Technological advances in rural and wildland fire management as determined using organisational knowledge

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Abstract

The engagement of both professional wildland and rural fire managers and Department of Conservation (DOC) operational staff was used to identify key emerging technologies of use in rural and wildland fire management. This investigation looked at opinions elicited from professional rural fire managers (59) and DOC operational fire staff (159), which were used to determine the most commonly perceived technology needs within rural and wildland fire management.

There were both clear similarities and clear differences found between the two groups, with differences centring on the length of time in role and role tasks. The similarities between the two groups concerned perceptions of strategies and policies, as well as that of research and science transfer needs. Remote sensing technology needs were noted as important by 49% and 41% of professional rural fire managers and operational fire staff, respectively. The second most recognised emerging technology need was communication and information improvement/tools – 34% by professional rural fire managers and 22% by operational fire staff. The survey participants identified approximately 20% of active helicopter time at fires is used for survey and monitoring purposes.

The use of email and online web-based surveys of staff and external professionals offers a useful vehicle to provide engagement, and can add value for researchers and managers. They can also offer a democratic and comprehensive approach to both research management need identification.

Background

The majority of wildland rural fires are directly attributable to people (Flannigan et al., 2009). Worldwide, for at the least the last 10 years, there has been a clear general increase in the area burned by wildfire as well as an increase in fire season length (Gill et al., 2013). For New Zealand, fire climate severity is likely to rise significantly with climate change in many parts of the country (Scion, 2011). Recent innovations in science and technology present opportunities to improve the organisational performance and effectiveness of wildfire management (Zimmerman, 2011). There has been steady testing and uptake of technology relating to wildland rural fire management.

Jiménez-Jiménez and Sanz-Valle (2011) found that both organisational learning and innovation add positively to an organisation's business performance. This paper attempts to outline the use and benefits of collective organisational knowledge in order to increase the productivity within organisations. Similar to the growth in information technology, the area of collective organisational knowledge is useful to consider in terms of organisational capability and potential uptake.

The research question I considered was: 'What are the emerging technologies in wildland rural fire management – as perceived by people within the New Zealand rural and wildland fire management industry?'

Methods

A survey-based approach was used to gather and identify issues pertinent to wildland rural fire management. The first survey focused on issues and perceptions of professional rural fire managers (PRFMs) and operational fire-fighting staff in New Zealand. That questionnaire identified the perceived cost-benefits resulting from the incorporation of the most recognised technology need from the first survey. Responses for the initial survey were completed by the end of October 2013, and 909 participants were invited by email to contribute their views. A listing of potential PRFM respondents was downloaded from the National Rural Fire Authority (NRFA) website on 4 May 2013. A comparison group of 653 individuals was selected, using an excel random number generator, of potentially active fire-fighters from the operational staff lists.

The 413 contacts from the NRFA website were reviewed for email addresses. A total of 256 individuals and key agencies had email addresses, and thus were approachable as PRFM participants for this survey. As this collection of individuals was the key group of interest, to maximise the number of respondents to the survey all members were approached. As the operational comparison group was far larger (973) this group was randomly assigned, using an excel random number generator, into two categories (not surveyed 320, surveyed 653), with twice as many staff members assigned into the survey. A total of 909 (256 + 653) individuals were then invited to take part in this initial survey.

An email was blind carbon copied to all survey participants directing respondents to the

SurveyMonkey.com™ online surveys. Each group – PRFM and operational staff – were randomly assigned to one of two surveys. At the data collection cut-off date (1 November 2013) a total of 59 (59/256 = 23% response rate) wildland rural fire managers and 159 (159/653 = 24.3% response rate) operational staff completed the surveys.

A variety of reasons were given for not taking part of this survey including:

- Not working for their representative agencies anymore
- Change of roles
- Not capable or trained for fire-fighting
- Not a formal request via their manager.

The questions covered three broad areas: general issues; fire management strategies and policies; and fire research – science and its transfer. General issues included questions such as regional location and length of time in the role. Fire management strategies and policies included questions such as 'Do your leadership skills primarily come from by training – or experience?' and 'In your view, how effective is the current succession management efforts?' Fire research and its transfer questions included 'In your view, how important is the engagement of the end-users in fire research?' This initial survey used Likert scales and was sent to recipients from 26 May 2013.

Results

Differences and similarities between rural and wildland fire managers and operational staff

The key differences found between the two groups from the survey were:

- Average length of fire management experience was 21.1 years for the PRFMs and 11.8 years for the operational staff
- The percentage of time spent on wildland and rural fire issues was 40% for the PRFMs and 7% for operational staff
- The usual role in wildland and rural fire-fighting for the PRFM group was an Incident Management Team (IMT) member or manager (53%), with 24% in field or support roles; for the operational staff 23% were in IMT roles, with 69% in field or support roles.

The key similarities found between the two groups were:

- Support for appropriate succession and inter-generational, i.e. organisational cohort, knowledge transfer in wildland and rural fire management, with the PRFM group 100% in favour and the operational staff 87% in favour, and with 12% unsure
- Eighty-seven percent of PRFMs and 83% of operational staff considered that the current succession management efforts were neutral or ineffective
- Agreement that the engagement of end-users in fire research is important, with the PRFM group 97% in favour and the operational staff 74% in favour, and with 21% considering it neither important nor unimportant.

Perceptions on technology issues from NZ forest and rural fire professionals and operational staff

From the initial stage surveys, the following question elicited perceptions about emerging technologies: 'What new and emerging technologies do you see as important for rural and wildland fire management?' Of the 59 PRFMs and 159 operational staff, 41 (69%) and 64 (40%) commented, respectively. The comments were divided into six different though related technology categories, as outlined in Table 1. Remote sensing technology, including thermal imaging, satellite, aircraft or RPA use, was the most widely considered emerging technology by both PRFMs and operational staff, identified by 49% and 41%, respectively.

Table 1: Key emerging technologies identified by professional rural fire managers (PRFMs) and operational staff

Emerging technologies	PRFM	Operational
Remote sensing – thermal imaging, satellite, aircraft or RPA use	49%	41%
Communication and information improvement/tools, e.g. tablets for fire ground, communication strategies for communities	34%	22%
Monitoring resource/asset locations, including GPS, and condition	39%	8%
Fire suppression developments, e.g. improved chemical retardants	17%	14%
Improved fire behaviour and extent models, weather reports	20%	11%
Fire-fighter health support	5%	3%

PRFMs and operational fire-fighters were asked to determine the allocation of active helicopter use, i.e. in flight and not on standby, in rural fire management (see Figure 1). A Chi-test test of independence showed a very clear and strong indication that there is no statistically significant independent relationship between the perceptions of the two groups ($\chi^2 = 0.838$, df = 5, $P(\chi^2 > 0.838) = 0.9746$). While this is not a 'time-in-use' analysis of actual helicopter work, I assumed that such data is approximate to the actual time expenditure of helicopter use in rural fire management.

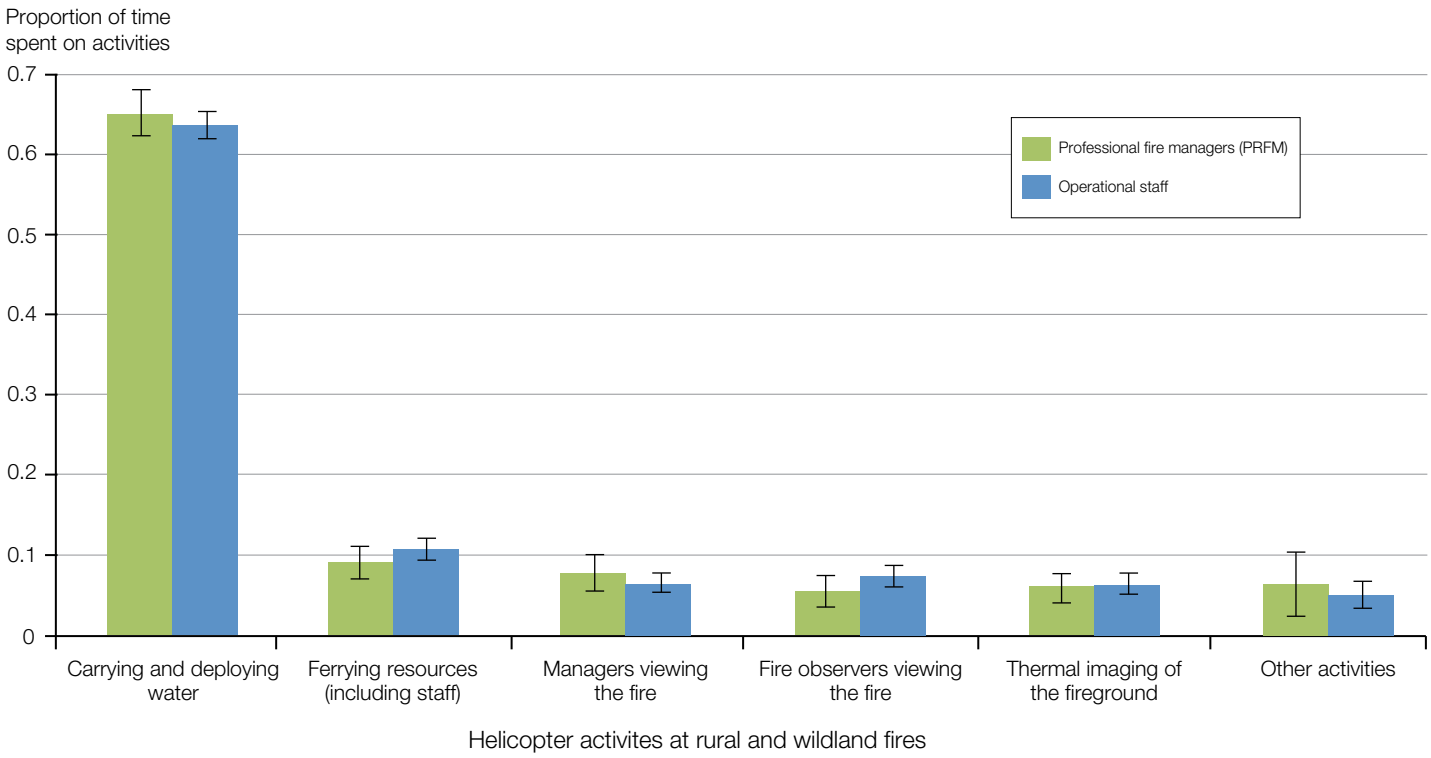

Figure 1: Allocation of active helicopter time as perceived by PRFMs and operational staff

The first two categories – carrying and deploying water (64.2%) and ferrying of resources including staff (10.3%) – were considered as 'Heavy' resource deployment. This totalled 74.5% of helicopter activity. The next three categories were: managers viewing the fires (6.8%); fire observers viewing the fire – its active management and the surrounding habitat and conditions (6.9%); and thermal imaging (6.3%).

Discussion

Elicitation approaches benefit studies, projects and programmes as they produce an indication of 'expert' or user consensus, as well as addressing a level of inherent uncertainty. Almost 70% of professional wildland rural fire managers who commented on emerging technology needs considered remote sensing technology as important to be considered for development, testing and potential integration into their work. Over a third of professional wildland rural fire managers were interested to see communication and information improvement/tools being researched and developed for use. These include tools such as tablets for managing the fire ground data recording and reporting needs, and the development of communication strategies for communities.

Some of these activities, such as the investigation into communication strategies for communities and fire behaviour apps, are being addressed by Scion, New Zealand's rural fire research leader. Results from the question, 'What new and emerging technologies do you see as important for rural and wildland fire management?', were entered into wordle (www.wordle.net/) to create a graphic depicting the relative occurrence of different words (Figure 2). This shows that the technology of thermal imaging, GIS and remote sensing were cited as important needs.

Current and developing issues

In terms of social demographics, it is perceived that there is a growing crisis in wildfire management for the western world, as evidenced in Australia (McLennan & Birch, 2005). These authors note that the volunteer workforce is decreasing in number through economic and demographic factors, e.g. privatisation, demands for increased productivity, movement to cities and a declining birth rate. While not as prevalent in New Zealand wildland rural fire management, as we have a mainly paid work force – forestry companies, territorial authorities and DOC – our demographics and influences would be similar to Australia. The average length of time in wildland rural fire management by professional managers in this survey was found to be over 20 years.

The survey has also showed that there are clear opportunities in terms of the perception of both sets of participants about improving the current succession management efforts. While this wealth of experience potentially has huge positives, the physical demands of active fire-fighting perhaps indicates that this experience is unlikely to be now found on the fire ground, and thus its absence may affect the safety of active wildland rural fire-fighters. Conversely, it offers an opportunity for agencies mentoring and fostering younger and newer staff. Running (2006) states that if climate change is increasing wildfires, as the information suggests, then

Figure 2: Relative frequency of words depicting the survey participants' views on new and emerging technologies important for rural and wildland fire management

such new sources of carbon emissions will increase the amount of greenhouse gases and that this could in turn accelerate global warming. Thus, any additional cost minimisation efforts in relation to wildfire management are becoming more important.

Conclusion

Hunt (2007) identifies the need for a methodology to effectively transfer technical and scientific research to departmental managers and staff. Digital networks also offer a useful vehicle to encourage the engagement of managers and staff with such investigations. They can also offer a democratic and comprehensive approach to research need identification. This does not address Hunt's (2007) recommendation for a method to effectively transfer technical information and wildland rural fire-related research to DOC managers and staff. However, it does indicate that the end-users, including all active personnel, can be directly engaged at key stages for research.

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