Extreme fire behaviours: Surveying fire management staff to determine behaviour frequencies and importance

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Extreme fire behaviours (EFBs) are phenomena that occur within intense fires that have been shown to contribute greatly to their to impacts. However, there exists little understanding regarding how often particular EFBs occur, how these contribute to fire behaviour and what importance should be allocated to each in the development of models for decision support. To address this problem, we surveyed fire fighters from fire and land management agencies in Australia regarding their experiences with EFBs.

METHODS

To collect data on EFBs, we considered all fires greater than 1,000 ha in Australia that occurred between 2006 and 2016. We approached representatives from management agencies responsible for fire response in each state via email and telephone and asked them to complete a guided survey. For each fire, we asked which (if any) EFBs had been observed and what data there may be to support this.

The EFBs we asked about were:

- Spotting
- Crown fires
- Pyro-convective events (PyroEvs)
- Eruptive fires
- Conflagrations
- Jump fires
- Fire tornados/whirls
- Fire channelling and
- Downbursts

Data were categorised into three types:

- direct measurements (linescans, images, video, etc.)
- indirect data (weather records, etc.) and
- the data based on anecdotal evidence (observations recorded in situation reports, etc.)

RESULTS

Information on EFBs was received for a total of 96 fires among 934 fires considered (~10%).

All EFBs were recorded at least four times with spotting being observed most frequently (72 times). Fire tornado/whirls (n=5), Fire channelling (n=4) and Downbursts (n=5) were observed the fewest times.

The relative frequency of various EFBs are presented in Figure 1.

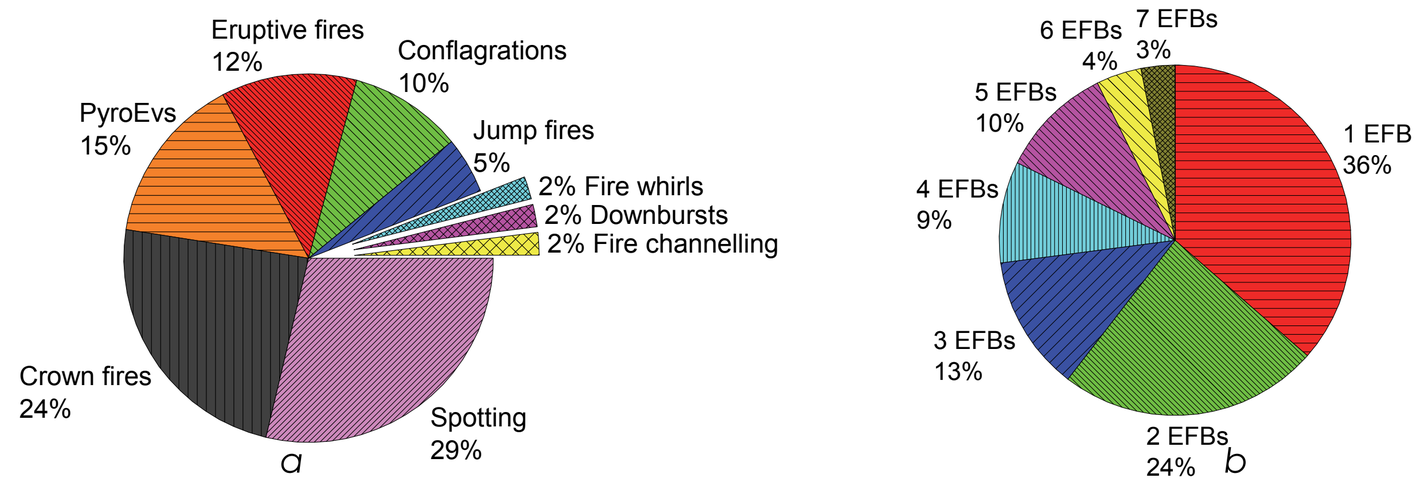

Fig. 1. Relative Frequency of EFBs. Figure 1a shows the relative frequency of each EFB form. The sum of all EFBs is 100 %. Figure 1b shows percentage of fires with different quantities of different EFBs.

Spotting and Crown fires were the most frequent EFBs, making up a total of 53 % of all EFB observations (Figure 1a). PyroEvs, Eruptive fires and Conflagrations were observed to have similar frequencies of occurrence, accounting for 37 % of the remaining observations. Jump fires, Fire tornado/whirls, Fire channelling and Downbursts combined accounted for 11 % of EFBs in total.

One third of fires in this study had at least one EFB observed (Figure 1b). Two and more EFBs were recorded in 64 % of these fires. Therefore, their interactions could have complimentary effects on fire behaviour, e.g. PyroEvs can facilitate long distance Spotting and Fire tornados/whirls. Consequently, the potential interactions of these phenomena should be a focus of investigation.

CONCLUSION

Among studied fires, it is common that there are multiple types of EFBs within a single event, with 64 % of the 96 fire having multiple different types. We found that many EFBs could be identified through direct data, suggesting empirical analysis of these phenomena should be possible. Spotting, Crown fires and Pyro-convective events were the most common EFBs (68 %), when combined with Eruptive fires and Conflagrations these EFBs comprise 90 % of all cases. Our findings suggest that these EFBs should be a strong consideration for further research due to their high frequencies and the fact that quantitative data is likely to be available.

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