestions for completing the analysis phase induce: consulting subject matter experts, preparing and analyzing survey data on existing training, and conducting an analysis of exiting training material (United States Department of Energy, 2014).

The design phase encompasses creating the learning objectives of the training and determining delivery and evaluation methods (United States Department of Energy, 2014). Dhawan (2016), suggests completing the following three activities in order to complete the design phase of the SAT: (1) decide what the student will learn and how learning will transfer, (2) decide what will be taught and using which method, and (3) determine how the student will be assessed (Dhawan, 2016).

Development occurs after the design of the training has been decided upon and involves the creation of all training aids such as videos, lesson plans, and tests (Dhawan, 2016; United States Department of Energy, 2014). Development can include use of existing training programs, the modification of existing training programs, or development of a completely new training program (United States Department of Energy, 2014)

As a part of the development phase of a Systematic Approach to Training, learning objectives should be developed (United States Department of Energy, 1997). A learning objective is defined as “a statement that specifies measurable behavior that a training should exhibit after instruction.”

There are three distinct components of a learning objective: “a statement of behavior that the trainee must exhibit, the conditions under which the action will take place, and the standards of satisfactory performance” (United States Department of Energy, 1997). In addition to the three distinct components of a learning objective, a learning objective should be attainable, specific, clear, and measurable (United States Department of Energy, 1997).

The first component of a learning objective is the conditions under which the action must be performed. The conditions may include the tools needed to perform the tasks, or may aid or limit the performance of the required action (United States Department of Energy, 1997). The action statement of a learning objective describes the performance requirements of the job. The learning objective must also include a standard. The standard is the criteria which must be met by the action to be considered acceptable. Standards may refer to a time limit, accuracy, quality, or quantity (United States Department of Energy, 1997).

There are two different types of learning objectives which may be used in order to achieve job competence: cognitive and psychomotor (United States Department of Energy, 1997). Cognitive learning objectives are developed using training needs analysis or job analysis and are the facts, principles and theory that are needed to perform the necessary job functions. The DOE describes six different levels of cognitive learning listed from most basic, to advanced: knowledge, comprehension, application, analysis, synthesis, and evaluation (United States Department of Energy, 1997). In contrast to cognitive learning objectives which are based upon principles and theory, psychomotor learning objectives are based on the physical actions needed to perform the job. There are three different levels of psychomotor learning objectives: observation, simulation, and performance.

The final phases of the SAT, implementation and evaluation occur must occur in order to ensure the training that has been developed is consistent with the desired learning objectives, is relevant to the job tasks and positions, and effective at conveying the training message (Dhawan, 2016; United States Department of Energy, 2014). The DOE handbook suggests having the trainees’ complete pretests over the information and learning objectives to be covered in the training program (United States Department of Energy, 2014). Pretests allow for the identification of the trainees’ strengths and weaknesses (United States Department of Energy, 2014), as well as allow for determining if learning occurred during the training or if trainees’ had mastery of the course objectives before training was conducted.

The SAT is not limited to use by the DOE. Many studies and industries have found success in using this model for the adaptation or creation of training programs. For example, Heikka (2008), applied the Systematic Approach to Training to solve a problem related to information security breaches in the telecommunications industry. This study found that by using the SAT to develop and implement an information security program, there was a positive change in the security behaviors as well as attitudes after completion of the program (Heikka, 2008). Similarly, the SAT has been used worldwide to develop training programs in the fields of emergency preparedness (Popp, Bus, Holland, & Murray, 2012), medicine (Yao et al., 2010), and even civil service (Vukovic, Zavrsnik, Rodic, & Miglic, 2008).

The logging industry may benefit from using a Systematic Approach to Training in that the regimented approach to training may be effective in conveying important procedural knowledge required when performing emergency first-aid. In addition, by creating clear and concise learning objectives for the training program, a unified view the desired outcome can be formed by both instructors and training participants. Using a systematic approach to create a video based training program and corresponding learning objectives may improve the consistency of the information presented during different sessions of the training program. Thorough documentation of the design and development process used to create the program may prove essential if there were a need to verify completion of an adequate training program by OSHA compliance officers.

While there are many reasons why the SAT may be successful in the logging industry, there are also potential pitfalls. A training program created through use of a SAT may not be effective at teaching the required skills needed for emergency first-aid in the logging industry due to variability of situations that may be encountered during a workplace injury. In addition, many industries which have seen success in using the SAT are highly regulated (ex. mining, energy, health care, etc.), and are personified by a culture and climate of safety. Logging in the intermountain region does not have the same level of regulation nor the safety culture prowess of the aforementioned industries. Finally, due to the lack of documentation, constancy, and rigor of the training program in prior years, there may be push back from the workers as the program becomes formalized. Finally, due to the relative absence of OSHA inspections and regulation in the intermountain region, companies may not see the value in creating a program which complies with OSHA standards.

Chapter 2: A mixed-methods analysis of logging injuries in Montana and Idaho[1]

2.1. Overview

Background: Despite advances in mechanization, logging continues to be one of the most dangerous occupations in the United States. Logging in the Intermountain West region (Montana and Idaho) is especially hazardous due to steep terrain, extreme weather, and remote work locations.

Methods: We implemented a mixed-methods approach combining analyses of workers' compensation claims and focus groups to identify factors associated with injuries and fatalities in the logging industry.

Results: Inexperienced workers (> 6 months experience) accounted for over 25% of claims. Sprain/strain injuries were the most common, accounting for 36% of claims, while fatalities had the highest median claim cost ($274,411). Focus groups identified job tasks involving felling trees, skidding and truck driving as having highest risk.

Conclusions: Injury prevention efforts should focus on training related to safe work methods (especially for inexperienced workers), the development of a safety culture and safety leadership, as well as implementation of engineering controls.

[1] This is the peer reviewed version of the following article: Lagerstrom E, Magzamen S, Rosecrance J. A mixed-methods analysis of logging injuries in Montana and Idaho. Am J Ind Med. 2017;60:1077–1087, which has been published in final form at https://doi.org/10.1002/ajim.22759. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving.

2.2. Introduction

Logging is one of the most dangerous occupations in the United States. According to the Bureau of Labor Statistics (BLS), in 2014, the national occupational fatality rate for all industries was 3.3 workers per 100,000 FTE (United States Bureau of Labor Statistics, 2017). During that same period, the occupational fatality rate for forestry workers (NAICS 113) was 92 per 100,000 FTE, 28 times higher than all industries combined (United States Department of Labor, 2015). Though logging injuries within the Untied States have decreased over the last 20 years, from 8.9 per 100 FTE in 1994 (United States Bureau of Labor Statistics, 2015) to 5.1 per 100 FTE in 2014 (United States Bureau of Labor Statistics, 2015), injuries in this sector continue to exceed the rate of total recordable cases for all industries combined (3.2 per 100 FTE) (United States Bureau of Labor Statistics, 2015).

Within the logging industry, there are different risks based on job task and logging system used. The forestry and logging industry subsector is divided into the following job tasks by the United States Department of Labor: fallers, supervisors, logging equipment operators, and truck drivers (United States Department of Labor, 2015). The logging system used determines the number of workers in each of these different job tasks as well as the configuration of equipment. There is a wide range in the possible configurations of machines and processes used in harvesting (i.e. logging system). The logging system of choice is dependent on the terrain and region of the harvest, as well as the resources of the contracted logging company. There are two main logging systems for felling trees (conventional chainsaw logging and mechanical logging) and four primary methods for moving felled trees (skidder, horse logging, line skidding, and helicopter logging) (Montana Logging Association, 2008). In conventional chainsaw logging systems, trees are felled, delimbed and cut to length by sawyers using a chainsaw (Montana Logging Association, 2008). In contrast, mechanical logging systems use feller-bunchers to fell, delimb, and cut the log to the desired length (Montana Logging Association, 2008). Moving cut tees from the tree stand to an area (landing) where the logs are loaded on logging trucks is often performed with skidders. A skidder is a type of heavy vehicle used in a logging operation to pull cut trees out of a forest in a process called "skidding", in which the logs are moved from the cutting site to a landing. At the landing they are loaded onto trucks for transporting to saw mills. When a skidder is unavailable or unable to operate due to terrain, weather conditions, or environmental conditions, horse logging, line skidding, and helicopter logging systems methods used for skidding. In each of the methods, a worker (the hooker/choke setter) is responsible for attaching cables to the logs to be hauled from the site.

The variety of work methods within the logging industry likely contributes to the differences in injury and fatality rates among professional loggers in the United States. Job task, logging system type, and degree of mechanization result in differences in the prevalence, type, and severity of occupational injuries and fatalities (Myers & Fosbroke, 1994). Some research has suggested that increasing mechanization of the industry may decrease the number of injuries and fatalities associated with logging (Bordas et al., 2001). For example, Myers and Fosbroke (1994) found a significant difference in the fatality rate of general logging labor in comparison to machinery operators (Myers & Fosbroke, 1994). General logging labor (i.e. fellers, limbers, buckers, and choke setters) had an occupational fatality rate of 371.8 per 100,000, while machinery operators had an occupational fatality rate of 48.5 per 100,000 (Myers & Fosbroke, 1994). Further, an analysis of injury claims data before and after mechanization indicated a significant decrease in injury claims when companies transitioned from conventional (i.e. chainsaw) logging to feller-buncher tree harvesting (Bell, 2002).

With modernization and mechanization comes an effort and ability to raise productivity (Bordas et al., 2001). New technology and equipment has allowed loggers to generate higher yield and harvest on extreme terrain, previously impossible with conventional logging methods. Earlier research on logging injuries and fatalities has identified differences in fatality rates by region (Myers & Fosbroke, 1994). The authors concluded that regional differences may be attributed to timber type, logging system, and terrain. Specifically, mechanization has allowed logging in the Intermountain West (which includes Montana and Idaho) to expand to previously remote areas with higher elevation, steeper slopes, extreme weather, and longer transportation times to processing plants. Previous logging injury research is not readily generalizable to this region due to these factors.

Currently, there is no specific research on logging injury and injury prevention in the Intermountain West. The objective of this study was to implement a mixed-methods approach to identify injury prevention strategies for the logging industry in this region. This research integrates an analysis of workers' compensation data and focus group results to better understand injuries and fatalities. The goal of the analysis is to inform the future direction of logging safety and training in the Intermountain West region.

2.3. Methods

Quantitative Analysis: Workers' Compensation Data

Injury claim data were obtained from two workers' compensation providers (Associated Loggers Exchange of Idaho and Montana State Fund), which cover companies active in the logging industry of Montana and Idaho. All injury and fatality claims occurring from July 2010 to June 2014 were obtained from companies in the logging industry (NAICS 113). Injury claim data from each company contained information on demographics, variables related to the time, type, and source of injury, as well as the cost associated with each injury claim. All personal identifiers were removed from the claims by the workers' compensation providers.

Frequency statistics were calculated for demographic and injury claim variables. Chi-squared tests were performed to determine if there was a significant difference in the distribution of variables relating to the timing of claims including day of the week, month of the year, season, and fiscal year. Chi-square tests were performed to determine if there was a significant difference in the number of claims by age group, level of experience, job type, data source, state, claim type, and body part injury. Fisher's Exact Test was used in place of chi-square analysis for cell counts with fewer than five observations. We implemented a Kruskal-Wallis test to determine if differences exist in the mean age and length of experience by job title (sawyer/hooker, equipment operator, truck driver, supervisor/owner, mill operator, and other).

To accurately compare year to year workers compensation costs, all claim values were adjusted to 2015 dollars using the CPI inflation calculator provided by the Bureau of Labor Statistics (Bureau of Labor Statistics, 2016).Claim values were rounded to the nearest dollar amount. Descriptive statistics (median and range values) for age, length of experience, and claim values were calculated by job type. Kruskal-Wallis tests were performed to determine if significant differences existed in age and length of experience based upon job task. Fisher's exact test was performed to determine if there was a significant difference in the distribution of incident type and nature of injury by job type. Due to the association between nature of injury and incident type, a two-way factorial analysis of variance (ANOVA)e was performed to determine if the significant differences seen in the ANOVAs for both nature of injury and incident type by adjusted total claim value were due to the effect of the factors independently, interaction, or due to confounding. As healthcare data costs were highly skewed, we log transformed data for analysis (Malehi, Pourmotahari, & Angali, 2015).

As workers' compensation claims data did not follow a normal distribution, a Wilcoxon-Mann-Whitney test was used to determine if there was a significant difference between the median claim value based on level of experience (< 6 months v. ≥ 6 months). Kruskal-Wallis tests were performed to determine if significant differences existed in the median claim values based upon age group, job task, nature of injury, or injury type. Significance for all tests was based on alpha of 0.05.

Data were analyzed using SAS software Version 9.4 (SAS Institute Inc, 2012).

Qualitative Analysis: Focus Groups

The recruitment of focus group participants was conducted among professional loggers attending the annual Intermountain Logging Conference held in Spokane, Washington in 2016. The professional loggers were asked to participate in focus group meetings regarding their perception of the association between logging tasks and logging injuries and fatalities. A summary of the workers' compensation data related to the nature, extent, and cost of injury, as well as work experience of injured worker was presented to potential participants and served as background information for the subsequent focus group discussions.

As per the methods outlined by Krueger (1994), focus groups were conducted to identify perceptions of work tasks and procedures that professional loggers associated with occupational injuries. An analysis of the focus group discussions and conclusions can often reveal how the topic under study is perceived among group members. As per established focus group methods (Krueger, 1994), the focus moderators encouraged group members to respond to the ideas and perceptions of other focus group participants. There are several advantages to using focus groups as a method of gathering qualitative data (Krueger, 1994). These advantages include (1) the inherent openness and free discussion of specific issues that is created, (2) focus groups are often composed of individuals with similar experiences, (3) the commonalties between participants drives natural and dynamic discussion. Unlike with structured interviews, focus group moderators are able to guide the discussion in order to achieve a deeper understanding of the underlying topic (Krueger, 1994).

Summary statistics from the analysis of workers' compensation data was presented by investigators to focus group participants. The presentation included the most common types of injuries, the number and types of injuries experienced by inexperienced workers, the most expensive injuries and the seasonality of claims. The purpose of the focus groups was to elicit workers' perceptions of the relevant workplace factors that may have led to the types of injuries documented in the workers' compensation data. The investigators conducted two focus group sessions of 90 minutes duration with the assistance of four logging safety management consultants. Focus group participants were active loggers from Montana and Idaho. Two focus group moderators (EL, JR) posed a series of questions designed to promote group discussion regarding logging practices and occupational injuries. The questions consisted of the following:

- What do you think are the most dangerous tasks (risks) leading to injuries in professional logging?
- How can these risks be prevented?
    - What are the most effective solutions to preventing logging injuries?
    - What can be done to reduce the number of injuries among inexperienced workers?
- What are the barriers to safe logging practice?
- How can safe logging practices be promoted or facilitated?

- How can the logging community improve and protect workers more effectively?

The moderators introduced all questions initially and then elicited feedback for each individual question sequentially. Group responses, which were based upon a consensus group approach, were recorded by the investigators. All focus group participants provided consent for participation in the research. Participant names or other unique identifiers were not recorded. Participants received education credits from their respective professional logging associations for attending and participating in the focus group sessions. To receive professional credit for participation, the focus group participants signed in on a list managed by their respective professional logging associations. To maintain focus group confidentiality, researchers did not have access to the list of participant names and there was no association between participant names and focus group opinion. The demographic information associated with the focus groups was provided by the professional logging associations. All research protocols were approved by the Institutional Review Board of the authors' academic institution.

2.4. Results

Descriptive Claim Characteristics

A total of 801 workers' compensation claims were analyzed for the period July 2010 to June 2015 (Table I). Workers between ages 50 – 59 had the highest proportion of claims (27%) and the mean length of employment at the time of injury was 74.52 months (SD= 105.84). Approximately 26% of claims occurring to employees with less than 6 months of experience (Figure 1). Chi-square tests indicated significant differences in the number of claims by day of the week ($\chi 2=234.89$, df=6, $p<.0001$), month of the year ($\chi 2=67.12$, df=11, $p<.0001$), season ($\chi 2=54.43$, df=3, $p<.0001$), and fiscal year ($\chi 2=23.34$, df=4, p=0001). Mondays accounted for the greatest proportion of claims (21.22%), claims decreased by day of the week with only 14 workers' compensation claims occurring on Sundays (1.75%). The highest number of claims occurred in the months of July (10.5%), August (10.5%), and September (10.7%), while the lowest number of claims occurred in March (4.0%) and April (3.25%). The spring season only accounted for 111 claims while the autumn, summer, and winter seasons accounted for 240, 233, and 217 claims respectively. Fiscal year (FY) 2014 (July 2013-June 2014) accounted for 196 of 801 (24.47%) of claims, while FY 2011 accounted for only 113 (14.11%) of claims.

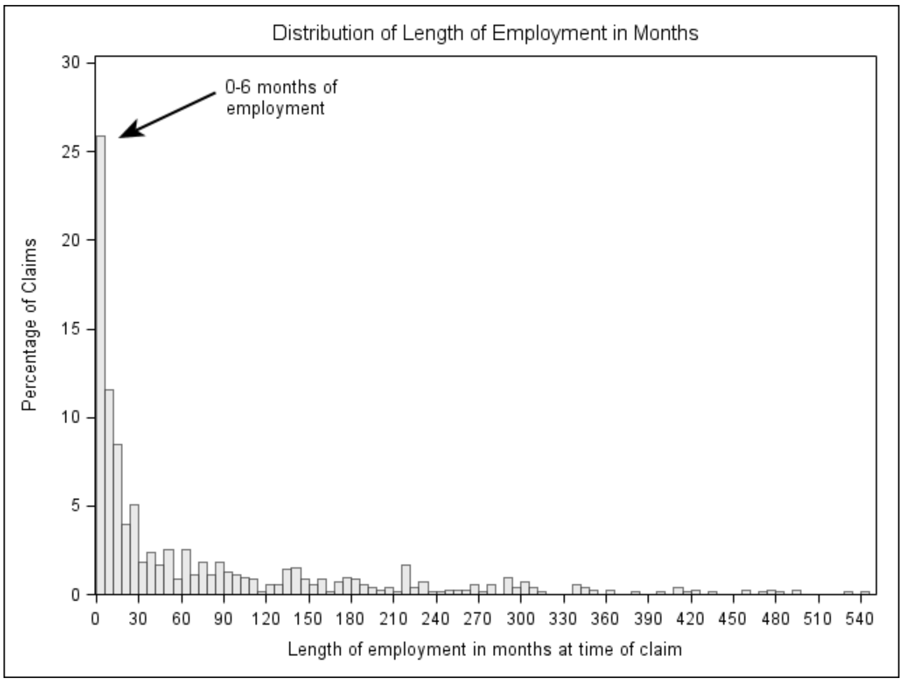

Figure 2.1: Distribution of the worker's length of employment in months at the time of workers' compensation claim

Table 2.1: Frequency and Descriptive Statistics for Injury and Fatality Claims

Categorical Variables (N=801)	**Percent (Chi-Square test for homogeneity p-value)**
Age Group	
Under 20	2.14%
20-29	21.73%
30-39	20.85%
40-49	18.84%
50-59	27.51%

60 and Over	8.92% (*p*<.0001)
Length of Employment	
<6 Months	25.92%
≥6 Months	74.08% (*p*<.0001)
Job Title	
Sawyer/Hooker	47.69%
Equipment Operator	22.35%
Truck Driver	17.85%
Other	5.74%
Supervisor	5.74%
Mill Operator	0.62% (*p*<.0001)
Fiscal Year	
2011	14.11%
2012	21.35%
2013	19.10%
2014	24.47%
2015	20.97% (*p*<.0001)
Season	
Spring	13.86%
Summer	29.09%
Autumn	29.96%
Winter	27.09% (*p*<.0001)
Data Source	
ALE	79.65%
MSF	20.35% (*p*<.0001)
State	
Idaho	64.17%
Montana	35.83% (*p*<.0001)
Claim Type	
Medical Only	57.68%
Temporary Disability	21.85%
Permanent Disability	20.10%
Fatal	0.37% (*p*<.0001)
Body Part	
Lower Extremity (thigh, knee, lower leg, shin, and calf)	17.60%
Upper Extremity (upper arm, shoulder, collarbone, elbow and forearm)	17.60%
Multiple Body Parts	12.86%
Back/Hip	12.23%

Hand/Wrist (wrist, hand, palm, fingers, knuckles, and thumb)	11.61%
Ankle/Foot (ankle, foot, heel, and toes)	7.62%
Eyes	5.62%
Ears/Nose/Mouth	5.49%
Trunk/Internal Injuries	5.24%
Neck	2.25%
Other	1.37%
Head	0.50%
	(*p*<.0001)

Table 2.2: Demographics and Claim Values by Job Task

Job Task	n	Median Age (Range)	Median Length of Experience in months (Range)	Median Adjusted Medical Claim Value (Range)	Median Adjusted Indemnity Claim Value (Range)	Median Adjusted Total Claim Value (Range)
Sawyer/ Hooker	382	34 (18-64)	11.50 (0-413)	$1,354 (0- 398,558)	$0.00 (0- 237,358)	$1,988 (0- 565,549)
Equipment Operator	179	49 (19-73)	45.00 (0-492)	$2,520 (0- 845,387)	$0.00 (0- 295,523)	$2,698 (0- 1,155,171)
Truck Driver	143	50 (17-73)	36.00 (0-434)	$1,057 (0- 812,044)	$0.00 (0- 409,363)	$1,208 (0- 1,021,543)
Other	46	47 (18-68)	64.00 (0-456)	$1,010 (0- 41,978)	$0.00 (0- 56,736)	$1,046 (0- 70,143)
Supervisor/ Owner	46	55 (31-65)	201.00 (10-540)	$2,083 (0-149,866)	$0.00 (0- 170,445)	$2,098 (0- 320,773)
Mill Operator	5	37 (32-54)	6.00 (0-88)	$409 (0- 93,125)	$0.00 (0- 113,672)	$409 (0- 206,797)
Total	801	44 (17-73)	24.00 (0-540)	$1,354 (0- 845,387)	$0.00 (0- 409,363)	$1,920 (0- 1,155,171)

Table II details the demographic data and average cost of claim by job task within the industry. All dollar amounts were adjusted for inflation to the 2015 dollar value before analysis. A Kruskal-Wallis Test determined there was a significant difference in the average age by job task type (χ^2=144.84, df=5, *p*<.0001) (Figure 2), as well as the average length of employment by job task type (χ^2=95.04, df=5, *p*<.0001) (Figure 3).

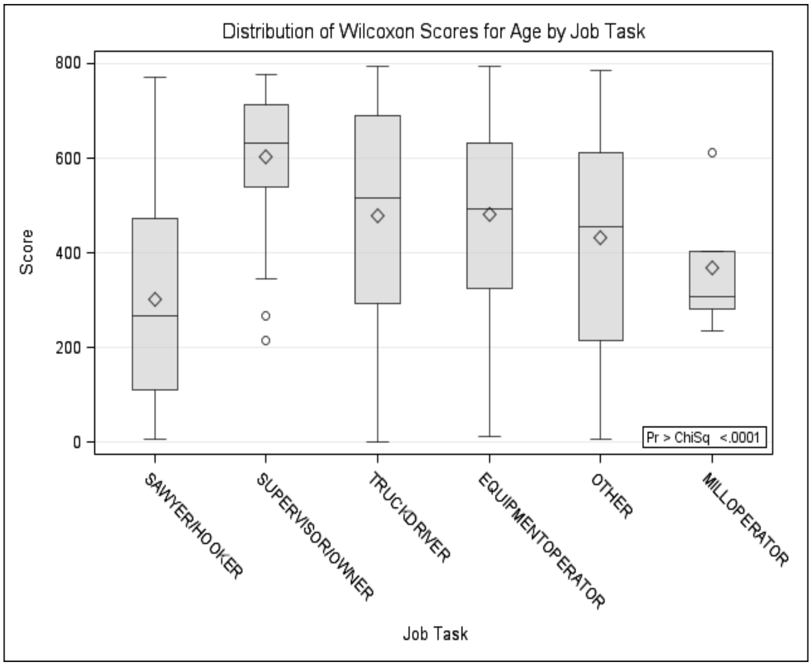

Figure 2.2: Kruskal-Wallis Box plot for age by job task

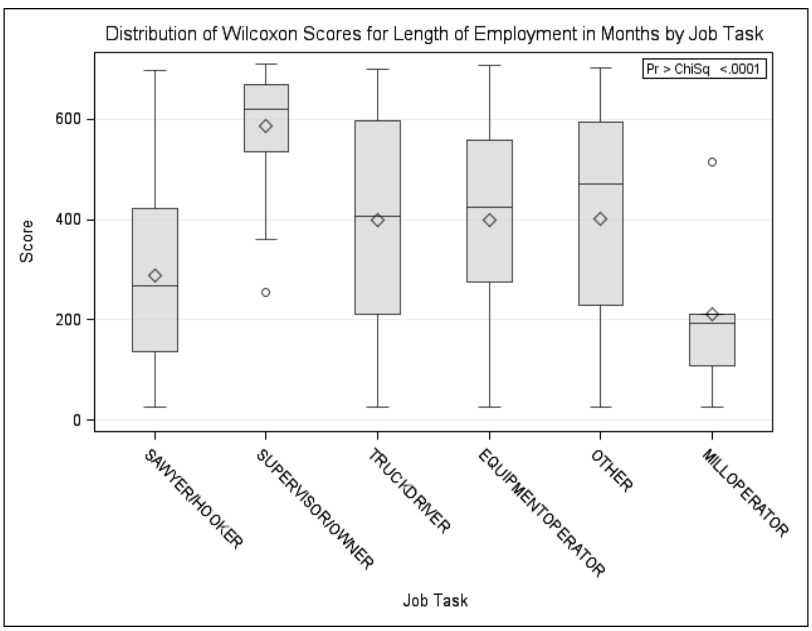

Figure 2.3: Kruskal-Wallis Box Plot for length of employment in months by job task

Claim characteristics of incident type and nature of injury varied significantly based up job type (Table III). Fisher's exact test indicated a significant difference in the type of incidents that occur based upon job task (p<.0001), as well as a significant difference in the nature of injury based upon job task (p<.0001). The most common incident type for sawyers and hookers was struck by injuries (51.3%), followed by falls (19.9%). The incident type for other job tasks was different than that of the sawyers and hookers, with falls being a more prominent incident type than struck by injuries for equipment operators, supervisors or owners, and truck drivers. The incident type distribution for equipment operators mirrored that of truck drivers with falls being the most prevalent accident type followed by overexertion and struck by injuries. Two out of three fatality claims recorded during this period occurred to sawyers/hookers, with the third occurring to a truck driver. Across all job types, sprain/strains were the most common nature of injury. Although both nature of injury and incident type were significant when run as independent ANOVAs, a two-way ANOVA identified that when both variables were included in the model of total cost, only the main effect due to nature of injury was significant (F=2.55, p=0.0135).

Table 2.3: Incident Type and Nature of Injury Distribution by Job Task

Job Task	n	Incident Type	%	Nature of Injury	%
Sawyer/ Hooker	382	Struck by Fall Overexertion Other Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	51.31 19.90 6.02 5.24 4.19 4.97 5.76 0.0 2.36 0.26	Sprain/Strain Contusion/Abrasion Laceration/Puncture Other Fracture/Dislocation Multiple Injuries Head Trauma Fatal	29.58 20.94 15.97 11.52 13.61 6.02 1.83 0.52
Equipment Operator	179	Struck by Fall Overexertion Other	22.35 28.49 11.73 12.85	Sprain/Strain Contusion/Abrasion Laceration/Puncture Other	41.90 17.32 11.17 13.41

		Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	10.06 3.91 3.91 6.15 0.0 0.56	Fracture/Dislocation Multiple Injuries Head Trauma Fatal	9.50 5.03 1.68 0.0
Truck Driver	143	Struck by Fall Overexertion Other Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	15.38 33.57 20.98 12.59 7.69 4.20 0.0 1.40 0.0 4.20	Sprain/Strain Contusion/Abrasion Laceration/Puncture Other Fracture/Dislocation Multiple Injuries Head Trauma Fatal	42.66 16.78 11.19 13.29 15.38 0.0 0.0 0.70
Other	46	Struck by Fall Overexertion Other Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	28.26 23.91 10.87 17.39 10.87 8.70 0.0 0.0 0.0 0.0	Sprain/Strain Contusion/Abrasion Laceration/Puncture Other Fracture/Dislocation Multiple Injuries Head Trauma Fatal	32.61 32.61 13.04 17.39 2.17 0.0 2.17 0.0
Supervisor/Owner	46	Struck by Fall	17.39 32.61	Sprain/Strain Contusion/Abrasion	50.00 13.04

		Overexertion Other Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	13.04 8.70 2.17 10.87 13.04 2.17 0.00 0.00	Laceration/Puncture Other Fracture/Dislocation Multiple Injuries Head Trauma Fatal	10.87 8.70 10.87 6.52 0.0 0.0
Mill Operator	5	Struck by Fall Overexertion Other Involuntary Movement Caught Between Voluntary Movement Equipment Overturn Animal Bite or Sting Vehicle Collision	40.00 40.00 20.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0	Sprain/Strain Contusion/Abrasion Laceration/Puncture Other Fracture/Dislocation Multiple Injuries Head Trauma Fatal	60.00 20.00 20.00 0.0 0.0 0.0 0.0 0.0

Cost Analysis

There was no significant difference in the median cost of the total claim values based upon age group ($\chi2$=8.45, df=5, p=0.13), experience level ($\chi2$=3.18, df=1, p=0.0745) or job task ($\chi2$=10.38, df=5, p= 0.0651). However, median total claim cost was significantly different by incident type ($\chi2$=32.23, df=9, p=0.0002).. Equipment overturns, caught between, and overexertion type claims had the highest median total claim values at $5,961 (Range= $539 - 1,155,171), $5,409 (range= 138 - 184,587) and $3,551 (range= $0 - 320,773), respectively.

Vehicle collisions ($280, range= $0 - 7,730) and animal bites and stings ($303, range= $122 - 1,250) had the lowest median claim values.

There were significant differences in median total claim costs by the nature of injury ($\chi 2$=129.99, df=7, p<.0001). Fatalities had the highest median total claim cost at $274,411 (Range= $170,762 - 412,613), followed by multiple injuries ($17,138, Range= $538 - 1,155,171) and fractures/dislocations ($11,466, Range= $0 - 1,021,543). Contusions/abrasions had the lowest median claim cost with a median adjusted claim value of $810 (Range= $0 - 565,549).

Results from Focus Groups

Sixty-three professional loggers ranging in age from their early 20s to more than 60 years participated in the focus groups (Table IV). The majority (42) of loggers worked in Idaho, were male and employed as equipment operators. During the focus group sessions, many of the owners who were also equipment operators indicated that they had experience in most of the work tasks throughout their logging career. Nearly 40% of the participants were greater than 50 years old.

Table 2.4: Demographic Distribution of Focus Group Participants

Focus Group Participants					
Sex	n	Job Title	n	Age Range	n
Male	58 (92%)	Operator / Owner	23 (37%)	21-25	2 (3%)
Female	3 (5%)	Operator / Not Owner	25 (40%)	26-30	6 (10%)
Unknown	2 (3%)	Sawyer / Hooker	3 (5%)	31-35	4 (6%)
		Truck Driver	12 (19%)	36-40	9 (14%)
				41-45	7 (11%)
				46-50	10 (16%)
				51-55	9 (14%)

				56-60	9 (14%)
				>60	7 (11%)
Total	63	Total	63	Total	63

Information from the two focus groups were summarized and analyzed into common themes (Table V). The first objective of the focus group discussions was to identify the most dangerous aspects of the various work tasks conducted by professional loggers (Table V). Both focus groups identified sawyers and hookers as the job positions at greatest risk for occupational injuries and fatalities. The occupational tasks and variables that they specifically identified as having the highest risk leading to injury included hand felling with chainsaws, falling trees and branches, getting hit by the skyline carriage, and being hit by a tree that was snagged on objects while skidding.

Drivers and mechanics were the job positions considered the next most dangerous. When discussing occupational risks and injuries to truck drivers, the loggers identified sprains and strains as a major issue. Ankle sprains for example were not uncommon and often sustained when they jumped or fell out of truck cabs or logging equipment, rather than using the steps. Truck drivers also reported upper limb strain injuries due to the manual installation of heavy stake extensions on the logging trailer. The extensions allow the trailer to carry more logs. This task involves manually lifting several four-foot metal extensions (30-40 lbs. each) overhead while standing on a narrow, often slippery surface several feet above the ground on the truck trailer. While engineering controls exist for improving this work task, many drivers have yet to install the new devices due to cost of retrofitting their current system. Truck drivers also reported high risk of road accidents due to poor drivers on the highway as well as driver fatigue from traveling long distances (8-10 hour routes were common) to saw mills for wood processing. Both truck drivers and equipment operators mentioned long hours of sitting as a contributor of low back pain.

The fifth job position considered to have increased risk of occupational injuries was for heavy equipment mechanics. The equipment mechanics indicated that their job tasks often involved manual lifting and handling of heavy equipment parts, twisting and bending in awkward upper limb and trunk positions and prolonged static (and often awkward) positions to access engine and other areas of equipment. Low back injuries and hand and finger injuries were common body areas affected.

Table 2.5: Focus Group Discussion of Tasks, Risks and Injuries by Job Task

Focus Group Discussion of Tasks, Risks, and Injuries by Job Task	
Job Task	Risks and Injuries

Sawyers and Hookers	• Falling tree branches and limbs
	• Hand felling
	• Falls
	• Working on steep slopes
	• Struck by Injuries
	    o Butt of swinging trees
	    o Carriage (During Line Skidding)
	    o Logs (During Line Skidding)
	• Entry level position (inexperienced workers)
	• Fatigue (8-10 hour workday)

Truck Drivers	• Manually placing stake extensions
	    o Poor positions
	    o Slippery work area
	    o Heavy, awkward lift
	    o Falls
	• Driving distance/time to mills
	• Vehicle collisions
	    o With other vehicles
	    o Single vehicle- slide off road due to weather conditions

Equipment Operators	• Falls from equipment • Prolonged sitting • Equipment overturns
Mechanics	• Heavy lifting • Twisting and bending to access engines • Back injuries

	• Hand and finger Injuries

After discussing the job tasks, injuries and risk, the focus groups were directed to the question of how risks and be prevented (Table VI). Common themes related to injury prevention discussed included improving safety communication (common risks, risks associated with unique situations), safety culture and safety leadership skills, job and safety training (especially for new hires), situation awareness, and ensuring proper and consistent use of personal protective equipment. Specifically, within communication, ensuring that frequent safety meetings occur, whether formal or informal, as well as ensuring that safety issues are corrected and addressed as soon as they observed were topics discussed within both focus groups.

Finally, the focus groups were asked what the logging community could do to ensure worker safety more effectively. Ideas included consistency in safety practices and requirements among landowners, enforcement of existing safety laws, use and availability of GPS technology for the location of injury and evacuation sties, and ensuring that all workers had access to training and knew evacuation procedures and the area's available emergency resources.

Table 2.6: Prevention Ideas and Barriers to Safe Logging Practices

Prevention Ideas and Barriers to Safe Logging Practices	
Prevention Ideas	Barriers
• Enhanced safety culture from the top down o Training in safety leadership o Frequent and consistent safety meetings with crew o Correct and address dangerous situations when they are observed o Encourage taking lunch breaks o Consider using break time to encourage communication between team o Empower workers to speak up during unsafe situations or when they do not	• Tough and independent work culture • Resistance to change • Lack of leadership • Drug/Alcohol use • Personnel and family issues migrating to job site • Cost and Production- Thin Margins • Cost to implement safety programs • Limited personnel to complete same amount of work

know how to safely/properly preform work tasks o Ensure safety is a priority from the top town (from the mills and the land owners) o Change in land management is providing consistency in safety expectations across worksites • Discussion of defensive driving and incident prevention during driving • Discussion on proper tree felling techniques • Discussion on proper hooking techniques • Lockout tagout training • Reduce driver's injuries during stake extension tasks • Provide lifting equipment, PPE, and guarding for mechanics	• Limited number of workers entering industry • Limited amount of formalized training available for new hires. Training is provided by employer at the job site.

2.5. Discussion

The logging industry in the Intermountain West region of Idaho and Montana presents a challenge for occupational injury and fatality prevention. Due to the terrain, remoteness of the region, and availability of emergency services, logging injuries and fatalities in this region are an ongoing challenge. While there are many similarities between the results of the present study and the work of other researchers throughout the country and world, there are also differences due to the unique attributes of the region, which contribute to differences in harvesting practices, techniques, and occupational culture.

Previous research in the logging industry has focused on the annual rate and characteristics of injuries (Bell & Helmkamp, 2003; Jack & Oliver, 2008; Lefort et al., 2003; Lynch et al., 2014; Priscah Mujuru et al., 2006; Myers & Fosbroke, 1994; Nieuwenhuis & Lyons, 2002), the effects of mechanization (Axelsson, 1998; Bell, 2002; Bordas et al., 2001; National Institute for Occupational Safety and Health, 2005; Roberts et al., 2005), worker's perceptions of the occupational risk (Bordas et al., 2001; Nieuwenhuis & Lyons, 2002), as well as the development of training strategies (Bell & Grushecky, 2006; Egan, 2005; Priscah Mujuru et al., 2006). This study presents new research to the field of logging injury analysis though use of mixed-methods approach to analyze region-specific injury and fatality data and presenting observations from professional loggers with insight on causation and prevention of injuries.

Our findings support the findings of Laschi et al., that workdays on a Monday were determined to have the highest percentage of accidents, as well as the work of Albizu-Urionabarrenetxea et al., that most injuries occured during the spring and fall seasons. Laschi et al. attribute the finding that Mondays have the highest injury rate over other days of the week to workers' lower attention levels and carefulness on the day after a weekend (Laschi, Marchi, Foderi, & Neri, 2016). Our work also supports previous research in that falling and processing job tasks were found to contribute to a disproportional number of injuries within the industry. Lefort et al. reported that the majority of workers' compensation claims were attributed to struck-by injury types (58%),followed by falls (14%) (Lefort et al., 2003). The results of the present study determined that struck-by injuries were attributed to 35% of all claims, while falls were responsible for 25% of claims in the Intermountain West region. The relatively higher prevalence of falls in the Intermountain West region may be due to the steep terrain, or due to wet or frozen conditions present during the autumn and winter seasons. While many previous studies focus on analysis and reporting of incident types (struck-by, fall, caught between, etc.), the results in the present study suggest that incident type and nature of injury (sprain/strain, laceration, fracture) are associated and the effect seen in the cost of claim can be attributed to nature of injury rather than incident type.

Sprain and strain injuries have been a substantial contributor to the number and cost of workers' compensation claims in the logging industry. A 12 study of injuries in the logging industry of Louisiana suggested that a shift was occurring in the type of injuries from primarily lacerations to sprain and strain injuries. The study period took place during the shift from conventional to mechanized logging and suggested that the reason for the change in injury type was due to mechanization (Albizu-Urionabarrenetxea, Tolosana-Esteban, & Roman-Jordan, 2013; Lefort et al., 2003). The authors believed that this switch was due to the declining number of workers who are actively involved in manual felling and the shift to mechanized operations. However, with the decline in laceration injuries, there was an increase in the number of injuries due to falls (specifically falls from machinery and vehicles) (Lefort et al., 2003). With the shift in injury type due to mechanization, there is evidence that as logging becomes more mechanized, “the accident rates decline, but the severity of the injuries increases”(Lefort et al., 2003). Due to the steepness of terrain present throughout the Intermountain West region, it has not been possible to use mechanized felling systems in all timbered areas. Due to the inability to mechanize, lacerations still contribute to almost 15% of injuries. Additionally, in the Intermountain West region, the high number of strain and sprain injuries cannot solely be attributed to falls from equipment and vehicles. For example, the most common injuries sustained by fallers and hookers (during manual felling) were sprain/strain injuries. The Intermountain West region may present a different set of hazards to fallers and hookers due to the terrain and conditions of their work. These conditions (such as unstable, steep, and slippery surfaces) may contribute to the higher number of sprain/strain injuries rather than laceration type injuries usually present during falling and hooking job tasks.

The high number of injuries occurring to inexperienced, young workers (Figure 1) is highly concerning seeing as more than 25% of all claims occurred to workers in their first six months on the job. A literature review by Albizu-Urionavarrenetxea et al. suggests that the primary reason many studies find a correlation between lack of experience and injury rate is due to inexperienced workers' lack of awareness of the possible occupational risks and hazards (Albizu-Urionabarrenetxea et al., 2013). Adequate training and apprenticeship programs should be in place to provide the background knowledge and skill set required for safely preforming essential job functions (Albizu-Urionabarrenetxea et al., 2013). The results of this study determined that the most common injuries for inexperienced workers in the logging industry are due to tasks related to falling and hooking or vehicle collisions. Injuries from falling can be prevented using a combination of personal protective equipment (PPE) and training. Training should focus on how to identify safe escape paths during tree falling as well as identifying hazards present in the environment such as dead tops, snags, and nearby trees.

Prior research has also identified the importance and need for adequate training on safe driving habits and machine and tool use (Albizu-Urionabarrenetxea et al., 2013; Lefort et al., 2003). In addition, the most frequently cited violation of federal safety standards was lack of adequate logging operations training (Lefort et al., 2003). Studies highlight the importance of using a participatory approach with the end-user in order to develop relevant safety training (Egan, 2005), yet little research or case studies have been published on the implementation and evaluation training programs in the logging industry using a participatory approach.

The use of participatory action research, such as focus groups with end-users, to develop ideas for safety interventions, has been shown to be highly effective at identifying practical applications of research or developing new areas of study (Food and Agriculture Organization of the United Nations, 1990; J. C. Rosecrance & Cook, 2000). Participatory action research is a continuous, interactive process with input from the community/stakeholders and the researchers. Benefits of using a participatory approach include end-user perspective and buy in, and results in locally tested outcome (Food and Agriculture Organization of the United Nations, 1990).

As shown in the present study, end-users can assist in identifying risks as well as solutions for occupational injuries. Previous research by Nieuwenhuis and Lyons (2002), identified similar barriers to health and safety in the logging industry including: financial restrictions, pressure of work, and lack of training (Nieuwenhuis & Lyons, 2002). The same study surveyed workers on potential intervention strategies and found that 45% of surveyed workers suggested topics that included enhanced safety training (Nieuwenhuis & Lyons, 2002).

Limitations

There are several limitations present in the currently study design. Use of workers' compensation claim data relies upon complete and thorough investigation and reporting by the provider. Additionally Alamgier et al. (2014), suggest that logging industry may have similar problems with injury reporting as the agricultural industry, in that many injuries are lost to surveillance due to "work on small firms that may remain unprotected from federal regulations, and therefore escape the capture of routine surveillance systems… and incomplete reporting from unpaid family workers, small employers, the self-employed, and owners and partners in unincorporated firms" (Alamgir, Martínez-Pachon, Cooper, & Levin, 2014).

Due to limited information on the number of employees in the workforce, demographic composition of the workforce, duration of the work week, and seasonal differences in productivity and hours worked, it was impossible to calculate injury and fatality rates. The lack of denominator data is further complicated in that data such as demographics and hours worked vary based upon region. Therefore, nationwide estimates of productivity and workhours would not provide an accurate representation when performing regional analysis. Future research should focus on overcoming these limitations to more adequately investigate rates of injury due to demographic factors such as age and experience.

2.6. Conclusions

The results of the present research provides the background for developing focused injury prevention strategies aimed at reducing injuries and fatalities in the logging industry. The mixed-methods approach used in the present study provides a more comprehensive understanding of logging injuries, their nature, costs and associated factors than a single methods approach. The insight from this study can be used to direct future intervention and training strategies. Injury prevention efforts in the Intermountain West region should focus on training related to safe work methods (especially for inexperienced workers), the development of a safety culture and safety leadership, as well as implementation of applicable engineering controls.

Chapter 3: Work-Related Musculoskeletal Symptoms among Professional Loggers in Montana

3.1. Overview

Introduction: Logging is one of the most dangerous industries in the United States. Logging mechanization is associated with increased productivity and may have an influence on the types and rates of injuries among professional loggers. However, in Montana, delayed mechanization due to terrain and environmental regulations resulted in the logging industry consisting of both conventional and mechanical logging systems.

Methods: Using the Standardized Nordic Questionnaire, we determined the 12-month period prevalence of musculoskeletal symptoms (MSS) among professional loggers in Montana and differentiated the prevalence based on logging system type, accounting for demographic and workplace covariates.

Results: In Montana, conventional logging workers were more than twice as likely to report MSS (OR: 2.24 (1.07-4.69)). In addition, increased MSS score was associated with conventional logging systems, increased years of experience, and increased BMI.

Discussion: Quantifying the current symptom prevalence of the logging population can help identify possible areas and opportunities for interventions.

3.2. Introduction

Logging is one of the most dangerous occupations in the United States (O. S. H. A. United States Department of Labor, 2017). Recent data from the Bureau of Labor Statistics indicate the occupational fatality rate for logging was nearly 40 times the fatality rate for all other occupations (132.7/100,000 full-time equivalent (FTE) v. 3.4/100,000 FTE, respectively)

(Bureau of Labor Statistics, 2017). In contrast, the total recordable case rate for injuries and illnesses in the logging industry was lower compared to all other industries (2.3 per 100 FTE v. 3.3 per 100 FTE, respectively) (United States Bureau of Labor Statistics, 2017). The stark differences between the relative morbidity and mortality rates for the logging industry in comparison all industries may be due to the severity of injuries seen in logging or under-reporting of recordable injuries.

Within the logging industry, injury and mortality rates and types of risk vary based on regional characteristics, job tasks, and logging system type. The logging system is the configuration of equipment, machines and processes that interact with workers in various job tasks to farm and harvest trees. There is a wide range of equipment configurations and job tasks in the industry. The configuration is dependent on the terrain and region of the harvest, as well as the resources of the contracted logging company. There are two main logging systems for felling trees: conventional chainsaw logging and mechanical logging (Montana Logging Association, 2008). In conventional chainsaw logging systems, trees are felled, delimbed and cut to length by sawyers (chainsaw operators) using a chainsaw (Montana Logging Association, 2008). Hookers/chokesetters may be a part of either conventional or mechanical logging systems and are responsible for manually attaching cables to the logs to be hauled from the site. In contrast to conventional logging systems, mechanical logging systems use large pieces of equipment to fell, delimb, and cut the log to the desired length (Montana Logging Association, 2008). Many researchers studying logging suggest that increasing mechanization by transitioning from conventional logging to mechanical logging should decrease the number of injuries and fatalities associated with logging (Axelsson, 1998; Bordas et al., 2001; Nieuwenhuis & Lyons, 2002). Injures common to conventional logging practices include acute injuries due to workers being struck-by trees and lacerations due to chainsaw use (Lagerstrom, Magzamen, & Rosecrance, 2017). In addition, conventional felling systems are associated with chronic injuries such as hearing impairment and vibration-induced pathologies from persistent chainsaw use (Nieuwenhuis & Lyons, 2002), exposures which are not prevalent in mechanical logging systems. An analysis of injury claim data from companies before and after mechanization indicated a significant decrease in injury claims when companies transitioned from conventional chainsaw felling to mechanical logging using feller-bunchers (Bell, 2002).

While the transition to mechanized logging has reduced the number of acute and traumatic injuries, use of harvesting equipment has been linked to an increase in chronic injuries, such as repetitive strain injuries (Nieuwenhuis & Lyons, 2002). In addition to changes in the type and severity of injuries experienced due to mechanization, industry modernization and mechanization is associated with increases in productivity and longer working hours (Bordas et al., 2001). While mechanization has allowed loggers to harvest more trees at a faster rate, mechanized systems have been associated with increased productivity pressure and excessive shift length compared to conventional logging (Nieuwenhuis & Lyons, 2002).

Logging in Montana is especially dangerous due to steep terrain, weather conditions, and remote work locations (Lagerstrom et al., 2017; O. S. H. A. United States Department of Labor, 2017); logging injuries and fatalities in this region are an ongoing challenge (Lagerstrom et al., 2017). The combination of unique characteristics in the region contribute to differences in the logging techniques used, workplace demographics and occupational culture compared to the logging industry in other regions of the country. In Montana, delayed mechanization due to terrain and environmental regulations has resulted in the logging industry currently consisting of both conventional and mechanical logging systems. While other regions have completed this transition, the delayed mechanization in Montana presents an opportunity to study the differences in MSS prevalence in loggers between logging systems within a regionally similar cohort.

Study Purpose

The purpose of this study was to determine the 12-month period prevalence of musculoskeletal symptoms (MSS) among professional loggers in Montana and differentiate the prevalence based on logging system types while accounting for demographic and workplace covariates. This information is needed to identify the current MSS symptom status of the logging population and to identify opportunities for occupational safety interventions.

3.3. Methods

Data Acquisition

A questionnaire was administered to loggers participating in OSHA-required emergency first-aid training workshops throughout Montana sponsored by the Montana Logging Association in the spring of 2017. The Montana Logging Association sponsors training sessions annually at different locations across the state of Montana to offer loggers an opportunity to complete this requirement. The questionnaire consisted of three different sections: demographic data, workplace conditions and job factors, and a musculoskeletal symptom (MSS) questionnaire. Participation in the questionnaire was voluntary and anonymous. Compensation was not provided to participants completing the questionnaire. All loggers in attendance at the workshops were eligible for participation.

To determine the 12-month period prevalence of MSS in the logging cohort, a modification of the Standardized Nordic Questionnaire was administered. The Standardized Nordic Questionnaire (SNQ) is a tool commissioned by the Nordic Council of Ministers in response for the need for a standardized method for analyzing and recording musculoskeletal symptoms (Crawford, 2007; Kuorinka et al., 1987). The SNQ was originally developed in order to evaluate musculoskeletal symptoms (MSS) of the low back, neck and shoulder (Kuorinka et al., 1987). The original SNQ was comprised of two different sections: a section on the prevalence of MSSs, and a section on work and lifestyle tasks (Crawford, 2007; Kuorinka et al., 1987). The section on the prevalence of MSSs separated the presence and duration of symptoms of MSSs into three different time periods (i.e. the workers entire life, the last year, or the last week) (Kuorinka et al., 1987).

The modified questionnaire administered in the present study included three questions in reference to nine anatomical regions of the body (neck, upper back, low back, shoulders, elbows, wrist/hands, hip/thighs, knees, and feet). First, “During the last 12 months have you had a job-related ache, pain, or discomfort?”; Second: “During the last 12 months has this ache, pain, or discomfort prevented you from doing your day’s work?”; and Third: “During the last 12 months have you seen a physician or physical therapist for this pain, ache or discomfort?” For each question, participants checked either yes or no for each of the nine anatomical regions.

Demographic information collected with the questionnaire included sex, age, height, weight, and education level. Job information collected by the questionnaire included primary logging system type used, hours worked per week, months worked per year, and years employed in the logging industry.

Data Analysis

Means, standard deviations, and frequency statistics were calculated for all demographic variables. Body mass index (BMI) was calculated from the respondents’ height and weight and categorized according to guidelines published by the National Institutes of Health (National

Institutes of Health, 2017). Years of experience in the logging industry was divided into decades of experience. Hours worked per week was divided into three different categories: less than full time (< 40 hrs/week), full time workers (40 – 60 hrs/week), and overtime (> 60 hrs/week). Finally, the number of months the logger worked per year was divided into two groups, one group for loggers working the full season (nine months or more), and a group working only a partial season (less than nine months). Frequency statistics were calculated to determine the 12-month period prevalence of MSS in the overall population and by logging system type. Two binary variables were created based upon the results of the SNQ to identify workers who experienced MSS in any anatomical area (Yes/No) or missed work due to MSS in the past 12 months (Yes/No). T-tests were performed to determine if loggers involved in conventional versus mechanical logging operations were statistically similar in terms of age, BMI, years of experience in the logging industry, hours worked per week, and months worked per year. Chi-square tests were performed to determine if there were significant differences in the prevalence of MSS in each anatomical region based upon logging system type (conventional versus mechanical). A continuous variable, MSS Score, was created for each respondent by summing the number of anatomical areas with reported MSS. MSS Score therefore ranged from zero to nine (corresponding to symptoms in all nine anatomical regions). A t-test was performed to determine if there was a significant difference in the MSS Score between loggers using conventional versus mechanical logging systems.

Multivariable logistic regression was performed to determine if demographic and workplace covariates identified above were associated with MSS or missed work days due to MSS. Poisson regression was performed to determine if the same demographic and workplace factors were associated with MSS Score. The following covariates were identified which potentially confound the relationship between logging system type and MSS, days missed due to MSS, and MSS Score: age, BMI, years employment in the logging industry, hours worked per week and months worked per year.

Data analysis was performed using SAS 9.4 (SAS Institute Inc, 2012). Statistical significance was based upon $p < 0.05$. The Research Integrity and Compliance Review office at Colorado State University determined that the methodology described in this study were exempt.

3.4. Results

A total of 1,059 workers attended the training workshops and 743 completed questionnaires were returned for an overall response rate of 70.2%. The demographics of the responding population of Montana loggers are presented in Table 1. Mean number of years in the logging industry (experience) was 22.0, and the mean number of hours worked per week in logging was 47.1 (SD=15.5). Most workers identified their primary logging system type as mechanical (84%), with 16% of respondents identifying that they primarily use a conventional logging system.

Table 3.1: Respondent Demographics

	Mean (SD) **n=743**
Age	45.9 (13.7) n=688
BMI	28.4 (4.8) n=582
Years in Logging Industry	22.0 (14.1) n=662
Hours Worked Per Week in Logging	47.1 (15.5) n=592
Months Worked Per Year in Logging	9.3 (2.6) n=593
	n (Percent)
Gender	
Male	701 (94.3%)
Female	21 (2.8%)

Missing	21 (2.8%)
Ethnicity	
Caucasian	664 (89.4%)
Other	33 (4.4%)
Missing	46 (6.2%)
First Language	
English	681 (91.7%)
Spanish	2 (0.3%)
Missing	60 (8.1%)
Highest Education Level Achieved	
Did not finish High School	55 (7.4%)
High School Diploma	410 (55.2%)
Some College	179 (24.1%)
B.S. or Higher	59 (7.9%)
Missing	40 (5.4%)
Primary Logging System Type	
Conventional	80 (10.8%)
Mechanical	408 (54.9%)
Both	28 (3.8%)
Missing	227 (30.6%)
BMI	
Normal (BMI<25 kg/m^2)	140 (18.8%)
Overweight (BMI=25-30 kg/m^2)	260 (35.0%)
Obese (BMI>30 kg/m^2)	182 (24.5%)
Missing	161 (14.8%)
Years of Experience in Logging	
0-10	186 (25.0%)
11-20	142 (19.1%)
21-30	138 (18.6%)
31-40	135 (18.2%)
40+	61 (8.2%)
Missing	81 (10.9%)
Hours Worked Per Week	
0-39 (Less than Full Time)	58 (7.8%)
40-60 (Full Time)	477 (64.2%)
60+ (Overtime)	57 (7.7%)
Missing	151 (2.3%)
Months Worked Per Year	
Less than 9 (Less than Full Season)	116 (15.6%)
9-12 (Full Season)	477 (64.2%)
Missing	150 (20.2%)

There were statistically significant differences in the average number of hours worked per week and the average number of months worked per year between conventional and mechanical loggers (Table 2). Workers in conventional systems, on average, worked 8.6 hours less per week (p<.05) and worked 0.7 fewer months per year (p<.05) compared to workers in mechanical systems. No significant differences were found between the age, BMI, or years of experience in the logging industry between conventional and mechanical loggers.

Table 3.2: Demographics by Logging System Type

	Conventional Logging Methods **Mean (SD)**	Mechanical Logging Methods **Mean (SD)**
Age	44.9 (14.0)	44.2 (13.1)
BMI	27.7 (4.0)	28.6 (4.8)
Years in Logging Industry	23.1 (14.1)	21.9 (13.6)
Hours Worked Per Week in Logging	**40.0 (12.7)***	**48.6 (13.4)***
Months Worked Per Year in Logging	**8.8 (2.6)***	**9.5 (2.1)***
*Indicates significance *p*<.05.		

The anatomical area with the highest 12-month period prevalence of MSS for all loggers was the low back (38.1%), followed by the shoulders (27.6%), neck (24.8%) and the knees (24.7%) (Table 3). Although not statistically significant, workers in mechanical logging operations had a higher prevalence of neck and upper back symptoms, while workers using conventional logging methods had a higher prevalence of MSS in every other body area. No significant difference was found in the MSS score between conventional and mechanical logging systems workers; mean MSS score in conventional logging workers was 2.1, while mean MSS score in mechanical logging worker was 1.8.

Table 3.3: Percentage of Workers Reporting Musculoskeletal Symptoms (one-year period prevalence): conventional v. mechanical operations

	Overall (n=649)	Conventional (n=80)	Mechanical (n=408)
Neck	24.8%	19.1%	27.0%
Upper Back	17.8%	17.5%	18.9%
Lower Back	38.1%	45.5%	39.4%
Shoulders	27.6%	34.9%	25.9%
Elbows	14.5%	17.7%	14.5%

Wrist/Hands	21.0%	27.4%	21.5%
Hip/Thighs	17.1%	21.9%	16.2%
Knees	24.7%	33.8%	25.8%
Feet	13.8%	20.6%	12.2%
Symptoms in any area	48.1%	59.7%	49.6%
Missed work due to symptoms in any area	6.0%	9.7%	6.3%
MSS Score (Mean Number of MSS Categories Reported)	1.8	2.1	1.8
+Overall category includes all respondents to MSS questionnaire (including truck drivers and workers in mixed logging systems)			

Multivariable logistic regression analysis (Table 4) resulted in a model which loggers using conventional logging systems had over two times the odds of any injury compared to mechanized logging system workers (OR: 2.24, 95% confidence interval of (1.07 – 4.69). In addition, workers with 21-30 or 31-40 years of experience had over three times (OR: 3.85 (1.51-9.79) and OR: 3.55 (1.09-11.55)) the odds of experiencing MSS in any body area in comparison to workers with less than 11 years of experience.

Multivariable logistic regression analysis of missed work due to MSS (Table 4) revealed no statistically significant parameters and no difference was found in the odds of missing work due to MSS between conventional and mechanical loggers.

The results of the Poisson regression for MSS Score modeled primary type operation, BMI, and years of experience in the logging industry as significantly associated with the MSS score (Table 4). The log estimate of MSS score for loggers using conventional versus mechanical systems was 0.26, which corresponds to a 1.29 increase in expected MSS score. The expected MSS score for workers with a BMI falling into the overweight range was 0.68 points higher than workers with a BMI in the normal range (log estimate: -0.39 (-0.60- -0.19)). The expected MSS score for workers with a BMI in the obese range was 0.70 points higher than workers with a BMI in the normal range (log estimate: -0.35 (-0.57- -0.13)). With higher levels of experience in the industry, there was a significant increase in the predicted MSS score in comparison to the referent group. Workers with 40 or more years of experience had the highest log estimate of MSS score (1.07), followed by the group with 21-30 years of experience (1.03), and the 31-40 year group (0.84). The log estimate of MSS score for workers with 40 or more years of experience was 1.07 over the referent group (less than 11 years of experience), which corresponds to a 2.91 increase in MSS Score.

Table 3.4: Regression Results

	MSS in any Anatomical Area (Y/N) Odds Ratio (95% CI)	Missed Work due to MSS (Y/N) Odds Ratio (95% CI)	MSS Score (0-9 Scale) Estimate (95% CI)
Primary Logging System			
Conventional	**2.24 (1.07-4.69)**	3.37 (0.96-11.80)	**0.26 (0.34-1.15)**
Mechanical	1.0 (referent)	1.0 (referent)	0.0 (referent)
Age	0.98 (0.95-1.02)	0.93 (0.86-1.01)	-0.01 (-0.023-0.00)
BMI			
Normal	1.0 (referent)	1.0 (referent)	0.0 (referent)
Overweight	0.71 (0.36-1.42)	0.75 (0.20-2.79)	**-0.39 (-0.60- -0.19)**
Obese	0.81 (0.39-1.70)	1.12 (0.67-4.669)	**-0.35 (-0.57- -0.13)**
Years of Experience in Logging			
0-10	1.0 (referent)	1.0 (referent)	0.0 (referent)
11-20	2.14 (0.98-4.70)	1.30 (0.27-6.10)	**0.48 (0.20-0.76)**
21-30	**3.85 (1.51-9.79)**	1.92 (0.26-14.12)	**1.03 (0.71-1.35)**
31-40	**3.55 (1.09-11.55)**	1.43 (0.08-24.46)	**0.84 (0.44- 1.24)**
40+	4.44 (0.96-20.25)	8.11 (0.42-157.15)	**1.07 (0.57-1.57)**
Hours Worked Per Week			
0-39	0.68 (0.23-1.96)	-	-0.23 (-0.60-0.14)
40-60	1.0 (referent)	1.0 (referent)	0.0 (referent)
60+	0.90 (0.33-2.44)	0.70 (0.08-5.94)	-0.18 (-0.52- 0.15)
Months Worked Per Year			
Less than 9	1.53 (0.76-3.11)	0.27 (0.03-2.27)	0.19 (-0.02-0.41)
9-12 (Full Season)	1.0 (referent)	1.0 (referent)	0.0 (referent)

3.5. Discussion

The combined effects of logging systems, workplace, and demographic factors all have a role in MSS prevalence and MSS score in the logging population. Years of experience, hours worked per week, and BMI were all included in models relating to the presence and severity (measured in MSS Score) of MSS in the Montana logging population. Workers in conventional logging systems experienced a 1.29 increase in the expected MSS score over mechanical logging workers. When controlling for age, each decade of experience was associated with a different, and significantly higher MSS score over workers with less than a decade of experience. Workers with 40 or more years of experience had the highest estimated MSS score, with a 2.91 increase over the referent. The experience group with 21-30 years of experience had a 2.80 increase in MSS score, and the 31-40 year group had a 2.32 increase in MSS Score over the referent category. Workers with a BMI outside the normal range was associated with increased MSS score, with overweight workers having an estimated 0.68 increase in MSS over workers with a normal BMI and obese workers having an estimated 0.70 increase in MSS score over workers with a normal BMI.

While mechanization of the logging industry has been associated with decreasing injuries (Axelsson, 1998; Bordas et al., 2001; Nieuwenhuis & Lyons, 2002), it is also associated with increased productivity pressure and excessive shift length compared to conventional logging (Nieuwenhuis & Lyons, 2002). The present study's authors found statistically significant differences in the hours worked per week and months worked per year between conventional and mechanical loggers. Workers in mechanical logging systems worked on average eight hours more per week (48.6 hours in comparison to 40.0 hours) and almost one more month per year than workers using conventional methods (9.5 months in comparison to 8.8 months). The logging season in Montana is dictated by environmental limitations not seen in other parts of the country. Loggers are unable to harvest in the summer months due to the potential for fire and regulations on use of internal combustion engines in the woods during periods of dry and hot weather. The spring and fall months are limiting due to rain. Mechanical logging operations may be unable to move their equipment in and out of logging sites during periods of rain due to deep mud, rendering the logging roads impassable. Peak season is in the winter, after the roads and mud have frozen, and fire danger is gone. While the use of conventional logging operations may allow workers to harvest in the spring and fall seasons, these operations experience limitations in due to bitter cold and snow in the winter season.

Many researchers studying logging suggest that increasing mechanization (by transitioning from conventional logging to mechanical logging) should decrease the number of injuries and fatalities associated with logging (Axelsson, 1998; Bordas et al., 2001; Nieuwenhuis & Lyons, 2002). In the present study, the authors found that workers in conventional logging systems had a one-year period prevalence of MSS of 60% while workers in mechanical logging systems had a one-year period prevalence of 50% and conventional logging workers were over twice as likely to report MSS. In 1998, a study was conducted by Hagen, Magus and Vetlesen to quantify MSS in Norwegian loggers (Hagen, Magnus, & Vetlesen, 1998). In this study, one-year period prevalence of MSS in the lower back was 24.8% among manual logging labors and 22.7% among logging equipment operators (Hagen et al., 1998). In comparison to the present study, the prevalence of lower back MSS in the Norwegian study population is quite low. However, the population demographics of the loggers in Norway were different from that of the population in the present study. Mechanical logging workers in the Norwegian study had an average of 14 years of experience and manual workers had an average of 17 years of experience (Hagen et al., 1998). In contrast, the present study population had on average 7 years more experience for mechanical operations and 6 years more experience in conventional logging operations. The difference in length of employment between these two populations could account for the differences in prevalence of MSS.

While the prevalence of MSS in any body area was non-significant between loggers using conventional and mechanical logging systems, workers in mechanical logging operations had a higher prevalence of neck and upper back symptoms than workers in conventional logging operations, while workers using conventional logging methods had a higher prevalence of MSS in every other body area. While the root cause of the ergonomic stressor varies between conventional and mechanized logging systems, both system types experience ergonomic hazards, which may result in injuries to various anatomical areas. Loggers in mechanized operations may experience symptoms in the neck and upper back due to constant head turning and twisting required to continually monitor the area outside the logging equipment (Lynch et al., 2014; Schettino, Campos, Minette, & Souza, 2017). Lewark 2005, in a systematic literature review found “sustained low-level muscle activity with few interruptions and with long working hours are possibly related to neck/shoulder pain (in loggers using mechanized systems). However, work organizational aspects are also of importance and several authors stress the need for a multifactorial approach for studying these phenomena” (Lewark, 2005). Workers in mechanical logging operations may experience MSS in the lower back due to vibration from sitting in in the seat of the logging equipment (Lynch et al., 2014), or may experience sprain/strain injuries in the lower back and lower extremity due to injuries incurred while climbing in and out of equipment (Axelsson, 1998). Zimmerman, Cook, and Rosecrance (1997), discovered a similar pattern of MSS in construction operating engineers which they attributed to prolonged and awkward postures, environmental conditions, noise, and whole-body vibration (Zimmermann, Cook, & Rosecrance, 1997). Both mechanized and conventional logging systems experience stressors in the hands and wrist. Use of a chainsaw is a well-documented risk for vibration-induced white finger (Axelsson, 1998; Nieuwenhuis & Lyons, 2002) and increased association with carpal tunnel syndrome (Bovenzi, Zadini, Franzinelli, & Borgogni, 1991), while persistent use of mechanized logging controls has been associated with increased incidence repetitive strain injuries in the hands and arms (Axelsson, 1998; Axelsson & Pontén, 1990). Workers in conventional logging systems also experience risks due to carrying heavy equipment, reaching, twisting, and walking over steep and varied terrain, which may be responsible for the increased prevalence of MSS in the lower body (Axelsson, 1998; Harstela, 1990).

Due to similarities in risk and work activities, the National Institute for Occupational Safety and Health (NIOSH), groups Agriculture, Forestry, and Fishing (AgFF) into a combined industry sector (National Institute for Occupational Safety and Health, 2016). The AgFF sector has high rates of both fatal and non-fatal injury rates in comparison to the overall working population and other industry sectors (National Institute for Occupational Safety and Health, 2016). As a sector, AgFF had an occupational fatality rate of 25.6 per 100,000 FTE, while the average across all industries was 3.4 per 100,000 FTE (National Institute for Occupational Safety and Health, 2016). Some of the unique risks to the AgFF sector which are shared between farmers and loggers include: outdoor work in harsh conditions, rural work locations, low profit margins, and seasonal variation (National Institute for Occupational Safety and Health, 2016). In addition, both of these industries require heavy and dangerous equipment, repetitive motions, and awkward postures (National Institute for Occupational Safety and Health, 2016). Forestry and farming vary in the season of work, the specific types of machinery and equipment, as well as degree of automation and mechanization. The MSS prevalence reported in Montana loggers as a result of this study was similar to the MSS prevalence found in a population of Kansas farmers by Rosecrance, Rodgers, and Merlino (2006). One-year period prevalence of low back pain in the farming population was reported to be 38% (J. Rosecrance, Rodgers, & Merlino, 2006). In addition, reported MSS in the shoulders was 26%, knees 24% and neck 22% (J. Rosecrance et al., 2006). This corresponds closely with the prevalence found in the Montana logging population, where MSS prevalence in the low back was 38%, shoulders 28%, knees 25%, and neck 25%. The mean age of Kansas farmers was 58 years, mean BMI 28, and mean duration employed a farmer was 36 years. In comparison, mean age of the Montana loggers in this study was 46 years, mean BMI 28, and mean duration as a logger was 22 years. While the one-year period prevalence of MSS in these populations is nearly identical, the mean age and duration of employment varies by over a decade. The comparison between logging and farming workers is interesting due to similarities in work tasks and culture between these two industries. The demographic differences between these two populations, paired with similarity of MSS survey results, demonstrates that loggers are experiencing the same symptom prevalence at younger ages, and after fewer years working in their industry, than farmers.

Limitations

There are several limitations in the current study design. The population used for the study was limited to loggers participating in a safety-training event in Montana. There is possible selection bias due to the lack of information collected from non-respondents. Due to the potential bias, we cannot be sure we obtained a representative sample from the population attending the safety training course. Due to industry differences across the nation and around the world, the authors cannot be certain that this population, and subsequent results, can be generalized to the logging industry across the region or the country. In addition, to obtain information on logging system type and job type, the researchers asked for participants to report their current (in the last year) job and logging system type, and did not obtain information on job type and logging system used in previous years. This may bias the results toward the null when comparing conventional and mechanical operations, as workers who are currently employed in mechanized systems may have changed jobs due to injury or the stressors of conventional logging systems.

Due to the retrospective nature of the survey instrument, the investigators relied on respondents' recall of past events to accurately complete the workplace factors and MSS questionnaire. Rosecrance et al. developed the modified version of the SNQ used in this study, to quantify the severity of MSS rather than the duration or start MSS, which reduced the impact of recall bias. Instead of asking if MSS occurred over the worker's entire life, the last year, or the last week, this study quantified the severity of MSS by asking if the worker had "experienced job-related symptoms", "been prevented from doing a day's work", or "seen a physician". Rosecrance et al. found lower kappa coefficients (κ=0.13-071) during a reliability analysis for questions related to whether the workers experienced job related symptoms in a particular body area, and higher kappa coefficients (κ=0.48-0.82) for the questions in regard to the worker seeing a physician in the last year for MSS localized to a worker's particular body area (J. C. Rosecrance, Ketchen, Merlino, Anton, & Cook, 2002). The authors reason that the difference between the reliability measures of these two questions is due to "respondent's better recall of actual events such as traveling to the physician's office versus the recall of subjective symptoms in the preceding 12 months" (J. C. Rosecrance et al., 2002).

3.6. Conclusions

Quantifying the current symptom prevalence in the logging population can help identify possible areas and opportunities for interventions, as well as measure the success of interventions after implementation. Researchers have demonstrated a significant association between the level of reported MSS and the development of injuries in the future (Nordlund & Ekberg, 2004). Therefore, the information collected in this study can be used to assess the potential development of injuries of logging workers.

Many study authors have indicated that mechanization is successful in reducing injury occurrence, however, in the Montana population, workers using mechanized systems are still experiencing high levels of MSS. Using regression models, conventional logging systems can be attributed to increased prevalence of MSS and higher MSS scores among loggers, however, other workplace factors, such as BMI and experience, also have a significant effect.

While emerging advancements in harvesting techniques, such as steep-slope harvesting, may have application in Montana, it should be noted that the prevalence of musculoskeletal symptoms in workers using mechanized logging systems was still 50%. Therefore, moving forward, injury prevention efforts in the logging industry should focus on engineering controls to decrease the occurrence of MSS in loggers using both mechanical and conventional logging systems and improve psychosocial work factors resulting from production concerns, leadership, and communication among crews (Lagerstrom et al., 2017).

Chapter 4: Safety Climate in the Montana Logging Industry

4.1. Overview

Introduction: Safety climate is an understudied topic in the hazardous industry of professional logging. We assessed safety climate in the logging industry of Montana, and identified determinants of safety climate based on worker demographics, workplace factors, and musculoskeletal symptoms.

Methods: A demographic, musculoskeletal symptom (MSS), and safety climate survey (NOSACQ-50) was administered to 742 professional loggers in Montana, USA. Analyses were conducted to determine the association between demographic characteristics, MSS, workplace variables and five safety climate dimension scores (management safety priority and ability, workers' safety commitment, workers' safety priority and risk non-acceptance, peer safety communication, learning, and trust in safety ability, and workers' trust in efficacy of safety systems).

Results: In four of the five safety climate dimensions assessed, safety climate was above 3.30 (scale: 1 – 4), indicating that the safety climate level was considered good for both leaders and workers. Variables identified as predictors of safety climate dimension scores included logging system type, supervisory status, age, years of experience and reported MSS. Across all five dimensions assessed, leaders responded more positively to the safety climate measures than did workers. Workers had significantly lower responses than leaders in two safety climate dimensions.

Conclusions: The disparity between management's views of their own safety priority versus workers' views of management's safety priority indicates a need to focus on safety interventions in those specific dimensions. The difference in safety climate between leaders and workers may be attributed to the difference in primary job duties and work environment. This may also indicate dissociation or distancing in the relationship between leadership and workers and indicate a need for greater management involvement.

Practical Applications: Assessing the current safety climate of the logging population and investigation of the determinants of safety climate is needed to identify possible areas and opportunities for future interventions.

4.2. Introduction

The construct of safety climate developed over the last 40 years in response to the need for leading, rather than lagging, indicators of occupational safety performance, including the prevention of injuries and incidents (Zohar, 1980). Zohar (1980) developed one of the first measures of safety climate, which was designed to discriminate between companies with high and low accident rates by measuring different dimensions of organizational climate (Zohar, 1980). Based on the compilation of ideas and research regarding safety climate and culture, Zhang et al. (2002), defined safety climate as: "the perceived state of safety at a particular place at a particular time, making the definition relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions" (Zhang, Wiegmann, Von Thaden, Sharma, & Mitchell, 2002).

Safety climate researchers have determined that it was important to measure safety climate before beginning an intervention to ensure an adequate climate for change (Neal, Griffin, & Hart, 2000). While studying the link between organizational climate and safety climate, researchers indicated that interventions aimed at improving the safety of an organization would be more successful if they occurred in a positive climate (Neal et al., 2000). The authors of the same study found that safety climate had an effect on worker motivation and compliance, which was important for determining safe work behavior and performance (Neal et al., 2000). Assessment of safety climate is a critical and underutilized tool for occupational groups with a history of and/or high risk for worker injury.

Due to the high rates of injuries and fatalities in the logging industry, logging has been included in the last two decades of the National Occupational Research Agenda (NORA) as a targeted industry subsector with the goal of stimulating innovative research and improved workplace practices (National Occupational Research Agenda (NORA) Agriculture, 2016). The major objectives of the 2016 update to the NORA included surveillance and providing outreach, communication and partnerships with local companies and industries (National Occupational Research Agenda (NORA) Agriculture, 2016). Commercial logging has long been considered one of the most dangerous occupations in the United States (O. S. H. A. United States Department of Labor, 2017). In 2016, the Bureau of Labor Statistics (BLS) reported the incidence rates of nonfatal occupational injuries and illnesses in the logging industry as 3.6 per 100 FTE (Statistics, 2017), and, in 2015, the Census of Fatal Occupational Injuries reported a fatal injury rate of 98 per 100,00 full-time equivalent workers (U.S. Bureau of Labor Statistics, 2017). In comparison, in 2015, the fatal injury rate for all industries in the United States was 3.4 per 100,00 full-time equivalent workers (U.S. Bureau of Labor Statistics, 2017).

Inherent dangers of the logging industry are induced by environmental conditions, heavy machinery, manual labor, and can vary based upon season, regional logging practices, and terrain. For example, in the Southeastern United States, logging is highly mechanized, the terrain flat, and the weather mild in comparison to logging in the Pacific Northwest or Intermountain regions of the United States, where logging is characterized by harsh terrain, severe weather, and remote work locations (Lagerstrom et al., 2017; O. S. H. A. United States Department of Labor, 2017).

In Montana, and the entire Intermountain region of Montana and Idaho, recent economic challenges have had a detrimental effect on the loggers, and have compounded hazards related to travel distances, workload, and psychosocial factors. As a result of the 2008 economic recession, demand for timber decreased, mills closed, and lumber sale prices decreased. Logging companies faced decreasing profit margins as the cost to harvest the timber remained static (and in some cases increased), while sale prices decreased. Closing mills had, and continues to have, an immediate and tangible impact to the timber haulers (logging truck drivers). Timber haulers must now drive further distances, often past mills, which have closed, to unload at operational mills. The increase in time and fuel necessary to transport each load of logs decreases the already shrinking profit margins. The psychological stressors of decreasing profit margins (Nieuwenhuis & Lyons, 2002), long working hours (Axelsson, 1998; Lilley et al., 2002; Nieuwenhuis & Lyons, 2002), and perceived workplace dangers (Nieuwenhuis & Lyons, 2002) are all present in the logging industry. In a survey of loggers, it was revealed that over 60% of respondents believed that the financial restrictions and payment were a barrier to workplace health and safety (Nieuwenhuis & Lyons, 2002). According to anecdotal opinions from loggers, to remain profitable during times of economic hardship, safety may be sacrificed for productivity (Lagerstrom et al., 2017).

To date, there have been no published studies that specifically assesses safety climate in the logging industry. Measuring safety climate of Montana loggers will support the NORA for AFF by providing industry surveillance, and will help determine readiness for future safety interventions. Measuring leading indicators, such as safety climate, is a step toward proactive injury surveillance and control.

The purpose of this cross-sectional study was to quantify safety climate in the logging industry of Montana and identify determinants of safety climate based on surveys of worker demographics, workplace factors, and musculoskeletal symptoms.

4.3. Methods

Data Acquisition

A survey was administered to loggers participating in Occupational Safety and Health Administration (OSHA)-required emergency first-aid training workshops throughout Montana, which were sponsored by the Montana Logging Association in spring 2017. The training sessions are held annually at different locations across the state of Montana to offer loggers an opportunity to complete this requirement. The survey consisted of three different sections: demographic data, a musculoskeletal symptom (MSS) survey, and a safety climate survey. Participation in the survey was voluntary and anonymous. Compensation was not provided to participants. All workers in attendance at the workshops were eligible for participation. The survey and methodology discussed in this paper were a part of a larger study, which included an in-depth analysis of MSS and training preferences among loggers in Montana.

Demographic information collected as a part of the survey included age, gender, and education level. Job information collected by the survey included logging system type, supervisory status (leader v. worker), whether the logger was an accredited logging professional (designation requiring continuing education on safe and environmental logging practices) and years spent employed in the logging industry.

The Nordic Occupational Safety Climate Questionnaire (NOSACQ-50) is one metric used to quantify specific areas, or dimensions, of safety climate in the workplace. Multiple studies have validated this measure in various industries, countries, and languages. The NOSACQ-50 was developed by a team of Nordic researchers trying to determine reasons why different occupational groups have higher accident and injury rates than other groups performing the same work (Kines et al., 2011). According to this research group, the definition of safety climate is a measure of "a workgroup members' shared perceptions of management and workgroup safety related policies, procedures, and practices" (Kines et al., 2011; Kines. P. et al.). To measure safety climate, the Nordic team developed a questionnaire composed of 50 items over seven different dimensions of safety climate. The seven safety climate dimensions covered by the NOSACQ-50 are: (1) management safety priority and ability; (2) management safety empowerment; (3) management safety justice; (4) workers' safety commitment; (5) workers' safety priority and risk non-acceptance; (6) peer safety communication, learning and trust in safety ability; and (7) workers' trust in efficacy of safety systems (Kines. P. et al.).

The survey used to assess safety climate in the logging industry was based on a modification of the English translation of NOSACQ-50, and was modified for this study to fit within survey time and space requirements. The modifications included using only five of the seven dimensions: management safety priority and ability, workers' safety commitment, workers' safety priority and risk non-acceptance, peer safety communication, learning, and trust in safety ability, and workers' trust in efficacy of safety systems. In total, 38 of the original 50 items were used. The items were answered in the form of a Likert scale (1-4) ranging from strongly disagree (1), to strongly agree (4). Within the survey, there were both positively and negatively worded items. In positively worded items, e.g. "Management encourages employees here to work in accordance with safety rules - even when the work schedule is tight", higher scores correspond to a higher level of safety climate. In negatively worded items, e.g. "My coworkers and I accept risk-taking at work", lower scores correspond to a higher level of safety climate.

To determine the presence of musculoskeletal symptoms in the logging population, a modification of the Standardized Nordic Questionnaire (SNQ) was administered. The modified questionnaire included three questions in reference to nine anatomical regions of the body. First, "During the last 12 months have you had a job-related ache, pain, or discomfort?"; Second: "During the last 12 months has this ache, pain, or discomfort prevented you from doing your day's work?"; and Third: "During the last 12 months have you seen a physician or physical therapist for this pain, ache or discomfort?" For each question, participants checked either yes or no for each anatomical region.

Data Analysis

Means, standard deviations, and frequency statistics were calculated for all demographic variables. The continuous variable, years of experience in the logging industry, was transformed into a categorical variable by decades of experience. Two binary variables were created based on the results of the modified SNQ, to identify workers who experienced MSS in any anatomical area (Yes/No), or missed work due to MSS in the past 12 months (Yes/No).

Dimension scores for NOSACQ-50 were analyzed and interpreted in accordance with published guidelines (Kines. P. et al.). A score for each dimension was calculated. Scores for negatively worded items were reversed when calculating mean dimension scores. Safety climate dimension scores were analyzed separately for leaders (owners/supervisors) and workers.

T-tests were performed to determine if there was a significant difference in safety climate dimension scores based on leader-worker status and MSS status, i.e. whether the respondent had experienced any MSS (Yes/No), or had missed work due to MSS (Yes/No).

A categorical response variable was created for safety climate scores corresponding to recommended levels published by the National Research Centre for the Working Environment in Denmark as soft guidelines for interpretation (Kines. P. et al.). Safety climate dimension scores above 3.30, on the scale of 1-4, indicate that the safety climate level of the workplace is good, dimension scores from 3 to 3.30 correspond to a fairly good safety climate, and scores below 3.00 correspond to fairly low or low safety climate dimension scores (Kines. P. et al.).

Multinomial logistic regression was performed to determine which demographic, workplace, and injury variables were associated with the categorical interpretation of the safety climate dimension scores. Separate logistic regression models were run for each of the five safety climate dimensions. Variables in the model included logging system type, supervisory status, if the worker was certified as an accredited logging professional (ALP), education level, age, years of experience in logging, and whether the respondent had reported any MSS.

Data analysis was performed using SAS 9.4 (SAS Institute Inc, 2012). Significance was based upon $p < 0.05$. The study protocol was approved by the corresponding author's Research Integrity and Compliance Review Office.

4.4. Results

Respondent demographics

A total of 1,059 workers attended the training workshops and 743 surveys were returned for an overall response rate of 70.2%. Mean age of respondents was approximately 46 (SD: 13.67); mean number of years employed in the logging industry was 22 (SD: 14.11). Overall, 48% of the respondents reported experiencing musculoskeletal symptoms due to their work in the past year, and 6% of the respondents reported missing work in the past year due to MSS (Table 1).

Table 4.1: Montana logging survey 2017: Respondent demographics

Table 1. Montana logging survey 2017: Respondent demographics	
	N total=743
Age	Mean: 45.88 (SD: 13.67; n=688)
Years in Logging Industry	Mean: 21.96 (SD: 14.11, n=662)
Owner or Supervisor	
Yes	284 (38.2%)
No	412 (55.5%)
Missing	47 (6.3%)
Accredited Logging Professional (ALP)?	
Yes	174 (23.4%)
No	414 (55.7%)
Missing	155 (20.9%)
Highest Education Level Achieved	
Did not finish High School	55 (7.4%)
High School Diploma	410 (55.2%)
Some College	179 (24.1%)
Bachelor degree or Higher	59 (7.9%)
Missing	40 (5.4%)
Primary Logging System Type	
Conventional	80 (10.8%)
Mechanical	408 (54.9%)
Both	28 (3.8%)
Missing	227 (30.6%)
Musculoskeletal Symptoms	
Symptoms in any area	274 (48.1%)
Missed work due to symptoms in any area	34 (6.0%)

Safety climate analysis and categorization

The results of the safety climate survey are presented in Table 2. When all responses were considered, dimension 1 had the highest mean overall score (3.40), followed by dimension 4 (3.39), 7 (3.34), and 6 (3.34). Dimension 5 had the lowest mean score (3.10) and, when interpreted, was the only dimension found to not fall into the "good" category. Across all five dimensions assessed, leaders had higher dimension scores survey than workers. In dimensions one and four, the difference between leader ratings and worker ratings was significant (p< 0.05).

Table 4.2: Montana logging survey 2017: Safety climate survey results by dimension

Table 2. Montana logging survey 2017: Safety climate survey results by dimension										
	Dimension 1* Management safety priority and ability		**Dimension 4** Workers' safety commitment		**Dimension 5** Workers' safety priority and risk non-acceptance		**Dimension 6** Peer safety communication, learning and trust in safety ability		**Dimension 7** Workers' trust in the efficacy of safety systems	
	Leader	Worker	Leader	Worker	Leader	Worker	Leader	Worker	Leader	Worker
Dimension Score	3.44**	3.37**	3.44 **	3.37**	3.14	3.07	3.36	3.32	3.36	3.33
Cronbach's Alpha	0.86	0.89	0.72	0.70	0.72	0.76	0.90	0.92	0.86	0.89
* NOSACQ-50 dimensions 2 and 3 were not included in the survey **t-test significant, *p*<0.05 for leaders (owners/supervisors) verses workers										

Safety climate and MSS reporting

T-tests were performed to determine if there was a significant difference in dimension scores between those who did or did not report experiencing MSS in the past year (Table 3). Leaders who experienced MSS had a significantly lower score on dimension five (p=0.05) than leaders who did not experience MSS. Workers who reported MSS had significantly lower scores on dimension one (p=0.03), and dimension five (p=0.013), in comparison to workers who did not report MSS. No significant differences in safety climate dimension scores were found with leaders nor workers who did or did not miss work due to MSS.

Table 4.3: Montana logging survey 2017: Safety climate dimension scores by musculoskeletal symptom status (MSS)

Table 3. Montana logging survey 2017: Safety climate dimension scores by musculoskeletal symptom status (MSS)						
		Dimension 1* Management safety priority and ability	**Dimension 4** Workers' safety commitment	**Dimension 5** Workers' safety priority and risk non-acceptance	**Dimension 6** Peer safety communication , learning and trust in safety ability	**Dimension 7** Workers' trust in the efficacy of safety systems
Leaders (owners/ supervisors)	No MSS	3.45	3.44	3.22	3.38	3.4
	Any MSS	3.46	3.47	3.09	3.35	3.33
	T-test p-value	NS	NS	**0.0498**	NS	NS
	No Missed Work Days	3.45	3.45	.16	3.36	3.36
	Any Missed Work Days	3.49	3.46	3.09	3.45	3.37
	T-test p-value	NS	NS	NS	NS	NS
Workers	No MSS	3.43	3.38	3.15	3.33	3.34
	Any MSS	3.30	3.36	3.01	3.29	3.30
	T-test p-value	**0.0283**	NS	**0.0128**	NS	NS
	No Missed Work Days	3.38	3.38	3.09	3.32	3.33
	Any Missed Work Days	3.15	3.19	2.94	3.12	3.21
	T-test p-value	NS	NS	NS	NS	NS
* NOSACQ-50 dimensions 2 and 3 were not included in the survey						

Regression results: demographics and workplace factors predicting safety climate

Multinomial logistic regression was used to examine differences in predictors of the three safety climate dimension categories: good, fairly good, and low (Table 4). In dimension one, two variables were significant in differentiating respondents with a low safety climate dimension score from those with high safety climate score: supervisory status and decades of experience. Workers were nearly four times (OR= 3.98, 95% CI: 1.40-11.35) as likely be categorized in the lowest level of safety climate than leaders. In comparison to workers who did not finish high school, workers who had a high school diploma or some college had 0.16 (CI: 0.04-0.66) and 0.15 (CI: 0.03-0.68) decreased odds, respectively of being placed in the lowest category of safety climate, respectively. As education increased from no high school diploma to some college, there were decreased odds of being in the low safety climate categorization for dimension one. In dimension four, workers using mechanical logging systems were over twice (OR= 2.25, 95% CI: 1.00-5.06) as likely to be categorized as having a 'fairly good' perception of safety climate rather than 'good' safety climate. In dimension five, two variables were significantly associated differences in categorization between low and high levels of safety climate and a single variable was associated with increased odds of a respondent's placement in the 'fairly good' safety climate categorization.

The odds ratio for a one-unit increase in the variable age was 0.95 (95% CI= 0.92-0.99) for low safety versus high safety climate scores. Therefore, as age increased, respondents were less likely to be categorized in the low safety climate group. Also in dimension five, respondents using mechanical logging systems were over three times more likely to report a score in the 'fairly good' safety climate category rather than the 'good' safety climate category, and respondents with low safety climate scores were almost three times more likely to report MSS than people with a high level of safety climate. In dimension seven, age was the only significant demographic predictor of safety climate categorization between respondents having a low versus a high level of safety climate. The odds ratio for a one-unit increase in the variable age is 0.94 for having a low vs. a high safety climate score. Younger ages were associated with categorization in the low safety climate group.

Table 4.4: Montana logging survey 2017: Multinomial logistic regression results

Table 4. Montana logging survey 2017: Multinomial logistic regression results										
	Likelihood Relative to Referent- "Good" Safety Climate Dimension Score									
	Dimension 1*		Dimension 4		Dimension 5		Dimension 6		Dimension 7	
	Fairly Good OR (95%CI)	Low OR (95%CI)	Fairly Good OR (95%CI)	Low OR (95%CI)	Fairly Good OR (95%CI)	Low OR (95%CI)	Fairly Good OR (95%CI)	Low OR (95%CI)	Fairly Good OR (95%CI)	Low OR (95%CI)
Primary Logging System:										
Conventional	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mechanical	1.82 (0.77-4.30)	0.66 (0.24-1.85)	**2.25 (1.00-5.06)**	1.16 (0.28-4.86)	**3.46 (1.28-9.33)**	2.00 (0.87-4.61)	1.76 (0.84-3.71)	2.18 (0.65-7.33)	2.37 (0.99-5.67)	0.80 (0.28-2.34)
Supervisory Status										
Owner/Supervisor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Worker	1.10 (0.56-2.15)	**3.98 (1.40-11.35)**	1.40 (0.74-2.65)	3.49 (0.96-12.71)	0.95 (0.43-2.09)	1.48 (0.70-3.13)	1.78 (0.96-3.31)	1.66 (0.65-4.21)	1.42 (0.73-2.77)	0.86 (0.32-2.29)
Accredited Logging										
Professional	1.33 (0.70-2.52)	0.43 (0.14-1.28)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.00	1.00	0.97 (0.51-1.82)	2.71 (0.89-8.21)	1.42 (0.64-3.14)	1.85 (0.87-3.93)	0.85 (0.46-1.55)	0.52 (0.20-1.39)	0.86 (0.46-1.63)	0.61 (0.22-1.66)
No										
Education Level										
Did not finish High School	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
High School Diploma	0.57 (0.16-2.05)	**0.16 (0.04-0.66)**	2.16 (0.55-8.41)	0.28 (0.06-1.36)	1.41 (0.23-8.77)	0.33 (0.08-1.33)	0.65 (0.21-2.05)	0.42 (0.09-1.99)	0.92 (0.27-3.14)	0.48 (0.10-2.38)
Some College	0.47 (0.13-1.78)	**0.15 (0.03-0.68)**	2.66 (0.65-10.94)	0.37(0.07-2.04)	1.94 (0.30-12.53)	0.33 (0.08-1.45)	0.40 (0.12-1.34)	0.31 (0.06-1.65)	0.75 (0.21-2.75)	0.75 (0.21-2.75)
B.S. or Higher	0.92 (0.21-3.96)	0.25 (0.03-1.88)	3.47 (0.73-16.56)	-	0.64 (0.08-5.45)	0.67 (0.13-3.41)	0.40 (0.10-1.65)	0.49 (0.07-3.44)	0.64 (0.14-3.01)	2.31 (0.36-14.98)
Age	1.01 (0.98-1.05)	1.02 (0.97-1.07)	1.00 (0.96-1.03)	1.04 (0.98-1.11)	1.02 (0.98-1.06)	**0.95 (0.92-0.99)**	1.03 (1.00-1.07)	1.04 (0.99-1.09)	1.01 (0.98-1.05)	**0.94 (0.89-1.00)**
Years of Experience in										
Logging	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0-10	0.53 (0.24-1.20)	0.78 (0.24-2.54)	0.77 (0.35-1.71)	0.39 (0.08-1.78)	0.51 (0.18-1.44)	0.99 (0.38-2.61)	0.59 (0.27-1.33)	**0.28 (0.08-0.94)**	0.83 (0.34-2.02)	1.09 (0.34-3.51)
11-20	0.41 (0.16-1.09)	1.22 (0.32-4.62)	0.84 (0.33-2.15)	0.40 (0.07-2.19)	0.45 (0014-1.40)	0.87 (0.28-2.74)	0.41 (0.16-1.06)	0.45 (0.13-1.64)	0.58 (0.21-1.62)	0.45 (0.08-2.42)
21-30	0.40 (0.11-1.43)	1.04 (0.19-5.66)	1.67 (0.50-5.65)	0.50 (0.06-4.21)	0.35 (0.081-1.55)	0.88 (0.20-3.83)	0.42 (0.13-1.40)	0.18 (0.03-1.11)	0.98 (0.26-3.65)	1.26(0.16-9.70)
31-40	0.32 (0.07-1.51)	-	1.19 (0.26-5.42)	-	0.32 (0.06-1.86)	0.56 (0.08-3.77)	0.37 (0.08-1.73)	0.12 (0.01-1.78)	0.47(0.09-2.40)	0.60 (0.03-10.73)
40+										
MSS Status										
No symptoms	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Symptoms	0.89 (0.51-1.56)	2.07 (0.90-4.76)	0.79 (0.50-1.35)	1.49 (0.51-4.34)	1.15 (0.58-2.25)	**2.98 (1.55-5.72)**	1.06 (0.62-1.81)	1.29 (0.58-2.89)	0.96 (0.55-1.68)	1.89 (0.79-4.49)

* NOSACQ-50 dimensions 2 and 3 were not included in the survey

4.5. Discussion

The purpose of this study was to provide a quantitative evaluation of the determinants of safety climate within the logging industry, and to provide a baseline measure of the safety perceptions of this population. Reoccurring predictors of safety climate within the population of loggers in the present study included logging system type and age. In dimensions four (workers' safety commitment) and five (workers' safety priority and risk non-acceptance), there were increased odds of loggers using mechanical systems being assigned to the middle category of safety climate than the good category of safety climate. This can be translated to loggers using mechanical logging systems having lower safety commitment and more likely to accept risks than loggers using conventional logging systems. In both dimensions five and seven (workers' trust in the efficacy of safety systems), as age increased, loggers were less likely to be categorized into the low safety climate category. There was only one dimension where positive MSS status was significantly associated with low safety climate. In dimension five, which is workers' safety priority and risk non-acceptance, workers who reported work-related MSS were nearly three times more likely to be assigned to the low category of safety climate than the high category, meaning, loggers who experienced MSS in the past year were more likely to have low safety priorities and accept risks in the workplace than loggers who did not report MSS.

While not significant in the regression model, the disparity between leaders' and workers' safety climate scores is of interest. Across all five dimensions, leaders (owners/supervisors) of logging companies had higher safety climate scores than workers, and in two dimensions, when workers were compared directly to leaders, workers had significantly lower responses. The significant differences were found in dimensions one (management safety priority and ability) and four (workers' safety commitment). The disparity between leaders' views of their own safety priority versus workers' views of leaders' safety priority deserves further investigation. In addition, it may be prudent for leaders to realize that their workers have a significantly different (and lower) view of their safety priorities than how they rate themselves. The difference in safety climate between leaders and workers may be attributed to the difference in primary job duties and work environment. In general, leaders have an increased emphasis on adherence to policy and procedures rather than practice. The difference in safety climate between leaders and workers may also indicate dissociation or distancing in the relationship between leadership and workers, signaling the need for greater management involvement.

While mechanization of the logging industry has been associated with decreasing injuries (Axelsson, 1998; Bordas et al., 2001; Nieuwenhuis & Lyons, 2002), it is also associated with increased productivity pressure and excessive shift length compared to conventional logging (Nieuwenhuis & Lyons, 2002). In the present study, a significant difference was found in the odds of mechanical logging systems being associated with lower categories of safety climate than conventional logging workers. The difference in safety climate scores between workers employed in conventional versus mechanical logging operations may be due to the teamwork and interaction between employees on conventional sites. Workers in mechanical logging systems often work in enclosed cabs and may be distanced from other workers, while conventional workers often work in proximity to each other, reinforcing communication and the team environment.

Researchers studying safety climate have identified many different factors, which influence safety climate in a workplace. Recently, investigators have found significant associations between safety climate and age, job type, company size, industry, and education level of the workforce (Terence Lee, 1998; Taeki Lee & Harrison, 2000; Siu, Phillips, & Leung, 2003; Sønderstrup-Andersen, Carlsen, Kines, Bjoerner, & Roepstorff, 2011; Wu, Liu, & Lu, 2007). Authors of a cross-sectional study of Danish workers (Sønderstrup-Andersen et al., 2011) found that there was a significant association between lower safety climate ratings among workers aged 18-29 in comparison to workers at the same workplace in older age groups (Sønderstrup-Andersen et al., 2011). The finding that younger workers perceive safety climate more negatively than older workers at the same workplace has been confirmed in studies of nuclear power plants (Terence Lee, 1998; Taeki Lee & Harrison, 2000), as well as a university laboratory (Wu et al., 2007), and the construction industry (Siu et al., 2003). This association between increasing age and higher perceptions of safety climate was seen in the present study in dimensions five and seven.

In addition to age, the Danish authors (Sønderstrup-Andersen et al., 2011) also found an association between the predictor variables of education, job type, size of company, and industrial sector and safety climate (Sønderstrup-Andersen et al., 2011). Higher education levels were associated with higher levels of management safety empowerment and co-worker safety priority, and salaried workers were found to have more favorable safety climate ratings than that of skilled or unskilled labor (Sønderstrup-Andersen et al., 2011). Interestingly, the Danish investigators found no association between length of employment and safety climate rating (Sønderstrup-Andersen et al., 2011). In the present study, the author’s found that increased education was associated with decreased likelihood of low safety climate in dimension one, and found no consistent association between worker experience and safety climate.

When comparing the results of the present study to research performed in other labor-intensive industries, logging workers had higher safety climate scores than both carpenters and construction workers. Lipscomb, Schoenfisch, and Cameron (2015) performed an analysis of the safety climate of carpenters from Washington State using three of the NOSACQ50 dimensions. Two of the three dimensions surveyed overlapped with the methodology of the present study. Lipscomb et al. found that the mean worker safety priority score was 2.90, and mean peer safety communication score was 3.11 (Lipscomb, Schoenfisch, & Cameron, 2015). This is lower than the results found in the present study, which were 3.07 and 3.32, respectively.

In comparison to a study of Norwegian construction workers (Kjestveit, Tharaldsen, & Holte, 2011), the authors of the present study found that logging workers had higher safety climate scores across all dimension surveyed. Interestingly, the lowest dimension score for both studies was dimension five: workers' safety priority and risk non-acceptance. In the study of Norwegian construction workers, the mean score for dimension five was 2.89 (Kjestveit et al., 2011), whereas in the present study, the mean score was 3.07.

Limitations

There are several limitations given the research design in the present study. The population was limited to professional loggers participating in an annual mandatory safety-training program in Montana. It is difficult to determine the extent of selection bias, as the authors had no information on non-respondents. Thus, the sample only represents the population sample attending the safety-training course. However, it is known that 743 of the 1,059 (70% response rate) members of the logging organization expected at the training program participated. Because the logging conditions in Montana are specific to the unique characteristics of the environment, steep grades of forests being harvested and worker demographics, generalization to the logging industry outside of this region should be done with caution.

The timing of the survey administration may have biased the results of the safety climate evaluation. Safety climate measures are based upon workers' current perception of the safety of their workplace. As such, safety climate measures in the same population can vary based on current events. Given that the most current event was a safety-related training, workers may have given more positive responses to the safety climate survey. If subsequent safety climate measures are gathered, the results of the baseline measure may be biased, as baseline responses may be falsely elevated if the subsequent measure is not taken in the same context.

4.6. Conclusions

As indicated in the results of the study, the authors provide a quantitative evaluation of the current safety climate in the logging industry. The methods of the current study are novel in the context of the logging industry and continued research is desperately needed due to continued high rates of injuries and fatalities among professional loggers. The data and subsequent results obtained during this study provide a baseline measure of both musculoskeletal symptoms and safety climate, which can be used as a standard of comparison after the application of safety interventions.

Moving forward, injury prevention efforts in the logging industry should focus on sustaining the safety climate of the logging industry, specifically targeting the mismatch between leaders (owners/supervisors) versus worker safety perceptions, and the association between MSS and safety climate.

4.7. Practical Applications

Quantifying the current safety climate of the logging population and investigating determinants of safety climate is needed to identify possible areas and opportunities for future interventions. Measuring safety climate of Montana loggers will support the NORA for AFF by providing industry surveillance and will help determine readiness for future safety interventions.

Measuring leading indicators, such as safety climate, is a step toward proactive injury surveillance and control.

Chapter 5: A Case Study in the Application of the Systematic Approach to Training in the Logging Industry

5.1. Overview

Introduction: The purpose of this research was to develop a targeted emergency first-aid and safety training program for the loggers in Montana. There were two key objectives for this program: participant demonstration of recall and retention of key concepts and improved participant reception by the intended audience in comparison to the previous year's training program.

Methods: The Systematic Approach to Training provides the overall model for this research. A mix of qualitative and quantitative analysis were used to complete the five phases of training development and evaluation. An analysis of previous research and a needs assessment were completed before design, development, and implementation of the training program with over 800 loggers (n=873) throughout Montana. Surveys and examinations were used for training program evaluation.

Results: The post-training survey data indicated increases in training applicability, understanding of learning objectives, and overall course enjoyment of the updated program in comparison to the previous year's training program. A paired t-test revealed that participants scored significantly higher (over 10%) on the examination from pre-training to post-training ($p<0.0001$), demonstrating recall of key training objectives. Participants identified additional important training topics as methods for overall course improvement, that will be incorporated into the continuous improvement process of training program.

Conclusions: By conducting an analysis of the specific needs and challenges facing loggers in the target population, applicability and specificity of the updated training program was be optimized. The results obtained by the training evaluation strategy will guide research and the continued development of the updated training program to align with ongoing analysis activities and participant suggestions.

Practical Applications: While end-user perspectives should be solicited from the target audience before training program development, the results obtained from this study will be used as a baseline and background research for training development in other logging populations or similar industries.

5.2. Introduction

Commercial logging continues to be one of the most dangerous occupations in the United States (Bureau of Labor Statistics, 2017). Despite advances in harvesting techniques, which have decreased occupational risk of injury and fatality from chainsaw injures and environmental hazards, the occupational fatality rate in logging work (100.1 per 100,000 full-time equivalents) was 27.8 times greater than the rate reported for all other occupations combined (3.6 per 100,000 full-time equivalents) (U.S. Bureau of Labor Statistics, 2017).

Researchers in the logging industry have focused on the annual rate and characteristics of injuries (Bell & Helmkamp, 2003; Jack & Oliver, 2008; Lefort et al., 2003; Lynch et al., 2014; Priscah Mujuru et al., 2006; Myers & Fosbroke, 1994; Nieuwenhuis & Lyons, 2002), the effects of mechanization (Axelsson, 1998; Bell, 2002; Bordas et al., 2001; National Institute for Occupational Safety and Health, 2005; Roberts et al., 2005), worker's perceptions of the occupational risk (Bordas et al., 2001; Nieuwenhuis & Lyons, 2002), as well as the development of training strategies (Bell & Grushecky, 2006; Egan, 2005; P. Mujuru et al., 2009). Currently, the Occupational Safety and Health Administration (OSHA) defines training requirements for the logging industry including "the minimal acceptable first-aid and CPR training program for employees engaged in logging activities" (United States Department of Labor). The standard includes a list of required topics, as well as acceptable training methods. However, researchers have found that inexperienced workers are more likely to experience workplace injuries (Lagerstrom et al., 2017), indicating that there is a need for training or other programs which will directly prepare loggers for work. Research has been, and continues to be, conducted to determine the needs and best methods of training new, as well as seasoned workers, on safe work practices (Bordas et al., 2001; Egan, 2005; Helmkamp et al., 2004; Nieuwenhuis & Lyons, 2002). While prior research has measured training effectiveness in the logging industry, the authors are not aware of an intervention-based study which measures the effectiveness and reception of a training program for the logging industry based on end-user perspectives.

The Systematic Approach to Training is a five-step training development process that aims to provide training programs so workers can "do their jobs safely, efficiently, and effectively, and to protect the workforce, the public and the environment" (United States Department of Energy, 2014). The five steps of The Systematic Approach to Training include: analysis, design, development, implementation, and evaluation. Key features of ensuring the development of a successful training program include insuring frequent communication with subject matter experts, and management commitment to the development and ongoing implementation and improvement of the program (Dhawan, 2016; United States Department of Energy, 2014).

Previous studies from various industries have demonstrated success in using The Systematic Approach to Training model for the adaptation or creation of training programs. For example, Heikka (2008), applied the Systematic Approach to Training to solve a problem related to information security breaches in the telecommunications industry. This study found that by using The Systematic Approach to Training to develop and implement an information security program, there was a positive change in the security behaviors, as well as attitudes, after completion of the program (Heikka, 2008). Similarly, The Systematic Approach to Training has been used worldwide to develop training programs in the fields of emergency preparedness (Popp et al., 2012), medicine (Yao et al., 2010), and even civil service (Vukovic et al., 2008).

The logging industry may benefit from employing a systematic and highly structured approach to emergency first-aid training because regimented procedural knowledge and skills are required for effective performance during emergency situations. In addition, by creating clear and concise learning objectives for the training program, a unified view of the desired training outcomes can be formed by both instructors and training participants. Using a systematic approach to create a video-based training program and corresponding learning objectives may improve the consistency of the information presented during different sessions of the training program. Thorough documentation of the design and development process used to create the program may prove essential if there were a need to verify completion of an adequate and approved emergency first-aid training program for the purposes of a training audit.

The purpose of this research was to develop a targeted emergency first-aid and safety training program that will reduce the injury rate and severity of injuries among professional loggers in the Intermountain region. In the logging industry, population demographics, risks, and logging systems vary by region. Due to this variation, training attitudes, needs, and preferences also vary by region. To develop a training program to best meet the needs of the end-user, research must be conducted to understand the population of interest. To our knowledge, this is the first study to use the Systematic Approach to Training to develop, implement, and evaluate a refined training program that specifically addresses the challenges and hazards of the logging industry.

The objectives of this study were to demonstrate recall and retention of key concepts included in the training program and to determine if the program was received more positively by the intended audience than the previous year's training program.

5.3. Methods

Data Acquisition

The Systematic Approach to Training provides the overall model for this research. A mix of qualitative and quantitative data were used to complete the five phases of training program development. In addition to the methodology contained in the following manuscript, additional research was conducted as a part of the analysis phase of the project. Preliminary projects and research with the Montana Logging Association included an analysis of workers compensation claims (Lagerstrom et al., 2017), musculoskeletal symptom prevalence, and measures of safety climate.

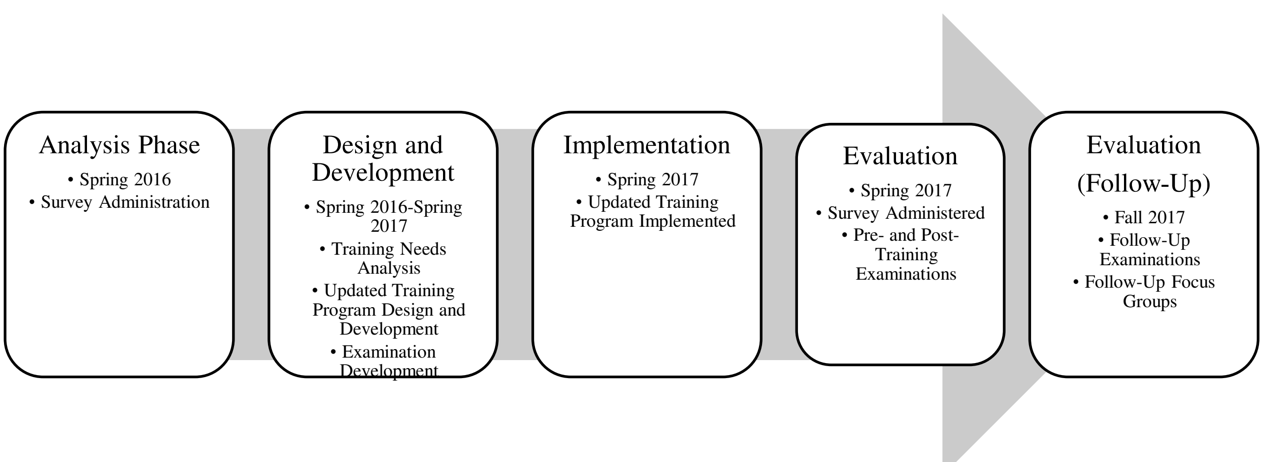

Figure 5.1: Research Timeline and Activities

Analysis Phase (Spring 2016)

In the spring 2016, a survey was administered by the safety staff of the Montana Logging Association (MLA) to all attendees of existing OSHA-required emergency first-aid training workshops that were held in various locations throughout Montana. The survey contained a combination of demographic questions, Likert scale questions to assess reception of the existing training program, and short answer questions. Participation in the survey was voluntary and anonymous, and all participants in the training program were eligible to participate. Compensation was not provided to survey participants.

The results from a descriptive study of workers' compensation claims were used to derive topics of discussion for prevention strategies for the most common injuries seen in the logging industry in the Intermountain region (Montana and Idaho) (Lagerstrom et al., 2017). Surveys administered in the spring 2016 provided baseline data on training reactions as well as end-user perspective on desired training format and training topics.

Training Program Design and Development (Spring 2016-Spring 2017)

An emergency first-aid and safety training program was developed in response to a training needs analysis. The training needs analysis was completed in accordance with requirements identified during the analysis phase of The Systematic Approach to Training. Topics covered during the training program were derived from three sources: OSHA Standards, workers' compensation data, and the results of surveys administered in the spring 2016. OSHA requires that loggers be trained in Cardiopulmonary Resuscitation (CPR) and First-Aid covering a range of specific medical emergencies and traumatic injuries. According to OSHA requirements, training should consist of lectures, demonstrations, practical exercises and examination (United States Department of Labor). In addition to guidance on the delivery of training materials, OSHA standards also dictate required topics to be covered in the training program.

Following completion of the training needs analysis, learning objectives for the emergency-first aid training course were developed. Learning objectives were written to clearly describe the trainee’s desired performance of a specific task under a set of pre-defined conditions (United States Department of Energy, 1997). After developing learning objectives for the overall course, as well as for individual topics areas, the course was organized and outlined into a series of training modules. The overall structure of the training program consists of 16 different modules. Each module contained a real-world video scenario followed by a didactic training session. In total, the videos cover approximately two hours of material. After each module is presented, the course instructor/moderator provides time for discussion and practice of the skill presented in the video. For example, during the cardiac emergency module, a video scenario is presented with a logging worker going into cardiac arrest in a maintenance facility. After the real-world scenario is presented, a didactic training message is presented on types of cardiac injuries, signs and symptoms, as well as treatment. Finally, after the module concludes, there is a time to practice CPR and rescue breathing on mannequins in the classroom.

The script for the didactic instruction was based on learning objectives created during the analysis and design phases of The Systematic Approach to Training. To create a script that was factually correct and relevant, an interdisciplinary team of healthcare providers was assembled. Two occupational medicine physicians with military experience and an Emergency Medical Technician (corresponding author) contributed to the didactic material covered in the script. The script was developed to provide the necessary information to adequately and appropriately respond to, and provide treatment for injuries that occur in the logging industry. The material presented during the didactic portion of the training modules was designed to be concise, with treatment recommendations achievable with the skill level and materials available to the Montana logging population.

While both courses were designed to provide loggers with the necessary safety, first-aid, and CPR training, there were many differences between the training program administered in 2016 versus the updated 2017 program. The 2016 course did not meet the minimum requirements identified by OSHA standards. In addition, the program contained generic video-based examples. The 2017 program was specifically designed to contain all the required topics in the OSHA standard. In addition, new videos were created utilizing logging specific examples, locations, and scenarios. Finally, the updated program reacted to participant (end-user) suggestions for improvement that were gathered after the 2016 program.

Implementation

The updated emergency first-aid and safety training program was administered to all attendees of the MLA training sessions in the spring 2017. A total of 14 training sessions were completed at 8 different locations throughout Montana.

Evaluation

Pre- and Post-Training Examination (Spring 2017)

As a part of the training development process, a pre- and post-training examination was developed. The purpose of the examination was to evaluate learning that occurred during the training sessions and to fulfill OSHA requirements for written evaluation of the materials presented during the emergency first-aid training course. The test questions were designed to test the participants on achievement of the key learning objectives for each module. The examination contained 44 questions, approximately three questions per module topic. All responses were either multiple choice or true/false.

Survey (Spring 2017)

After completion of the training session and associated examination, participants were asked to complete a survey to assess the reception, relevance, and perceived gaps in the updated training program. The spring 2017 survey included the same questions as the survey administered during the analysis phase of the project in the spring 2016. Participation in the survey was voluntary and anonymous and all participants in the training program were eligible to participate. Compensation was not provided to survey participants.

Follow-Up Examination (Fall 2017)

As a part of the evaluation strategy, a follow-up training evaluation was conducted at approximately seven months post-training (fall 2017). A total of six follow-up sessions were conducted over a two-week period in various locations throughout Montana as a part of the Montana Logging Association's (MLA) fall chapter meetings. Participants were recruited for participation by the MLA through emails to their list of annual members. Participants electing to participate in the follow-up activities received a $50 incentive. All participants who attended the chapter meeting were eligible for participation in the follow-up activities regardless of training status (attended training in spring 2017 versus did not attend training in spring 2017). The follow-up activities consisted of an examination and focus group session. The follow-up examination was identical to the pre- and post-training examination. If the follow-up participant had attended the updated (2017) emergency first-aid and safety training session, their tests were matched with their pre- and immediate post-training examination scores. The results from the focus group session were reported in separate study.

The methodology contained in this study was reviewed and approved by the Institutional Review Board at the corresponding author's university.

Data Analysis

Survey Data

Survey data obtained during the analysis phase (spring 2016) was compared to the survey data obtained during the evaluation phase (spring 2017) of the project. Response rates were calculated by dividing the total number of survey responses by the total number of people in attendance at the spring training sessions hosted by the MLA. Descriptive statistics were calculated for the demographic variables collected as a part of the survey. Means and standard deviations were calculated for the age of the survey participants. A t-test was performed to determine if there was a significant difference in the age of the survey respondents from 2016 to 2017. Frequency statistics were calculated for the categorical demographic variables gender and education level. A chi-square test of independence was used to determine if the distribution of gender or education level was statically different from 2016 to 2017.

Likert-scale responses to the 12 questions, which assessed the reception (i.e.. participants' opinion regarding reception, appcability, pace, content, etc.) of the training program, were compared between 2016 and 2017. Means and standard deviations were calculated for each question by year. The difference between the 2017 and the 2016 mean survey response score was calculated and a Wilcoxon-Mann-Whitney test was used as a non-parametric alternative to a two-sample t-test to determine if there was a significant difference in survey responses from 2017 to 2016.

During the short-answer section of the surveys, participants were asked for suggestions regarding improvements to future years' programs and additional topics that they believe should be included or emphasized. Qualitative data from the short-answer section of the surveys was categorized based on themes and the most frequently occurring themes were reported.

Examination Data

Descriptive statistics were calculated for each examination period: pre-training, post-training, and follow-up. Paired sample t-tests were performed to determine the change in examination scores for three time periods: pre-training to post-training, post-training to follow-up, and pre-training to follow-up. Changes in examination responses from pre-training to post-training were assessed using McNemar's Test.

Follow-up participants were categorized as either having attended the updated training program during spring 2017 (trained), or not in attendance at the spring training session (untrained). Descriptive statistics were calculated for the age and gender of follow-up participants. A t-test was performed to determine if there was a significant difference in the age of trained versus untrained follow-up participants. Fisher's exact test was used to determine if the distribution of gender was statically similar between trained and untrained follow-up participants. Follow-up examination scores were calculated for all participants. A t-test was performed to determine if there was a significant difference between the mean score for trained versus untrained follow-up participants.

5.4. Results

A total of 742 (70% response rate) and 568 (65% response rate) surveys were returned in 2016 and 2017, respectively (Table 1). There were no significant differences in the age ($p>0.05$), gender distribution (XX=0.20, $p>0.05$), or education level (X2=6.49, $p>0.05$) between the two years.

Table 5.1: Participant Demographics in Training Survey: Baseline (2016) versus Update (2017)

Table 1: Participant Demographics in Training Survey: Baseline (2016) versus Update (2017)		
	2016 (15 Sessions, N=742)	2017 (14 Sessions, N=568)
	Mean (SD)	Mean (SD)
Response Rate (Number Responses/Total Number in Attendance)	742/1059=70.07%	568/873= 65.06%
Age (p>0.05)	45.88 (13.67) (n=688)	45.85 (13.99) (n=507)
	Frequency (Percentage)	Frequency (Percentage)
Gender (X^2=0.20, p>0.05)	Female- 21 (2.91%) Male- 701 (97.09%) (n=722)	Female- 18 (3.35%) Male- 519 (96.65%) (n=537)
Education Level NHS- Did not finish High School HS- High School Diploma SC- Some College/Associates Degree BS- Bachelor's Degree or Higher (X^2=6.49, p>0.05)	NHS- 55 (7.82%) HS- 410 (58.32%) SC- 179 (25.46%) BS- 59 (8.39%) (n=703)	NHS- 52 (9.44%) HS- 297 (53.90%) SC- 135 (24.50%) BS- 67 (12.16%) (n=551)

The scale used to assess reception and relevance of the training program was based on a 1-5 Likert scale, with one corresponding to strongly disagreeing with the statement, three, having a neutral response, and 5, strongly agreeing with the statement. Across all survey questions, participants at the 2017 training session responded more positively than respondents at the 2016 training sessions (Table 2). This difference was significant in every question except question 11, "I think that being trained on CPR and First-Aid is worthwhile". The survey questions that had the largest change between the two years were question three (the course provided me with new information), and question six (the course was enjoyable).

Table 5.2: Training Survey Responses: Baseline (2016) versus Update (2017)

Table 2: Training Survey Responses: Baseline (2016) versus Update (2017)			
Question	2016 Mean (SD)	2017 Mean (SD)	Difference between Means (P-Value)
1. I understood the objectives of the course	4.38 (0.58)	4.52 (0.58)	0.13 (*p*<0.01)
2. The length of the course was appropriate to cover the content	4.12 (0.70)	4.35 (0.62)	0.23 (*p*<0.01)
3. The course provided me with new information	3.75 (0.81)	4.19 (0.65)	0.44 (*p*<0.01)
4. On-the-job application of each objective was discussed during the course	4.10 (0.59)	4.28 (0.59)	0.18 (*p*<0.01)
5. The examples presented helped me to understand the content	4.18 (0.55)	4.34 (0.55)	0.16 (*p*<0.01)
6. The course was enjoyable	3.68 (0.86)	4.08 (0.70)	0.40 (*p*<0.01)
7. The materials covered will be useful on the job	4.23 (0.59)	4.38 (0.56)	0.15 (*p*<0.01)
8. The instruction materials were clearly presented	4.27 (0.54)	4.36 (0.60)	0.10 (*p*<0.01)
9. The pace of the course was appropriate to cover the content	4.13 (0.64)	4.30 (0.59)	0.17 (*p*<0.01)
10. The time given by the instructor to complete practice activities was appropriate	4.17 (0.61)	4.33 (0.58)	0.17 (*p*<0.01)
11. I think that being trained on CPR and First-Aid is worthwhile	4.51 (0.62)	4.56 (0.58)	0.05 (*p*>0.05)
12. I would attend this training even if it was not required.	3.79 (0.97)	3.98 (0.85)	0.19 (*p*<0.01)

The categorical distribution of responses for question three “the course provided me with new information” changed significantly (X2=89.33, p<0.001); in 2016, 68% of respondents either agreed or strongly agreed with the statement, while in 2017, 89% or respondents agreed or strongly agreed with the statement (Figure 2). This pattern was repeated for question six “the course was enjoyable” (X2=69.12, p<0.001). In 2016, 63% of respondents either agreed or strongly agreed with the statement, whereas in 2017, 83% of respondents either agreed or strongly agreed with the statement. The categorical distribution of responses to the 12 survey questions are displayed in Figure 2. There was a significant difference in the distribution of responses for every question, except question 11, “I think that being trained on CPR and First-Aid is worthwhile” (X2=3.26, p=0.516).

Figure 5.2: Participant Response Distribution to Likert-Scale Survey Questions: Baseline (2016) versus Update (2017)

Qualitative responses to the open-ended questions on the survey were analyzed for common themes. Included on the list for both 2016 and 2017 (Table 3) were the suggestions for more information on radio communication procedures and more time for hands on/practical experience. In 2017, two of the most common suggestions for improvement were in regard to the length of the course, with some respondents commenting that the course should be shortened, while others suggesting that the course should be lengthened to provide more information and to allow the instructor to slow down.

Table 5.3: Top Five Suggestions for Improvement from Training Survey: Baseline (2016) versus Update (2017)

Table 3: Top Five Suggestions for Improvement from Training Survey: Baseline (2016) versus Update (2017)	
2016	2017
1. More/New Videos 2. Practical Applications/Realistic Scenarios 3. New Material 4. Include Instruction on Radio Communication 5. Include CPR/Choking for Children	1. More information on Radio Communication 2. Fire Safety Training 3. Shorten the course 4. Hands-on/ Practical Experience 5. Lengthen the course/provide more information/slow down

A total of 826 pre-training examinations and 802 post-training examinations were completed during spring 2017 for response rates of 95% and 92%, respectively (Table 4). Seven hundred ninety-nine pre- and post-training examinations were paired. A paired-sample t-test was performed to provide a measure of immediate recall of learned knowledge from pre-training to post-training. On average, participants' score increased significantly by 4.51 (SD=3.88) points (out of 44 questions), equating to approximately 10% improvement from pre-training to post-training.

Of the 44 trained follow-up participants, 35 were matched to both their pre-training and post-training examinations. On average, participants in the follow-up scored significantly lower on their follow-up examination than they did on the post-training examination (mean= -3.50, SD=3.45) . There was no significant difference between pre-training examination scores and follow-up examination scores ($p>0.05$).

Table 5.4: Participant Examination Scores (Pre-Training, Post-Training, and Follow-Up)

Table 4: Participant Examination Scores (Pre-Training, Post-Training, and Follow-Up)	
Mean Pre-Training Examination Score (n=826)	80.45% (mean= 35.40, SD= 4.29)
Mean Post-Training Examination Score (n=802)	90.57% (mean= 39.85, SD= 3.14)
Mean Follow-Up Examination Score (n=44)	82.02% (mean= 36.09, SD= 2.79)
Mean Difference Pre-Training to Post-Training (n=799)	10.25% (mean= 4.51, SD= 3.88) (paired t-test p<0.0001)
Mean Difference Post-Training to Follow-Up (n=36)	8.95% (mean= -3.50, SD= 3.43) (paired t-test p<0.0001)
Mean Difference Pre-Training to Follow-Up (n=36)	0.75% (mean= 0.33, SD= 4.06) (paired t-test, p=0.6251)

McNemar's test was used to determine if training influenced examination question response. In 32 of the 44 examination questions, McNemar's test was significant, indicating a change in question response from pre-training to post-training. In 12 of the 44 questions, McNemar's test was non-significant, indicating no change in response from pre-training to post-training. In nine of these of these questions, over 90% of respondents answered the question correctly on the pre-training examination, leaving little room for a significant change in the correct proportion of responses.

In total, 69 participants attended follow-up sessions. Of the 69 in attendance, 44 attended the updated training program while 25 did not attend the updated training program. There was no significant difference in mean age (p>0.05), or gender composition (p>0.05) between trained and untrained groups (Table 5). There was a significant difference in mean follow-up examination scores between trained and untrained participants, with trained participants scoring nearly four points higher than untrained participants (p<0.01).

Table 5.5: Follow-Up/Focus Group Participant Demographics and Examination Scores

Table 5: Follow-Up/Focus Group Participant Demographics and Examination Scores				
Training Status	n (total=69)	Age Mean (SD)	Gender	Follow-Up Score Mean (SD)
Trained this year	44	51.19 (13.60)	Male (42) Female (2)	36.09 (2.79)
Not trained this year	25	53.27 (12.97)	Male (21) Female (4)	32.56 (2.99)
		p=0.55	(Fishers Exact Test: p=0.18)	p<0.01

5.5. Discussion

By conducting a thorough analysis of the specific needs and challenges facing loggers in the target population, applicability and specificity of the information could be ensured. The loggers' perceptions of increased applicability, understanding of learning objectives, and overall course enjoyment of the updated program were confirmed using the post-training survey. While participants demonstrated recall of key training objectives, the authors were not able to verify retention using the difference between pre-training examination scores and follow-up examination scores, however, the mean examination score at follow-up was 82%. There was a 10.12% mean exam score increase from pre-training to post-training and an 8.55% mean exam score decrease over the follow-up period, for a mean score difference of 1.57%. Therefore, participants maintained 15.51% (1.57%/10.12%) of improvement that resulted from the training program. Qualitative data from the surveys provided ideas and suggestions that can be used to continually develop and improve the updated program, as well as make new training programs. At the suggestion of the survey responses, additional sections can be developed and added to the video program to cover the requested topics. In addition, the examinations should be re-developed based on the results of McNemar's tests. While the examination questions should still assess key learning objectives, the questions should be designed so that the majority of participants do not know the answer to the questions pre-training. This will help researchers to more clearly determine if the training program was effective at teaching the learning objectives.

There were several benefits of using The Systematic Approach to Training to develop an industry and population specific training program. The updated program was perceived by participants to be more effective at conveying useful and new knowledge required when performing emergency first-aid. In addition, by creating clear and concise learning objectives for the training program, participants responded more favorably to survey questions regarding understanding the learning objectives of the program. Using the Systematic Approach to Training was successful at creating a unified view of the desired training outcomes for both instructors and training participants and ensured the consistency of the information presented during different sessions.

While a limited amount of research has been conducted, the results of the present study are consistent with the work of previous research conducted on training in the logging industry. Many of the suggestions from previous researchers on training preferences in the logging industry were used in the design and development of the updated training program for the present study.

Helmkamp et al. (2004), conducted a study in which the researchers assessed safety behaviors in the West Virginia logging industry and reported that "many of the loggers said they related to the real life victim stories portrayed in the (training) video" (Helmkamp et al., 2004). Researchers surveying loggers in the Southeastern United States had the following suggestions for training programs: have experienced logging workers participate in the development of more effective training program, have the training programs be sensitive to the economic cost of training and safe work practice and emphasize the positive economic impact of safe work, and create training programs on proper safety procedures (Bordas et al., 2001). A third research study in which the authors surveyed loggers from northern New England, made the following suggestions: “training should be tailored to the needs and preferences of the logger audience, or run the risk of becoming irrelevant”, “most loggers prefer less formal, on-the-job training, especially training that involves members of the logging community in its delivery”, and efforts should be made to “illustrate how specific training may benefit loggers” (Egan, 2005). The authors of the New England study concluded that “logger training programs require contact with the target audience—the logging community—in order to maintain the relevance and credibility of the programs’ content and delivery” (Egan, 2005).

At per the suggestions of the aforementioned research studies, the authors of the present study ensured the updated training program provided relevant and specific training that included the hazards and environmental conditions that loggers in the targeted population experience. At suggested by Bordas et al. (2001), experienced loggers involved in the present study contributed to the design and script of the updated training program, and were portrayed in video examples of scenarios, which were filmed on logging sites throughout Montana and Idaho.

Following suggestions to include the target population in the development of the training program may have been one of the reasons the authors found that participants responded more positively to all survey questions after receiving the updated training in comparison to training participants at baseline. The survey questions with the greatest mean score improvement from baseline to the updated training were: “the course provided me with new information” and “the course was enjoyable”. The survey questions with the most positive responses were: “I think that being trained on CPR and First-Aid is worthwhile”, “I understood the objectives of the course”, and “the materials covered will be useful on the job”. In addition to the positive responses observed in the survey, on average, participants experienced an increase in their examination score from pre-training to post-training by over four questions (over a 10% increase), demonstrating recall of key training objectives. While there was significant improvement from pre-training to post-training, there was no significant difference in training scores from pre-training to follow-up. We were unable to determine if participants retained new information from the updated training program and missed questions they had correctly responded to on the pre-training exam, or if they had reverted to their baseline (pre-training) responses. Therefore, the authors were not able to verify retention of key training objectives from the difference between pre-training and follow-up examination scores. However, at follow-up, participants answered 82% of the questions correctly and there was a significant difference in the examination scores of trained versus untrained participants; participants who had attended this years' program had significantly higher follow-up examination scores than follow-up participants who did not attend this year's training.

While the authors were not able to verify retention of key learning objectives through the examination, the training program created as a result of this project had several strengths. Survey respondents appreciated the applicability and usefulness of the training program. One of the challenges facing the logging industry is developing safe work practices and safety training that are cost-effective. In the southern U.S., a survey of logging training preferences indicated that although safety training was considered useful, it was believed to be impractical and detrimental to productivity (Bordas et al., 2001). Similarly, researchers in Ireland reported that despite mixed findings on the practicality and ability for training to decrease injury and fatality rates, loggers held the opinion that training was useful and should be more readily available (Nieuwenhuis & Lyons, 2002). One of the advantages of a video-based training program is the increased accessibility of the training. While the program created as a result of this work was not designed to be a stand-alone resource, much of the information provided in the program is now be available upon request at any location or time, rather than waiting for the annual training program to occur. While using the videos from the training program alone would lack the practical experience on the trainers and discussion segments of the course, they could provide valuable didactic safety information to newly hired workers prior to the formal scheduled training period.

Limitations

This study had several limitations. The overall design of the study was limited to a specific population: loggers in the Intermountain region. While this allowed the updated training program to be tailored to a specific group, the authors are unable to determine if the same program would have similar reception and applicability in different regions of the United States or around the world. One of the major limitations of the study was that all training participants received the updated training program and there was not a randomly selected control group. Due to this limitation, the authors are unable to determine causation, and if the noted changes observed in the surveys and examinations from baseline to post-training and follow-up were due to the training or other events or programs. Finally, the research suffered due to missing data and sample size. While the response rates to the surveys and examinations were relatively high, there was missing data within responses. In addition, the authors were unable to recruit the desired number of participants for the follow-up activities, impacting the power of our results.

5.6. Conclusions

By conducting an analysis of the specific needs and challenges facing loggers in the target population, applicability and specificity of the updated training program was optimized.

The results of surveys obtained during this investigation showed increased participant reception scores from the safety training program that was developed using the Systematic Approach to Training. Analysis of pre-training, post-training, and follow-up examination scores demonstrated participant recall of key learning concepts in the updated training program. The results obtained by the training evaluation strategy will guide research and the continued development of the updated training program to align with ongoing analysis activities and participant suggestions.

Practical applications of this research include dissemination and implementation of the safety training program to a wider audience While end-user perspectives should be solicited from the target audience before training program development, the results obtained from this study can be used as a baseline and background research for training development in other logging populations or similar industries.

Chapter 6: Evaluation of a Safety Training for the Logging Industry: A Qualitative Approach

6.1. Overview

The purpose of this study was to assess the effectiveness of a safety training program and to identify the current safety perceptions among Montana loggers utilizing qualitative assessment methods. Sixty-nine professional loggers participated in one of six focus groups sessions during a two-week period in various locations throughout Montana. The focus groups were conducted approximately seven months following the implementation of a new safety training program focused on emergency first aid. The focus groups began by participants recalling their overall impressions of the training program, any opportunities they had to use the information they learned, and if they had any suggestions for improving the curriculum. The focus groups then progressed to a discussion of the most significant safety issues in professional logging and how those issues could be addressed. The focus groups were audio recorded, transcribed, and analyzed with the strategy described by Krueger (1994) to code and prioritize themes. Focus group participants who attended the safety training program expressed generally positive feedback and were impressed with the new design. When asked to brainstorm ideas on safety concerns and possible new training topics, several themes emerged. Common themes were related to safety factors including situation awareness, the role of training and experience on safe work practices, hazards related to driving and motor vehicle accidents, as well as barriers to recruiting and training new workers. The present study authors provide an example of how a participatory approach involving professional loggers can be used to develop improved training materials and to identify solutions for addressing occupational risks in the logging industry. The iterative evaluation process utilized in the present study can be used in the continuous improvement process of training materials to better address the complexity of occupational hazards in the industry of professional logging.

6.2. Introduction

Occupational injuries and illness are detrimental to productivity and are a source of economic strain, accounting for nearly $170 billion in spending in the United States every year (United States Department of Labor, 2016). Although the logging industry only represents a small proportion of the overall US workforce, it is one of the most dangerous occupations. In 2016, the nationwide fatality rate for the logging industry was 100.1 per 100,000 full-time equivalent workers, almost 30 times higher than the nationwide fatality rate for all occupations combined (U.S. Bureau of Labor Statistics, 2017).

There are many risk factors and hazards which contribute to the high rate of injuries and fatalities in the logging industry. These hazards include use of heavy equipment and machinery, manual labor, and environmental hazards (such as weather, falling trees, unstable slopes, and steep terrain) (Lagerstrom et al., 2017; O. S. H. A. United States Department of Labor, 2017). While the logging industry has become increasingly mechanized, many of these hazards remain. The hazards and risks experienced by loggers are not uniform across the United States or around the World. Regional attributes related to worker demographics, environmental conditions, equipment availability and design, as well as training, induce variation on the risks and injury/fatality rates (Myers & Fosbroke, 1994). In some regions of the United States, hazards due to steep terrain and weather are less prevalent and pose less of a risk to workers, while in other regions, these hazards have a significant effect on production and workplace safety. Specifically, researchers found fatality rates were highest in the Central, Mountain, and Eastern U.S. and lowest in the Great Lakes, Northeast, and Southern regions of the country (Myers & Fosbroke, 1994). Researchers studying the effect of hazards on regional variation of logging fatality rates developed a list of possible factors which may lead to higher fatality risk and regional variation (Myers & Fosbroke, 1994). This list includes harvesting of hardwoods, selective harvesting (in comparison to clear cut harvesting), traditional harvesting methods (non-mechanized), steep terrain, and small logging businesses (Myers & Fosbroke, 1994).

While hazards, risk, and harvesting methodology vary by region, training standards are defined at a national level. To develop a training program to best meet the needs of the end-user, research must be conducted to understand the population of interest. Currently, OSHA defines first-aid training standards for the logging industry in Appendix B of title 29 of the Code of Federal Regulations (CFR) 1910.266 (United States Department of Labor). The standard defines "the minimal acceptable first-aid and cardio pulmonary resuscitation (CPR) training program for employees engaged in logging activities" (United States Department of Labor). The standard states acceptable training methodology and a list of required training topics to be covered, which range from treatment of amputations to recognizing and assessing a drug overdose. Due to the non-regional specific nature of the standard, providing training with strict adherence to the minimum required topics may result in gaps in necessary skills and safety knowledge, depending on regional and demographic characteristics, as well as recent injury and fatality trends. Prior researchers have documented this gap between training and preparing loggers for work in the forests. Because of this gap, research has been, and continues to be, conducted to determine the needs and best methods of training new, as well as seasoned workers, on safe work practices. Researchers surveyed loggers on the needs and applicability of logging safety training and have identified the need for adequate training on safe driving habits and machine and tool use (Albizu-

Urionabarrenetxea et al., 2013; Lefort et al., 2003). Additionally, the identification of specific training topics and training development methods in the logging industry have been assessed by Egan (2005). The importance of using a participatory approach with the end-user (professional loggers) to develop relevant safety training has also been discussed (Egan, 2005).

The use of participatory action research, which involves end-users throughout the research process, is effective at identifying practical applications of research or developing new areas of study (Food and Agriculture Organization of the United Nations, 1990; J. C. Rosecrance & Cook, 2000). The benefits of using a participatory approach includes identifying end-user perspectives and enhanced participation that often results in locally tested outcomes (Food and Agriculture Organization of the United Nations, 1990). Lagerstrom et. al. (2017), used this approach with focus groups of professional loggers from the Intermountain region of Montana and Idaho to identify barriers and facilitators of safe work practices in the logging industry, as well as to generate injury prevention ideas (Lagerstrom et al., 2017). The authors concluded that injury prevention efforts in the Intermountain region should focus on training related to safe work methods (especially for inexperienced workers), the development of a strong safety culture, the need for safety leadership, as well as development and implementation of applicable engineering controls (Lagerstrom et al., 2017). There are very few, if any, published research studies on the implementation and evaluation of safety training programs in the logging industry using a participatory research approach.

The purpose of this study was to assess the effectiveness of a safety training program and to identify the current safety perceptions among Montana loggers utilizing qualitative assessment methods.

While the primary purpose of the focus groups was to obtain participant feedback on the training program, the focus groups were also used to generate ideas for the continuous development of training programs and discussion of relevant and emerging threats to occupational safety. By querying professional loggers regarding emerging threats and hazards, there is an opportunity to develop interventions and training programs to proactively address safety concerns before they result in injuries or fatalities.

6.3. Methods

Data Acquisition

The present study was a part of a larger project to develop a safety training program for the Montana logging industry. The focus groups described in in this study were an element of the overall evaluation strategy of a safety training program. Using the Systematic Approach to Training, a video-based program was created to provide emergency-first aid and CPR training to loggers in Montana. The training program was designed to comply with OSHA standards for logging safety training programs, contained in 29 CFR 1910.266 (United States Department of Labor), and to meet the specific needs and challenges facing loggers in the Intermountain region (Montana and Idaho). After conducting a thorough analysis of industry training needs, which included qualitative and quantitative methodology to assess industry demographics, injury characteristics, safety climate and training perceptions, training design and development began. The program was implemented in the spring of 2017 with over 800 loggers in Montana (n=873). To evaluate the program, a combination of surveys, examinations and focus groups were utilized. The results of the focus groups evaluation are the subject of the following report.

The focus groups were conducted approximately seven months following the implementation of the new safety training program focused on emergency first aid (fall 2017).

Each focus group session lasted approximately sixty minutes. A total of six follow-up sessions were conducted over a two-week period, in various locations throughout Montana, as a part of the Montana Logging Association's (MLA) fall chapter meetings. Participants were recruited for participation by the MLA through widespread emails to their list of annual members. Participants electing to participate in follow-up activities received a $50 incentive. All participants who attended the chapter meeting were eligible for participation in the follow-up activities.

The focus groups were conducted by the corresponding author, one graduate assistant, and at least one member of the MLA safety team. Two methods of data collection were used: note taking and audio recording. In addition, a large poster board was used to record the responses to the group consensus of the top five safety issues that loggers encounter.

Table 1 contains an outline of the questions asked during the focus groups with the estimated time allotted time for each question. The focus groups began with an opening question and then moved to the key questions used for analysis. The focus groups concluded by the moderator giving a summary of the focus group discussion and asking for group input, changes, or additions they would like to make to the summary. The questions were asked sequentially, but participants were given the opportunity to return to the introduction question before the final ending question.

Table 6.1: Focus Group Questions

Table 1: Focus Group Questions		
Question Type	Question	Estimated Time
Opening (Round Robin Format)	Go around the circle and introduce yourself and tell us your favorite thing about job	5
Introduction Question	Thinking back to this years' training, what are the first things that come to mind that could be done better in the future? Were there topics or skills that needed to be emphasized? (Was there anything missing?)	10

Key Questions	Raise your hand if there was a time that you used the training from the first-aid program? (Then do follow-up questions) 1. Did you feel prepared? 2. Was there anything that you wished you knew? 3. Were there any barriers to using the skills you learned? (time, knowledge, supplies, etc.) 4. What would help you preform the skills that you learned during the training program?	10
	What are the five most important safety issues in logging? (List the names on the board/and leave room for next question)	5
	What can be done to address those issues?	15
	The following are major topics that were included in the training program. Raise your hand if you feel prepared to handle an emergency as each topic comes up. 1. Bloodborne Pathogens (Use of PPE) 2. Head, neck, and back injuries 3. Choking 4. Cardiac Emergencies (CPR) 5. Lacerations/Amputations 6. Fractures 7. Impaled Objects 8. Heat/Cold Emergencies 9. Allergic Reactions 10. Burns 11. Electrical Emergencies 12. Poisoning 13. Eye Injuries	5
Ending Questions-Summary	(After moderator gives two minute summary of the discussion) If you were summarizing the discussion, what would you change?	5
		55 minutes

Data Analysis

Audio files from the focus groups were transcribed verbatim and divided by question for analysis. The audio transcriptions were read by two of the study authors and the computer-based classic analysis strategy described by Kruger (1994) was used for coding and prioritization of themes (Krueger, 1994). Transcriptions were read line by line and each participant response was open coded using an inductive approach (i.e., the identification and assignment of conceptual labels that emerge from the text), in which analytical categories were developed to create an initial coding framework (Cho & Lee, 2014). Appropriate categories were created during open coding to capture as many nuances as possible. Investigators reviewed each initial coding to refine and reduce the number of codes by collapsing them together as appropriate (Pope, Ziebland, & Mays, 2000). The final coding framework was used to identify themes that cut across focus groups (Conway, Pompeii, Casanova, & Douphrate, 2017) and provide a robust assessment of the safety behaviors and emergency first-aid motivation present across participants' work sites. After coding, themes were prioritized based on frequency, extensiveness, intensity, specificity, internal consistency, and participant perception of importance (Krueger, 1994).

6.4. Results

A total of 69 participants attended the focus group meetings. Mean participant age was 52 and 91% of participants were male. Focus group size ranged from 7-19. The purpose of conducting focus groups during the follow-up period was to gather subjective data for the continual development of the safety training program.

Very few focus group participants reported needing to perform first-aid over the follow-up period. Of the participants who did, they all felt prepared to handle the situation. Many of the injuries discussed were traumatic injuries and amputations, occurring at home or while commuting, rather than at work. There were also several instances of providing treatment for choking victims, mostly at home.

When participants were asked for ideas on improving the safety and first-aid training program, many expressed that they were very impressed with the new videos and program. Many groups stressed the importance of continuing to update videos to keep things interesting. One focus group discussion brought up the importance of the instructors and students staying on topic, as the training can easily get sidetracked by conversations and questions. Several topics were discussed for inclusion in the training program and included: crushing injuries, radio communication, and increased examples of injuries which could occur in mechanized logging, such as injures from hydraulic lines. The desire for important information, such as CPR, to be repeated, and increased time for practice of practical skills so that reaction would be automatic in emergency situations.

Later in the focus group, the topics covered during the training program were reviewed. This review provided time for participants to reflect on the topics, and the moderators a chance to elicit feedback on specific topics that needed additional clarification. Several focus groups requested clarification on emergency response to electrical emergencies and information on bloodborne pathogens. In both cases, focus group participants wanted to have additional information on keeping themselves safe while caring for individuals with these injuries or conditions. Participants requested the topics of hydraulic lines, radio etiquette, compartment syndrome, and additional information about fire extinguishers/emergencies to be covered in the annual safety and first-aid training session.

Two key questions were responsible for the bulk of the focus group conversation. The first question was to have the group brainstorm a list of the five most important safety topics in logging. The second question was to discuss those five topics and generate ideas on what could be done to address those safety issues. From the top five lists, conversation led to specific details on the hazards loggers face, as well as some ideas on possible prevention strategies.

Reoccurring issues on the top five lists (Table 2) were hazards due to the commute or driving (4), situation awareness (4), experience or needing to provide training for inexperienced employees (4), communication (3), an aging workforce (3), and trips and falls (2).

Table 6.2: Top Five Safety Issues in the Logging Industry by Focus Group Session

Table 2: Top Five Safety Issues in the Logging Industry by Focus Group Session		
Session 1 (n=19)	Session 2 (n=7)	Session 3 (n=11)
1. Slips, Trips and Falls 2. Lack of PPE 3. Motor Vehicle Accidents/ Driving 4. Situational Awareness 5. Communication	1. Motor Vehicle Accidents/ Driving 2. Complacency 3. Situational Awareness 4. Environmental Hazards/ Difficult Terrain 5. Slips, Trips and Falls	1. Situational Awareness 2. Motor Vehicle Accidents/ Driving 3. Trained Employees/ Experience 4. Aging workforce 5. Environmental Hazards/ Difficult Terrain
Session 4 (n=12)	Session 5 (n=7)	Session 6 (n=13)
1. Communication 2. Aging workforce 3. Trained Employees/ Experience 4. Drug Free Employees 5. Motor Vehicle Accidents/ Driving	1. Complacency 2. Aging Workforce 3. Trained Employees/ Experience 4. Public Safety (Public access of worksites) 5. Employee Recruitment	1. Communication 2. Trained Employees/ Experience 3. Complacency 4. Situational Awareness 5. Planning (Pre-Task Planning)

The safety issues were categorized based on the epidemiologic triangle and ranked by the number of times each safety issue was discussed during the focus group sessions (Figure 1).

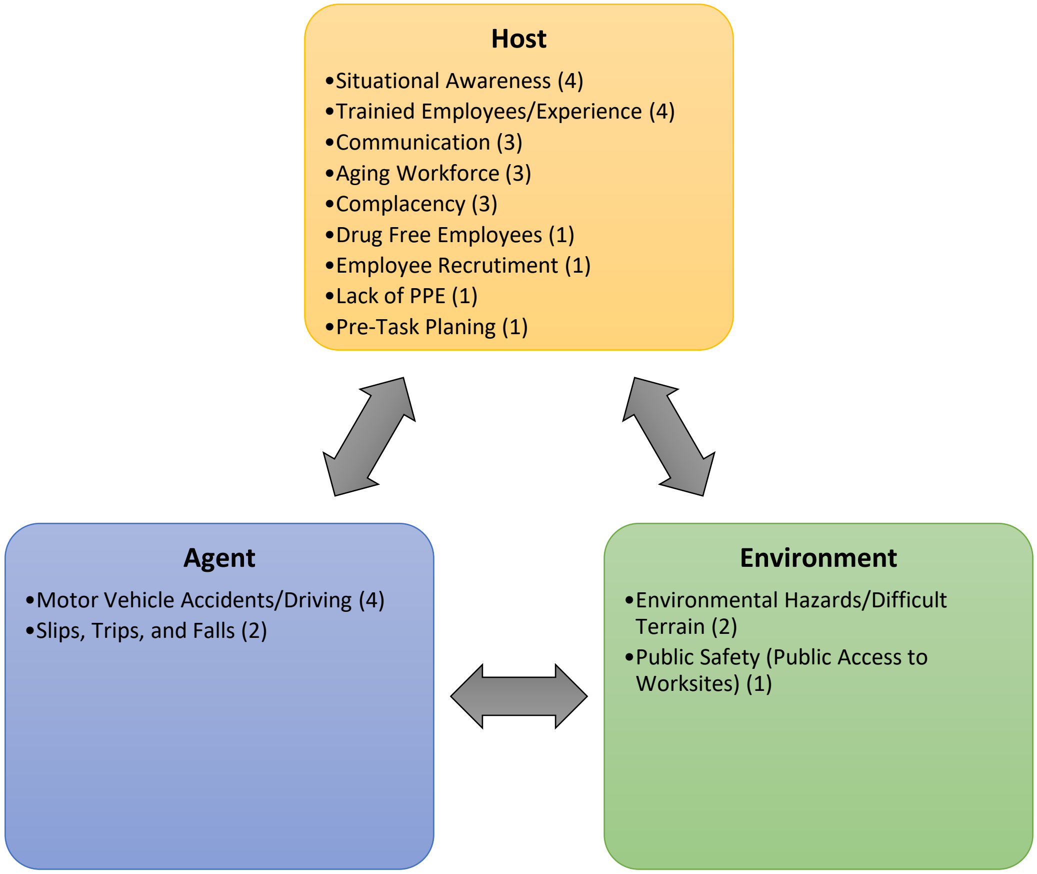

Figure 6.1: Epidemiologic Triangle Categorization of the Top Safety Issues in Logging

Host factors are factors which relate to the demographics and actions of the population of interest (Lagerstrom, Magzamen, Stallones, Gilkey, & Rosecrance, 2016). Agent factors are attributed to the energy or forces acting on the host, while environmental factors pertain to risks due to the social and physical environment (Lagerstrom et al., 2016). Conversation naturally developed around the interaction between these factors and key safety issues. In addition to the connections seen between host, agent, and environmental factors, connections developed between the major themes (training, aging workforce, recruiting and retaining workers, and maintaining awareness of your surroundings on a worksite). For example, it was expressed that logging companies are having a difficult time recruiting and retaining workers. Logging companies need these newer workers because of the aging workforce. Recruitment was described as an ongoing problem. While some companies were trying to recruit experienced workers from other companies by offering them higher wages, other companies were trying to recruit workers new to the industry that they could train. Even when trying to recruit workers without experience, focus group participants discussed the difficulty of recruiting workers who were interested, willing to work hard, and able to pass a drug test.

Many companies in the Montana logging industry train employees on their own, providing mentoring and on-the-job training. It was well recognized that the older workers had skill and experience that they believed could help inexperienced or younger workers succeed in the industry, but several of the focus groups discussed problems they were having with cross-generational communication. A possible idea was generated to have a class that supervisors and owners could take to help communicate using different styles and approaches.

The idea of using simulation technology was discussed as a possible way to overcome the challenge of recruiting and training inexperienced workers. Recent technological developments in simulation technology may be able to provide initial training to workers before they are exposed to the environmental hazards of an active logging site or employers invest time and money in training. While use of simulation may make it easier to train workers, many focus groups noted that there is a gap between simulations and the hazards experienced on an active job site.

The topic of motor vehicle accidents was frequently mentioned, and focus group participants provided extensive information about the problems they faced with their commute (long distances, environmental conditions, distracted driving, fatigue, etc.) and work as commercial drivers. The conversation intensified when the topic of recent Department of Transportation (DOT) regulations regarding commercial driving emerged. Participants, especially those working as commercial drivers, conveyed frustration regarding recent rules on tracking and counting working/driving hours. They expressed concern that the new regulations may actually increase the number of fatigue-related motor vehicle accidents because they felt the new time keeping system did not allow them to take breaks and rest periods throughout their day.

Fatigue was a universal theme across the focus groups. Many loggers face commutes which are hours long, which, when paired with a long and physically intensive work day, leads to physical and mental fatigue. Several of the focus groups discussed the connection between complacency, fatigue, and situation awareness as they pertain to injuries. Some groups took these associations a step further and connected the role of the aging workforce and how older workers experience increased complacency and fatigue in comparison to when they were younger and had more energy. Two groups also noted that older workers tend to have more severe and longer lasting injuries than younger workers.

There were two ideas for additional training programs. One focus group generated the idea of having a management or coaching course that would help managers lead their teams and effectively communicate across generations. This idea had high internal consistency (participants returned to and elaborated on this idea from a previous question) and participants viewed this as a very important idea, with several focus group participants saying they would be willing to participate in such a course if it existed. The second idea was to generate a program or training ideas that would help facilitate frequent and informal training sessions with employees. Both ideas were related to the idea of changing communication and culture of the workgroup.

The ending question allowed participants an opportunity to communicate the importance of topics that were discussed during the focus group session, as well as interject new ideas which had not been discussed. During this period, participants reemphasized their desire to have additional information on fire suppression methods and safety on the work site, the need for repetition of critical information (i.e. CPR), and the need for additional information on the prevention and symptoms of drug use in the workplace.

There are several advantages to using focus groups as a method of gathering qualitative data, which were present in this study. One of the most important advantages was the dynamic discussion that occurred, which allowed for a deeper understanding of the underlying topics (Krueger, 1994).

6.5. Discussion

The follow-up focus groups conducted during this study provided a qualitative evaluation of a first-aid and safety training program which was tailored to the specific hazards and risks present in the Montana logging industry. The knowledge gained from this study can be used for the continuous improvement of safety training programs in the logging industry. Additionally, participants had unique and novel insight into the relevancy of the training program and the absence of necessary skills or knowledge needed for safe work practices. As seen in Figure 1, the majority of safety issues were categorized as pertaining to the host, rather than safety issues associated with agent or environmental factors. The epidemiologic triangle has been used in previous studies to understand the interaction between different risk factors, their contribution to injuries and illness, and has been used to develop appropriate intervention strategies (countermeasures) (Hulme & Finch, 2015; Lagerstrom et al., 2016; Runyan, 2003). With the majority of safety issues identified by the focus groups categorized as host-related factors, it may be prudent to focus on providing training and guidance on company policy to address factors within this specific aspect of the triangle.

During the focus groups, the researchers found that the many of the safety concerns in the logging industry were related to the theme of an aging workforce. Logging supervisors were increasingly concerned with the rising age of their workers, and the safety and injury implications of employing older workers in a physically intensive industry. Focus groups identified that older workers may experience a greater number of injuries related to trips and falls, and the injuries are often more serious and take longer to recover from than workers who are younger. The authors found that focus groups reported older workers may also experience complacency, fatigue, and may resist changes to safety best practices and regulations. However, there was an equal concern for employing younger, less experienced workers. Focus groups stressed the association between safe work practice and experience, and recognized the lack of available training resources that could adequately prepare new workers to safely navigate hazards created by environmental conditions and heavy equipment. While lack of training was considered a major barrier to safe work, some focus groups did not believe that training could be effective due to problems they experienced while trying to communicate and teach workers from younger generations. The paradox between retaining aging workers and recruiting younger, less experienced workers is leading to issues ensuring a sustainable and healthy workforce for the future.

Just as the loggers in the present study were concerned with the effectiveness of training programs, and that training programs could not adequately prepare inexperienced workers to safely work in the woods, Bordas et al. (2001), found that loggers believed that there were fundamental problems in the delivery of safety training to loggers (Bordas et al., 2001). Bordas et al. found that in the Southeastern U.S., logging crew managers believed that it was difficult to communicate with their logging crews and they found difficulty in implementing safety training programs (Bordas et al., 2001). Just as supervisors and owners in the present study, managers from a study of training preferences in the Southeastern region reported that they would like help organizing safety training programs or resources that they could provide to their workers (Bordas et al., 2001).

Neiwenhaus and Lyons (2002), found that despite mixed findings on the practicality and ability for training to decrease injury and fatality rates, when surveyed, loggers in Ireland held the opinion that training is useful and should be more readily available (Nieuwenhuis & Lyons, 2002). More precisely, they found that 45% of surveyed workers suggested topics that included enhanced safety training (Nieuwenhuis & Lyons, 2002). This finding was echoed in the present study, as focus group participants were interested in improving training programs, and even creating additional programs and opportunities, yet were concerned with the gap that existed between training programs and on-the-job experience. The same study identified similar barriers to health and safety in the logging industry as the present study including: financial restrictions, pressure of work, and lack of training (Nieuwenhuis & Lyons, 2002).

The authors of the current study saw the cited benefits of using a participatory approach for the development of the training program (Food and Agriculture Organization of the United Nations, 1990; J. C. Rosecrance & Cook, 2000). According to the focus groups, the training program was able to more effectively communicate the practical applications of the necessary training elements. An additional benefit the focus groups provided was ideas for the continuous development of training programs and discussion of relevant and emerging threats to occupational safety.

Strengths and Limitations

There are limitations inherent to studies utilizing focus groups. In the present study, focus group participants were recruited from a narrow population group: active members of the Montana Logging Association. While this recruitment strategy limits the generalizability of the results, the primary purpose of the focus groups was to evaluate the new training program. Therefore, the authors limited their recruitment of participants to this specific subset of the logging population to ensure a high proportion of focus group participants had attended the new training program. While focus groups are limited in sample size, the authors found the general themes of the focus groups to be consistent across sessions. While additional participants and focus group sessions may have provided specific examples or insight, it is unlikely that the overall themes of the focus groups would have changed with a larger sample size.

Future Work/ Policy and Practice Implications

As a result of the evaluation methodology, there are opportunities for continuous improvement of the safety training program. Suggestions for new topics emerged and included additional information on radio communication, fire safety, and crushing injures. Additional clarification to existing topics was also suggested. One of the most frequent suggestions of focus group participants was the need for continually updated videos and materials to keep the training interesting and relevant. For this reason, the training program should undergo continuous evaluation. Future evaluation strategies could involve surveying a sample of training participants each year, eliciting feedback from stakeholders, and/or continuing to observe trends in workplace injuries and fatalities.

The effectiveness of on-the-job training programs was a frequent topic of discussion during the focus groups. Based on this theme, the researchers recommend applying the

Systematic Approach to Training to on-the-job training. Advantages to applying the Systematic Approach to Training to on-the-job training programs would be to formalize the training objectives, evaluation standards, and ensure that the program conveys safety-critical information to employees (U.S. Department of Energy, 1987). In addition, formalizing on-the-job training using the Systematic Approach to Training may help resolve some of the communication issues that were discussed, as well as convey requirements and expectations for safe work practices.

Based on the focus group findings, the researchers recommend creating a safety leadership program for leaders and management in the logging industry. Leadership and communication were themes present during the follow-up focus groups, and participants reported that they would be interested in participating in programs which could lead to improvement in these areas. In addition to safety leadership, several other training programs were proposed which may have an impact on the safety of the logging industry. Focus group participants suggested training programs which would help with communication and employee relationships/retention. These concepts could be included in the safety leadership program or could be considered for a stand-alone training program. Another proposed training program was to create a video-based program to introduce safe operation of logging equipment for new operators. These videos could provide an overview of the equipment, potential hazards, as well as environmental considerations.

While the programs created as a result of this project were designed to specifically address hazards in the Intermountain region, there is an opportunity for adaption of the emergency first-aid and safety training program to fit the needs of other regions or similar industries. One of the major advantages of this project was the relevancy and applicability to a specific population. Considerations should be made to retain this attribute if the program is applied to other populations to maintain relevancy.

6.6. Conclusions

The authors of the present study provide an example of how a participatory approach can be used to develop improved training materials and to identify risks and solutions for addressing occupational hazards in the logging industry. Using an iterative evaluation process, the training program can be continually developed and modified to meet the changing occupational hazards and challenges that professional loggers encounter. Additionally, as technology and mechanization in the logging industry continues to develop, research is needed to determine emerging safety threats and trends for the development of training and intervention strategies.

Chapter 7: Conclusion

7.1. Project Summary

The long-term purpose of our research program was to reduce the injury rate and severity of injuries among professional loggers in the United States. The purpose of this project was to use the Systematic Approach to Training as a model to develop, implement and evaluate an emergency first-aid training program for professional loggers in the Intermountain region of Montana and Idaho.

An analysis of workers' compensation claim data provided background knowledge of the nature and cost of injuries in the logging industry. Focus groups with workers provided a qualitative perspective of the inherent risks of logging as well as barriers and facilitators to safe work practice. Surveys provided data on the demographics of the working population, the prevalence of musculoskeletal symptoms, safety climate, as well as the reception of current training programs. The training program developed was evaluated through the repeated use of training reception surveys, pre- and post-training examinations, as well as the use of focus groups during the follow-up period. The methods proposed are novel in the context of the logging industry and research is desperately needed due to the high rates of occupational injuries and fatalities among professional loggers.

7.2. Future Work

The data and knowledge gained from this project will be used as the basis and justification for additional proposals to develop targeted safety interventions addressing hazards present in the logging industry of Montana and neighboring Idaho. While this work specifically addressed hazards and safety using a training program, other intervention strategies should be considered to address identified hazards. Identified hazards should be appropriately evaluated and interventions should be considered using the hierarchy of controls, with elimination, substitution and engineering controls being preferred to administrative controls, such as training.

As a result of the evaluation methodology, there are opportunities for continuous improvement of the training program created as a result of this project. Suggestions for new topics emerged and included additional information on radio communication, fire safety, and crushing injures. Additional clarification to existing topics was also suggested. One of the most frequent suggestions of focus group participants was the need for continually updated videos and materials to keep the training interesting and relevant. For this reason, the training program should undergo continuous evaluation. Future evaluation strategies could involve surveying a samples of training participants each year, eliciting feedback from stakeholders, and/or continuing to observe trends in workplace injuries and fatalities.

Based on the findings of the safety climate evaluation and follow-up focus groups, we recommend creating a safety leadership program for leaders and management in the logging industry. While overall safety climate measures were at a good level, there was a disparity in the perceived safety climate between leaders and workers. In addition, leadership and communication were themes present during the follow-up focus groups, and participants reported that they would be interested in participating in programs which could lead to improvement in these areas. In addition to safety leadership, several other training programs were proposed which may have an impact on the safety of the logging industry. Focus group participants suggested training programs which would help with communication and employee relationships/retention. These concepts could be included in the safety leadership program or could be considered for a stand-alone training program. Another proposed training program was to create a video-based program to introduce safe operation of logging equipment for new operators. These videos would provide an overview of the equipment, potential hazards, as well as environmental considerations.

While the programs created as a result of this project were created to specifically address hazards in the Intermountain region, there is the opportunity for adaption of the emergency first-aid and safety training program to fit the needs of other regions or similar industries. One of the major advantages of this project was the relevancy and applicability to a specific population. Considerations should be made to retain this attribute if the program is applied to other populations to maintain relevancy.

While the results of this project have been disseminated using peer-reviewed publications, dissemination using other outlets should be considered. Much of the information obtained as a result of these analysis strategies could be valuable to logging workers and company owners, especially with the addition of specific and practical applications. For this reason, an effort should be made to disseminate finding using trade shows, conferences, and trade publications to reach stakeholders not tied into the academic community.

7.3. Limitations

In addition to the limitations mentioned in each individual chapter, the overall study had a number of limitations. The overall design of the study was limited to a specific population, loggers in the Intermountain region. This was a convivence sample, and therefore, the entire study suffers from lack of random selection of study participants. We are not able to generalize our results to expanded populations in different regions or industries. In addition, because we wanted to offer the new training program to all loggers in attendance of the training program, we did not have a randomly selected control group for comparison. We are unable to determine if the results we saw post-training or during the follow-up period were due to the new training program or due to other recent changes or events. Due to the use of cross-sectional study design, and in many of the chapters, retrospective data collection, we are unable to establish causation in our research.

Since the long-term goal of our research program is to reduce the number and rate of injuries and fatalities in the logging industry of Montana and Idaho, additional epidemiologic studies on the surveillance of morbidity and mortality are needed. Due to the limited timeline of the present research project, as well as the lack of reliable denominator data, we were unable to establish baseline or subsequent rates of injuries and fatalities in our population.

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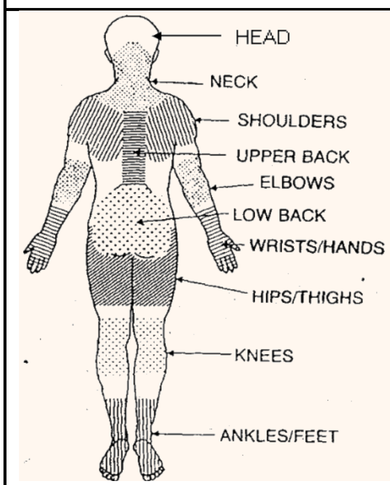
Appendix I: Training Survey Year 0

Demographic Questions	
Unique Code (Your Birth Year and Mothers Initials) (EX 1985-ML)	19__ __-__ __
Age	_______years
Gender	☐Male ☐Female
Height	______feet _____inches
Weight	______lbs
Ethnicity	☐African American (non Hispanic) ☐Caucasian (non Hispanic) ☐Latin/Hispanic ☐Other___________
First Language	☐English ☐Spanish ☐Other:_____________
Primary Job Description	☐Chainsaw Operator ☐Harvester operator ☐Forwarder operator ☐Skidder operator ☐Other:_________________
Approximate number of employees in your company	________
Owner or Supervisor?	☐No ☐Yes
Primary Type of Operation	☐Mechanized (feller-buncher/grapple skidder or cut to length processer/forwarder) ☐Conventional (chainsaw/cable skidder) ☐Machine/Yarder ☐Helicopter ☐Small scale (tractor or horse)
Years in Logging Industry	______Years or _______ Months
Hours worked per week in logging	_______ hours/week
Months worked per year in logging	_______ months/year
Do you have any other jobs to supplement your income? Please List. (ex. Wildland fire)	
Accredited Logging Professional (ALP)?	☐No ☐Yes
Education Level	☐Did not finish high school ☐High School Diploma/GED ☐Some College/Associate's Degree ☐Bachelor's Degree or Higher
Your Approximate Annual Income from Logging	$___________/year
Your Approximate Total Annual Income	$___________/year

Injury Questionnaire

	Body Areas	**In the past 12 months have you experienced a job-related, ache, pain, discomfort, or numbness in the following body areas?**	During the past 12 months have these job-related symptoms caused you to miss work?	During the past 12 months have you seen a physician for these job-related symptoms? (M.D., Osteopath, Chiropractor)
	Neck	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No
	Upper Back	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No
	Lower Back	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No
	Shoulder	☐ Yes ☐No ☐Right ☐Left ☐Both	☐ Yes ☐No	☐ Yes ☐No
	Elbows	☐ Yes ☐No ☐Right☐Left☐Both	☐ Yes ☐No	☐ Yes ☐No
	Wrist/Hand	☐ Yes ☐No ☐Right☐Left☐Both	☐ Yes ☐No	☐ Yes ☐No
	Hip/Thighs	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No
	Knees	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No
	Feet	☐ Yes ☐No	☐ Yes ☐No	☐ Yes ☐No

Safety Climate Survey **SD=**Strongly Disagree; **D=**Disagree; **A=**Agree; **SA=**Strongly Agree	
Management encourages employees here to work in accordance with safety rules- even when the work schedule is tight	☐SD ☐D ☐A ☐SA
Management ensures that everyone receives the necessary information on safety	☐SD ☐D ☐A ☐SA
Management looks the other way when someone is careless with safety	☐SD ☐D ☐A ☐SA

Management places safety before production	☐SD ☐D ☐A ☐SA
Management accepts employees here taking risks when the work schedule is tight	☐SD ☐D ☐A ☐SA
My coworkers and I have confidence in management's ability to deal with safety	☐SD ☐D ☐A ☐SA
Management ensure that safety problems discovered during safety inspections are corrected immediately	☐SD ☐D ☐A ☐SA
When a risk is detected, management ignores it without action	☐SD ☐D ☐A ☐SA
Management lacks the ability to deal with safety properly	☐SD ☐D ☐A ☐SA
My coworkers and I try hard together to achieve a high level of safety	☐SD ☐D ☐A ☐SA
My coworkers and I take joint responsibility to ensure that the workplace is always kept tidy	☐SD ☐D ☐A ☐SA
My coworkers and I do not care about each other's safety	☐SD ☐D ☐A ☐SA
My coworkers and I avoid taking risks that are discovered	☐SD ☐D ☐A ☐SA
My coworkers and I help each other to work safely	☐SD ☐D ☐A ☐SA
My coworkers and I take no responsibility for each other's safety	☐SD ☐D ☐A ☐SA
My coworkers and I regard risks as unavoidable	☐SD ☐D ☐A ☐SA
My coworkers and I consider minor accidents to be a normal part of our daily work	☐SD ☐D ☐A ☐SA
My coworkers and I accept dangerous behavior as long as there are no accidents	☐SD ☐D ☐A ☐SA
My coworkers and I break safety rules in order to complete work on time	☐SD ☐D ☐A ☐SA
My coworkers and I never accept risk taking even if the work schedule is tight	☐SD ☐D ☐A ☐SA
My coworkers and I consider that our work is unsuitable for cowards	☐SD ☐D ☐A ☐SA
My coworkers and I accept risk-taking at work	☐SD ☐D ☐A ☐SA
My coworkers and I try to find a solution if someone points out a safety problem	☐SD ☐D ☐A ☐SA
My coworkers and I feel safe when working together	☐SD ☐D ☐A ☐SA
My coworkers and I have great trust in each other's ability to ensure safety	☐SD ☐D ☐A ☐SA
My coworkers and I learn from our experience to prevent accidents	☐SD ☐D ☐A ☐SA
My coworkers and I take each other's opinions and suggestions concerning safety seriously	☐SD ☐D ☐A ☐SA
My coworkers and I seldom talk about safety	☐SD ☐D ☐A ☐SA

My coworkers and I always discuss safety issues when such issues come up	☐SD ☐D ☐A ☐SA
My coworkers and I can talk freely and openly about safety	☐SD ☐D ☐A ☐SA
My coworkers and I consider that a good safety representative plays an important role in preventing accidents	☐SD ☐D ☐A ☐SA
My coworkers and I consider that safety inspections have no effect of safety	☐SD ☐D ☐A ☐SA
My coworkers and I consider safety training to be good for preventing accidents	☐SD ☐D ☐A ☐SA
My coworkers and I consider early planning for safety as meaningless	☐SD ☐D ☐A ☐SA
My coworkers and I consider that safety inspections help find serious hazards	☐SD ☐D ☐A ☐SA
My coworkers and I consider safety training to be meaningless	☐SD ☐D ☐A ☐SA
My coworkers and I consider it important to have clear-cut goals for safety	☐SD ☐D ☐A ☐SA

In regard to today's training… SD=Strongly Disagree; D=Disagree; N=Neutral; A=Agree; SA=Strongly Agree	
I understood the objectives of the course	☐SD ☐D ☐N ☐A ☐SA
The length of the course was appropriate to cover content	☐SD ☐D ☐N ☐A ☐SA
The course provided me with new information	☐SD ☐D ☐N ☐A ☐SA
On-the-job application of each objective was discussed during the course	☐SD ☐D ☐N ☐A ☐SA
The examples presented helped me to understand the content	☐SD ☐D ☐N ☐A ☐SA
The course was enjoyable	☐SD ☐D ☐N ☐A ☐SA
The materials covered will be useful on the job	☐SD ☐D ☐N ☐A ☐SA
The instruction materials were clearly presented	☐SD ☐D ☐N ☐A ☐SA
The pace of the course was appropriate to cover the content	☐SD ☐D ☐N ☐A ☐SA
The time given by the instructor to complete practice activities was appropriate	☐SD ☐D ☐N ☐A ☐SA
I think that being trained on CPR and First-Aid is worthwhile	☐SD ☐D ☐N ☐A ☐SA
I would attend this training even if it was not required.	☐SD ☐D ☐N ☐A ☐SA
Short Answer	
How many times have you attended the first-aid/CPR training by the MLA?	
Have you ever used the knowledge that you learned from this course while at work, at home, or in the community? **Please Explain**	
What additional topics that would you like to see covered?	
What would make the course more effective? **(Check all that apply)**	☐Video ☐Examples of real life situations ☐Role-Play ☐Guest Speakers ☐Printed Resources ☐Other:_______________

Appendix II: Training Survey Year 1

Demographic Questions	
Unique Code (Your Birth Year and Mothers Initials) (EX 1985-ML)	___ ___ ___ ___-___ ___
Did you attend last year's first-aid training by the MLA?	☐No ☐Yes
Age	_______years
Gender	☐Male ☐Female
Primary Job Description	☐Chainsaw Operator ☐Harvester operator ☐Forwarder operator ☐Skidder operator ☐Other: _________________
Approximate number of employees in your company	________
Are you an Owner or Supervisor?	☐No ☐Yes
Primary Type of Operation	☐Mechanized (feller-buncher/grapple skidder or cut to length processer/forwarder) ☐Conventional (chainsaw/cable skidder) ☐Machine/Yarder ☐Helicopter ☐Small scale (tractor or horse) ☐**FIRE ONLY (not involved in logging)**
Years in Logging Industry	______Years or _______ Months
Hours worked per week in logging	_______ hours/week
Months worked per year in logging	_______ months/year
Accredited Logging Professional (ALP)?	☐No ☐Yes
Education Level	☐Did not finish high school ☐High School Diploma/GED ☐Some College/Associate's Degree ☐Bachelor's Degree or Higher

In regard to today's training…

SD=Strongly Disagree; **D=**Disagree; **N=**Neutral; **A=**Agree; **SA=**Strongly Agree

I understood the objectives of the course	☐SD	☐D	☐N	☐A	☐SA
The length of the course was appropriate to cover content	☐SD	☐D	☐N	☐A	☐SA
The course provided me with new information	☐SD	☐D	☐N	☐A	☐SA
On-the-job application of each objective was discussed during the course	☐SD	☐D	☐N	☐A	☐SA
The examples presented helped me to understand the content	☐SD	☐D	☐N	☐A	☐SA
The course was enjoyable	☐SD	☐D	☐N	☐A	☐SA
I would recommend this course to others	☐SD	☐D	☐N	☐A	☐SA
The materials covered will be useful on the job	☐SD	☐D	☐N	☐A	☐SA
The instruction materials were clearly presented	☐SD	☐D	☐N	☐A	☐SA
The pace of the course was appropriate to cover the content	☐SD	☐D	☐N	☐A	☐SA
The time given by the instructor to complete practice activities was appropriate	☐SD	☐D	☐N	☐A	☐SA
I think that being trained on CPR and First-Aid is worthwhile	☐SD	☐D	☐N	☐A	☐SA
I would attend this training even if it was not required.	☐SD	☐D	☐N	☐A	☐SA
The instructors presented the materials in a way that was clear and easy to understand	☐SD	☐D	☐N	☐A	☐SA
Discussion during the training session was interesting and added value to the course	☐SD	☐D	☐N	☐A	☐SA
Short Answer					
How many times have you attended the first-aid/CPR training by the MLA?					
What additional topics that would you like to see covered?					
Is there anything that you would change, add, or remove from the course?					
Additional Comments:					

Appendix III: 2017 Montana Logging Association Safety Training Needs Analysis

2017 Montana Logging Association Safety Training Needs Analysis

The Montana Logging Association (MLA) is a non-profit organization that serves and represents approximately 1,200 Montanans who work in the state's logging industry. Within the MLA there are approximately 400 member businesses involved in harvesting and transporting timber from forest to mill in Montana. The MLA provides numerous programs and services that benefit members, such as group health insurance and workers' compensation plans. The MLA also works to advance professional standards for our members by offering an Accredited Logging Professional program, Professional Log Hauler program and a Safety Services program (which includes annual first-aid safety training).

Currently, OSHA defines the training requirements for annual first-aid training for workers in the logging industry in Appendix B of 29 CFR 1910.266. However, research has documented a gap between training and preparing loggers for work in the forests. Because of this gap, research has been, and continues to be, conducted to determine the needs and best methods of training new, as well as seasoned workers, on safe work practices. To develop a training program to best meet the needs of the end-user, research must be conducted to understand the population of interest. Due to a nationwide variance in worker demographics, risks, and the logging system utilized, training attitudes, needs, and preferences vary accordingly. By designing the training program to meet the specific needs and challenges facing loggers in the Intermountain region, applicability and specificity can be ensured. Through use of continued evaluation and use of a participatory approach, the training program can be continually developed and modified to meet the rapidly changing hazards and challenges that workers in this industry face.

The purpose of the proposed research program is to provide a training program which will meet OSHA standards (29 CFR 1910.266 Appendix B), while working toward the long-term goal of reducing the injury rate and severity of injuries among professional loggers in the Intermountain region.

- Target Audience/Audience Analysis (based on 2016 survey data):
    - Educational background:

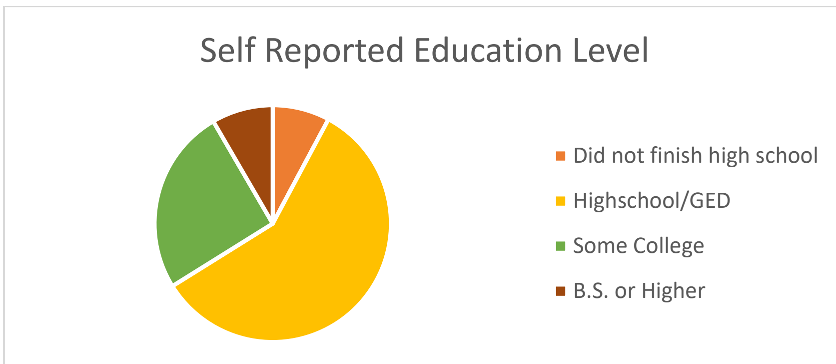


Figure 11.1: Education Level of Participants

-
    - Job duties:

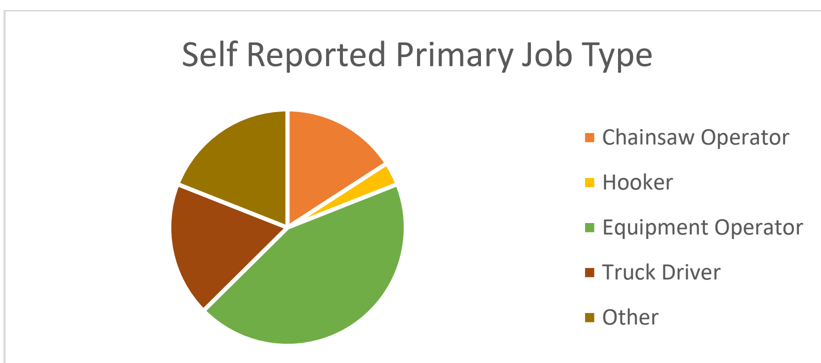


Figure 11.2: Primary Job Type of Participants

-
    - Previous training history:

Of the 550 participants in the 2016 training session that provided an answer as to how many times they had received first-aid training from the MLA, the mean response was 12.5 times and median response was 11 times.

- Climate of the organization:

Overall, the safety climate in the logging industry is positive. Across all 5 dimensions surveyed, mean responses were between 3.1 to 3.40. According to Kines' rule of thumb for interpreting the results of each dimension: A score of more than 3.30 indicates a good level allowing for maintaining and continuing developments, a score of 3.00 to 3.30 points to a fairly good level with slight need of improvement, a score of 2.70 to 2.99 shows a fairly low level with need of improvement, and a score below 2.70 indicates a low level with great need of improvement (Kines. P. et al.).

Table 11.1: Test Population Safety Climate Scores

2016 Safety Climate Survey, Mean Dimension Scores	**Dimension 1** Management safety priority and ability	**Dimension 4** Workers' safety commitment	**Dimension 5** Workers' safety priority and risk non-acceptance	**Dimension 6** Peer safety communication, learning and trust in safety ability	**Dimension 7** Workers' trust in the efficacy of safety systems
Overall	3.4	3.17	3.1	3.39	3.34

- Behavioral norms and Attitudes toward training (2016 Survey Data):

Table 11.2: 2016 Training Reception Survey Data

2016 Questions. Responses based upon 5-point Likert scale (1-Strongly Disagree, 5- Strongly Agree)	**2016 (All Sessions) Mean Value**
I understood the objectives of the course	4.14
The length of the course was appropriate to cover content	4.29
The course provided me with new information	3.86
On-the-job application of each objective was discussed during the course	4.14

The examples presented helped me to understand the content	4.14
The course was enjoyable	3.43
The materials covered will be useful on the job	4.29
The instruction materials were clearly presented	4.43
The pace of the course was appropriate to cover the content	3.57
The time given by the instructor to complete practice activities was appropriate	3.71
I think that being trained on CPR and First-Aid is worthwhile	4.57
I would attend this training even if it was not required.	3.21

- Potential Problems (Analysis and Solutions)

Table 11.3: Potential Problems and Solutions for Proposed Training

Potential Problems (Analysis and Solutions)	
Problem Analysis	Potential Solutions
Lack of skills and/or knowledge: • Workers lack the knowledge and skill to administer emergency first aid • Workers lack the confidence to administer emergency first aid • Workers lack the knowledge and skill to prevent workplace injuries • Workers lack the experience to safely perform their duties • Employers lack the knowledge of applicable regulatorily standards and requirements	Lack of skills and/or knowledge: • Development of Emergency First-Aid Training program for logging workers which includes repetition and skills practice • Provide education on applicable regulatory standards and compliance.
Motivational problems: • Due to production expectations, workers and employers may lack motivation to operate safely • Due to lack of recent regulatory inspections, employers lack motivation to document compliance with regulatory standards • Due to cost, employers may lack the motivation to acquire necessary training and materials to operate safely	Motivational problems: • Develop a culture of safety which will not accept placing production above safe operation. o Development of a safety leadership training program • Provide formal feedback to company owners and supervisors during safety inspections by the MLA

and in compliance with regulatory standards	• Subsidize or provide opportunities for company owners to acquire training and materials at reduced cost or free.
Environmental problems: • Workers lack the necessary first-aid materials necessary for providing basic care • Lack of workplace resources to describe procedures for emergency response and evacuation • Environmental conditions (weather, remoteness, etc.) may contribute to unsafe work conditions • Safety signage needed for safe operation may be worn or outdated • Equipment may be in poor repair or lacking safety features • Required PPE may not be available at worksite	Environmental problems: • Subsidize or provide opportunities for company owners to acquire training and materials at reduced cost or free. • Develop a resource manual which could be placed on each worksite which provide procedures for emergency response and evacuation • Develop a culture of safety which will not accept placing production above safe operation (such as seen during extreme weather events and unstable terrain).

- Cost/Benefit Analysis

Table 11.4: Cost Benefit Analysis of Proposed Training

Cost/Benefit Analysis	
Costs	Benefits
To the MLA • Capital used to create the training program • Providing a venue for training • Providing the trainers and materials for conducing the training program • Providing administrative organization	To the MLA • Provide a service which was guaranteed by the organization • Provide a training program in compliance with regulatory standards • Provide a training program which is reactive to the requests of the organization members

To the Company Owner
• Direct Cost to send workers to training program
    o Attendance Fees
    o Wages during training program
• Possible loss of revenue due to lost work hours
	To the Company Owner
	• Direct Cost to send workers to training program
	    o Attendance Fees
	    o Wages during training program
	• Possible loss of revenue due to lost work hours

To the Individual • Time devoted to attending training program • Transportation to and from training site	To the Individual • Knowledge gained during program which can be used to administer lifesaving care at the worksite and at home • Knowledge gained during program may prevent (or reduce the impact of) injuries which may result in lost work time or loss in quality of life

Appendix IV: 2017 Montana Logging Association Safety/Emergency First-Aid Task Analysis

<u>2017 Montana Logging Association Safety/Emergency First-Aid Task Analysis</u>

0. Workplace Injury

1.0 Primary Assessment (Seven Basic Steps of First-Aid)

1.1 Ensuring your own safety

1.1.1 Assess the Environment for Hazards

1.1.2 Acquire and don appropriate PPE

1.2 Assessing the scene

1.2.1 Determine mechanism/nature of injury

1.2.2 Determine number of injured workers

1.3 Checking for Response

1.3.1 Is the worker responsive to speech?

1.3.2 Is the worker responsive to touch?

1.3.3 Is the worker unresponsive?

1.4 Checking for signs of circulation. Check skin condition- is the workers skin warm and dry?

1.4.1 If the worker is unresponsive and has signs of decreased circulation, begin CPR and emergency evacuation procedures

1.5 Listening for breathing

1.5.1 Is the person talking? Are they able to speak in full sentences?

1.5.2 Check for chest rise and fall

1.5.3 Check breathing rate. Normal rate is between 12-20 breaths per minute.

1.5.4 If the person is not breathing, open the airway using the head-tilt chin-lift procedure and begin artificial respirations/rescue breaths

1.6 Triage

1.6.1 Determine if more than one worker needs help. Treat the worker with the most serious injuries first.

1.6.2 Determine if the worker has more than one injury. Treat the most serious or life threatening conditions first.

1.7 Treating for Shock

1.7.1 Keep the worker calm, conscious and warm

1.7.2 Elevate the worker's legs to help promote blood return to the heart

1.7.3 If the person develops signs of shock, begin emergency evacuation process/.

2.0 Determine need for emergency response and evacuation

2.1 Determine Method of Evacuation

2.2 Contact Emergency Dispatch

2.3 Prepare Evacuation Zone

2.4 Prepare Worker for Evacuation

3.0 Secondary Assessment and Treatment

3.1 Head, Neck and Back Injuries

3.2 Lacerations, Abrasions, and Amputations

3.3 Fractures/Musculoskeletal Emergencies

3.4 Impaled Objects

3.5 Chest Injuries

3.6 Heat and Cold Emergencies

3.7 Allergic Reactions

3.8 Burns

3.9 Electrical Injuries

3.10 Poisoning

3.11 Eye Injuries

3.12 Other Medical Emergencies

4.0 Follow-Up and Review

4.1 Crew discussion chain of events leading to injury

4.2 Record injury in accordance with OSHA guidelines

4.3 Workers compensation notification

4.4 Discussion crew roles during first-aid and evacuation. What when well, what should have gone differently.

4.5 Crew discussion of the need for additional training and topics

Appendix V: 2017 Montana Logging Association Safety Training Syllabus

2017 Montana Logging Association Safety Training Syllabus

1. Effective Date: 3/1/2017
2. Code: EFA-2017
3. Training Unit Topic: Emergency First-Aid for Loggers
4. Task: Provide emergency first aid treatment and apply basic injury prevention strategies for the most prevalent occupational injuries in the logging industry of the Intermountain region.
5. Target Audience: Current and Prospective Loggers and Wildland Firefighters in Montana
6. Pre-requisite Skills: n/a
7. Overall Course Objectives:
    a. During the Montana Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in accordance with the requirements of 29 CFR 1910.266 Appendix B.
    b. During the Montana Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in response to the most common injury and incident types present in the logging industry.
    c. During the Montana Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in accordance with topics generated by worker recommendations from survey methods.
    d. Given the need for a worker to respond to an occupational injury, participants will be provided the necessary knowledge and skill practice to identify basic treatment steps and appropriate methods of evacuating and transporting the injured worker to a higher level of care, prior to the development of further injury or disability.
    e. During the MLA's safety training sessions, participants will be provided a platform for discussion and query regarding injury prevention opportunities to minimize risk and injuries due to preventable scenarios.
8. Instructional Strategies:
    a. Video Based Learning
    b. Lecture Based Learning
    c. Guided Discussion
    d. Guided Discussion/Scenarios
    e. Demonstration/Simulation
9. Time:
    a. Video Based Learning: 1.5hr
    b. Lecture Based Learning: .5hr
    c. Guided Discussion: 2hr

d. Guided Discussion/Scenarios: 1hr
e. Demonstration/Simulation: 1hr
f. Total Time: 6 hours

10. Resources:
    a. Video Based Learning Modules
11. Evaluation Methods:
    a. Simulated Demonstration of Required Skills
    b. Formative Evaluation

Appendix VI: 2017 Montana Logging Association Safety Training Outline and Course Objectives by Module

2017 Montana Logging Association Safety Training Outline and Course Objectives by Module

1. Module 1: Introduction
    a. Title: Course Introduction
    b. Objectives
        i. From memory, state the steps for treatment of shock of an injured coworker in accordance with the procedures described in the first-aid training.
        ii. During an emergency, identify, prepare, and relay the coordinates of the helicopter landing zone to emergency dispatchers without delaying evacuation of the injured worker.
        iii. From memory, state the purpose of the Good Samaritan Law.
        iv. From memory, state the definition of first-aid.
    c. Outline
        i. Course Introduction
        ii. Definition of First-Aid
        iii. Communicating with Responders
        iv. Emergency Evacuation (handling and transporting injured persons)
        v. Good Samaritan Law
    d. Scenario(s) Presented
        i. None
    e. Discussion Points
        i. Radio Use
        ii. Emergency GPS Locators
        iii. Local Resources
        iv. Helicopter evacuation zones
        v. Driving Safety, Defensive Driving
    f. Skill Practice
        i. GPS locator demonstration
        ii. Radio use demonstration
2. Module 2: Bloodborne Pathogens
    a. Title: Bloodborne Pathogens
    b. Objectives

i. From memory, describe the possible routes of transmission of bloodborne pathogens in the workplace in accordance with the procedures described during the first-aid training.
ii. After preforming a simulated first-aid task, demonstrate removal of gloves without contaminating yourself.
iii. From memory, list the ways of preventing the transmission of BBP in the workplace in accordance with the procedures described during the first-aid training.

c. Outline
    i. Introduction to BBP
    ii. 29 CPR 1910.1030
    iii. HIV
    iv. Hepatitis B
    v. Hepatitis C
    vi. Transmission (Sources) of BBP in the Workplace
    vii. Prevention
d. Scenario(s) Presented
    i. None
e. Discussion Points
    i. Vaccine for Hepatitis B
    ii. Disposal of sharps and waste
f. Skill Practice
    i. Glove removal

3. Module 3: Primary Survey
    a. Title: Primary Survey- The Seven Basic Steps of First Aid
    b. Objectives
        i. During an emergency, identify ensuring your own safety as the most important priority before providing treatment or assessment to an injured worker.
        ii. From memory, describe the describe signs and symptoms of adequate and poor circulation in accordance with the procedures described during the first-aid training.
        iii. From memory, describe the describe signs and symptoms of adequate and poor breathing in accordance with the procedures described during the first-aid training.
        iv. From memory, state the steps for treatment of shock of an injured coworker in accordance with the procedures described during the first-aid training.
    c. Outline
        i. The seven basic steps of first aid
            1. Ensuring your own safety
            2. Assessing the scene
            3. Checking for response

            4. Checking for signs of circulation
                a. Figure- major arteries
            5. Listening for breathing
            6. Triage
            7. Treating for shock
    d. Scenario(s) Presented
        i. Sudden loss of consciousness at the worksite. Not breathing. Contacting emergency dispatcher with location. Primary survey.
    e. Discussion Points
        i. Importance of scene safety
        ii. Knowing your location
        iii. Communicating with dispatchers
    f. Skill Practice
        i. None
4. Module 4: Head, Neck, and Back Injuries
    a. Title: Head, Neck, and Back Injuries
    b. Objectives
        i. From memory, describe the describe signs and symptoms of head, neck and back injuries in accordance with the information described during the first-aid training.
        ii. From memory, describe the treatment (immobilization) of head, neck and back injuries in accordance with the procedures described during the first-aid training and the availability of supplies on your worksite.
    c. Outline
        i. Spinal anatomy
        ii. Signs and Symptoms (paralysis)
        iii. Treatment (immobilization of injured persons)
    d. Scenario(s) Presented
        i. Sawyer hit by falling tree
    e. Discussion Points
        i. Contents of first aid kit and required stretcher or backboard
        ii. Review of signs and symptoms of head injuries
        iii. Use of hardhats and PPE
        iv. Communication (frequent check ins/communication) with employees
    f. Skill Practice
        i. none
5. Module 5: Choking
    a. Title: Choking
    b. Objectives
        i. Upon identifying a person displaying the universal choking sign and lack of evidence of breathing, demonstrate use a combination of abdominal thrusts and back blows to dislodge the object without hesitation.

ii. From memory, describe the treatment of a conscious choking victim in accordance with the procedures described in the first-aid training.
iii. From memory, describe the treatment of an unconscious choking victim in accordance with the procedures described in the first-aid training.

c. Outline
    i. Conscious Choking
        1. Treatment- back blows and abdominal thrusts
    ii. Unconscious Choking
        1. Treatment- CPR
    iii. Special populations and circumstances
d. Scenario(s) Presented
    i. Choking scenario at worksite. Conscious choking treatment.
e. Discussion Points
    i. Special populations
    ii. When to call for help
    iii. Universal Choking sign
f. Skill Practice
    i. Practice treatment for conscious choking

6. Module 6: Cardiac Emergencies
    a. Title: Cardiac Emergencies
    b. Objectives
        i. From memory, describe and identify the signs and symptoms of cardiac emergencies in accordance with the information described in the first-aid training.
        ii. Upon identifying a person who is not breathing (respiratory arrest), demonstrate use of the head-tilt chin lift to open the airway and begin rescue breathing (artificial ventilation) without hesitation.
        iii. Upon identifying a person who is not breathing and has signs of decreased circulation (cardiac arrest), demonstrate CPR without hesitation.
        iv. From memory, describe when and how to use an AED in accordance with the information described in the first-aid training.
    c. Outline
        i. Signs and symptoms of cardiac emergencies
        ii. Technique-Chest Compressions
        iii. Technique-Airway
        iv. Technique-Rescue Breathing
        v. Complications
    d. Scenario(s) Presented
        i. Cardiac emergency in machine shop.
        ii. CPR/AED use on mannequin.
    e. Discussion Points
        i. Review of signs and symptoms of cardiac emergencies.
        ii. Importance of not driving yourself if you have chest pain

        iii. Timely response to signs and symptoms of chest pain/cardiac emergencies
    f. Skill Practice
        i. CPR/AED practice and practical examination
        ii. Rescue breaths
        iii. Technique for opening airway

7. Module 7: Lacerations and Amputations
    a. Title: Lacerations and Amputations
    b. Objectives
        i. Using the procedures described in the first aid training program, identify and describe three different treatment options for stopping bleeding (hemorrhage) due to a laceration or amputation in order of least aggressive to most invasive.
        ii. Observe simulation of application of direct pressure to an injury (laceration or amputation) until bleeding stops.
        iii. Observe simulation of application of a tourniquet to an injury (laceration or amputation) until bleeding stops.
        iv. Given a workplace injury, detect and respond to the signs and symptoms of shock before the workers' condition deteriorates.
        v. From memory, describe treatment for shock in accordance with the procedures described in the first-aid training and the availability of supplies on your worksite.
        vi. From memory, explain the basis for the methods of treatment for shock in accordance with the procedures described in the first-aid training.
        vii. From memory, explain the circumstances under which personal protective equipment (ex. chaps, eye protection, head protection, etc.) is required in the workplace in accordance with OSHA standards.
    c. Outline
        i. Lacerations, abrasion, amputation definition
        ii. Signs and Symptoms
        iii. Shock
        iv. Treatment (pressure, elevation, pressure points, tourniquet)
            1. Anatomy of major arteries
    d. Scenario(s) Presented
        i. Leg laceration from chainsaw. Lack of proper PPE. Rushing to complete the job.
        ii. Hand amputation from equipment. Lack of LO/TO.
    e. Discussion Points
        i. Use of PPE when operating chainsaw and other pieces of equipment (chaps, eye protection, gloves, etc.)
        ii. Do not rush to complete jobs.
        iii. Lockout/Tagout discussion
        iv. Crew communication and awareness of surroundings when operating equipment and when walking around the worksite

f. Skill Practice
    i. Tourniquet demonstration
8. Module 8: Fractures
    a. Title: Fractures
    b. Objectives
        i. Observe simulation of application of a splint to an injury to immobilize the joints above and below the injury site.
        ii. Using the procedures described in the first aid training program, identify and describe the method of examining an injured and unconscious worker for fractures and dislocations before proceeding to injury treatments.
        iii. Given a workplace injury, detect and respond to the signs and symptoms of complications due to fractures before workers' condition deteriorates.
    c. Outline
        i. Identification, "look, feel, move techniques"
        ii. Complicating Factors
        iii. Treatment- Splinting and immobilization techniques
    d. Scenario(s) Presented
        i. Fall from equipment, broken ankle, splinting
    e. Discussion Points
        i. Three points of contact when descending from equipment and trucks. Fall prevention.
    f. Skill Practice
        i. Splinting application demonstration
9. Module 9: Impaled Objects and Chest Injuries
    a. Title: Impaled Objects and Chest Injuries
    b. Objectives
        i. From memory, describe the location of the major arteries which could be injured with an impaled object as described in the first-aid training.
        ii. Given an impalement-type workplace injury, identify and describe treatment methods for impaled objects in accordance with the procedures described in the first-aid training.
        iii. Given a sucking chest wound develops in response to a chest injury, identify and describe treatment the treatment methods for applying a 3-sided occlusive dressing.
    c. Outline
        i. Types of impaled objects
        ii. Treatment of impaled objects
        iii. Sucking chest wounds (signs and symptoms, treatment)
        iv. Pneumothorax (signs and symptoms, treatment)
    d. Scenario(s) Presented
        i. Marlin spike impalement through leg.
        ii. Chest crushing from swing radius of equipment. Failure to have proper signage on equipment.

e. Discussion Points
    i. Location of major arteries in leg.
    ii. Prevention of equipment swing injuries (struck-by injuries). Situational awareness. Equipment signage. Training of new/inexperienced workers on workplace hazards.
f. Skill Practice
    i. None

10. Module 10: Heat and Cold Emergencies
    a. Title: Heat and Cold Emergencies
    b. Objectives
        i. Differentiate between the signs and symptoms of heat exhaustion and heat stroke as described in the first-aid training.
        ii. Differentiate between the signs and symptoms of frostnip, frostbite, and hypothermia as described in the first-aid training.
        iii. Describe the describe the treatment of a heat or cold related emergency as described in the first-aid training.
    c. Outline
        i. Heat Exhaustion (Signs and Symptoms, Treatment)
        ii. Heat Stroke (Signs and Symptoms, Treatment)
        iii. Frostnip (Signs and Symptoms, Treatment)
        iv. Frostbite (Signs and Symptoms, Treatment)
        v. Hypothermia (Signs and Symptoms, Treatment)
    d. Scenario(s) Presented
        i. None
    e. Discussion Points
        i. Group discussion on past experiences with Heat/Cold Emergencies
    f. Skill Practice
        i. None

11. Module 11: Allergic Reactions
    a. Title: Allergic Reactions
    b. Objectives
        i. Identify and discuss the possible causes of allergic reactions in the workplace to anticipate possible occupational illness.
        ii. Given a workplace injury, detect and respond to the signs and symptoms of an allergic reaction before workers' condition deteriorates.
        iii. During an allergic reaction, determine the need for emergency evacuation and contact emergency dispatchers without delay.
    c. Outline
        i. Allergic Reactions-Definition
        ii. General Signs and Symptoms
        iii. Causes
        iv. Treatment
        v. Insect stings and Bites- Signs and Symptoms and Treatment

        vi. Plants- Signs and Symptoms and Treatment
    d. Scenario(s) Presented
        i. Worker encounter with a bee hive
    e. Discussion Points
        i. Use of personal Epi-Pen and Benadryl
        ii. Importance of discussing allergies and medical conditions with your crew
    f. Skill Practice
        i. None

12. Module 12: Burns
    a. Title: Burns
    b. Objectives
        i. Upon request, differentiate between the signs and symptoms of the different types of burns as described in the first-aid training.
        ii. Given a workplace injury, detect the signs and symptoms and provide treatment of a burn injury, as described in the first-aid training.
    c. Outline
        i. Types of burns
        ii. Treatment of burns
    d. Scenario(s) Presented
        i. Thermal burn in shop
    e. Discussion Points
        i. Group discussion on experience with Burns
    f. Skill Practice
        i. None

13. Module 13: Electrical Injuries
    a. Title: Electrical Injuries
    b. Objectives
        i. When assigned to a job and before beginning work, identify the hazards associated with the job (such as overhead lines) and take steps to ensure personal and crew safety before proceeding.
        ii. During an emergency, identify ensuring your own safety as the most important priority before proceeding to providing treatment or assessment to an injured worker.
        iii. Given a workplace injury, detect the signs and symptoms and provide treatment of an electrical injury as described in the first-aid training
    c. Outline
        i. Importance of Scene Safety
        ii. Treatment (trauma and medical issues, head neck and back injury consideration, evacuation)
    d. Scenario(s) Presented
        i. Equipment driven into contact with electrical wires. Worker electrocuted upon contact with equipment and ground.
    e. Discussion Points

        i. Safe equipment operation around power lines
        ii. Contacting power company with requests to cut power or remove lines
        iii. Scene Safety
    f. Skill Practice
        i. None

14. Module 14: Poisoning
    a. Title: Poisoning
    b. Objectives
        i. Upon recognition of an instance of workplace poisoning, identify resources such as the poison control hotline or SDS as possible sources of treatment information while proceeding with basic first-aid as described.
        ii. Through observation, identify and discuss the possible causes of poisoning in the workplace to anticipate possible occupational illness.
        iii. When assigned to a job and before beginning work, identify the hazards associated with the worksite and take steps to ensure personal and crew safety before proceeding.
        iv. Given a workplace injury, detect the signs and symptoms and provide treatment of a seizure as described in the first-aid training.
    c. Outline
        i. Causes
        ii. Signs and Symptoms
        iii. Treatment
        iv. Seizure Treatment
    d. Scenario(s) Presented
        i. Worker ingests antifreeze from Gatorade bottle after coworker uses bottle to refill antifreeze in machine shop.
    e. Discussion Points
        i. Use of unlabeled containers.
        ii. GHS/ Safety Data Sheets
        iii. Contacting Poison Control
        iv. Group discussion on experience with Poisoning/ Contacting poison control
    f. Skill Practice
        i. None

15. Module 15: Eye Injuries
    a. Title: Eye Injuries
    b. Objectives
        i. From memory, explain the circumstances under which eye protection is required in the workplace in accordance with OSHA standards.
        ii. From memory, explain the reasoning behind use of eye protection in the workplace.
        iii. Given a workplace injury, detect the signs and symptoms and provide treatment of eye injures as described in the first-aid training.
    c. Outline

        i. Importance of wearing eye protection (PPE)
        ii. Treatment of foreign objects in the eye and impalement
        iii. Chemical injuries to the eye
    d. Scenario(s) Presented
        i. Worker splashes battery acid in eyes while maintaining equipment.
    e. Discussion Points
        i. PPE
        ii. OSHA Eye Wash Station Regulations
    f. Skill Practice
        i. None

16. Module 16: Other Medical Emergencies
    a. Title: Other Medical Emergencies- Altered Mental Status
    b. Objectives
        i. List the possible causes of altered mental status using the AEIOU-TIPS acronym as described in the first-aid training.
        ii. Upon recognition of an instance of altered mental status in the workplace, quickly investigate possible causes of the illness while proceeding with basic first-aid.
        iii. Given an instance of altered mental status in the workplace, detect the signs and symptoms and provide treatment of a stroke using the FAST acronym as described in the first-aid training.
    c. Outline
        i. Causes of Altered Mental Status (Alcohol, Epilepsy, Insulin/Diabetes, Overdose, Uremia, Trauma, Infection, Psychiatric, Stroke)
        ii. Treatment of Altered Mental Status
        iii. Stroke Signs and Symptoms (FAST)
    d. Scenario(s) Presented
        i. None
    e. Discussion Points
        i. Drug and Alcohol Use on the Job
        ii. Communicating medical history to coworkers
        iii. Diabetes
    f. Skill Practice
        i. None

Appendix VII: Training Gap Analysis- Training Program to OSHA Requirements

A gap analysis was performed between OSHA requirements for logging safety training 29 CFR 1910.266, the desired additional topics from the year 0 training evaluation, and the emergency first-aid training program created as a result of specific aim 5, objective 1. The desired outcome of the gap analysis is identification of required topics and skills which were not included within the emergency first-aid training program developed as a result of objective 1. The gap analysis will be used to drive continuous improvement of future versions of the training program which include all OSHA required topics and skills.

To perform the gap analysis, OSHA requirements were considered the desired end state of the training program. OSHA requirements were listed alongside the current training objectives, outline, and script. Finally, the gap is defined as the proposed changes needed to update the training program to meet OSHA standards (Table 15.2).

Table 15.1: Gap Analysis- Proposed Content Changes for 2018 and Beyond- Table Outline

Gap Analysis- Proposed Content Changes for 2018 and Beyond- Table Outline		
Future State	Current State	Proposed Changes
A training program which includes: • OSHA required topics (29 CFR 1910.266 Appendix B) • Desired additional topics from Year 0 training evaluation • Prevention and treatment of the most common injury types and causes. (Determined by specific aims 1 & 2)	Current (2017) training objectives and program	Changes that need to be made for the training program to meet OSHA standards, desired additional topics, and to include prevention and treatment of the most common injury types and causes. (For 2018 and beyond)

Table 15.2: Gap Analysis- Proposed Content Changes for 2018 and Beyond

<table>
<tr><th colspan="3">GAP Analysis- Proposed Content Changes for 2018 and Beyond</th></tr>
<tr><th>Future State</th><th>Current State (Year 1-2017)</th><th>Proposed Changes (For Year 2-2018)</th></tr>
<tr>
<td><u>A training program which includes:</u>
• OSHA required topics (29 CFR 1910.266 Appendix B)
• First-aid and CPR training shall be conducted using the conventional methods of training such as lecture, demonstration, practical exercise and examination (both written and practical). The length of training must be sufficient to assure that trainees understand the concepts of first aid and can demonstrate their ability to perform the various procedures contained in the outline below.
o The definition of first aid.
o Legal issues of applying first aid (Good Samaritan Laws).
o Basic anatomy.
o Patient assessment and first aid for the following:
▪ Respiratory arrest.
▪ Cardiac arrest.
▪ Hemorrhage.
▪ Lacerations/abrasions.
▪ Amputations.
▪ Musculoskeletal injuries.</td>
<td><u>Current (2017) training objectives, outline, and examination.</u>

<u>(See Appendix III, IV, V, VI & VIII)</u></td>
<td><u>Changes that need to be made for the training program to meet OSHA standards, desired additional topics, and to include prevention and treatment of the most common injury types and causes. (For 2018 and beyond)</u>
• Snake bites
• Fatigue management
• Availability and application of safety devices (lifting equipment, PPE, guarding, stake extensions for truckers)</td>
</tr>
</table>

▪ Shock. ▪ Eye injuries ▪ Burns. ▪ Loss of consciousness. ▪ Extreme temperature exposure (hypothermia/hyperthermia) ▪ Paralysis ▪ Poisoning. ▪ Loss of mental functioning (psychosis/hallucinations, etc.). ▪ Artificial ventilation. ▪ Drug overdose. ○ CPR. ○ Application of dressings and slings. ○ Treatment of strains, sprains, and fractures. ○ Immobilization of injured persons. ○ Handling and transporting injured persons. ○ Treatment of bites, stings, or contact with poisonous plants or animals. • Desired additional topics from Year 0 training evaluation ○ Radio Communication ○ Injury prevention of common accidents/ Practical Application ○ Video Footage of logging accidents ○ Driving Safety ○ Snake Bites ○ Steep and remote rescue procedures ○ Heat Emergencies • Prevention and treatment		

of the most common injury types and causes. (Determined by specific aims 1 & 2) ○ Prevention of Struck-by injuries ○ Fall Prevention ○ Treatment of most common injury types: sprain/strain, contusion/abrasion, lacerations/punctures/ amputations ○ Management of fatigue due to long working hours ○ Vehicle Collisions/Road Safety/Defensive Driving ○ Provide available safety devices (lifting equipment, PPE, guarding, stake extensions for truckers) for positions which are at risk		

Appendix VIII: Sample Examination

Sample Examination
Module 1: Introduction

1. What is the purpose of the Good Samaritan Law?
    a. It requires you to help in an emergency situation.
    b. It allows you to refuse helping in an emergency situation.
    c. If you perform help in an emergency situation, and are trained to do so, and protects you from a lawsuit.
    d. It requires others to help you in an emergency situation.

2. What is the first step of basic first aid response?
    a. Triage
    b. Treating for shock
    c. Checking for signs of circulation
    d. Ensuring your own safety

3. Which is **<u>not</u>** a step of treating for shock?
    a. Splashing water on the person's face
    b. Slightly elevating the legs of the person to promote blood return to the heart and brain.
    c. Keeping the person warm and dry
    d. Providing treatment and medical attention as soon as possible

Module 2: Bloodborne Pathogens

4. True or False: Disease or infections such as HIV, Hepatitis B and Hepatitis C may be present in the body without showing symptoms:
    a. True
    b. False

5. Bloodborne Pathogens can get inside your body through which of the following (select all that apply):
    a. A small cut on your ungloved hand
    b. Your eye
    c. Your mouth
    d. All of the Above

6. The risk of getting what infection can be reduced by getting a vaccine?
    a. HIV
    b. AIDS
    c. Hepatitis B

d. Hepatitis C

Module 3: Primary and Scene Survey

7. Which is **not** a sign of good circulation?
    a. Pink Skin
    b. Warm Skin
    c. Dry Skin
    d. Numbness and Tingling

8. Which is a sign of poor circulation?
    a. Loss of consciousness
    b. Anxiety
    c. Blue, pale, and cool skin
    d. All of the Above

9. Why should you elevate a persons' legs if they are in shock?
    a. To let them rest
    b. To help blood return to the heart and brain
    c. To keep them calm
    d. So they don't leave

Module 4: Head, Neck and Back Injuries

10. True or False: Symptoms of a head, neck, or back injury may not be visible
    a. True
    b. False

11. When should you move someone you believe may have a head, neck, or back injury:
    a. When they are in pain and want to be more comfortable
    b. When they were found on the ground and are cold
    c. When you are able to help them to the comfortable position
    d. When they are in immediate danger

12. Which is **not** a symptom of a spinal cord injury?
    a. Numbness in parts of the body
    b. Severe cough
    c. Loss of bladder control
    d. Neck pain

Module 5: Choking

13. Only give a chocking victim CPR when:
    a. They give the universal choking sign
    b. When they cannot make noise
    c. When they ask for it
    d. When they become unconscious and unresponsive

14. When there is a conscious chocking victim, what should your first step be?
    a. CPR
    b. Give 5 blows to the back between the shoulder blades, followed by 5 abdominal thrusts just above the belly button
    c. Asking them to lay down
    d. Giving them a drink of water

15. Where should you place your hand for abdominal thrusts?
    a. Center chest, on the nipple line
    b. Between the shoulder blades
    c. Just above the navel or belly button
    d. Just below the breastbone

Module 6: Cardiac Emergencies/ CPR

16. How should you open a person's airway for breathing during CPR?
    a. Open their mouth with your hand
    b. Perform the Head-Tilt Chin-Lift maneuver
    c. Perform the Jaw-Thrust Maneuver
    d. Lay the person on their side

17. What is the ratio of compressions to breaths when performing CPR?
    a. 50 Compressions: 2 Breaths
    b. 30 Compressions: 2 Breaths
    c. 30 Compressions: 1 Breath
    d. 20 Compressions: 1 Breath

18. When performing chest compressions, what is the compression rate?
    a. 6 Compressions Per Minute
    b. 100 Compressions Per Minute
    c. 60 Compressions Per Minute
    d. 150 Compressions Per Minute

Module 7: Lacerations, Abrasions, and Amputations

19. What condition can be developed if a person has significant bleeding?
    a. Diabetes
    b. Seizures
    c. Shock
    d. Heart Attack

20. If a person is bleeding from their hand, where should you apply pressure?
    a. Directly to the injured area
    b. To the pressure point on the femoral artery
    c. To the pressure point on the carotid artery
    d. To an area 2-3 inches above the injured area

21. Which of the following should be considered when deciding to use a tourniquet?
    a. Only use if elevation of the wound and direct pressure does not stop the bleeding
    b. Write down the time the tourniquet was placed
    c. If the tourniquet is allowed to come off or loosen after putting it on, it could kill the patient
    d. All of the Above

Module 8: Fractures

22. Field management of a limb fracture includes:
    a. Controlling bleeding
    b. Immobilizing the fractured extremity in a splint
    c. Checking for signs of circulation distally (away from the torso) to the point of injury to ensure adequate blood supply if no tourniquet is used
    d. All of the Above

23. What is the principle for examining potential fractures in an unconscious person?
    a. Look, Listen, and Feel
    b. Look, Feel, and Move
    c. Touch, Listen, and Move
    d. None of the above

24. How many quarters are in a dollar?
    a. 1
    b. 2
    c. 4
    d. 8

Module 9: Impaled Objects/Chest Injuries

25. Which of the following should **<u>not</u>** be attempted with an impaled object?
    a. Stabilizing the impaled object and not removing it because it could be preventing deadly bleeding
    b. Placing sterile bandaged around the wounds to help prevent infections
    c. Removing the object so you can apply a bandage and apply pressure to the wound

26. If a person has a penetrating injury to the chest, and blood bubbles from the wound what should you do?
    a. Place an airtight dressing over the wound and tape it on 3 sides to allow air to escape but not enter
    b. Clean the wound with water and apply firm pressure with sterile gauze
    c. If there is a sharp branch impaled into the chest cavity, remove it immediately so you can apply pressure with a bandage to stop the bleeding

27. Which is a symptom of internal bleeding?
    a. Rapid Breathing
    b. Pale Skin
    c. Cool Skin
    d. All of the Above

Module 10: Heat and Cold Emergencies

28. Which is more severe, Head Exhaustion or Heat Stroke?
    a. Heat Exhaustion
    b. Heat Stroke

29. What is the difference between Heat Stroke and Heat Exhaustion?
    a. You should not attempt to cool a person with Heat Stroke
    b. Heat stroke involves decreased blood flow to the brain which may cause headaches or seizures
    c. Expect profuse sweating during heat stroke
    d. Heat stroke causes decreased heart rate

30. True or False: In severe cases of hypothermia shivering may not be observable
    a. True
    b. False

Module 11: Allergic Reactions

31. True or False: Anaphylaxis is potentially life-threatening. Even if treated with an epi-pen, a person should receive emergency medical care.
    a. True
    b. False

32. Which of the following are the symptoms of a life threatening allergic reaction? Itchy skin
    a. Swelling of the lips and face
    b. Difficulty breathing
    c. Unconsciousness
    d. All of the above

33. What is the most common symptom of an allergic reaction?
    a. Hives
    b. Facial swelling
    c. Vomiting
    d. Headache

Module 12: Burns

34. Burn treatment should involve which if the following steps?

a. Basic first aid like checking for breathing and signs of circulation
b. Removing jewelry and debris from around the burn
c. Calling for a medical evacuation if the burn causes blisters and goes deep into the flesh
d. All of the above

35. Which degree of burns is characterized as painful, red, and blistered?
a. First
b. Second
c. Third
d. Fourth

36. Which degree of burns is characterized as dry, red, and slightly painful?
a. First
b. Second
c. Third
d. Fourth

Module 13: Electrical Emergencies

37. In the case of an electrical emergency victim, you should treat the patient as:
a. A trauma and cardiac patient
b. Just as a trauma patient
c. Just as a cardiac patient
d. As a person suffering from a stroke

38. What kind of dressing should you apply to a severe electrical burn?
a. Dry dressing
b. Splint
c. Clean and wet dressing
d. None of the Above

39. What state are we in right now?
a. Idaho
b. Florida
c. Montana
d. None of the Above

Module 14: Poisoning

40. If a seizure occurs (as a result of poisoning or any other causes), you should (please select all that apply):
a. Clear the area for dangerous objects
b. Try to prevent them from falling or having further injuries
c. Turn the person on their side if they start to vomit
d. All of the above

41. What is the poison control number?
    a. 1-800-222-2222
    b. 1-800-222-1222
    c. 1-800-333-1333
    d. 1-800-333-3333

42. True or False: I am reading and answering all questions.
    a. True
    b. False

Module 15: Eye Injuries

43. True or False: You should apply direct pressure to an eye injury.
    a. True
    b. False

44. How long should you rinse an eye after a chemical injury?
    a. 3 Minutes
    b. 5 Minutes
    c. 10 Minutes
    d. 15 Minutes

45. Who is the current president of the United States?
    a. Clinton
    b. Bush
    c. Obama
    d. Trump

Module 16: Other Medical Emergencies

46. True or False: Head trauma can cause altered levels of consciousness and may cause a person to act erratically or violently.
    a. True
    b. False

47. When identifying a stroke, the FAST acronym stands for:
    a. Face, Activity, Speech, Temperature
    b. Face, Arms, Speech, Time
    c. Focus, Activity, Symptoms, Time
    d. Feel, Arms, Speech, Temperature

48. If you believe someone has had or is having a stroke, you should call EMS immediately and remember the pneumonic FAST. The “T” in FAST stands for:
    a. Time: you should record the time that the symptoms started.
    b. Taste: you should ask the person if they can taste food or drinks
    c. Telephone: you should ask the person if they remember their telephone number
    d. Temperature: you should make sure the person does not have a fever

Appendix IX: Gap Analysis- Learning Objectives to Examination Content

A gap analysis was performed between the course objectives developed during specific aim 5, objective 1 and the examination developed as a result of specific aim 5, objective 3. The result of the gap analysis is identification of examination questions that do not align with module and overall course objectives, as well as identification of course objectives that were not included on the examination (Table 17.2). The gap analysis will be used to continually improve the training program and corresponding examination to provide accurate and relevant examination of necessary and required knowledge and skills.

Table 17.1: Gap Analysis- Learning objectives versus examination questions- Table Outline

Gap Analysis- Learning objectives versus examination questions- Table Outline		
Future State	Current State	Proposed Changes
Examination questions based upon specific module learning objectives	Content analysis of examination	Changes that need to be made for the examination to parallel to learning objectives

Table 17.2: Gap Analysis- Learning objectives versus examination questions

Gap Analysis- Proposed Content Changes for 2018 and Beyond (Between Learning Objectives and Examination)		
Future State	Current State (Year 1-2017)	Proposed Changes (For Year 2-2018)
Examination questions based upon specific module learning objectives **List of 2017 learning objectives** 1. During the Montana	**Content analysis of examination** **Examination Question Corresponding to Numbered Learning Objective**	**Changes that need to be made for the 2018 examination for questions to parallel learning objectives** **Potential Additions to Examination:**

Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in accordance with the requirements of 29 CFR 1910.266 Appendix B. 2. During the Montana Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in response to the most common injury and incident types present in the logging industry. 3. During the Montana Logging Association's Annual Safety training sessions, a course will be delivered to participants that provides first-aid and CPR training in accordance with topics generated by worker recommendations from survey methods. 4. Given the need for a worker to respond to an occupational injury, participants will be provided the necessary knowledge and skill practice to identify basic treatment steps and appropriate methods of evacuating and transporting the injured worker to a higher level of care, prior to the development of further injury or disability.	1. Gap (No corresponding examination question) 2. Gap 3. N/A 4. N/A 5. N/A 6. 3, 9, 19 7. Gap 8. 1 9. Gap 10. 4, 5 11. N/A 12. 6 13. 2 14. 7, 8 15. Gap 16. 3, 9, 19 17. 10, 12 18. 11 19. 14 20. 14, 15 21. 13 22. Gap 23. 16 24. 17, 18	• Purpose of 29 CFR 1910.266 Appendix B • How to reduce risk of injury due to most common injury types seen/Use of PPE • Preparation of helicopter evacuation zone • Definition of first aid • Signs and symptoms of adequate breathing • Signs and symptoms of cardiac emergencies • AED Use • Treatment options for hemorrhage • Location of major arteries • Treatment of heat and cold emergencies • Causes of allergic reactions • Possible causes of workplace poisoning • Causes of altered mental status **Questions to be removed from Examination:** 27. Symptoms of internal bleeding

5. During the MLA's safety training sessions, participants will be provided a platform for discussion and query regarding injury prevention opportunities to minimize risk and injuries due to preventable scenarios. 6. From memory, state the steps for treatment of shock of an injured coworker in accordance with the procedures described in the first-aid training. 7. During an emergency, identify, prepare, and relay the coordinates of the helicopter landing zone to emergency dispatchers without delaying evacuation of the injured worker. 8. From memory, state the purpose of the Good Samaritan Law. 9. From memory, state the definition of first-aid. 10. From memory, describe the possible routes of transmission of bloodborne pathogens in the workplace in accordance with the procedures described during the first-aid training. 11. After preforming a simulated first-aid task, demonstrate removal of	25. Gap 26. Gap 27. N/A 28. N/A 29. 19, 20, 21 30. 3, 9, 19 31. 3, 9, 19 32. Gap 33. N/A 34. 23 35. 22 36. Gap 37. 25, 26 38. 26 39. 28, 29 40. 30 41. Gap 42. Gap 43. 32, 33 44. 31 45. 25, 36 46. 34 47. 2 48. 2 49. 37, 38	

gloves without contaminating yourself. 12. From memory, list the ways of preventing the transmission of BBP in the workplace in accordance with the procedures described during the first-aid training. 13. During an emergency, identify ensuring your own safety as the most important priority before providing treatment or assessment to an injured worker. 14. From memory, describe the describe signs and symptoms of adequate and poor circulation in accordance with the procedures described during the first-aid training. 15. From memory, describe the describe signs and symptoms of adequate and poor breathing in accordance with the procedures described during the first-aid training. 16. From memory, state the steps for treatment of shock of an injured coworker in accordance with the procedures described during the first-aid training. 17. From memory, describe the describe signs and	50. 41 51. Gap 52. 2 53. 40 54. Gap 55. Gap 56. 43. 44 57. Gap 58. 46 59. 47, 48	

symptoms of head, neck and back injuries in accordance with the information described during the first-aid training. 18. From memory, describe the treatment (immobilization) of head, neck and back injuries in accordance with the procedures described during the first-aid training and the availability of supplies on your worksite. 19. Upon identifying a person displaying the universal choking sign and lack of evidence of breathing, demonstrate use a combination of abdominal thrusts and back blows to dislodge the object without hesitation. 20. From memory, describe the treatment of a conscious choking victim in accordance with the procedures described in the first-aid training. 21. From memory, describe the treatment of an unconscious choking victim in accordance with the procedures described in the first-aid training. 22. From memory, describe and identify the signs and symptoms of cardiac emergencies in accordance with the information described in the first-aid		

training. 23. Upon identifying a person who is not breathing (respiratory arrest), demonstrate use of the head-tilt chin lift to open the airway and begin rescue breathing (artificial ventilation) without hesitation. 24. Upon identifying a person who is not breathing and has signs of decreased circulation (cardiac arrest), demonstrate CPR without hesitation. 25. From memory, describe when and how to use an AED in accordance with the information described in the first-aid training. 26. Using the procedures described in the first aid training program, identify and describe three different treatment options for stopping bleeding (hemorrhage) due to a laceration or amputation in order of least aggressive to most invasive. 27. Observe simulation of application of direct pressure to an injury (laceration or amputation) until bleeding stops. 28. Observe simulation of application of a tourniquet to an injury (laceration or amputation) until bleeding stops.		

29. Given a workplace injury, detect and respond to the signs and symptoms of shock before the workers' condition deteriorates. 30. From memory, describe treatment for shock in accordance with the procedures described in the first-aid training and the availability of supplies on your worksite. 31. From memory, explain the basis for the methods of treatment for shock in accordance with the procedures described in the first-aid training. 32. From memory, explain the circumstances under which personal protective equipment (ex. chaps, eye protection, head protection, etc.) is required in the workplace in accordance with OSHA standards. 33. Observe simulation of application of a splint to an injury to immobilize the joints above and below the injury site. 34. Using the procedures described in the first aid training program, identify and describe the method of examining an injured and unconscious worker for fractures and dislocations before proceeding to injury treatments.		

35. Given a workplace injury, detect and respond to the signs and symptoms of complications due to fractures before workers' condition deteriorates. 36. From memory, describe the location of the major arteries which could be injured with an impaled object as described in the first-aid training. 37. Given an impalement-type workplace injury, identify and describe treatment methods for impaled objects in accordance with the procedures described in the first-aid training. 38. Given a sucking chest wound develops in response to a chest injury, identify and describe treatment the treatment methods for applying a 3-sided occlusive dressing. 39. Differentiate between the signs and symptoms of heat exhaustion and heat stroke as described in the first-aid training. 40. Differentiate between the signs and symptoms of frostnip, frostbite, and hypothermia as described in the first-aid training. 41. Describe the describe the treatment of a heat or cold related emergency as described in the first-aid		

training. 42. Identify and discuss the possible causes of allergic reactions in the workplace to anticipate possible occupational illness. 43. Given a workplace injury, detect and respond to the signs and symptoms of an allergic reaction before workers' condition deteriorates. 44. During an allergic reaction, determine the need for emergency evacuation and contact emergency dispatchers without delay. 45. Upon request, differentiate between the signs and symptoms of the different types of burns as described in the first-aid training. 46. Given a workplace injury, detect the signs and symptoms and provide treatment of a burn injury, as described in the first-aid training. 47. When assigned to a job and before beginning work, identify the hazards associated with the job (such as overhead lines) and take steps to ensure personal and crew safety before proceeding. 48. During an emergency, identify ensuring your own safety as the most important priority before		

proceeding to providing treatment or assessment to an injured worker. 49. Given a workplace injury, detect the signs and symptoms and provide treatment of an electrical injury as described in the first-aid training 50. Upon recognition of an instance of workplace poisoning, identify resources such as the poison control hotline or SDS as possible sources of treatment information while proceeding with basic first-aid as described. 51. Through observation, identify and discuss the possible causes of poisoning in the workplace to anticipate possible occupational illness. 52. When assigned to a job and before beginning work, identify the hazards associated with the worksite and take steps to ensure personal and crew safety before proceeding. 53. Given a workplace injury, detect the signs and symptoms and provide treatment of a seizure as described in the first-aid training. 54. From memory, explain the circumstances under which eye protection is required in the workplace in		

accordance with OSHA standards. 55. From memory, explain the reasoning behind use of eye protection in the workplace. 56. Given a workplace injury, detect the signs and symptoms and provide treatment of eye injures as described in the first-aid training. 57. List the possible causes of altered mental status using the AEIOU-TIPS acronym as described in the first-aid training. 58. Upon recognition of an instance of altered mental status in the workplace, quickly investigate possible causes of the illness while proceeding with basic first-aid. 59. Given an instance of altered mental status in the workplace, detect the signs and symptoms and provide treatment of a stroke using the FAST acronym as described in the first-aid training.		

Appendix X: McNemar's Test, Change in Knowledge Test Responses by Question, Pre- to Post-Training

Table 18.1: McNemar's Test, Change in Knowledge Test Responses by Question, Pre- to Post-Training

McNemar's Test, Change in Knowledge Test Responses by Question, Pre- to Post-Training												
Module 1: Introduction			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
	Question 1 (n=812, p<.05)	Pre-Test Incorrect	19 (2.34%)	35 (4.31%)	Question 2 (n=811, (p<.05)	Pre-Test Incorrect	13 (1.60%)	40 (4.93%)	Question 3 (n=811, p>.05)	Pre-Test Incorrect	3 (0.37%)	14 (1.73%)
		Pre-Test Correct	19 (2.34%)	739 (91.01%)		Pre-Test Correct	24 (2.96%)	734 (90.51%)		Pre-Test Correct	22 (1.87%)	772 (95.19%)
Module 2: Bloodborne Pathogens			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
	Question 4 (n=811, p>.05)	Pre-Test Incorrect	0 (0.00)	6 (0.74)	Question 5 (n=811, p>.05)	Pre-Test Incorrect	3 (0.37)	17 (2.10)	Question 6 (n=811, p<.01)	Pre-Test Incorrect	116 (14.30)	2.13 (26.26)
		Pre-Test Correct	5 (0.62)	800 (98.64)		Pre-Test Correct	12 (1.48)	779 (96.05)		Pre-Test Correct	33 (4.07)	449 (55.36)
Module 3: Scene/Primary Survey			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
	Question 7 (n=810, p<.05)	Pre-Test Incorrect	76 (9.38)	103 (12.72)	Question 8 (n=810, p<.05)	Pre-Test Incorrect	93 (11.48)	115 (14.20)	Question 9 (n=809, p>.05)	Pre-Test Incorrect	1 (0.12)	13 (1.61)
		Pre-Test Correct	71 (8.77)	560 (69.14)		Pre-Test Correct	83 (10.25)	519 (64.07)		Pre-Test Correct	12 (1.48)	783 (96.79)
Module 4: Head, Neck, and Back Injuries			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
	Question 10 (n=809, p>.05)	Pre-Test Incorrect	0 (0.00)	11 (1.36)	Question 11 (n=809, p>.05)	Pre-Test Incorrect	2 (0.25)	7 (0.87)	Question 12 (n=809, p>.05)	Pre-Test Incorrect	29 (3.58)	35 (4.33)
		Pre-Test	7 (0.87)	791 (97.78)		Pre-Test	9 (1.11)	791 (97.78)		Pre-Test	31 (3.83)	714 (88.26)

		Correct				Correct				Correct		
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 5: choking	Question 13 (n=809, p<.01)	Pre-Test Incorrect	48 (5.93)	122 (15.08)	Question 14 (n=810, p<.01)	Pre-Test Incorrect	3 (0.37)	137 (16.91)	Question 15 (n=810, p<.01)	Pre-Test Incorrect	59 (7.25)	209 (25.80)
		Pre-Test Correct	42 (5.19)	597 (73.79)		Pre-Test Correct	9 (1.11)	661 (81.60)		Pre-Test Correct	32 (3.95)	510 (62.96)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 6: Cardiac Emergencies/CPR	Question 16 (n=810, p<.01)	Pre-Test Incorrect	6 (0.74)	34 (4.20)	Question 17 (n=812, p<.01)	Pre-Test Incorrect	16 (1.97)	245 (30.17)	Question 18 (n=811, p<.01)	Pre-Test Incorrect	22 (2.71)	318 (39.21)
		Pre-Test Correct	9 (1.11)	761 (93.95)		Pre-Test Correct	22 (2.71)	529 (65.15)		Pre-Test Correct	4 (0.49)	467 (57.58)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 7: Lacerations/Amputations	Question 19 (n=810, p>.05)	Pre-Test Incorrect	17 (2.10)	23 (2.84)	Question 20 (n=810, p>.05)	Pre-Test Incorrect	245 (30.25)	104 (12.84)	Question 21 (n=808, p<.01)	Pre-Test Incorrect	128 (15.84)	137 (16.96)
		Pre-Test Correct	26 (3.21)	744 (91.85)		Pre-Test Correct	99 (12.22)	362 (44.69)		Pre-Test Correct	56 (6.93)	487 (60.27)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct				
Module 8: Fractures	Question 22 (n=808, p<.01)	Pre-Test Incorrect	55 (6.81)	132 (16.34)	Question 23 (n=808, p<.01)	Pre-Test Incorrect	392 (48.51)	272 (33.66)				
		Pre-Test Correct	33 (4.08)	588 (72.77)		Pre-Test Correct	27 (3.34)	117 (14.48)				
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 9: Impaled Objects/Chest Injuries	Question 25 (n=808, p>.05)	Pre-Test Incorrect	50 (6.19)	71 (8.79)	Question 26 (n=808, (p<.01)	Pre-Test Incorrect	29 (3.59)	141 (17.45)	Question 27 (n=804, p<.05)	Pre-Test Incorrect	20 (2.49)	65 (8.08)
		Pre-Test Correct	54 (6.68)	633 (78.34)		Pre-Test Correct	14 (1.73)	624 (77.23)		Pre-Test Correct	44 (5.47)	675 (83.96)

			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 10: Heat/Cold Emergencies	Question 28 (n=804, p<.05)	Pre-Test Incorrect	6 (0.75)	43 (5.35)	Question 29 (n=804, p<.01)	Pre-Test Incorrect	91 (11.32)	138 (17.16)	Question 30 (n=804, p<.01)	Pre-Test Incorrect	33 (4.10)	144 (17.91)
		Pre-Test Correct	25 (3.11)	730 (90.80)		Pre-Test Correct	86 (10.70)	489 (60.82)		Pre-Test Correct	25 (3.11)	602 (74.88)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 11: Allergic Reactions	Question 31 (n=805, p<.05)	Pre-Test Incorrect	1 (0.12)	28 (3.48)	Question 32 (n=805, p<.05)	Pre-Test Incorrect	4 (0.50)	24 (2.98)	Question 33 (n=805, p<.01)	Pre-Test Incorrect	77 (9.57)	189 (23.48)
		Pre-Test Correct	12 (1.49)	764 (94.91)		Pre-Test Correct	11 (1.37)	766 (95.16)		Pre-Test Correct	24 (2.98)	5.15 (63.98)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
Module 12: Burns	Question 34 (n=806, p<.01)	Pre-Test Incorrect	28 (3.47)	116 (14.39)	Question 35 (n=806, p<.01)	Pre-Test Incorrect	45 (5.58)	161 (19.98)	Question 36 (n=806, p<.01)	Pre-Test Incorrect	35 (4.34)	112 (13.90)
		Pre-Test Correct	26 (3.23)	636 (78.91)		Pre-Test Correct	20 (2.48)	580 (71.96)		Pre-Test Correct	33 (4.09)	626 (77.67)
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct				
Module 13: Electrical Emergencies	Question 37 (n=806, p<.01)	Pre-Test Incorrect	12 (1.49)	83 (10.30)	Question 38 (n=806, p<.01)	Pre-Test Incorrect	261 (32.38)	312 (38.71)				
		Pre-Test Correct	28 (3.47)	683 (84374)		Pre-Test Correct	37 (4.59)	196 (24.32)				
			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct				
Module 14: Poisoning	Question 40 (n=801, p>.05)	Pre-Test Incorrect	7 (0.87)	30 (3.75)	Question 41 (n=801, p<.01)	Pre-Test Incorrect	18 (2.25)	272 (33.96)				
		Pre-Test Correct	30 (3.75)	734 (91.64)		Pre-Test Correct	4 (0.50)	507 (63.30)				
Module 15: Eye Injuries			Post-Test	Post-Test			Post-Test	Post-Test				

			Incorrect	Correct			Incorrect	Correct				
	Question 43 (n=801, p>.05)	Pre-Test Incorrect	10 (1.25)	32 (4.00)	Question 44 (n=802, p<.01)	Pre-Test Incorrect	6 (0.75)	280 (34.91)				
		Pre-Test Correct	44 (5.49)	715 (89.26)		Pre-Test Correct	10 (1.25)	506 (63.09)				
Module 16: Other Medical Emergencies			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct			Post-Test Incorrect	Post-Test Correct
	Question 46 (n=801, p<.01)	Pre-Test Incorrect	10 (1.25)	46 (5.74)	Question 47 (n=801, p<.01)	Pre-Test Incorrect	22 (2.75)	142 (17.73)	Question 48 (n=801, p<.01)	Pre-Test Incorrect	9(1.12)	75 (9.36)
		Pre-Test Correct	11 (1.37)	734 (91.64)		Pre-Test Correct	14 (1.75)	623 (77.78)		Pre-Test Correct	11 (1.37)	706(88.14)

Appendix XI: Trade Publication 1- Enhancing Safety Culture: Part 1. Type, Frequency and Cost of Logging Injuries

Enhancing Safety Culture: Part 1. Type, Frequency and Cost of Logging Injuries

Article by Bryan Lorengo, John Hansen and Elise Lagerstrom

Over the past three years the Montana Logging Association (MLA) and Colorado State University (CSU) have been working together to enhance and sustain the safety culture within the Montana logging industry. The university and MLA partnership has resulted in several projects related to logging safety. The first project was an analysis of the injury claims during a 5-year period to better understand the type, frequency and cost of logging injuries.

To perform this analysis, workers' compensation claim data were obtained from two workers' compensation providers (Associated Loggers Exchange and Montana State Fund), which cover companies active in the logging industry of Montana and Idaho. Injury claim data contained information on worker age, length of employment, time of injury, injury type and cause, as well as the cost associated with each injury claim. Worker and company name were not included.

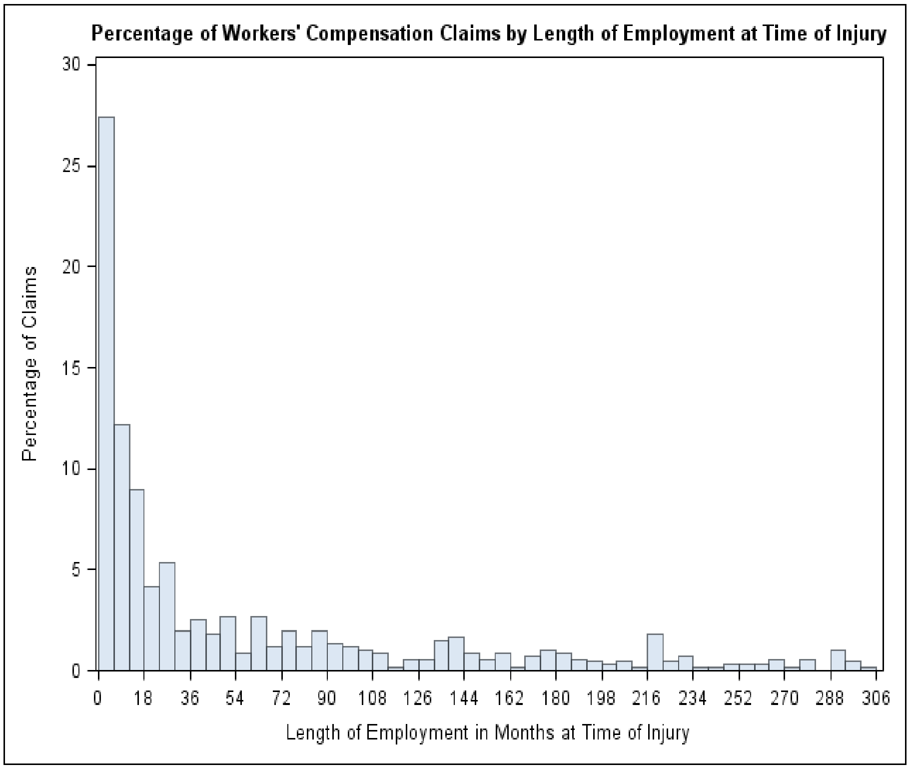


Figure 19.1: Length of Employment at Time of Injury Claim

A total of 801 workers' compensation claims were analyzed for the period July 2010 to June 2015 with **more than 25% of all injuries occurring to workers with less than 6 months of experience (Figure 1)**. Job tasks that involved felling trees, skidding and truck driving had the highest injury risk. While sprain/strain injuries were the most common type of injury, accounting for 36% of all claims, fatalities had the highest average total claim cost at $274,411, followed by multiple injuries ($17,138), and fractures/dislocations ($11,466). The results of this first project provide the background for developing focused injury prevention strategies to reduce injuries and fatalities in the logging industry. Based on the results, injury prevention efforts in the west should focus on training related to safe work methods (especially for inexperienced workers), which could be accomplished through more formal methods, such as an educational program offered through local colleges or extension programs, or could be more informal, using mentorship on the job. Use of either method should recognize the hazard of having inexperienced workers on a job and should focus on site-specific hazard identification and recognition. To continue the sustainability of the workforce, we must be able to attract and retain workers. Workers, especially new workers, may be unable or unwilling to return to their position after an injury.

While training programs for inexperienced workers may provide the greatest impact on the current injury rate, OSHA requirements dictate that all loggers must receive annual first-aid training. While some may dread the disruption and inconvenience, we believe that this presents an opportunity for injury prevention. If safety training programs are frequently updated and developed to address specific and emerging issues, there is a chance at reversing the current injury trend. For example, the most common type of injury for sawyers and hookers are struck-by type injuries, which could include being struck by equipment or falling limbs (Table 19.1). Some of these injuries may be avoided by ensuring workers are trained on recognizing and retreating to safe areas while felling trees, recognition of environmental hazards such as trees with dead tops, as well as safety while working around heavy equipment.

Table 19.1: Claim Characteristics by Job Task

Job Task	Number of claims	Median Age (Range)	Median Length of Experience in months (Range)	Top Three Incident Types	Top Three Nature of Injury	Median Adjusted Total Claim Value (Range)
Sawyer/ Hooker	82	4 18-64)	1 1.50 (0-413)	1. Struck by 2. Fall 3. Voluntary Movement (Injuries resulting from normal work movements, such as stepping down from equipment)	1. Sprain/Strain 2. Contusion/Abrasion 3. Laceration/Puncture	$1,988 (0- 565,549)
Equipment Operator	79	9 19-73)	4 5.00 (0-492)	1. Fall 2. Struck by 3. Other	1. Sprain/Strain 2. Contusion/Abrasion 3. Other	$2,698 (0- 1,155,171)
Truck Driver	43	0	3 6.00	1. Fall 2. Overexertion 3. Struck by	1. Sprain/Strain 2. Contusion/Abrasion 3. Fracture/Dislocation	$1,208 (0- 1,021,543)

		17-73)	(0-434)			
Other	6	7 18-68)	6 4.00 (0-456)	1. Struck by 2. Fall 3. Other	1. Sprain/Strain 2. Contusion/Abrasion 3. Other	$1,046 (0- 70,143)
Supervisor/ Owner	6	5 31-65)	2 01.00 (10-540)	1. Fall 2. Struck by 3. Overexertion	1. Sprain/Strain 2. Contusion/Abrasion 3. Laceration/Puncture	$2,098 (0- 320,773)
Mill Operator		7 32-54)	6 .00 (0-88)	1. Struck by 2. Fall 3. Overexertion	1. Sprain/Strain 2. Contusion/Abrasion 3. Laceration/Puncture	$409 (0- 206,797)
All Tasks Combined	**01**	**4 17-73)**	**2 4.00 (0-540)**	**1. Struck by 2. Fall 3. Overexertion**	**1. Sprain/Strain 2. Contusion/Abrasio n 3. Laceration/Punctur e**	**$1,920 (0- 1,155,171)**

While there are hazards associated with working in the woods, through continued development and improvement of safety programs, equipment, and technology, we can reduce some of this risk. The economy may skew our judgment and drive decisions on equipment purchase, speed of work, and safety attitudes. However, if the goal of work is to provide for your family, we must ensure that all workers are trained and equipped to arrive at work and return home safely each day.

The full methodology and results of this study can be found in the *American Journal of Industrial Medicine.*

Lagerstrom, E.A., Magzamen S., Rosecrance J. A mixed-methods analysis of logging injuries in Montana and Idaho. *American Journal of Industrial Medicine.* 2017; 1–11. https://doi.org/10.1002/ajim.22759

Appendix XII: Trade Publication 2- Enhancing Safety Culture: Part 2. Attitudes toward Safety among Montana Loggers

Enhancing Safety Culture: Part 2. Attitudes toward Safety among Montana Loggers

Article by Bryan Lorengo, John Hansen and Elise Lagerstrom

Over the past three years the Montana Logging Association (MLA) and Colorado State University (CSU) have been working together to enhance and sustain the safety culture within the Montana logging industry. The university and MLA partnership has resulted in several projects related to logging safety. This article is a summary of the second project which covers the results of a survey of safety attitude of loggers in Montana.

During this project, workers were asked to complete a survey on their attitudes regarding workplace safety. This survey has been used to evaluate safety in many different industries and workplaces.

The survey measured safety attitudes in five categories: (1) management commitment to safety, (2) workers' safety commitment, (3) workers' safety priority and risk assessment, (4) safety communication and trust in safety ability, and (5) workers' trust in safety systems. Professional loggers answered 38 questions using a scale from 1-4, with a 1 meaning they strongly disagreed with the statement and a 4 meaning they strongly agreed with the statement.

In four out of the five categories, safety attitudes were at a good level (Table 20.1). However, in category three (workers' safety priority and risk assessment), safety attitudes can be improved. In this category, workers were asked to respond to statements regarding their attitude on whether accidents and risk are avoidable at work, if minor accidents were a part of their normal daily work, and if they accepted risks to complete work on time. In this category, the scores of both company owners/supervisors and workers showed the need for slight improvement.

Table 20.1:Safety Attitudes Survey Results by Category

Safety Attitudes Survey Results by Category					
	Category 1 Managemen t commitment to safety	**Category 2** Workers' safety commitmen t	**Category 3** Workers' safety priority and risk assessment	**Category 4** Safety communication and trust in safety ability	**Category 5** Workers' trust in safety systems
Company Owners or Supervisors	3.44	3.44	3.14	3.36	3.36
Workers (not supervisors)	3.37	3.37	3.07	3.32	3.33
*According to the developers of the survey, scores greater than 3.30 indicates that safety climate (safety attitudes) are at a good level and safety programs should be maintained. Scores from 3.00 to 3.30 indicate that slight improvements are needed. Scores between 2.70 and 2.99 indicate a low level of safety attitude, and scores below 2.70 indicate very low safety attitudes.					

In every category, company owners and supervisors had higher safety attitude scores than workers responding to the same questions. This means that owners and supervisors believe that their workplace is safer than their workers do. It is not uncommon to see disagreement between supervisor and worker scores. It is very important to know that workers and supervisors who are on the same site may have different visions of safety. Frequent and open communication between supervisors and workers often help resolve differences in safety perceptions and attitudes.

While safety attitudes and safety behaviors are an important part of preventing injuries and fatalities, having a safe workplace also includes preparing to respond injuries when the do occur. The third phase of this project was the development an emergency first-aid training program to limit the extent and severity of logging injuries.

Appendix XIII: Trade Publication 3- Enhancing Safety Culture: Part 3. Updating Annual First-Aid and Safety Training

Enhancing Safety Culture: Part 3. Updating Annual First-Aid and Safety Training

Article by Bryan Lorengo, John Hansen and Elise Lagerstrom

Over the past three years the Montana Logging Association (MLA) and Colorado State University (CSU) have been working together to enhance and sustain the safety culture within the Montana logging industry. The university and MLA partnership resulted in several projects related to logging safety. This article is a summary of the third project which covers the updating the Annual First-Aid and Safety Training Program offered by the MLA.

There were three main goals for this project:

(1) Use a team to develop a video-based training program that cover topics and injuries commonly seen in the industry. Use updated examples and new video from local areas and workers.

(2) Determine if the new training program covers all required OSHA training topics.

(3) Develop a test to evaluate recall and retention of knowledge and skills taught during the training session.

How we developed the program:

A training needs analysis was completed to determine the topics that would be covered in the training program. Topics covered during the training program came from three sources: OSHA Standards, workers' compensation data analysis, and surveys from loggers attending first-aid training sessions in 2016.

To create a program that was correct and relevant to loggers in Montana, a team of healthcare providers and logging safety experts from the MLA was assembled. Two occupational medicine physicians with military experience and an Emergency Medical Technician developed the training material covered in the program, while logging safety experts ensured that the material was applicable to logging. The training material was developed to provide the necessary information to respond and provide treatment for injuries that occur in logging.

The 2017 training program consisted of 16 different modules (topics). Each module contained a real-world video scenario, followed by a learning session taught by the medical providers and logging safety rangers. After each module was presented, there was time for discussion and practice of the skill presented in the video.

For example, during the cardiac emergency module, a video scenario was presented with a worker going into cardiac arrest in a maintenance facility. After the real-world scenario is presented, training material was presented on types of cardiac injuries, signs and symptoms, as well as treatment. Finally, there was time to practice CPR and rescue breathing.

How we are testing the program:

We are testing the training program using four different steps.

(1) Administering a survey to obtain suggestions for the improvement of future training.

(2) Administering a pre- and post- test to evaluate recall of information presented during training program.

(3) Conducting follow-up (6 months post-training) focus groups with loggers who attended the new emergency first-aid training program. Focus groups will be centered on questions regarding the relevancy of first-aid training, changes in job performance resulted from

the learning process, capabilities to perform the newly learned skills, the absence of necessary skills or knowledge, and barriers to transfer of knowledge to skills in the field.

(4) Administering a test during the focus groups to test retention of information presented during the training program.

While training workers in first-aid is important, it is even more important to prevent injuries from occurring. Moving forward, we hope to continually update the training program, as technology changes and new risks emerge. In addition, we hope to begin development of a training program to prepare inexperienced workers by introducing them to equipment and the hazard of working in the woods.