Precision Silviculture Programme

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Thinning to Waste Injuries: Analysis of IRIS data 2019 - 2023

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EXECUTIVE SUMMARY

This report provides a baseline of injury types, frequency, and severity with associated causes the Precision Silviculture Programme can use to measure progress and success of implemented initiatives and developed technologies. The report summarises lost time, medical treatment and minor injury reports related to silvicultural thinning supplied to the New Zealand Forest Industry Incident Recording Information System (IRIS) database from January 2019 to December 2023. There was a total of 169 thinning related injury incidents recorded over this five-year period. The incidents comprised 78 lost time injuries, 31 medical treatment injuries, and 60 minor injuries. The most common cause of injury for lost time, medical treatment and minor injury events was slipping/tripping/falling while walking between trees. Overall, the hands, wrists and fingers were the most frequently injured parts of the body. Comparison with previous studies has shown the type and cause of injury has changed little over the last 23 years.

We need to develop technology or techniques that allow the worker to thin without being exposed to slippery unstable terrain, the sharp chainsaw, and/or falling trees and debris. Until we develop new technology to make thinning safer, the options for the thinning worker are better tools, the use of personal protective equipment, training in good technique, gaining experience without being injured, adequate rest breaks, good hydration, and healthy nutrition.

INTRODUCTION

The New Zealand Forest Industry's Incident Recording Information System (IRIS) database includes records for both injury events (lost time, medical treatment, and minor injury) and non-injury events (contact and near hit incidents). This report focuses on injury events in silvicultural thinning for the period January 2019 to December 2023. Descriptions for event types are also provided in the context of the report.

An aim of the Precision Silviculture Programme is "to develop new thinning systems that decrease labour requirements and improve the safety and productivity of thinning operations." This analysis will provide a detailed baseline of injury characteristics (type, cause, frequency, and severity) against which comparisons can be made at the end of the Programme to measure progress and success of implemented initiatives and technologies. It will also help to guide the Programme on where key areas for improvement are needed.

Findings from the report will also provide guidance in reducing injuries and improving productivity in thinning by providing identification of both high frequency and high consequence injury events.

Figure 1: Thinner at work

METHODS

There are three injury types recorded in the IRIS database that were analysed in this report:

Lost Time Injury - an incident that results in injury to an employee to the extent that they do not return to work at the start of the next regularly scheduled workday.

Medical Treatment Injury - an incident requiring medical treatment for the injured party by a medical practitioner (including prescribed medication) other than onsite First Aid Treatment. Employee returns to work at the start of the next regularly scheduled workday or scheduled shift.

Minor Injury - also referred to as First Aid Cases or Treatment Not Required. For example, contact with an energy source (e.g. tool or falling branch) has occurred resulting in minor injury and treatment is applied onsite (first aid) or not sought.

Other categories in the IRIS database but not used in this report are:

- Contact – No Injury

Contact with an object or energy source where first aid treatment was not sought. The contact may have resulted in minor bruising and/or abrasions, or personal protective equipment has prevented more serious injury.

- Near Hit

An event that given similar circumstances, could have resulted in injury or property damage. A near hit may be a warning that control measures may not be working as intended or management of a hazard is absent.

- Property Damage

Unintentional damage to property or machinery because of operational activity. No threat to personal safety

IRIS data was reviewed for the five-year period January 2019 to December 2023. The criteria for selection (Table1) were:

- ACTIVITY = Silviculture
- OPERATION = Thin to Waste

Table 1: Variables used in the analysis

Variable	**Categories**[1]
Task	Felling; Plotting; Travel
Lost hours	9 hours considered 1 working day
Body part	Foot; Ankle; Head; Eye; Face; Shoulder; Knee; Hip/upper leg/thigh; Hand/wrist
Injury type	Fracture; Crush; Bruising; Puncture; Sprain/strain; Sting/bite; Cut/laceration
Injury cause	Chainsaw; Tree/log; Manual hand tools; Uneven surface underfoot
Injury severity	Lost time; Medical treatment; Minor; Near hit; Property damage; Contact-no injury
Incident cause	Body stressing; Hit by object; Loss of control; Slip/trip/fall

[1] Not an exhaustive list of categories used in the database. There are more categories for many variables.

Most records in the database were entered accurately and fully. However, approximately ten percent of records in the database had to be recoded because of errors or omissions when the data was entered. For example, using the category “Other” rather than the actual Task (Thinning). The “Incident cause” category was also difficult for data analysis because of overlap in the definitions for “Loss of control” and “Poor technique”. The narrative descriptions of the injury event were carefully examination to better understand the cause of injury. Accurate data makes analysis faster and the results more reliable.

RESULTS & DISCUSSION

There was a total of 169 thinning related injury reports to the IRIS database during the period January 2019 to December 2023. Most reports were for lost time injuries followed by minor injuries, and there were more reports in 2019 and 2021 compared with other years (Table 2).

Table 2: Thinning related injuries reported to the IRIS database

Event type	2019	2020	2021	2022	2023	Total
Lost time injury (LTI)	13	14	16	18	17	**78**
Medical treatment injury (MTI)	8	5	8	7	3	**31**
Minor injury	18	13	14	6	9	**60**
Total	**39**	**32**	**38**	**31**	**29**	**169**

Most injuries occurred during felling (Figure 2). These injuries include any injury event and are not limited to being hit by the falling tree or being cut by the chainsaw.

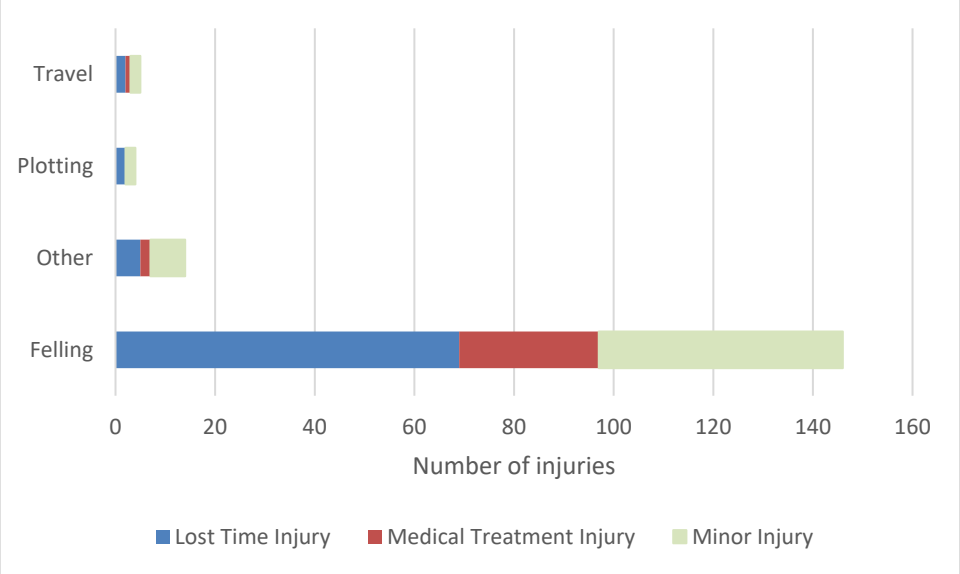

Figure 2: Number of injuries by thinning task

Table 3: Injuries by thinning task

Thinning task	2019	2020	2021	2022	2023	Total
Felling	33	31	29	26	27	**146**
Other	4	1	4	3	2	**14**
Plotting	2		1	1		**4**
Travel			4	1		**5**
Total	**39**	**32**	**38**	**31**	**29**	**169**

The number of LTI reports has fluctuated over the 5-year period with a rise in numbers to 2022 (Figure 3). Medical Treatment Injuries (MTI) were stable from 2019 to 2022 with a decrease in numbers 2023. Minor injuries decreased from 2019 to 2022 with an increase in 2023. A possible reason for the increase in minor injuries is more treatment was done onsite as first aid rather than by a medical practitioner. Improved first aid training and better stocked first aid kits could result in

injuries being handled onsite. Most of the minor injuries were cuts and bruises which could be dealt with onsite.

Previous work (Ashby & Parker, 2003) showed that 30% of injured silviculture workers had less than six months experience. Their data included thinning, planting and pruning workers. Current data in the IRIS database does not have that level of detail about experience but presumably less experienced workers are more likely to be injured where work hardening, experience and technique would help them avoid injury.

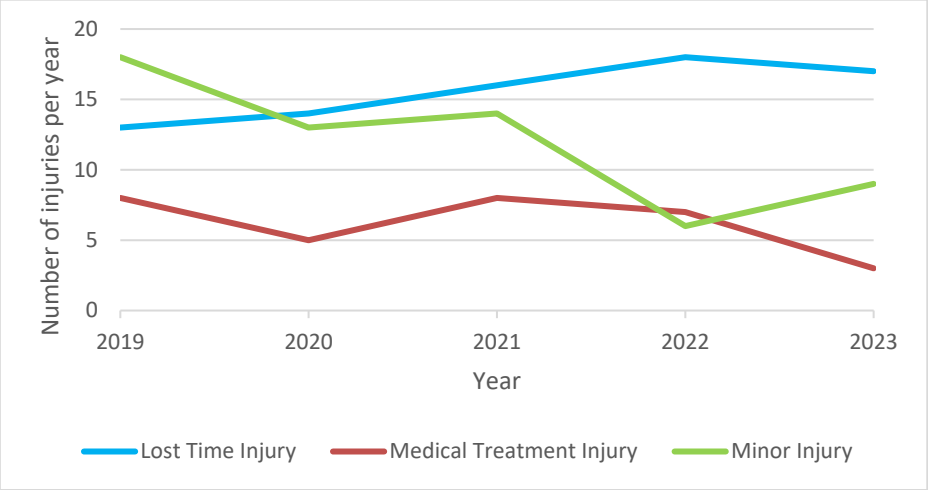

Figure 3: Annual trend in thinning-related injury incidents

Lost time injuries

LTIs are incidents that result in injury to an employee to the extent that they do not return to work at the start of the next regularly scheduled workday or any other subsequent scheduled shift. A total of 78 LTI events occurred during thinning in the five-year period 2019 to 2023 (Figure 2). Minor injuries declined in number and LTIs rose over that period.

Injury event

The total amount of lost time from thinning LTIs over the five-years was 7790 hours, with an average of 100 hours lost per incident (Table 4).

Table 4: Thinning related LTIs by injury inflicting event

Event "Incident cause"	Number of injuries	Total number of hours lost	Average number of hours lost
Slip/Trip/Fall	31	2119	68
Hit by object	13	1466	113
Poor Technique	12	1688	141
Loss of Control	10	1152	115
Body Stressing	5	561	112
Hit object with body	3	212	71
Environmental	2	24	12
Condition or Use of PPE	1	32	32
Lack of Training	1	536	536
	78	**7790**	**100**

The event which featured most frequently in LTI reports was “Slip/Trip/Fall” with 31 injuries which comprised 40% of all thinning LTIs and a total of 2119 hours lost. The most frequent events leading to falling were slipping or tripping on vegetation (9 injuries), simply slipping or tripping and detail not supplied (8 injuries), steep slopes (6 injuries) and “ground giving way” (5 injuries). The hands (8 injuries) and arms (5 injuries) were most frequently injured and most of these injuries were lacerations and all were inflicted by the chainsaw. Under the incident cause “Slip/Trip/Fall” sprains & strains were the leading type of lost time injury (12 injuries) with the ankle (3 injuries) and wrist (3 injuries) being the most frequently injured body parts. These were followed by the shoulder (2 injuries) and knee (2 injuries).

The most severe “Slip/Trip/Fall” injuries were: walking downhill, tripped and fell on old stump injuring shoulder – 320 hours lost; slipped on a steep track wearing spiked gumboots and broke ankle – 312 hours lost; walking downhill, slipped on a branch and fell backwards and sprained wrist – 300 hours lost.

The second most frequent cause of injury was being “Hit by object” with 13 reports. Thinners were hit by the tree being felled (8 injuries) or hit by broken branches falling from height (4 injuries). The most severe injury resulted in a fracture to the neck and 480 hours lost after being hit by the tree. A thinner was dragged over by a regen tree caught in the felled tree resulting in a dislocated knee and 432 hours lost.

Injury events categorised as “Poor technique” were recorded as the cause of 12 lost time injuries and the most frequent event was chainsaw kickback resulting in three injuries. There were two injuries each from being hit by the driving tree and being hit by the tree during posting and one injury recorded as “hit by tree”.

The ten injuries classified as “Loss of control” were all lacerations inflicted by the chainsaw. Eight of the injury events were chainsaw kickback and two were the result of slipping and falling onto the saw.

However, the “Incident cause” category is quite arbitrary and can mask trends in injury events. Further analysis of the data revealed that chainsaw lacerations were a major source of injury and were classified under “Poor technique” (5 injuries), “Loss of control” (10 injuries) and “Slip/Trip/Fall” (8 injuries). Similarly, there were five injuries classified under “Poor technique” where the faller by hit by a tree. These can be added to the eight ‘Hit by tree’ events classified under “Hit by object” already mentioned above.

Overall, the most common causes of injury were slipping, tripping and falling, being hit by a tree and being cut by your own chainsaw either from a kickback or falling and landing on the saw.

Body part injured

The most frequently injured body parts were the hands, wrists and fingers (Table 5). There were 14 lost time injuries and a total of 1095 hours lost. Nine of the injuries were due to slipping or tripping and falling either on to the saw (6 injuries) or on to the ground (3 injuries).

Table 5: Thinning related LTIs by part of body injured

Body part	Number of injuries	Total number of hours lost	Average number of hours lost
Hand/Wrist/Finger	14	1095	78
Back/Spine	11	648	59
Head	11	1657	151
Shoulder	6	711	119
Upper/Lower Arm	6	325	54
Knee	5	653	131
Ankle	4	113	28
Chest	4	77	19
Elbow	4	328	82
Lower Leg	3	973	324
Foot	3	497	166
Neck	3	576	192
Eye	2	89	45
Abdomen/Pelvis	2	48	24
	78	**7790**	**100**

It is useful to have a greater understanding of the circumstances leading to injury rather than just presenting raw summaries of numbers. In Table 6 the available narrative associated with each hand injury report is paraphrased. The forest environment of a thinning worker can be steep and the undergrowth thick and with many tripping hazards. It can also be wet and slippery. Added to this they carry a chainsaw which needs to be handled skilfully to prevent kickback or contact with the body.

Table 6: Narrative report from hand, wrist and finger LTI events occurring during thinning

Walking downhill and slipped on a branch causing him to strain his wrist when he put it out to stop himself as he fell backwards
Track came off excavator and idler fell out. Using another excavator to put back in place. While directing excavator operator to guide idler back into position his wrist has been trapped between track frame and root rake resulting in fractured wrist
Cutting his way from tree to tree in heavy undergrowth. He removed his right hand from the chainsaw throttle handle in order to move undergrowth. His right-hand index finger has made contact with the spinning chain of the chainsaw. This resulted in a laceration requiring medical treatment and time off work
Thinner has come across two toppled trees, one above the other. Cut the lower stem first, and being under tension, it snapped. They then cut the stem fully off at the butt to allow the second stem to fall safely. Whilst finishing off the cut, the above tree has dropped and hit thinner's hand in chainsaw mitt
The operator was walking from tree to tree and tripped or slipped over old thinnings and fell on his saw cutting his left forearm

Thinner was walking through undergrowth and slipped on wet slash, fell and sliced his finger on chainsaw. The chain was not spinning
Slipped and fell on the chainsaw whilst walking out from the work area. Saw was not running but severed nerve in hand and surgery required
Walking a across a steep grass clearing and slipped on slippery papa rock. Finger got caught under the rear hand guard, under the throttle and when body weight came onto the saw it squashed [their] finger between the saw and rock face
Thinning on a steep face, placed his chainsaw up hill and he slipped forward (on loose dirt and debris) and fell onto the chainsaw (brake engaged). His wrist came in contact with the chain and he received a significant cut to his wrist resulting in stitches. No long-term harm to tendons or blood vessels
Thinner tripped and fell landing on wrist and spraining it but was able to carry on working but swelled up after work
Climbing over wind throw and foot caught a branch, he tripped and put his right hand down to catch himself and the top of his hand ran down some rocks and sticks. He took some skin off the top of his hand, and his wrist was sore from catching his fall and resulted in a sprain
Thinning on a roadside batter (loose gravel), lost his footing, slipping down. He let go of chainsaw when slipping and put his hand out and back of his left hand came in contact with chain cutter. Wound was cleaned and stitched
Leader caught in regen, started posting the tree to the ground and the first cut didn't fall the stem so placed his saw down and started pushing the tree with his right hand. The tree was therefore under pressure and has come back and caught his left hand between the stem and butt of the tree causing bruising to hand

Insights from the narrative descriptions:

- The environment is demanding and the chainsaw is unforgiving
- Wearing gloves would reduce the chance of hand injury but gloves must be good quality and well-fitting to provide a good sense of touch and maintain dexterity
- Good footwear is essential to provide as much grip as practical in wet and steep conditions
- Inspect the soles of boots regularly to ensure there is enough tread to provide grip.

The head and face were the second most frequently injured parts of the body with 11 injuries and a total of 1657 hours lost.

Table 7: Narrative report from head LTI events occurring during thinning

While trimming branches, chainsaw kickback occurred connecting with the operator's face causing lacerations to the cheek.
Chainsaw kicked back and struck operator in the face with wound to lip and chin
Cutting vines and scrub around base of tree and bar tip struck the tree causing the saw to kick back and strike helmet, visor and face. Resultant laceration to face on the right side of nose towards eye
Clearing around a tree in preparation for falling and the saw kicked back and hit him the face. 30 stitches from near left eye down to mouth
Chainsaw kickback to helmet and cut forehead
Felling a tree and did not see a regen tree interlocked in the crown which was pulled over striking the thinner on helmet
Attempted to drive hung up over with second tree but second tree hit hangup and its butt kicked up hitting him resulting in a fractured jaw
Rolled van down 10m bank resulting in concussion injury
Silviculture worker was cut in the face from kickback while trimming a tree in preparation for falling
Lost footing and hit the back of head resulting in concussion

Slipped and fell forward on slope whilst reaching forward to cut some scrub and the chainsaw hit something in the undergrowth causing a kickback. The bar cut thru his helmet visor (wire mesh) and cut his forehead above the left eyebrow

Insights from the narrative descriptions:

- Always be aware of where the tip of the chainsaw bar is to reduce the opportunity for kickback and try to keep your head away from the path of a potential kickback
- Be aware of other trees or vines which could come down when a tree is felled

Injury type

Lacerations were the most common injury type with 26 reports and a total of 2185 hours lost (Table 8). Most of these were to the arms, hands and fingers and to the head and face (Figure 3). Sprains & strains were the next most common injury with 18 reports and 1555 hours lost. Most of these were to the back, followed by the shoulders, hands/wrist and ankles.

Table 8: LTI type during thinning

Injury type	Number of injuries	Total number of hours lost	Average number of hours lost
Cut/Lacerated	26	2185	84
Sprain/Strain	18	1555	86
Bruising	13	437	34
Fracture	6	1928	321
Concussion	5	827	165
Not Recorded	4	182	46
Crush	2	139	70
Foreign Body	2	24	12
Dislocated	1	432	432
Scratch/Abrasion	1	81	81
	78	**7790**	**100**

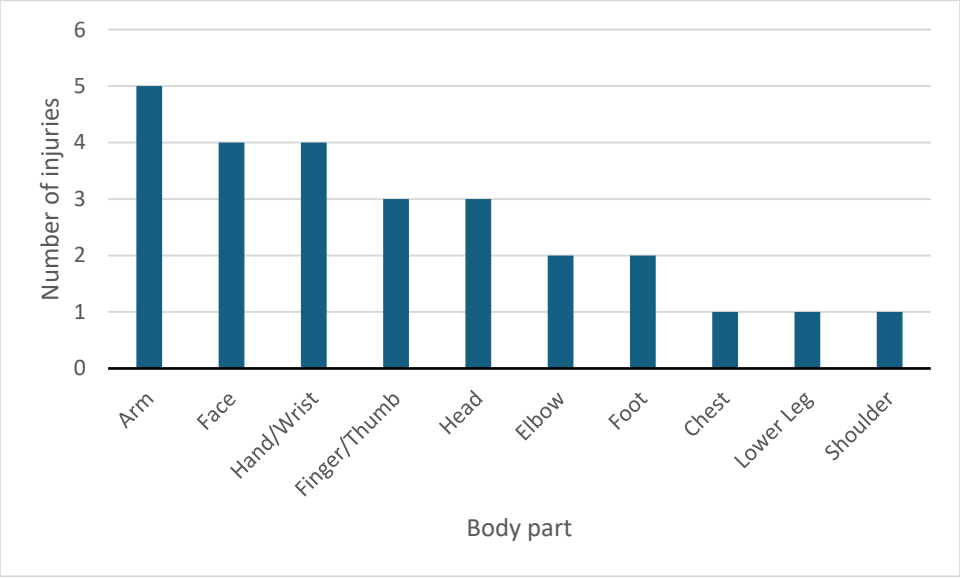

Figure 4: LTI laceration injuries by body part

When laceration injuries are broken down by body part the arms, hands and fingers and the head and face were the most frequently injured (Figure 4). Almost all the laceration injuries were inflicted by the thinning worker's chainsaw. The injury reports show that working in steep, sometimes wet and slippery conditions and pushing through heavy undergrowth while carrying a chainsaw is physically demanding and hazardous. The thinning worker requires a lot of skill and experience to negotiate this environment safely.

Medical treatment & minor injuries

Medical treatment injuries (MTIs) are injury events that are serious enough to require some treatment by a medical practitioner and are too serious to be just treated by first aid onsite. These injuries do not result in the loss of the whole next day off work. Minor injuries are where treatment is applied onsite. Medical treatment and minor injury reports are important because they add another dimension to the understanding of the exposure to risk during thinning operations. They may have resulted in more serious lost time injury under slightly different circumstances.

Injury event

There were 31 MTIs and 60 minor injuries recorded for thinning over the five year period. MTIs have been combined with minor injuries for analysis. The most frequently recorded event was slipping, tripping and falling while walking between trees (Figure 5). Slipping then resulted in the thinner falling to the ground or onto an object. The chainsaw was the object most frequently fallen onto resulting in cuts from the chain or burns from the exhaust.

The second equal most frequently reported medical treatment or minor injury event slipping over and spraining a joint – wrist or ankle (Figure 5).

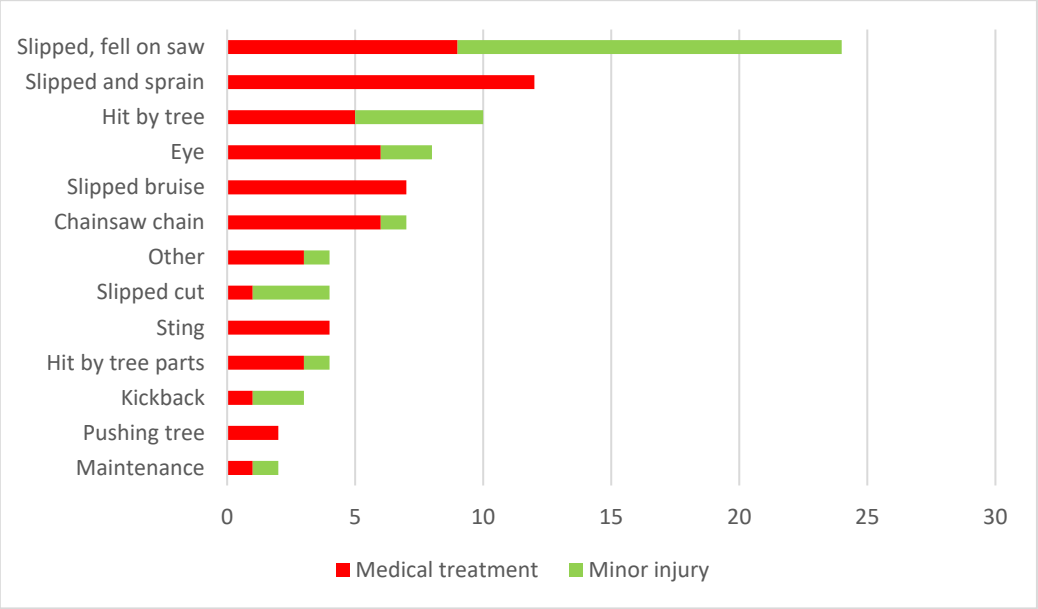

Figure 5: Medical treatment and minor injuries by injury inflicting event during thinning

The narrative text describing the circumstances related to injury are very informative because they give the reader a better understanding of what happened. In some cases, there is a bare description of events but in others a more detailed story emerges which helps understand the circumstances leading up to injury (Table 9).

Table 9: Narrative report of medical treatment and minor injuries from slipping over and falling on chainsaw during thinning

Pre trimming a standing tree prior to placing the felling cuts. he was working on an unstable area (old landslide) lost his footing and balance. The chainsaw cutter bar and chain have made contact with the underside of his left forearm causing a laceration which required medical treatment and 10 stitches
Cut elbow
Chainsaw cut to the leg
Was fitting his spare chain when he slipped down the hill approx. 1m, pulling his hand over the sharp cutting teeth as he fell. lacerated his thumb approx. 3cm long, 1cm deep
A worker had finished thinning a tree with his chainsaw and on retreating stumbled into a concealed hole. He slipped and fell backwards down a bank and was struck on the left top side of his head possibly by the chainsaw or a sharp stake
A thinner was walking out of the forest at the end of the day carrying he chainsaw in his right hand. He stumbled and tripped, as he tripped the chainsaw got tangled around his legs and the bar can around the back of his right leg and a tooth on his chain put a small cut in his calf
Lost his footing while working on steep terrain. He dropped the chainsaw and fell, accidentally putting his hand down onto the stationary bar and chain of the chainsaw cutting his fingers on the chain
Walking to tree and slipped on branch and long grass landing on handle of chain saw hurting rib cage
Fell down bluff with chainsaw. A lot of undergrowth could not see.
Cutting tree slipped backwards down face, saw flipped back as left hand came out of mitt to grab undergrowth. Bar coming down across back of left hand cutting top of hand, requiring 6 stitches. Slid on stick
Walking up a steep hill with his chainsaw (not running) in his hands when he slipped on loose rock and fell onto the saw. A dogtooth on the saw jabbed him in the upper left arm causing a wound approx. 2cm in size
Walking through undergrowth to his next tree when he has slipped and fallen down a steep bank. The palm of his right hand has made contact with the chainsaw cutter bar and chain. The chainsaw was running but being at idle the chain was stopped. The worker sustained a 2 cm laceration to the palm of his hand
Walking across a hillside to an area where he could refuel his chainsaw when he slipped and dropped the saw. He tried to stabilise himself but in doing so the left underside of his lower arm was cut on the chainsaw which was switched off
Slipped on steep slope, released the chainsaw from his grip, and it fell and rolled down the hill towards the chainsaw. His left elbow hit the chain bar of the saw as it was facing upward toward him
Moving next to a tree when his wedge hammer got caught on some blackberry, it pulled him off balance. He fell, he put his hand out to break the fall and it hit the chain resulting in small cut to his right hand
Walking to tree and stepped down a small bank where underground was soft causing him to fall and land on his chainsaw bar which was stationary at the time. He was holding the chainsaw with one hand - laceration to the left outer quad/buttock
Slipped on terrain due to heavy thinning already on the ground and steep hill with loose debris on surface. Hit hand on the chain of chainsaw on the way down, suffering a minor cut to the hand.
Slipped on pine needles and saw slipped out of hand with mitt and cut on right hand from chain
Climbing up steep face towards ridge to next tree to be cut, lost footing and dropped chainsaw. Saw fell between trees down the slope. Couldn't reach top handle so had to grab the tip of the bar to extract the saw. Bar slipped from hand causing slight laceration of fingers

Climbing over a log when he slipped and rolled forward downhill. His right hand got caught under the weight of the chainsaw being carried (not running). He bruised two knuckles on his right hand
While walking to next tree worker slipped down bank and saw hit his knee
A thinner slipped on a steep slope and his chainsaw spun around and he burnt his arm on the muffler
Walking up hill to start thinning the next row of trees, when slipped and fell onto the chainsaw. He cut his inner forearm on the chain

Insights from the narrative descriptions:

- Falling on your own chainsaw and being injured is common
- Footwear with good grip is essential and care is needed with foot placement to reduce the risk of slipping
- Gloves could reduce the number of hand lacerations, but gloves can be hot and may reduce dexterity when handling the chainsaw

Table 10: Medical treatment and minor injuries from being hit by the tree during thinning to waste

Thinner was posting down a hang up and the tree struck his left foot just behind the steel toe cap fracturing his toe
Thinner was cutting down a regen tree and it rolled onto his hand, and the branch stubs from trimming cut his finger – 5 stitches. Tree around 12cm in diameter
Tree was hung up in another tree. Proceeded to cut it out and when posting the butt it swung out and hit me off balance sending me down the hill a few meters releasing chainsaw, the chainsaw has then struck me on the back of the calf with the saw chain (static)
Felled a tree and it landed on a high stump causing the hinge to snap and the butt of the tree hit faller on the jaw propelling him 4.3m away from the tree
Hit on the head and shoulder from behind by a hung up tree left by another worker
Started his back cut and in a split second the stem came flicking towards him and got his ankle jammed against a bank
As tree went over it appeared to 'jump' and slid back striking worker on the foot
Felled tree fell on foot. Standing too close
A waste thinner had cut a large wattle down and then cut a regen stem. The regen fell against the cut wattle causing the butt end to lift/slid out, landing on the thinners steel toe cap boot
Tree got hung up on branches and he moved to left hand side of tree and drove another tree to knock down the hang up. As he stepped back to observe, the tree hit the hang up and the tree butt bounced back and hit his left knee

Insights from the narrative descriptions:

- Great care needed before felling to identify any other trees or loose material in the canopy which could hit the thinner when the tree starts to fall
- Stand well away from the tree as it falls because it could move unexpectedly sideways or back over the stump

Body part injured

MTI and minor injuries to thinners' hands and fingers were the most frequently reported body part (18 injuries) followed by the arm (12 injuries) and the eye (8 injuries). The hands and fingers were also the most frequently injured in LTIs. However, the back and head accounted for a high proportion of LTIs but were much less frequently minor or MTIs. This is likely because injuries to the back and head tend to be serious and result in time off work. As mentioned throughout this

report there is a recurring theme of injury resulting from slipping, tripping and falling and colliding with the chainsaw.

Injury type

Figure 6 repeats the findings reported earlier, that lacerations are common medical treatment and minor injuries for thinning workers, and this is a pattern repeated with LTIs. Almost all MTI and minor injury lacerations were the result of being cut by the chainsaw (29 injuries).

Strains and sprains and bruising were equal second most common type of injury and again, this is reflected in LTIs. The most common event that resulted in a strain or sprain was slipping or tripping while walking in the forest (15 injuries). Events that resulted in bruising were mostly slips and falls (11 injuries) and being hit by a falling tree (6 injuries).

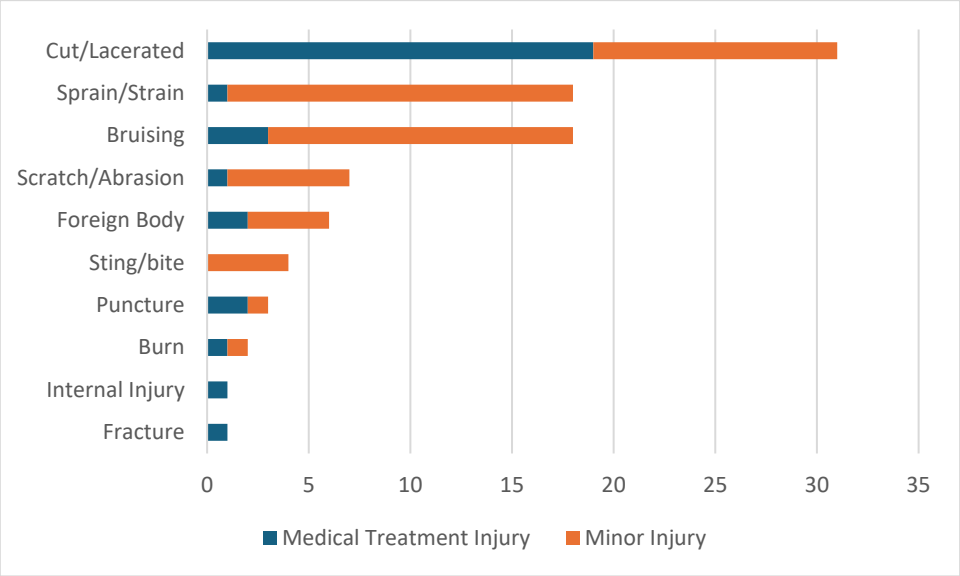

Figure 6: Medical treatment and minor injury by injury type during thinning to waste

CONCLUSIONS

One of the purposes of this report is to identify high frequency and high consequence injury events to help provide guidance in reducing injuries and improving productivity in thinning. The analysis was divided into two parts – LTIs which are high consequence and lower frequency; and MTI and minor injuries which occur more frequently but have a lower consequence (i.e. less time off work).

Most injury events in LTI, MTI and minor injury occurred while walking between trees. Thinning workers work in difficult terrain – often steep slopes, wet conditions, heavy undergrowth, hazards underfoot while carrying a chainsaw. They are also exposed to risk from the falling tree and dislodged debris falling from above. Under these conditions they must make decisions on which trees to thin and maintain a productive pace of work. Technology or techniques that allow the worker to thin from the safety of a cab or even a remotely controlled machine would be a great safety advantage.

There are few studies of injuries to workers in thinning to waste operations. However, the analyses of New Zealand thinning worker injuries that have been published have reported the most frequent cause of injury has not changed in 23 years – falling on the chainsaw and being hit by the tree (Ashby & Parker, 2003). There is a great need to develop new thinning technology and methods to reduce injury.

Until we develop new technology to make thinning safer the options for the thinning worker are:

- Personal protective equipment
    - boots that provide ankle support and provide good grip
    - gloves to protect hands but thin enough for good dexterity
- Good technique acquired by training and experience including adequate rest breaks, hydration and nutrition

One of the aims of the Precision Silviculture Programme is “to develop new thinning systems that decrease labour requirements and improve the safety and productivity of thinning operations.” This analysis provides a detailed baseline of injury characteristics (type, cause, frequency and severity) against which comparisons can be made at the end of the Programme to measure progress and success of implemented initiatives and technologies.

ACKNOWLEDGEMENTS

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