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## A qualitative assessment of safe work practices in logging in the southern United States

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### Abstract

**Background**—The logging industry is recognized as one of the most dangerous professions in the U.S., but little is known about safety management practices on remote logging sites.

**Methods**—A total of six focus group sessions were held among logging supervisors and front line crew members in Arkansas, Louisiana, and Texas (N = 27 participants).

**Results**—Participants perceived that logging was a dangerous profession, but its risks had been mitigated in several ways, most notably through mechanization of timber harvesting. Log trucking-related incidents were widely identified as the primary source of risk for injury and death on logging work sites. Human error, in general, and being out of the machinery on the work site were highlighted as additional sources of risk.

**Conclusions**—Participants indicated high levels of personal motivation to work in a safe manner but tended to underestimate workplace hazards and expressed widely varying levels of co-worker trust.

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#### AUTHORS' CONTRIBUTIONS

All authors contributed to the conception or execution of the work. S.H.C. constructed the data collection instruments, collected data, performed qualitative data analyses, and drafted the manuscript. L.A.P. provided critical revision of the data collection instruments, collected data, provided oversight of the analyses, and provided critical revision of the manuscript. V.C. collected data; V.C. and D.I.D. designed the parent study, established the advisory board, and provided critical review of the data collection instruments and the manuscript. All authors provided final approval of the version to be published and agree to be accountable for all aspects of the work.

#### DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

#### ETHICS REVIEW AND APPROVAL

The Committee for the Protection of Human Subjects at the University of Texas Health Science Center and the Institutional Review Board at the University of Texas Health Science Center Northeast reviewed and approved the study protocol. Signed informed consent was obtained from each subject prior to participating in the study.

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## INTRODUCTION

Logging has long been recognized as one of the most dangerous occupations in the United States (U.S.) [Milham, 1997]. Logging workers had the highest fatal work injury rate in the U.S. in 2014, with 109.5 fatalities per 100,000 full-time equivalent (FTE) workers (all worker fatal injury rate: 3.3 per 100,000 FTE workers) [United States Department of Labor, Bureau of Labor Statistics, 2015a]. Additionally, the number of fatal work injuries among loggers has increased each year since 2012, following a decade of year-to-year variability [United States Department of Labor, Bureau of Labor Statistics, 2015b].

The states of the southern U.S. harvest more than half of the country's industrial wood output, a proportion that is expected to increase over the next several decades [Haynes, 2003]. In Arkansas, Louisiana, and Texas (i.e., the Ark-La-Tex region), most logging operations are fully mechanized, which involves extracting timber in remote production settings through the use of heavy machinery, which are often operated in relatively close physical proximity to each other. When the harvesting of a cut site has been completed, the logging crew and machinery will be moved to the next cut site, which may vary substantially from the previous one both in terms of terrain and remoteness. Machine operators are assigned to a single type of machine in which they work alone and exercise considerable self-direction. Machine assignment is based on individual operator efficiency and mastery of machinery operation. Given this environment, safe work practices depend, in part, on individual motivation to work safely and an organizational climate that promotes and reinforces safe work habits among workers [Rummer, 1995; Christian et al., 2009].

The structure of southern logging crews and their degree of mechanization underwent a substantial change in the 1990s, the results of which are today's primary practices [Goergen et al., 2013]. By the late 1990s, southern U.S. logging crew composition and work processes relied on small, highly experienced work groups who received on-the-job training on machine operation and repair—including the associated safe work practices—and who had lower rates of injury than loggers in other regions of the U.S. [Greene et al., 1998; Sygnatur, 1998; Bordas et al., 2001]. Currently, logging contractors and foremen in the Ark-La-Tex region who pursue certain optional professional certifications must participate in more formalized logging safety training; such training focuses primarily on general logging safety practices and first aid rather than safety management practices [de Hoop, 2000; Arkansas Timber Producers Association, 2011; Louisiana Forestry Association, 2015; Texas Forestry Association, 2015]. Safety management practices offer a comprehensive approach to managing workplace safety through the improvement of working conditions as well as workers' attitudes and behaviors toward safety [Vinodkumar and Bhasi, 2010]. Leadership practices associated with safety management have been shown to reduce safety-related events and work-related injuries [Vinodkumar and Bhasi, 2010; Clarke, 2013]. Safety management is one component of the broader construct of "safety climate," which characterizes the degree to which an organization values occupational safety and is measured by assessing workers' perceptions of their organizations', managers', and peers' commitment to safety through policies, procedures, and practices [Kines et al., 2011]. Safety climate has been well examined in the organizational safety literature, with positive safety climates associated with safe worker behaviors and reduced workplace injuries [Zohar and

Luria, 2005; Neal and Griffin, 2006]. Safety climate has also been shown to predict perceptions of risk, accidents, and injuries [Cooper and Phillips, 2004; Silva et al., 2004; Smith et al., 2006]; however, the influence of safety climate on risk perception appears to be influenced by the stability of the workgroup (including ongoing management involvement) and the work setting, with decreased stability associated with a disconnect between the risk perception and safety responses of the organization and those of the individual workers [Meliá et al., 2008].

Using qualitative methods of focus group discussions among logging supervisors and crew members, we sought to understand more about their perception of logging risk and their associated safe work practices, including safety climate and management, within logging work crews located in the southern U.S. Findings from these analyses are intended to inform a larger study involving the development, implementation, and evaluation of safe management practices among logging supervisors.

## MATERIALS AND METHODS

Focus group discussions (N = 6 discussions) were conducted among logging supervisors and crew members in Arkansas, Louisiana, and Texas. Owners, supervisors, foremen, and machine operators of local, independent logging companies were eligible for inclusion if they were 18 years of age or older and identified their primary occupation as being a logging contractor (i.e., logging company owner) or a logger (i.e., machine operator, foreman, or supervisor but not an owner).

The project team was assisted by an advisory board comprised of logging experts, which included logging company owners, leaders of timber investment management organizations, representatives from state timber producers and/or forestry associations, and faculty from university agricultural health and safety research centers and forestry extensions in the Ark-La-Tex region. This group of industry experts was assembled to help guide and facilitate all research activities and provided input on focus group development and administration. Identification and selection of advisory board members were made through existing logging safety research partnerships with the Southwest Center for Agricultural Health, Injury Prevention, and Education located in Tyler, Texas.

Study participants were recruited by one member of the advisory board from each state. Employing purposive sampling, recruiting advisory board members identified and contacted two to four timber company owners among those whose crews were working in close proximity to the focus group meeting sites in each of the three states. The company owners and senior level supervisors were invited to participate in a supervisors' focus group (hereafter, supervisors); the recruited supervisors' machine operators and foremen were invited to participate in a crew members' focus group (hereafter, crew members). Supervisors did not have to participate for their crew members to do so, and vice versa. All participants were provided with dinner prior to the discussion and a \$50 gift card incentive to participate.

Two separate focus group sessions (one for supervisors, one for crew members) were held at each of the three locations for a total of six focus group discussions. At each location, the crew member (n = 17) and supervisor (n = 10) focus groups were conducted simultaneously; each focus group discussion included two to seven participants. All focus groups took place in the evening, and a meal was provided upon participant arrival. Following the meal, participants were directed to separate rooms corresponding to their assigned group (i.e., supervisor focus group, crew member focus group), where they were provided with information on the session and the broader research project, followed by a question-and-answer period. Written informed consent was obtained, after which participants were asked to complete a brief sociodemographic survey. All sessions were conducted in English and attended by either two members of the research team, or one member of the research team and one member of the advisory board. Research team members conducting each focus group session were trained and experienced in leading such discussions.

Each focus group session consisted of an approximately 1 hr discussion that explored a modified set of the safety climate scales proposed in Kines et al. [2011], including: (i) management safety priority and ability; (ii) management safety empowerment; (iii) workers' safety commitment; (iv) workers' safety priority and risk non-acceptance; and (v) peer safety communication, learning, and trust in safety ability [Kines et al., 2011]. Focus group guiding questions were prepared in advance by the research team and included structured content probing questions centered on each topic area, which were used to clarify or expand on information provided by participants during the sessions. Separate focus group guides were constructed for the supervisor focus group sessions and the crew member focus group sessions; although the same topic areas were present in both focus group guides, the number of questions and their phrasing varied depending on whether participants were crew members or supervisors. Additional details on the safety climate scales utilized in this study and example questions selected from the focus group guides have been provided in Supplemental Table SI; interested researchers may obtain the complete focus group guides by contacting the corresponding author. At the end of each session, participants were asked to provide any additional comments related to any topic addressed during the session.

Focus group audio recordings were transcribed verbatim into text and loaded into NVivo qualitative analysis software (QSR International, Burlington, MA). An iterative process was used in analyzing the data, for which the focus group was the unit of analysis. First, we described the study sample in terms of sociodemographic and occupational characteristics according to job type (e.g., front line crew member/foreman, supervisor/owner) using frequencies and percentages or means and standard deviations (SD). Given the small sample, Fisher's exact tests and Kruskal–Wallis equality-of-populations rank tests were used to compare categorical covariate prevalence and continuous covariate means, respectively.

Open coding was conducted on the discussion text 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 and Lee, 2014]. New categories were created during open coding to capture as many nuances as possible. The initial frameworks for crew members and supervisors were created independently and varied considerably. Then, each initial framework was reviewed and its

codes refined and reduced in number by collapsing them together, as appropriate [Pope et al., 2000]. Remaining codes of the reduced lists were grouped together under primary headings to form two final coding frameworks (i.e., one for the supervisor focus groups, one for the crew member focus groups) [Burnard et al., 2008]. The final coding frameworks for both groups were compared to identify themes that cut across occupational categories and provided a robust assessment of the safety climate and safety motivation present across participants' work sites and job roles. Coding and code construction was initially performed by the two members of the research team who had led the focus groups; their codes were compared to assess consistency of the coded text as well as the application of the codes, discussed by the members of the research team until consensus was reached, and used to construct the initial coding framework. The research team worked collaboratively to develop the final coding frameworks, which were lower-level, descriptive codes specific to the supervisors and crew members, as well as the cross-cutting framework, which was a separate analysis that synthesized the data from both groups to provide conceptual organization and thematic coherence by identifying higher-level, more holistic codes.

## RESULTS

Table I presents descriptive statistics for the 27 individuals who participated in focus group sessions, by job category. Approximately two-thirds of participants, all of whom were male, were machine operators or foremen (63.0%), with owners and supervisors comprising the remaining respondents (37.0%). The average age of participants was 46.3 years (SD: 11.9 years). Approximately, three-fourths of respondents were white, non-Hispanic (77.8%), with the remainder being black, non-Hispanic (18.5%) or black, Hispanic (3.7%). Slightly more than one-third of participants reported educational attainment beyond high school (37.0%), while a relatively small proportion had not completed high school (7.4%). On average, respondents reported working in the logging industry for 23.4 years (SD: 11.4 years) and in their current job for 15.8 years (SD: 9.5 years). No statistically significant differences were seen across job categories.

The initial coding framework for the supervisor focus groups contained 33 codes, which were grouped into a final coding framework of nine codes. The same procedure was applied to the crew member focus groups, which yielded 35 initial codes and a final coding framework containing six codes. From the evaluation of these final coding frameworks, seven cross-cutting themes emerged: (i) perception of risk in the logging industry; (ii) workplace safety beliefs and worker trust; (iii) safety communication; (iv) the intersection between safety, productivity, and job security; (v) logging skill; (vi) worker hiring, training, integration, and tenure; and (vii) remaining risk factors. Differences among groups, both within and between sites, are noted.

### Perception of Risk in the Logging Industry

All participants agreed that working in logging posed a risk of physical injury. The risk of fatality was rarely mentioned, and those who did varied in their assessment of it, with some participants believing that "it's probably very rare that anybody down here across the south

gets killed” while others contended that “usually now, when there’s an accident, somebody gets killed.”

Some participants characterized the risks of logging as being unforeseeable and uncontrollable: “I think you go out there every day, and you wake up every morning and say, ‘God, I hope everything goes right.’ But it’s one of them deals that you just don’t know.” Other individuals characterized the risks of logging as equivalent to the risks of injury in any workplace: “It’s no different than any other industry. Accidents are going to happen, no matter how good your safety program is, no matter what you do.” A distinction was made between the risks of logging in the Pacific Northwest compared to logging in the Ark-La-Tex region. Participants indicated that, in the southern states, risks associated with logging have been significantly reduced over the years, primarily due to the mechanization of the industry.

Both supervisors and crew members held conflicting opinions on whether the risk of injury in logging could be completely eliminated. Although many indicated that logging was inherently dangerous, and its risks could not all be fully eliminated, some disagreed:

Supervisor 1: [W]hat I would say is when you’re dealing with the size of equipment that we have to deal with and what we’re producing – the timber, in general – there are so many variables. You can negate a large number of that, but the potential is always there.

Interviewer: So, do you think that there might be some risks in logging that you can’t avoid?

Supervisor 2: You can avoid all of it, I think.

Some participants believed that the elimination of risks could be accomplished but not without sacrificing productivity: “You could probably avoid them, but you wouldn’t be able to do your job productively, I would say. It’s pretty much a choice you’ve got to make.”

### **Workplace Safety Beliefs and Worker Trust**

All participants indicated that they valued their own and their co-workers’ safety. Among supervisors, safety was characterized as requiring the effort of all workers: “I think [safety]’s a group deal...of course, everybody has to do individual stuff, but you’ve got to help watch other things. It’s a team effort...Everything out there works as a team.” Crew members agreed that their co-workers, including their supervisors, valued each other’s safety. Work-related injury was widely identified as the worst possible outcome of a day’s work.

Supervisors stressed the high level of trust they had in their employees’ ability to work safely as well as the trust that their crew members had in each other. According to supervisors, workers valued the safety of their peers at least equally to their own and were actively engaged in safeguarding each other: “It’s kind of like the army, you know. I’m going to be here to protect this man, you know, worry about me later. Then that man’s going to be trying to protect me.” Supervisors went so far as to characterize their work crews as “a family,” a sentiment that was not expressed by crew members. In contrast to the supervisors, crew members differed in the degree to which they relied on each other to stay safe. They voiced a relatively wide range of opinions on how much trust they placed in the other

workers on the job site. Although most conveyed significant levels of trust in their co-workers, several participants suggested that they were actively on guard against peers' errors and oversights:

Crew member 1: Are you going to put your life in his hands? Watch your own back. Don't leave it up to the next man to follow the rules. You follow some and then still look out, but don't leave any room.

Crew member 2: But that still goes into that trust issue, though.

Crew member 1: It does, but you can trust somebody too much, especially—

Crew member 2: I've always been a firm believer that no man's better than his word.

Crew member 1: Well, that's true, but when you're [working] with a lot of different people every day...you don't know who you can trust and who you can't trust.

Crew member 2: I still feel better thinking I can trust that man I work with every day. We all do.

Crew member 3: You've got to, to an extent.

Crew member 1: Just don't turn your back on him.

### **Safety Communication**

Both the supervisors and crew members described a relatively fluid working environment in which all employees participated in providing each other with constant information on the work at hand via two-way radios, hand signals, machine signals, cell phones, and/or one-on-one conversations. Peer-to-peer feedback on unsafe practices was included in these communications: “[S]ay somebody is not doing something safe, they’ll call them out on the radio, you know, with everybody saying, ‘Hey, you know you’re not supposed to be doing that’.” Participants indicated that verbal feedback was only one method of communicating risk. Stopping their machines was portrayed as an appropriate method of highlighting and addressing a potentially dangerous situation, which would include speaking with the individual about the issue: “I’m going to stop what you’re doing, I’m going to stop what I’m doing, and we’re going to talk about it.” Crew members revealed that they preferred to speak to the individual directly rather than report the behavior to their supervisor: “You don’t throw your coworkers under a bus... You holler at them, get their attention, and they know what they’ve done by then. Man to man.” However, crew members conceded that there might be specific situations in which speaking directly with the supervisor was appropriate. Participants indicated that the recipients of safety-related feedback were generally quick to correct their behavior, but they also mentioned that individuals occasionally “get mad about it” or that a situation could “get bad enough where you actually have to get rude,” in which case, “if they don’t like it, they don’t have to come back.”

Crew members acknowledged their freedom to voice concerns about the job site to their supervisors. At least one individual indicated that he could share concerns with his supervisor and might go so far as to refuse to cut timber under certain circumstances:

When my boss buys timber on a mountain, I'm not going to button my lip up. If he buys timber on a mountain, and I go to cut it and roll my cutter off the side, that's a risk I take sometimes. But that's part of what I do for a living, so I accept that risk. And I go by my gut. If my gut feels funny, I won't do it. But if my gut feels all right and I slept good last night, I'll take it. I'll take the risk. It wouldn't be the first time – and it won't be the last time – I roll one over. (Crew member)

Although supervisors seemed to respect their crew members' choice not to cut on sites they deemed too dangerous, they indicated that they would assume the risk and cut the timber themselves: "A lot of times...you'll have to talk to your shear operator to see if he thinks it's safe enough to cut...And if he says no, then I'll get on it and do it." In a similar vein, crew members almost unanimously stated that they are involved in the setting up of the site initially as well as other on-site decisions involving safety issues: "We're always included in decision making, because usually what we're deciding on affects how we're working."

In contrast to the constant communication among workers on-site, participants reported that more organized safety-focused team meetings occurred relatively infrequently. Described as "these little tailgate meetings" held "maybe every three months, and sometimes sooner, sometimes further," safety meetings took place "out on the job" so that "the whole crew is there." Crew members speculated that safety meetings were held to meet insurance requirements, and some crew members stated that "we used to have safety meetings" but that they had not had them in some time. Supervisors stated that they typically held safety meetings when their crews were "moving into a new site" or "into an area that people might not be as familiar with" as well as a way to combat "the tendency to be a little complacent at times." The supervisors indicated that safety meetings seemed to be effective at improving awareness of safety issues, and crew members acknowledged that such meetings were helpful "to an extent" at "keep[ing] you on your toes." However, crew members also stated that the meetings did not present new material on safe work practices and were perceived as reducing the day's productivity, which could impact their income.

### **The Intersection Between Safety, Productivity, and Job Security**

Supervisors and crew members stated that safety was at least as important as productivity, if not more so, as safety was generally characterized as a prerequisite for productivity. Although both safety and productivity were identified as important, the supervisors stated that they would not sacrifice working safely to increase their productivity: "Production isn't everything." Supervisors stated that employees who demonstrated a lack of safety awareness typically were low performers, the combination of which put their jobs in jeopardy. Crew members recognized that poor performance and safety issues could lead to disciplinary action, but they indicated that acting in an unsafe manner would more quickly lead to termination than poor performance alone. As a result, crew members believed that they had been hired and retained with safety and productivity in mind:

Our supervisor picked us specifically and kept us specifically. He don't want nothing to happen to none of us, because they've all got good jobs, and they're making a good living with us. (Crew member)

Although the supervisors acknowledged that they would not tolerate individual behaviors that put themselves or their crews at risk, they differentiated between employees who were inadvertently acting unsafe while “trying to improve” themselves and those who were acting unsafe while “literally doing something to antagonize” their co-workers. They stated that the former might merit “spend[ing] more of your time with that employee if you think he's worth saving,” whereas the latter would probably be terminated.

### Logging Skill

Participants stated that an individual's skill as a logger was a key factor in working safely. Supervisors characterized logging skill as a raw material that was innate and unteachable: “You either got it or you don't is basically what it is, you know. And usually you can tell within the first week if somebody's going to make it or not.” Like supervisors, crew members believed that some people possessed a natural proclivity for operating logging equipment: “Either you've got it or you don't, pretty much.” However, one crew member suggested that logging ability might be acquired rather than innate: “When I started my job sixteen years ago, they said I didn't have it. I'm still here, and nobody else is. I've got it, apparently. I must have found it.”

### Worker Hiring, Training, Integration, and Tenure

Supervisors preferred to hire experienced machine operators rather than inexperienced ones. The ability to hire experienced workers was a sign of a better equipped, higher-functioning crew, while crews with weak leadership, safety issues, or outdated machinery could not be as selective in their hiring. Crew member job candidates were typically vetted by reputation prior to hiring, which increased the trust supervisors had in their new employees. This was possible because the supervisors indicated that, due to their small communities, they knew of virtually all of the loggers in the area by reputation, if not personally. A logger's reputation was an important part of the hiring process: “And then you know who to work [with] and not to work [with]. And who is going to stay and who is not going to stay. And especially, like he was saying, [which] ones you need to watch for that aren't safe.”

Crew members relied on on-the-job training to instruct workers new to logging on how to operate the machinery and individuals new to their crew on their crews' work practices; these were described as two distinct situations. Crew members often encouraged aspiring operators to watch others work for a while and then try to run the machinery themselves, which reflected how they had learned. The reliance on on-site, hands-on training was due, in part, to the absence of widely available formal training programs in logging. As a result, experience with the machines, or “seat time,” was identified as the best way to learn to be an operator:

Go learn it. Experience is the best thing, and I run a hundred different pieces of equipment, and I've not yet had to read a manual to do it. You just get on it and learn it. Get the feel for it. (Crew member)

Experienced operators hired onto existing crews were expected to begin working immediately. One participant described his first morning on a new crew as, “It was kind of like, ‘Get to work’.”

The supervisors indicated that once trust and skill were more fully developed, logging teams tended to stay together for years or even decades. Experience—whether in terms of individual experience or experience as part of a particular crew—was considered a critical factor in working safely. Supervisors characterized experience as contributing to a breadth of safety-promoting behaviors, from appropriately organizing the work site to keeping a safe distance from other workers.

### **Remaining Risk Factors**

Given this environment, participants identified three remaining risk factors as the most critical dangers in logging: (i) human error; (ii) worksite and work task issues; and (iii) trucking.

#### **Human error**

Participants cited errors due to carelessness, inattention, forgetfulness, or miscalculation of risk as not only significant safety risks but also one of the most difficult categories of risk to mitigate. Supervisors recognized the risk due to human error, and they tended to characterize it as residual risk that remained after other risks were reduced or eliminated: “[Y]ou can negate most of [the risk in logging], but it’s always going to come back to—ninety-nine percent of it is going to wind up being human error.” Like the supervisors, crew members identified human error as a primary risk factor for injury on the job; unlike supervisors, they tended to consider it almost entirely avoidable: “I’ve been climbing off that loader for sixteen, seventeen years now. If I decide to jump off it one day and sprain my ankle, that’s my fault, because I knew better. They put steps there for a reason.”

Crew members indicated that their jobs were repetitive, and this repetition put them at risk of injury due to complacency: “You’re going to get lazy, and you just don’t really pay attention. That’s when accidents happen.” Some crew members reported actively working to “keep it interesting” as a way of reducing the risk of injury: “Sometimes I’ll change up the way I’m cutting...just to keep it from being boring.” Supervisors also recognized the risk of complacency, particularly as a factor in under-estimating potential risks.

#### **Worksite and work task issues**

Being outside of the machines and “on the ground” at the work site was widely considered to be the riskiest location for workers: “Well, the way [the machines are] self-contained now, it’s pretty safe...unless you’re on the ground [which is] the dangerous place in the woods.” Machine repair and chain saw use were the two primary reasons given for being on the ground at the work site. Although machine repair was required on all sites, chain saw use seemed to be strongly influenced by work site location (as indicated by focus group location), for which there was evidence of significant variability. Whereas, the Arkansas- and Texas-based participants indicated that their machinery had replaced chain saws and, thus, they used chain saws “[v]ery, very little,” the Louisiana-based participants reported

that “[w]e crank one...at least once a day.” Other job task and work site-specific risk factors identified by crew members included increased pace of production, large crew sizes, adverse weather conditions, power lines, and uneven or elevated terrain.

## Trucking

Log truck drivers were believed to be at the greatest risk of injury on a logging site, to get injured more often, and to be more likely to suffer a fatality than any other crew member. Supervisors—and, more specifically, logging company owners—identified log trucking as “our biggest issue” as well as the source of their “biggest liability” and “biggest turnover”:

You haven’t heard us mention skidder accidents. You haven’t heard us mention cutting over the lines. You haven’t heard us mention—I don’t remember the last [chain] saw accident I had. But I think what you’re hearing from us is trucking—whether it’s truck accidents, or a truck driver falls and breaks a leg getting out of the truck. It’s those trucking accidents is what dominates us now. (Supervisor)

Some supervisors stated that the riskiest part of trucking was on the road, whereas others argued that on-site issues were more problematic. The on-site issues were characterized as shared across logging; this was in contrast to the risks on the road, which were believed to vary by a number of factors.

Like supervisors, crew members indicated that the most serious accidents on their cut sites involved “trucks—anything to do with a truck—trimming a truck, throwing your truck straps, pulling the truck out of the woods, and taking a truck down the blacktop.” Although crew members discussed the dangers of truckers and trucking, they tended to identify specific tasks of truckers on the site as increasing the risk of log truck-related injuries: “Most dangerous thing in the woods now, I would say...is when you load a truck and then go to strapping it down and pulling off the truck [from the work site onto the roadway].” Relatively few crew members mentioned the risks associated with log trucking on the road, and crew members, in general, did not raise issues around the safety of the truck drivers once they left the work site.

Given the risks and legal liability associated with log trucking, the majority of the participating owners indicated they no longer directly employed truck drivers on their crews. Instead, they contracted out trucking, often on a day-to-day basis, despite the fact that they suggested that having their own truck drivers was safer than hiring out trucking to unknown drivers. The contract logging truck drivers were portrayed by supervisors and crew members as lacking experience with log trucking, which differs from other types of over-the-road trucking because it includes off-road hauling and the transport of shifting, inconsistently shaped, and exposed cargo with a relatively low center of gravity:

How am I going to tell Mr. So-and-So how to run his trucking company, when he hires over-the-road drivers that never pulled a log in their life and sends them to my woods? They think they can drive a million miles across the interstate and then go in the woods and get a load of logs, [but] it’s a whole different ball game. (Crew member)

Drivers that had previously worked as loggers were considered superior to those who had not, but few supervisors or crew members reported working with truck drivers who were also experienced loggers.

## DISCUSSION

Logging in the Ark-La-Tex region is a complex, interactive occupation in which crew members perform demanding tasks using large machinery in close proximity to one another. Although the potential for catastrophic events is present, participants reported low incidence of injuries and a complete absence of fatalities over several years at their logging work sites, with the exception of log truck-related incidents. Participants characterized logging as a dangerous industry, although a substantial proportion of participants believed that (i) logging was no more dangerous than many other occupations; (ii) logging in the southern U.S.—including the Ark-La-Tex region—was safer than that of other regions of the U.S.; and (iii) the dangers of southern U.S. logging have been considerably reduced by increasing mechanization.

These findings suggest that our participants may be underestimating the occupational hazards associated with logging. Although substantial reductions in fatal injuries have been noted over the last decade among U.S. logging equipment operators on fully mechanized operations, a relatively consistent number of fatal injuries have been attributed to the use of specialty logging machinery (e.g., mechanical harvesters, skidders, log loaders) [United States Department of Labor, Bureau of Labor Statistics, 2015b]. Additionally, the number of non-fatal injuries incurred while performing equipment maintenance or operating chain saws has remained relatively steady among southern U.S. logging crews despite mechanization, with increasing injury severity [Nieuwenhuis and Lyons, 2002; Lefort et al., 2003; Roberts et al., 2005].

Our findings are consistent with previous studies demonstrating that workers' subjective appraisals of occupational risks may not accurately reflect the true nature of workplace hazards, including those in logging [Klen, 1997]. The underestimation of work-related risks by our sample may be due to participants' tendencies to minimize the risk of infrequent events, minimize the likelihood of negative experiences, in general (i.e., optimism bias), or inflate their perceived ability to exercise control over workplace hazards [Weinstein, 1984; Mearns et al., 1998; Weyman and Kelly, 1999; Cooper, 2003; Gucer et al., 2003; McCool et al., 2009]. Our participants unanimously expressed high levels of individual safety motivation (i.e., internal and external factors that encourage safety-promoting behaviors due to individual perceptions of value) [Al-Haadir et al., 2013]. However, there were notable differences in the levels of co-worker trust expressed by the supervisors compared to those of crew members. Supervisors indicated higher and more consistent levels of trust than did crew members, which may reflect the supervisors' authority to hire and retain those employed. Levels of trust have been identified as a modifying factor of individual safety performance, and distrust of co-workers (including supervisors, peers, and contractors) is a predictor of reduced safety performance [Conchie and Donald, 2006]. However, our participants expressing distrust in their co-workers indicated heightened alertness for and frequent correction of unsafe co-worker behaviors. This mindfulness, or "chronic unease,"

has been described as an attribute of safety culture targeted to reducing the influence of complacency [Parker et al., 2006; Fruhen et al., 2014]. In the context of our sample, chronic unease appears to have been used to mediate low levels of trust by minimizing individual variability in safety-related practices.

Previous studies have suggested that upper-level managers establish a framework for acceptable safety behavior, which is enacted as and revised through site-specific practices of co-workers [Zohar and Luria, 2004; Conchie and Donald, 2006]. In most of the logging organizations involved in this study (7/10% or 70%), however, the company owners worked alongside front-line crew members and performed a proportionate amount of work. In the remaining three organizations, owners and/or upper-level managers rotated across several work sites, and each work site had a dedicated supervisor who also acted as a front-line worker. Future research might focus on better understanding how levels of trust function in small workgroups in which owners and upper-level managers work alongside and perform equivalent tasks as front-line workers.

Unlike industrial settings, logging work sites are not permanent, which prevents the development and implementation of environmental controls and complicates the regulation and reinforcement of safety practices. Because logging job sites change frequently, crew members and supervisors have the ability to structure aspects of their work environment on a daily basis to enhance their safety. This degree of influence and autonomy provides a significant opportunity to introduce interventions that promote existing safety practices and introduce leadership practices that empower logging crew members and enhance the operation's safety culture [Farrand, 2011].

In contrast to the variability of the work sites, the logging crews described by this study's participants were highly experienced and stable, with dedicated three- or four-person teams and low rates of voluntary turnover. The combination of worker tenure and workgroup stability may have mitigated the risks of frequently changing work site locations and hazardous work tasks. Previous studies have demonstrated a significant correlation between years of experience and reduced accident rates, with years of logging experience highlighted as more influential than mechanization in reducing the risk of work-related injury [Shaffer and Milburn, 1999; Nieuwenhuis and Lyons, 2002; Lefort et al., 2003; Roberts et al., 2005]. Lack of familiarity of work-teams in other industries has been associated with increased work-related errors but not occupational injuries [Thomas and Petrilli, 2006; Weaver et al., 2015]; further study is necessary to determine what influence increased familiarity has on the safety-related behaviors and outcomes of logging crews.

Our findings should be interpreted bearing in mind this study's limitations. Although strategies were applied to improve study validity and rigor, the authors acknowledge that the small sample size and the use of purposive sampling limit the representativeness of the study population. The analytical strategy for these focus groups prioritized recurring themes, thereby focusing on points of convergence among participants, which may have overlooked less common individual experiences. Additionally, these participants represented high-reliability organizations (i.e., those that operate in hazardous conditions with below-average rates of adverse events [Reason, 2000]), and caution should be observed when generalizing

these findings to other logging companies in the Ark-La-Tex region or beyond. However, a significant strength of this study was the recruitment of participants from local logging communities. The loggers participating in these focus groups represented operations of varying sizes and complexities working in differing topographical areas of the Ark-La-Tex region.

To our knowledge, our study is the first to address safety management practices among logging crews in the southeastern U.S., an understudied working population. Logging cut crews present unique challenges related to the health and safety management of workers. Our findings reveal supervisor– and worker–worker dynamics which should be recognized and appreciated when developing safety management and leadership training materials for logging contractors. Findings from this focus group study will ground the development, implementation, and evaluation of safety management practices among logging supervisors in this region. Research and interventions focused on improving safety management and leadership among logging supervisors represent an important step in the promotion of a preventative health and safety culture among loggers.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table I.**

## Demographic and Occupational Characteristics of Focus Group Participants by Job Category

	All	Job category		P-value
	n = 27	Front-line crew member/foreman n = 17 (63.0%)	Supervisor/owner n = 10 (37.0%)	
Sex				1.000 <sup>a,b</sup>
Male	27 (100.0)	17 (100.0)	10 (100.0)	
Female	0 (0.0)	0 (0.0)	0 (0.0)	
Age (years)				0.900 <sup>c</sup>
Mean (standard deviation)	46.3 (11.9)	45.4 (12.4)	47.7 (11.5)	
Ethnoracial category				0.124 <sup>a</sup>
White, Non-Hispanic	21 (77.8)	11 (64.7)	10 (100.0)	
Black, Non-Hispanic	5 (18.5)	5 (29.4)	0 (0.0)	
Black, Hispanic	1 (3.7)	1 (5.9)	0 (0.0)	
Educational level (highest completed)				0.258 <sup>a</sup>
Did not complete high school	2 (7.4)	1 (6.3)	1 (10.0)	
High school diploma	14 (51.9)	11 (68.7)	3 (30.0)	
Some college/technical training	7 (25.9)	3 (18.7)	4 (40.0)	
Bachelor's degree	3 (11.1)	1 (6.3)	2 (20.0)	
Years in logging industry				0.138 <sup>c</sup>
Mean (standard deviation)	23.4 (11.4)	20.9 (11.2)	27.7 (11.1)	
Years in current job				0.379 <sup>c</sup>
Mean (standard deviation)	15.8 (9.5)	15.3 (11.2)	16.8 (5.3)	
Current work site				0.530 <sup>a</sup>
Arkansas	9 (33.3)	6 (35.3)	3 (30.0)	
Louisiana	11 (40.7)	8 (47.1)	3 (30.0)	
Texas	7 (25.9)	3 (17.7)	4 (40.0)	

<sup>a</sup>Fisher's exact test.

<sup>b</sup>The use of Fisher's exact test allowed for the calculation of P values equal to 1.00.

<sup>c</sup>Kruskal-Wallis equality-of-populations rank test.