Food and Agriculture Organization of the United Nations

Accident reporting and analysis in forestry

Guidance on increasing the safety of forest work

FORESTRY WORKING PAPER 2

Accident reporting and analysis in forestry

Guidance on increasing the safety of forest work

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Cover photo: *Workers in Zambia load logs onto a truck* © Jonas Cedergren

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About the author

Professor Garland has more than 45 years of experience in occupational safety and health in forestry, including in Africa, Europe and North and South America. He has worked extensively with the joint FAO/ECE/ILO Committee on Forest Technology and Training. For the International Labour Organization (ILO) he produced a global account of working and living conditions in the forest sector, and he started ILO FORWORKNET and edited it for several years. Professor Garland has arranged numerous international meetings on working conditions on forestry. He is Affiliate Professor, Department of Environmental and Occupational Sciences, University of Washington, and Professor Emeritus in Forest Engineering, Resources and Management, Oregon State University. At present he works on safety issues in forestry in Chile as a Fulbright Fellow. He is a member of the Forest Activities Code Committee of the Oregon Occupational Safety and Health Administration (OSHA) and helped write (and revise over time) the Oregon OSHA safety code for forest activities. Professor Garland has served as an expert at more than 70 forestry accidents across the United States of America. In this capacity, he has reviewed original accident reports; conducted detailed interviews of those involved; collected evidence; performed machine and site inspections; and determined the true causes of accidents to a high legal standard.

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Acronyms

FACE	Fatal Accident and Control Evaluation
FAO	Food and Agriculture Organization of the United Nations
ILO	International Labour Organization
NIOSH	National Institute for Occupational Safety and Health (USA)
OR-FACE	Oregon Fatal Accident and Control Evaluation
OSHA	Occupational Safety and Health Administration (USA)
USA	United States of America
USD	United States dollar(s)

Executive summary

An accident is an unplanned event that causes death, damage or disruption to people, objects and operating systems. Accidents are an effect of hazards and exposure to those hazards. Hazards can be created by either unsafe (dangerous) conditions or unsafe (inappropriate) behaviour (or a combination of these).

This report discusses forestry accidents and illnesses, makes international comparisons, examines the use of accident reporting forms, and provides sample forms. It presents examples of successful safety and health improvements arising from accident reporting and analysis and discusses various legal and regulatory approaches for improving worker safety and health.

The target audience for this report comprises decision makers, producer organizations, trade unions and forest companies. The objective is to provide support and essential knowledge to organizations wanting to improve occupational safety and health in forestry. The report concerns accident management in professional and industrial forestry. Many of the findings and processes, however, are applicable to other forms of forestry, including small-scale forestry and agroforestry.

The facts, figures and examples presented in the report are mainly from developed countries, mostly in the Northern Hemisphere, with large forest sectors and where occupational safety and health has received much attention. Much less information is available in developing countries. The document is designed to serve as a "roadmap" for countries, institutions, companies, producer organizations and trade unions who strive to improve occupational safety and health in forestry. The recommendations and guidance should help in developing legal frameworks, compensation schemes and accident reporting and analysis systems where these are lacking or inadequate.

This document is part of FAO's work on Forest Technology and Decent Rural Employment, and informs FAO's contribution to the Sustainable Development Goals (SDGs), especially SDG 1 (End Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 15 (Sustainably Managed Forests).

Statistics on accidents in forestry are largely inadequate, making comparisons and data aggregation difficult. Those reliable data that do exist suggest that forestry-related work is among the most hazardous of all non-military activities.

The purposes of accident reporting and analysis are to improve the lives of workers and to avoid occupational accidents and illnesses. A major impediment to accident reporting and analysis is the concern that it will lead to the apportioning of blame to individuals or organizations. It is in no one's best interest to allocate blame for forestry accidents and illnesses; in a properly functioning accident reporting and analysis system, therefore, efforts are directed towards describing accidents and finding their

causes, not apportioning blame. Nevertheless, a range of actors must assume certain responsibilities:

- Individuals must take responsibility for their personal safety and health by complying with safe work practices and safety regulations.
- Employers must take responsibility for ensuring that their workers operate in safe conditions by providing adequate training and supervision and by ensuring compliance with safe practices.
- Because it benefits from forestry activities, society in general has a responsibility to encourage overall forestry-worker safety and health.

The safety culture – that is, the shared beliefs, practices and attitudes in an organization – is the basis for improving safety by shaping behaviour. An organization's safety culture is the result of factors such as:

- management and employee norms, assumptions and beliefs;
- management and employee attitudes;
- values, myths and stories;
- policies and procedures;
- supervisor priorities, responsibilities and accountability;
- production and bottom-line pressures versus quality;
- actions, or lack of actions, to correct unsafe behaviours;
- employee training and motivation; and
- employee involvement or "buy-in".

The way in which forestry accidents are viewed shapes how accidents are analysed. Accident investigation, reporting and analysis should reflect the machinery, accessories and products involved.

Most safety and health regulations assign responsibilities to business organizations that have employees. By accepting workers' compensation arrangements, employers are not open to negligence lawsuits from workers for injuries or illnesses. Safety laws at the national and subnational levels need to specify what should be reported, by whom, to whom and when. Prompt and official accident and illness reporting in forestry is in the best interest of the sector.

Countries, and subnational jurisdictions, require legal frameworks for reporting forestry accidents and illnesses. At a minimum, reporting should include:

- requirements for reporting for covered organizations and all sectors;
- standardized reporting forms, and special forms for forestry;
- what, when, where and to whom to report, including triggering events and incidents plus recordkeeping;
- a requirement to submit more-detailed information for special surveys and studies; and
- privacy provisions that protect individuals and firms but allow summaries.

The purpose of accident analysis is to find out, in an unbiased fashion, what occurred, the causes of the accident, and ways in which similar accidents might be avoided in the future. The availability of an investigation protocol for those at accident scenes will assist in accident investigation and analysis.

Bias can obstruct investigations and needs to be recognized and minimized. As an effect of conflicting interests, investigations of accidents can be classified into two groups:

1. accident investigation, which connotes a criminal act or blame and may create adversarial relationships; and
2. accident analysis, which is an effort to determine system failures that avoids the apportioning of blame and the pinpointing of singular causes.

The output of an accident analysis is an accident report – that is, the documentation of the analysis of a given accident. Accident reporting, in turn, is the collation of forestry accident reports. Reports should be written simply enough to match the knowledge of those expected to use them.

Employers participating in workers' compensation insurance or a country's social insurance programme have reporting obligations. Other insurance arrangements will likely require reporting based on the nature of the insurance cover. Self-insured organizations require accident reports. General industry accident reports are used to:

1. estimate the causes and magnitude of accident problems;
2. identify and prioritize the need for preventive measures;
3. evaluate the effectiveness of preventive measures;
4. monitor risks, issue warnings and conduct awareness campaigns; and
5. provide feedback for those involved in prevention.

Accident reports contain data on important aspects of accidents, such as injured worker demographics (age, education, gender, etc.); time/day/month of accident; body part injured; type of injury; duration of injury; type of accident (e.g. fall or strike); employment time; job class; activity prior; tools/equipment; injury agent; and description of accident.

The usefulness of accident reporting is in the patterns that emerge from a large number of reports of accidents occurring under similar circumstances. The standardization of reporting allows comparisons between sectors, forestry regions and countries and helps identify the prevention efforts needed.

Much detail is lost in summarizing accident reports. In many existing systems, too, certain important information may not be recorded at all (e.g. site information such as slope, tree size/condition, specific equipment, actual experience versus employment with firm, weather, fatigue indicators, and personal protective equipment used). There is a need, therefore, to include forestry-related data in accident reporting schemes.

When equipment is involved as a potential cause of an accident, machine manufacturers may be liable for damages. Manufacturers keep proprietary control of their records of accidents and machine damage, but accident analysis can help identify problems and potential solutions when such records are made known through litigation or accident investigations.

The cost of accidents hugely exceeds the cost of preventive efforts, including reporting and analysis. Managers find it difficult to allocate resources to preventive measures, however, because it is impossible to show "the accident that did not happen" due to preventive measures.

The direct costs of accidents include medical treatment; lost wages; rehabilitation; follow-up care; compensation payments; and accident costs. Indirect costs include lost

production; replacement worker recruitment and training; injury reserve costs; lost future earnings; future medical expenses; and sector wage losses. Workers' compensation and social insurance may cover direct costs, typically amounting to about 30 percent of total accident costs.

Effective accident reporting and analysis in forestry leads to cooperative efforts to improve safety and health, including the:

- elimination of hazards or the substitution of unsafe practices with safer processes;
- introduction of engineering controls such as guarding and safer technologies;
- improvement of organizational safety measures, work schedules, supervision and training; and
- increased use or improvement of personal protective equipment.

In some countries, unskilled or inadequately skilled labour (e.g. immigrants) is undertaking an increasing amount of forestry work; it is important that adequate training materials are provided in accessible language that takes into account cultural backgrounds. A "macho" culture, for example, must be tempered when working with chainsaws. Another organizational safety measure is improving the supervision of workers, as required by regulations and operational necessity.

Forestry accident reporting and analysis have contributed to the development and use of personal protective equipment and clothing as a measure to reduce accidents. Organizations such as the American National Safety Institute and the International Labour Organization specify the required performance of such equipment and clothing. Personal protection measures include:

- head protection with helmets and hard hats;
- ear protection, and the minimization of noise levels in machines;
- eye protection;
- hand protection with gloves;
- leg protection with pants and chaps;
- foot protection with boots; and
- cold-weather protection.

Improvement is needed in personal protective equipment in hot and humid environments to ensure adequate comfort.

The effort to improve worker health in forestry based on health reporting and analysis has been insufficient. Some occupational health disorders, such as chemical exposure (e.g. pesticides), hearing losses, heat- and cold-related diseases, repetitive stress syndromes, and some musculoskeletal trauma, have been the subject of improvement efforts. Forest-worker health screenings are lacking worldwide, however, and occupational health is generally not addressed. The difficulty of the work involved in forestry makes fatigue a major concern for the safety and health of workers. Diseases – such as obesity, diabetes, and neck and shoulder damage – commonly suffered by sedentary machine operators and those involved in transportation require better reporting and analysis.

Existing information – although weak – suggests that forestry accidents and health concerns are serious problems in forest sectors worldwide, especially in developing countries. An important part of improving occupational safety and health is to have

in place adequate procedures for accident reporting and analysis. To achieve this, the following steps should be taken:

- **Increase reporting of forestry accidents and illnesses**. Forestry companies and governments should put effective mechanisms in place to enable workers to report accidents and to trigger investigations by authorities.
- **Improve forestry accident investigation**. International agencies and national safety organizations should provide training on forestry accident reporting and analysis. The adoption of an accident analysis protocol would help investigators in making their reports.
- **Tailor accident reporting forms**. Generalized accident reporting forms should be adapted to suit local conditions and specific forestry activities.
- **Designate institutions to oversee forestry accident reporting and analysis**. National and international institutions should be designated to collect, review and analyse forestry reporting and accident analysis and the findings publicized widely.
- **Increase funding for forestry accident reporting and analysis**. Funds to ensure adequate forestry accident reporting and analysis should be obtained from sources such as insurers, employer and employee associations, foundations, and governments.
- **Assist developing countries to improve forestry accident reporting and analysis**. Projects, workshops and training programmes should be developed to draw attention to the benefits of forestry accident reporting and analysis and to help build support within countries and among stakeholders.

A harvesting area in western Norway. Forest activities often take place in remote areas, on steep terrain, in areas covered with vegetation and obstacles, and where even walking can be hazardous

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1 Introduction

An estimated 13.7 million people are employed formally in the forest sector worldwide, and millions more are employed informally, especially in developing countries (ILO, undated). Worldwide, about 3.5 billion m^3 of wood is harvested each year using various logging techniques and systems and involving heavy machinery and cutting equipment. Forest activities often take place in remote areas, on steep terrain, in areas covered with vegetation and obstacles, and where even walking can be hazardous. Forestry work is seen as "difficult, dangerous and dirty" – and sometimes deadly. Many workers receive little or no training. Accidents should be seen as preventable, not inevitable. Nevertheless, the difficult circumstances commonly found in forestry work mean that accidents are more likely than in most other sectors. Although global data have not been tabulated, it is likely (using agriculture as a guide) that accidents in professional forest operations worldwide exceed 170 000 per year. Quantifying the number of fatalities and accidents in forestry is complicated; in large parts of the world, for example, it is difficult to account for illegal logging, the felling of urban trees, and family forestry.

This report provides guidance on accident reporting and analysis in the forest sector. It discusses forestry accidents and illnesses, makes international comparisons, examines the use of accident reporting forms, and provides sample forms. It presents examples of successful safety and health improvements arising from accident reporting and analysis and discusses various legal and regulatory approaches for improving worker safety and health.

The target audience for this report comprises decision makers, producer organizations, trade unions and forest companies. The objective is to provide support and essential knowledge to organizations wanting to improve occupational safety and health in forestry. The report cites predominantly web-based information sources that are readily accessible to most forestry stakeholders.

1.1 ABOUT ACCIDENTS, INCIDENTS AND WORK-RELATED DISEASES

Accidents and incidents

Accidents are unplanned events that cause damage or disruption to people, objects or operating systems. They are an effect of hazards and exposure to those hazards. Hazards may be caused by either unsafe (dangerous) conditions or unsafe (inappropriate) behaviour, or a combination of these. For many dangerous activities, hazards can be minimized by measures such as safe work procedures, engineering design/controls, personal protective equipment, and planning. Some activities are inherently dangerous, however, and hazards cannot be eliminated except through special or extraordinary measures. In forestry, logging and some other tasks are inherently dangerous.

BOX 1
Key terms

Fatal accidents are accidents in which lives are lost.

Disabling accidents are accidents that require medical treatment or more than one day's absence from work. In the worst cases, disabling accidents severely injure workers to the extent that they cannot work again.

Incidents are accidents that cause no injury. Reporting incidents and near misses in forestry is important because it provides information on hazardous behaviour and unsafe working methods and equipment that can be used to reduce the potential for future accidents and thus the potential for death and serious injury.

A **near miss** is an unplanned event with the potential to cause, but does not actually result in, injury to workers, an interruption to operations, or damage to equipment.

The term **non-fatal occupational injury** is commonly used to refer to accidents in a sector in which no lives are lost.

Occupational (or forestry) illnesses are illnesses and damaging health conditions resulting from work (forestry) activities due to exposure to hazardous substances, disease carriers, working conditions or cumulative trauma.

Work-related illnesses

It is important to report and analyse occupational illnesses, but determining these in forestry is difficult. Medical treatment, health screenings and assessments, and worker surveys can enable the detection of forestry-related illnesses. Lyme disease and other insect-borne diseases are examples of disorders prevalent in forest regions that forestry workers may contract in performing work-related duties. Heat stroke and other heat-related ailments can occur in forestry (Staal Wästerlund, 2018). Cold weather aggravates some diseases, such as Raynaud's syndrome (a condition that reduces blood flow to certain areas of the body, typically the fingers, in response to cold temperatures or stress). Concerns are emerging about obesity and diabetes among sedentary truck drivers and machine operators, including in forestry. Skin cancers are known among outdoor workers. Human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS) is an issue among forestry workers in some countries. Efforts to reduce the effects of machine vibration on forestry workers have been underway for many years. The physically demanding work associated with some forestry activities can cause cumulative damage to joints and backs.

1.2 SCOPE AND LIMITATIONS OF THIS DOCUMENT

The data cited in this document are for professional and industrial forestry, and local-scale and informal forestry is not addressed directly due to a lack of data. In general, too, legal frameworks, codes of practice and other regulatory measures, and data are available only for professional and industrial forestry. Nevertheless, many of the findings

and processes herein are applicable to other forms of forestry, including small-scale forestry and agroforestry.

Is it a forestry accident?

Accidents that are not strictly forestry accidents (and are not addressed directly in this document) but which involve trees, forestry tools or forestry machinery should be reported and investigated because lessons can be learned for application in the forest sector. These include accidents occurring:

- in the non-commercial harvesting of wood products by individuals for personal use (e.g. for woodfuel or local building);
- in nursery work;
- as a result of recreational activities in forests, hunting, forest grazing, and the gathering of forest foods and plants;
- in construction work in forests;
- in forest firefighting in organizations with their own reporting systems;
- in general transportation in forest landscapes;
- in the use of forestry tools or equipment for non-forestry operations, such as those involving chainsaws for treecutting on farms; and
- during illegal logging and other illegal forest uses.

The recommendations made in this document and the guidance on accident investigation, reporting and analysis in forestry are designed to help in developing legal frameworks and compensation and insurance schemes. The document should also be helpful for developing reporting and analysis schemes for accidents involving the use of forestry tools and machinery in other sectors.

Russian machine operator working in a protected cabin

© FAO/VASILY MAKSIMOV

2 Accidents in forestry

Statistics on accidents in forestry are largely inadequate, making comparisons and data aggregation difficult. Existing data are typically unreliable. For example:

- **Fatalities**. These can be enumerated, but are they always the result of forestry activities?
- **Accidents**. How many days should a worker be absent from work for an event to be considered an accident that should be reported?
- **Circumstances**. Are the data collected consistent with, and relevant to, the injury type?
- **Causes**. Are data based on competent and thorough investigations?
- **Rates**. Do numerators and denominators cover the same populations consistently?
- **Time series**. Are definitions and inclusions consistent?
- **Subnational comparisons**. Are the same types of forestry activity being compared? Are the threshold values the same between regions?

Satisfactory responses to these questions, combined with knowledge of the underlying data, allow analysts to make informed assessments and draw conclusions about accidents in forestry and to make recommendations for reducing the likelihood of such accidents in the future.

Reporting on forestry illnesses is even more complicated and undeveloped than reporting on forestry accidents. If forestry is similar to other sectors, many more occupational deaths are due to illnesses than to accidents: it has been estimated that 2.3 million occupational deaths occur per year worldwide, of which 2 million are due to illness (and the remainder to accidents) (Tampere University of Technology, 2014). It would be beneficial to report the incidence of forestry illnesses and to develop reliable forestry health statistics, but this may be possible only through efforts such as special studies, worker health screenings, and forest-industry questionnaires.

2.1 Global comparisons

Using questionnaires and published data, Ackerknecht (2014) estimated forestry fatality rates in professional and legal operations, by country (excluding developing countries), on the basis of timber production and employment. Rates were in the range of 0–2.05 fatalities per million m^3 harvested. The estimated rate in the United States of America of 0.22 casualties per million m^3 (Ackerknecht, 2014) yields reasonable estimates of fatalities for the state of Oregon (4–5 deaths per year) and the United States of America as a whole (80–100 fatalities) (depending on annual production). If the annual worldwide harvest of around 3 539 million m^3 incurred a fatality rate similar to that in the United States of America, there would be almost 800 fatalities globally per year. Assuming a disproportionately high fatality rate in developing countries, the number

of fatalities worldwide could be in the range of 800–1 000 annually in legal and professional operations. Fatality rates change over time: Table 1 compares the rates estimated by Ackerknecht (2014) for 2010–2012 with those of Poschen (1993) for 1985–90 and Blombäck (2002) for the mid-1990s, showing a declining trend in all included countries. Fatality rates would likely be considerably higher if accidents in non-professional and illegal operations were included.

TABLE 1
Forestry fatality rates per million m³ harvested, various countries and periods

Activity	1985–1990 (Poschen, 2015)	mid-1990s (Blombäck, 2002)	2010–2012 (Ackerknecht, 2014)
Austria	2.80	1.41	0.01
Sweden	0.24	0.16	0.04
Germany	1.70	1.26	0.00
Canada (British Columbia)	0.38	0.28	0.17
New Zealand	0.70		0.16
USA	0.70	0.26	0.22

2.2 Other measures and rates

For small numbers of fatalities and other accidents, enumeration (census counts) and detailed accounts are likely to be more useful than estimated rates by volume or number of workers. For forestry services, helpful measures for comparison include the number of accidents per area treated (e.g. weeding and pre-commercial thinning); the number of accidents per number of trees planted; and the number of accidents per unit distance (e.g. road maintenance).

The most common measure for comparisons (e.g. between sectors and countries) is fatality rate per number of workers (e.g. "fatalities per 1 000 workers"), but data are not easily comparable if seasonal work is involved (and the number of workers therefore fluctuates). Some studies use fatalities per 1 000 000 hours worked, which is feasible if data are collected on actual hours worked. Many statistics use the formula:

$$R = (N/EH) \times 200\,000\,000$$

Where the rate (R) = the number of fatal occupational injuries per 100 000 full-time-equivalent workers; N = the number of fatal work injuries; EH = the total hours worked by all employees in the calendar year; 200 000 000 = base for 100 000 full-time-equivalent workers (working 40 hours per week, 50 weeks per year) (Bureau of Labor Statistics, 2013).

Employment in small forestry firms is difficult to estimate. Informal work arrangements, transient employment, immigrant labour, self-employed workers, small contractors and other factors all add uncertainty to estimates of employment, which, in turn, reduces the usefulness of estimates of fatality or injury rates based on employment.

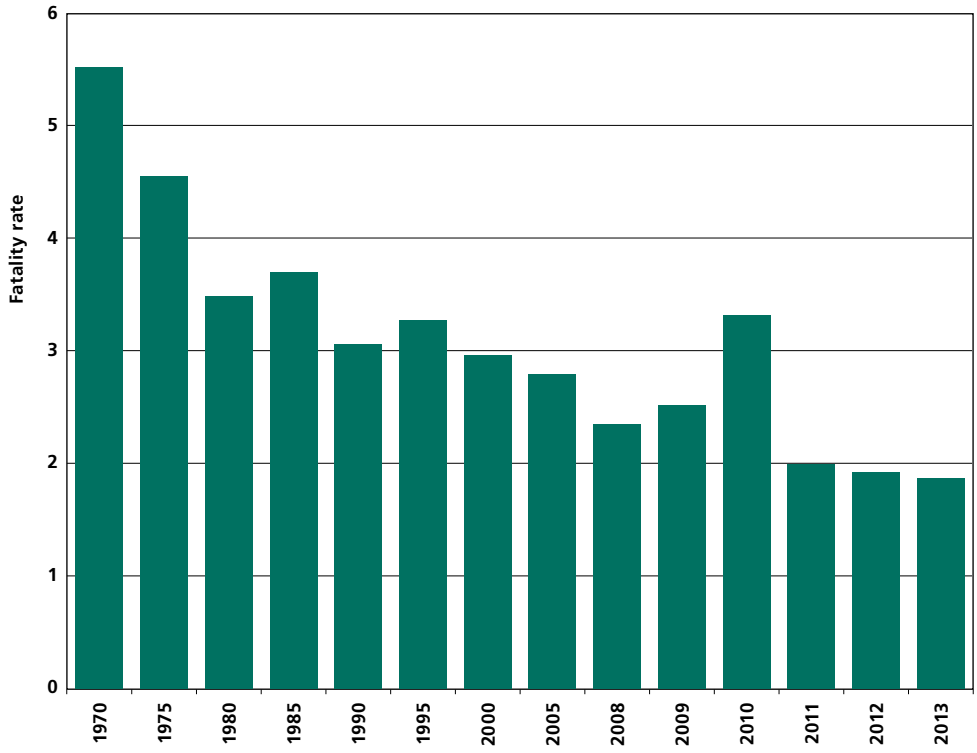
2.3 Country examples

Fatality rates in forestry tend to vary by country depending on their stage of development. In Slovenia, a country in economic transition, Klun and Medved (2007) documented higher fatality rates per unit volume than those in Austria, Germany, Sweden and Switzerland; they also found that fatality rates were seven times higher for non-professional forest workers (e.g. in farm forestry) than for professional forestry workers.

The volume of the timber harvest has fallen over time in Japan and so has the fatality rate (Figure 1). The harvest volume fell from 45 million m^3 in 1970 to about 20 million m^3 in 2013, and the number of fatalities dropped from 248 per year (a rate of 5.5 fatalities per 1 million m^3) to 39 (a rate of 1.95 fatalities per 1 million m^3). Safety professionals in Japan regard this as still too high, however (Y. Yamada, personal communication, 20 February 2016).

Countries and regions usually have unique patterns of accident statistics based on their particular forestry operations and social circumstances.

FIGURE 1
Forestry fatality rate, Japan, 1970–2013

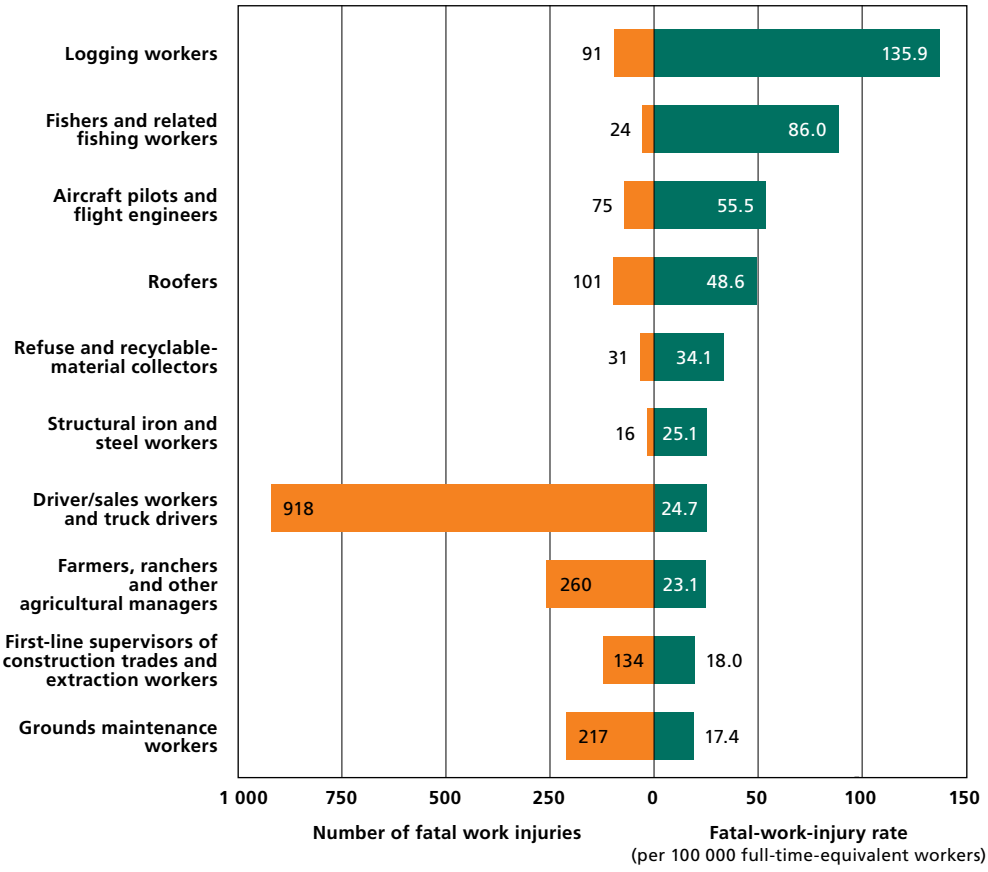


Source: Y. Yamada, personal communication, 20 February 2016.

2.4 Comparisons with other sectors

Employment – standardized to 1 000 or 100 000 employees – is used to compare accident statistics across industrial sectors. Such high-level comparisons are most useful to indicate serious problems in a sector and year-to-year trends within sectors. Figure 2 shows that, in the United States of America in 2014, logging had the highest fatality rate among the sectors shown. This is consistent with year-to-year trends: the author has reviewed fatality data over a 30-year period, and logging has been in the top three industries for fatality rates throughout. When another sector has a worse fatality rate than logging in a given year, it is likely due to rare events such as a mining disaster or the sinking of a fishing vessel.

FIGURE 2
Fatality rates in selected sectors, United States of America, 2016



Source: Bureau of Labor Statistics (2017).

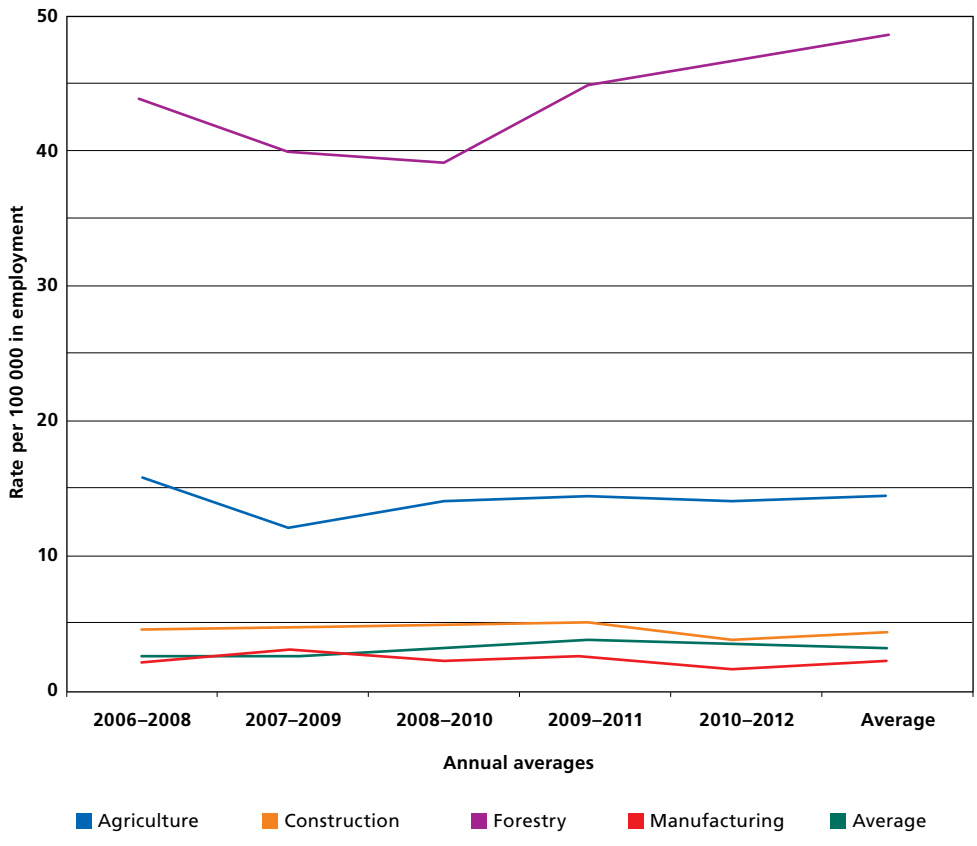
Table 2 shows that fatality rates in the European Union are also high in forestry compared with other sectors and similar to those in the United States of America. Figure 3 shows that forestry fatality rates in New Zealand are higher than in other sectors in that country.

TABLE 2
Estimated average annual rate of fatal accidents in the European Union, certain sectors

Sector	Manufacturing (1994–2001)	Construction (1994–2001)	Agriculture, hunting and forestry (1994–2001)	Forestry only (2000–2005 data)
Average number of fatal accidents per 100 000 workers	3.5	12.7	12.6	24–30

Source: Gifford (2009).

FIGURE 3
Fatality rates in employment in forestry and other sectors, New Zealand, 2006–2012

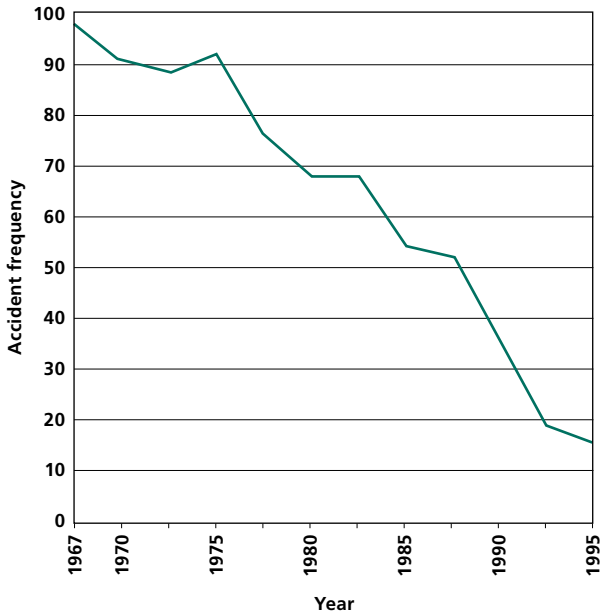


Source: Independent Forestry Safety Review Panel (2014).

2.5 Forestry accidents in relation to mechanization

The most dramatic reductions in forestry accidents have come from the increasing mechanization of harvesting and silvicultural operations; technological developments in motor-manual operations[1] have also improved safety. Figure 4 shows the extraordinary reduction in accident rates in Sweden between 1967 and 1995 that occurred as harvesting shifted from the manual cutting and handling of trees using chainsaws to the use of harvesting machines. The number of accidents decreased steadily from 8 656 per year in 1970 to 1 469 in 1990. Although the number of worker-hours per year decreased in that period, from 96 million to 41 million, the accident rate declined more, from 90 per million worker-hours to 35 per million worker-hours (Axelsson, 1998). The accident rate continues to decline in Sweden.

FIGURE 4
The accident frequency rate (number of accidents per million worker-hours) in Swedish forestry, 1967–1995



Source: Axelsson (1998).

Similarly large reductions in accidents have occurred with increasing mechanization in other countries, including Brazil, Canada, New Zealand and the United States of America. The trade-off in reducing the number of disabling accidents is an increase in cumulative trauma (repetitive stress injuries) among machine operators; other occupational

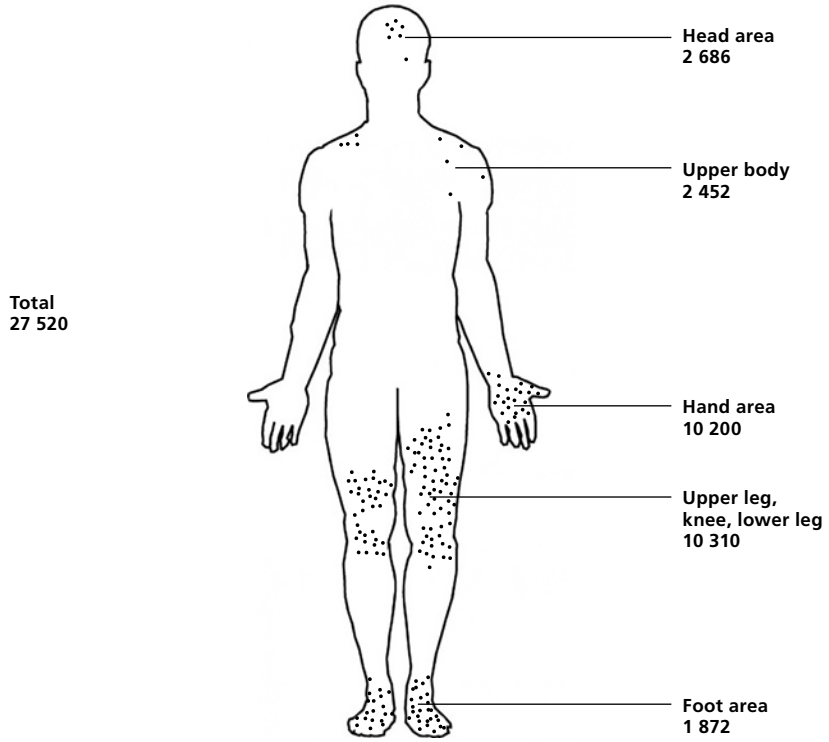
[1] Motor-manual operations are operations in which workers perform manual work with the assistance of machinery. In forestry, the most common example of such operations is work involving chainsaws.

illnesses associated with more sedentary work are also becoming a concern. A challenge for forestry accident reporting and analysis is to characterize the state of mechanization in a given operation and assess the associated type and extent of risks to worker health.

2.6 Chainsaw accidents

The chainsaw is a very useful tool in forestry, and professionals and non-professionals use it worldwide. It can also be deadly. Trees and tree limbs cut by chainsaws can fall on workers, with potentially fatal consequences. Cuts by chainsaws can cause fatalities and a wide range of traumatic injuries, including amputations, and significant amounts of flesh and bone can be damaged or removed, making healing difficult. Figure 5 shows the frequency and location on the body of accidents involving chainsaws in the United States of America in 1999. Tree felling is the most deadly occupation in forestry; in developing countries, chainsaws may be involved in nearly half of all forestry accidents (Blombäck, 2002).

FIGURE 5
Chainsaw injury numbers, by location on the body, 1999, United States of America



Source: Data seen in Smith (undated).

Significant improvements in chainsaw safety have been made in recent years, achieving reductions in vibration, exhaust gas emissions, saw weight and kickback potential. Chainsaw manufacturers recognize differences between professional and non-professional users in their products and training materials. Personal protective equipment and training have been effective in reducing chainsaw injuries. An increase in the ease of maintenance has also improved chainsaw safety because equipment is inherently safer if it is well-maintained.

Given the prevalence of chainsaws in the forest sector and their potential to cause injuries and fatalities, special attention should be paid to investigating, reporting and analysing chainsaw accidents. Moreover, the increasing availability of battery-powered chainsaws will lead to greater overall chainsaw use, including among amateurs, increasing the urgency of improving chainsaw safety and health through accident reporting and analysis.

2.7 Other forest activities, and site conditions

Forestry accident reporting and analysis should cover forest activities other than logging (the most hazardous activity). Ecological restoration and vegetation management, for example, may use some of the equipment and practices used in logging. Differences in operation and workforce are likely to apply, however – for example, ecological restoration work in the United States of America may involve relatively high numbers of immigrants, women, indigenous peoples, illiterate workers and workers distrustful of authority (Alliance of Forest Workers and Harvesters and Labor Occupational Health Program, 2012), which should be taken into account in accident reporting and analysis.

Harvesting machines are now being used on slopes in excess of 100 percent (i.e. greater than 45 degrees) in varying site conditions (Visser and Stampfer, 2015). This should also be considered in accident reporting and analysis.

Workers in southern Africa delimb a felled tree without eye protection and other safety gear

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3 Accountability

3.1 Accountability is not same as apportioning blame

The entire accident reporting and analysis approach is imperilled if those involved in a forestry accident perceive that they could be blamed for their actions or inaction. The purposes of accident reporting and analysis, however, are to improve the lives of workers and to minimize future occupational accidents and illnesses. Legal protections may exist in the form of workers' compensation laws that limit the rights of workers to sue employers for accidents, with the financial liability transferred to state-controlled or -monitored insurance funds. At a minimum, workers should be protected from the reprisals or legal actions of employers and co-workers; otherwise, workers will have no incentive to help determine the causes of accidents. Accident investigators in the public sector may need protection from legal proceedings when there is a risk they will be legally sued.

Not all countries or regions provide employer or worker protections. In cases of gross negligence or callous disregard for life, individual employers may be charged with criminal offences and brought to trial (e.g. in New Zealand and the United States of America). In some regions, such as the Canadian province of British Columbia, injured workers may be held accountable for not complying with safety rules, such as not wearing protective chainsaw chaps, thereby forfeiting certain compensation benefits. Some accidents occur outside the scope of workers' compensation regimes, such as those involving contractors, landowners, equipment manufacturers and private individuals who are not employees. If a court determines that a legal complaint regarding an accident has merit, lawsuits may proceed to assign sole or multiple liability for civil (financial) awards, but not criminal guilt.

The objective of accident analysis is to find the root causes of accidents and to suggest ways to eliminate or minimize these and thereby to prevent future similar accidents. It is in no one's interest to apportion blame for forestry accidents and illnesses. Nevertheless, a range of actors must assume certain responsibilities. For example:

- Individuals must take responsibility for their safety and health by complying with safe work practices and safety regulations.
- Employers must take responsibility for ensuring that their workers operate in safe circumstances by providing adequate training and supervision and by ensuring compliance with safe practices.
- Because it benefits from forestry activities, society in general has a responsibility to encourage overall forestry-worker safety and health.

In a well-functioning accident reporting and analysis system, efforts are directed at describing the accident and finding the causes, not assigning blame.

3.2 Motivation and demotivation for accountability

The most basic form of motivation for individuals and organizations is to provide rewards for doing the right thing and punishments for doing the wrong thing. Often overlooked, however, are forms of demotivation – that is, when doing the right thing incurs punishment or doing the wrong thing goes unpunished (or is rewarded). Conditions that will motivate safe practices include:

- a commitment by management to accident reporting and analysis and improving safety;
- the rewarding of individuals or organizations for safe practices (e.g. through pay increases, promotions or public recognition); and
- the punishment, with fines or other penalties, of organizations and individuals who fail to report accidents.

Individuals and organizations will be demotivated to implement safe practices when:

- Organizations or individuals who act to improve accident reporting and analysis receive signals from management that their efforts are unappreciated (e.g. by a lack of promotion, a lack of emphasis on safety and health, and signals that safety is not their responsibility).
- Organizations or individuals who are failing in their responsibilities in accident reporting are tolerated because this is "the way it works" (e.g. managers are promoted despite this shortcoming).

The importance of motivation for safety improvement is evident in the example of a South American company – a subsidiary of a large European corporation – that was increasing its harvesting in conifer plantations. When a fatality occurred in forest operations, the corporation's board of directors in Europe required the general manager in South America and the responsible production manager for operations to travel to Europe to explain the cause of the fatality and to set out the actions they were taking to ensure that such an accident would not happen again. This action by the board signalled to the managers the importance the company attached to worker safety and health. The managers made strong efforts to provide worker training and improvement, and no more fatalities occurred.

3.3 Accidents are systemic

Figure 6 shows an accident "hierarchy", indicating a relationship between near misses, minor accidents, and fatalities. This relationship (in which 1 000 near misses might occur for every 100 minor accidents and every 1 fatality) is an estimate by the author for forestry, following ratios in earlier general studies of accidents.

Thinking on causal relationships in accidents has evolved over time. Herbert W. Heinrich, a pioneering occupational safety researcher, analysed large amounts of accident data collected by an insurance company and identified causal factors of industrial accidents, including "unsafe acts of people" and "unsafe mechanical or physical conditions". Heinrich developed the "five domino model" of accident causation, which depicts an accident sequence as a causal chain of events, represented as dominos that topple in a chain reaction (Figure 7). If the sequence is interrupted by the elimination of

FIGURE 6
A hierarchy of accidents of varying severity in forestry

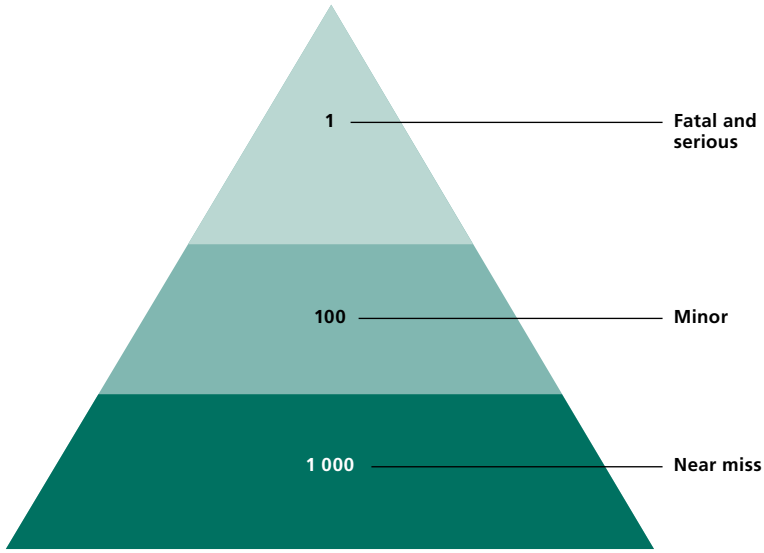
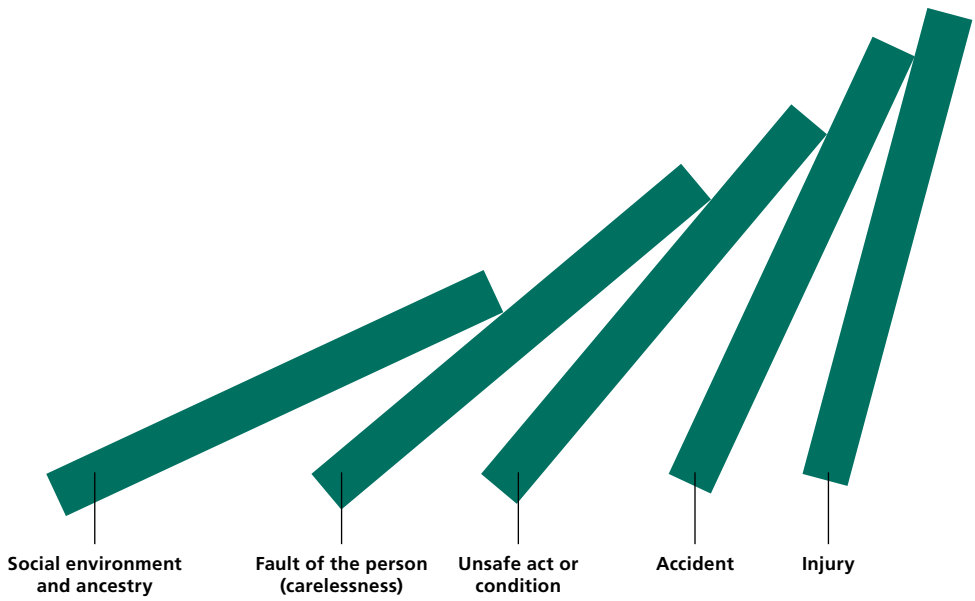


FIGURE 7
Domino theory of accident causation by Heinrich



one or more causal factor, however, the accident won't occur (Marsden, 2017). Heinrich found that about 2 percent of accidents were unavoidable in the industrial settings of the time (Heinrich, 1931; Heinrich, Petersen and Roos, 1980), and the remaining 98 percent were caused either by unsafe acts by workers or by unsafe conditions, both of which management could control. Later, multiple causes of accidents were identified and more emphasis was placed on a system of causes (Petersen, 1990). Accidents typically have at least three causes:

1. basic or root causes (e.g. safety management);
2. indirect causes (e.g. unsafe conditions/acts); and
3. direct/proximate causes (e.g. struck by tree).

The severity of an accident may be due to chance, but its occurrence is predictable. Contemporary accident analyses address operating-system design; worker knowledge, skills and abilities; and the hazards presented by the job environment.

3.4 Developing a safety culture

The Occupational Safety and Health Administration (OSHA) of the United States of America identifies safety culture as the basis of continual safety improvement. A safety culture comprises the shared beliefs, practices and attitudes that exist in an organization. Culture is the atmosphere created by those beliefs, practices and attitudes that shape behaviour. An organization's safety culture is the result of factors such as:

- management and employee norms, assumptions and beliefs;
- management and employee attitudes;
- values, myths and stories;
- policies and procedures;
- supervisor priorities, responsibilities and accountability;
- production and bottom-line pressures versus quality;
- actions, or lack of actions, to correct unsafe behaviours;
- employee training and motivation; and
- employee involvement or "buy-in".

In a strong safety culture, everyone feels responsible for safety and pursues it on a daily basis; employees go beyond the call of duty to identify unsafe conditions and behaviours and intervene to correct them. The way in which forestry accidents are viewed shapes how they are investigated, reported and analysed. Thus, the safety culture of an organization is a crucial factor.

A climber scales a eucalypt tree to harvest seeds in Bulawayo, Zimbabwe, with appropriate safety equipment. Tree-climbing is one of many hazardous activities in forestry

© FAO/TAWANDE ANTONY

4 Stakeholders in forestry accidents

The key to improving forestry accident reporting and analysis is to build a community of interest among stakeholders to ensure that the concerns of all stakeholders are addressed. Stakeholders should be identified and their primary interests specified (some will have more than one). Table 3 groups stakeholders by their general interest (Appendix 1 describes a range of stakeholder groups and their primary interests). The order in which the stakeholder groups are presented in Table 3 is approximately from those closest to the accident to those most removed from it. The extensive list of stakeholder groups shows the breadth and depth of interest in improving forestry accident reporting and analysis.

TABLE 3
Stakeholder groups in forestry accidents

1 Workers and people
Families and survivors
Workers
Co-workers and supervisors
Company owners/contractors
Employers
Forestry workforce, forest sector and leaders
Potentially marginalized groups, such as women, youth, immigrant workers, indigenous workers, illiterate workers, aging workers and vulnerable workers
Community-based organizations, non-governmental organizations
Local, subnational and national media
Internet users, social media users
2 Research and safety organizations and professions
Subnational, national and international research organizations
Subnational and national safety academics
Forestry education/training institutions
Forestry extension programmes
Local, subnational and national safety organizations
International safety organizations
International Labour Organization, FAO, International Organization for Standardization
Medical profession
Legal profession

Table continues

Table continued

3 Industry
Companies employing contractors
Forest landowners and managers
Stockholders and shareholders
Equipment manufacturers
4 Government interests
Local law-enforcement investigators
Subnational safety-enforcement agencies
National safety-enforcement agencies
Policy analysts, regulatory decision makers
Legislative bodies and institutions
5 Associations
Contractor and industry associations
Unions, worker associations and groups
Forestry certification organizations
Consumers of forest products
6 Insurance
Workers compensation, social insurance
Private insurance
Insurance rating organizations

A worker in southern Africa manoeuvres a board during the milling process without adequate protective equipment

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5 Laws and regulations regarding accidents, health and workers

5.1 National and subnational safety laws

Many countries have national laws to promote safety and health. Such laws reaffirm society's interest in protecting workers, establish safety and health goals, and create a government administration to enforce safety and health regulations – including reporting requirements. In the United States of America:

- The Occupational Safety and Health Act (1970) is the primary federal law governing occupational safety and health in the country's private sector and federal government. The main goal of the Act is to ensure that employers provide employees with an environment free of recognized hazards, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat and cold stress, and unsanitary conditions. The Act created the OSHA.
- The State of Oregon passed its own occupational safety and health law, the Oregon Safe Employment Act (1973), to enforce the state's workplace safety and health rules. About half of all states in the United States of America have their own safety laws, agencies and enforcement. These rules and agencies are supported partially by the federal government, and state plans must be approved nationally. Requirements for state plans include the following:
  - They must meet federal requirements and may exceed them.
  - Employee coverage must meet or exceed federal coverage; smaller firms and uncovered industries are typically included.
  - Penalties in state plans can exceed the penalties that federal courts may impose.
  - The reporting of occupational injuries and illnesses must follow federal guidance and forms.

State plans typically provide more coverage and enforcement for the types of industry found in a given state or region.

A number of countries – especially developing countries – are on a trajectory of improving their safety and health legal frameworks. Early safety and health laws usually state the importance of worker safety, but, to hold an employer responsible, employees needed to show, in court, that the employer has been negligent, or the state needs to show criminal intent to injure workers. Over time and with greater social pressure, countries have added laws on workers' compensation, in which workers relinquish their right to sue employers in return for a system of compensation for death and injury. Further changes to laws have involved adding specific regulations on safety improvement and voluntary codes of practice that must be followed to ensure compliance and employer

protection. Other developments include extending the legal obligations of employers to improve safety and health management, worker accident and health reporting, and the treatment and rehabilitation of workers. New Zealand recently improved its industrial and forestry safety legal framework because:

> "Too many New Zealanders die or are seriously hurt while working. In comparison with other similar countries, our workplace health and safety record is woeful. Every year:
> - 52 people die on the job
> - Hundreds more are seriously injured
> - 600–900 die from work-related diseases.
>
> "Something has to change. We all need to work smarter and work together to do something about it. On 4 April 2016, the Health and Safety at Work Act (HSWA) came into force bringing new responsibilities for everyone in the workplace. The new law is part of a reform package aimed at reducing the number of serious work-related injuries and deaths in New Zealand by at least 25 percent by 2020" (Worksafe, 2017).

Other countries have followed slower trajectories of improvement due to limited resources (ILO, 2015a).

5.2 Worker rights and responsibilities

In most countries, safety and health regulations emphasize that everyone who goes to work deserves to return home healthy and intact. In some, however, laws do not cover all workers, or they are ineffective in protecting workers; moreover, forestry accident and illness reporting and analysis may be deficient. In developed countries, regulations provide health cover for illness and injury; payment for lost workdays; rehabilitation assistance; support for retraining and job-change; and compensation for death and disability. Workers are also entitled to know about accidents and illnesses in the company in which they work and to participate in accident investigations and safety and health improvements. Some regulations assign the primary responsibility for worker behaviour to companies; others (e.g. in New Zealand) assign some responsibility to workers for their own safety-related actions. Compensation may be reduced if workers fail to comply with safety and health measures (e.g. in British Columbia, Canada).

5.3 Companies, managers and owners

Most safety and health regulations assign responsibilities for safety and health to business organizations with employees. Some forms of businesses are not covered – such as sole proprietors (i.e. with no employees); the business owners themselves; partnerships; and some not-for-profit and volunteer organizations. Company directors and managers are considered to be agents of the business and are not necessarily personally responsible. With the acceptance of workers' compensation arrangements, employers are not open to negligence lawsuits from workers for injuries or illnesses. In a number of countries,

however, business owners, managers and supervisors may be held liable by the state, both criminally and civilly, for criminal acts, gross negligence, and intentional malfeasance. New concepts of safety and health responsibilities for social insurance coverage mean that everyone who obtains benefits and conducts activities has safety and health responsibilities – including businesses, company officers, workers and other individuals. In New Zealand, responsibilities for safety and health extend to visitors and customers (Worksafe, 2017).

5.4 Product liability law

In general, under product liability law, manufacturers, distributors, suppliers, retailers, advertisers and others who make products available to the public are held responsible for the injuries those products cause. Some safety and health regulations prescribe those products (e.g. protective equipment) and machines (or their characteristics) that may be used in forest activities. Accident reporting and analysis need to reflect the role of machines, accessories and products in accidents and illnesses. Third-party lawsuits may be brought against those who provide products with defects implicated in accidents or injuries. New Zealand's Health and Safety at Work Act (2015) sets out the responsibilities in safety and health of product designers, manufacturers, importers, suppliers and installers.

5.5 Reporting laws

Safety laws at the national and subnational levels should specify what should be reported, by whom, to whom and when. Accident reporting may be triggered by the nature of the injury, with categories such as death; amputation; requiring overnight hospitalization; spinal injuries; severe laceration; and exposure requiring hospital treatment. Another trigger may be the nature of the incident, such as: catastrophe involving three or more employees; aircraft accident; chemical spill; explosion; and vehicle accident. The law should also specify deadlines by which reports must be submitted (e.g. within 8, 24 or 72 hours of an incident, or periodically, such as annually). The reporting period should include accident investigation, hazard reduction, and co-worker safety. Safety and health organizations should lead the reporting process. Other legal entities are required to report accidents, especially first-responders, local law-enforcement authorities, medical organizations (e.g. hospitals), medical examiners and physicians. The nature of the reports of such entities is highly variable, and the reports generally do not follow safety and health formats.

5.6 Individual and company privacy

The privacy of individuals and companies is addressed in some safety and health laws and regulations. In the United States of America, the Health Insurance Portability and Accountability Act (1996) has numerous provisions for protecting individual privacy. Research into workplace accidents and health requires anonymity and the maintenance of the privacy of companies and human subjects. Even subnational summary reports of forestry accidents and illnesses might not be made public if the number is so low that entities and individuals might be identified. Thus, privacy laws can affect the nature and

adequacy of forestry accident reporting and analysis. The deep knowledge of forestry accidents developed in litigation is often unavailable if covered by confidential settlement agreements, although trials are public.

5.7 Basic obligations of reporting laws

Legal frameworks for reporting forestry accidents and illnesses are needed at the national and subnational levels. At a minimum, frameworks should specify:

- requirements for reporting for covered entities in all relevant sectors;
- standardized reporting forms and special forms for forestry;
- what reports are required, by when they should be prepared, where they should be submitted, and who is required to report, and the need to include triggering events and incidents and maintain records;
- requirements for submitting more-detailed information for special surveys and studies; and
- privacy provisions that protect individuals and entities but allow summaries.

Good practice in Zambia: drinks and fresh, well-prepared food are sold near a busy logging site

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6 Accident analysis

Accidents produce stress and involve emotions and unpredictable behaviour. The purpose of accident investigation and analysis is to find out, in an unbiased fashion, what occurred, the causes of the accident, and ways in which similar accidents might be avoided in the future. The availability of an investigation protocol for those at accident scenes will assist in accident investigation and analysis. A protocol provides guidance for the correct conduct, procedures and responsibilities in an accident investigation (usually written as policy). The author of the present report has used such protocols immediately at accident events and – at times – years after an event, with tangible benefits. Improved accident investigation is crucial for accurate reporting and analysis.

Not all those who investigate accidents are truly unbiased, however. Some investigators have vested interests and purposes, for example to absolve clients of blame or responsibility. Some investigators may focus only on whether laws or regulations have been violated; they may seek to protect themselves, the victims or co-workers. Some investigators may have financial interests in the investigation outcome and may thus attempt to obstruct investigations. Such motivations need to be recognized and minimized. If conflicting interests or aims exist, different investigations of the same accident may have different findings; unbiased investigations, on the other hand, would produce consistent findings.

Due to the potential for conflicting interests, investigations of accidents can be classified into two groups:

1. accident investigation – connotes a criminal act or blame and may create adversarial relationships; and
2. accident analysis – an effort to determine system failures in which the apportioning of blame and the pinpointing of singular causes are avoided.

This report generally uses the term accident analysis to emphasize that the objective is to find out, in an unbiased fashion, what occurred, the causes of the accident, and ways in which similar accidents might be avoided in the future. The term investigation is used more narrowly to describe the investigative work done at an accident scene directly after the accident.

Individuals who are knowledgeable about forestry activities and accident investigation are needed for accident analysis. If that knowledge is unavailable in one person, a team should be assembled. Organizations should designate and train individuals to investigate forestry accidents in the field. Organizational policies and regulations may specify who should be involved. Employers may decide whom to include in investigation teams, and labour agreements may specify that employee union representatives need to be involved. Safety agencies with jurisdictions may require investigations by their own personnel. Insurers may have their own investigators, as may industry associations.

6.1 Accident reports versus accident reporting

The result of an accident analysis is an accident report. This documents the finding of the analysis of a single accident event. Accident reporting, on the other hand, comprises the forestry accident reports for a specified period. The content of an accident report varies but usually includes:

- Executive summary
- Introduction
- Background
- Accident description
- Findings
- Conclusions
- Review and follow-up
- Attachments/appendices.

Descriptions should be sufficiently detailed and clear to enable those involved in the event and those using the report to fully comprehend what took place.

An accident analysis training course for foresters and law enforcement in Montana, United States of America © John J. Garland

6.2 Accident investigation resources

The International Labour Organization (ILO) provides a good practical guide to the investigation of occupational accidents and illnesses (ILO, 2015b). The *ILO Encyclopaedia of Occupational Health and Safety* provides general guidance on accident reporting

(Monteau, 2011). A number of agencies and forestry associations provide guidance on accident investigation. The Oregon OSHA, for example, offers an online course and materials for accident investigation that strongly relate to forestry accidents.[2]

6.3 Observations on accident analysis and investigation

Staal Wästerlund (1990) reported on efforts to improve forestry safety in Zambia and noted the need to keep reporting forms simple enough to match the knowledge of those expected to use them. Such an improvement can increase the number of accidents reported. Forestry workers involved in accidents – who could be crucial witnesses – may face communication barriers. For example, immigrant workers may not understand the safety framework they work within; some employees have difficulty in accepting their rights and responsibilities in accident investigations.

[2] http://osha.oregon.gov/edu/courses

A forwarder in action in the United States of America

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7 Accident reporting guidance

This chapter provides detailed reporting guidance with examples. Box 2 contains a simplified reporting form for immediate use based on typical reporting forms used by governments and safety organizations. Ideally, such a form would be re-created (and adapted to local circumstances) in Excel for ease of completion, compilation and analysis.

BOX 2

Sample accident reporting form

CASE NUMBER	DATE OF SUBMISSION
SUBMITTED BY	
Name	
Address	
Phone	
Relationship (employer, worker, family, medical, union, other)	
EMPLOYER OF INJURED IDENTIFICATION	
Identification number	
Address	
Phone	
BUSINESS ACTIVITY IN FORESTRY	
Private or public	
Employment numbers	
Type of business relationship (employer, contractor, subcontractor, casual labour)	
Business activity of principal if contractor	
INJURED WORKER INFORMATION	
Name	
Address	
Gender	
Date of birth	
Nationality	

Box continues

Box continued

INJURED WORKER INFORMATION (continued)	
Native language spoken	
Occupation title	
Type of relation to principal (employee, independent contractor, casual worker, volunteer, other – describe)	
Payment type (hourly, production, variable by contract, other)	
THE ACCIDENT	
Date	
Start time	
End time	
Location (land directions, GPS coordinates, marked at site)	
City, county, state, region	
What happened to cause the accident?	
What was worker doing before accident?	
What occurred after accident?	
What was worker's typical task?	
Was worker doing typical work or unusual event occurred?	
Accident type (fatality, serious, other)	
Accident at work or travel to/between work? Describe	
Type of injury if known	
Body part involved	
Was injured using personal protective equipment? Describe	
What equipment/tools were associated with accident?	
Was accident investigated/described? By whom? (e.g. medical, authorities, employer, other)	
Contact information	

An accident report provides data for more-or-less standardized accident reporting. When summarized, such data constitute surveillance of industries, sectors, countries and other classifications, which epidemiologists, for example, can use in making comparisons and determining trends. Data on industrial health may also be derived from medical sources, surveys and special studies. Poschen (2011) addressed forestry safety and health in the *ILO Encyclopaedia of Occupational Health and Safety.*

7.1 Legal and voluntary reporting obligations

Accident reporting in forestry varies worldwide. Article 11 of ILO Convention 155 (the Occupational Safety and Health Convention) calls for "the establishment and application of procedures for the notification of occupational accidents and diseases, by employers and, when appropriate, insurance institutions and others directly concerned, and the production of annual statistics on occupational accidents and diseases". Only about one-third of United Nations member countries have adopted the convention, however; many developed countries and developing countries with significant forest sectors have not. On the other hand, some countries with significant forest sectors had legal frameworks comparable with ILO Convention 155 before the latter's creation.

Although beyond the scope of this publication, a summary of the legal frameworks in place for forestry accidents and health, by country and subnational region, would be helpful in interpreting reporting results.

Legal obligations

In the United States of America, employers have obligations under the federal OSHA to prepare and maintain records of serious occupational injuries and illnesses. Some states, such as Oregon, have reporting requirements equal to or exceeding federal requirements.

Employers participating in workers' compensation insurance or a country's social insurance programme have reporting obligations. Other insurance arrangements likely require reporting based on the nature of the coverage. Self-insured organizations require accident reports.

Voluntary reporting

New Zealand has had a voluntary accident-reporting scheme among contractors in logging and silviculture since the early 1980s. Data and reporting forms are specific to forestry activities and require the provision of a high level of detail for lost-time injuries, minor injuries and near misses (Parker *et al.*, 2004). The accident-reporting scheme continues to provide useful information on steep-slope-logging machines (Visser and Stampfer, 2015). In Louisiana, United States of America, logging companies agreed, on a voluntary basis, to submit accident reports annually to the Louisiana Logging Council as part of a strategic partnership agreement between logging companies and the federal OSHA because they were not covered by mandatory requirements (de Hoop and Lefort, 2003). Guidance on safety and health in forestry in the ILO's 1998 code of practice on safety and health in forestry work is not legally binding but provides guidance that can be used as a benchmark for good practice (ILO, 1998).

7.2 Organizations that report

The organizations that report on forestry health and safety are diverse. In any given country they may include:

- national and subnational safety regulators and accident compensation organizations;
- insurance organizations providing various forms of insurance;
- social insurance organizations;
- forestry and contractor associations;
- employer associations and worker unions;
- forestry academic and research institutions;
- medical research institutions;
- insurance rating organizations;
- individual experts on forestry;
- private forestry companies and self-insured organizations; and
- advocacy groups, interest groups, news agencies and other media.

7.3 What accidents are reported

Fatalities are almost always reported, but accident categories are inconsistent. Reporting on "time away from work" varies between countries and organizations – for example, an absence of 1, 2, 3, 4, or up to 14 days might be needed to qualify for reporting. The seriousness of injuries – overnight hospitalizations, amputations or loss of eyesight, for example – might determine the need for reporting. Days with restricted work activity or requiring job transfers may be reported. The time allowed for reporting also varies. As of 1 January 2015, all employers in the United States of America must report to the OSHA:

- all work-related fatalities within eight hours; and
- all work-related inpatient hospitalizations, amputations and losses of eyesight within 24 hours.

Near misses and incidents in forestry are generally reported only in special reporting schemes, cooperative reporting, reports on equipment-related damage, and some private organizations and companies.

The definition of work-related accidents and health issues has been broadened to include transportation involving work, heart attacks, workplace violence and others. The trend in developed countries is to connect more accidents and illnesses with work and to reduce the time allowed for reporting to competent authorities.

7.4 Who is covered and not covered in reporting

The exemption of certain individuals and organizations in reporting is a problem in the forest sector. Owners, independent subcontractors and individuals who are not employees may be exempt from a company's reporting requirements. In some countries, reporting requirements are directed at large companies. In the United States of America, new OSHA rules retain an "exemption for any employer with ten or fewer employees, regardless of their industry classification, from the requirement to routinely keep [accident] records". The company-size exemption would rule out the majority of logging firms from reporting on accidents (beyond mandatory requirements). Some

forestry states have lowered the size limit to five employees. In Oregon, all employers (with some exceptions) with employees are subject to safety rules and reporting requirements.

7.5 Where do forestry accident reports come from?

The number of forestry accidents is well reported in some countries, and resources are sufficient to produce an enumeration (census) of forestry reports. In developing countries, resources may be limited to readily available forestry reporting. In large countries, forestry accident reporting at the national level may be the result of a sampling of companies, with limited coverage of small forestry firms. For example, the United States Survey of Occupational Injuries and Illnesses mandates employer participation, but many forestry employers are omitted from the sampling. In some states with significant forest sectors, such as California, Montana, Oregon and Washington, there is substantial coverage of the forest sector, producing data that are useful for reports.

7.6 What is typically covered in forestry accident reports?

General industry accident reports are used to:

- estimate the causes and magnitude of accident problems;
- identify and prioritize the need for preventive measures;
- evaluate the effectiveness of preventive measures;
- monitor risks, issue warnings and conduct awareness campaigns; and
- provide feedback for those involved in prevention.

Accident reports typically present data on aspects such as:

- injured worker demographics (age, education, gender, etc.);
- time/day/month of accident;
- body part injured;
- type of injury;
- duration of injury;
- type of accident (e.g. victim fell, or was struck);
- the length of time the victim had been employed before the accident;
- job class;
- prior activity;
- tools/equipment involved;
- injury agent; and
- description of the accident.

The usefulness of accident reports is in the patterns that emerge when a large number of accidents occur under similar circumstances and are reported. The standardization of reporting allows comparisons between sectors, regions and countries and helps identify effective preventative efforts.

7.7 What is needed in forestry accident reports?

The distillation of individual accident analyses into accident reports must be done in such a way that the data "speak" to those who understand forest operations and

accidents. Much information is lost in converting accounts of accidents into summary reports, and some information (e.g. site information such as slope, tree size/condition, specific equipment, actual experience versus employment with firm, weather, fatigue indicators, and personal protective equipment use) may not have been recorded in the first place. There is a need to include more forestry-related data in accident reporting schemes (as per New Zealand's approach) and to conduct special studies of forestry accidents. The uniqueness of forestry accidents in differing forestry operations and levels of worker skills (e.g. among professional, non-professional and casual workers) means that, to be useful, reports must include specific data to a high degree of detail. Alternatively, a process of combining accident reports with existing data reviewed by experts in forestry accidents could help link up reports with individual accident reports. Table 4 gives examples in forestry where such data have led to improvements in worker safety.

TABLE 4
Linking accident report indicators, causes and preventive measures

Report data indicator	Cause (from accident report)	Preventive measure
Number of cuts to left leg	Chainsaw	Introduce anti-cut chainsaw pants or chaps; change technique
Cut/amputations left hand	Chainsaw	Introduce chain brakes; use protective gloves
Struck by logs in yarding	Crew too close to operation	Supervise to get in the clear
Struck by log from truck	Driver struck while removing load restraints	Modify unloading practice; use binder racks to protect driver
Struck by tree	Feller cut tree with hang-up in it	Prohibit practice; use alternative techniques, equipment
Fall from height	Operator fell mounting/ dismounting machine	Improve access design, training
Struck by wood, saw part	Loop-chain broke on machine, or wood object thrown	Improve guards and operator protection

7.8 Accident reporting formats

Various general accident reporting forms are available online and can be used as a basis for developing forms to suit specific forestry situations. For forestry accidents, however, additional data would be beneficial. Appendix 2 lists aspects that could be added to reporting forms for forestry accidents and illnesses and subsequently summarized in accident reports submitted to authorities; this would ensure that crucial information is captured to allow the true causes of forestry accidents to be determined. No publicly available reporting formats containing such aspects exist outside special studies. FAO and other interested parties, including the ILO, could convene panels of experts on forestry accidents and illnesses to develop reporting formats targeted at forestry activities, such as motor-manual and mechanized operations; ecological and vegetation management; silviculture; forestry transportation; and forestry maintenance.

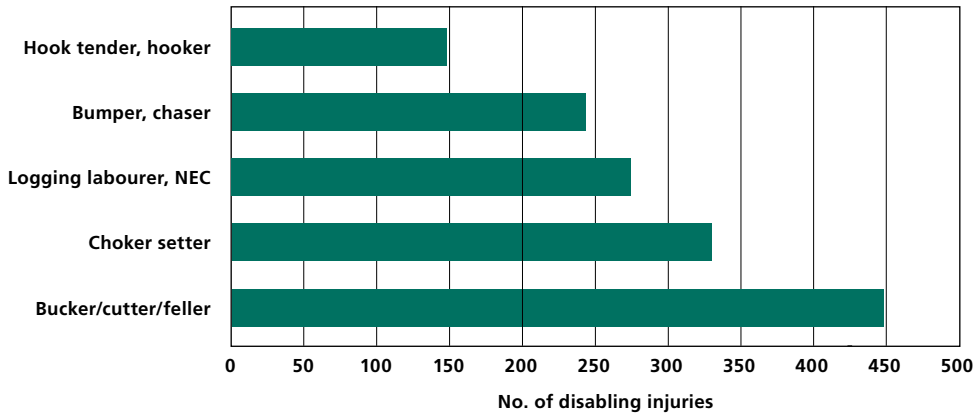
Forwarding in the Khimki Forest, Russian Federation: operators working in protective cabins face fewer hazards than workers on the ground. By Daniel Beilinson - Timber Truck Uploaded by High Contrast, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=22200659

7.9 Summaries of forestry accident reports

Presenting summary data from accident reports is helpful in communicating findings. Figure 8 presents such data graphically for forestry accidents in Oregon.

FIGURE 8

Top five occupations in logging for accepted disabling claims, Oregon, United States of America, 2000–2004



Note: NEC = not elsewhere classified.

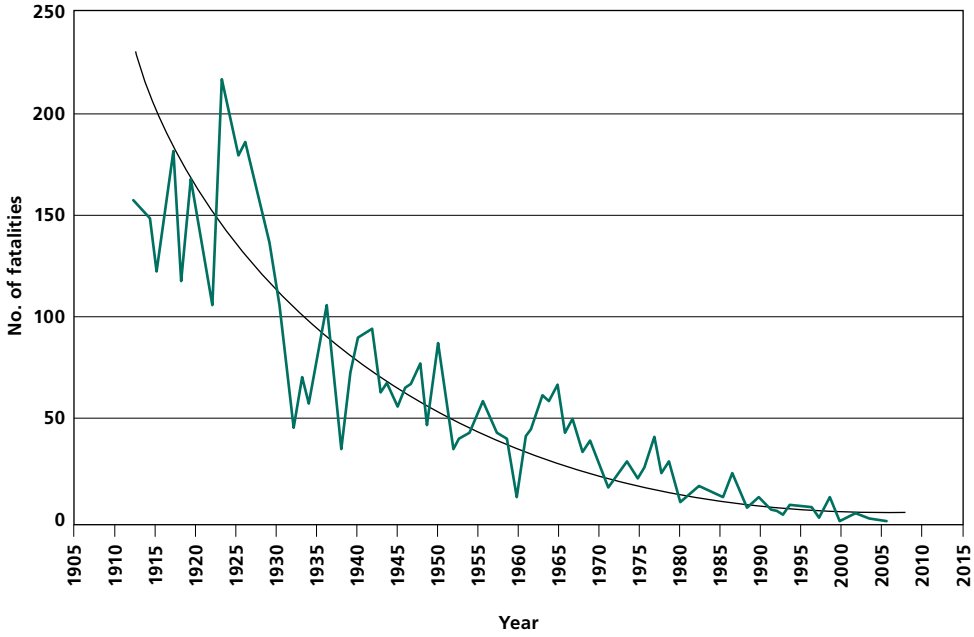
Source: Oregon Department of Consumer and Business Services (2005).

Figure 9 shows, graphically, important trends in accident data for workers in Chile, by worker age. Longer-term trends are also of interest; Figure 10 shows that the number of logging-related fatalities in Washington, United States of America, fell dramatically in the 100 years from 1905 to 2005.

FIGURE 9
Evolution of the age of workers suffering accidents in forest-sector enterprises belonging to the Chilean Safety Association, 1998–2002 to 2004–2008

Source: Ackerknecht (2010).

FIGURE 10
The number of logging-related fatalities in Washington, United States of America, 1905–2005



Source: Washington Labour and Industries data.

A forest worker makes a back-cut to fell a tree in Zambia

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8 Analysis of reported accidents

When stakeholders interested in forestry accidents and illnesses review forestry reports and can identify interventions, significant changes can occur in the way in which forestry operations are conducted. Such changes often respond to technological, economic and social pressures and the need to improve worker safety and health. The author is aware of a number of changes that have been made in forestry – in different places and over differing periods – in response to the reporting of accidents. Initial interventions often evolve into a series of improvements within the sector as technologies improve and management commitment grows. Table 5 shows some responses to accident and illness surveillance in forestry that the author has participated in or observed.

TABLE 5
Forest-sector changes in response to accident reporting knowledge

Period	Location	Reporting stimulus	Intervention and changes
Current	Oregon, Washington, USA; New Zealand, Chile	Injuries to workers on steep slopes	Replacing hand felling and cable logging with tethered machines
2000+	West coast, USA	Arm and shoulder injuries incurred by log truckers	Replacing steel wire rope and chains used to secure logs on trucks with synthetic rope
1990+	British Columbia, Canada	Deaths and injuries to tree fellers	Adoption of British Columbia feller standards, training and certification
1990+	Nordic countries	Machine operator overload and stress	Introducing machines with reduced vibration; changing control and work organization
1985+	Chile	Overall high forest industry accident rates and poor working conditions	Improving reporting, training, management commitment, working and living conditions
1980+	West coast, USA	Truck drivers struck by logs falling from trucks	Developing binder racks to protect drivers and assigning safety responsibility to unloading facility
1970+	Worldwide	High levels of chainsaw injuries, including those caused by kickback and vibration-induced damage	Improving saws/chains by introducing chain brakes, reducing vibration levels and heating saw handles; providing training
1960+	Canada; Sweden; USA	Deaths and injuries among timber fellers	Improving training and work arrangements; developing tree-felling machines

Feller-buncher/shovel logger tethered machine on steep slopes in Washington, United States of America © John J. Garland

8.1 Analysis of individual accidents

Analyses of reported accidents and fatalities exist in some countries. In Oregon and other states of the United States of America, the National Institute for Occupational Safety and Health (NIOSH) supports efforts to analyse fatalities in industries through the Fatal Accident and Control Evaluation (FACE) programme. In Oregon, OR-FACE is designed to prevent occupational fatalities through surveillance, targeted investigation, assessment and outreach associated with traumatic work-related deaths (OHSU, undated). Annual reports cover the industry-related fatalities in the state, including in forestry and logging. To the extent that forestry and logging have fatalities, they will be included in annual OR-FACE report statistics, with brief descriptions (Box 3 provides an example).

Fatalities are investigated more completely when the companies and individuals concerned cooperate fully. For example, the incident described in Box 3 (in which a 30-year-old logger was killed when a log fell on him) was fully investigated by a competent logging accident analyst, giving rise to recommendations. FACE investigations can also lead to the production of educational materials (for example, the incident in Box 3 was summarized in a two-page report and used by the industry in "tailgate" safety meetings). Nationally in the United States of America, the Forest Resources Association produces "safety alerts" for forestry, which are brief descriptions of accidents, including specific characteristics, injuries and recommendations.[3]

[3] https://forestresources.org/resources/safety/safety-alert

BOX 3

Example of descriptions of forestry and logging fatalities included in Oregon Fatal Accident and Control Evaluation annual reports

Swinging log in turn Forestry/Logging Logging March 18 Lincoln OR 2008-07-1	A 30-year-old logger, working as a rigging slinger in a cable yarding operation, was killed when a log in a turn of logs upended and struck him. The rigging slinger signaled to go ahead on the turn without first getting in the clear. He stood 15–25 feet from the turn. The log that struck him was 37 feet long. As the turn moved forward, the log struck a stump and swung toward the rigging slinger. He dove to the ground for cover, but the log came down on top of him. The victim was pronounced dead at the scene.

8.2 Equipment implications

When equipment is involved as a potential cause of an accident, machine manufacturers may be liable for damages. Records kept by manufacturers of injuries and machine damage are proprietary, but they may be made known through litigation or accident investigations and can then be used in accident analyses to identify problems and potential solutions. In the late 1990s, for example, workers were killed or injured by wooden objects thrown from high-speed circular "hot" saws, but manufacturers asserted that this was not possible. Litigation and associated accident analysis established the throwing mechanisms and caused manufacturers to add sufficient guarding to reduce the danger posed by thrown objects (Garland and Rummer, 2009). Similarly, chainsaws and harvesters using bar saws would throw pieces of chain towards operators when they broke. The "chain shot" phenomenon and process was identified in accident analyses and measures were taken to improve chain maintenance and operator protection after injuries and fatalities occurred (Rummer and Klepac, 2011). In forestry, machine accountability is complicated when one manufacturer produces a base machine carrier, another modifies it for forestry use, and yet another adds an attachment for specific use. If liability issues can be set aside, cooperative efforts on safety using manufacturers' data and involving researchers can lead to improvements.

8.3 Resource allocations and magnitude of safety problems

The cost of accidents grossly exceeds the costs of preventive efforts, including reporting and analysis. Managers have difficulty allocating resources to preventive measures, however, because it is impossible to demonstrate "the accident that did not happen" due to such preventive measures. The annual cost of industrial accidents and illnesses in the United States of America is likely a staggering USD 200 billion (National Safety Council, 2013). Logging occupations are major contributors to this cost (Leigh *et al.*, 2000). Other occupations that are large contributors to both the total national cost and cost per person include truck drivers; labourers (e.g. in construction); janitors and cleaners; nurse's aides; assemblers; carpenters; and miscellaneous food preparation occupations. In Oregon,

the total compensation costs as written policies for all industries combined exceeds USD 880 million dollars, with logging's share at least USD 45 million (DBCS, 2015).

8.4 Cost of accidents: individuals, companies, insurance and society

The emotional and financial costs to workers and their families of fatalities and disabling injuries cannot be calculated. Nevertheless, there can be a huge difference in the amount of compensation paid to an injured worker (or to the families of workers killed in work-related accidents) in a developed country compared with that paid in some developing countries to workers (or their families), who may be working in remote (and possibly illegal) forestry operations. In industrialized countries, the lifetime cost of a permanently disabled logging worker evaluated in insurance settlements is in the range of USD 2 million–3 million. Ironically, the compensation paid for a death tends to be lower than that paid for the lifetime care of a disabled worker (DBCS, 2015). At the lowest level of humane treatment for killed or disabled workers, a company may offer a modest settlement and help return them home. Workers' compensation systems and social insurance have formulas for evaluating worker payments that are sometimes limited by legislation and discounted to current net payments. In developed countries, there is a wide range of payments – in the order of USD 1 million to USD 50 million – in cases where liability litigation has established negligence or fault in an accident.

Direct and indirect cost of accidents

The direct costs of accidents include medical treatment; lost wages; rehabilitation; follow-up care; compensation payments; and accident costs. Indirect costs include lost production; replacement worker recruitment and training costs; injury reserve costs; lost future earnings; future medical costs; and sector wage losses. Workers' compensation and social insurance may cover direct costs, which could amount to only about 30 percent of total accident costs; employers and workers absorb the remaining indirect costs (Leigh *et al.*, 2000). In workers' compensation insurance, those covered ultimately pay all costs through their premiums. Social insurance may prorate injury costs among covered insured firms and society at large.

Insurance rates and accident costs

The cost of forestry claims is usually substantially higher than in other sectors. Table 6 shows that, in Oregon, both claim costs and lost workdays are above average in forestry.

TABLE 6
Cost of injury claims and number of lost workdays in logging and forestry compared with the average of all claims in 2010 in Oregon, United States of America

Sector	No. of claims	Average total cost (USD)	Average no. of workdays lost
All claims	18 526	22 720	77
Logging and forestry	230	45 360	118.2

Source: DBCS (2013).

Table 7 shows the cost of workers' compensation insurance in two states of the United States of America as a percentage of employee wages (assumed to be USD 20 per hour). In Washington, the rate for motor-manual workers is extremely high, largely because many costly accidents have occurred in a relatively small workforce. The rate is much lower in Oregon, where there have been fewer accidents and the costs are spread over a larger worker population.

TABLE 7
Logging rates and industry rates as percent of hourly wage and hourly cost in two states in the United States of America, 2015

State	Activity	Insurance cost (USD/hr)	Cost as % of average wage*
Washington	Forestry – motor-manual	20.18	100.9
	Forestry – mechanized	1.87	9.35
	All industry	0.70	–
Oregon	Forestry – motor-manual	3.72	18.6
	Forestry – mechanized	0.77	3.86
	All industry	0.03	–

Note: Average wage is assumed to be USD 20 per hour.

Sources: Data from Oregon Department of Consumer and Business and Washington State Department of Labor and Industries.

Employers are increasingly less able to compete in markets as the rate of workers' compensation insurance approaches 50 percent of the payroll. At high rates, therefore, there is a tendency to use independent contractors as a way of avoiding the requirement to pay workers' compensation insurance. The difference in insurance rates between mechanized and motor-manual work strongly motivates companies to shift to mechanized operations.

A forest worker practises direction felling without protective equipment

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9 Improvement efforts

Effective accident reporting and analysis in forestry leads to cooperative efforts to improve safety and health. Saari (2011) listed control measures for reducing accidents and discussed the hierarchy of controls. Modified descriptors are:

1) elimination of the hazard or substitute safer processes;
2) engineering controls like guarding and new, safer technologies;
3) organizational safety measures, work schedules, supervision and training; and
4) personal protective equipment.

Each of these is discussed below.

9.1 Hazard elimination

Mechanized logging removes workers from the hazards they may encounter when working on the ground and places them in protective cabins (Axelsson, 1998). The use of logging machines in steep terrain was previously impossible due to safety concerns, but recent developments in logging equipment, especially tethered logging machines, now enables safe operation on steep slopes. This development eliminates the hazards of tree felling, cable logging and the heavy workloads and strain involved in traversing difficult terrain. Hazards are eliminated and a safer process is in use.

9.2 Engineering controls

The increased use of hydraulic excavators and similar machines in forestry exposes operators to hazards such as machine rollover and being struck by trees or logs during handling. Machines used in construction and agriculture lack sufficient protection for forestry applications. The International Organization for Standardization and national and subnational safety-enforcement organizations have developed machine guarding and protection for operators of machines used in forestry. The manufacturers of forestry machines now incorporate such engineering controls, machine testing and procedures in their products.

9.3 Organizational safety measures

Logging training efforts are underway worldwide in many companies, associations and training institutions that provide organizational safety measures. Training obligations are codified in rules and regulations, and supporting training materials are widely available. Worldwide efforts to train workers in first aid and cardiopulmonary resuscitation have saved untold lives in forestry and other occupations.

In some countries (such as the United States of America), immigrants are undertaking an increasing amount of forestry work. Where this is occurring, it is important that training materials are produced in appropriate languages to ensure that workers

understand them. For example, the author has provided logging training materials in Spanish for use by employers in Oregon. Another organizational safety measure is to improve the supervision of workers, as required by regulations and operational necessity. Employer associations provide training for frontline supervisors, including on their safety obligations.

9.4 Personal protective equipment

Forestry accident reporting and analysis have contributed to the development and use of personal protective equipment and clothing to reduce accidents. Standards organizations such as the American National Safety Institute, as well as the ILO, specify the

A worker in Grenada wearing personal protective equipment © FAO/Giuseppe Bizzarri

performance of protective measures. Personal protective equipment relevant to forestry includes:

- head protection with helmets and hard hats;
- ear protection for workers on the ground, and the minimization of noise levels in machines;
- eye protection;
- hand protection with gloves;
- leg protection with pants and chaps;
- foot protection with boots; and
- cold-weather protection.

Improvement is needed in personal protective equipment in hot and humid environments to ensure adequate comfort.

9.5 Worker health

The effort to improve forestry worker health based on health reporting and analysis has been insufficient. Some occupational health disorders, such as chemical exposure (e.g. pesticides), hearing losses, heat- and cold-related diseases, repetitive stress syndromes, and certain musculoskeletal trauma, have been the subject of improvement efforts (Lewark, 2005), mainly in Europe and other developed countries. Forest-worker health screenings are lacking worldwide, however, and occupational health is generally not addressed. The difficulty of the work involved in forestry makes fatigue a major concern in the safety and health of workers. Diseases commonly suffered by sedentary machine operators and those involved in transportation – such as obesity, diabetes, and neck and shoulder damage – require better reporting and analysis.

Machine operator in a protected cabin

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10 Conclusion

The review of forestry accident reporting and analysis in this report shows that existing practices are inadequate, including in developed countries. Existing information indicates that forestry accidents and health concerns are serious problems in the forest sector worldwide. In some large countries with significant forest industries, however, the sampling done of forestry enterprises does not produce data that adequately interrogate the problems. Many developing countries with forest sectors lack adequate resources for and commitment to forestry accident reporting and analysis. Although many countries have legislative authority for reporting forestry accidents, the results fall short of what is needed. The recommendations below are designed to improve forestry accident reporting and analysis among relevant international agencies, such as FAO and ILO, and in countries with significant forest sectors.

10.1 Recommendations

Increase reporting of forestry accidents and illnesses
Data and understanding of accidents in the forest sector are important for ensuring worker safety, but the extent of such accidents is underreported. The arbitrary exclusion from coverage of accident reporting by size of operation is doing a disservice to the forest sector. Mechanisms should be put in place to enable workers to report accidents (with protections against retaliatory measures) and to trigger accident investigations by authorities.

Improve forestry accident investigation
The basis of determining cause and effect in forestry accidents is competent accident investigation in the field. International agencies and national safety organizations should provide training (e.g. workshops and web-based courses) on forestry accident investigation, reporting and analysis. An accident analysis protocol would help investigators in making their reports.

Tailor reporting forms for national conditions and specific forest activities
Generalized reporting forms designed for use in all (or other) industries are insufficient for reporting on forestry accidents. Additional sections and questions (such as those suggested in Appendix 2), and tailoring forms for specific countries and forestry activities, are needed. National and international experts could help develop such forms.

Designate institutions to oversee forestry accident reporting and analysis
National and international institutions should be designated to collect, review and analyse forestry reporting and accident analysis. Findings should be publicized widely to

enable the sector to improve its safety over time. In many countries, the forest sector lags behind other sectors in reporting, analysis and improvement efforts; specific national or subnational organizations should be assigned responsibility for forestry safety and health.

Increase funding for forestry accident reporting and analysis
Accidents and illnesses in the forest sector consume considerable resources, and efforts to improve safety and health would provide economic and social benefits and should be supported. In many cases, however, stakeholders are disaggregated and not well organized. Agencies may have limited funds for new action, and other stakeholders may have interest but little funding. It is necessary, therefore, to raise funds from sources such as insurers, employer and employee associations, foundations, and governments. Given the potential economic and social benefits, a well-conceived programme of improvement would likely garner financial support.

Assist developing countries to improve forestry accident reporting and analysis
Developing countries may need special assistance for accident reporting and analysis in the forest sector. Many have high levels of informal or illegal logging and operators with little capacity to address the safety and health of forestry workers. International support is needed to encourage governments to address safety and health in their forest sectors and improve worker conditions. Projects, workshops and conferences should be developed to draw attention to the issue and to help build support within countries and among stakeholders.

Create an international "help desk" for improving forestry accident reporting and analysis
When international companies introduce new products, they often set up help desks to aid new and potential users, offering promotional information on how the products might be used and expertise to help users get started. An international institution could establish such a help desk to provide expert help in using this guidance document to improve safety and health in developing and other participating countries. Experts could respond quickly to requests through social media, "live chat" and Skype. This approach recognizes that technological advances in many developing countries could enable significant rapid improvement in forestry safety and health.

10.2 Final word

A worldwide snapshot of forestry accident reporting and analysis taken today would show deficiencies. There are wide discrepancies between developed and developing countries, large and small companies, organized and disorganized forest-sector institutions, and the extent to which worker safety and health is valued in society. Nevertheless, a comparison of a snapshot taken today with one taken 40 years ago would show progress in developed countries, countries in transition, and many developing countries. Forestry worker safety and health are of concern to a large and energetic group of stakeholders. Progress is not only possible, it is inevitable – given competent accident investigation, reporting and analysis.

Workers load delimbed logs onto a truck in Zambia

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Appendix 1. Stakeholders in forestry accident reporting and analysis

Those personally affected by the accident

1. **Family and survivors.**
   Family members and survivors of deceased or severely disabled workers face tragic circumstances. Moreover, families may have lost their main sources of income. These stakeholders want to know how their loved ones were killed or injured, who is accountable, and what will be done to prevent future accidents.

2. **Victims.**
   No one will know the last thoughts of deceased workers, but those injured may or may not know what happened to them and may need an accident investigation and report to add to their knowledge. These workers can provide valuable insights into accidents and their actions and motivations leading up to the event.

3. **Co-workers and supervisors.**
   Co-workers and supervisors want to be sure that the cause of the accident is identified and the risks eliminated so no one else is hurt or killed. They want to know who is accountable and whether their own actions contributed to the accident. They want to move forward with their dangerous work as safely as possible.

4. **Company owners, contractors and employers.**
   Owners and employers are often held accountable for accidents. They want to know the causes of accidents, how to eliminate those causes and other hazards, and how to assure employees of their commitment to safety. They want to know whether their procedures, training and safety policies need review and modification in light of an accident.

Forest business stakeholders

5. **Companies employing contractors.**
   Large companies employ forestry contractors in part to transfer liability and responsibility for forestry accidents to their contractors. Their concerns centre around

whether they bear a certain level of responsibility for an accident by their actions or inaction and the requirements they impose on their contractors. Companies want the accident cause to be identified so their other contractors can take action to prevent similar accidents in the future. They also want to engage safe and effective contractors with solid accident prevention programmes.

6. **Contractor and industry associations.**
Contractors and the forest industry form associations to advance their interests. Some associations provide their members with workers' compensation insurance and associated consulting services. Associations are interested in individual accidents to the extent that the reporting of such accidents can help members avoid similar accidents in the future. They are also interested, on behalf of their members, in accident trends and causes. When associations have insurance or consulting responsibilities, they want summary reporting and analysis for their management. Association employees may investigate forestry accidents.

7. **Forest landowners and managers.**
Forest landowners and their managers need safe and healthy workers to manage and harvest their forest lands. They employ contractors and seek to select those with appropriate safety management in their operations. Landowners are often named in litigation for their actions or requirements that contribute to accidents. Forest-worker accidents and illnesses incur costs that the forest resource must ultimately cover. Some landowners seek to deflect responsibility for forestry accidents to employers' operations, but others proactively support measures to ensure the safety and health of forest workers. Landowners may conduct their own analyses and keep reports as proprietary information. They actively decide on the technologies to be employed on their lands and control the safety activities of those working for them. Forest landowners may be large private owners, public land managers, or small private forest owners. Often there is a strong forest landowner association or coalition that can support accident reporting and analysis.

8. **Stockholders and shareholders.**
Stockholders and shareholders in companies that use forest workers are sensitive to the working conditions provided by those companies. The corporate vision and goals may reflect safety and health efforts and a commitment to being injury-free. For example, the first of the four stated "core values" of Weyerhaeuser (a large forestry company) is as follows: "Safety: It's first on our list for a reason. We always start with safety, no exceptions" (Weyerhaeuser, undated). Marshalling corporate leaders to improve accident reporting and analysis leading to fewer injuries is a shared goal in the sector.

Unions, worker associations and groups

9. **Unions, worker associations and worker groups.**
   Organized labour and worker groups have stated goals of improving worker lives by eliminating accidents. Often they set aside adversarial positions to engage in cooperative efforts with employers on agreements emphasizing safety and health. Such agreements may, for example, specify that worker representatives should be included in accident investigations and on safety committees. Worker groups may prepare their own accident reports and statistics as well as review official reporting. They can be strong advocates for improving forestry accident reporting and analysis.

10. **Groups with special interests, such as women, youth, immigrant workers, indigenous peoples, illiterate workers, aging workers, vulnerable workers, community-based organizations and non-governmental organizations.**
    Women, youth, immigrants, indigenous peoples, illiterate workers, aging workers and vulnerable workers (e.g. from certain ethnic groups, or those fearful of authorities) require special attention in accident reporting and analysis and their unique circumstances need to be considered. Advocates for such special groups support improved forestry accident reporting and analysis.

Other forestry stakeholders

11. **Forestry workforce, forest sector and leaders.**
    In many societies there is a general awareness of the forestry workforce and its status. This awareness is heightened by news coverage of accidents or occupational rankings (e.g. headlines such as "Why is logging the most dangerous job in America?"; Moore, 2017). Advocates for the forestry workforce include sector leaders in industry, government, academia and worker groups, and workers themselves. The need to recruit and retain a high-quality workforce requires supporting efforts to reduce accidents in dangerous forest work. There is societal concern in many countries and regions for the plight of forest workers.

12. **Equipment manufacturers.**
    Equipment manufacturers and suppliers of forestry products do not want their products to be the cause of accidents. They want good accident reporting and analysis by competent investigators. They keep records of incidents involving their products and may conduct investigations themselves. Many of the incidents reported to them are near misses without injury but causing damage. Should their product be at fault, they will want to make modifications to prevent future accidents. Manufacturers may have an association with a strong safety emphasis to help them address safety issues. Individual manufacturers, suppliers and associations can be good collaborators in efforts to improve forestry reporting and analysis.

13. **Forestry certification organizations and consumers of forest products.**
Consumers of forestry products and the public generally want organizations to operate with high ethical and sustainable standards. To provide such assurance, certification organizations with specific standards audit forestry organizations and certify that standards are being met. Often, certification standards include measures regarding worker safety and health that aligns their interests with forestry accident reporting and analysis. Leveraging the coverage of the standard for accident reporting and analysis would reach many forestry organizations.

Government interests

14. **Local law-enforcement investigators.**
Local law-enforcement personnel may initially investigate forestry fatalities or serious accidents but may lack qualifications for investigating forestry accidents, which are often of a different nature to traffic accidents. Some poorly investigated accidents are reported, summarized, and used for misappropriate interventions.

15. **Subnational safety-enforcement agencies.**
Safety-enforcement agencies in states, provinces or other subnational jurisdictions typically investigate fatalities and serious injuries involving several workers. Some investigators in such agencies lack expertise in forest accidents and even accident investigation knowledge. Knowledgeable forestry experts are involved in accident investigations in some forestry regions, but there is a need for quality control and oversight. Some agencies focus on whether applicable laws or rules have been broken rather than on accident causation. These agencies may collect and report accidents across industry sectors and maintain research and statistics groups to analyse data. Agencies at this level are primary collaborators in improving forestry accident and health reporting and analysis.

16. **National safety-enforcement agencies.**
Depending on the scale of the forest sector, national safety-enforcement agencies may be involved in forestry accident investigation, reporting and analysis. In addition, national agencies promote laws, regulations and policies on safety and health to be followed by subnational agencies and the forest sector in general. The national authority can compel accident investigation and accident reporting – even requiring participation in surveys and national sampling studies. However, the forest sector may be considered too difficult in terms of data collection and analysis: for example, small forestry firms are difficult to work with for some national agencies and may be exempted from agency coverage. National agencies collect, report and analyse information across sectors for comparison and action. In the United States of America, the OSHA promulgates logging regulations and directives and has some educational resources (United States Department of Labour, undated). Thus, national safety-enforcement agencies are primary collaborators for improving forestry accident reporting and analysis.

Insurance companies and schemes

17. **Workers' compensation and social insurance.**
At the national and subnational levels, workers' compensation insurance covers employers' relationships with employees with respect to accidents, providing financial support for workers in exchange for immunity from employee legal actions. The cost of such insurance depends on accident rates and costs, and state or private insurers maintain accident reports and may conduct investigations. Insurers may be subnational jurisdictions such as states and provinces, quasi-state-owned, or private (regulated) companies. Some countries have social insurance for all people, including covering workers for accidents in a national system. Such insurers collect accident reports from a variety of sources, but the availability of the information they compile on accidents in forestry may not be public. Public workers' compensation insurers may have research and statistics' functions and produce useful forestry reports. Workers' compensation and social insurance organizations can be allies in accident reporting and analysis in forestry.

18. **Private insurance.**
In some countries and subnational jurisdictions, private insurance organizations provide employers with workers' compensation and other insurance; they may be for-profit or not-for-profit. Such organizations may do accident investigations, collect and summarize reports, and assess risks by sector and activity. Large organizations may be self-insured. Private insurance information is proprietary, but collaboration may be possible.

19. **Insurance rating organizations.**
There may be a national organization to provide rates for insurers. Rates may be inclusive of all employees or variable by activity within a sector; in forestry, for example, higher rates may apply for motor-manual work than for machine operations. Usually, data by sector is restricted to an organization, but cooperation may be possible.

Other professions

20. **Medical profession.**
The medical profession, including first-responders and hospital emergency teams, has direct contact with those injured in forestry accidents. Medical workers have an interest and often a legal responsibility to prepare reports on such accidents. The information they hold may be protected by patient privacy rights. Cooperative efforts with medical professionals and researchers in some countries provide worker health screenings and special projects dealing with occupational injuries and diseases. Medical professionals are strongly motivated to help with accident reporting and analysis to reduce injuries generally.

21. Legal profession.

The legal profession has an interest in forestry accident reporting and analysis as it relates to litigation involving forestry accidents. Parties may sue for damages as a result of forestry accidents caused by other parties. If workers' compensation arrangements eliminate suits between employees and employers, other suits may be brought by, and against, contractors, subcontractors, landowners, processing facilities, professionals, agencies, equipment manufacturers, suppliers and private individuals. Virtually anyone may be involved in a lawsuit. The courts decide on the merits of lawsuits. Attorneys rely on experts in forestry accidents to provide guidance in bringing or defending lawsuits, investigating or re-investigating accidents and providing expert testimony on the causes of accidents. Attorneys want good investigation, reporting and analysis at the time of the accident to determine the facts of the matter. Experts vary in their competence. Frequently, expert investigations show that initial accident investigations and reporting did not correctly identify the cause of the accident when it was analysed more carefully and when more detailed knowledge has been obtained under oath from witnesses. Resulting judgements in court usually involve financial settlements but may include equipment modifications or changes in production processes. Tapping expert knowledge can improve forestry accident reporting and analysis.

Researchers and academics

22. Subnational research and academic institutions.

Forestry regions often have research and academic institutions interested in forestry accidents as part of studies on forest operations. Although institutions solely dedicated to forestry accident research are rare, individual researchers and small groups worldwide have made important contributions to forestry accident reporting and analysis. Such individuals are passionate supporters of improved forestry accident reporting and analysis.

23. National research institutions.

The United States National Institute of Occupational Safety and Health (NIOSH) has a unit that promotes and funds research on forestry safety and health. It is small compared with other units but uses the national occupational research agenda process to support research in forest activities. NIOSH also funds regional centres, which may have forestry research projects – such as the Pacific Northwest Agriculture Safety and Health Center. In Germany, the Board of Trustees for Forestry Work and Technology (Kuratorium für Waldarbeit und Forsttechnik, or KWF) has a unit for the development of safe machinery and practices. Other countries have similar national research institutes with forestry competence working on forestry accidents.

24. International research organizations.

The largest group of researchers interested in forestry accident reporting and analysis is part of the Ergonomics Research Unit of the International Union of Forest

Research Organizations. These researchers are in research institutes and universities but come together to work on forestry workforce issues, including worker safety and health. They are committed to reducing forestry accidents and have published on accident reporting and analysis.

25. **Forestry education/training institutions.**
Many forestry educational institutions have staff with strong interests in forestry safety and health. Their publications reflect their support and indicate that they are advocates for improved accident reporting and analysis. Disconcertingly, however, forestry workforce issues and safety and health are absent from curricula in most forestry educational universities. Trees seem to be more important than people.

26. **Forestry extension programmes.**
Forestry extension programmes may be associated with universities or research institutes. Forestry agents and specialists are in close contact with the forest-sector workforce. Although they may lack expertise in forestry accidents, such agents and specialists are aware of the importance of forestry accident reporting and analysis. These professionals can assist in efforts to improve forestry safety.

Organizations with interest in occupational safety

27. **Local organizations.**
Informal organizations may exist at the local level with an interest in forestry safety. Such organizations may be termed "safety councils" and hold periodic events dealing with forestry safety (e.g. the Clatsop County Safety Council in Oregon, United States of America). Although such groups may be difficult to contact and organize, they support improved forestry accident reporting and analysis.

28. **Subnational organizations.**
Subnational safety organizations – in various forms and with diverse funding arrangements – may exist that support forestry efforts. For example, the British Columbia Forest Safety Council[5] was created in September 2004 as a not-for-profit society dedicated to promoting safety in the forest sector. It includes all of the major forestry organizations and is fully supported by WorkSafeBC and the provincial government. The Council's mandate is to work within the forest industry to eliminate casualties and injuries. Staff in subnational forestry safety organizations are likely to be ardent supporters of accident reporting and analysis improvements.

29. **National forestry safety organizations.**
In some countries, there may be a singular identifiable national safety organization while in others there are cooperative efforts led by industry associations. Corporación

[5] www.bcforestsafe.org

Chilena de la Madera is a Chilean association of entrepreneurs in the forest sector that maintains sector safety statistics along with the mutual insurance organization, Asociacion Chilena de Seguridad.

There is no single national forestry safety organization in the United States of America, but some safety organizations work with national forestry and logging associations.

The National Timber Harvesting and Transportation Safety (THATS) Foundation is a charitable 501(c)3 organization administered by the Forest Resources Association. Established in 1991, THATS has the following mission: "to promote, support, and serve as a catalyst for safe and professional work attitudes, practices, and conditions in timber harvesting and transportation".

30. **International organizations.**
The ILO and FAO are leaders in worldwide safety improvement efforts in Forestry. The International Organization for Standardization provides international safety and product standards that influence forestry safety.

Media

31. **Local, subnational and national press, internet users, social media users**
There is much interest in the press, on the internet and among social media users in forestry safety. These media can serve to disseminate information to help improve forest safety.

Policy analysts, regulatory decision makers, legislative bodies and institutions

32. **Policy-makers**
Improving forestry safety may require changes to legal frameworks, but forestry accident reporting and analysis may not be of immediate concern to those involved in the development of policies and regulations. Efforts to increase support among policy-makers may be crucial for improving worker safety and health in the forest sector.

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Appendix 2.
Accident reporting forms

Additional suggested categories for a more useful forestry form

Slope at scene	
Slope of unit	
Terrain class	
Timber diameter	
Tree species	
Log diameter	
Log length	
Activity: final harvest, thinning, clear cut, partial cut, vegetation management description	
Machine involved:	
Age, make and model	
Vehicle ID number	
Machine safety features functioning: describe deficiency, operator manual?	
Machine attachment: describe	
Equipment involved:	
Make and model	
Equipment safety features functioning: describe deficiency	
Personal protective equipment in use: describe	
Activity of injured: routine operation, maintenance, unusual activity/event	

Form continues

Form continued

Experience of injured: with organization, prior experience months	
Prior training: months, certification, years in education	
Supervision: direct, co-workers, working alone	
Business relation: permanent, temporary, seasonal; employee, subcontractor, casual; existenc of contract	
Compensation: fixed salary, hourly, production basis (how measured), monthly/annual	
Medical: none, workers' compensation, social insurance, private, other	
Citizenship: of country, different country, immigrant, work authorization, undocumented	
Language: fluent in national language/does not read, write or speak national language; mother tongue of victim	
Has the operation undergone safety inspection? Describe	
Fatigue: sleep hours prior; typical sleep hours; hours worked/day; machine operating hours; travel hours	
Illnesses: questions on Nordic questionnaire for cumulative stress, skin, respiratory, insect	
Exposure to chemicals, blood-borne pathogens, insects	

Felling in tropical forest can be very dangerous. The lean of the tree can be difficult to assess. Dead branches may not be visible. Trees can be hollow. Trees are often interconnected by climbers, so other trees may be pulled down when they fall (1). Branches from the falling tree or neighbouring trees (2, 3) can break off and swing backwards (4). Climbers are often torn off and may break and snap back (5).

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References

Ackerknecht, C. 2010. Work in the forestry sector: some issues for a changing workforce. *Unasylva*, 61(234/235): 60–65.

Ackerknecht, C.G. 2014. Occupational accidents footprint: new concept linked to chain of custody management. *Ciencia & Trabajo*, 16(51): 131–136.

Ackerman, S.-.A., Fryer, D., Jackson, R. & Upfold, S.J., eds. 2015. *South African chainsaw safety and operating handbook.* Scottsville, South Africa, Forest Engineering Southern Africa and Institute for Commercial Forestry Research.

Alliance of Forest Workers and Harvesters & Labor Occupational Health Program. 2012. *Healthy forests, abused workers: safety, health and working conditions among forest ecosystem restoration workers in southern Oregon.* AFWH Occasional Report. Ashland, USA, Alliance of Forest Workers and Harvesters (AFWH).

Axelsson, S.-A. 1998. The mechanization of logging occupations in Sweden and its effects on occupational safety and health. *Journal of Forest Engineering*, 9(2): 25–31.

Blombäck, P. 2002. Improving occupational safety and health: the International Labour Organization's contribution. In: T. Enters, P.B. Durst, G.B. Applegate, P.C.S. Kho & G. Man, eds. *Applying reduced impact logging to advance sustainable forest management*, Chapter 19. Bangkok, Asia Pacific Forestry Commission and FAO.

Bureau of Labor Statistics. 2013. *How to compute a firm's incidence rate for safety management* [online]. Injuries, illnesses, and fatalities. [Cited 23 December 2015]. www.bls.gov/iif/osheval.htm

Bureau of Labor Statistics. 2017. *Census of fatal occupational injuries* [online]. [Cited 2 March 2018]. www.bls/iif/oshcfoi1.htm

DBCS. 2013. 2012 *Report on Oregon's workers compensation system*. Salem, USA, Oregon Department of Consumer and Business Services (DBCS).

DBCS. 2015. 2014 *Report on Oregon's workers compensation system*. Salem, USA, Oregon Department of Consumer and Business (DBCS).

de Hoop, C.F. & Lefort Jr, A.J. 2003. Loggers and bureaucrats: a strategic partnership creates better accident summaries and safety education. *In*: T. Yoshimura, ed. *Proceedings of the International Seminar on New Roles of Plantation Forestry Requiring Appropriate Tending and Harvesting Operations*, September 29–October 5, 2002, Tokyo, Japan, pp. 376–384. Tokyo, Japan Forest Engineering Society and IUFRO 3.04/3.06/3.07.

Garland, J. & Rummer, R. 2009. *Understanding the hazards of thrown objects: incidents, research and resolutions.* Lake Tahoe, USA, Council on Forest Engineering.

Gifford, M. 2009. *Safety and health in the European forestry sector: the impact of more open markets and regulation*. Geneva, Switzerland, International Labour Organization.

Heinrich, H.W. 1931. *Industrial accident prevention: a scientific approach*. McGraw-Hill.

Heinrich, H.W., Petersen, D. & Roos, N. 1980. *Industrial accident prevention: a safety management approach.* New York, USA, McGraw-Hill.

ILO. 1998. *Safety and health in forest work: an ILO code of practice.* Geneva, Switzerland, International Labour Organization (ILO).

ILO. 2004. *Occupational safety and health in Tanzania: country profile*. Geneva, Switzerland, International Labour Organization (ILO).

ILO. 2015a. *Tanzania marks the World Day for Safety and Health 2015* [online]. International Labour Organization (ILO) [Cited 5 January 2016.] www.ilo.org/addisababa/media-centre/news/WCMS_366558/lang--en/index.htm

ILO. 2015b. *Investigation of occupational accidents and diseases: a practical guide for labour inspectors.* Geneva, Switzerland, International Labour Organization (ILO).

ILO. Undated. *Forestry, wood, pulp and paper sector* [online]. International Labour Organization (ILO) [Cited 12 February 2018]. www.ilo.org/global/industries-and-sectors/forestry-wood-pulp-and-paper/lang--en/index.htm

Independent Forestry Safety Review Panel. 2014. *Independent forestry safety review: an agenda for change in the forestry sector.* New Zealand (also available at https://safetree.nz/wp-content/uploads/2015/03/20141031-FINAL-REPORT-Independent-Forestry-Safety-Review-EMBARGOED-to-11am-Fri-31-Oct.pdf).

Klun, J. & Medved, M. 2007. Fatal accidents in forestry in some European countries. *Croatian Journal of Forest Engineering*, 28(1): 55–62.

Leigh, J.P., Markowitz, S., Fahs, M. & Landrigan, P. 2000. *Costs of occupational accidents and injuries.* Ann Arbor, USA, University Michigan Press.

Lewark, S., ed. 2005. *Scientific reviews of ergonomic situation in mechanized forest operations.* Technical Report 2. Uppsala, Sweden, Department of Forest Products, Swedish University of Agricultural Sciences.

Marsden, E. 2017. *Heinrich's domino model of accident causation* [online]. Risk Engineering. [Cited 21 December 2017]. https://risk-engineering.org/concept/Heinrich-dominos

Monteau, M. 2011. *Analysis and reporting: accident investigation* [online]. ILO Encyclopaedia of Occupational Health and Safety, Part VIII: accidents and safety management. [Cited 22 December 2017]. www.iloencyclopaedia.org/part-viii-12633/audits-inspections-and-investigations/57/analysis-and-reporting-accident-investigation

Moore, T. 2017. *Why is logging the most dangerous job in America?* [online]. AOL. [Cited 11 January 2018]. www.aol.com/article/finance/2017/10/23/why-is-logging-the-most-dangerous-job-in-america/23252720/

National Safety Council. 2013. *Injury facts.* National Safety Council.

OHSU. Undated. *Oregon Fatality Assessment and Control Evaluation (OR-FACE)* [online]. [Cited 21 December 2015]. Oregon Health and Safety Unit (OHSU). www.ohsu.edu/xd/research/centers-institutes/oregon-institute-occupational-health-sciences/oregon-fatality-assessment-control-evaluation-face/index.cfm

Oregon Department of Consumer and Business Services. 2005. *Occupational safety and health in Oregon's forests: logging and forestry services CY 2000–2004*. Salem, USA.

Parker, R., Ashby, L., Tappin, D. & Moore, D. 2004. The New Zealand Forest Industry Accident Reporting Scheme (ARS). 2004 Council on Forest Engineering (COFE)

Conference Proceedings: "Machines and People, The Interface", Hot Springs, April 27–30, 2004.

Petersen, D. 1990. *Safety management: a human approach.* 3rd edition. American Society of Safety Engineers.

Poschen, P. 1993. Forestry, a safe and healthy profession? *Unasylva*, 172(44): 3–12.

Poschen, P., ed. 2011. *Forestry* [online]. Encyclopaedia of Occupational Safety and Health, Chapter 68. International Labour Organization. [Cited 23 December 2017]. www.iloencyclopaedia.org/part-x-96841/forestry

Rummer, R. & Klepac, J. 2011. Thrown object hazards in forest operations. In: *Proceedings of the 2011 National Symposium on Agriculture, Forestry, and Fishing Health and Safety, June 26–30, Boise, Idaho*, pp. 1–13.

Saari, J., ed. 2011. *Accident prevention* [online]. Encyclopaedia of Occupational Safety and Health, Chapter 56. International Labour Organization. [Cited 23 December 2017]. www.iloencyclopaedia.org/part-x-96841/forestry

Smith, D.W. Undated. *Chainsaw safety*. AgriLIFE Extension, Texas A&M System (also available at http://agrilife.org/agsafety/files/2011/06/CHAINSAW-SAFETY2.pdf).

Staal Wästerlund, D. 1990. *Final report on ergonomics and work study in forestry and forest industries.* Geneva, Switzerland, International Labour Organization (ILO) and Zambia Forestry and Forest Industries Corporation (ZAFFICO).

Staal Wästerlund, D. 2018. *Managing heat in agricultural work: increasing worker safety and productivity by controlling heat exposure.* Rome, FAO.

Tampere University of Technology. 2014. *Global estimates of occupational accidents and fatal work-related diseases in 2014.* Tampere, Finland, VTT Technical Research Institute.

United States Department of Labor. Undated. *Logging* [online]. Occupational Safety and Health Administration. [Cited 11 January 2018]. www.osha.gov/SLTC/logging/index.html accessed on 12/26/15

Visser, R. & Stampfer, K. 2015. Expanding ground-based harvesting onto steep terrain: a review. *Croatian Journal of Forest Engineering*, 36(2): 321–331.

Weyerhaeuser. Undated. *Vision and values* [online]. Weyerhaeuser. [Cited 11 January 2018]. www.weyerhaeuser.com/company/vision-and-values/

Worksafe. 2017. *Managing health and safety: general FAQs* [online]. Worksafe (New Zealand). [Cited 22 December 2017]. https://worksafe.govt.nz/managing-health-and-safety/getting-started/mythbusting-and-faqs/general-faqs

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