Time submitted: 27/04/2020 11:52:56 PM

# Submission Number: NND.001.00938

# Submission Of: Marc Freestone

## Your Details

Email address:

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What is your submission based on? I am making this submission based on my personal situation

What was your personal situation in relation to the 2019-20 Bushfires?

Where do you live? Warragul, Victoria

## Your Submission

In your experience, what areas of the bushfire emergency response worked well?

In your experience, what areas of the bushfire emergency response didn't work well?

A reliance on fuel reduction burning as the principle method of reducing the size of bushfires appears misguided. I have attached a brief study of the relationship between the size of summer fires, rainfall and the total area of fuel reduction burning in Gippsland, Victoria. There is a strong correlation between annual rainfall and bushfire size (large fires always occur in the season following a dry year, smaller fires usually occur following wetter years). But there is no relationship between the size of bushfires and the total area of land treated by fuel reduction burns in the previous year, previous three years or previous ten years. This suggests that in order to prepare for and reduce the severity of future bushfires, we should focus on what causes low rainfall years. There is no evidence from this study that investing heavily in increased fuel reduction burning will help reduce the size of future bushfire seasons.

In your experience, what needs to change to improve arrangements for preparation, mitigation, response and recovery coordination for national natural disaster arrangements in Australia?

The debate in the community since the fires has mostly centred on the question of why were the fires so big? This is a critical question as it underpins our response to the fires and how we can better prepare our community for future fires (paragraphs a and b in the Terms of Reference). If we do not address the factors that caused or influenced the fires, then we are not addressing the problem and we run the risk of barking up the wrong tree – acting (or being seen to take action) on factors that will not help prevent or reduce the severity of future catastrophic bushfires.

The debate has mainly focused on the role of planned burning versus the effects of low rainfall and climate change. While everyone can have an opinion in this debate, if we want to work out the real drivers behind why these fires were so large, we need to look at the evidence and best available scientific research. Which factors are correlated with large summer bushfires is a scientific question and should be answered by scientists, rather than a public vote.

The attached study illustrates that low rainfall, not low levels of fuel reduction burning, is associated with large summer bushfires in Gippsland. This suggests that in order to prepare for and reduce the severity of future bushfires, we should focus on what causes low rainfall years. There is no evidence from this study that investing heavily in increased fuel reduction burning will help reduce the size of future bushfire seasons.

I am concerned that this Royal Commission might be tempted to make some recommendation around fuel reduction burning targets. I would encourage the Commissioners to study the experience of Victoria following the 2009 fires and subsequent Royal Commission, which recommended a target of 5% of all public land be subject to fuel reduction burning annually. The reality of this recommendation was that DELWP focused on burning large areas of remote public land around the State that was of little benefit to public safety, caused significant environmental damage (and almost the extinction of the Mallee Emu-wren) and cost enormous resources that could have been directed into other more effective measures. Fuel reduction burning and its effects on bushfires is a complex area of science to which a 'one size fits all' recommendation from this Royal Commission cannot be applied. For example, we now know that fuel reduction burning in some ecosystems (e.g. wet forest and some heathy woodlands in Victoria) actually increases fuel loads by stimulating fire-responsive wattles and negatively impacting fire retardant rainforest species. On the issue of fuel reduction burning, I would encourage the Royal Commission to study, and make recommendations based on, the best available science.

Is there anything else you would like to tell the Royal Commission?

Please see attached a study of the relationship between the size of summer fires, rainfall and the total area of fuel reduction burning in Gippsland, Victoria.

Do you agree to your submission being published? Yes I agree to my submission being published in my name

Supporting material provided:

Royal Commission into National Natural Disaster Arrangements – submission from Marc Freestone.pdf

Royal Commission into National Natural Disaster Arrangements – submission from Marc Freestone

## INTRODUCTION

My name is Marc Freestone and I am a current PhD student with the Australian National University studying a botanical science related project. As a botanist and former resident of Orbost, I have followed the fires and resulting public debate with great interest and have visited friends who came very close to losing their houses at Jarrahmond, near Orbost, where I grew up. I have also seen first-hand the total destruction of very long unburnt rainforests, for example those in Martins Creek Nature Conservation Reserve, places I had visited many times before and held very dear.

The debate in the community since the fires has mostly centred on the question of why were the fires so big? This is a critical question as it underpins our response to the fires and how we can better prepare our community for future fires (paragraphs a and b in the Terms of Reference). If we do not address the factors that caused or influenced the fires, then we are not addressing the problem and we run the risk of barking up the wrong tree – acting (or being seen to take action) on factors that will not help prevent or reduce the severity of future catastrophic bushfires.

The debate has mainly focused on the role of planned burning versus the effects of low rainfall and climate change. While everyone can have an opinion in this debate, if we want to work out the real drivers behind why these fires were so large, we need to look at the evidence and best available scientific research. Which factors are correlated with large summer bushfires is a scientific question and should be answered by scientists, rather than a public vote. Although it is outside my main area of expertise, here I present a very simple analysis of the correlations between fuel reduction burning and the size of bushfires in following summers, and between total annual rainfall and the size of bushfires in following summers. It is important to note that this analysis is almost certainly oversimplified, fire behaviour and fire ecology are complex issues.

## METHODS

My main area of interest has been the fires in East Gippsland and so I have calculated the total area of summer bushfires in the Gippsland DELWP region for each season from the 1966/67 season (the start of continuous recording of areas subject to fuel reduction burning in Gippsland available from DELWP) to and inclusive of the 2019/20 season. These data came from the DELWP Spatial Datamart service using the “Fire History Records of Fires primarily on Public Land showing the fire scars” layer filtered for the DELWP Gippsland Region, which was imported into QGIS, tabulated, and the area of all FIRE records for TREAT_TYPE (bushfires) combined for each season (labelled as the year preceding the bushfire season (e.g. 2019 for the most recent 2019/20 season). As data on the size of the most recent 2019/20 fire season was not available on DELWP Spatial Datamart at the time of writing (27/04/2020), I have estimated the area of land burned by bushfires in the last fire season within the DELWP Gippsland region at 800,000 ha, which is likely a conservative estimate.

Calculating the total area of fuel reduction burns per year used the same data and method, but combined the FUEL REDUCTION and ECOLOGICAL records for TREAT_TYPE, representing prescribed burns undertaken for both fuel reduction and ecological purposes. Burns as a result of logging operations (SLASH records) were not included due to some uncertainty about the accuracy of the records (e.g. there were large groups of years where SLASH – ASH returned no area of burning) and also the small and relatively insignificant areas of this treatment. To assess the cumulative effect of fuel reduction burning over several years preceding summer bushfires, the combined area of fuel reduction burning over the previous three and ten years were also calculated.

Total annual rainfall was calculated using data from the Nowa Nowa Bureau of Meterology station accessed from the BOM website, as this location is central to the areas impacted in the most recent fires and has a continuous record back to 1967. To assess the cumulative effect of rainfall over several years preceding summer bushfires, the combined total annual rainfall over the previous two and three years were also calculated for each year.

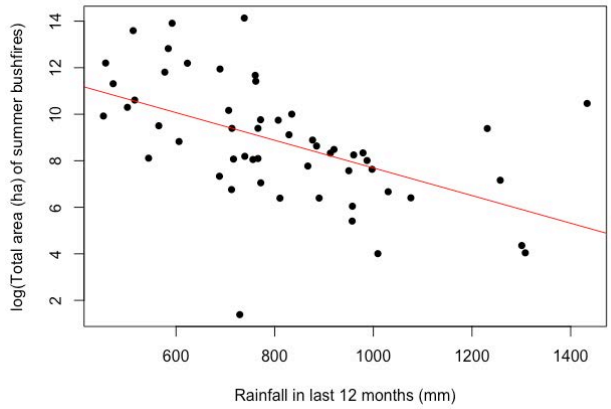
The dataset analysed in this study is presented in Appendix 1.

The data were imported into R statistical software and analysed using linear regression analyses. To meet assumptions of normality required when undertaking linear regression analyses, the area of bushfires was log-transformed, a standard protocol in statistical analyses. This also had the effect of making trends in the data easier to visually interpret. R code is presented in Appendix 2.

## RESULTS

There is a highly significant negative correlation between total annual rainfall in the year preceding a bushfire season and the total size of bushfires in the following season ($F = 19.48$, $p < 0.001$; Figure 1). Years of low rainfall are followed by large summer bushfires, years of high rainfall are usually followed by smaller summer bushfires.

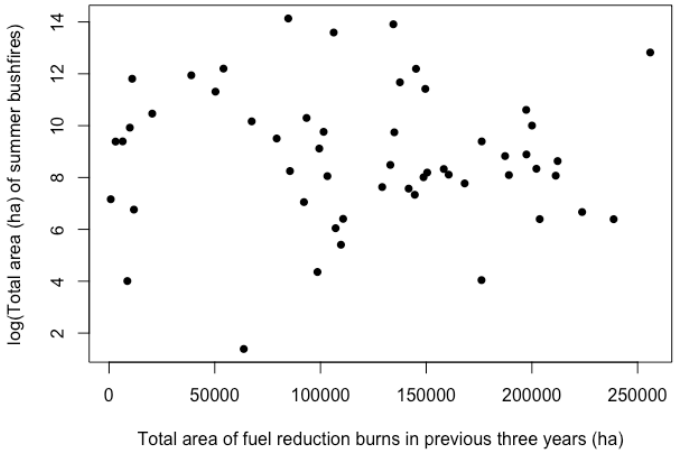
**Figure 1.** Correlation between annual rainfall the year preceding a summer bushfire and the total area burned by bushfires in the following fire season in Gippsland. The trend line from the linear regression model is in red.



The correlation between total rainfall across the two years preceding a bushfire season and the total size of bushfires in that season is also significant, albeit less so ($F = 7.68$, $p = 0.008$), as is the correlation between total rainfall across three years preceding a bushfire season ($F = 6.47$, $p < 0.001$).

There is no relationship between the total area of land subject to fuel reduction burning in the previous year and the total size of bushfires in the following season ($F = 0.57$, $p = 0.453$). There is also no relationship between the total area of land subject to fuel reduction burning in the previous three years and the total size of bushfires in the following season ($F = 0.10$, $p = 0.745$, Figure 2) nor between the total area of land subject to fuel reduction burning in the previous ten years ($F = 0.136$, $p = 0.714$). Large bushfires occur following periods with little total annual prescribed burning, moderate amounts of prescribed burning and large amounts of prescribed burning. Likewise, small bushfires occur following periods with little, moderate and large amounts of prescribed burning.

**Figure 2.** Correlation between the total area of land subject to fuel reduction burning in the previous three years preceding a summer bushfire and the total area burned by bushfires in the following fire season in Gippsland. No trend line is shown as there is no correlation.




## DISCUSSION

### *Rainfall*

In Gippsland, large bushfires occur in the season following dry years. The drier the year, the worse the bushfire season. This is useful, because if it is the case that low rainfall causes large bushfires (i.e. causation, not just the correlation observed in this study), then we should be able to predict the size of summer bushfire seasons and prepare resources to combat them accordingly. As rainfall appears to be strongly influential of bushfire size, it is recommended that the Royal Commission investigate the likely causes of low rainfall years. Although beyond the scope of this study, if the causes of dry years in recent decades is likely linked to human-caused global warming, then action on reducing our emissions and leading international

efforts to follow suit may well be the best means of reducing the size of future summer bushfires in Gippsland.

*Fuel reduction burning*

There appears to be no relationship between the size of summer bushfires and the total area of fuel reduction burns undertaken in Gippsland. This is not to say that fuel reduction burns are never effective in reducing the size of bushfires, there are enough published and anecdotal observations to prove otherwise, but nevertheless, this study illustrates that the total area of fuel reduction burning doesn't affect the size of bushfires in following years. It is possible that fuel reduction burning may affect the intensity of bushfires more than their size, fire intensity was not assessed in this study. The lack of a relationship between total area of fuel reduction burning and size of bushfires may be because fuel reduction burning is less effective when fires are more intense. It may also be the case that there is some relationship, but that it is swamped by the effect of rainfall.

CONCLUSIONS

This study illustrates that low rainfall, not low levels of fuel reduction burning, is associated with large summer bushfires in Gippsland. This suggests that in order to prepare for and reduce the severity of future bushfires, we should focus on what causes low rainfall years. There is no evidence from this study that investing heavily in increased fuel reduction burning will help reduce the size of future bushfire seasons.

FOOTNOTE: It is important to note that this is a very simplistic study and that I did not consider collinearity issues (i.e. that that the size of one bushfire season can affect the size of following seasons), interactions between rainfall and fuel reduction burning, or other factors that might affect the size of summer bushfires. Nevertheless, the strength of the correlation between rainfall and bushfire size was so strong, and the correlation between fuel reduction burning and bushfire size so weak, that it is unlikely that the major conclusions of this study would change by undertaking more complicated analyses.

APPENDIX 1 – DATASET USED IN ANALYSES

| Year | Bushfire (ha) | FRB in last 1 year | FRB in last 3 years | FRB in last 10 years | Rainfall in last 1 years | Rainfall in last 2 years | Rainfall in last 3 years |
|---|---|---|---|---|---|---|---|
| 1966 | 11916 | 3096 | 3096 | 3096 | 1231 | - | - |
| 1967 | 134337 | 7840 | 10936 | 10936 | 577.2 | 1808.2 | - |
| 1968 | 864 | 814 | 11750 | 11750 | 712.5 | 1289.7 | 2520.7 |
| 1969 | 55 | 0 | 8654 | 11750 | 1009.1 | 1721.6 | 2298.8 |
| 1970 | 1290 | 0 | 814 | 11750 | 1257.3 | 2266.4 | 2978.9 |
| 1971 | 12006 | 6435 | 6435 | 148463 | 766.1 | 2023.4 | 3032.5 |
| 1972 | 81720 | 43900 | 50335 | 160469 | 472.5 | 1238.6 | 2495.9 |
| 1973 | 17366 | 51151 | 101486 | 242188 | 771.4 | 1243.9 | 2010 |

| Year | Bushfire (ha) | FRB in last 1 year | FRB in last 3 years | FRB in last 10 years | Rainfall in last 1 years | Rainfall in last 2 years | Rainfall in last 3 years |
|---|---|---|---|---|---|---|---|
| 1974 | 78 | 3512 | 98562 | 259554 | 1300.9 | 2072.3 | 2544.8 |
| 1975 | 3143 | 48603 | 103265 | 259632 | 755.9 | 2056.8 | 2828.2 |
| 1976 | 4 | 11597 | 63712 | 262775 | 729.2 | 1485.1 | 2786 |
| 1977 | 25980 | 7260 | 67460 | 250862 | 706.7 | 1435.9 | 2191.8 |
| 1978 | 35017 | 1563 | 20420 | 142505 | 1433.4 | 2140.1 | 2869.3 |
| 1979 | 20401 | 1016 | 9839 | 176658 | 452.8 | 1886.2 | 2592.9 |
| 1980 | 153630 | 36314 | 38892 | 197004 | 689.1 | 1141.9 | 2575.3 |
| 1981 | 22101 | 162695 | 200025 | 349344 | 834.6 | 1523.7 | 1976.5 |
| 1982 | 370333 | 56950 | 255958 | 359440 | 584.2 | 1418.8 | 2107.9 |
| 1983 | 597 | 19009 | 238654 | 648053 | 810.7 | 1394.9 | 2229.5 |
| 1984 | 4137 | 82356 | 158315 | 631285 | 912.9 | 1723.6 | 2307.8 |
| 1985 | 2064 | 27823 | 129189 | 635344 | 997.4 | 1910.3 | 2721 |
| 1986 | 3330 | 50444 | 160624 | 634264 | 544.3 | 1541.7 | 2454.6 |
| 1987 | 3274 | 110851 | 189118 | 637591 | 766.1 | 1310.4 | 2307.8 |
| 1988 | 5619 | 50856 | 212151 | 614885 | 884.9 | 1651 | 2195.3 |
| 1989 | 2374 | 6483 | 168189 | 585487 | 867.2 | 1752.1 | 2518.2 |
| 1990 | 4844 | 75702 | 133041 | 567460 | 920.2 | 1787.4 | 2672.3 |
| 1991 | 3608 | 68288 | 150473 | 418673 | 739.4 | 1659.6 | 2526.8 |
| 1992 | 787 | 79751 | 223741 | 400180 | 1030 | 1769.4 | 2689.6 |
| 1993 | 599 | 55642 | 203681 | 30634 | 890.1 | 1920.1 | 2659.5 |
| 1994 | 3202 | 75867 | 211260 | 30635 | 716.5 | 1606.6 | 2636.6 |
| 1995 | 4177 | 70608 | 202118 | 29701 | 979 | 1695.5 | 2585.6 |
| 1996 | 7254 | 50928 | 197403 | 31814 | 876.8 | 1855.8 | 2572.3 |
| 1997 | 40446 | 75752 | 197287 | 35738 | 516.2 | 1393 | 2372 |
| 1998 | 3010 | 22053 | 148733 | 72911 | 987.2 | 1503.4 | 2380.2 |
| 1999 | 1532 | 46793 | 144598 | 70302 | 688 | 1675.2 | 2191.4 |
| 2000 | 1155 | 23330 | 92177 | 69460 | 771.8 | 1459.8 | 2447 |
| 2001 | 223 | 39561 | 109684 | 65771 | 957 | 1728.8 | 2416.8 |
| 2002 | 1374270 | 21862 | 84754 | 62386 | 738.4 | 1695.4 | 2467.2 |
| 2003 | 13412 | 17860 | 79283 | 1435869 | 565 | 1303.4 | 2260.4 |
| 2004 | 9108 | 59697 | 99419 | 1448682 | 829 | 1394 | 2132.4 |
| 2005 | 17035 | 57355 | 134912 | 1454589 | 807.2 | 1636.2 | 2201.2 |
| 2006 | 1099437 | 17406 | 134458 | 1467447 | 592 | 1399.2 | 2228.2 |
| 2007 | 1941 | 66936 | 141697 | 2559630 | 950.2 | 1542.2 | 2349.4 |
| 2008 | 117195 | 53236 | 137578 | 2521125 | 760.6 | 1710.8 | 2302.8 |
| 2009 | 6814 | 67128 | 187300 | 2635309 | 606 | 1366.6 | 2316.8 |
| 2010 | 11986 | 55899 | 176262 | 2640592 | 713.4 | 1319.4 | 2080 |
| 2011 | 57 | 53130 | 176157 | 2651423 | 1308 | 2021.4 | 2627.4 |
| 2012 | 90937 | 40556 | 149585 | 2651256 | 761.7 | 2069.7 | 2783.1 |
| 2013 | 197393 | 51496 | 145182 | 1367923 | 623 | 1384.7 | 2692.7 |

| Year | Bushfire (ha) | FRB in last 1 year | FRB in last 3 years | FRB in last 10 years | Rainfall in last 1 years | Rainfall in last 2 years | Rainfall in last 3 years |
|---|---|---|---|---|---|---|---|
| 2014 | 422 | 15092 | 107144 | 1551904 | 957.5 | 1580.5 | 2342.2 |
| 2015 | 605 | 44125 | 110713 | 1543218 | 1076 | 2033.5 | 2656.5 |
| 2016 | 3824 | 26349 | 85566 | 1526787 | 960.1 | 2036.1 | 2993.6 |
| 2017 | 29636 | 22934 | 93407 | 431173 | 501.4 | 1461.5 | 2537.5 |
| 2018 | 198754 | 4836 | 54119 | 458868 | 457.3 | 958.7 | 1918.8 |
| 2019 | 800000 | 78474 | 106244 | 540427 | 513.1 | 970.4 | 1471.8 |

## APPENDIX 2 – R CODE

```
setwd("~/Documents/Fire data_DELWP")
data <- read.csv(file = "firedata.csv", header = TRUE)
head(data)
str(data)

model <- lm(log(Bushfire) ~ FRB.3yrs, data = data)
summary(model)
confint(model)

plot(model, which = 1)
hist(model$residuals)
plot(model, which = 2)

plot(log(Bushfire) ~ FRB.3yrs, data = data, xlab = "Total area of fuel reduction
burns in previous three years (ha)", ylab = "log(Total area (ha) of summer
bushfires)",pch=16)
abline(model, col = "red")
```