International trends in productivity and safety – is New Zealand keeping pace?

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Abstract

Understanding international trends in harvesting productivity and safety performance, and knowing how we compare with other timber-producing regions of the world, should assist with the global competitiveness of New Zealand's forestry sector. International productivity and safety data was gathered using three methods: contacting industrial and academic harvesting experts from around the globe; web searches for statistical information; and through a limited review of published papers. Productivity was measured in terms of cubic metres per crew-day or man-day (a unit of one day's work by one person). Safety was assessed in terms of fatalities per million cubic metres harvested. International trends show improvements in both harvesting productivity and safety performance over time. New Zealand is better than many, but not all, countries for both performance measures but there is room for improvement. The literature indicates that a focus on similar factors can lead to improvements in both performance measures and that productive operations are generally also the safest.

Introduction

Less than 12 per cent of the 30 million cubic metres harvested from New Zealand's plantation forests in 2013 was consumed by its domestic markets. The remaining 88 per cent was exported as logs or as finished or semi-finished products (MPI, 2014). New Zealand was recently acclaimed as the largest softwood log exporter in the world. However, all of the exported material has to compete in a global marketplace against other forest product and alternative material providers.

If it expects to be globally competitive the New Zealand forest industry must, among other things, control costs and be productive, harvest in a manner which is environmentally and socially acceptable, and maximise value capture along the supply chain. Understanding international trends in performance, and knowing how this country currently compares with other timber-producing regions of the world, should assist with attaining global competitiveness.

This paper focuses on two performance indicators for competitiveness, forest harvesting productivity and safety, the latter being a measure of social acceptability.

Methodology

Data for this paper was gathered using three methods: contacting industrial and academic harvesting experts from around the globe; web searches for statistical information; and through a limited review of published papers. Expert opinion provided current information, more so on productivity than safety. Web searches and published papers provided historical and trend information on both.

Productivity

Harvesting productivity can be expressed in many ways including: $ per unit volume, volume per man-hour (or day), volume per machine-hour (or day), and volume per crew-hour (or day). None are perfect measures for international comparisons. Monetary measures of productivity suffer from international exchange rate variation and, in some countries, issues related to government subsidies for capital equipment purchases.

Man-hour and machine-hour productivity measures require a good knowledge of the average number of persons or machines being used in a harvesting operation and a good understanding of what activities are included in hourly productivity, e.g. whether delays are included or excluded activities. Daily productivity measures require knowledge of the length of the day that the production relates to. Crew daily productivity is one of the easiest measures to obtain data on.

Harvesting experts were contacted in the following countries: New Zealand, Australia, South Africa, Columbia, Japan, Ireland, the United Kingdom, France, Italy, the Czech Republic, Norway, Sweden, Finland, Austria, the United States (Oregon, Washington, Maine, Virginia and Georgia) and Canada. Additional productivity data was obtained from earlier contacts with companies in Chile and Brazil and published studies carried out in Brazil and Canada.

Harvesting experts were asked:

- 'What is the average daily productivity for (a) ground-based and (b) cable-logging clearfall harvesting operations in your region?'

- 'What daily productivity would you expect for the top five to 10 per cent of harvesting operations in your region?'
- 'How many hours per day would an average harvesting operation work?'

Productivity trends were also supplied by some experts. In other cases they were obtained from published literature and reports.

Safety

Safety performance indicators include:

- Number of fatalities or accidents
- Fatalities or accidents per 1,000 workers
- Fatalities or accidents per 100,000 person hours worked
- Fatalities or accidents per stated output level (e.g. million cubic metres).

Number of fatalities or accidents takes no account of inputs (e.g. number of workers or person hours) or outputs (e.g. cubic metres). Expressing fatalities or accidents on a per 1,000 workers or a per 100,000 worker hours basis normalises fatality or accident rates, but requires good data on the number of workers or hours worked in the forest industry. Reliable worker data at a national or regional level can be difficult to obtain. Volumetric output is an easier statistic to obtain since this information is collected and reported annually by the Food and Agricultural Organization (FAO) in Rome, e.g. the *FAO Yearbook – Forest Products 2008–2012*.

Fatalities are a more reliable statistic for comparison purposes than accidents. Difficulties abound when comparing accident data between countries because national reporting requirements and definitions vary significantly (Gifford 2009; Lilley et al., 2013). Gifford (2009) also notes that under-reporting of accidents is common for many industries including forestry. An indicator of the difficulties in using accident data for between country comparisons can be seen in the accident per fatality rates shown in Table 1.

These rates have been obtained from published data that spans different periods over two decades. One would not expect the one to two orders of magnitude difference shown between countries. The differences are possibly due to under-reporting of accidents in some cases and differences in definitions of accidents in other cases. Peter Poschen, from the International Labour Organization (ILO), notes that, 'Virtually the only significant expression permitting a comparison of occupational hazards between countries is the number of fatal accidents per million cubic metres of timber harvested and, even here, data are very difficult to obtain' (Poschen, 1991).

Fatality rates were obtained from published rates or by calculations based on official data for the number of fatalities combined with FAO or, in a few cases, company statistics of total volume harvested. Fatality rates can vary significantly from year to year. To overcome this variation, fatality rates were averaged where possible over an extended period, usually five years.

Fatality rate data were obtained for New Zealand (1968–2014), Australia (1989–1992, 2008–2013), Japan (2012), China (1981–1990), Malaysia (1987–1995), South Africa (a single unnamed company, 2000–2012), Chile (1987–1995, 1999–2004, 2011–2013), British Columbia (2005–2013), Oregon (2000–2011), Washington (1998–2002), Georgia (2011), the United States (all states combined, 2009), Sweden (2000–2004), Finland (2000–2004), Norway (1987–1995), Latvia (1987–1995), Ireland (2009–2013), the United Kingdom (2008–2012), Spain (2000–2004), France (2010–2012), Germany (2000–2004), the Czech Republic (2004–2011), Switzerland (2000–2004), Austria (2000–2012) and Slovenia (2000–2004).

Table 1: Number of forestry accidents per fatality for selected regions and countries

Country or region	Accidents per fatality
All Europe	328
France	205
British Columbia	95
Australia	56
New Zealand	33*
China	2

* Serious harm accidents only

Productivity comparisons and trends

Average crew daily production levels for ground-based harvesting operations are shown in Figure 1 in bands of 200 cubic metres. Average production for New Zealand ground-based operations is 250 cubic metres. The kiwi standing on the bar shows the approximate position within the 200 cubic metres band. It should be noted that the average is only based on data included in the Future Forests Research (FFR) Benchmarking Programme managed by Rien Visser from the University of Canterbury. Crews operating in some major Central North Island companies' forests do not contribute data.

Average New Zealand daily production for ground-based harvesting operations was higher than those in the eastern United States and Canada, Japan, South Africa and most of Europe. Ground-based operations in Finland, Oregon, Washington, Brazil and Chile all had higher average productivity levels than New Zealand, ranging from 20 to 130 per cent higher. Crew daily production levels for the top ground-based harvesting operations are shown in Figure 2.

Production levels for top crews ranged from 15 to 175 per cent higher than production levels for average ground-based crews. When top Central North Island New Zealand crews are included, production levels of over 600 cubic metres per day are being regularly

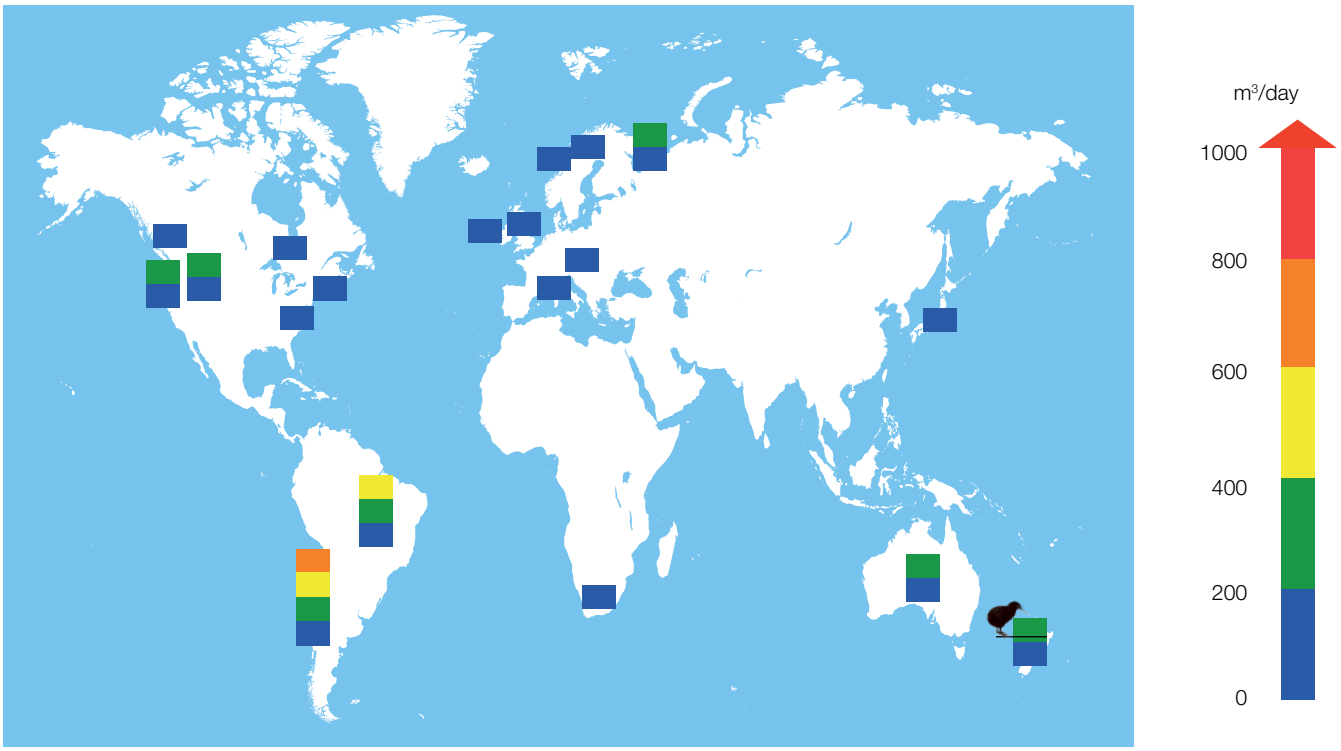

Figure 1: Average daily harvesting productivity for ground-based operations

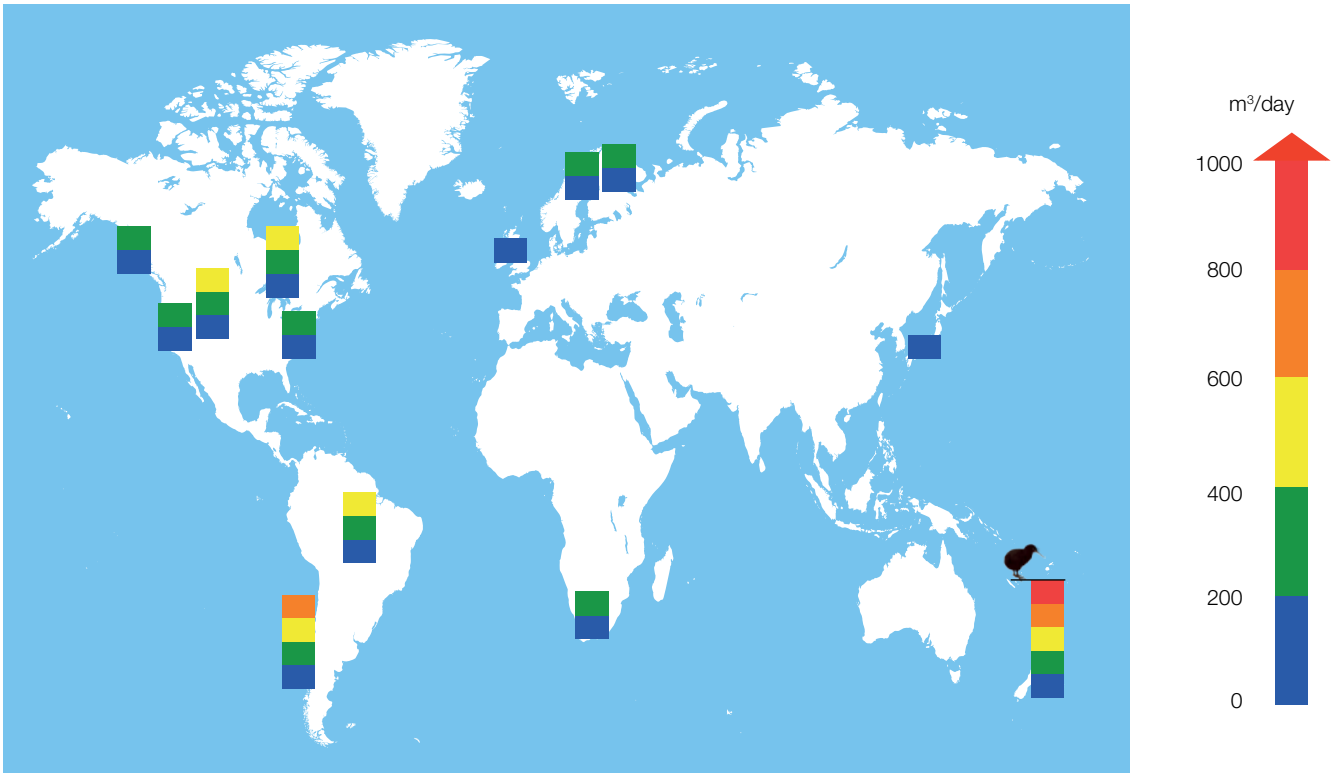

Figure 2: Top daily harvesting productivity for ground-based operations

achieved for cut-to-length systems and over 1,000 cubic metres for tree-length systems. Production levels over 600 cubic metres per day were found for top ground-based crews in Chile, but none had production levels over 1,000 cubic metres for single shift operations.

Average crew daily production levels for cable-logging harvesting operations are shown in Figure 3. Average production for New Zealand cable logging operations that provide data for the FFR Benchmarking Programme is 207 cubic metres. Oregon and British

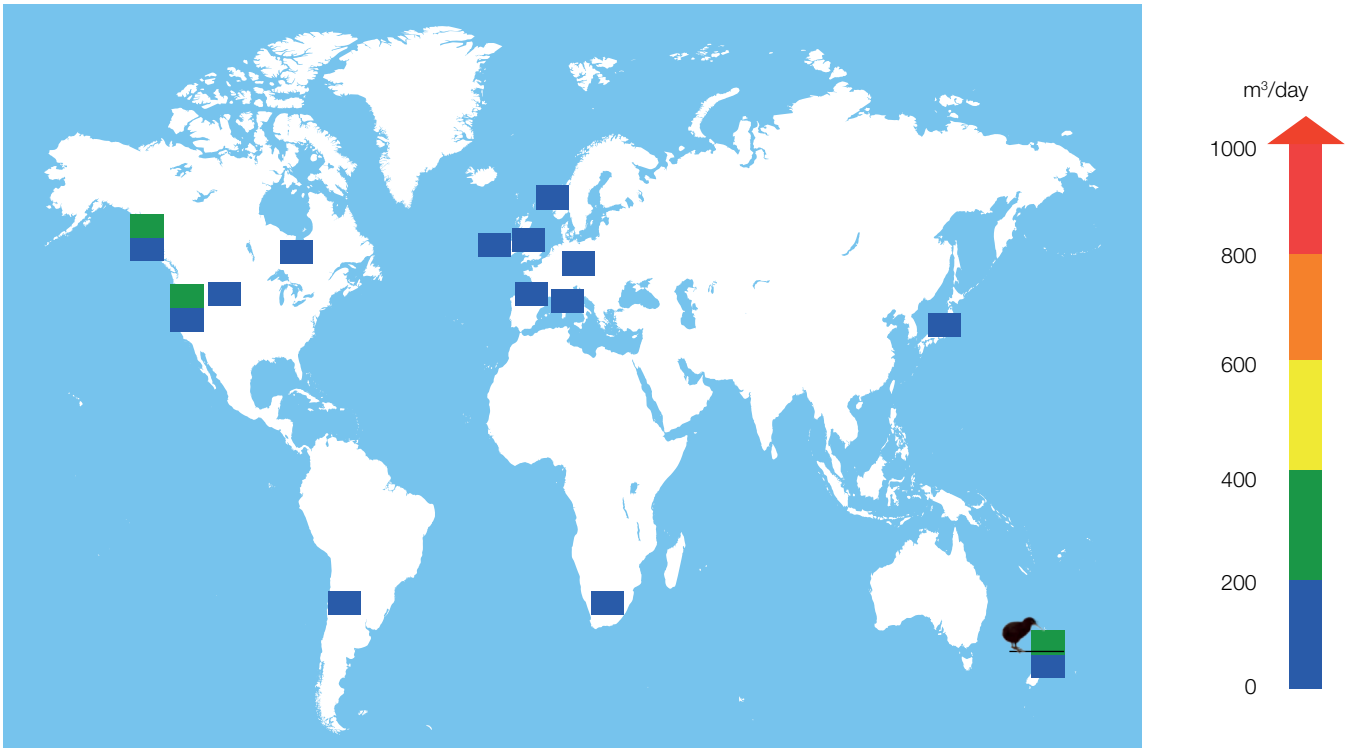

Figure 3: Average daily harvesting productivity for cable-logging operations

Columbia had similar production levels to New Zealand. All other countries had lower average cable logging productivity levels.

Production levels for top cable logging crews in Chile and the Pacific Northwest were 40 to 70 per cent above those of average operations. When cable logging operations from Central North Island New Zealand were included, production levels over 500 cubic metres per day were reported. Production studies of New Zealand cable logging operations working with tethered felling and bunching machines have reported production levels of 345 to 455 cubic metres per day (Amishev & Evanson, 2010).

Mechanisation of harvesting operations has had, and continues to have, a profound effect on daily production per man-day. For example, man-day productivity levels increased at an average rate of five per cent per year between 1955 and 2005 in Sweden (Skogforsk, 2008), levels in 2005 being about 25 cubic metres per man-day. Some Swedish harvesting crews are currently achieving over 60 cubic metres. In France, man-day productivity levels increased at an average rate of four per cent per year between 1980 and 2010 (Morgan Vuillermoz, pers. comm.). No, or very little, cable-logging occurs in Sweden and France. This is not the case in British Columbia, where between 1994 and 2005 man-day productivity levels increased by an average of five per cent per year.

New Zealand's man-day productivity levels are climbing, but at a much lower rate. In 1974 average man-day productivity was 17.6 cubic metres, although top crews were producing at more than double this rate – 40 cubic metres (Fraser et al., 1976). The 2013 Ministry for Primary Industries statistics indicate that man-day productivity is currently 30 cubic metres, about two cubic metres per man-day higher than those found in the 1991 Logging Industry Research Organisation (LIRO) logging industry survey (Lyons & Raymond, 1993). Man-day productivity levels have climbed at an average rate of 1.4 per cent per year over the past four decades.

One reason for the slow rate of improvement in productivity is that a much greater proportion of New Zealand's harvest today is coming from steep cable-logging terrain than it was 40 years ago. Until recently steep terrain has limited the degree to which mechanisation of activities has occurred, particularly felling and hooking on logs. Crew daily productivity on cable-logging terrain has increased at an average rate of less than 0.5 per cent per year over the past 40 years. Visser (2012) has argued that the proliferation of log grades handled by New Zealand harvesting crews is also a limiting factor for productivity.

Man-day productivity levels from some of New Zealand's top crews are significantly higher than the national average of 30 cubic metres and indicate potential gains in improvement. These include cut-to-length crews producing at over 75 cubic metres per man-day, tree-length ground-based crews at over 100 cubic metres, and cable logging crews at close to 90 cubic metres.

Safety comparisons and trends

Average fatality rates for harvesting operations, based on the most recent data available, are shown in Figures 4 and 5 in bands of 0.25 fatalities per million

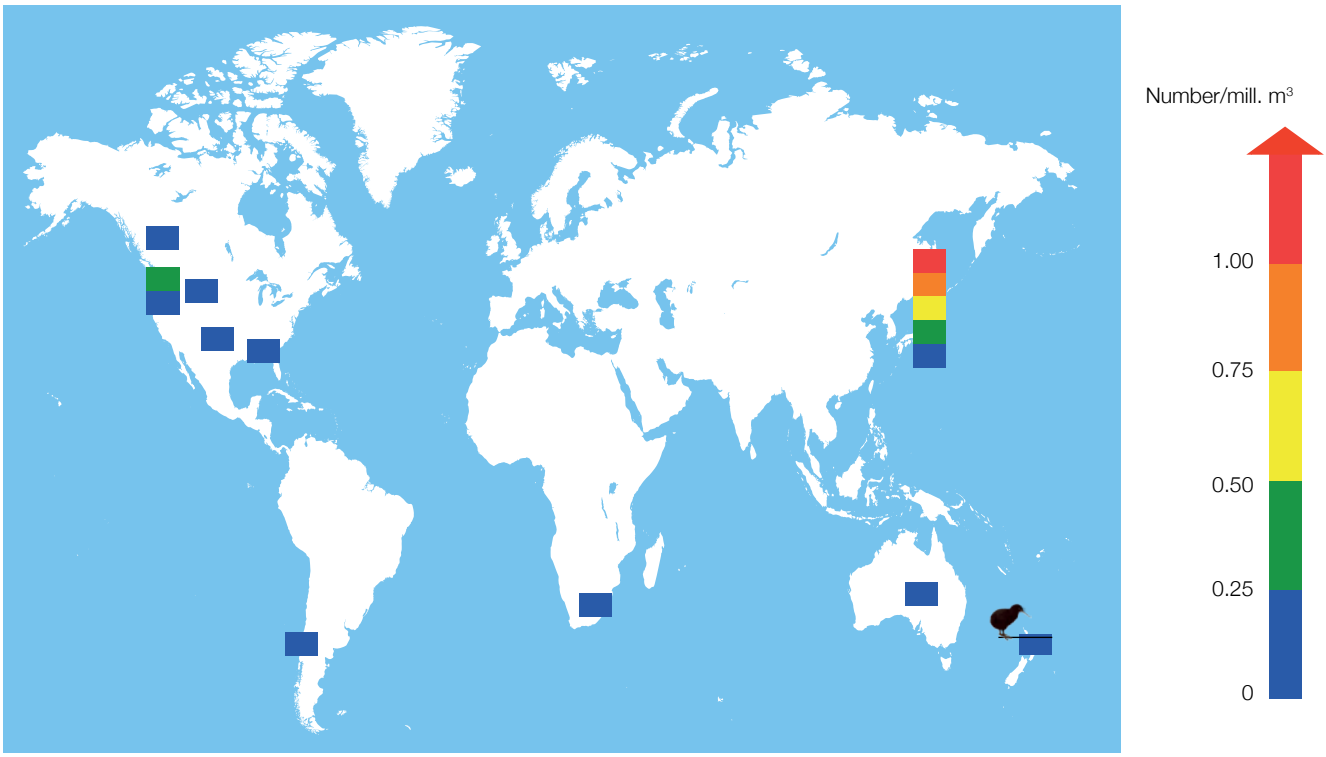

Figure 4: Fatality rates in selected regions and countries, excluding Europe

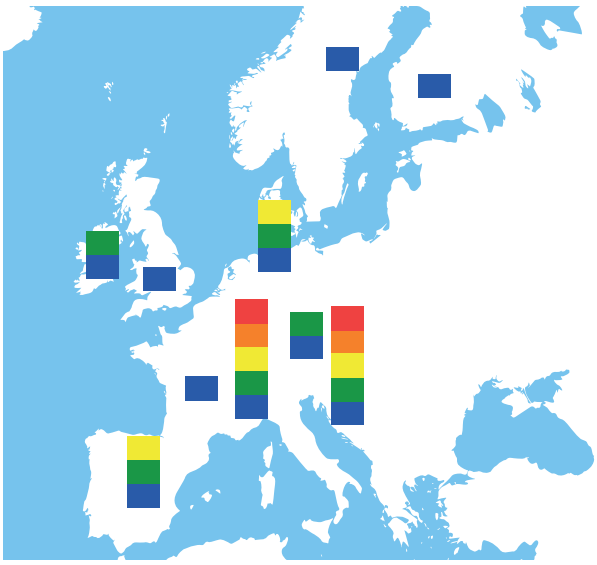

Figure 5: Fatality rates in selected European countries

cubic metres up to 1.0. Any rate above 1.0 is lumped into a single category. Average fatality rates for New Zealand harvesting operations for the period 2011 through mid-2014 were 0.21 per million cubic metres. The kiwi standing on the bar shows the approximate position within the 0 to 0.25 fatalities band.

Fatality rates ranged from 4.90 in Slovenia to 0.04 in Australia. Slovenia, Japan, Switzerland, Austria, Germany, Spain, Ireland and Oregon had fatality rates considerably higher than New Zealand. Chile, Washington, the Czech Republic and the United Kingdom had fatality rates similar to New Zealand. The United States (all states combined), France, British Columbia, South Africa, Sweden, Finland, Georgia and Australia had lower fatality rates.

New Zealand's fatality rate between 1987 and 1995 was double what it currently is. At that time Malaysia, Switzerland, Chile, Latvia, Austria, Germany, Norway, Australia and China had fatality rates higher than New Zealand, and the United States, British Columbia, Sweden and Finland had lower rates.

Fatality rates have generally decreased over the past few decades. In some countries where the fatality rate was low in the 1980s and 1990s, such as Finland and Sweden, the improvement has been small. In other countries the improvement has been substantial. For

example, the fatality rate in Australia fell from 0.61 for the period 1989 to 1992 to 0.04 for the period 2008 to 2013. In Switzerland, where harvesting takes place on terrain that is steeper than Australia, the fatality rate for professional forest workers fell from 2.3 to 1.0 between 1985 and 2004 (Klun & Medved, 2007). Figure 6 shows that the fatality rate in New Zealand has decreased by a factor of more than 3.0 over the past 45 years.

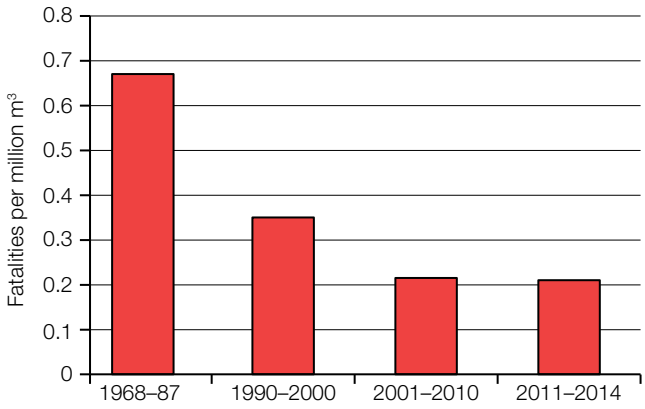

Figure 6: Trend in fatality rates for NZ forest harvesting operations over a 45-year period

Getting workers off the ground and into the relative safety of cabs on mechanised equipment has undoubtedly contributed to an improvement in fatality rates around the world. This is particularly evident in countries, such as Sweden and Finland, where harvesting operations are almost entirely mechanised and fatality rates are some of the lowest in the world.

At the 2nd International Forest Engineering Conference held in Vaxio, Sweden in 2003 a senior industry leader from that country said that having achieved a vision set several decades earlier of 'no hand on the log, no foot on the ground', it was resetting its vision to include 'no man in the forest'. Improvements in productivity and safety were some of the reasons for the new vision. Within a few years remotely controlled harvesting machines were being trialled. Recent investment by the New Zealand government and forest industry in new steep terrain harvesting technologies (such as tethered felling and bunching machines, vision systems, grapple carriages and remotely controlled machines on the hillside) should lead to greater mechanisation on steep terrain and improved worker safety, as well as improved productivity (FFR, 2013).

Mechanisation alone is not the solution to improving safety. Blomback et al. (2003) comment that, 'Countries that do not have effective safety regulations and worker training will tend to have accident rates several times higher than industrialized countries, whether work is done with hand tools or machines.' Klun and Medved (2007) showed that fatality rates in non-professional forest workers in Europe were two to 10 times higher than professionally trained workers. In addition to regulation and training, Gifford (2009) notes the importance that changing attitudes to safety and having a 'safety culture' can have on accidents. As an example of this, a large integrated forest company in South Africa was able to reduce its fatality rate from 0.7 for the period 2000 to 2005 to under 0.1 for the period 2006 to 2013.

Concluding comments

International trends show improvements in both productivity and safety over time. Key factors affecting safety include terrain, culture, regulation, training, work organisation and mechanisation. These same factors affect productivity performance. Gifford (2009) notes the strong links between safety, productivity and profitability. Productive crews tend to be safe crews and vice versa.

New Zealand is performing better than many countries with respect to both productivity and safety, but there is still room for improvement. Of concern is the relatively low rate of improvement in productivity, possibly due to the increase in the proportion of harvest volume coming from steep terrain. Although safety has improved, New Zealand's fatality rates are still more than double those of some other regions including some on similar terrain to this country. Integrated efforts that improve both safety and productivity should also improve the global competitiveness of New Zealand's forest sector.

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References

Amishev, D. and Evanson, T. 2010. *Innovative Methods for Steep Terrain Harvesting*. Proceedings of FORMEC 2010 Conference held in Padova, Italy (July 2010). Available at http://intra.tesaf.unipd.it/formec2010/Proceedings/Ab/Ab071.pdf accessed on 30 July 2014.

Blomback, P., Poschen, P. and Lovgren, M. 2003. *Employment Trends and Prospects in the European Forest Sector.* Geneva Timber and Forest Discussion Papers ECE/TIM/DP/29. Geneva: United Nations.

Fraser, T., Murphy, G. and Terlesk, C.J. 1976. *Survey of the Logging Industry for the Year Ending 31 March 1974*. NZ Forest Service, FRI, Economics of Silviculture Report No. 84.

Future Forests Research Ltd. 2013. *Annual Science Report*. Rotorua, NZ: FFR.

Gifford, M. 2009. *Safety and Health in the European Forestry Sector.* Working Paper WP264. Geneva: International Labour Organisation.

Klun, J. and Medved, M. 2007. Fatal Accidents in Forestry in Some European Countries. *Croatian Journal of Forest Engineering*, 28(1): 55-62.

Lilley, R., Samaranayaka, A. and Weiss, H. 2013. *International Comparison of International Labour Organisation Published Occupational Fatal Injury Rates: How Does New Zealand Compare Internationally?* Commissioned report for the Independent Taskforce on Workplace Health and Safety. Dunedin, NZ: University of Otago.

Lyon, C. and Raymond, K. 1993. *A Survey of the Logging Industry – 1991*. LIRO Report 18 (1). Rotorua, NZ: Logging Industry Research Organisation.

Ministry for Primary Industries. 2014: *Forestry Statistics*. Wellington, NZ: MPI. Available at: www.mpi.govt.nz/forestry/statistics-forecasting/forestry-statistics accessed on 28 July 2014.

Poschen, P. 1991. *Forestry, a Safe and Healthy Profession?* FAO Document Repository. Available at: www.fao.org/docrep/u8520e/u8520e03.htm accessed on 29 July 2014.

Skogforsk. 2008. Productivity Just Continues to Rise. *Skogforsk News*, No. 1. Uppsala, Sweden: Skogforsk. Available at: www.skogforsk.se/upload/Dokument/News/News2008-1.pdf accessed on 30 July 2014.

Visser, R. 2012. *Considering the Benefits of a New Supply Chain*. Proceedings of the 2012 New Zealand Institute of Forestry Conference held in Christchurch, New Zealand (July 2012) [Abstract only]. Available at: www.treesandstars.com/euan/NZIF2012/28Visser.pdf accessed on 30 July 2014.

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