



# Logging Fatalities in the United States by Region, Cause of Death, and Other Factors — 1980 through 1988

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Logging has been reported to be one of the most hazardous industries in the United States for fatal injury. However, most studies have been at the state level and did not look at the logging industry specifically, but identified the risk of this industry through comparisons of fatalities across all industries. National data on logging injuries have concentrated on nonfatal injuries, not fatal injuries. To learn more about fatal logging injuries, the National Institute for Occupational Safety and Health analyzed the National Traumatic Occupational Fatality surveillance system for demographic differences in logging fatalities occurring in the United States from 1980 through 1988. The results indicate that there are regional differences in logging fatality rates, with the highest fatality rates occurring in those regions of the country harvesting primarily hardwood sawtimber. No significant differences in fatality rates between African-American and white workers were found.

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## INTRODUCTION

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Previous research has shown that logging is a hazardous industry from both a nonfatal and fatal-injury perspective (Frazier & Coleman, 1983; Leigh, 1988; Paulozzi, 1987; U.S. Department of Health, Education, and Welfare, 1974; U.S. Department of Labor, 1984). Individual state studies of occupational groups based on total mortality have consistently shown statistically significant elevated Proportional Mortality Ratios (PMR) and

Standardized Mortality Ratios (SMR) for the logging industry and logging occupations with respect to unintentional deaths (Mace, 1986; Singleton & Beaumont, 1989; Commonwealth of Pennsylvania, 1987; Milham, 1983). However, no single study evaluated the fatal injury experience of the logging industry at a national level.

Therefore, the National Institute for Occupational Safety and Health (NIOSH), initiated an evaluation of its death certificate-based occupational fatality data to determine the causes of work-related death among non-managerial workers in the logging industry for the United States. The research goals were to define differences that may exist between logging fatalities due to cause of death, forest region, race, and other demographic characteristics.

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## DATA SOURCES AND METHODS

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Work-related logging fatalities for 1980 through 1988 were identified within the NIOSH National Traumatic Occupational Fatality (NTOF) surveillance system. The NTOF system is a census of all death certificates filed in the 52 Vital Statistics Reporting Units (all 50 states, the District of Columbia, and New York City) that involved victims 16 years of age or older who died from an external cause of death (International Classification of Disease 9th Edition [ICD-9], E800-E999) (World Health Organization [WHO], 1977) and had the injury at work item on the certificate marked as "yes." Further details on NTOF, including its advantages and limitations, may be found in Bell et al. (1990) and Jenkins et al. (1993).

Logging industry deaths included all cases that were coded to the Standard Industrial Classification (SIC) code 2411, "Logging Camps and Logging Contractors" (Executive Office of the President, 1987). The "usual" occupation of the victim, coded using the Bureau of the Census 1980 coding system (U.S. Department of Commerce, 1980), cause of death (ICD-9 E-code), age, state of death, sex, race, year of death, and injury description entries of each identified death certificate were maintained for analysis.

Employment figures for logging were obtained from the Bureau of the Census, County Business Patterns (CBP) State Files, for the years 1980 through 1988 (U.S. Department of Commerce, 1980-1988). The CBP counts only the nonmanagerial workforce, and excludes managers and self-employed workers. Therefore, logging deaths that occurred to victims coded as Executives, Administrators, and Managers (BOC Occupation Codes 003-037) were excluded from the analysis. The fatality rates calculated using the CBP are inflated to some extent because self-employed workers are not included in the CBP. It was assumed that any increase in the rates caused by this exclusion of self-employed workers would be of the same magnitude for all regional or cause of death comparisons, making the results presented here still valid.

Employment estimates for African-American workers were obtained from the Bureau of Labor Statistics (BLS) Employment

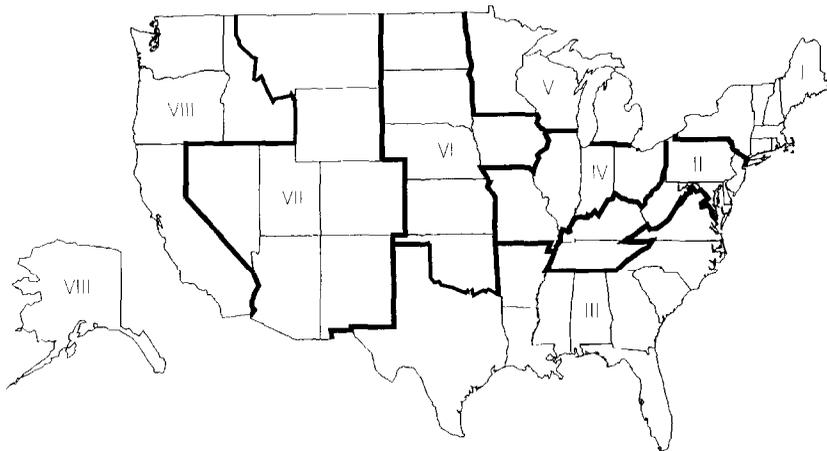
and Earnings data tables (U.S. Department of Labor, 1981-1989). Employment for the female workers were obtained from the BLS Employment, Earnings, and Hours data tables (U.S. Department of Labor, 1991). Finally, employment figures by occupation within the logging industry were obtained from the BLS National Industry-Occupation Employment Matrix (NIOEM), 1984 and 1995 Projections public use data files (U.S. Department of Labor, 1986). The calculation of fatality rates using the NIOEM were made possible by combining certain BOC occupational codes in the NTOF to match the BLS NIOEM occupation codes. For the purpose of calculating these rates, an assumption was made that the occupation-specific employment percentages provided by the 1984 NIOEM were the same as the occupation-specific employment percentages in the logging industry for the entire 9-year study period. Additional information on the CBP, Employment and Earnings, and NIOEM employment data can be found in Fosbroke and Myers (1992).

Comparisons by occupational groups were based on examining average annual fatality rates. African-Americans and whites were examined by calculating the risk ratios for African-Americans relative to whites (Last, 1988).

Both the NTOF and CBP data were classified into eight regional groups based on the dominant forest type in each state, as defined by the Society of American Foresters (1980; Figure 1). The State of Hawaii was excluded from the analysis because it represents a unique forest type not seen elsewhere in the United States and because no logging deaths were reported in the state for this 9-year period. Forest types were selected as the method of classification because of the differences in logging operations due to the types of trees being harvested (Barrett, 1980; U.S. Department of Agriculture, 1973). The annual fatality rates for the United States, cause of death classes, and the eight regions were then calculated for the 9-year period.

Statistical tests for differences between regions and cause of death categories were conducted using the nonparametric Kruskal-Wallis (K-W) test on the normalized rank scores (van der Waerden method) of annual fatality rates by specified classes (i.e., region

FIGURE 1  
FOREST REGIONS OF THE UNITED STATES



I	<b>Northeast</b>	III	<b>South</b>	V	<b>Lake States</b>	VII	<b>Mountains</b>
II	<b>East</b>	IV	<b>Central</b>	VI	<b>Plains</b>	VIII	<b>Pacific</b>

or cause of death) (Conover, 1980). Cause of death classes were defined by grouping specific ICD-9 E-codes using a scheme presented by Jenkins et al. (1993).

The use of the K-W test was selected because it required no distributional assumptions to be made about the fatality rates calculated by region or by cause of death. The use of normal scores for the K-W ranked data increases the power of the K-W test by providing a relative measure of scale to these ordinal data (Conover, 1980). Multiple comparisons, using Fisher's Least-Significant-Difference (LSD) test on the normal scores of the K-W test results, were made to identify statistical differences between individual regional or cause of death class members (Conover, 1980).

Finally, narrative injury descriptions of the death certificates were evaluated to gain a better evaluation of the most common causes of death. Subcategories were assigned within each specific cause of death class based on a subjective evaluation of the narrative descriptions by the authors.

## RESULTS

A total of 1,323 logging industry deaths were identified in the NTOF data files for the

9-year period, 1980 through 1988. Forty-five deaths coded as Executives, Managers, and Administrators were removed from the data, leaving 1,278 deaths for further analysis. Table 1 provides a breakdown of the characteristics of these nonmanagerial deaths. The largest number of fatalities and highest fatality rates were among males, whites (including hispanics), and workers in the combined occupation group of logging occupations/general laborers.

The relative risk for African-Americans relative to whites was 0.86 (141.1/164.4). However, an analysis of these rates using a K-W test found no significant difference in the normalized rank scores of African-American and white fatality rates. When the comparison was restricted to the South region, which accounts for nearly all African-American logging employment and logging-related fatalities, the relative risk for African-Americans relative to whites was 0.98, showing almost equal risk for the two groups.

Though rates could not be calculated by detailed BOC occupation codes, the majority of logging deaths (65.5%) occurred to workers classified as having logging occupations (e.g., fellers, limbers, buckers, choker setters), followed by truck drivers (11%), general laborers (7.5%), and material moving machine operators (5.5%). All

**TABLE 1**  
**FREQUENCIES AND FATALITY RATES PER 100,000 NON-MANAGERIAL WORKERS IN THE LOGGING**  
**INDUSTRY BY SELECTED DEMOGRAPHIC CHARACTERISTICS: 1980-1988**

Demographic Characteristic	Deaths 1980-1988	Fatality Rate, 1980-1988
<b>Gender</b>		
Male .....	1275	172.8
Female .....	3	5.4
<b>Race</b>		
White .....	1067	164.4
African-American .....	211	141.1
<b>Occupation*</b>		
Logging and General Laborers .....	943	371.8
Transportation Operatives .....	144	118.7
Non-Managerial Supervisors .....	33	89.1
Machinery Operatives .....	115	48.5
Mechanic and Repair Occupations .....	11	29.3
All Other Occupations .....	32	31.0
Total Non-Managerial Workers .....	1278	161.8

\* The following 1980 Bureau of the Census Occupation Codes were used to define occupational groups: Logging and general labor= 496, 873-889; Transportation operatives= 804-834; Non-managerial supervisors= 243, 303-307, 494, 503, 553-558, 663, 803, 863; Machinery operatives= 703-799, 843-859; Mechanic and repair occupations= 504-549; All other occupation= all remaining BOC occupations excluding 003-037.

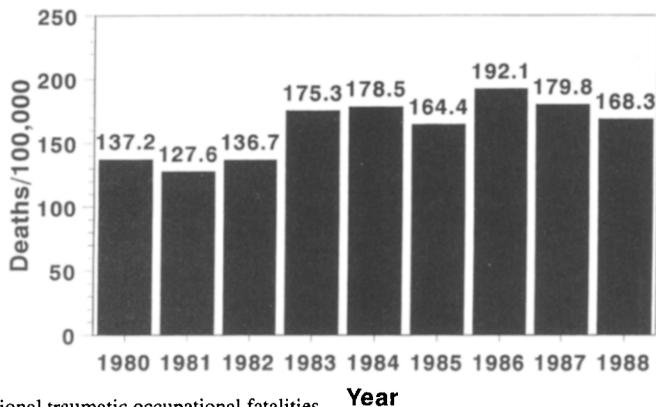
remaining detailed occupations accounted for only 10% of the nonmanagerial worker logging deaths.

Figure 2 provides the annual U.S. logging industry fatality rates for 1980 through 1988. Employment of nonmanagerial workers in the logging industry ranged from 80,497 to 98,381 workers during this 9-year period, with an average annual employment of 87,738 workers. The 9-year average annual fatality rate was 161.8 deaths per 100,000 workers, with an average of 142 nonmanage-

rial worker deaths annually. There were no significant trends found in these rates over the 9-year period.

There were significant differences between the rank scores of fatality rates by forest region ( $F_{7,64} = 7.46$ ;  $Pr F = 0.0001$ ). Table 2 presents the multiple comparison results between forest regions. The vertical lines shown under the "Multiple Comparison" heading indicate regions where the average rank scores were not significantly different (i.e., the difference between the two average

**FIGURE 2**  
**ANNUAL U.S. DEATH RATES\* FOR NON-MANAGERIAL WORKERS IN THE LOGGING INDUSTRY**



\* Numerator: national traumatic occupational fatalities,  
 Denominator: county business patterns — state files.

rank scores was less than the LSD value of 0.7029). The highest ranked fatality rates occurred in the Central and East regions, although the multiple comparison indicates that the average score for the East region was not significantly different from the average score for the Mountain region. The lowest fatality rates were found in the Lake States and the Northeast, although their average scores were not significantly different from that for the South region.

A significant difference in the rank scores of fatality rates by cause of death groups was found ( $F_{17,144} = 29.8$ ;  $Pr F = 0.0001$ ). The multiple comparison results (Table 3) showed that the highest ranked fatality rate in the logging industry was associated with being struck by a falling object. This was followed by three groups that were not found to be significantly different from each other (motor-vehicle incidents, machinery incidents, and being caught in, under, or between objects). These four causes of death accounted for approximately 87% of all nonmanagerial worker deaths. Causes of death that showed moderate importance were environmental causes, falls, and electrocutions. There was a large degree of overlap within the multiple comparisons for average annual fatality rates under 4 deaths per 100,000 workers.

The evaluation of the narrative injury descriptions for the leading causes of death provided a better determination of the types of events common in logging fatalities. Deaths due to falling objects were primarily related to felled trees (431 of 636 deaths), followed by

falling logs (102 deaths), and limbs and snags (77 deaths). The remaining 26 deaths involved other falling objects. For the 102 deaths due to falling logs, 51 were related to the loading or unloading of logging trucks.

Motor-vehicle deaths primarily involved logging trucks (65.6%) and were traffic-related (152 of 183 deaths). The most frequent victim was the driver of the motor vehicle (84 deaths) for traffic-related events. Nontraffic motor-vehicle incidents (i.e. off public roadways) differed from traffic incidents in that pedestrians were the most common victims (13 of 31 deaths). For both traffic and nontraffic incidents, a large proportion of the victims were unspecified as to whether they were drivers, passengers, or pedestrians (73 of 183 deaths).

Machinery deaths were more varied than the other leading causes of death. The most common incidents involving equipment rollovers (76 of 185 deaths), being run over by equipment (29 deaths), being caught between pieces of equipment (19 deaths), and deaths related to cable breaks (14 deaths). Finally, deaths due to being caught in, under, or between objects mainly involved rolling logs (68 of 114 deaths) and trees (15 deaths).

## DISCUSSION

Certain aspects of the risk of fatal injury in the logging industry are evident. First, the risk of fatal injury did not change greatly during this 9-year time period. Each annual rate was in excess of 100 deaths per 100,000 workers,

TABLE 2  
MULTIPLE COMPARISON RESULTS OF DIFFERENCES BETWEEN NORMALIZED RANK SCORES OF  
NON-MANAGERIAL WORKER FATALITY RATES\* IN THE LOGGING INDUSTRY BY REGION: 1980-1988

Region	Multiple Comparison**	Average Normal Score	Average Annual Rate/100,000
Central		1.05	394.3
East		0.70	338.8
Mountain		0.34	254.4
Pacific		-0.03	166.8
Plains		-0.05	188.7
South		-0.32	143.2
Northeast		-0.80	98.6
Lake States		-0.88	87.0

\* Numerator: National Traumatic Occupational Fatalities Denominator: County Business Patterns—State Files

\*\* alpha= 0.05, df=64, LSD=0.7029. Vertical bars denote regions with no significant differences in average normal scores.

**TABLE 3**  
**MULTIPLE COMPARISON RESULTS OF DIFFERENCES BETWEEN NORMALIZED RANK SCORES OF**  
**NON-MANAGERIAL WORKER FATALITY RATES\* IN THE LOGGING INDUSTRY BY CAUSE OF DEATH:**  
**1980-1988**

Cause of Death	Multiple Comparison**	Average Normal Score	Average Annual Rate/100,000
Falling Objects		1.93	80.6
Motor Vehicles		1.21	23.1
Machinery		1.20	23.5
Caught In/between		0.88	14.4
Environmental		0.48	4.9
Falls		0.20	3.2
Other Causes		0.11	3.4
Electrocution		-0.06	2.1
Homicide		-0.30	0.8
Unknown Cause		-0.30	2.1
Air Transport		-0.48	0.8
Explosions		-0.54	0.6
Fires		-0.59	0.8
Suicides		-0.68	0.5
Drowning		-0.69	0.3
Suffocation		-0.76	0.3
Rail Transport		-0.82	0.3
Water Transport		-0.82	0.2

\* Numerator: National Traumatic Occupational Fatalities Denominator: County Business Patterns—State Files

\*\* alpha=0.05, df=144, LSD=0.4238. Vertical bars denote causes of death with no significant differences in average normal scores.

a rate that far exceeds the national average of 7 deaths per 100,000 workers for a similar time period (Jenkins et al., 1993).

There is also evidence that this risk has remained relatively high for a long period of time. Statistics from 1955 for the logging industry estimated the annual fatality rate in that year to be 214 deaths per 100,000 full-time workers, and the lost workday injury rate to be 16 injuries per 100 full-time workers (McCormack, 1963). The statistics for the logging industry 33 years later, in 1988, showed a fatality rate of 168 deaths per 100,000 workers (Figure 2) and a lost workday injury rate of 13 injuries per 100 full-time workers (U.S. Department of Labor, 1990). There is no evidence that the risk of fatal or nonfatal injury has decreased appreciably in the logging industry at the national level for more than three decades.

Race is not related to the risk of fatal injury in the logging industry. The risk ratio of 0.86 for African-Americans relative to whites indicates that African-Americans working in the logging industry were not at any higher risk of dying on the job than their white counterparts. This finding differs from race-specific comparisons for other industries, or specific causes

of death, which have shown African-Americans having higher occupational fatality risks compared to whites (Bell, 1991; Jenkins et al., 1993; Myers, 1989).

The identification of loggers and general laborers as the combined occupation group with the highest fatality rate was not surprising, and agrees with previous studies from various states (Mace, 1986; Singleton & Beaumont, 1989; Commonwealth of Pennsylvania, 1987; Milham, 1983; Paulozzi, 1987). The high fatality rate for transportation operatives, primarily heavy truck drivers, is partially related to the high proportion of motor-vehicle deaths associated with the logging industry. A total of 85 of the 141 truck driver deaths involved motor-vehicle incidents (71 deaths per 100,000 truck drivers). The remaining occupational groups have higher observed fatality rates than the general private sector workforce fatality rate of 7 deaths per 100,000 workers during a similar time period (Jenkins et al., 1993), but are still well below the rates experienced by loggers, general laborers, and transportation operatives.

Being struck by falling objects is the most common cause of death in the logging industry, accounting for approximately 50% of these

logging deaths. Felled trees were the most common object involved, accounting for 68% of the struck by falling object deaths. While it was not possible to identify the exact circumstances surrounding the fatalities reported in NTOF, previous research on 65 logging deaths investigated by OSHA related to the felling of trees indicated that the worker at most risk is the feller of the tree (83%; Peters, 1991).

No forest region examined in this study had a logging fatality rate that could be considered acceptable from a public health standpoint. Still, the regional results found in this study raise a question about why logging in different parts of the United States should have such widely different risks for fatal injury. Variations in logging practices and environmental conditions between these regions may provide some insight, but cannot be examined with the limited information provided by death certificate data used in this study.

A comparison of the differences that exist between the various forest regions, which might be considered in future research, follow for those regions with the highest (Central and East) and lowest (Lake States and Northeast) logging fatality rates. Table 4 provides a more complete list of these possible factors.

The two regions with the highest fatality rates, the Central and East, are areas where the primary type of logging is hardwood sawtimber. Hardwood logging operations are usually two- to three-man businesses, logging on properties owned by private individuals, with the operators usually having no formal safety and health program. The hardwood forests are naturally occurring, with little or no forest management practices applied to them. The

trees to be cut typically weigh in excess of one-half ton (U.S. Department of Agriculture, 1984). In many stands, the terrain is sloped and rough. The type of harvesting employed is usually diameter-limit partial cuts (i.e., only trees above a certain diameter are harvested) or single-tree selection methods using chainsaws to fell trees. Previous research suggests that these conditions, and other factors such as the shape of the trees being felled, may increase the risk for fatal logging injuries in hardwood logging operations (Peters, 1991; Gaskin, 1989). Significantly higher fatality rates for hardwood logging regions are supported by this study.

The regions with the lowest fatality rates, the Lake States and the Northeast, have some similar characteristics to the East and Central regions in that logging involves small operations and occurs on rough slopes, especially in the Northeast. However, in the Lake States and the Northeast, there is a major conifer and hardwood pulpwood market that does not exist in the Central and East regions. The size and weight of the trees being harvested is less than that typically seen in the Central and East regions. The methods of harvesting pulpwood using clear-cutting are more mechanized than those used for harvesting sawtimber, reducing the workers' exposure to the task of felling trees with a chainsaw. Finally, logging in the Lake States and Northeast is associated with large wood product industries that provide a more stable market for timber, possibly increasing the experience level of the workers in these two regions.

Existing regulations may also influence regional logging fatality rates. The Occupational

TABLE 4  
POSSIBLE FACTORS INFLUENCING THE RISK OF FATAL OCCUPATIONAL INJURIES  
IN THE U.S. LOGGING INDUSTRY

Potentially Lower Fatality Risk	Potentially Higher Fatality Risk
<ul style="list-style-type: none"> <li>Softwood harvesting</li> <li>Pulpwood harvesting</li> <li>Clearcut harvesting</li> <li>Plantation stands</li> <li>Mechanized harvesting</li> <li>Steady wood markets</li> <li>Level terrain</li> <li>Corporate operation</li> <li>Managed forest stands</li> <li>Logging safety regulated</li> </ul>	<ul style="list-style-type: none"> <li>Hardwood harvesting</li> <li>Sawtimber harvesting</li> <li>Selective harvesting</li> <li>Natural stands</li> <li>Traditional harvesting</li> <li>Cyclical wood markets</li> <li>Steep terrain</li> <li>Small business operation</li> <li>Unmanaged forest stands</li> <li>Logging safety unregulated</li> </ul>

Safety and Health Administration (OSHA) adopted the American National Standards Institute's (ANSI) Safety Requirements for Pulpwood Logging as a consensus standard in 1971 (ANSI, 1971; U.S. Department of Labor, 1988). The resulting regulation did not extend to other types of logging operations. The ANSI and OSHA regulations may have a greater influence in improving worker safety in regions of the country where the timber industry has a strong pulpwood base. Pulpwood regions, such as the South, Northeast and Lake States, do have lower fatality rates, but the impact of these standards has not been evaluated.

Six states (California, Oregon, Washington, Alaska, Michigan, and Hawaii) developed their own logging standards during the 1970s, which were more detailed than the Federal OSHA regulations (U.S. Department of Labor, 1989). Four of these states (California, Oregon, Washington, and Alaska) are located in the Pacific region as defined in this paper. This region had a lower fatality rate than the East, Central, and Mountain regions, which lack similar state regulations.

In 1976, NIOSH published a criteria document, "Recommendations for an Occupational Standard for Logging from Felling to First Haul," which applied to all logging operations (U.S. Department of Health, Education, and Welfare, 1976). In 1989, OSHA proposed extending the federal pulpwood regulations to all logging operations, incorporating many of the provisions in the NIOSH criteria document and the state logging regulations from the western states (U.S. Department of Labor, 1989). The proposed rules include sections related to training, first aid, chainsaw and equipment operation, personal protective equipment, protective systems on equipment, felling, bucking, limbing, loading and unloading logs, and transportation. These provisions of the proposed OSHA standard address many of the potential hazards discussed in this paper.

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## SUMMARY

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The results presented in this paper suggest that regional differences in logging fatalities may be associated with regional differences in

timber type and logging operations. The failure to achieve a large reduction in fatality and injury rates for logging over the past three decades may reflect a lack of consideration of these differences, as well as the lack of standards to address the many work-related hazards faced by these workers. If properly implemented, the new OSHA logging regulations may result in a decrease in the fatality rates described here.

There is a need for better epidemiologic studies of the risk factors associated with logging-related deaths. Research efforts are needed to better understand the reasons for the significant differences found here for fatality rates by logging regions, including the list of possible factors suggested in Table 4. Future prevention, intervention, and regulatory efforts need to address these regional differences if significant reductions in fatalities are to be realized.

Other areas of research that are needed to reduce the fatality rate in the logging industry include evaluating the effectiveness of present logging standards for worker safety and health, and the effectiveness of training programs, including hazard recognition for workers. Research is needed to identify the best methods to regulate the logging industry, the best methods for conducting training for workers, and for determining the impact of poor logging techniques on logging injuries. Finally, the differences in worker risk between small and large logging operations need to be better defined.

Safe logging (as in any industry) is a combination of proper technique and hazard recognition (Peters, 1991). It is clear from these NTOF data that logging is hazardous regardless of the forest region that it occurs. More needs to be done in promoting proper technique and hazard recognition if logging is to cease being one of the most dangerous industries in the United States.

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