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IMPACTS OF WINDTHROWN SALVAGE ON FALLER AND BREAKER-OUT SAFETY IN CABLE LOGGING OPERATIONS

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Figure 1 - An area of windthrow in Mohaka Forest

ABSTRACT

Hazards occurring to the fallers and breaker-outs within cable hauler crews working in windthrow salvage conditions were recorded. The most hazardous parts of the faller's job were those of felling, clearing around the tree to be felled and clearing a path to the tree to be felled. The two most dangerous tree types were "hung-up" and "rootball trees". The majority of breaker-out hazards (70%) occurred during the "wait" phase of breaking out with the most frequent hazard being "standing within one tree length of the drag".

INTRODUCTION

Much of the previous research into the salvage of windthrow timber has focused on the development of fast and cost-effective ground-based extraction systems (Childs, 1966; Donovan, 1982; Eager, 1976; Eager, 1982; Gleason, 1983). While safety has been a major consideration in the development of such systems, emphasis has traditionally been placed on the use of appropriate felling techniques, rather than the identification of specific hazards. Since most of the information to date on windthrow salvage has been based around ground-based extraction systems, little information exists on the type and frequency of hazards encountered by cable hauler breaker-outs operating in windthrow conditions.

In windthrow recovery operations, it is often the faller who is perceived as having a substantial increase in hazard exposure (Prebble, 1982; Sperry, 1982; Vincent, 1982). It is the faller who has to fell standing and hung-up trees, and spars, as well as removing the rootballs from toppled trees. All of these situations contain hazards such as excessive lean, tension, hang-ups and a substantial increase in both the quantity and size of debris retained in and around such trees. While it is commonly acknowledged that all of these factors add to the potential dangers of felling, the actual rate and type of hazard occurrence has not been investigated.

The objective of this study was to assess the impact of windthrow salvage on the hazards encountered by both breaker-outs and fallers working within cable hauler windthrow recovery operations.

This study involved two separate cable extraction systems. The first was a Madill 171, equipped with a 28mm swaged skyline, 22mm swaged mainrope, 19mm tail rope and 13mm drop line. The setting contained a mixture of standing trees, standing broken spars, toppled full length trees with rootballs still attached (rootballs), partially toppled trees and an assortment of broken tops and pieces. Two fallers, normally working separately, felled standing trees, spars and cut off rootballs where it was safe to do so, but did no trimming. Two to four breaker-outs were used, depending on the number of strops being used by the hauler.

Figure 2 - Breaker-outs working in windthrow

The second system involved a Madill 009 running a 28mm swaged mainrope, 22mm tail rope and 22mm strops. The setting contained mainly toppled full length trees with rootballs, as well as standing long spars and full trees. Two fallers felled and delimbed in the bush and removed rootballs from toppled trees whenever safely possible. Two breaker-outs worked together on the extraction face.

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METHOD

Productivity

Activity sampling was carried out at one minute intervals for four complete days at each operation. One researcher observed the breaker-outs, while another observed each of the fallers.

As part of the faller study, tree type was categorised into four groupings:

1. Upright tree
2. Spar
    - short <10 m,
    - medium 10 to 20 m
    - long > 20 m
3. Hang-up
4. Rootball

The fallers' and breaker-outs' work cycles were broken down into the following tasks:

<u>Fallers</u>

Clear Path	*Clearing a path to the tree to be felled.*
Clear Object	*Clearing around base of tree to enable placement of felling cuts.*
Walk/Select	*Walking to the next tree once it had been selected.*
Fell	*Felling the selected tree.*
Trim	*Removing the branches and sloven from the felled tree.*

<u>Breaker-outs</u>

Wait	*Waiting for the return of the butt rigging.*
Walk	*Walking away to a safe point once the drag had been hooked up.*
Hook-Up	*Connecting strops to the logs*
Line Shift	*Undertaking a line shift.*
Mechanical Delay	*Delays caused by mechanical breakdowns*
Operational Delay	*Delays caused by operational interference.*
Re-Hook	*Re-hooking logs which have broken free during initial break out.*

For both fallers and breaker-outs, the type and frequency of hazards encountered were noted by each researcher, as were any obvious reasons for their occurrence. Additional information collected for the breaker-outs included the number of pieces per drag and drag composition.

Hazards

The hazard identification lists were based on those used by Parker and Kirk (1993), Kirk and Sullman (1995) and the Department of Labour's Occupational Safety and Health Service's "*Safety Code for Forest Operations*" Part 2 (Cable Logging) and Part 3 (Logging). Unanticipated hazards were added to the list as they were identified.

The following hazard definitions were used for the fallers and breaker-outs:

Fallers

Kickback	*Kickback of such a severity that the chainbrake engages.*
Hang-Up	*Faller is working directly under a hung-up tree.*
Balance	*Faller loses balance and falls off the object on which he was standing.*
Tension	*While cutting the stem/tree, a sudden unexpected release of tension occurs.*
Saw Above	*Faller uses the chainsaw above shoulder height.*
Overcut	*Faller overcuts the hinge wood.*
Sailer	*Faller is working directly under a sailer that could cause serious injury if it became dislodged and struck the faller.*
Butt Kick	*Faller does not retreat a safe distance away from the tree once felled and is nearly struck by the butt of the tree.*
Lean	*Faller tries to fell the tree against its predominant lean but loses control of it during felling.*
Flying Debris	*Sudden release of tension throws pieces of the stem into the air in the direction of the faller.*
Splitting	*During felling, the butt of the tree suddenly splits violently (barber-chair).*
Eye	*During felling, objects are thrown into the faller's eyes.*
Escape	*Faller fails to establish or identify an escape route from the tree to be felled.*
Movement	*Stem suddenly begins to roll while the faller is trimming it.*

Breaker-outs

Downhill Side	*Hooking up drag from downhill side of the drag.*
Spragged	*Hand badly spragged during hookup*
Within one tree length	*Being within one tree length of the drag and/or moving ropes.*
Bight of rope	*Standing within the bight of a working rope.*
Near Moving Rope	*Standing within one metre of moving rope*

Hazard Ratios

Hazard ratios, in terms of hazards per stem, were calculated for the fallers using the following equation:

$$\frac{x}{y} * \frac{100}{1}$$

where: x = total number of hazards
y = total number of stems felled

Hazard incidence for the breaker-outs were calculated were calculated for the fallers using the following equation:

$$\frac{A}{B}$$

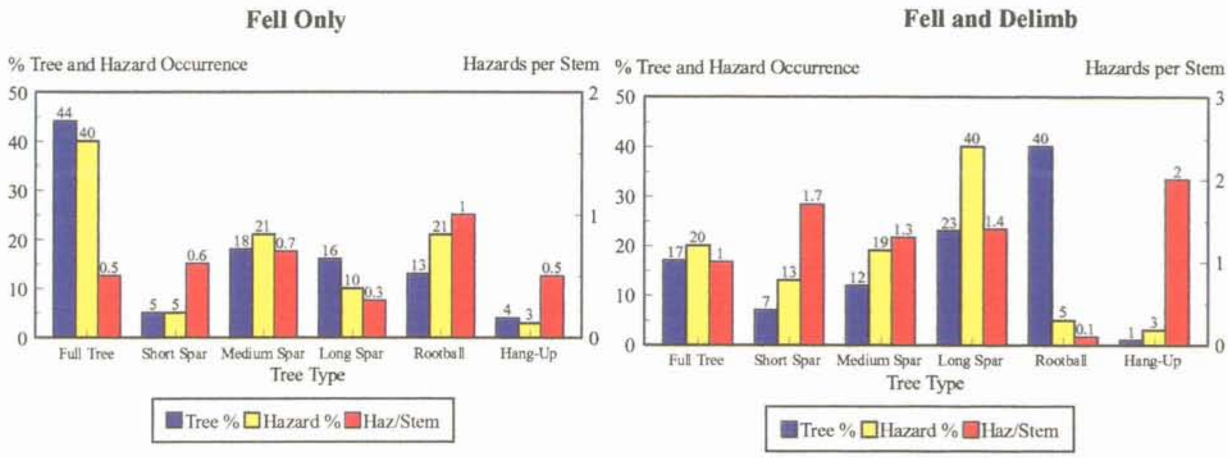
where: A = % of total time spent undertaking the task
B = % of total hazards occuring while undertaking the task

RESULTS AND DISCUSSION

Fallers

The percentage of tree types, hazard occurrence, and hazard ratios are shown in Figure 3.

Figure 3 -Tree and hazard occurrence and hazards per stem



Tables 1 and 2 show hazard type ranked (according to frequency of occurrence) related to task and tree type.

Table 1 - Most common hazard per task and tree type (fell only)

Tree Type	Clear Path	Clear Object	Walk/Select	Fell	Trim
Whole Tree	(1) Tension (2) Kickback (2) Balance	(1) Hang-Up (2) Tension (2) Sailer (2) Eye	(1) Balance	(1) Butt Kick (2) Hang-Up (3) Lean (3) Eye	N/A
Short Spar	None	None	None	(1) Overcut (2) Sailer (2) Balance (3) Hang-Up (3) Kick-Back	N/A
Medium Spar	(1) Kickback (2) Tension	(1) Tension	None	(1) Overcut (2) Butt Kick (3) Hang-Up	N/A
Long Spar	(1) Saw Above	(1) Balance (1) Saw Above	None	(1) Sailer (2) Butt Kick (3) Tension (3) Flying Debris (3) Lean	N/A
Rootball	(1) Tension	None	(1) Balance	(1) Tension (2) Splitting (3) Butt Kick (3) Hang-Up (3) Eye	N/A
Hang-Up	None	(1) Tension (1) Balance	None	(1) Tension (1) Butt Kick (1) Splitting (1) Hang-Up	N/A
All Tree Types Combined	(1) Tension (2) Kickback (3) Saw Above	(1) Tension (2) Balance (2) Hang-Up	(1) Balance	(1) Tension (2) Butt Kick (3) Sailer	N/A

Key: (1) = Most Frequently Occurring Hazard (3) = Least Frequently Occurring Hazard

Table 2 - Most common hazards per task and tree type (fell and delimb)

Tree Type	Clear Path	Clear Object	Walk/Select	Fell	Trim
Whole Tree	(1) Saw Above	1) Saw Above	None	(1) Butt Kick (2) Lean	None
Short Spar	(1) Sailer	(1) Saw Above	None	(1) Overcut (2) Sailer	None
Medium Spar	(1) Tension (2) Saw Above	(1) Saw Above	None	(1) Hang-Up (2) Sailer (3) Eye	(1) Movement (2) Kickback (2) Eye
Long Spar	(1) Saw Above (2) Sailer (3) Tension	(1) Saw Above (2) Tension (2) Sailer	None	(1) Sailer (2) Butt Kick (2) Escape (3) Balance (3) Kickback (3) Lean (3) Hang-Up (3) Below	(1) Kickback (2) Tension
Rootball	None	None	None	(1) Tension	(1) Kickback (1) Saw Above
Hang-Up	None	(1) Tension	None	(1) Tension	None
All Tree Types Combined	(1) Saw Above (2) Tension (3) Sailer	(1) Saw Above (2) Sailer (3) Tension	None	(1) Sailer (2) Butt Kick (3) Eye (3) Overcut (3) Tension (3) Lean	(1) Kickback (2) Tension (2) Saw Above (2) Eye (2) Movement

Key: (1) = Most Frequently Occurring Hazard (3) = Least Frequently Occurring Hazard

Fallers : (Fell Only)

The fallers predominantly encountered full upright trees (44%). Correspondingly, this tree type generated the greatest proportion of total hazards (40%). The most hazardous tree type for the fallers was rootballs, which generated one hazard per stem, followed by medium spars (0.7) and short spars (0.6) (Figure 2). The two most frequently encountered hazards whilst cutting rootballs were tension and splitting (Table 1).

Even using partial split cuts to remove as much tension as possible from the rootball, significant tension wood related hazards still occurred. Although the hauler possessed enough power to break out and extract complete trees with attached rootballs, this was not often done due to the relatively small rope sizes being used. Consequently, the fallers would attempt to place some sort of split cut at the base of each rootball in order to facilitate extraction.

By far the most hazardous parts of the faller's job in terms of hazards/100 stems were those of felling (50/100), clear object (4/100) and clear path to tree (3/100). The overall hazard/tree rating for the fallers in this operation was 58 hazards per 100 trees felled.

Fallers : (Fell and Delimb)

The fallers mainly encountered rootball trees (40%) and long spars (23%). As with operation one, the fallers were instructed to leave any tree which they considered too dangerous to handle. In stark contrast to operation one, the main tree type only generated 5% of the total hazards, resulting in 0.1 hazards per stem (Figure 2).

The prime reason for the low hazard ratio with rootball trees in this operation was the fact that the hauler's rope sizes and power easily enabled such rootball trees to be broken out and extracted whole. This meant that in most situations there was no need for the fallers to even attempt a split cut. The trees were trimmed wherever possible, and then left for the hauler to extract.

The hazard of "hang-up", where one tree had partially blown over but was caught up in a nearby standing tree, generated the highest number of hazards per stem (2) (Figure 2). In the cases where such trees could not be left for the hauler, their subsequent felling generated significant tension related hazards (Table 2).

Short spars generated the second highest number of hazards per stem (1.7). Most short spars were difficult to fell as they lacked the crown of the tree, and its associated weight to assist with the initial movement of the tree during felling. Consequently, the most common hazard encountered while felling short spars was overcutting the holding wood (Table 2).

The hazard of "saw above" occurred frequently during the "clear path" and "clear object" elements. This was largely attributed to the particular windthrown nature of the block. Consequently, there were large collections of broken heads and associated debris against the trunk and on the ground surrounding the base of the trees. In order to reach the base of the tree, the fallers often had to cut their way through this collection of debris. This resulted in frequent use of the saw above shoulder height since much of the hindering debris was located at this level.

The most hazardous parts of the faller's job, in terms of hazards per 100 trees, were those of felling (33/100), clearing object (24/100) and clearing a path to the tree (16/100). The overall hazard per tree rating was 83 hazards per 100 trees felled and delimbed.

Fallers : General

One alarming feature identified during this study was that the hazard ratios recorded for this study, in terms of hazards per 100 trees, (57 to 83/100), were far higher than those recorded for fallers working in non-winthrow stands (15/100) (Kirk et al., 1996) and (3/100) (Fraser and Kirk, 1996). It became evident during the study that an individual's experience and attitude contributed considerably to their hazard exposure. Fallers entered into situations which, under "normal" felling conditions, they would not have attempted. Such a phenomenon is neither new nor restricted to the forest industry or windthrow salvage operations. Other researchers (Lark, 1991) have found similar trends in other industries and attribute such behaviour to a state of mind known as "optimistic bias", that is when discussing personal risks, people claim they are less likely to be affected than their companions. Weinstein (1989) has found this exact phenomenon in numerous studies relating to different hazards. As a result, he found that the "it can't happen to me" syndrome is a common belief in workers continually undertaking hazardous jobs.

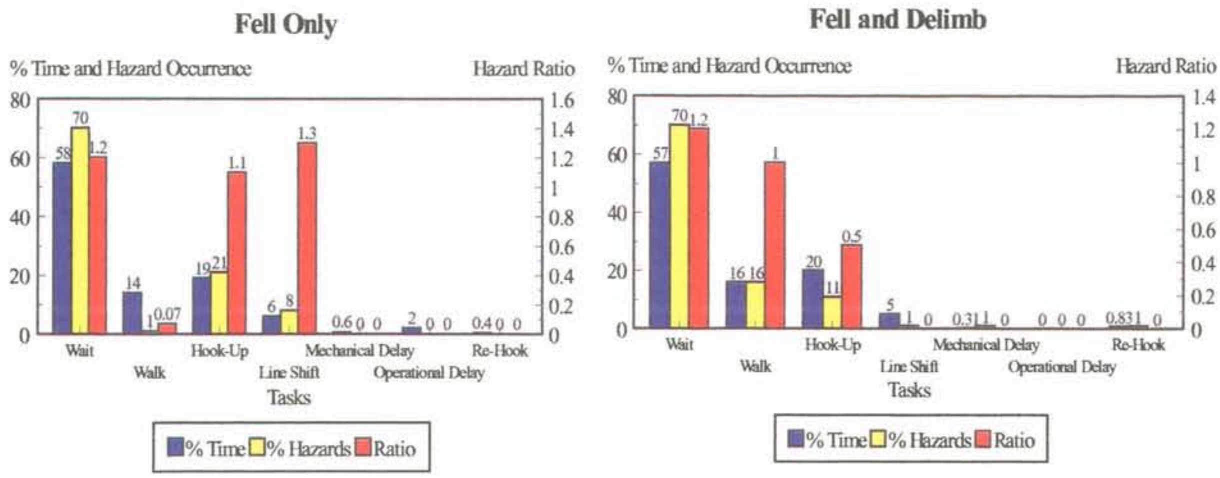
There are numerous explanations of why people take unnecessary risks, including boredom, sensationalism, poor risk perception and familiarity with the risk. In this case, all of these factors are valid explanations. Zimolong (1985) states that a person's accepted risk level is established as a result of previous exposures to risk. In this particular case, constantly high daily exposure to a wide range of risks may have lead to familiarity with certain hazardous situations and the development of poor risk perception. This phenomenon has been recorded in previous withrow salvage operations (Sperry, 1982).

A factor which appeared to play a significant role in the development of poor risk perceptions by workers was fatigue. All the fallers involved in the study mentioned feelings of moderate to severe fatigue. This was attributed to the combination of the extended working hours and weeks associated with the urgent need to harvest the windthrown timber, and the extremely hot temperatures (35 $^{0}C^{+}$) being experienced at the time of the windthrow salvage operation.

Breaker-outs

The percentage of all observed hazards that occurred within each phase of the breaking out cycle and their corresponding hazard ratios for both crews are shown in Figure 4.

Figure 4 - Percentage and ratio of hazards observed during each task



The hazards encountered by the breaker-outs of the "fell only" crew are shown in Table 3 and the "fell and delimb" crew in Table 4. All hazards have been ranked according to frequency of occurrence.

Table 3 - Most common breaking out hazards (fell only)

Hook-Up	Wait	Walk	Line Shift
(1) Downhill side of drag (2) Spragged (2) Walking on stem over 1 m above ground	(1) Within one tree length (2) Dragging through standing spars (3) Working directly below chute (4) Rolling material	(1) Within one tree length	(1) Within 1m of moving rope (2) Bight of rope (3) Downhill side of moving tractor

Key: (1) = Most Frequently Occurring Hazard (4) = Least Frequently Occurring Hazard

Table 4 - Most common breaking out hazards (fell and delimb).

Hook up	Wait	Walk	Line Shift
(1) Standing under swinging strops (1) downhill side of drag	(1) Within one tree length (2) Slash caught on tail rope (3) Near moving rope	(1) Slips/trips (2) Main rope caught under stem, violent release (3) Walking under elevated rigging	None

Key: (1) = Most Frequently Occurring Hazard (4)= Least Frequently Occurring Hazard

Breaker-outs : (Fell Only)

The breaker-outs spent the majority of their time (58%) waiting (Figure 3). Correspondingly, the majority of total hazards (70%) occurred during this period, with the most frequently occurring hazard being standing within one tree length of the drag and/or moving ropes (Table 3). The second most common hazard was dragging through standing spars. When the drag reached the standing spars, invariably one of the stems would catch on a spar resulting in the whole drag flicking around uncontrollably and breaking, creating the potential for broken material to roll downhill towards the breaker-outs.

Hazards observed during line shifts accounted for 8% of all hazards observed during the study and generated the highest hazard ratio of all the breaking out tasks (1.3). The most commonly occurring hazard during line shift phase was standing within one metre of moving rope. This was followed by standing/walking in the bight of the rope, and standing on the downhill side of a moving tractor (Table 3). Twenty-one percent of all hazards were observed during the hook-up phase of the operation, giving a hazard ratio of 1.1. The majority of the hazards involved hooking-up on the downhill side of the drag, being spragged and walking along a stem over one metre above the ground. The number of hazards per cycle for this crew was 0.17, meaning that on average the breaker-outs encountered a hazard every six cycles.

Breaker-outs : (Fell and Delimb)

The breaker-outs spent the majority of their time waiting (57%). Correspondingly, the majority of hazards (70%) occurred during this period. The three most frequently occurring hazards were: waiting within one tree length of the drag being extracted, getting large pieces of slash caught on the tail rope, and being within one metre of a moving rope (Table 4).

Hazards observed during the walk phase of the operation accounted for 16% of all observed hazards (Figure 3). The most commonly occurring hazards during this phase of the operation were slips and trips followed by the mainrope being caught under a stem and being violently released and walking under elevated rigging (Table 4). Eleven percent of all hazards were observed during the hook-up part of the cycle (Figure 3). Standing under swinging strops and hooking up the drag from the downhill side were equally common hazards recorded during the hook-up phase (Table 4). The number of hazards per cycle was 0.12, which means on average one hazard was observed every eight cycles.

Breaker-outs : General

The type and frequency of hazards observed during the study did not differ significantly from those observed in a previous study evaluating standard (non - windthrow) conditions (Kirk and Sullman, 1995). There was, however, a difference in the types of hazards experienced between the two crews observed here, and a number of hazards which were not seen in the previous study.

These included dragging through standing spars, slash being lifted by the tailrope and rootballs standing up during break out. Rootballs standing up during break out is particularly concerning as they tended to stand up and then fall to one side. When it is considered that the single most commonly observed hazard was standing within one tree length, the risks associated with the rootball's erratic behaviour becomes apparent. This could have been partly due to hazard familiarity and partly due to the physical fatigue experienced by the breaker-outs' working long hours and weeks in very high temperatures.

All the breaker-outs studied mentioned that they felt physically fatigued. Those with only one day off a week stated that this was not enough time to recover from breaking out, especially during periods of such high temperatures.

The effects of fatigue need to be seriously considered when undertaking windthrow salvage operations, as there is a need to salvage the timber as quickly as possible before it deteriorates. This usually results in crews working extended working hours and weeks over the duration of the salvage operation. If full consideration is not given to the effects of fatigue and ambient environmental conditions on worker performance, there is a serious risk of increased engagement in hazardous situations. Such a development within an inherently hazardous working environment can have dire consequences in terms of worker safety and health and not least of all, the productivity of the operation.

The extra slash produced in windthrow operations created a potential hazard in the form of material (rootballs and slash) being accidentally pushed over the edge of the landing. In such circumstances the material has a high probability of rolling towards and injuring the breaker-outs working directly below the landing.

CONCLUSIONS

Faller

- The most dangerous trees for fallers to deal with were hung-up trees, rootballs and long spars.
- The most frequently encountered hazards by the fallers were tension wood and the use of the chainsaw above shoulder height.
- The hazard ratios recorded for this study, in terms of hazards per 100 trees, (57 to 83/100), were far higher than those recorded for fallers working in non-winthrow stands (3 to 15/100).
- The use of large capacity haulers with large rope sizes enabled the break out and extraction of trees containing rootballs, thereby significantly reducing the risks encountered by fallers dealing with such situations.
- Constantly high daily exposure to a wide range of hazards appeared to lead to familiarity with certain hazardous situations and the development of poor risk perception by fallers.
- All fallers blamed the extended work days and weeks for their feeling severely fatigued.

Breaker-out

- The majority of the breaker-outs' time (57%) was spent waiting for the return of the rigging gear, which also accounted for 70% of all total hazards.
- Lin(shifts and waiting for the return of the rigging were the most hazardous breaking out tasks.
- As with the fallers, the breaker-outs' constantly high daily exposure to a wide range of hazards appeared to lead to hazard familiarity and the development of poor risk perception.
- The most frequently occurring breaker-out hazards were standing within one tree length of the drag being extracted, hooking up the drag from the downhill side and standing within one metre of a moving rope.

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