FOREST MANAGEMENT PRACTICES AND THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION LOGGING STANDARD

John R. Myers, M.S.F. and David Elton Fosbroke, M.S.F.[1]

Abstract: The Occupational Safety and Health Administration (OSHA) has established safety and health regulations for the logging industry. These new regulations move beyond the prior OSHA pulpwood harvesting standard by including sawtimber harvesting operations. Because logging is a major tool used by forest managers to meet silvicultural goals, managers must be aware of what the OSHA standard would mean to them. Many aspects of the new standard pertain to the training of logging employees, safe equipment operation, and safe harvesting techniques, but there are sections of the OSHA standard that impact forest management practices, especially for hardwood forests, in much the same way as environmental regulations. There is the potential for forest management practices to influence the safety of logging operations by considering how the stand will be harvested when selecting silvicultural treatments for a stand. Forest managers will also be responsible for balancing conflicts between environmental issues and OSHA regulations, such as the removal of hazardous trees from a stand, the placement of skid trails, or where logging is initiated in a stand. These and other issues are discussed to give forest managers a better appreciation of their role in making logging a safer industry.

INTRODUCTION

Logging is one of the most flexible tools available to the forest manager to meet the silvicultural, biological diversification, economic, and recreational goals developed for a forest stand. In reviewing such classical forestry texts as "The Practice of Silviculture" (Smith 1962) and "Regional Silviculture of the United States" (Barrett 1980), the majority of the topics directly, or indirectly involve harvesting methods that can be applied to a forest stand and the expected future results that these harvesting methods will produce in the forest stand. The use of silvicultural systems and logging to promote wildlife habitats is also a common practice (Yoakum and Dasmann 1969), as well as the use of specific silvicultural treatments and logging to enhance recreational uses of forest stands (Knudson 1980). Thus, natural resource management, especially silviculture, is highly dependent on logging.

Given this close relationship between forest management and logging, forest managers must be aware of what regulations impact the logging industry. Environmental regulations and public concerns on environmental issues related to logging are now commonly included in the decisions a forest manager makes in practicing silviculture in any forest stand (Cubbage et al. 1993). A new issue, which until recently has not been a concern for forest managers in the central hardwood region, is worker safety in the logging industry. This will assume more significance with the final promulgation of the Occupational Safety and Health Administration's (OSHA) Logging Operations Standard (U.S. Department of Labor 1989).

As with any new set of regulations, forest managers will need to know and understand the OSHA logging standards and how these regulations impact upon their management decisions. Equally important, forest managers should consider and assess how their management decisions impact upon logging safety.

[1]Mathematical Statistician and Health Statistician, National Institute for Occupational Safety and Health, Division of Safety Research, 1095 Willowdale Road, Morgantown, WV 26505.

THE OSHA LOGGING OPERATIONS STANDARD

Background

Logging is one of the most hazardous industries in the United States from both a fatal and nonfatal injury perspective (U.S. Department of Labor 1984, Paulozzi 1987, Leigh 1988, Myers and Fosbroke 1994). In 1989, the logging industry had a work-related fatality rate of 193 deaths per 100,000 workers (U.S. Department of Health and Human Services 1994), a rate more than 34 times higher than the total private sector fatality rate of 5.6 deaths per 100,000 workers (Jenkins et al. 1993). The greatest risk for fatal injuries in the logging industry were in those regions that were associated predominantly with hardwood sawtimber harvesting (e.g., Central Hardwood and Eastern Mixed-Hardwood regions), with fatality rates of over 300 deaths per 100,000 workers (Myers and Fosbroke 1994). In 1989, the logging industry had an estimated injury rate of 19.2 work-related injuries per 100 full-time workers compared to a general private sector rate of 8.2 work-related injuries per 100 full-time workers (U.S. Department of Labor 1991). Data suggest that these fatal and nonfatal injury rates have remained well above the national average for more than 30 years (McCormack 1963, Myers and Fosbroke 1994).

Based on these types of injury statistics, OSHA acted in 1989 to address the major occupational hazards associated with logging through a new proposed standard specific to the logging industry. Prior to this proposed rule, OSHA maintained a standard which was only applicable to pulpwood logging (U.S. Department of Labor 1988a). The 1989 proposed rule, which replaces the pulpwood standard, covers the entire logging industry, including sawtimber operations. The final OSHA logging standard was signed on October 4, 1994, with an effective date of January, 1995.

Impact On The Logging Industry

Unlike the prior pulpwood standard, the OSHA logging standard covers both pulpwood and sawtimber harvesting operations. As such, the standard impacts mostly those parts of the country which do not harvest large quantities of pulpwood and do not have existing state-specific regulations on worker safety and health for sawtimber logging operations. In general, logging operators in the eastern hardwoods, central hardwoods, and mountain regions of the United States are for the first time required to plan for and meet worker safety and health standards set by OSHA. Logging operators in the South and Lake States that harvest primarily pulpwood will see less of an impact on their operations because of their compliance with the prior OSHA pulpwood standard, while those engaged with sawtimber harvesting will be affected. Logging operators in the Pacific Northwest will see little impact because of existing state regulations that cover sawtimber harvesting. The main focus here is on the probable impacts the OSHA standard has on hardwood sawtimber operations that primarily use manual felling with log skidders as the timber harvesting method.

The OSHA logging standard contains four areas: Training; general requirements; equipment protective devices; and tree harvesting. The intent of these sections is to provide, as much as possible, performance requirements for employers to reduce the risk of work injuries. A performance requirement is one that states the objective of a rule, but allows employers broad latitude in how they meet the objective (U.S. Department of Labor 1989). Specification requirements, a rule which sets forth a specific requirement that employers must adhere to, also exist in the standard.

The new OSHA standard requires employers to be more responsive to the training of their employees for the specific tasks they are to perform, including providing them with sufficient knowledge to identify and avoid hazardous conditions on the logging site. The new standard requires employers to maintain the proper maintenance of tools and equipment used on the logging site, and requires a greater use of safety devices on such equipment as skidders and yarders to protect the operator and other workers. The standard also requires the employer to be more conscious of work assignments and work activities to prevent bystanders from being exposed to hazards related to felling trees or rolling logs on the logging site.

These general changes may require hardwood sawtimber logging operations to be modified, not only in how employers prepare their employees and equipment to do the logging job, but also in how the logging operation is laid out and conducted. Such methods as having the bucking crew and skidder crew located within the same area where trees are actively being felled is not be permitted under the OSHA standard. The location of skid trails and landings may have to be modified in such a way as to reduce the exposure of skidder operators or workers in the landing area from hazards caused by tree felling.

Impact On Forest Management

While the OSHA logging standards are the primary responsibility of the employer, forest managers need to understand these standards to reduce, as much as possible, conflicts between management objectives and logging safety requirements. The impact of the new OSHA regulations could result in changing the requirements of a hardwood logging job to the extent that forest management decisions may need to be modified to facilitate the logging of a stand in accordance with safety regulations. Being aware of the OSHA requirements before finalizing the marking and layout of a logging operation can avoid such potential conflicts.

Some aspects of the OSHA regulations that forest managers should consider are:

Snags. One specific provision of the standard for hazard abatement requires the identification and removal of hazardous dead, broken, or rotted trees or limbs from the area before felling marked trees. If the hazardous tree, or limb, is not removed, then it must be avoided. No work can occur in the hazard area around the hazardous tree or limb except to make the area safe. In the case of hazardous trees, since the concern by OSHA is that the tree may fall unexpectedly into a work area, the hazard zone defined by the hazardous tree would be expected to be the same as that for a tree which is being manually felled--two tree-lengths around the hazardous tree (Figure 1). Table 1 provides some examples of the acreage associated with the hazard zone from hazardous trees left in the stand.

Table 1. Acreage* for a hazard zone associated with hazardous trees in a stand of timber.

Height of Hazardous Tree (feet)	Acreage of Hazard Zone
50	0.72
60	1.04
70	1.41
80	1.85
90	2.34
100	2.88

* Acreage=[π {2 (Height of Tree in Feet)}^{2}]/ 43,560

Forest managers who intend to leave snags, or other poor quality trees, for the purpose of wildlife habitat should determine if the tree will pose a hazard to a feller. If so, the manager should adjust the marking of timber to ensure that the hazardous tree will not be within two tree-lengths of any marked tree, or mark the hazardous tree for removal and select an alternative, nonhazardous tree for wildlife purposes. The manager should also consider the placement of skid trails, landings, or other similar work areas to ensure they are all two tree-lengths away from the hazardous trees. Managers may also consider flagging the area around hazardous trees to ensure that loggers working in the stand are aware of the hazard.

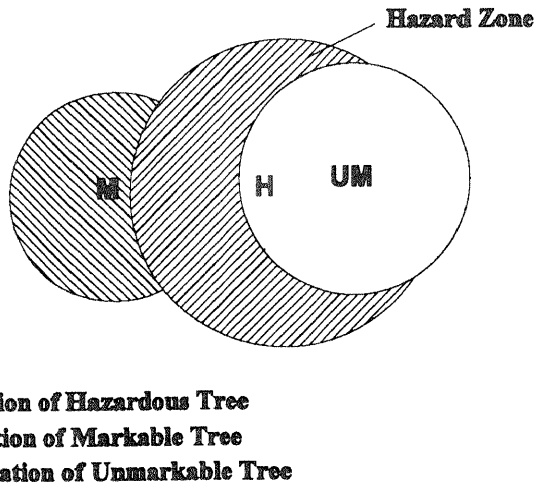

Figure 1. Diagram of the OSHA "Two Tree-Length" Rule and its impact on marking trees.

Skid Trails and Roads. The requirements for road construction are not included in the OSHA logging standard because they are covered under the OSHA Construction Standard (U.S. Department of Labor 1988b). The placement of skid trails, however, are affected by the standard. The placement and construction of trails are not permitted to exceed the stability limitations of the machine.

The standards would require the forest manager to give more consideration to the placement of skid trails such that they do not involve crossing steep grades, which are common in hardwood stands. Where such grades are unavoidable, other options may need to be considered for the moving of logs, such as cutting roads to reduce the grade. At the same time, the manager would need to make decisions during the layout of the trails on whether to remove hazardous trees (which if left standing, might meet management goals for wildlife habitat) to allow for the placement of skid trails on acceptable grades, or whether to relocate skid trails in less acceptable areas to retain specific hazardous trees.

Locating trails to meet safety considerations also has the potential to conflict with trail locations that would meet environmental considerations, especially with respect to the crossing of streams, or other sensitive areas in the stand. The running of skid trails perpendicular up steep slopes, which may be feasible without exceeding the stability limitations of a skidder, is a limited option due to current environmental regulations that, in many instances, restrict or ban such trail locations because of the environmental concerns. Thus, the objective of reducing as much as possible the running of skidders on steep slopes is a recommended practice from both a safety and environmental standpoint. However, the use of the most level terrain for the placement of skid trails from a safety perspective, may conflict with buffer zone locations, or require the crossing of streams that would be unacceptable from an environmental perspective.

Location of Landings or Yards. One provision of the OSHA standard is the requirement that work ongoing in a stand be spaced such that fellers actively felling trees be at least two tree-lengths away from other logging activities such as bucking, limbing, skidding, yarding, or landing activities. This requirement, while not necessarily impacting the placement of landings and yards, would require the recognition of where the landings and yards are located with respect to ongoing felling activities. The forest manager must decide during the marking of the stand on whether to refrain from marking any tree within two tree-lengths of the

proposed landing or yard, or whether to mark timber in this area knowing that no landing or yarding activities would be permitted while those trees are felled. The location of hazardous trees within two tree-lengths of the landing or yarding area must also be resolved, as stated previously.

Sequence of Harvesting. The OSHA standard requires that harvesting of the stand be conducted such that the manual felling be conducted up-slope of, or on the same level as, previously felled trees (Figure 2). The standard would, from a practical standpoint, encourage the logging operation to proceed from the bottom of the slope to the top of the slope. In many instances, skid trails would need to be constructed prior to initiating logging, especially if the landing areas and access roads for the logging job are located at the top of the slope. If the access roads are located at the bottom of the slope, skid trails would require constant maintenance to remove slash because the skid trails would go through previously timbered areas. Concerns for soil erosion and run-off from the logging site also need to be considered. This may require planning for the placement and maintenance of water bars, or other soil stabilization techniques, during the logging operation rather than at the end of the operation to reduce erosion. Initiating logging at the top of the slope and using the lower slope as a buffer zone during the logging operation is still feasible, but would require logging to be conducted laterally, and would not allow for felling trees up-slope into previously logged areas.

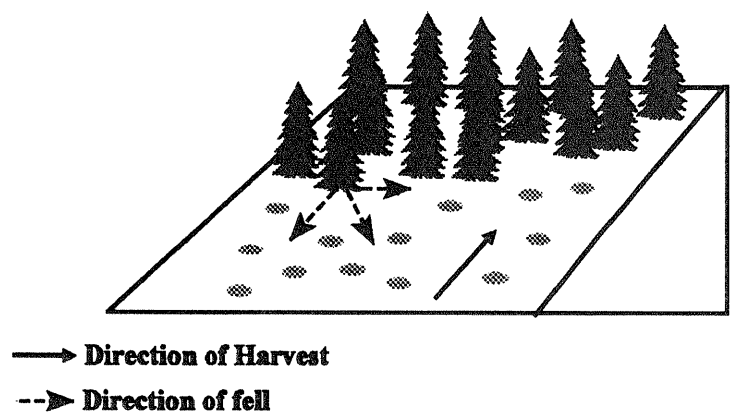

Figure 2. OSHA requirement for felling trees on sloped terrain.

The issues presented here are not all-inclusive of the potential impact the OSHA logging standard may have on a forest manager. They reflect the more obvious issues forest managers dealing with hardwood stands will need to consider when planning a harvest.

The forest manager should also consider that more time may need to be allotted to complete some logging jobs. Time requirements will be affected by such factors as: The type of harvest proposed for the stand; the temporary suspension of work due to felling occurring within two tree-lengths of other activities; the requirement that fellers not be located within two tree-lengths of each other while felling trees; the required suspension of logging operations due to hazardous weather; the suspension of work in an area until a hazardous tree, or other hazardous condition has been

removed; the requirement that hung-up trees be removed by the use of skidders, or other similar mechanical system that isolates the worker from the hung-up tree; and the requirement that trees felled on slopes be blocked prior to limbing or bucking if they cannot be limbed and bucked from the up-hill side of the tree. Failure by the forest manager to consider these new work requirements for the logging crew when determining the amount of time needed to safely log a stand of timber could result in poor time estimates. Taking such factors into account will prevent unnecessary conflicts with the logging operator over how quickly the logging job is being conducted.

The new OSHA standard may also create a new level of responsibility for the forest manager. With the adoption of the logging standard by OSHA, the standard has become a common industry practice and establishes a standard of care for third party, non-direct employers (Smith 1991). The forest manager may not cause a logging operator to knowingly violate the OSHA standard, which could be a consequence of the manner in which the forest manager marks the timber and lays out skid trails, landings, and other aspects of the harvest. If a forest manager knowingly sets forth requirements in violation of the OSHA standard, the forest manager may be found to be a liable party under third-party tort law for any injury, fatality, or property loss that is incurred by the logging operator, or worker, because of that requirement. Furthermore, OSHA is considering a requirement in construction that would place responsibility upon primary contractors for maintaining injury and illness records for all employees working on a work site, including subcontractors (Newell 1994). This precedent of making primary contractors accountable for injuries of subcontract employees could extend to other industries, including logging. Thus, while not directly responsible for ensuring that a logging operation is conducted in compliance with the OSHA logging standard, forest managers are indirectly responsible because they are the individuals planning and stating the conditions under which the logging operations will be conducted.

FOREST MANAGER'S IMPACT ON LOGGING SAFETY

Compliance with the OSHA logging standard will be the primary responsibility of the logging operator. However, this does not mean that forest managers do not have a professional or moral obligation to consider the safety of workers performing logging in a stand for which the forest manager is responsible. The Society of American Foresters' code of ethics makes it clear that forest managers are to perform their work with the utmost honesty, integrity, and professionalism (Society of American Foresters 1992). Forest managers have traditionally applied these professional standards to the land owner, or other employer of their services. Clearly, the forest manager has a professional obligation to the land owner, or other employer, to ensure that all logging operations performed on their land meet existing regional, state, or federal laws, including those related to safety. Furthermore, forest managers should apply these same professional standards to all constituencies they interact with. Logging operators are clearly a constituent of the forest manager--one that forest managers need if they are to meet most, if not all the goals outlined to them by a land owner, or other employer. Therefore, the forest manager has a clear professional obligation to assist the logging operator in making any logging operation as safe as possible whether one views this from the professional obligation to the owner of the timber, or from the professional obligation to society in general.

There are several ways that the forest manager can become involved in promoting the safety of workers logging a stand under the forest manager's care. The single most effective means would be through the contract for the logging job. It is common practice to include conditions in logging contracts for environmental requirements in the logging operation (e.g., placement of water bars, culverts, seeding skid trails). The incorporation of safety into the contract can be simply done by including a provision that the operator will perform the logging operation in compliance with the OSHA logging standard. Provisions for fines, or halting work on the site for violations of this provision, would be handled in the same manner as with environmental requirements. The forest manager will need to have a sound working knowledge of the OSHA standard, but this is no different than the need of the forest manager to have similar working knowledge of environmental or other regulations that are part of conducting a timber harvest.

The forest manager can also influence the safety of the logging operation beyond the provisions of the OSHA standard. Decisions on what types of silvicultural treatment will be used in a particular stand can greatly influence the types of hazards the logging workers will face when harvesting the timber. Many of the hazards faced by loggers are

associated with felled trees striking other standing timber, which can result in the felled tree becoming hung up, breaking a top, or changing its direction while falling (Peters, 1991). The use of silvicultural treatments that will minimize the likelihood of felled trees striking standing trees would reduce worker risk.

Where the use of potentially lower-risk silvicultural treatments is not possible, the forest manger can still reduce the risk to the logging worker through the layout of the logging operation and through the marking of the timber to be harvested. The issues of the placement of landings, skid trails, and roads has been previously mentioned. The marking of timber around hazardous trees has also been noted, but there is more the forest manager can do, especially in marking the stand.

The felling of a tree is the greatest hazard in logging (Peters 1991, Myers and Fosbroke 1994). The forest manager should be aware of this and attempt to visualize how each marked tree will be felled by a logger, noting possible hazards the logger will face in the process (e.g., high likelihood of the marked tree becoming hung up in an adjacent tree, limited options for the placement of an escape path for the feller). A system for assessing the likelihood of hanging a felled tree into a standing tree, and other related hazards, has been proposed by Peters et al. (1993), and may be adaptable for use by forest managers for field use. If the hazard can be reduced by removing another tree in the felling area, the forest manager may consider marking that tree along with the original tree marked for removal. If there is no obvious way to reduce the hazard to the logger, the forest manager should consider marking an alternative tree which poses less risk.

The forest manager should also consider leaving den trees that are sound and pose little or no hazard to the logger. As many hazardous trees as possible should be removed in the stand, leaving only those that are needed to meet specific management goals. While this may require leaving merchantable trees for wildlife purposes, it does give the forest manger more flexibility in marking the stand by not losing large areas of the stand due to the OSHA hazard zone requirement for hazardous trees.

The use of directional felling when logging the stand is another requirement the forest manager may consider. This will encourage the proper use of undercuts and backcuts when felling a tree, improve the likelihood that hazards identified by the forest manager when marking the stand are noted by the feller when dropping the tree, and allow for safer limbing, bucking, and skidding of the felled timber because trees would be felled in a logical, rather than a random direction. The use of directional felling also has the benefit of reducing the damage to the residual standing timber, improving the long-term timber value of the stand (Simmons 1979).

While forest managers cannot ensure that all aspects of a logging operation are conducted in a safe manner, the more emphasis they place on worker safety in those aspects of the logging operation where they are involved, the more likely the logging operator is to log the stand in a safe manner. Taking such a position on logging safety is no different than the forest manager's role in actively enforcing environmental requirements, or placing penalties on a logger who harvests non-marked trees. By setting the goal of having all logging operations they oversee being done safely, forest managers can have an impact, an impact which they should actively pursue as part of their professional work ethic.

THE FUTURE

With the establishment of the OSHA logging standard, logging safety is an area that many forest managers managing hardwood forests will be asked to incorporate into their management decisions for the first time. This will require forest managers to not only understand what parts of the OSHA standard will affect their management decisions for a stand of timber, but also place an ethical obligation on them to see that they do all in their power to ensure that a logging operation is conducted in a safe manner. This will require forest managers to view their decisions in a new light, similar to their taking new views on management decisions based on environmental regulations and constraints. To do this job well, forest managers must have a better understanding of the basic concepts of logging safety and how to apply these concepts in a stand of timber. Education on safety concepts will be a part of this, not only for forest

managers presently working in the field, but as part of the formal educational system for the forest managers of the future. The more forest managers understand safety issues, the better they will be able to incorporate these issues into their everyday work.

The need to balance safety issues with other factors such as environmental regulations, economic goals, bio-diversity goals, or the many other constraints a forest manager must consider, is unavoidable. Forest managers cannot ignore the OSHA standard any more than they can ignore environmental regulations. This will necessitate compromise and ingenuity on the part of the forest manager. Still, in most instances, solutions do exist and it will be the forest manager who will need to find these solutions.

In many instances, the concepts of forest management and forest harvesting have not worked closely together. The forest manager makes the decisions on what is to be harvested with little concern on how the harvesting is done. New harvesting methods are only viewed as an improvement to an existing silvicultural tool. This "removed" attitude toward harvesting systems ignores how important a tool harvesting is to forest management. As with any tool, the forest manager can only use it effectively if he completely understands it. Forest managers need to know how harvesting systems work, how economical harvesting will be in any given stand of timber, and not remove themselves from the role of making harvesting systems better. Forest managers also need to become more involved in the development of safer harvesting systems (National Research Council 1990). By tying together the goals of forest management with the goals of developing safer harvesting systems, the forest manager gains additional flexibility in balancing logging safety with all the other issues that must be considered in managing a forest. Research into the development of management-harvesting models could provide many solutions, not only for logging safety issues, but for environmental and other concerns as well (National Research Council 1990). Without this interaction between forest management and forest harvesting, the forest manager will always be asked to adapt to, rather than influence, harvesting technology--asked to adapt to a tool, rather than shape the tool for the intended purpose.

SUMMARY

The new OSHA logging standard will have an impact on the forest manager managing hardwood stands. Areas for which the forest manager will see the greatest impacts are the marking of stands, the placement of roads and skid trails, the location and development of landings or yards, and possibly the sequence in which the stand is logged. The forest manager can also play a major role in decreasing the hazards in logging timber through taking a professional interest in logging safety. Of the many influences that the forest manger can effect, the greatest safety influences can be effected in the logging contract, and in how the stand is marked for harvesting. Finally, the forest manager should take a more active role in the development of new harvesting technology, especially since it is the forest manager who is a major end user of these new harvesting techniques.

LITERATURE CITED

Barrett, J.W. (ed.). 1980. Regional silviculture of the United States, 2nd ed. New York, NY: John Wiley and Sons.

Cubbage, F.W., J. O'Laughlin, and C.S. Bullock III. 1993. Forest Resource Policy. New York, NY: John Wiley and Sons.

Jenkins, E.L., S. M. Kisner, D. E. Fosbroke, L.A. Layne, N.A. Stout, D. N. Castillo, P.M. Cutlip, and R. Cianfrocco. 1993. Fatal injuries to workers in the United States, 1980-1989: a decade of surveillance--national profile. (Pub. No. 93-108). Morgantown, WV: National Institute for Occupational Safety and Health.

Knudson, D.M. 1980. Outdoor recreation. New York, NY: MacMillan Publishing Co., Inc.

Leigh, J.P. 1988. Odds ratios of work-related deaths in United States workers. British Jour. Ind. Med. 45:158-166.

managers presently working in the field, but as part of the formal educational system for the forest managers of the future. The more forest managers understand safety issues, the better they will be able to incorporate these issues into their everyday work.

The need to balance safety issues with other factors such as environmental regulations, economic goals, bio-diversity goals, or the many other constraints a forest manager must consider, is unavoidable. Forest managers cannot ignore the OSHA standard any more than they can ignore environmental regulations. This will necessitate compromise and ingenuity on the part of the forest manager. Still, in most instances, solutions do exist and it will be the forest manager who will need to find these solutions.

In many instances, the concepts of forest management and forest harvesting have not worked closely together. The forest manager makes the decisions on what is to be harvested with little concern on how the harvesting is done. New harvesting methods are only viewed as an improvement to an existing silvicultural tool. This "removed" attitude toward harvesting systems ignores how important a tool harvesting is to forest management. As with any tool, the forest manager can only use it effectively if he completely understands it. Forest managers need to know how harvesting systems work, how economical harvesting will be in any given stand of timber, and not remove themselves from the role of making harvesting systems better. Forest managers also need to become more involved in the development of safer harvesting systems (National Research Council 1990). By tying together the goals of forest management with the goals of developing safer harvesting systems, the forest manager gains additional flexibility in balancing logging safety with all the other issues that must be considered in managing a forest. Research into the development of management-harvesting models could provide many solutions, not only for logging safety issues, but for environmental and other concerns as well (National Research Council 1990). Without this interaction between forest management and forest harvesting, the forest manager will always be asked to adapt to, rather than influence, harvesting technology--asked to adapt to a tool, rather than shape the tool for the intended purpose.

SUMMARY

The new OSHA logging standard will have an impact on the forest manager managing hardwood stands. Areas for which the forest manager will see the greatest impacts are the marking of stands, the placement of roads and skid trails, the location and development of landings or yards, and possibly the sequence in which the stand is logged. The forest manager can also play a major role in decreasing the hazards in logging timber through taking a professional interest in logging safety. Of the many influences that the forest manger can effect, the greatest safety influences can be effected in the logging contract, and in how the stand is marked for harvesting. Finally, the forest manager should take a more active role in the development of new harvesting technology, especially since it is the forest manager who is a major end user of these new harvesting techniques.

LITERATURE CITED

Barrett, J.W. (ed.). 1980. Regional silviculture of the United States, 2nd ed. New York, NY: John Wiley and Sons.

Cubbage, F.W., J. O'Laughlin, and C.S. Bullock III. 1993. Forest Resource Policy. New York, NY: John Wiley and Sons.

Jenkins, E.L., S. M. Kisner, D. E. Fosbroke, L.A. Layne, N.A. Stout, D. N. Castillo, P.M. Cutlip, and R. Cianfrocco. 1993. Fatal injuries to workers in the United States, 1980-1989: a decade of surveillance--national profile. (Pub. No. 93-108). Morgantown, WV: National Institute for Occupational Safety and Health.

Knudson, D.M. 1980. Outdoor recreation. New York, NY: MacMillan Publishing Co., Inc.

Leigh, J.P. 1988. Odds ratios of work-related deaths in United States workers. British Jour. Ind. Med. 45:158-166.

McCormack, C.R. 1963. Injuries and accident causes in logging operations, 1955. (Report No. 252). Washington, D.C.: Bureau of Labor Statistics.

Myers, J.R. and D.E. Fosbroke. 1994. Logging fatalities in the United States by region, cause of death, and other factors--1980 through 1988. Jour. Safety Res. 25(2):97-105.

National Research Council. 1990. Forestry research: a mandate for change. Washington, D.C.: National Academy Press.

Newell, S. 1994. Personal communication, August 12, 1994. Director, Office of Statistics, Occupational Safety and Health Administration, Washington, D.C.

Paulozzi, L.J. 1987. Fatal logging injuries in Washington state, 1977 to 1983. Jour. Occ. Med. 29(2):103-108.

Peters, P.A. 1991. Chainsaw felling fatal accidents. Transactions of the ASAE 34(6):2600-2608.

Peters, P.A., C. C. Hassler, and M.D. Erickson. 1993. Predicting hazardous tree reactions from stand geometry. Paper No. 937525. St. Joseph, MI: American Society of Agricultural Engineers.

Society of American Foresters. 1992. Code of ethics for the members of the Society of American Foresters: 1976, amended 1992. Bethesda, MD: Society of American Foresters.

Simmons, F.C. 1979. Handbook for eastern timber harvesting. Broomall, PA: U.S. Forest Service, Northeastern Area State and Private Forestry.

Smith, D.M. 1962. The practice of silviculture. New York, NY: John Wiley and Sons.

Smith, G.D. 1991. A standard of care extended to third party non-direct employers on multiple employer work sites. Prof. Safety 37(7):35-44.

U.S. Department of Health and Human Services. 1994. Logging industry fatality rate for 1989--in-house data records. Morgantown, WV: National Institute for Occupational Safety and Health.

U.S. Department of Labor. 1984. Injuries in the logging industry. (Bull.2203). Washington, D.C.: Bureau of Labor Statistics.

U.S. Department of Labor. 1988a. CFR 29 Part 1910.266--Pulpwood logging. Washington, D.C.: Occupational Safety and Health Administration.

U.S. Department of Labor. 1988b. CFR 29 Part 1926--Safety and health regulations for construction. Washington, D.C.: Occupational Safety and Health Administration.

U.S. Department of Labor. 1989. CFR 29 Part 1910--Logging operations; notice of proposed rulemaking. Washington, D.C.: Occupational Safety and Health Administration (Federal Register, May 2, 1989, pp. 18798-18817).

U.S. Department of Labor. 1991. Occupational injuries and illnesses in the United States by industry, 1989. (Bull. 2379). Washington, D.C.: Bureau of Labor Statistics.

Yoakum, J. and W.S. Dasmann. 1969. Habitat manipulation practices. In: R.H. Giles (ed.). Wildlife Management Techniques. Washington, D.C.: The Wildlife Society.