Best & Visser *New Zealand Journal of Forestry Science* (2024) 54:11
https://doi.org/10.33494/nzjfs542024x369x
E-ISSN: 1179-5395
published on-line: 31/05/2024

RESEARCH ARTICLE Open Access

New Zealand Journal of Forestry Science

A qualitative study of the machine operator's experience of wellbeing in the New Zealand logging industry

Trevor Best* and Rien Visser

School of Forestry, University of Canterbury, New Zealand

*Corresponding author: trevor.best@pg.canterbury.ac.nz

(Received for publication 19 January 2024; accepted in revised form 21 April 2024)
Editor: Horacio E. Bown

Abstract

Background: Prompted by the need to reduce exposure to the physical hazards of the logging workplace, more of Aotearoa New Zealand's loggers now find themselves operating a machine rather than working 'on the ground'. This change has enabled more production to be achieved with less workers and with a significant reduction in the rate of serious harm incidents. However, mechanisation is not without its risks to operator wellbeing. This study explores the wellbeing of operators and the psychosocial demands and coping adaptations that contributed to that experience.

Methods: Twenty-seven operators were recruited from three regions to participate in a semi-structured interview to explore their experiences of stress and wellbeing. References with consistent meaning were first, coded, and then, using Axial Coding, themes or categories were identified. Defining properties for each of these categories were then used to conceptualise the relationships between the themes.

Results: Stress and wellbeing were described as a specific set of experiences resulting from the adaptations participants made in the face of threats to production, a sense of place within the crew and to family wellbeing. Those adaptations were arranged in two pathways that were dependent on what resources were available to the participants. If left entirely to their own skills and time, the participants would cope with threats by working longer hours. If through the decisions their forest owner / manager and contractor made, they had access to sufficient supply chain capacity, work security and job control supported by an effective organisational culture and interpersonal relationships, they could access the work-life balance that was at the heart of their sense of wellbeing.

Conclusions: This research has provided an inventory of the psychosocial hazards faced by logging machine operators working in Aotearoa and the resources that enable them to cope. In doing so it has suggested that the potential for operator wellbeing is established in the designing of the overall supply chain (skids, roads, logging equipment configuration, and truck capacity) and the contracts that connect the various services, and then achieved through the way logging businesses are led and managed.

Keywords: Psychosocial hazards, stress, wellbeing, resources

Introduction

Over the past decade, the New Zealand logging industry has been going through something of a revolution in the way it does its work. Prompted by the need to reduce the exposure of workers to the physical hazards of the workplace, more of the workforce now find themselves operating a machine rather than working 'on the ground'. Benchmarking data shows that between 2008 and 2020 the ratio of machines per worker increased by 100% in those crews that submitted data and that worker numbers reduced by 24% in the ground based operations and 12% in the cable based operations (Visser[1]). While this change is associated with a 53% reduction in the notifiable injury and serious harm incidents recorded between 2012 and 2017 (Forest Growers Research 2018), the increasing production capacity has seen the

[1] Visser, R. (2022). *Cost and productivity benchmarking update 2020/21*. 4. Unpublished Forest Growers Research report.

annual harvested volume grow from 18.7 million cubic metres in 2008 to 34.5 million cubic metres in 2020. More work is being achieved by fewer operators. However, mechanisation is not without risks to operator wellbeing (e.g., Hunt 2017; Paul 2017) and as the production per operator grows, the implications of operator wellbeing on industry productivity and profitability also grows. Clearly, there is now a need to understand the stress implications of mechanisation to ensure worker health and wellbeing and industry profits are not negatively impacted.

What makes wellbeing a challenging subject for any forest manager is that the objective is not well defined, and the risks being managed are typically subjective and, therefore, different for every worker. Through the Health and Safety in the Workplace Act (New Zealand Government 2015), managers are obligated to manage hazards in the psychosocial domain. That is, the domain which contains the relationship between our physical and mental capabilities and the social environments in which our lives progress (Woodward 2015). Psychosocial hazards require specific expertise to observe and measure. These hazards tend to be captured within the discourse of work-related stress which defines psychosocial hazards as:

> *those aspects of work design and the organisation and management of work, and their social and environmental contexts, which have the potential for causing psychosocial or physical harm.* (Cox et al. 2002, p. 195).

Using that definition a summary framework of work-related psychosocial hazards has developed (see Table 1) along with validated instruments that can establish their presence within the workplace (Bentley et al. 2019). However, unlike physical risks, where elimination is the best case scenario, wellbeing risks can also have a motivational impact that enhances wellbeing. As much as work can lead to stress, it also has the potential to enhance wellbeing (Modini et al. 2016). This is reflected in the notion of health as being more than just the absence of harm but is a state of physical, mental and social wellbeing (World Health Organisation 2019). The goal, therefore, is to manage the psychosocial conditions such that 'well-ful' conditions are promoted and those conditions likely to be hazardous to wellbeing are minimised.

As both wellness and stress are subjective conditions determined in the relationship between the individual and their social environments, managing wellbeing requires having an understanding of the psychosocial conditions that exist within any particular context (Dewe & Cooper 2017). Thus far, logging in Aotearoa New Zealand appears to have attracted relatively little attention from researchers. Rebecca Lilley and colleagues (2002) found that both the total workday length of forestry workers and the number of workers working more than five days per week had increased in the previous ten years. There were also substantial groups of workers whose break times were compromised. Hide et al. (2010) noted within their study of cable logging that work pace and workload were not within the direct

TABLE 1: Work-related psychosocial hazards

Psychosocial Hazard	Explanation
Job Content	Lack of variety or short work cycles, fragmented or meaningless work, under use of skills, high uncertainty, continuous exposure to people through work.
Workload and work pace	Work overload or under load, machine pacing, high levels of time pressure, continually subject to deadlines
Work schedule	Shift working, night shifts, inflexible work schedules, unpredictable hours, long or unsociable hours
Environment and Equipment	Inadequate equipment availability, suitability or maintenance, poor environmental conditions such as lack of space, poor lighting, excessive noise
Control	Low participation in decision making, lack of control over workload, pacing, shift working
Organisational culture and function	Poor communication, low levels of support for problem solving and personal development, lack of definition of, or agreement on, organisational objectives
Interpersonal relationships at work	Social or physical isolation, poor relationships with superiors or co-workers, interpersonal conflict, lack of social support
Role in Organisation	Role ambiguity, role conflict, and responsibility for people
Career Development	Career stagnation and uncertainty, under promotion or over promotion, poor pay, job insecurity, low social value to work
Home-work interface	Conflicting demands of work and home, low support at home, dual career problems.

Source: adapted from Leka & Cox, as cited in Bentley et al. (2019, p. 6)

control of the operator but driven more by the pace of adjacent workstations. They also noted the inconsistent nature of break times. Finally, Lovelock and Houghton[2] highlighted the potential for psychosocial impacts to spill over into adjacent social settings by suggesting that some of the stress observed at work may originate outside the workplace. They referred to stressors that included high drug use in worker families and communities, insecure and crowded accommodation and conflict with unemployed family members as having the potential to impact forestry workplaces. More recently, forestry workplaces have been part of national surveys of workplace psychosocial conditions (e.g., Bentley et al. 2019; Khieu et al. 2022). While they suggest that bullying is more likely to happen in forestry workplaces, they also point to motivating conditions such as influence over work, the predictability of work and clarity over role as features of the forestry workplace. However, the relevance of their findings for this study is difficult to establish because they do not distinguish between silviculture and logging workplaces. The general sense is, therefore, that compared to the known psychosocial hazards set out in Table 1, this body of work presents a relatively incomplete picture. The paucity of research on the psychosocial conditions operating within logging in Aotearoa New Zealand is likely to be hindering management efforts to promote wellbeing (Adams et al. 2014; Lovelock & Houghton[2]; Nielsen 2015).

Research on psychosocial conditions undertaken in logging operations overseas does start to fill in some of the gaps in our knowledge, albeit in a different geographic context. Within this body of work there appears to be two different groups: research focused on conditions promoting stress; and research focused on understanding the conditions that promote wellness. The first group are characterised by the association of a hazardous psychosocial workplace condition with a negative psychophysiological response (Chirico et al. 2019). For example, mental strain suffered by Japanese operators of logging machinery was shown to be associated with ergonomic conditions in the machine, the nature of the employment contract, work pressure and work repetition (Inoue 1996). Lower back disorders were significantly associated with psychological demand in a group of Norwegian forestry enterprise employees (mostly manual workers) (Hagen et al. 1998). The same study found an association between neck and shoulder disorders and increasing psychological demands and decreasing intellectual discretion. These are all hazards that fit within the framework outlined in Table 1 but both were limited to the psychosocial hazards included in their testing.

The second group of overseas studies in logging operations are more focused on the psychosocial conditions that promote a sense of wellness. Hanse and Winkel (2008) found that job rotation was the only psychosocial factor tested that had a positive impact across all three measures of wellbeing used in the study. Daily task variety, access to breaks when required and job control were also associated with a positive response in at least one of the three measures. In a Tasmanian study of forest managers and workers, work control, satisfaction with income, job security, feeling confident in being able to express opinions and views, social support and higher work efficacy were positively associated with either one or both of the measures of wellness used (Mylek & Schirmer 2015). Finally, a study of loggers working in the Arkhangelsk region of the Russian Federation has shown that task variety, support to develop skills, involvement in decision making, physically challenging work and support from colleagues were positively associated with one or more of the three measures of wellness used (Korneeva et al. 2022). Conversely, task complexity, working overtime, poor pay, surveillance of performance, rule based culture, family demands interfering with work and harassment and bullying appeared to be conditions that detracted from wellbeing. These studies highlight the potential to enhance wellbeing through effective management of psychosocial conditions.

The existing research gives some indication of the psychosocial conditions likely to be operating in Aotearoa New Zealand. However, that research offers little guidance on how psychosocial conditions that enhance wellbeing have been achieved. The purpose of this study, therefore, was to explore what was considered as wellbeing by a group of operators working in logging in Aotearoa New Zealand and the psychosocial demands and coping adaptations that contributed to that experience. The intention was to provide forest managers with information that could assist in designing workplaces and processes that promote psychosocial wellbeing.

Methods

This study was done within the context of a larger grounded theory study aimed at generating an explanation of the process of wellbeing as it is constructed by machine operators working within the logging industry (Best 2022). Grounded theory is based on a theoretical framework (symbolic interactionism) in which the meaning of any event or experience comes either from the context or the perceptions of the person witnessing the event or having the experience (Tolich & Davidson 1999). From this theoretical perspective, actions construct self, situations and society (Charmaz 2014). Actions and interactions are windows into the meanings individuals are applying to events and the social environment in which those events happen. This study represents an exploration of the events, actions and interactions that the participants considered to be contributing factors in what they understood as their wellbeing.

[2] Lovelock, K., & Houghton, R. (2017). *Health on the outside, sick on the inside. Work related health in forestry*. Unpublished WorkSafe New Zealand report. *(Updated 05/06/2024: Published report retrieved from:* https://ndhadeliver.natlib.govt.nz/delivery/DeliveryManagerServlet?dps_pid=IE28074591*).*

Participants

The participant population were machine operators working in the logging industry of Aotearoa New Zealand. They were either directly employed or sub-contracted to use machinery to fell and / or extract trees, cut them to length and load them as logs for transport. The strategy used to sample this population was driven by the need to collect and analyse data concurrently (Birks & Mills 2015). That meant starting with a purposive sampling framework to generate the initial data and then moving to a theoretical approach as more data was sought to fill in details about developing themes / categories (Birks & Mills 2015). The initial sampling framework aimed to cover the contextual factors the literature suggested could be associated with the experience of stress in the workplace: 1. Length of the working day; 2. Work security; and 3. The type and location of machines within the logging operation. To cover the potential variation in these factors participants were recruited from Tainui / Raukawa – Te Arawa Waka / Central North Island, Te Tai Rāwhiti / Poverty Bay – East Coast and Muruhiku / Otago – Southland. Sampling continued until no new codes were being generated within the analysis. In all, 27 participants were interviewed (five in Murihiku, 12 in Tainui / Te Arawa Waka and 10 Te Tai Rāwhiti).

Participation was voluntary with participants made aware of the nature of the research prior to giving consent and having the right to decline to be interviewed or withdraw at any time. As the study was likely to involve Māori as participants, the research was designed to treat participants with manaaki and respect their mana through their control of the data.

Data collection

Data was generated through a semi-structured intensive interview. The aim was to gather in-depth information about the events, activities, processes and relationships that the participants used to construct their experience of stress and coping. That meant having a conversation aimed at reviewing critical incidents the participants identified as stressful: what happened, what was at stake, who was involved and what was the result. Aspects of the operator experience that contribute to wellbeing were also canvassed through questions on how they got into logging and what they enjoyed about it. Given the reflexive nature of the interviewing and analysis process, the primary researcher should be considered as a co-constructor of the data rather than a passive, objective observer of the data.

Analysis

The process of analysis (see Figure 1) started with Initial Coding: breaking transcripts down into references that represented recurring experiences, phrases, explanations, characteristics and actions (Birks & Mills 2015). These references were relevant to the process of stress included in the critical incidents described by participants. References with consistent meaning were grouped in a code and given a label that represented the meaning of that code. Using the framework described by Corbin and Strauss (2015) as Axial Coding, themes could then be identified by looking at the relationships between the codes. Using the logic of "when this happens, I do this, in anticipation of having this result", Corbin and Strauss (2015, p. 157) demonstrated the relationships between codes through three components:

- Conditions: the circumstances or situations (why, where, how come and when) that scaffold the social process being studied:
- Actions / Interactions: the participants' responses (by whom and how) to events, issues or problems;
- Consequences: the outcomes (what happens) of the actions / interactions.

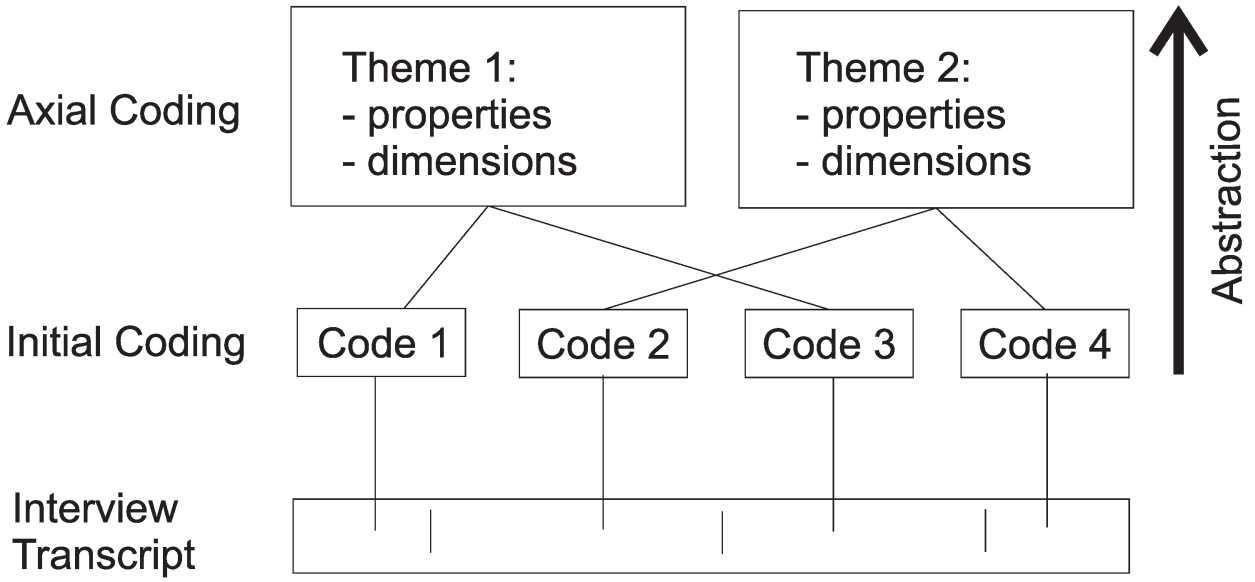

FIGURE 1: Analysis process using initial coding and axial coding to develop themes.

As a concept built up from other concepts, themes have properties and dimensions. Properties can be thought of as the characteristics of a theme that give it definition and meaning while dimensions set out the range of conditions under which that category arises, is maintained and changes (Birks & Mills 2015; Charmaz 2014). This process was facilitated by NVivo software and used memos as a discursive space in which thinking about codes and themes could develop. Through constant comparison of codes with codes, codes with themes and themes with themes, the references were re-assembled into a framework of concepts that provide an explanation of the process that generates stress and wellness within a participant's life.

Results

From the interviews and analysis, three themes were identified. The first theme was threats to wellbeing, and the second and third were two different coping /impact pathways: coping strategies that appeared to be detrimental to wellbeing and coping strategies that appeared to be core to wellbeing. The purpose of this section is to detail the properties of each of these themes. Note that a more complete list of participant responses is presented in Best (2022). The quotes used from the participants are referenced and numbered (i.e. P4 as fourth interview) so that quotes from the same individual can be identified. The quotes are reproduced verbatim. That means they may contain words that are offensive to some people[3]. Amongst the participants these words have similar meaning and use. They were critical to the interpretation of not just the conditions, actions / interactions and consequences being described by the participants but also the emotions associated with them. In describing the findings, the language has been retained in the quotes to ensure the reader not only gains a better understanding of the findings but also so they can assure themselves that the findings reflect the meaning and voice of the participants.

Threats to wellbeing (Theme 1)

Any situation that threatens something valued by the participants is likely to be a stressor and, therefore, detrimental to machine operator wellbeing. The findings pointed to several environmental conditions or situations that were considered stressful by the participants: threats to achieving throughput, threatening targets, threats to a sense of place within the crew, and threats to family wellbeing.

Threats to achieving throughput

Anything that acted as a constraint on throughput was often used as examples of critical incidents that generated stress for the participants. Logging is a linear manufacturing process (harvester – prime mover – processor – fleeter / loader) dependent on several inter-related factors for throughput. Participants referred to critical incidents in which one or more of a number of obstacles got in the way of wood flowing through the process. They included the operating capabilities and availability of machines, the availability and skills of the operators and the capacity of the skid to store the log sorts required by the cut plan as well as provide operating space for the processor, loader and any fleeting equipment. This was a source of felt pressure throughout the day (e.g., "*I've got it structured for the day and I know where I need to be*" – P22). If it was not going well the crew was expected to adapt. P4 noted that "*if you're at the slower link in the chain, you've just got to work through the smoko while they're not working, or you've got to reduce your maintenance for the day or you've got to do something to try to make it flow … ".* It was also a source of embarrassment if you were perceived as being the bottleneck (e.g., "*Yeah, so if I get behind, that's probably when I stress a bit*" – P16*)* which was made obvious to all by the stockpile sitting in front of your machine and the next machine waiting for wood. In crews that did not enjoy good working relationships this tension was only greater. When asked to talk about a stressful incident P21 referred to a crew mate's performance: "*I'm up his ass all the time. But he won't go out of his way to stay back … He can do it way better. You can see, if he wants to have a day off or something like that, he'll just mow the wood down".* Actions like not helping when needed or ignoring crew members had a significant impact on throughput. When it rained the difficulties only increased. "*… You'll be going along on a good landing … then it pisses down and everything you were doing just turned to sh*t because you're struggling to move and you're trying to get things out*" (P18). If the capacity of any part of the process was not sufficient to get the work done in the required time frames, then the crew or individuals would end up working late. P6 complained that "*if you're behind, you're going to end up working extra to try and keep it ahead".*

Threatening targets

While throughput was something of a felt experience, production (uplifted loads per day) was something more measurable. Not meeting the contracted target created the perception that production or uplift was not adequate. Threats to the perception of adequate production not only came from obstacles to actual production but also the implicit agreement that the target was achievable. On that basis, participants pointed to three obstacles to the perceived 'fairness' of the target: unachievable targets; difficult relations with the forest owner / manager (or their supervisor); and, being measured by either the forest owner / manager or the contractor. Being physically unlikely to meet the target was perceived to have ramifications for the contractor / employer's monthly cashflow and as such failure to meet that target created pressure within the crew, e.g., P6: "*been in a forest before … where they've wanted so much out of there, which we were coming so close, but we got to a certain point in the block where we just couldn't do it anymore, and the pressure was mounting on us, obviously.*"

[3] The reviewers, Editor and Journal manager support the inclusion of full quotes but consider that offensive language is inappropriate in a scientific paper so have replaced some letters with asterisks.

That tension was felt because of what making target meant to the participants. It was seen as the point at which the crew's capability was confirmed and their ability to provide for their family / whānau secured.

While the target was also a factor in the relationship between the crew and the forest owner / manager and their staff, that relationship went beyond being solely about price. The forest owner / manager controlled both of the logistical elements adjacent to the logging process (the skids, and roading infrastructure and trucks) and through that control, had a significant impact over the crew's throughput. By setting the log cut plan, the forest owner / manager also had a significant impact on the work content and the storage requirements of the skid. When the relationship between the crew and the forest owner / manager was not working, it was something of a threat as noted by P20: *And then when you get into a situation where there's a genuine problem, and they're* [the forest owner / manager's supervisor] *out of their depth, you can't have a good honest conversation with them, because once they realize that they're out of their depth or they can't come up with an answer, they just put it all on you, "You just have to manage it. You'll just have to manage it." It's like, "What the f*** does that look like," you know?*

As P20 indicated resolving problems that were judged to have been caused by the forest owner / manager put operators in something of a bind and, without the necessary control over the resources, presented as something unresolvable.

Finally, with the advent of computer assisted log processing, throughput as measured by the number of logs and log grades cut can be known at any point of the day and reported back to the forest owner / manager. That level of scrutiny was perceived to raise questions about the level of trust the forest owner / manager had in the operator and crew. One participant noted that *"the level of surveillance is way more than it used to be",* explaining that he felt his professional capability was being questioned. Another noted that the numbers were always just there on the screen and that it was a *"constant pressure"* that those not operating a processor did not have to endure.

Threats to sense of place within the crew

Any situation that threatened either the recognition of personal capability and experience or having input into the way the workplace or crew was organised seemed to threaten the participant's sense of place within the crew and, therefore, their sense of wellbeing. Within the formal hierarchy (owner, foreman) power could be concentrated to the extent that "*it's all just secret … you never seem to know what's going on"* (P21). That was not helped by the lack of leadership skills amongst some of the people in those positions, e.g., "*he'd never interreact with you … only if you f*** up … then it would be 'Oi" [and] you'd get a blasting"* (P17). Furthermore, the position of each crew member in that hierarchy was reflected in what operators were paid and how they were paid, something each crew member had some sense of despite the individualised nature of the agreement. Higher status positions received higher pay and a higher sense of security (e.g., salary rather than hourly wages). Steep hierarchies as reflected in the distribution of power, the skills of those in higher positions or in employee pay structures are a threat to team performance (that is, throughput) and, therefore, individual wellbeing (Anderson & Brown 2010).

Outside of that formal hierarchy, power and influence was exerted through an informal hierarchy. The position an operator had within that hierarchy had a significant impact on who could legitimately have a say on what went on in the crew, e.g., P5 complained that: *The hauler driver had just so much say in what I did so, [I'd] get a week ahead … he'd be like, "Oh no, I need you to feed the ropes" so I would spend the next week down the hill … then they'd go to the end of the week and there'd be no wood on the deck.*

What is more, mechanisation, and the resulting loss of ground worker roles (manual felling, skid worker, breaker out / choker setting) was changing the way an operator's position in the crew was being earnt. In the now fully mechanised crew, the relatively inexperienced operators had not, in the eyes of more experienced operators, 'earnt' their seat in the machine. P13 complained about the "*guy who's never done a day's … hasn't got a single bit of dirt under his nail, and he's in the machine … that really boils my blood, actually."* Who gets to have a say on how the crew operates is a clear indication of who matters on the job and whether you have a sense that you matter impacts on your sense of wellbeing (Hicks 2015).

Threats to family wellbeing

When asked the question "what had been the most stressful experience of your life to date" participants invariably referred to something that threatened the integrity of the family / whānau or their ability to meet the needs of the family / whānau. These threats seemed to come from four specific sources: loss of income and related to that, loss of the ability to work, getting somewhere to live and, finally, loss of family integrity. Loss of income threatened the ability of participants to meet their family's financial commitments: e.g., "*if you were an employee and your boss wasn't paying you, what can you do? You'd be bloody stressing about it if you had a mortgage and sh*t like that"* (P4). As the interviewing was happening during a significant correction in the market price for logs that resulted in reduced production quotas or in extreme cases, a complete shut, loss of income due to a market downturn was foremost in the minds of participants. However, operators were also aware that logging contracts usually came with fixed terms, particularly, those working in the wood lot industry and that they could be out of work after that. With these contracts there was the sense that "*the faster we work, the faster we're burning through the work that's keeping us going ... we need to work more to make money but the more we work, the more we're putting ourselves out of work"* (P4). When the operational objective is always to work faster, the sense that it is counter-productive to one's security is disconcerting. This

tension is also reflected in the belief that logging skills are quite specialised and that rural workers have fewer opportunities: e.g., "*I enjoy coming out to the bush that much. If I lost that, I wouldn't know where to start … "And there's not much job opportunities [where we are]. How am I going to pay my bills?"* (P12). Money was a large motivator for the participants so having to go with less was seen as a significant threat.

There was also concern about exposing family members to the safety risks. When asked whether they would sanction a family member becoming a logger those who had experienced the industry's dangers answered in the negative: *Nah. Nah. And I suppose some of it is down to the risk, the danger side of it. Yeah. I mean, I've known people, injuries, and that have died over time I've been there and yeah, a fair few. You know? (P25).*

This is acting against a traditional male norm. Men who work with machines have long socialised their male offspring to appreciate the value of operating skills (Lovelock 1999). Not being willing to encourage others into operating is an indication that some of the operators at least were concerned about the threat represented by the risks they faced.

A third threat to family wellbeing was the challenge of securing housing within the mostly rural and provincial locations in which the participants lived. This reflected the distance between home and work and the implications it had for the time participants were able to spend with family / whānau. Participants talked about commuting times ranging from 30 minutes (largely considered acceptable) to 90 – 120 minutes (generally considered unsuitable). The longer commute times appeared to create some tension within the participants, e.g., "*If we have to travel far then it takes a bit of toll on you. You got to wake up a bit earlier, get home later.*" (P19). That tension had an impact within the family home, e.g., "*Dad coming home and just f***ing losing it … especially little kids and that, just being f***ing annoying, the noise. 'Dad can we do this?' 'F*** off, I'm not doing nothing.' Sh*t like that"* (P17). This tension appeared to engender feelings of guilt within the affected participants, particularly as it contributed to the final threat to family wellbeing, the loss of family integrity.

There was also reference by participants to the experience of the family unit breaking up and the impact that had on their mental health and work. P13 talked about how he *"went through my hard times with my ex and all of that. Man, I'll tell you what, it was hard. …, and almost lost my job because of it."* Participants placed a lot of importance on their responsibility to the family / whānau to the extent that when the family was threatened, work had something less of a priority over the use of their time. Achieving a balance between time spent at work, time recovering from work and time spent with family was a significant source of stress for the participants.

Achieving a sense of wellbeing was made difficult through a number of obstacles the participants appeared to face. Anything that threatened the flow of wood through the logging system or achievement of target, threatened the operator's perception of skill and capability and the financial security of the crew. Relative positions within the crew (both formally and informally) and the rewards able to be achieved through work could also be directly threatened by who had power over what within the crew. Threatening changes were also evident in how someone made their way up those hierarchies. Mechanisation was undermining traditional rites of passage, creating tension amongst older operators who viewed younger operators as not necessarily having earnt their 'seat'. Finally, both challenges to production and position within the crew contributed to threats to family / whānau through threats to the family's income either as a result of situations beyond the loggers control or through the loss of the loggers capacity to work. These are all conditions or actions / interactions that threatened the participant's sense of wellbeing. Given the nature of the contracts used within logging in Aotearoa New Zealand (time or volume bound contracts paid for by a price per uplifted tonne piece rate), the sense of place within the crew and family wellbeing are all built on meeting throughput expectations and the daily target implied by the piece rate. Next, we will examine how the operators adapted to those threats and the impacts those adaptations had on their wellbeing, conditions the participants associated with stress.

Subsequent pathways: Coping adaptations/ resources (Theme 2) and their health impacts (Theme 3)

Within the participants testimony, the two remaining themes (coping adaptations and their impacts) were organised around two different pathways, separated by the resources used to overcome the threats and the impacts their use had on the operators. In the first pathway, the operators relied entirely on their own resources (time and skills) and if that was not enough to get the work completed within their available energy reserves then the impact was what the participants described as 'stress'. In the second pathway, access to resources that could only be deployed by either the forest owner / manager or the contractor sustained the operator's energy levels. This created the opportunity for both more enjoyment of work and a healthier work life balance. The properties that define the alternative pathways are detailed in the next two sections.

Pathway to stress

When asked what participants did not like about working as an operator, the most common response was 'the long hours'. Participants in this study consistently reported workdays (including travel) of more than 11 hours per day with some working more than 55 hours per week. While the burden appeared to fall mostly on loader operators, who arrived early (3.30 – 4.00 am) to load out trucks (e.g., "*[massive hours?] 75 – 80 per week including Saturday morning"*- P20), others were also reporting days in excess of 11 hours (including travel) after they had dealt with maintenance (e.g., dropping off or picking up chains) or reporting (e.g., uploading log files from processors).

Some participants considered their hours to be an action taken to overcome obstacles to meeting target e.g., *"if you're in a sh*t block … it's going to be hard, so your hours will creep up"* (P6). Others could point to their own decisions to ensure throughput by "*have[ing] a nice stockpile of wood"* (P21) for the next workstation. Those working on the skid (processor and loader) were "*prepared to come early and load trucks"* (P2) so that they could maintain the space on the skid for processing and storing wood as any "*backlog…works its way back to everybody in the bush"* (P2). Finally, while some participants worked what they considered to be reasonable hours, their workday was extended somewhat by the commute they faced to the workplace, e.g., "*we were starting [work] at 5.00 am, so leaving at quarter to 4.00 am"* (P25). If they were the driver of the vehicle, the commute was also considered to be 'working', e.g., "*I'm driving as well, the other fella just goes to sleep"* (P25). Whether that was work recognised by the employer was not consistent amongst the contractors with "*some crews do [pay for travel] and some crews don't,'* (P6). The actual hours worked, therefore, reflected the pressure to meet production or throughput targets in the face of the obstacles inherent within a difficult operating environment.

While working longer hours was something that generated complaints, responses to a follow up question about whether participants would work shorter hours if they could were mixed. As hourly rate workers, the operators benefitted from working long hours by being paid more. It also benefitted the operators position within the fraternity. In the absence of physical work, long working hours was interpreted as the foundation of the participant's reputation as being a hard worker, willing to do whatever it took to get wood out. That also meant working weekends to get ahead or catch up, e.g., P13: *Nobody loves doing that. I try not to, but if I have to, I have to. If I have to get ahead somewhere, I'll put the hours in to do it.*

In describing the consequences of critical incidents, the participants identified a relationship between their work hours and stress. If working longer hours resulted in the depletion of the operators energy over the working day or week then fatigue played a part in their sense of wellbeing. P22 noted that "*mentally, you're absolutely shot at the end of the day"* something that P18 suggested was unexpected: "*I go home more tired now than what I did when I was physically on the ground, busting my ar*e".* Participants also described the progression of fatigue over the week as lack of sufficient recovery one day to the next. This was particularly so for those who worked Saturdays so that when "*Sunday comes, you sort of can't be bothered doing anything … because you're tired"* (P14).

A number of outcomes were attributed to that fatigue. Firstly, despite the love of physical exercise and being physically fit, those participants who had been *"gymmers"* (P5) noted losing motivation to exercise. When they *"[got] home late at night, [they were] not motivated to go for a run"* (P1). Participants also recognised that sitting for long hours at a time had contributed to them gaining weight so much so that they had a name for it: "*digger figure"*, (P2). For example, "*I've packed it on. I used to be pretty skinny"* (P26). Given the importance of physical capability and activity to their sense of wellbeing, it was something that concerned those who had noticed it, e.g., P25: "*I'm conscious of it because I've always been quite, well, we used to joke you're nearly growing horns on your head when you're on a chainsaw and that, how fit you were".* However, it appears it was not just about the lack of activity. Some participants talked about using food and other substances as a means of coping with the mental strain of their work. For example, P17 talked about his unhealthy eating habits and asked "*what was it for? Relaxing and trying to calm me down, comfort eating".* P7 noted that he "*was drinking a bit much, … probably drinking to get to sleep".*

Some participants were not so much concerned about the impact of fatigue on themselves but more about "*how you're affected [by hours on the job] that can stress you at home, if you get tired"* (P18) and the pressure that put on relationships at home. For example, P15 noticed that *"I didn't see it, but nah, my wife said, "Yeah, all the time grumpy. Tired. If not grumpy, tired."* That was particularly so towards the end of the week with families placed in the position that "*they sort of know by Thursday, Friday, I'm f***ing sh*tty as"* (P17).

Finally, on top of the impact of fatigue on relationships, the length of time at work made family / whānau life more difficult. Older participants noted that *"they [my children] hardly seen me through most of their lives"* (P16), something younger participants were struggling to reconcile. For example, P20 reflected that "*sometimes it can make that couple of hours with the kids a little bit harder and then you'd be just wanting to get their stuff done and then hitting the sack "*. That added to the difficulty of maintaining a solid relationship with the partner with participants noting that they would get "*frustrated with my partner, only because she gets wound up because I'm not really there",* (P13). Fatigue also made maintaining work relationships difficult and the contest for social position somewhat more intense. For example, P25 appeared to get into a conflict with a crew mate over him learning to operate the relatively high-status position on the processor: *"whether he felt it was threatening his role, I'm not too sure but he suggested that I get a job elsewhere and … we had a good row over it".*

Hobfoll (1989) would argue that within these situations, conflict is an example of the defensive behaviour people use to preserve the self when their energy resources are overwhelmed. Any threat to the sense of place within the formal or informal hierarchies is a threat to self. Protecting that position when fatigued invariably meant acting defensively and, possibly, with an element of aggression.

Participants suggested chronic experiences of stress were resolved by either leaving logging and working within some other industry for a period or by looking for work in another crew. The common element of either resolution was the participants' sense of powerlessness about changing their immediate work circumstances. P12 described a situation in which he felt he "*was getting nowhere, watching fellas upgrade and I was still teaching*

*them on the skids … and just thought, b****r you".* He then "*started with this other fella and I was with him for 16 years".* Those who chose to leave logging altogether were more frustrated with the general working conditions that were similar in every crew. Of the participants, four had left for a period or were in the process of leaving and a few participants were able to talk about colleagues that had left. The reasons indicated for leaving were the precarious nature of the work through exposure to markets and safety hazards, the conflict between the circumstances within the family / whānau at the time and hours of work and the exposure to repetitive work for long periods. Importantly, however, two participants had returned once their family / whānau circumstances had changed and it was possible for them to work the required hours without detriment to their family / whānau.

Responding to the daily challenges of maintaining throughput or uplift required either deploying the existing resources differently or increasing the level of resource. The most readily available resource in the short term was the operator's time, something the participants seemed happy to give, especially if they were on an hourly rate. But that willingness to comply was also happening because of the potential impact on their reputation as a hard worker. It could be argued, therefore, that the conflict working long hours generated, both within the family / whānau and in the operator themselves, was at the heart of the stress experience. Time taken working, commuting and recovering reduced the time available to meet family / whānau needs and enjoy that aspect of an operator's life. Sitting down for long hours and not being extended physically, was counter to the participants sense of wellbeing. Coping with these stressors appeared to be difficult for participants because they did not have power over some of the resources required to ensure work could be completed within an acceptable time frame. As a result of that perceived sense of powerlessness, they appeared to resort to being more aggressive in their interactions within the crew, changing crews or leaving logging altogether to resolve the stressor in a way that enhanced their sense of wellbeing. Wellbeing was not within the participants control because key resources were either directly controlled by the other actors in the logging workplace (forest owner / manager or contractor) or their use required negotiation between various actors including actors outside the workplace (e.g., family / whānau). Detailing what conditions contributed to the participants sense of wellbeing and the resources required to achieve those conditions is the purpose of the next section.

Pathway to wellbeing: What is wellbeing for operators?

Participants referred to three sets of actions / interactions that promoted a sense of wellbeing. The first was having the time and energy to act on what was considered important in each setting. The attractiveness of working in the 'bush' had been in some part due to the physical nature of the work. However, once the participants started operating machinery that part of the work disappeared and needed to be replaced by physical activity outside of work (e.g., "*my whole shed's full ... of gym stuff ... [and it gets used] every night"* – P16). For others that meant being able to engage in activities outside of work. Participants were involved in coaching their children's sports teams (e.g., "*I coached her through school sports ... as many things as I could do"* – P22), being active at their children's school (e.g., "*I'm on a Board of Trustees"* – P20) or being actively involved in parenting, sometimes to a significant extent due to the breakdown of relationships (e.g., "*I ... was a single parent, I had my kids week-about, I've done it since they were two and four"* – P25). These opportunities were facilitated at work by early finishing times (that is, 3.00 pm – 4.00 pm) and by having some flexibility over early start times (e.g., "*so if I've got a board meeting and I'm not going to get home until nine or 10 o'clock at night, I just won't get earlies the next day"* – P20), weekend work (e.g., "*We don't work weekends ... sometimes he'll give me the day off on Friday and I have a three day weekend. ... I have my daughter every weekend"* – P19) or even whether work was full time (e.g., "*I was initially just part-time"* – P25). Having some flexibility over time at work had come with the potential for job sharing or job rotation that seemed to be associated with mechanisation.

However, this desire to make the best use of their time and energy on what they considered important also applied to the work environment. In considering what they liked about operating, participants described the conditions required for them to enjoy their work. As a reflection of the role of skill and capability in establishing status within the crew and the fraternity, having time to do things well at work was highly valued and a source of wellbeing. To the participants, that meant operating without any sense of time pressure from adjacent work stations or the target, e.g., P5:

*[if] I've felled a few days ahead and you come across a really tricky bit, that's fine. You can take your time and deal with it but then as soon as you come across that same tricky bit, with the hauler right up your ar*e and that pressure on*

Getting ahead of the following work stations meant there was the opportunity to plan the work to be done. For the harvesters and prime movers that meant setting out routes where "*going for a walk to see how you're going to work a piece"* (P25) could be useful. Similarly, for those operating a processor or loader on the skid, that meant having time to think about the 'jigsaw puzzle' that is log making or organising log stacks (e.g., "*in my head I have what I need to be doing during the day and where I need to be at"* – P22). The sense of achievement that comes with production and throughput also appeared to be a condition that enabled the operators to enjoy their work. P2 noted that "*if you're getting the trucks away, everybody's a lot happier*" while P4 put more emphasis on throughput in his comment "*if its flowing through nice, you're sweet and you're doing what needs to be done".* Within these references there is the sense that participants saw themselves as professionals going about their work in a methodical and professional way

and, if given the chance to work that way, the work itself was enjoyable.

Furthermore, operating had the potential to create mind states beyond a sense of satisfaction at a job well done. P2 talked about getting *"into my own zone of what I'm doing and I really enjoy my work".* Others spoke about "*getting into a groove*" (P22) or getting "*into a bit of a rhythm with the logs and your sorting and fleeting"* and starting to *"have fun with it" (*P23). These references point to operators getting into a state of flow and how much that is a valued part of their work. Csikzentmihayli (1990, as cited in Demerouti & Fullagar 2013) defined flow as a state of mind that happened when a person was so engaged in an activity that their sense of what was happening around them was lost. He found boredom, anxiety and flow to be a function of the relationship between challenge and skill. Where there was a balance between challenge and skill, the result was flow. Where there was a mis-match between challenge and skill, boredom or anxiety were more likely to arise (Demerouti & Fullagar 2013). Experiencing flow could therefore, be considered an objective the participants had for their work and was part of what they considered to be doing the work well.

The last set of actions / interactions that contributed to a sense of wellbeing reflected what participants considered to be financial security. This sub-theme contained references that described what participants thought financial success meant to them. While many more participants spoke about the impact of income insecurity on their stress levels, those that did speak about the financial benefits of their work referred to it in two ways. Some spoke about having access to financial resources accumulated as a result of their work along with what they were doing with those resources to increase their sense of flexibility and security. P3 described how he had "*only got a year to go and my mortgage is paid for, and then I'll be picking fruit in a campervan".* Owning a house appeared to be at the centre of this participant's financial aspirations. P8 considered that "*financially we're pretty .... we don't have too much worries, we've got the house we wanted"*. While others talked about having signs of success which were representative of status assets such as cars (e.g., *"We have a few creature comforts. The big ones is I went and scored ... [the] ... V8s"* – P12) and other sought after equipment (e.g., "*big boat ... Jet skis, motorbikes"* – P16). The work was undertaken as the means of accruing the resources necessary for making their way in the world outside work. A natural outcome of that is a sense of wellbeing when that is achieved.

Pathway to wellbeing: What adaptions / resources promote wellbeing?

Clearly, promoting wellbeing required balancing the operators' time across the settings in which they live - work, family / whānau and community - in accordance with their interests. While, all participants referred to long hours as a feature of the job, some talked about this as an experience of their past work life and could describe reasons why that was not something they experienced now. Those reasons represented a set of resources that promote healthy workplace conditions and were categorised within three key sub-themes: ensuring adequate capacity and capability; enabling management of risk and setting the crew up to perform. Their key property was that their deployment was directly controlled by either the forest owner / manager or the contractor.

Forest Owner / Manager resources

Ensuring adequate capacity and capability started with the harvesting infrastructure provided by the forest owner / manager. By providing the roads and skids on which logging crews work, the forest owner / manager designed the workplace and, through their relationships with the next steps in the supply chain, controlled the uplift of logs away from the crew. Participants provided incidents that highlighted what happened when there were adequate skid and truck resources and how that was valued, e.g., "*never have problems getting trucks ... there's always trucks ready to come here [so] it's an easy place to get the loads in"* (P10). In this case, the forest owner / manager had secured enough trucks in the rotation to ensure availability when required. However, the problem of insufficient trucks could also be resolved by having adequate skid capacity. While P20 noted that "*as a loader driver ... the things that make my job hard or stressful are when [forest owners] don't take into consideration ... what skid size we've got"*, fellow loader driver P18 suggested that the forest owner having given them some freedom to construct and set up their own 'dump' had made things easier for him in his work. In either case, ensuring adequate capacity in the supply chain had facilitated a greater sense of wellbeing by the participants involved.

The logging contract was also a key resource in ensuring adequate capacity and capability. Although having sufficient machine and operator resources to service that contract are ostensibly decisions solely within the perogative of the contractor, the contract sets the strategic context in which those decisions are made. The scope of what is possible is established by the forest owner / manager through their decisions on the structure of their logging contracts and how those are awarded to the contractors. Elements of the logging contract such as the crew day rate, the process for calculating the production target and the term had an impact on the machinery available to ensure throughput and production expectations could be met. As a reflection of the logging contract, resources that developed operator capacity and capability were identified within the narratives offered by participants on how they became operators and how their crews developed capacity. Developing as an operator depended on there being opportunities within their crew for an inexperienced operator. While some of the participants got an opportunity to try operating machines when a vacancy came up within the crew (e.g., "[I] *was probably only there for a year and I ... started off running the hauler ... [the boss] said anyone interested in the gang and I put my hand up to do it*" – P1), others transitioned

out of work on the ground (feller, skiddie or QC) by covering for more senior operators while they were on breaks (e.g., "*And jumping in a digger whenever I could"* – P8). More recent recruits got opportunities through developing operating skills in other industries (e.g., civil construction, agriculture) or through an 'apprenticeship' where the transition from groundwork (e.g., QC) was enabled by the availability of a machine that was less critical to the crew's production (e.g., fleeting and sorting with a Bell logger). Providing those opportunities was enabled by having achievable targets that relieved some of the production pressure and allowed crews to take risks such as developing inexperienced operators (e.g., " *I find that we don't have any problem beating target so that means, if I look at what [the] others are doing, I think it's working, so let them make the decisions where they are … "* – P2). Given the importance of overcoming obstacles to throughput, participants valued machinery that could work different positions within the core process (e.g., "*my machine is all guarded for the bush so it can do both felling or processing ... so I've been processing the last two days ... and then tomorrow I'll be falling again*" – P25) or core process machinery that was adaptable and therefore, more able to cope in difficult situations (e.g. tethered skidders rather than using a hauler).

The second key set of resources that promoted wellbeing amongst the participants were the tools used by forest owner's / manager's to re-balance the risks inherent in the logging contract and alleviate participant fears over the security of their income. The nature of the forest company's estate and the way contractors had been treated through the business cycle generated a sense of security in the operator's position. P4 noted that:

Contractors I've worked for have had really good contracts with really well-established forest companies in ex-state forests … so … people have been cut down [to] three or four days per week with low targets … and we've just been going as normal.

An increasing amount of wood being harvested within a region also translated into a sense of security through the demand for operators amongst the local contractors. Participants were aware of the amount of work that was available in their region. For example, both P12 and P14 commented "*there's heaps of work"* and "*there's no shortage of work out there"* and appeared to assume that their income was relatively secure as a result.

While that sense of security was founded on access to harvestable wood (e.g., *"we've been told we've got two years in this forest alone, so that's pretty good to hear*" – P8), much of the trust was built in the day-to-day relationship between the operators and the logging supervisor and how the forest owner / manager responded to adverse events that threatened operator wellbeing. Participants spoke warmly about mutually respectful relationships. For example, P2 acknowledged that he was "*not afraid to try something with [his] mechanical processing … even if the supervisor is standing and watching [because] she'll ask why you did that … and she's not afraid to think that's not a bad idea"*. P20 acknowledged that relationship came with responsibilities for the operator. "*My supervisor is an ex-logger … he knows his sh*t. We get on well, he knows he can trust me, it's like a no-surprises agreement, if I ever f*** up, I don't hide sh*t, it is what is, let's move on".* At an organisational level, operators expressed their appreciation for the efforts made by forest owners / managers to keep them employed or paid through any market downturns or the COVID-19 shuts (e.g., "*they got the wage subsidy and they just paid us ... they [topped up the subsidy] so we got our full pay right through"* – P19). Finally, given the threat injury represents to the income generating capacity of operators, participants also expressed more confidence in the safety of logging operations and gave credit to forest owners / managers and contractors for making that happen (e.g. "*things have come on leaps and bounds from I first started ... I had my fair share of accidents when I was younger but there are a lot more [protections] in place now"* – P2).

Contractor resources

Participants working in what they considered a healthy work environment identified a third key set of resources that was primarily within the control of their contractor / employer that set the crew up to perform and had a positive impact on their wellbeing. From P8's perspective, it was a set of resources that enabled the crew to be '*tight knit'*. Within P8's explanation were three resources that participants considered were essential to a well performing crew:

1. P8 explained that *"... we can all swap around a bit. So, if someone needs to go and do another job, jump on another machine and that sort of stuff, we can".* That meant breaks could be taken throughout the day (e.g., "*so he shares the load a bit … just want to … break the processing up"* – P26) or early load outs could be rotated amongst a group of operators (e.g., "*me and the old man, we share the earlies"* – P14). It also meant spare or flexible machines could be used to clear up bottlenecks (e.g., "*just did everything there … whatever needed done that day, that's what I was doing* – P4). Being someone able to operate a range of machines was also a source of pride for those who could (e.g., "*there's not many machines I can't drive … obviously, there's operators a lot better, but I can hold my own with most of them, you know"* – P18) and an aspiration for those who were relatively new to operating (e.g., "*I look up to him quite a bit, just how he … can do anything out here … operate anything"* – P23). In fully mechanised crews, multi-skilled operators were considered "*absolutely vital"* (P20) for the crew but were also a means of establishing your position within the crew.

2. Important to P8 in their definition of 'tight knit' was that "*…everyone knows the target we've got to hit"* (P8). P6 talked about "*having worked in crews where the foreman has been great … [and has been] like look how do you want to do this … and then … bouncing ideas off each other to plan out the whole block and what I've found in the past is if you can do that, the job normally goes a lot better".* P8 referred to going "*for a walk [to]*

get your input" and "*the more input the better, the more ideas the better".* In this, there was an element of contributing to the performance of the crew and, therefore, being given an opportunity to enhance one's position within the crew. The participants who were also foreman were aware they had a role in ensuring operators had this opportunity to contribute to the crew's performance and recognised what it did for the operator's position within the crew, e.g., "*I take a bit of pride in that and what I do to grow that is things like, you listen to everybody … you try their ideas, you give everyone a voice. It empowers them"* (P20). However, it was suggested by other participants that conditions which created a safe place to have a say went beyond the formal hierarchy, e.g., "*if you've got a really good relationship … amongst where you are, your day goes good and people aren't afraid to say something … [like], you know, we need to do this … then people take it on board"* (P2). Feeling comfortable speaking up was also recognised as important for getting help, e.g., *"it's alright if you're doing it wrong, it's OK to say I don't know"* (P13). Furthermore, participants recognised that creating those relationships meant spending time together. Despite the difficulties of doing so, some participants were strong advocates for having 'smoko' with work mates, e.g., "*I think if people got together and had smoko would be beneficial to the industry"* (P25) even if that was with a sub-section of the crew, e.g., "*so I was processing today and had smoko with the wheel loader guy on the skid"* (P25). For most, however, it was clear that having radio communications between the cabs had taken over the role of smoko, e.g., "*even out on the job, we're yapping all the time on the radios"* (P18) and *"it makes the day a lot more fun … just giving each other stick"* (P19). The camaraderie of the crew was highly valued (e.g., *"you'd meet up with a good bunch of guys"* - P3 - *and "…I enjoy the people …the little bit of banter"* - P20) but the nature of a mechanised environment presents as an obstacle to its development and needs to be actively negotiated if that obstacle is to be overcome.

3. Finally, P8 considered crew members were more accountable to their 'tight knit crew' because "*… they get paid good money to hit* [the target]". Participants referred to satisfaction with what they were paid in several ways. Those who had worked outside the logging industry recognised that the industry paid well compared to alternative work such as dairy farming or civil construction. Those who were being paid a salary (that is, a fixed amount per week for a fixed number of hours) recognised that as well as the sense of security that came with that (e.g., "*people get stressed over money … I just said [to the crew owner] I want X amount every week, in my hand"* – P3) there was also the incentive to work to the fixed hours (e.g., "*[it's] a good thing because I never work over my hours"* – P19). Those who were paid for some of the travel time recognised that this was not the norm for the industry and, as such, it was something others did not get. It was also seen as recognition of skills and responsibilities, particularly if the participant drove others to work. Finally, amongst those being paid on an hourly rate basis (wages), being paid for down time was highly valued (e.g., *"[the boss] has said that if we do our target in four days, he'll pay us for Friday … so that's an incentive*" – P10). While the total amount was a factor in a participants satisfaction with their pay (especially relative to their work mates or other opportunities), the way they were being paid had secondary but equally important impacts on their sense of wellbeing.

Participants also recognised that in building a *'tight knit crew'* the contractor had taken a specific approach to the relationships within the crew. Participants were quick to praise those employers they had worked for that treated them like 'family' or had tried to have a 'family-like' environment. Several participants were also able to identify what it was their employer had done to earn that respect and loyalty. P5 appreciated an employer's willingness to remain calm when machinery sustained damage, e.g., *"usually he was pretty good about it … there wasn't really any damage that he got angry at me about".* For P3 it was because "*he's the only guy I've ever worked for that you don't have to want for anything … you just ask him for it, and he provides it".* For P8 and P20 that willingness to provide extended to using specialist manual falling contractors to help with felling trees on ground too difficult for the mechanical harvester and not putting their employees at risk. Being willing to help employees work through problems at home was also recognised and admired. For example, participants referred to employers that were willing to help with housing problems by helping with the bank or providing time off to secure accommodation. In some instances, the employer was acting as a pay day lender, (e.g., "*such and such has asked me for an advance for the last three weeks in a row"* - P7) or providing for dental care (, e.g., P26). Finally, P9 and P19 appreciated the concern their respective employers showed towards their work life balance: "*he's real considerate that you have a life outside of work"* (P9) and "*it's good with these bosses now … they look at … that sort of thing to see if you're spending more time at work and not at home"* (P19). These did not appear to be actions employers deliberately took to retain employees. Participants admired these actions because they appeared to be taken in response to their specific problems and concerns without an expectation that something extra would be given in return. It runs counter to the "hard man" narrative referred to by P1 as the "*old hardness …. you've got to show a certain amount of mental hardness to be doing it day in day out"* that is interpreted to be what it takes to belong in a logging crew. It suggests operators are not 'hardened up' by physically difficult work or rites of passage or being made to 'stand on their own two feet' but by being shown some care and attention.

Operator influencing skills

While operators might not have had formal control over the deployment of forest owner / manager or contractor resources, some of the participants provided testimony on skills they used to influence the decisions of the other

actors. Experienced and skilful operators negotiated with their crew boss / foreman to adapt their logging system to make wood flow more smoothly through the workstations. These were participants that had a good feel for throughput based on what wood was coming to them and what was leaving (e.g., "*it's more a sense of, I'm in this flow, there's a volume coming into me, and there's a volume leaving me, they better be the same*" – P4). With this sense of flow, they were able to suggest adjustments to the operation that could improve throughput (e.g., "*I know I can read what's going to happen or see what's going to happen and I can see that there's an easier way*" – P10). Participants also referred to the way they could make the work of the next operator easier as a way of improving throughput (e.g., "*I know that if I can do my job effectively and efficiently, and do one little thing for someone else, it'll make everyone else's day, it just flows on down the thing*" – P9). That need to make things easier for others to make things easier for themselves also applied to other actors in the supply chain. Participants recognised that these relationships were reciprocal (e.g., "*look after your machinery and … your gear … and you'll get looked after by the boss*" – P8) with both parties standing to gain through an effective relationship.

To experience wellbeing, operators must access resources that are mostly within the control of the other actors in the logging field. Both the forest owner / manager and contractor deployed resources for their own benefit. However, those were the resources that determined whether the work required to meet production expectations could be done within healthy hours of work and in a way that promoted operator wellbeing.

Discussion

The three themes revealed by this research show how machine operators working in the logging industry in Aotearoa NZ construct and enact stress and wellbeing. In the relationship between the threats and coping strategies identified, stress and wellbeing are explained as a transaction taking place between the person and conditions within the environment. The subsequent health outcome is constructed in the balancing of those threats and the resources required to meet the challenge. Furthermore, by recognising who has control of the coping resources, those themes suggest that the health outcome is largely a product of decisions made by those who effectively design the workplace. Both key findings reflect general theories of stress and wellbeing found within the literature.

Within the stress literature, theories of stress and wellbeing position resources in specific ways that are supported by the findings of this research. Resources are an essential part of the transactional framework of stress and its derivatives, the 'balance' models of stress (Dewe & Cooper 2017). These are models that explain wellbeing as a transaction taking place between the environment and individuals that leads to some psycho-physiological affect (e.g., fatigue, or alternatively, engagement). The fit between an individual's personal, social, economic and environmental resources and the external demands they are facing determines the direction of the wellbeing response and the resultant affect (Hobfoll 2001). The job demands - resources model (JD-R, Demerouti et al 2001, as cited in Bakker & Demerouti 2007) is the most popular framework in occupational health psychology for investigating the relationships between job characteristics and employee well-being (Lesener et al. 2019). Its popularity rests on the scope of its definitions for the environment characteristics represented by job demands and job resources (Bakker & Demerouti 2007), and the tested validity of the model. For example, Lesener et al. (2019 pp. 92-93) using a meta-analysis of 74 longitudinal studies validated the two core assumptions: "(1) job characteristics lead to employee wellbeing; and (2) job resources foster wellbeing which in turn facilitates the acquirement and maintenance of job resources". Within the JD-R model, job demands and resources interact to create several different outcomes that support the conclusions made about the role of resources in this study. Firstly, job resources may buffer the impact of job demands on job strain (Bakker & Demerouti 2007) reflecting the relationships described in the two coping pathways where use of specific resources result in specific health outcomes. Secondly, personal resources such as those reflected in *Operator Influencing Skills* can play a similar role as job resources (Bakker & Demerouti 2007). Finally, those who experience stress resulting from job demands overwhelming their job resources, perceive and create more job demands over time (Bakker & Demerouti 2017). An example would be the relationship between fatigue and conflict where conflict increases the likelihood that workplace conditions will increase fatigue. The impact of resource loss and gain as theorised within the JD-R model concurs with the impacts referred to in the participants narrative within two coping pathways described by the participants.

Within the pathway to wellbeing the resources utilised have been assigned to the actor / role within the logging contractual structure that has control over the deployment of that resource. In doing so the findings are attempting to explain the origins of job demands and resources and the impact they have on the participants health outcomes (stress or wellbeing). This is similar to the way that Dollard and Bakker (2010) have looked to define the contextual conditions that precede the working conditions represented by job demands and resources through a concept called Psychosocial Safety Climate (PSC). PSC is defined as specific policies, procedures and practices that contribute to the balancing of production with worker psychological health. The findings in this study represent an examination of the practices that contribute to the PSC within the logging context. Those practices are captured in the resources deployed as a result of forest owner / manager and contractor decision making. Dollard and Bakker (2010) argue that a supportive PSC will reduce job demands and enhance job resources and, as a result, promote worker wellbeing. That hypothesis has been supported in numerous studies since (Amoadu et al. 2023; Loh et al.

2020). What the findings capture is that the PSC within logging relies on the polices, practices and procedures of two organisations – the forest owner /manager and the contractor - as captured by the terms of the contract and the way the contract is operated. Developing an effective PSC requires some agreement on the values, goals and beliefs between the two organisations and, given the nature of the risks involved for both parties, a degree of shared organisational trust.

The primary limitation associated with the methodology and methods used to complete this study relates to the decision to recruit from a limited number of regions within Aotearoa. Only three regions were used to recruit the 27 participants. While those regions attempted to cover the variability in operator working conditions within the logging industry, the themes revealed by the participants can only be considered directly representative of those regions in which the participants worked. Transferability across regions, industries and countries will be limited by the differences between those contexts and the context that has been sampled in this study. To put that another way, applying these themes to male dominated, physically demanding work places other than logging or to forest industries in other countries will depend on the extent to which the operating environment has similar features to the logging industry in Aotearoa New Zealand.

If left entirely to their own skills and time, the logging machine operator participants would cope with threats by working longer hours which could have a detrimental impact on their health and wellbeing. If through the decisions their forest owner / manager and contractor made, they had access to sufficient supply chain capacity, work security and job control supported by an effective organisational culture and interpersonal relationships they could access the work-life balance that was at the heart of their sense of wellbeing.

Conclusions

In providing an explanation of the construction of wellbeing by machine operators in Aotearoa New Zealand's logging industry, this research has provided an inventory of the psychosocial hazards faced by logging machine operators working in Aotearoa and the resources that enable them to cope. In doing so, it provides detail on both the operation of the relevant psychosocial hazards listed in Table 1 within this context and the known resources used to eliminate or minimise those hazards. As such, the findings have a number of implications for those looking to enhance operator wellbeing within the workplace. Firstly, the potential for operator wellbeing needs to be established when designing skids and specifying harvesting and trucking contractor capabilities. Operator wellbeing is essentially a function of the harvesting system (skids, roads, logging equipment configuration and trucks) having the capacity for daily uplift to meet target across the range of likely operating conditions within healthy daily work hours including travel. Where uplift cannot be met within those hours then the resources need to be in place to rotate operators through the impacted workstations (e.g., by sharing the early load outs amongst a group of operators).

Secondly, the findings suggest that those employing logging machine operators can and need to lead and manage their business in a way that ensures operator wellbeing. What that means is delineated within the findings. There is a need to invest in operator skills through training and mentoring so that multiple operators can work across a range of machines. Having multi-skilled operators enables job rotation, some flexibility over work hours because operator absence can be covered and reducing the tendency towards an informal hierarchy that arises from operators having limited skill sets. There also needs to be transparency around targets and input encouraged from operators on how to organise the crew to meet that target. Operators need to be paid well, and despite some resistance from operators towards fixed salaries, there is some evidence within the findings that where that was facilitated by adequate harvesting system resources, salaries encouraged operators to limit their time on the job. Care and respect towards operators are demonstrated by providing them with the resources required to do the work, helping them through problems at home, being concerned about their work-home balance, and by allowing them to meaningfully contribute to the design of operations, where possible. Ensuring there are sufficient operators on site means being active in developing a network of potential recruits so that gaps in the roster can be filled quickly when they arise. That might include negotiating with the forest owner / manager to allow the inclusion of development positions within the operating configuration of the crew. Finally, contractors need to be prepared for the inevitable market downturns that might affect operator income whether that is being able to provide alternative work or providing financial management skills training. While these actions require significant investment from the employer, the benefit to them is higher levels of operator retention and skills and production system resilience, all of which will improve business profitability, cashflow and certainty.

Finally, the logging contract and the way it is operated needs to create the potential for an effective psychosocial safety climate that ensures the forest owner and contractor resources outlined above are deployed. That has implications for the term of the contract and the way the logging rate and daily production expectations are set and managed.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

The opportunity for, and support of, this study was developed by both TB and RV. TB completed all of the field work and analyses as within the scope of his PhD project. TB took the lead in writing this manuscript, with RV providing revisions.

Acknowledgements
The authors wish to express their gratitude to Prof. David Conradson for his support in completing the PhD research which is the basis for this paper.

Funding
The PhD research project that is the basis for this article was carried out with the financial support of Forest Growers Research Ltd, the Forest Industry Safety Council, the New Zealand Institute of Forestry, the Ministry for Primary Industries and the School of Forestry (University of Canterbury). We gratefully acknowledge their support.

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