

Wildfires in New Zealand from 1991 to 2007*

Stuart A.J. Anderson^{1*}, Jonathan J. Doherty², H. Grant Pearce¹

Abstract

An analysis was undertaken of wildfire records in New Zealand from 1991-2007 to determine trends in fire occurrence, area burned and fire causes. Each year an average of 3,033 wildfires burned 5,865 ha. The total area burned was made up of 54% grasslands, 40% scrublands and 6% forests. Unknown and miscellaneous causes accounted for almost half (46%) of the total number of fires and 31% of the area burned. The most significant known cause of wildfires was land clearing (escapes from burnoffs), accounting for 20% of wildfires and 47% of the area burned. Natural causes (lightning) made up only 0.1% of both the number of wildfires and area burned. The South Island accounted for 34% of wildfires and 75% of the total area burned, and Northland and the Eastern North Island accounted for 60% of the remaining area burned in the North Island. There was also a significant increase in the number of wildfires reported annually, from around 1200 in 1991 to more than 4000 in 2007. This is the most detailed and comprehensive analysis of wildfire occurrence undertaken in New Zealand to date, and the findings have relevance for development of wildfire reduction and readiness strategies.

Introduction

An understanding of wildfire occurrence and causes in relation to fuels, weather and topography can enable fire managers to better quantify fire risk and target mitigation measures to reduce specific risks. This requires long-term fire records of good quality data. In New Zealand, Rural Fire Authorities (RFAs) have over the last few decades developed different wildfire reporting systems, leading to inconsistencies in both the quality and accuracy of data collection. At the national level, there have been difficulties in collecting data of adequate quality and coverage from all RFAs annually (Opperman 2005). The most reliable national wildfire reporting system is based on an annual return of fire records form provided to the National Rural Fire Authority (NRFA) each year by RFAs. This paper summarises the outcomes of an analysis of these records (Doherty *et al.* 2008). Notwithstanding these issues of data quality, the analysis and findings provide a useful overview of the occurrence and severity of wildfires in New Zealand over much of the last two decades. The findings and recommendations provide information to support fire prevention and reduction strategies.

Methods

The NRFA's database of annual fire returns ("Annual Returns") was used for this study. This database contains records of wildfires by fire year (1 May - 30 April) and RFA. It excludes the large number of prescribed burns carried out across the country annually. Data were grouped together by fire cause for each RFA, and classified into three fuel types (forest, scrub or grass). In the case of forests, this includes exotic plantations, native forests, woodlots, and other tree vegetation such as tree mixes in riverbeds, shelterbelts, hedges, wetlands, etc. The fire causes listed were inconsistent from year to year, and to reduce the range of causes and provide consistency, data were collated into a set of 14 standard causes. Other causes listed that were

clearly not applicable to wildfires were omitted, such as animal rescue, false alarm, landslip, etc. Lightning was only listed as a separate cause from 2000/01. Prior to this, it was included as a miscellaneous cause (Craig 2002). Given changes in the composition of RFAs over time, they were grouped according to their geographic regions as of the 2006/07 fire year. This produced 13 regions: Northland, Auckland, Waikato, Wanganui/Manawatu, Central North Island, Taranaki, Eastern North Island, Greater Wellington, Nelson/Marlborough, West Coast, Canterbury, Otago, and Southland.

Every attempt was made to include all of the data, with electronic records available from 1988/89 to 2006/07. However, many records for 1989/90 and 1990/91 were missing and could not be located. As a result, only records from 1991/92 to 2006/07 were used. In some cases, records that appeared contradictory and could not be verified were omitted (this was only the case for a small number of records). The area burned did not always appear to be recorded accurately, with the number of fires sometimes listed without any corresponding area burned. Results presented in relation to area burned should therefore be considered as based on the *reported* rather than the *actual* area burned. Not all returns were submitted by RFAs each year: in some years the percentage of returns submitted by RFAs was between 85% and 95%.

Results

Number of fires - trends

From 1991/92 to 2006/07 there was an increase in the reported number of wildfires from around 1,200 to more than 4,000 annually (Figure 1). The linear regression shows the strongly increasing trend in the data ($R^2 = 0.81$; $P < 0.001$). The national average number of wildfires reported annually was 3,033. The national average number of annual wildfires over four-year periods was:

- 1,566 (1991/92 to 1994/95),
- 2,714 (1995/96 to 1998/99),
- 3,563 (1999/2000 to 2002/03),
- 4,289 (2003/04 to 2006/07).

*This is a refereed paper.

¹ Scion, Rural Fire Research Group, Christchurch

² Pitcairn Crescent, Bryndur, Christchurch

*Corresponding author:

stuart.anderson@scionresearch.com

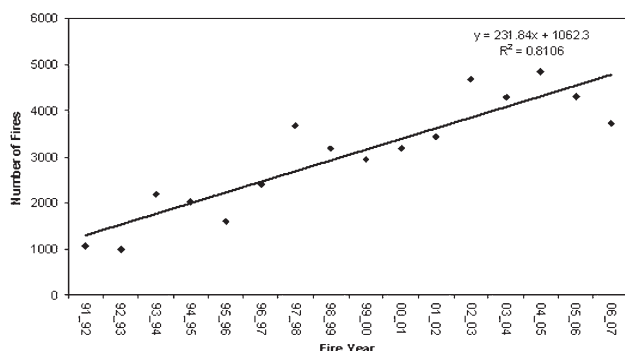


Figure 1. National number of wildfires, 1991/92 to 2006/07.

The North Island accounted for two thirds (66%) of the total number of wildfires. Four regions (Waikato - 10%, Central North Island - 9%, Eastern North Island - 14%, Canterbury - 18%) accounted for just over half of the number of wildfires (Figure 2).

The national trend of increasing numbers of fires annually was also observed in 10 of the 13 regions of the country. Exceptions were the Auckland region and the West Coast which showed no clear trend, and Waikato which had a slightly positive trend ($R = 0.07$, $P=0.071$).

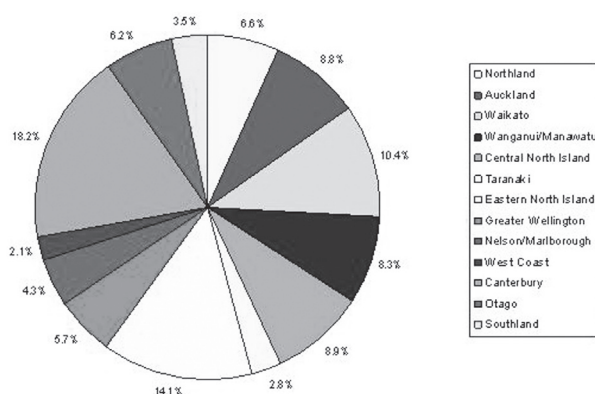


Figure 2. Proportion of total number of wildfires by region, 1991/92 to 2006/07.

Number of fires by cause

It can be difficult to determine fire cause and, particularly in the case of very small fires, may not be worth the resources and cost involved. A high number of fires were attributed to miscellaneous (33%) and unknown (13%) causes - 46% in total to "unspecified" causes (Figure 3). Although the number of fires increased for most causes, the proportion of fires for each cause remained mostly constant. Other significant fire causes were land clearing (20%) and vehicles (17%). The number of land clearing fires varied between years, arson and incendiary fires increased over time, and fires from cigarettes remained relatively low at less

than 50 fires per year for most years. Lightning accounted for just 0.1% of fires. However, as already stated, lightning was only listed as a separate fire cause from 2000/01 and was classed as a miscellaneous cause prior to this (Craig 2002)

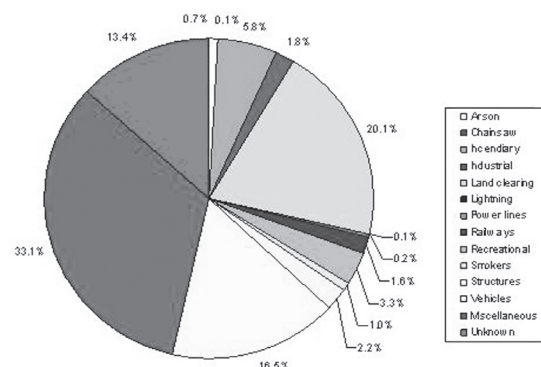


Figure 3. The total proportion of wildfires nationally by fire cause, 1991/92 to 2006/07.

Area burned

The national total area burned displayed no distinct directional trend ($R^2 = 0.002$, $P=0.880$) (Figure 4). The national average annual total area burned was 5,865 ha, and over four-year periods this was:

- 4,221 ha (1991/92 to 1994/95),
- 8,898 ha (1995/96 to 1998/99),
- 5,455 ha (1999/2000 to 2002/03),
- 4,885 ha (2003/04 to 2006/07).

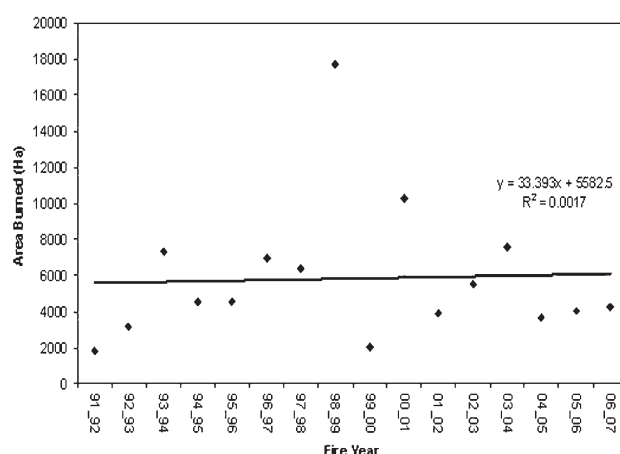


Figure 4. New Zealand total area burned for all fuel types, 1991/92 to 2006/07.

The annual total area burned was influenced by large individual fire events and/or large areas burned in a single region, such as the Alexandra fires (Otago, 7,800 ha) in

1998/99 and Blenheim fires (over 6,500 ha) in 2000/01.

Area Burned by fuel type

Grass fires accounted for the majority of the total area burned, totalling 50,403 ha (54%) over the study period with an average of 3,150 ha/year. Scrub fires burned 37,287 ha (40%), with an average of 2,330 ha/year. The total forest area burned was 6,170 ha (6%), with an average of 386 ha/year. The smallest forest area burned was in 1991/92 (119 ha or 3%), with the largest in 1997/98 (1,399 ha or 22%). On a proportional basis, forest fires accounted for less than 10% of the total area for most years.

Area burned by cause

Wildfires from land clearing burning accounted for the largest proportion of the area burned, at 44,070 ha or 47% of the total (Figure 5). Annually, an average of 2,754 ha was burned by land clearing wildfires. Fires of unknown cause represented nearly a quarter (24%) of the total area burned. Miscellaneous causes represented 7%, and the unknown and miscellaneous causes combined therefore represented 31% of the total area burned. Other causes accounted for relatively low proportions, such as incendiary (6%) and vehicles (5%). Lightning accounted for only 0.1% of the area burned.

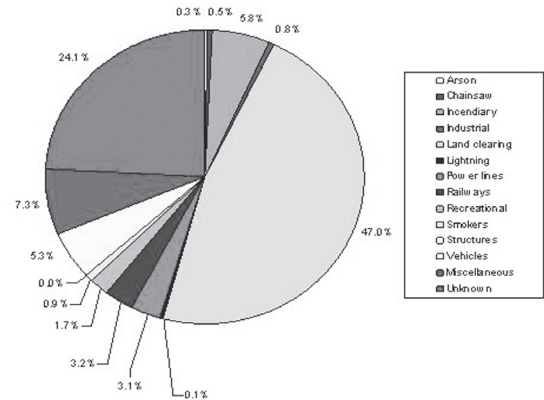


Figure 5. Proportion of total area burned by cause nationally, 1991/92 to 2006/07.

Area burned by region and fuel type

The South Island accounted for 75% of the total area burned, with Otago making up 42% of the national total. Northland and the Eastern North Island accounted for 15% of the total national area burned (Figure 6). Otago also recorded the highest average grass (1781 ha/year) and scrub (631 ha/year) areas burned annually. Nelson/Marlborough had the highest annual average forest area burned (83 ha/year). Nelson/Marlborough and the Eastern North Island accounted for around 40% of the total forest area burned.



Distributor for Mercedes & Solberg



A World Leader in the manufacture of fire hose, fire pumps and fireline accessories.

- Wick 80-4H - lightweight & versatile
- Wick 375 - 4 stage, 10HP, 2-stroke engine
- Forestflo percolating hose
- Pyroblend non-percolating hose
- Precision engineered pump parts



Solberg Scandinavian AS is a company specializing in the fields of fire protection and fire fighting.

- Fire-Brake - combats class A fires
- Re-Healing foams - combats class B fires
- Arctic Foam (AFFF & AFFF/ATC)



Ph: (09) 984 4700
Fax: (09) 921 3391
info@connellbros.com
www.connellbros.com

Other regions that recorded significant levels in terms of the total forest area burned were Northland (12%), Otago (12%), Canterbury (10%) and the Central North Island (8%).

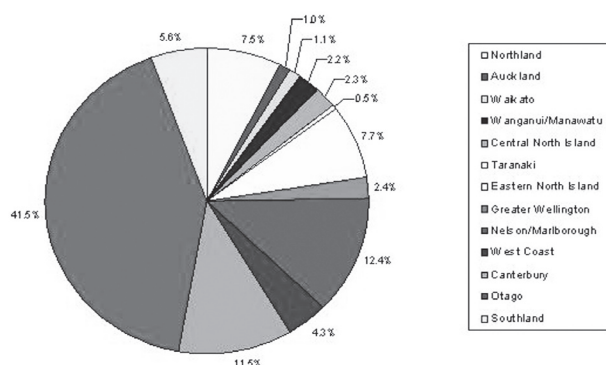


Figure 6. Proportion of the total area burned by region, 1991/92 to 2006/07.

Discussion and conclusions

The main reason for the four-fold increase in the annual number of fires is most likely from improved reporting of wildfires by the public through the use of the 111 system, and better reporting by RFAs. There did not appear to be any year-on-year trend in area burned, with considerable variation nationally and regionally. Large fire events had a major influence on results for area burned and significance of causes to area burned.

It is important to consider both area burned and number of fires. For example, Otago accounted for around 40% of the total area burned but only 6% of the total number of fires; Canterbury 12% of the area burned and 18% of the total number of fires; and Auckland just 1% of the area burned and 9% of the number of fires. A large number of small “nuisance fires” over time can potentially cost as much in time and resources as larger fires. Reducing both the number of fires and area burned is therefore important.

Land clearing was the most dominant cause for the total number of fires (20%) and total area burned (47%). However, large proportions were also attributed to unknown and miscellaneous causes. The combined ‘unspecified’ (unknown and miscellaneous) causes represented 46% of the total number of fires and 31% of the total area burned. Lightning accounted for only 0.1% of both the total number of fires (34 fires) and total area burned (91 ha) from 1991 to 2007. The overwhelming majority of fires in New Zealand are therefore caused by human activities, which can largely be mitigated against.

The relationships between weather and fire occurrence need to be explored. The number of fires and area burned were highly variable, and were most likely significantly influenced by weather and fire season severity (Harrington *et al.* 1983, Flannigan and Harrington 1988). Climatic factors also significantly influence fire occurrence, and fire

severity varies from year to year in different parts of the country as a result of normal climatic variability, ENSO (El Niño-Southern Oscillation), and long-term climate patterns (Pearce *et al.* 2003, 2007). Understanding the impact of climate change on future fire occurrence and severity (numbers and area burned) is also important (Flannigan 2005, Flannigan *et al.* 2005, Pearce *et al.* 2005).

Acknowledgements

Thanks are extended to the National Rural Fire Authority for providing access to their Annual Returns of Fires database for this study.

References

- Craig, A. 2002: Wildland Fires in New Zealand in the 1990s: Retrospective and Challenges. *International Forest Fire News* 26: 87-91.
- Doherty, J.J.; Anderson, S.A.J.; Pearce, G. 2008: *An analysis of wildfire records in New Zealand: 1991-2007*. Scion Report Number 12789. Scion, Christchurch.
- Flannigan, M. D.; Harrington, J. B. 1988: A study of the relation of meteorological variables to monthly provincial area burned by wildfires in Canada (1953-80). *Journal of Applied Meteorology* 7: 441-452.
- Flannigan, M. D.; Logan, K. A.; Amiro, B. D.; Skinner, W. R.; Stocks, B. J. 2005: Future area burned in Canada. *Climatic Change* 72: 1-16.
- Harrington, J. B.; Flannigan, M. D.; Van Wagner, C. E. 1983: *A study of the relation of components of the Fire Weather Index to monthly provincial area burned by wildfires in Canada 1953-80*. Information Report PI-X-25. Canadian Forest Service, Chalk River.
- Opperman, T. 2005: *New Zealand Vegetation Fire Database Summary and Initial Data Quality Findings*, Ensis Client Report No. 11928. Ensis (Scion), Christchurch.
- Pearce, H. G.; Douglas, K. L.; Moore, J. R. 2003: *A fire danger climatology for New Zealand*. New Zealand Fire Service Commission Research Report 39, Wellington. 289p.
- Pearce, H. G.; Mullan, A. B.; Salinger, M. J.; Opperman, T. W.; Woods, D.; Moore, J. R. 2005: *Impact of climate change on long-term fire danger*. New Zealand Fire Service Commission Research Report No. 50, 70p.
- Pearce, H. G.; Salinger, J.; Renwick, J. 2007: *Impact of climatic variability on fire danger*. New Zealand Fire Service Commission Research Report 72, Wellington. 117p.