Emergency Leaders for Climate Action

Submission to: Victorian Bushfire Inquiry

Addressed to:

Tony Pearce; Inspector-General Emergency Management, Victoria

Submission from:

Emergency Leaders for Climate Action
https://emergencyleadersforclimateaction.org.au/

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About Emergency Leaders for Climate Action

Climate change is escalating Australia's bushfire threat placing life, property, the economy and environment at increasing risk.

Emergency Leaders for Climate Action (ELCA) was formed in April 2019 due to deep shared concerns about the potential of the 2019/20 bushfire season, unequivocal scientific evidence that climate change is the driver of longer, more frequent, more intense and overlapping bushfire seasons, and the failure of successive governments, at all levels, to take credible, urgent action on the basic causal factor: greenhouse gas emissions from the burning of coal, oil and gas. Greenhouse emissions are causing significant warming, in turn worsening the frequency and severity of extreme weather events that exacerbate and drive natural disasters such as bushfires.

ELCA originally comprised of 23 former fire and emergency service leaders from every state and territory and every fire service in Australia, from several State Emergency Service agencies, and from several forestry and national parks agencies. At the time of submission, ELCA continues to grow and now comprises 33 members, including two former Directors General of Emergency Management Australia. Cumulatively, ELCA represents about 1,000 years of experience.

Key members from Victoria include:

- *Craig Lapsley PSM:* Former Emergency Management Commissioner; Former Fire Services Commissioner; Former Deputy Chief Officer, Country Fire Authority.
- *Russell Rees AFSM:* Former Chief Fire Officer, Country Fire Authority Victoria.
- *Ewan Waller AFSM:* Former Chief Fire Officer, Forest Fire Management Victoria.
- *Neil Bibby AFSM:* Former CEO, Victorian Country Fire Authority. Former Deputy Chief Officer, Melbourne Metropolitan Fire Brigade.
- *Dr Jeff Godfredson AFSM:* Former Chief Fire Officer, Melbourne Metropolitan Fire Brigade.
- *Mary Barry:* Former CEO, State Emergency Service Victoria.

In April and May 2019 ELCA corresponded with the Prime Minister and sought opportunities to brief him on the alarming potential of the looming bushfire season, then again later in 2019 when the catastrophic fire season, as warned, started to rapidly intensify. Ultimately a short meeting was held with Ministers Littleproud and Taylor on 4 December, after hundreds of homes and a number of lives had already been lost in NSW and Queensland. No tangible changes or action resulted from that meeting.

ELCA recommended a number of significant measures that would have aided firefighting efforts, including additional funding for large firefighting aircraft in aid of the states and territories, and mobilisation of elements of the Australian Defence Force to support emergency services. The recommendations were initially ridiculed, then ignored, then belatedly implemented after the worst damage and most deaths had already occurred.

ELCA members are united in their views on the effects of climate change on bushfires and natural disasters based on scientific evidence, emerging knowledge, and longterm observations. This submission reflects a general consensus of ELCA members on some other matters pertaining to fire management and may not fully represent individual / expert views on particular issues.

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Recommendations

1. The Inquiry Report should clearly acknowledge and explain that the 2019/20 Victorian bushfires were driven by unprecedented extreme weather and fire danger indices on multiple days, by cascading events including drought, heatwaves, dry thunderstorms, and an unprecedented number of pyroconvective events. The Report should clearly acknowledge and explain for the historical record that it is irrefutable that climate change was the main driver of the unprecedented 2019/20 bushfire season.

2. The Inquiry Report should explain how climate change has resulted in the Victorian bushfire season lengthening, and overlapping with other states and territories, limiting the ability of Australian firefighting agencies to assist each other. Increasing overlap of fire seasons between the northern and southern hemispheres is limiting the availability of large firefighting aircraft, particularly between August and November each year.

3. Strong climate mitigation and adaptation policies are required from all levels of government including the Victorian State Government, to start to address the escalating bushfire and natural disaster risks driven by climate change, the root cause of worsening extreme weather. Victoria must accelerate and increase measures to tackle climate change. More substantial action is required to reduce Australia's emissions, including accelerating the transition to renewables and storage technologies, non-polluting transport, infrastructure, food production and the phase out of fossil fuel projects. The Victorian Government must continue to step up to strengthen its climate policies and local government must continue to meet and beat emission reduction goals and renewable energy targets. Some of these climate impacts are already locked in, and all levels of government will play a critical role in building community preparedness and resilience.

4. The Victorian Government should demand that the Federal Government maintain funding and support for an ongoing research capability given the imminent cessation of funding in 2021 for the Bushfire & Natural Hazards Cooperative Research Centre. Research is crucial to understanding and tracking escalating natural disaster risks and enabling fire and emergency services to plan and prepare for worsening conditions. An evidence-based ability to track and predict escalating risks driven by climate change must underpin the development of national and state resilience, adaptation and mitigation strategies, funding needs for community education and engagement, and enhanced resourcing of emergency services.

5. The Victorian Government should demand that the Federal Government ensure critical government research agencies have funding restored. This includes agencies such as the Bureau of Meteorology (BoM), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and ABC Local Radio as the national emergency broadcaster. These agencies must be sufficiently resourced to improve predictive capabilities, understand effects of climate change on natural disasters now and into the future, and be able to warn and alert communities and emergency services in a timely, comprehensive manner.

6. The Inquiry should find that fuel reduction is one of the only ways to reduce fire intensity and therefore must be a major part of any mitigation strategy. It should recommend that research underpin the development of new policies that recognise the need for better asset protection strategies, shrinking windows available for controlled burning due to a warming climate, the need to fund and research cultural burning practices, and the need to ensure that risks on both public and private lands are monitored and managed.

7. The Inquiry should find that due to the escalating impacts of climate change, existing hazard reduction approaches could become less effective at mitigating and controlling fires during extreme weather events that result in long distance spotting, intense and sustained ember attack, and pyroconvective fires. As a result, fuel reduction approaches will need to be better integrated with overall mitigation strategies including fire detection and suppression, community education, hardening of infrastructure, warnings, evacuation, and other measures

8. The Inquiry should recognise that if more prescribed burning is to be required, then additional resources will be required by land management agencies and fire services expected to carry out this work Benchmarks should be developed to ensure that agencies are properly resourced to manage lands under their control, and that they have sufficient resources to participate in prescribed burning operations on a regular, planned basis.

9. The Inquiry should note the decision to progressively reduce the amount of logging of native forests in Victoria from 2024-5, and that this provides an opportunity to harness existing knowledge and resources to increase fuel management across Victoria through a reallocation of human and other resources.

10. A range of new rapid fire-detection technologies should be trialed. Together with rapid detection, new fast-attack strategies for new outbreaks, particularly remote fires caused by lightning, need to be introduced with clear objectives, e.g. putting fires out within 24 hours and before they exceed ten hectares. Fast attack should involve rapid dispatch of a suitable number of water bombing aircraft to achieve rapid turnaround and constant direct attack on fire fronts, complemented, as soon

as possible by aerial insertion (where practicable) or ground insertion of remote area fire teams to complete extinguishment.

11. The Victorian Government should conduct a trial, in consultation with AFAC and NAFC, of amphibious water-scooping aircraft in a first attack / direct attack firefighting role (CL415). Australian fire services at present use small and large fixed wing water bombers, but not medium sized. Given the success of 3,200 litre single engine air tankers (SEAT), a twin engined purpose-built aircraft with significantly greater air speed, range, flexibility and twice the payload may prove to be a useful addition to current arrangements. They are used extensively and successfully throughout the world in other fire-prone countries

12. In the wake of the devastating 2019/20 fires, and recognising that climate change continues to drive an increase in Australia's bushfire threat, it is critical that building and planning regulations and standards be reviewed, particularly Australian Standard 3959.

13. Roof design and strength is a critical factor in future bushfire design of homes and other buildings. Requirements need to be increased to reflect increasing wind velocities fueled by climate change, and fire storms and fire tornadoes caused by pyroconvective events that damage and remove roofs. If a roof is damaged or destroyed survivability of the structure and its ability to act as a refuge are greatly reduced.

14. With varying legislation and building codes across states and territories a more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical. As fire danger indices and fire paths from 2019/20 are analysed, locations might be identified where rebuilding should not occur due to excessive levels of fire and life risk.

15. Consideration should be given in remote communities or communities deemed to be at extreme risk with limited egress, to providing dual-purpose community buildings capable of providing all community members with refuge in an extreme bushfire situation.

16. The Victorian Government should request that the Federal Government conduct a fundamental review of longstanding Defence Assistance to the Civil Community (DACC) arrangements in view of heightened and worsening natural disaster risk driven by climate change. The arrangements can be cumbersome and slow, and levels of understanding between the ADF and emergency services about respective capabilities, needs, and arrangements must be improved. The ADF should focus on utilisation of existing capabilities for civil defence roles under the control of emergency services and state and territory governments, rather than developing

new capabilities that might serve to duplicate state and territory capabilities and ultimately cause confusion and inefficiencies.

1. Overview of the Bushfire Challenge

1.1 The 2019/2020 Bushfire Season

The 2019-20 season's fires were incredibly extensive, even compared to recent severe fires elsewhere in the world. Around 21 percent of Australian temperate broadleaf and mixed forests was burnt. This can be compared to the average annual area burnt for most continents, including Australia, which is generally below 5 percent, except for Africa and Asia, which have average annual areas burnt of 8-9 percent (Boer et al. 2020). According to the Department of Environment, Land, Water and Planning (DELWP) preliminary bushfire report summary, the fires (as at 11 January 2020) have impacted at least 60 percent of over 50 national parks and nature reserves in Victoria (DELWP 2020). The report states that "given that a significant area of habitat across Victoria has now burnt multiple times since 2000, this could result in regeneration failure for Alpine Ash" (DELWP 2020, p 24). In addition, the Warm Temperate Rainforest in Victoria are of "immediate concern", with 70 percent within bushfire affected areas in 2019/20 (DELWP 2020, p 42).

In the future, Victoria is very likely to experience an increased number of days of Very High fire danger and above. Communities, emergency services and health services across Victoria must be prepared for this escalation of bushfire risk

Climate change is clearly driving worsening bushfire weather in Victoria. Bushfire conditions are now more dangerous than in the past, and the risk to life, property and the environment has increased. Fire seasons have lengthened in Victoria and across the rest of Australia, and the number of days of Very High Fire Danger and above have increased, reducing windows of opportunity for land managers and fire services to conduct hazard reduction burns.

Members of ELCA have observed and become increasingly concerned by the increasing *overlap* of bushfire seasons between not only Australian States and Territories, but also the northern hemisphere. Over the previous century it had been well established that fire seasons started in the north and moved south, consecutively affecting different jurisdictions, thereby enabling the sharing of firefighting plant, equipment and firefighters (Luke & McArthur 1978; Wallace-Wells 2019). Cross-jurisdiction sharing of resources was a cornerstone of fire service operational doctrine in Australia for decades but can no longer be relied upon. Overlapping fire seasons will increasingly constrain the ability of Australian fire services to defend life and property and contain major fires now and into the future, because they limit the sharing of vital personnel and equipment. The basic issue facing all

fire services now is that jurisdictions cannot release resources to assist others when their own state or territory is burning – an increasingly common occurrence that reduces overall firefighting capacity when it is needed most.

Another major problem is limited access to large firefighting aircraft at the start of Australian fire seasons, because they are still being used in places like California during its extended fire season (i.e. we rely on the same pool of aerial firefighting equipment). This has significant relevance to how the relatively small fleet of leased large firefighting aircraft (fixed and rotary wing) are shared during a crisis – reinforcing the fact that there are simply not enough to go around.

Without minimising in any way the human cost of losses experienced during this bushfire season, the ecological cost is even more vast. An estimated one billion animals perished in the fires (University of Sydney 2020). Vast, silent stretches of skeletal forests where everything, including tree canopies, were consumed by fire are testament to the ecological disaster that has occurred. As noted previously, it is estimated that 21% of Australia's south eastern broadleaf forests have been burned, compared to an average of 3% in any given fire season. Because of the number of days of Very High fire danger and above leading to extreme fire behaviour, there were fewer unburned patches left in many areas to provide refuge for wildlife. It is estimated that 170 species were affected in Victoria, including 19 mammal species, 13 frog species, ten reptile species, nine bird species, 29 aquatic species and 38 plant species (Andrews 2020). Many of the few animals that survived the most severe fires have likely since succumbed to starvation, injuries and predation by feral animals.

Economic costs have been very high, with an estimated $4.5 billion lost in tourism due to bushfires. The bushfire smoke that blanketed Greater Sydney is estimated to have reduced that city's gross domestic product by around $12-50 million per day (SMH 2019a). About 23,000 fire-related insurance claims were lodged between November and February in NSW, Queensland, Victoria and South Australia, totaling about $1.9 billion (ICA 2020).

1.2 The core problem and what must be done

ELCA contends that we are now experiencing the real and rapidly escalating costs of failing to act on the underlying causal factor: climate change caused by greenhouse gas emissions from the burning of coal, oil and gas.

During the bushfire season diversionary tactics appear to have been used extensively to take attention away from the lack of action on climate change. These included blaming the Australian Greens and their supporters for stopping fuel reduction, blaming "arsonists" for

starting the fires, and statements that "we've had bad fires like this before". Basic research quickly refutes such myths and assertions; they are irresponsible and misrepresent the factual basis upon which action must be taken to safeguard life, property and the environment, and the safety of future generations. They therefore need to be comprehensively refuted on the basis of evidence in the Inquiry report.

A simple analogy: when a pot on the stove boils over, there is no point trying to continually mop up boiling water: obviously, the cause of the problem – the heat source, must be dealt with. In relation to bushfires and climate change: the worldwide fire problem has reached a point where fire services can no longer cope. The pot (warming climate) is boiling over, but governments around the world, with the Australian Government being one of the main recalcitrants, are resisting efforts to reduce greenhouse gas emissions.

The Australian Government has a duty to help save our firefighters and the communities who rely upon them, by dealing with the core problem that is driving disastrous bushfire seasons: by rapidly and deeply cutting greenhouse emissions, eventually enabling the risk to be reduced back to manageable levels.

The Victorian Government can play a leading role in helping to better educate the Federal Government by demanding stronger climate action on behalf of all Australians.

2. Victorian fire history

Although Victoria comprises just 3% of Australia's land mass, 67 percent of all known civilian fatalities since the beginning of the 20th century (Blanchi et al. 2014), and around 50 percent of the economic losses due to bushfires have occurred in the state (Buxton et al. 2011). Nearly 80 percent of Australians were affected either directly or indirectly by the 2019/2020 bushfires. Tragically, thirty-three people lost their lives in the fires across Australia, including five Victorians (Victorian Government 2020). Just under 3,100 homes were destroyed, with more than 300 in Victoria. Thousands of outbuildings and sheds were also destroyed. The 2019/20 bushfire season has been Australia's most destructive fire season on record, with previous major bushfire events; Ash Wednesday (1983) and Black Saturday (2009) destroying 2,000 and 2,029 homes, respectively (Victorian Government 2020).

Victoria experienced serious bushfires with life, stock and property losses in:

- 1851 (Widespread damage. 12 lives, about 5M ha, 1M sheep, and thousands of cattle lost)
- 1898 (2,000 buildings and 12 lives lost)
- 1926 (widespread damage and 60 lives lost)
- 1931/32 (20 lives lost)
- 1939 (650 buildings, the town of Narbethong and 71 lives lost)
- 1942 (20 homes and 1 life lost)
- 1943/44 (550 homes and 20 lives lost)
- 1952
- 1961/62 (454 homes and 32 lives lost)
- 1965 (66 homes, 7 lives and 4,000 stock lost)
- 1967/68 (53 homes lost)
- 1969 (230 houses, 23 lives and 12,000 stock lost)
- 1977 (116 houses, 4 lives and 198,500 stock lost)
- 1983 Mt Macedon 1 February (50 houses lost)
- 1983 Ash Wednesday 16 February (2000 homes, 73 lives and 270,000 stock lost)
- 1985 (185 homes, 3 lives and 46,000 stock lost)
- 1997 (41 homes and 3 lives lost)
- 2003 (41 homes and 1.2M hectares lost)
- 2005/06 (57 homes, 4 lives and 64,000 stock lost)
- 2006/07 (51 homes, 1 life and 1,741 stock lost)
- 2009 (2029 homes and 173 lives lost)
- 2013 (5 lives lost)

(Luke & McCarthur 1978. FFMV 2019)

It needs to be noted that previous serious bushfire seasons in Victoria with extensive losses of life and property generally saw the most significant losses on 1 or 2 days of what would today be termed Extreme and "Code Red" fire danger. The trend worldwide, including in Tasmania, Queensland, NSW and California over the last 5 years, has been for there to be *multiple* days of very serious fire weather over a longer, more extended fire season.

The fact that NSW, where the previous worst fire season on record resulted in the loss of 248 homes (2013) eclipsed this by more than 10 times during the 2019/20 season (2,448 homes and 25 lives lost), should be deeply concerning to all Victorians (NSW RFS 2020). If Victoria suffered a similar increase in losses, more than 20,000 homes could be lost in a single fire season. This is not far-fetched. California, which is similar in terms of bushfire risk to Victoria, suffered losses of 10,000 homes in 2017, then nearly 20,000 homes and

nearly 100 people killed in 2018, marking a 5-fold increase in previous heaviest losses during a single fire season (CalFire 2020). California's escalating fire problem is also fueled by climate change.

As noted above, Victoria has historically suffered its greatest losses on one or two days. If, like NSW and Queensland in 2019/20, the whole of Victoria experienced multiple days of Severe, Extreme and Code Red fire danger over an extended fire season as occurred in NSW, the types of losses being experienced in California could easily be imagined. This is the type of threat, driven by worsening climate change, that authorities must now consider and plan for.

3. Climate change and the 2019/2020 bushfire crisis

3.1 How climate change aggravated the 2019/2020 bushfire crisis

The ongoing drought coupled with increasing periods of extreme heat, both aggravated by climate change, set the scene for the catastrophic fires in the summer of 2019/20.

Bushfires rely on five main factors to take hold and spread: high temperatures, low rainfall, low humidity, strong winds and a suitable fuel source. 2019 was the hottest year on record across Australia with mean temperature 1.52°C above average and mean maximum temperature 2.09°C above average (BoM 2020b) (see Figure 1 below).

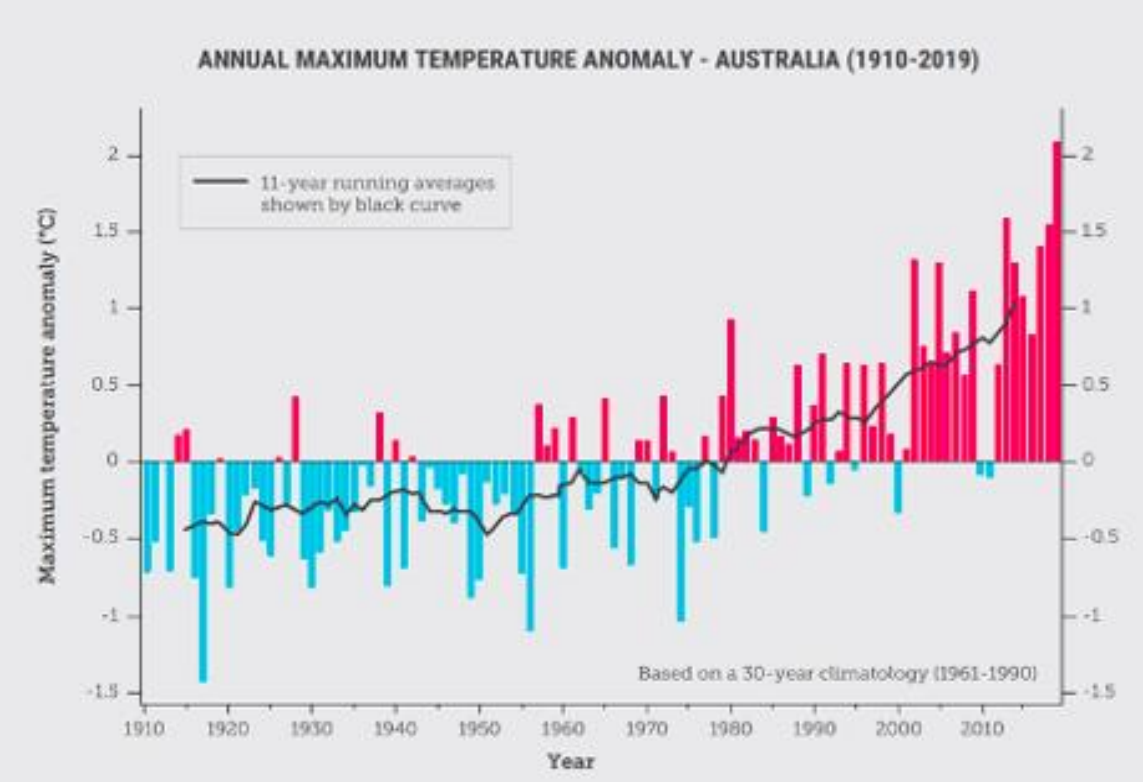

Figure 1: Annual maximum temperature anomaly Australia (1910 to 2019). Source: BoM (2020a).

It was also the driest year on record across Australia with rainfall 40 percent below average (BoM 2020b). Victoria's rainfall in 2019 was about 28% below average, and most of Gippsland, the Mallee, northern and northeastern districts, and parts of the Wimmera and central districts had annual rainfall totals in the driest 10 per cent of records (decile 1) (BoM 2019a). The dry conditions throughout the year came on the back of prolonged rainfall deficiencies across most of southeastern Australia since the beginning of 2017, underpinning one of the worst droughts on record (Figure 2 below shows the 2018 to 2019 rainfall trends).

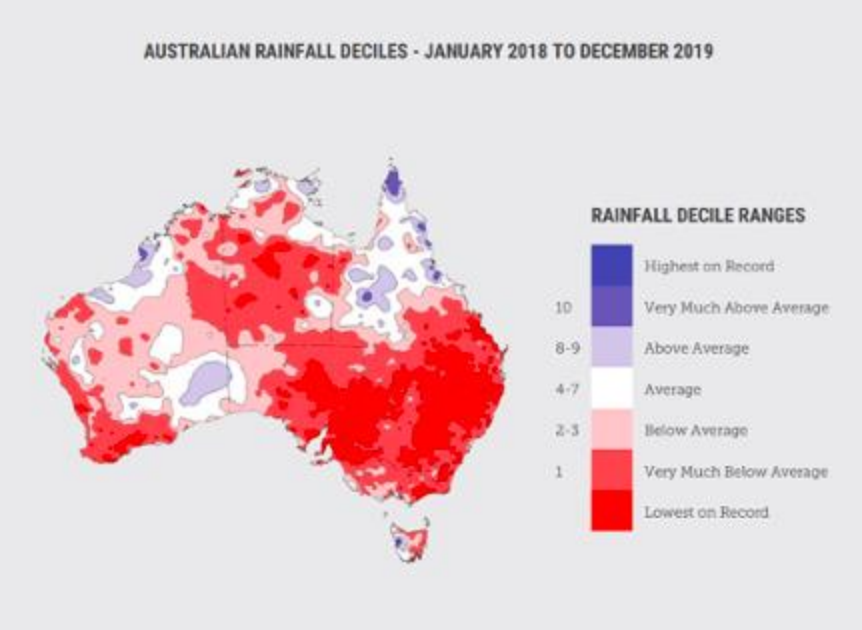

Figure 2: Australian rainfall deciles – 1 January 2018 to 31 December 2019. Source: BoM (2020b)

In eastern Australia, including Gippsland, the prolonged dry conditions over the year contributed to drying out vegetation, making it more flammable, and creating the perfect conditions for fires to take hold and spread quickly given a source of ignition (provided in many cases by lightning) and the right weather. Prolonged heat also increased evaporative demand, further exacerbating soil and vegetation dryness and increasing the amount of "available fuel" which in turn added to fire intensity, convection, spotting distances, and intensity of ember attack. Unsurprisingly, the annual accumulated McArthur Forest Fire Danger Index (FFDI) was the highest on record in 2019 (measured since 1950) (BOM 2020e).

Australia's climate has on average warmed by more than 1°C since 1910 (BoM 2020a. CSIRO and BoM 2018). Averages however tend to mask the increase in record extremes being experienced each year. Every year since 2013 has been amongst the ten hottest years on record for Australia, with only one of the ten hottest years (1998) occurring before 2005 (BoM 2020c). Cool season rainfall has also been declining across southern Australia over recent decades. In the southwest of Australia, May-July rainfall has decreased by around 20 percent since 1970 and in the southeast, April-October rainfall has decreased by around 11 percent since the 1990s (CSIRO and BoM 2018). These trends have contributed to an increase in the length of fire seasons and to the severity of dangerous fire weather across large parts of the continent (CSIRO and BoM 2018).

Although the El Niño–Southern Oscillation (ENSO), commonly a driver of serious bushfire seasons in eastern Australia remained neutral throughout 2019, a very strong positive Indian Ocean Dipole also contributed to low rainfall across Australia over the past year, building upon longer-term rainfall deficiencies in eastern Australia since the beginning of 2017. Apart from NSW in 2013, all previous major bushfire seasons with heavy losses of property in NSW and most in Victoria occurred during El Niño events, but climate change is increasingly swamping the influence of natural variability (Gergis and Carey 2020). This should be of significant concern – when an El Niño inevitably returns, it is likely to result in elevated temperatures and reduced rainfall, so the prospect of an even more disastrous bushfire season at some time in the future is likely.

As the climate continues to change, bushfire seasons are starting earlier and lasting longer. Major fires burned across Queensland and New South Wales from August 2019. Fires ignited in the Northern Territory and Western Australia in September, and across Tasmania and South Australia by late October. By late November, every state was alight when fires broke out in Victoria, following lightning strikes in East Gippsland (Canberra Times 2020; Victorian Government 2020).

3.2 Climate change driving an increase in extreme bushfire events

Climate change could be driving an increase in the occurrence of extreme bushfires in Australia (Dowdy & Pepler 2018; Dowdy et al. 2019; Climate Council 2019c). Bushfires can transition to more extreme events such as pyroconvective interactions (when fires burn in close proximity and influence each other, spreading faster and in unpredictable ways) and pyrocumulonimbus events (fire-generated storms). Extreme bushfires have a high level of energy, and exhibit chaotic and unpredictable behaviour, which are often harder or impossible to control and more dangerous to both firefighters and communities (Sharples et al. 2019).

Fires that burn in close proximity can influence each other; this is due to pyroconvective interactions between individual fires. Commonly this is seen when intense spotting (when embers from a primary fire are blown downwind and ignite new spot fires) causes multiple fires to form and coalesce. As the primary fire and spot fires interact, local rates of spread can increase, sometimes in unexpected directions. This can result in broad “flaming zones” which can entrap firefighters and increase the likelihood of extreme bushfires (Sharples et al. 2019). Pyroconvective conditions are more likely to occur when atmospheric instability is high, combined with dangerous near-surface conditions (e.g. low humidity, strong winds and high temperatures) (Dowdy & Pepler 2018; Climate Council 2019c). Modelling suggests that the increased risk of extreme fire weather events under the influence of

climate change may lead to increased incidence of pyro-convective fire behaviour. Australia has already seen an increase in these events with the 2003 Canberra bushfires, 2009 Back Saturday bushfires in Victoria, and the 2019/2020 fire season in Queensland, NSW and Victoria, all examples of pyroconvective events (Dowdy & Pepler 2018; Dowdy et al. 2019; Climate Council 2020a).

Pyroconvective events (fire-generated storms) occur when bushfires couple with the atmosphere, generating explosive thunderstorms that can include strong downdrafts, gusting winds and lightning, making bushfire behaviour very unpredictable. These storms are often "dry" and do not produce any useful rain. One of the features of this extreme bushfire season has been an increase in the number of fire-generated storms.

Pyroconvective events were previously considered rare, with Australia experiencing only two confirmed and two possible fire-caused storms between 1978 and 2001 (McRae et al. 2015). Since 2001, 78 fire-caused storms have been recorded, including a staggering 33 percent increase in 2019 (with around 15 fire-caused storms in the Victorian high country in March 2019 alone). Fire researchers estimate that an additional 30 fire-caused storms have occurred since September 2019, with a further 15 possible fire-caused storms being investigated (The Guardian 2019). This represents an astounding shift in the frequency of these events. Veteran firefighters, including members of ELCA, have limited experience of such conditions, and established firefighting doctrine does not adequately consider the dangers and variable associated with pyroconvective activity.

In December 2019, more than 2000 bush and grass fires burned throughout the month in New South Wales, and other significant fires broke out in South Australia, Tasmania and Victoria. From 12 December, a slow-moving hot air mass developed over western Australia and started to move from west to east across the country. This resulted in a series of days above 40°C in Perth from 13-15 December and then a swathe of broken records for daily December maximum temperatures in locations across South Australia, Victoria, ACT and New South Wales, southeast Queensland, Central Australia, and much of Tasmania. For a number of locations, records were set for the warmest day for any time of the year, and on two consecutive days (17 and 18 December) records were broken for the national area-averaged maximum temperature (40.9°C and 41.9°C respectively) (BoM 2020b). Heavy smoke blanketed Sydney, especially throughout December, as the Gospers Mountain Fire burned out of control. A recent report estimates that up to 417 early deaths occurred as a result of particulates contained in bushfire smoke over the summer (Arriagada et al. 2020). This figure could be higher, as we don't yet know the long-term contribution to morbidity and mortality from the intense and chronic exposure over summer

As the heatwave arrived on the east coast, catastrophic conditions were again forecast for the Greater Sydney Region (the second time this has ever occurred), marking the beginning of another seven-day State of Emergency for New South Wales from 19 December. The week ending 24 December 2019 was Australia's hottest week on record, and the month as a whole was Australia's hottest December on record (3.21°C above average, surpassing the previous December record set in 2018 by more than a full degree). It was also the hottest month on record for minimum and maximum temperatures, with the national maximum temperature an astounding 4.15°C above average. The monthly accumulated FFDI was also the highest on record for any month since records began in 1950 (BoM 2019b).

The end of 2019 and the first days of 2020 brought particularly extreme fire weather to southeastern New South Wales and eastern Victoria, with numerous locations recording their warmest January day on record on 4 or 5 January across southeastern Australia. Bushfires flared on New Year's Eve 2019, hitting many small towns on the south coast of New South Wales, destroying hundreds of houses including around Batemans Bay, Mogo, Lake Conjola and Cobargo and tragically killing nine people. In an unprecedented move, the New South Wales Government issued evacuation orders for the south coast prior to New Year's Eve, a commendable decision that almost certainly saved many lives. On the same day multiple fires burned through East Gippsland, cutting off escape routes and destroying properties. Another seven-day State of Emergency was declared from 3 January 2020 for New South Wales. From 27 January until the end of the month, a very hot air mass brought high temperatures to southern Australia. On 31 January, as temperature records were broken in locations across New South Wales, Victoria and Tasmania, a State of Emergency was declared in the Australian Capital Territory as the Orroral bushfire grew to eight percent of the territory's land area, threatening homes and properties there and in New South Wales (ACT Government 2020).

ELCA submits that the evidence is irrefutable – climate change caused by the burning of coal, oil and gas super-charged the 2019/20 bushfire season. It is not possible to "adapt" to such catastrophic conditions and they can only be partially mitigated. There should now be a clear understanding within the community, media and within all levels of government that the base cause of extreme weather leading to natural disasters must be addressed through rapid and deep cuts to greenhouse gas emissions.

Recommendation 1: The Inquiry Report should clearly acknowledge and explain that the 2019/20 Victorian bushfires were driven by unprecedented extreme weather and fire danger indices on multiple days, by cascading events including drought, heatwaves, dry thunderstorms, and an unprecedented number of pyroconvective events. The Report should clearly acknowledge and explain for the historical record that it is irrefutable that climate change was the main driver of the unprecedented 2019/20 bushfire season.

Recommendation 2: The Inquiry Report should explain how climate change has resulted in the Victorian bushfire season lengthening, and overlapping with other states and territories, limiting the ability of Australian firefighting agencies to assist each other. Increasing overlap of fire seasons between the northern and southern hemispheres is limiting the availability of large firefighting aircraft, particularly between August and November each year.

3.3. Fire risk will continue to escalate without genuine and sustained efforts to tackle climate change.

Climate change fueled the extreme weather we experienced during the 2019/20 bushfire season. The severity and frequency of extreme weather-driven events – including bushfires and smoke – will continue to increase in coming decades, with commensurate increases in costs, due to the greenhouse gas emissions that have already been, and continue to be emitted. If Australia fails to take strong action to rapidly phase out coal, oil and gas as part of a global effort, the impacts of climate change, including worsening bushfire conditions, will continue to escalate.

Australia urgently needs a plan to cut domestic greenhouse gas emissions to net zero and to phase out fossil fuel exports, because we are one of the world's largest polluters. We are the 14th largest emitter of greenhouse gases globally and emit more per person than any other developed country. We are also the third largest exporter of fossil fuels (The Australia Institute 2019).

What Australia, including Victoria, does matters. The longer we delay the harder the problem will be to solve. We cannot call on other countries to take action if we fail to do so. We cannot leave this escalating disaster for our children and grandchildren to try to fix.

As Australia continues to face a worsening bushfire threat, it will be critical that there is a clear forward plan for how the Federal and the Victorian State Government will support relevant emergency services and fire management agencies, coupled with strong federal policy to rapidly tackle the root cause of the problem - climate change.

Recommendation 3: Strong climate mitigation and adaptation policies are required from all levels of government including the Victorian State Government, to start to address the escalating bushfire and natural disaster risks driven by climate change, the root cause of worsening extreme weather. Victoria must accelerate and increase measures to tackle climate change. More substantial action is required to reduce Australia's emissions, including accelerating the transition to renewables and storage technologies, non-polluting transport, infrastructure, food production and the phase out of fossil fuel projects. The Victorian Government must continue to step up to strengthen its climate policies and local government must continue to meet and beat emission reduction goals and renewable energy targets. Some of these climate impacts are already locked in, and all levels of government will play a critical role in building community preparedness and resilience.

4. Research capability to inform and protect fire and emergency services

Given the increasing weather extremes caused by climate change, sustaining, and in some cases improving research capability will be critical to ensuring that fire and emergency services are properly informed, protected, and resourced into the future.

Over the last decade or more, the Bushfire Cooperative Research Centre, then the Bushfire & Natural Hazards Cooperative Research Centre (CRC) have each driven, in consultation with fire and emergency services and their peak council, the Australasian Fire & Emergency Service Authorities' Council (AFAC), ground-breaking research into bushfires and natural disasters. The research has enhanced understanding of the effects of climate change and changing risk patterns, informing development of strategies to adapt to and mitigate risks as far as possible. Practical applications of the research extend to areas as diverse as cabin protection systems for fire trucks, personal protective uniforms, and decision-making strategies for command staff.

The Australian Government recently confirmed during Senate Estimates in Canberra that the Bushfire & Natural Hazards CRC would not be funded past 2021 (SBS 2020). This potentially removes critical research capabilities at a time of accelerating change and could leave fire and emergency services without the necessary knowledge and evidence base to develop fire prevention and suppression capabilities and strategies, or to prepare and inform communities.

Withdrawal of federal funding is not confined to the CRC. The CSIRO and Bureau of Meteorology (BoM) have each had funding for climate change research reduced. BoM plays a critical operational role in helping emergency services prepare for floods, cyclones, heat waves, storms, and fires. Their suite of predictive capabilities requires ongoing investment as does their organisational capability to deliver prompt expert advice. ABC local radio has adopted the role of National Emergency Broadcaster, yet the ABC is facing increased budget cuts. These cuts have a direct impact on the people, governments and emergency services of VIC.

Recommendation 4: The Victorian Government should demand that the Federal Government maintain funding and support for an ongoing independent research capability given the imminent cessation of funding in 2021 for the Bushfire & Natural Hazards Cooperative Research Centre. Research is crucial to understanding and tracking escalating natural disaster risks and enabling fire and emergency services to plan and prepare for worsening conditions. An evidence-based ability to track and predict escalating risks driven by climate change must underpin the development of national and state resilience, adaptation and mitigation strategies, funding needs for community education and engagement, and enhanced resourcing of emergency services.

Recommendation 5: The Victorian Government should demand that the Federal Government ensure critical government research agencies have funding restored. This includes agencies such as the Bureau of Meteorology (BoM), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and ABC Local Radio as the national emergency broadcaster. These agencies must be sufficiently resourced to improve predictive capabilities, understand effects of climate change on natural disasters

now and into the future, and be able to warn and alert communities and emergency services in a timely, comprehensive manner.

5. Fuel management and prescribed burning

5.1 Climate change drove extreme weather in 2019-20 fires

Fuel management and particularly hazard reduction burning must play a larger role in fire management under a changing climate, although its effectiveness may reduce under the current trajectory of worsening extreme weather driven by climate change. Current strategies could prove to be increasingly ineffective as windows to conduct prescribed burning reduce due to hotter, drier weather extending into the cooler seasons as a direct result of climate change (Mathews et al. 2012. Ximenes et al. 2017).

The destructiveness of the 2019-20 bushfires was driven by unprecedented extreme weather. Australia has suffered serious bushfires before, but not on this scale. There was no appreciable, provable difference in overall fuel levels between these fires and the many previous fires – yet the 2019-20 fires burned 10 times more homes in NSW than ever before, and burned more forested land than ever before (Boer et al 2020. NSW RFS 2020). Significantly, there were more days of Total Fire Ban and Severe, Extreme and Code Red fire danger than ever before, with all of these factors determined on the basis of forecast and actual weather conditions (BoM 2020b, 2020d. Climate Council 2020a). On those days, when pyrocumulonimbus clouds formed above fires, long distance spotting and intense ember attack occurred, reducing the effectiveness of hazard reduced areas and the effectiveness of fire breaks (Climate Council 2020b).Fires burned over a variety of land tenures in all states, including public and private land, and through a variety of fuel types. They burned through rainforests previously considered immune to intense fires, through eucalypt forest, scrubland, grassland, crops, pasture, recently burned areas, and back yards. Assertions that failure to act on fuel reduction alone was the reason for the fires cannot withstand scrutiny.

Logically, one might expect, with better home construction, better planning standards, better water supplies, and fire and land management agencies resourced to unprecedented levels including an array of aerial firefighting assets, that no fire could surpass the size and destructive potential of fires in the past. However, this view fails to consider the unprecedented fire weather experienced, in all its facets, in 2019-20.

Unfortunately, current firefighting and mitigation arrangements are no match for nature in all its fury; especially in a rapidly warming and drying climate with more frequent and severe extreme weather events, and longer, more intense bushfire seasons. This has also been the case in California, which has a significantly larger firefighting resource base than Australia. As previously noted, in 2017 around 10,000 homes were lost in California, with nearly 20,000 homes lost in 2018 together with almost 100 lives (CalFire 2020).

5.2 Misinformation during the 2019-20 fires

During the 2019-20 fires, and previous fire seasons in Australia, there has been considerable misinformation circulated in all forms of media and even sometimes by ill-informed politicians, strongly asserting that hazard reduction burning is a "silver bullet" capable of preventing massive losses even during the most extreme conditions. Further, allegations by politicians responsible for resourcing of government agencies, that some agencies, such as National Parks services, resisted or failed to carry out sufficient burning resulting in the scale and ferocity of the fires (Canberra Times 2019).

Such claims unfortunately clouded informed debate, serving to misrepresent reliable data that showed the worst damage caused by the fires was on days of Severe, Extreme and Code Red fire danger ratings – i.e, due to extreme weather driven by climate change (BoM 2020b, 2020d. Climate Council 2020a).

ELCA's position was also misrepresented as a rejection of the use of fuel reduction techniques. This is incorrect. ELCA interventions were aimed at correcting the record where there were claims that climate change was not a factor, and that the fires were entirely due to high fuel loads and a lack of hazard reduction. ELCA recognises that the trajectory of climate change and its effects on bushfire occurrence and behaviour will make fuel reduction strategies more critical than ever before, but also more difficult to achieve.

Fuel loadings are the most significant factor following weather and climate. However, the defining difference of the 2019-20 fires was the clearly identified, unprecedented weather conditions, not necessarily a significant difference in fuel levels compared to previous fire events (BoM 2020b, 2020d. Climate Council 2020a).

Arguably it would be impossible, with current resource levels, to increase the amount of burning to a level where it could mitigate fires on such a scale (over 12 million hectares). Even though prescribed burning is becoming more difficult to carry out safely, the rate of burning in New South Wales – where the recent bushfires have been most destructive – has actually increased, rather than decreased as falsely reported (Broome et al. 2016). This either means that more resources must be put into fuel reduction to increase burning

further, or that extreme weather-driven events are becoming increasingly difficult to deal with and are reducing the effectiveness of fuel reduction measures.

Unsupported assertions that the Australian Greens and their supporters stopped hazard reduction burning are incorrect. The Greens are not in Government in any jurisdiction and cannot enact legislation. Greens policies recognise that burning is necessary, provided practices are ecologically sustainable (Greens 2020). The NSW Nature Conservation Council also overtly supports prescribed burning, and works with the NSW RFS, farmers and community groups through the Hot Shots Program to educate people about ecologically sustainable burning (NCC, 2020).

During the bushfires, Victorian Country Fire Authority (CFA) Chief Officer Steve Warrington, NSW Rural Fire Service (RFS) Commissioner Shane Fitzsimmons, and Queensland Fire & Emergency Services acting Commissioner Mike Wassing all responded to statements by some politicians and media reports explaining that they were ill-informed and that burning on its own is not a panacea for uncontrolled fires (The Guardian 2020a. ABC 2020). Notwithstanding, like ELCA, they also support a thoughtful and evidence-based approach to increased, targeted burning.

5.3 Hazard reduction

Hazard reduction involves controlled application of fire or other means, such as mechanical clearing or thinning, for the reduction or modification of available fuels within a predetermined area in order to mitigate against the future spread of an uncontrolled bushfire. The most common approach is prescribed burning, or the application of fire under controlled conditions.

Different vegetation types in different locations and geographies respond to fires differently, and prescribed burns need to take into account not just flammability but ecological impacts of burning frequency, intensity and timing. Hazard reduction can involve other methods such as mechanical clearing of fire breaks or thinning of vegetation, which is labour-intensive and cannot be practically carried out over large areas. The goal of hazard reduction is not to produce areas that will not burn, but areas that will burn at a lower intensity and therefore be controlled more easily by firefighters (Climate Council 2020b).

Of all the factors that contribute to the intensity of a fire (temperature, wind speed, humidity, topography, fuel moisture and fuel load), only fuel load can be readily modified by human effort, but bearing in mind that since the industrial revolution it is now clear that

humans have also modified the world's temperature, and action on emissions may eventually assist to bring this down.

Because of the temperature, wind velocities, low humidity and fuel dryness in 2019-20, on days of Very High fire danger and above, areas of lower fuel loads were unlikely to significantly slow the progress of fires, although it must be noted that lower fuel loads do lead to reduced fire intensity, a critical factor close to assets and people.

5.4 Increased, targeted burning needed

ELCA holds the view that a renewed focus on, and funding for, thoughtful and evidence-based approaches to significantly increased hazard reduction burning must be a key outcome of the unprecedented fire season.

As extreme weather and the number of days of elevated fire danger continue to increase, hazard reduction (prescribed burning) may have to be prioritised closer to communities, assets and critical infrastructure with a focus on more frequent burning close to settlements and assets in order to create permanent fuel-reduced zones. There may also be a need for more focus on increased use of "cool burns" or more frequent "light burning", as recently suggested in Gippsland, over larger areas.

Different vegetation types in different geographies have adapted to differing fire regimes, so a 'one size fits all' approach is unlikely to be ecologically sustainable or lead to desired outcomes in all locations. Jarrah forest in WA is quite different from dry sclerophyll forest in Hawkesbury sandstone, or remnant Gondwana forest in Tasmania or SE Queensland. Nuanced, appropriate approaches are needed.

There are insufficient resources within fire and land management agencies to simply dictate an increase in burning. As a key element in mitigating the effects of future fires, benchmarks need to be developed for funding requirements of fire, emergency and land management agencies so that they can conduct increased, targeted fuel reduction works, and have operational capabilities (people, equipment, infrastructure) commensurate with increasing risks and strategic fuel management requirements. A suitable reporting and auditing framework will be integral to this work but will be pointless unless there is a significant increase in budgets, resources and training to enable a significantly increased burning program to be implemented and achieved.

5.5 Cessation of native forest logging – an opportunity

Victoria's decision to phase out commercial logging of native forests could be seen as an opportunity if the decision is taken to increase fuel reduction efforts throughout Victoria.

At present it appears likely that thousands of highly skilled forest workers will progressively lose their jobs. With them will go a huge amount of knowledge and practice in managing fuel loads and fires, not to mention plant and equipment used during bushfires including bulldozers.

Strong consideration should be given to re-tasking workers into areas of fuel management, track management, and general forest management work. Their skills and knowledge of the bush, once lost, will never be regained.

5.6 Cultural burning practices

Cultural burning practices can no longer be ignored. Traditional owners in some areas still conduct cultural burning, and in others, attempts are being made to re-learn and resurrect former practices. This is highly worthy of support, research, and necessary funding.

Concepts surrounding cultural burning are complex and inter-related. People who live on and have a deep connection with Country develop knowledge of the interactions of weather, fuel types, topography, animals and people. They generally light "cool" fires when they can be easily controlled.

It is simplistic to conceive of cultural burning as simply an alternative burning technique that can be taught to firefighters and land managers – it involves a deep, spiritual connection to Country and deep understanding of the interactions of ecosystems. According to cultural burning expert, Victor Steffensen, "Maintaining the health and diversity of all the ecosystems with and without fire is key to protecting and serving our animals into the future. Burning the country to look after it this way takes more time and effort than any other modern fire management techniques" (Steffensen 2020). The techniques are very sophisticated and present not only an opportunity to heal the land, but to engage and respect Traditional Owners by assisting them to apply and further develop their knowledge.

In reviewing hazard reduction treatments, an excellent opportunity exists to better engage and support regional Aboriginal organisations and businesses in fire management and reafforestation projects to achieve both social justice, regional economic impacts and climate change mitigation and adaptation outcomes. There are already some good examples of Aboriginal organisations which could benefit from greater Government

support through the adoption of preferential procurement policies for bushfire risk reduction on government tenures.

5.7 Windows for burning reducing due to climate change

Windows of opportunity to conduct safe burns have become much shorter due to higher temperatures, drier conditions, and fewer days of low/moderate fire danger outside the bushfire season as a result of climate change (Mathews et al. 2012). The shorter periods of suitable burning weather can be especially significant in areas where volunteer rural fire brigades are engaged in hazard reduction burning, as volunteers are generally only available in significant numbers on weekends, further reducing opportunities for prescribed burns.

Workforces of forestry and national parks services around Australia have in many cases suffered cuts in real terms, if not in gross numbers. Changes in land tenure such as private land being incorporated into new or existing national parks without a corresponding increase in staff numbers to effectively manage those estates can further limit the proportion of burning able to be conducted. Ssignificant frustration has been experienced in some regional areas in Queensland and NSW where grazing lands have been transferred to national parks over the years without a commensurate increase in resources for national parks agencies to manage fuel loads.

5.8 Mechanical thinning of forest

Reducing biomass close to settlements and assets has the potential to lower fire intensity and reduce crowning and spotting. It can also provide areas of tactical advantage from which to conduct hazard reduction burns, and backburns during fires. Mechanical clearing of fire breaks close to assets should be investigated further however it has always proven to be a difficult, expensive and sometimes impractical approach. It is not possible to mechanically clear large areas, particularly in rugged terrain where the worst fires often occur.

Given the intensifying bushfire threat driven by climate change, mechanical clearing and maintenance of fire breaks close to vulnerable communities might be increased where practical.

5.9 Management of fuel on private lands

There was much speculation and debate during the recent fires about fuel loads on publicly managed lands (that comprise about 15% of NSW and 30% of Victoria). However, the

greatest impact on fire intensity and ember load immediately adjacent to a structure can be directly proportional to the amount of effort put into managing fuel loads between the back door and back fence line. A well-known adage in the fire services is: "If you own the land, you own the fuel." This can sometimes appear to be conveniently forgotten during some fire events. A cross-tenure approach to bushfire risk reduction is critical with a greater focus on reducing risk on private property as well as public lands.

5.10 Grazing does not reduce fuel loads and fire risk

Assertions made during the fires that grazing of national parks should be reintroduced as it leads to a reduction in bushfire fuel levels have been proven to be false. Grazing instead leads to serious environmental and ecological damage, particularly in fragile alpine environments, with no reduction in bushfire risk or fire intensity where it is applied.

The Victorian Alpine Grazing Taskforce found that "the scientific research is adequate and consistently reveals that grazing has a deleterious effect on biodiversity", leading to a ban on grazing in Victoria's alpine parks (DSE, 2005). It also concluded that "the most flammable fuel types in the park, which contribute virtually the entire available fuel load to wildfires, are branches, twigs, bark, eucalyptus leaves and shrubs. With the exception of some shrubs, cattle do not eat these fuels", and further, "It was also pointed out that cattle eat the new green shoots and not the dead, dry grass that constitutes the more flammable component of the fine fuel", concluding that: "cattle grazing does not make an effective contribution to fuel reduction and wildfire behaviour in the Alpine National Park" (DSE, 2005, pp 39, 40 and 43).

The suggestion that grazing be re-introduced to publicly owned land should be summarily discarded as it has no foundation in fact.

5.11 Accepting the risks of increased burning

If the community and governments determine that more burning is desirable, then there will also be a need for acceptance of the associated inevitable risks. Some burns will escape, and there will be unwelcome smoke impacts. In the past this resulted in a reluctance to continue burning programs and a risk averse approach, resulting in increased fuel loads. If increased burning becomes a requirement, then there will be a need for governments to accommodate increased complaints against the inevitable by-products – increased smoke impacts and escaped burnoffs.

Increased burning is necessary and needs to be strongly supported by governments at all levels, and the many benefits explained to communities. Above all, the practitioners

carrying out this difficult and sometimes risky operation on behalf of us must be fully supported, including legally and morally, if something does go wrong.

Recommendation 6: The Inquiry should find that fuel reduction is one of the only ways to reduce fire intensity and therefore must be a major part of any mitigation strategy. It should recommend that research underpin the development of new policies that recognise the need for better asset protection strategies, shrinking windows available for controlled burning due to a warming climate, the need to fund and research cultural burning practices, and the need to ensure that risks on both public and private lands are monitored ad managed.

Recommendation 7: The Inquiry should find that due to the escalating impacts of climate change, existing hazard reduction approaches could become less effective at mitigating and controlling fires during extreme weather events that result in long distance spotting, intense and sustained ember attack, and pyroconvective fires. As a result, fuel reduction approaches will need to be better integrated with overall mitigation strategies including fire detection and suppression, community education, hardening of infrastructure, warnings, evacuation, and other measures.

Recommendation 8: The Inquiry should recognise that if more prescribed burning is to be required, then additional resources will be required by land management agencies and fire services expected to carry out this work Benchmarks should be developed to ensure that agencies are properly resourced to manage lands under their control, and that they have sufficient resources to participate in prescribed burning operations on a regular, planned basis.

Recommendation 9: The Inquiry should note the decision to progressively reduce the amount of logging of native forests in Victoria from 2024-5, and that this provides an opportunity to harness existing knowledge and resources to increase fuel management across Victoria through a reallocation of human and other resources.

6. Strategies to deal with very large fires

6.1 Lightning-caused fires

The Gospers Mountain fire north west of Sydney started as a result of a lightning strike on 22 October 2019. It was in a remote area with difficult access, and efforts to control the fire quickly were unsuccessful. Eventually it grew to 512,000 ha, becoming the largest forest fire in Australia's recorded history (SMH 2019b).

Many fires during the 2019/20 fire season exceeded 100,000ha in size. According to the NSW RFS, the majority of the large fires were started by dry lightning storms, and then burned into populated areas (News.com.au 2019).

It is likely that the potential for lightning-ignited bushfires will increase in the future, as lightning occurs more frequently under warmer conditions (Williams 2005; Romps et al. 2014; Abatzoglou et al. 2016). There is a strong positive association between temperatures and fire occurrence in the Southern Hemisphere, with a tight coupling between lightning-ignited fire occurrences and the upward trend in the Southern Annular Mode (Mariani et al. 2018).

Fires ignited by lightning can be difficult to suppress as they often occur in inaccessible remote areas. Lightning storms also often result in multiple simultaneous ignitions. In 2016, thousands of dry lightning strikes caused multiple intense bushfires in Tasmania, burning over 120,000 hectares, including nearly 20,000 hectares in the Tasmanian Wilderness World Heritage Area (Styger et al 2018; Earl et al 2019).

The likelihood of sustained ignition of vegetation following a lightning strike is largely dependent on fuel moisture content (Dowdy 2015). The warming, drying climate is projected to produce drier, more flammable fuel (Mathews et al. 2012). Since the mid-

1990s, southeast Australia has experienced a 15% decline in late autumn and early winter rainfall, and a 25% decline in average rainfall in April and May (CSIRO and BoM 2016). April to October rainfall has also decreased in southwest Australia, with May-July rainfall seeing the largest decrease of around 20% since 1970 (CSIRO and BoM 2018). The shift in rainfall patterns can make a difference to the dryness of fuel and soil conditions, even if total seasonal or annual rainfall remains stable. For example, in the Tasmanian Wilderness World Heritage Area there has been an observed increase in the incidence of fires associated with lightning since the late 20th Century. This is thought to be due to a shift in rainfall patterns, with less frequent but more intense rainfall during the Summer months resulting in drier fuels (Styger et al. 2018).

The 2019/20 fire season in Victoria highlighted the problems associated with clusters of lightning-caused fires in remote areas. They are a significant drain on specialised resources such as aircraft and remote area fire teams (RAFT). Many fires were started by lightning in northern NSW, the Hunter region, the Blue Mountains, the southern ranges, and southern alpine region, as well as Gippsland. Coupled with multiple days of Severe, Extreme and Catastrophic fire danger, despite many of the fires being controlled in the early stages, many grew to mammoth proportions and resulted in significant losses.

6.2 Backburning

Backburning is often one of the only strategies that can be implemented with any hope of success once fires escape containment in conditions of Very High fire danger and above. It is inherently risky as it involves new fire being introduced into a landscape, which, in the case of the 2019/20 bushfire season, was very dry having been primed by years of drought. As previously explained, intense weather conditions exacerbated by climate change resulted in many days of elevated bushfire danger where established fires often spread almost unimpeded. This resulted in thousands of kilometres of active fire edges, often in remote, inaccessible areas, that could not be attacked directly except by limited air attack.

There were several examples in NSW of backburning operations escaping under conditions of elevated bushfire danger, sometimes destroying properties. Veteran firefighters described the associated decision-making processes as “damned if you do, damned if you don’t”, as the alternative was often to place firefighters in front an intense approaching fire front, or to allow a fire to run unimpeded until weather conditions moderated sufficiently to enable some form of direct attack. This highlights the need for new firefighting approaches to be developed.

6.3 Reinvigorating proven control strategies

When fires become mega-fires, control becomes increasingly difficult as there can be hundreds or even thousands of kilometres of fire perimeter to contend with. When there are multiple mega-fires burning simultaneously, obvious resourcing problems arise. Fire agencies need to make difficult decisions about risk versus reward and utilisation of increasingly scarce resources. In practice, this means that as more fires break out, there are fewer and fewer resources available to deal with them, and then greater likelihood that new fires will also rapidly increase in size.

ELCA submits that it can ultimately be impractical and unrealistic trying to control very large fires – fire services are relegated to limited containment objectives, and to life and asset protection on the worst fire weather days. As fire chiefs said on several occasions during the 2019/20 fire season, it was going to take substantial rain to control the fires. Ultimately this proved to be correct when torrential rain extinguished fires in NSW and Victoria in February 2020.

There are no known new techniques or strategies that can assist in dealing with mega-fires, although additional resources are always helpful. Even the use of more large aerial tankers (LAT) and very large air tankers (VLAT) than ever before deployed in Australia made little difference in containing major fires in 2019/20.

However, there are three areas in which concerted effort can make a difference, not by controlling mega-fires, but by stopping them from developing in the first place:

1. Rapid, accurate fire detection and location capabilities
2. Rapid aerial first attack to contain the fire until arrival of ground crews
3. Rapid deployment of highly trained remote area fire teams.

Improved fire detection technologies approaches might include, in conjunction with lightning detection systems:

- remote controlled cameras capable of identifying smoke,
- infra-red and thermal imaging technologies capable of identifying new fires,
- use of large drones and advanced imaging, perhaps deployed by the ADF,
- increased aerial patrols, and
- use of existing fire lookout towers.

Once new fires are detected, a rapid initial response and suitable weight of attack (in terms of number of aircraft, tankers, personnel etc.) are necessary to limit fire spread. It has been established that rapid deployment of suitable firefighting aircraft to remote fires correlates

with increased likelihood of early control, and a smaller area burned (Waters & Fuller 2020; Plucinski 2012).

Lightning-caused fires in very remote locations may not be able to be reached quickly enough by helicopters, LAT and VLAT. LAT and VLAT can be too large to be effective due to their high air speed, relative lack of maneuverability, straight line drop pattern, and limited airport options often distant from the fire (longer turnaround times). As will be explained in the following section, a different type of firefighting aircraft is routinely used in a fast attack role in countries such as Canada, France and Spain, often in conjunction with helicopters and 802 Air Tractor single engine air tankers (SEAT), which are already used extensively in Australia. Twin engine amphibious water-scooping aircraft with twice the capacity of a SEAT can be used to great effect in first attack roles where there is access to suitable bodies of water for scooping, or small airfields.

The third component crucial to rapid suppression in conjunction with rapid detection and fast initial air attack is availability of sufficient numbers of strategically located remote area fire teams, together with suitable ground and air transport.

6.4 Early detection and initial attack

With the increasing number, intensity and frequency of bushfires, there is an urgent need to adopt new and innovative ways to detect and rapidly respond to bushfires during early stage ignition, notably during Severe, Extreme and Code Red fire danger rating days with the aim of deploying ground and aerial firefighting resources to rapidly attack, contain and successfully extinguish new fires before they take hold and overwhelm firefighting capabilities.

Some key elements of an early detection and initial attack system are:

- rapid detection, location and reporting of bushfire ignitions, together with local weather conditions
- tracking of the movement, intensity and contributing factors affecting a fire (terrain, fuel conditions, weather, firefighting efforts),
- provision of early, timely and continuous information to communities, rapid response of initial fire attack equipment including ground crews and water-bombing aircraft.

Early detection sensing networks are already available with modern technologies that provide 24-hour bushfire ignition detection and real time fire movement tracking coupled with live, localised weather information and air quality data (LVIN, 2020). The provision of a comprehensive, timely detection and reporting system capable of triggering an

appropriate initial response, provide critical situational data, real-time information to assist tactical and operational decisions, and early and ongoing updates to nearby communities will increasingly be demanded by people living in bushfire-prone areas.

Recommendation 10: A range of new rapid fire-detection technologies should be trialed. Together with rapid detection, new fast attack strategies for new outbreaks, particularly remote fires caused by lightning, need to be introduced with clear objectives, e.g. putting fires out within 24 hours and before they exceed ten hectares. Fast attack should involve rapid dispatch of a suitable number of water bombing aircraft to achieve rapid turnaround and constant direct attack on fire fronts, complemented, as soon as possible by aerial insertion (where practicable) or ground insertion of remote area fire teams to complete extinguishment.

7. Firefighting aircraft

7.1 Firefighting aircraft a tool, not a solution

During the 2019-20 bushfires, firefighting aircraft were used extensively under local and national arrangements. There was significant public dialogue about the use of aircraft, and ELCA concedes that our calls for the Federal Government to provide increased support to states and territories in funding large aircraft leased from overseas may have helped fuel an incorrect perception that aircraft alone can control fires, and led to added expenditure on a large number of LAT and VLAT which was probably less cost-effective than other approaches that could have been taken had there been the necessary assured Federal funding and lead-time. This section is lengthy given the need to correct some perceptions of ELCA's position.

The influence of climate change, as previously detailed, has resulted in significant overlap between the northern and southern hemisphere bushfire seasons, reinforcing the need to consider establishing a fleet of medium, large and very large firefighting aircraft in Australia, because all LAT and VLAT aircraft, except one converted Boeing 737 LAT purchased by the NSW Government, are leased from overseas.

Aircraft cannot control fires on their own. They are expensive assets, there are varying types with differing, complementary roles, and they are ineffective unless used in close coordination with firefighting crews on the ground.

Given the significant expense, it is crucial that more research be conducted into the operational efficacy and cost effectiveness of various aerial firefighting platforms, and that a wider, and more cost effective range of capabilities be introduced into Australia rather than continually increasing the use of VLAT and LAT, which have been proven to be very useful in certain roles, but nevertheless have inherent operational restrictions together with significant costs. Use of firefighting aircraft in Australia at present appears to be based more on personal opinion and perceptions than evidence from research, and historically a reluctance to try anything different until there is a compelling reason, such as the 2009 Black Saturday fires which acted as a catalyst for fire services to revisit existing aerial strategies that did not include large aircraft.

ELCA is concerned about the direction in which aircraft utilisation for firefighting in Australia is heading, given the demonstrated lack of impact of aircraft during extreme fires on the worst fire weather days. Whilst they definitely have a role to play, contracting more LAT and VLAT each year is unlikely to make an appreciable difference to community safety into the future given their inherent limitations. The concerns extend to the lack of progress and utilisation of night vision fire-bombing aircraft that had previously been approved, but has not been expanded in capability or capacity in Victoria nor the rest of Australia to include Type 1 Helitaks, LATs and VLATs. Extending the capacity to conduct air attack at night, when fire behaviour normally moderates, could have significant positive benefits particularly the evening prior to forecast Severe, Extreme and Code Red fire danger days.

The aftermath of the 2019-20 fires should be taken as an opportunity to conduct a fundamental review of the operational and cost effectiveness of various aerial platforms, and how the different types can be integrated, using their particular strengths, to augment and support ground operations.

More research into aerial firefighting is necessary in Australia. In terms of relative roles of different types of aircraft and fleet mix, the most relevant study identified is that conducted by the Rand Corporation, sponsored by the United States Forest Service in 2012 on behalf of the US Forest Service. It recommended a mix comprising just a small number of LAT and VLAT for specific roles, with a large fleet of smaller 6,000 litre water-scooping aircraft, backed up by helicopters and small fixed wing aircraft, in order to benefit from the most flexible operational mix while remaining cost effectiveness (Keating at al. 2012). This and other studies highlight the benefits of aircraft being tasked and utilised in a fast attack role in order to keep fires as small as possible until ground attack crews can extinguish them

(Keating et al. 2012; Plucinski 2012; Waters & Fuller 2020). LAT and VLAT are not suited to a first attack role because of the speed and altitude they must operate at, straight line drops, and long return (cycle) times due to their need to return to large airports, land, refill, then return.

7.2 National arrangements for firefighting aircraft

Australian fire and land management agencies involved in firefighting have significant experience and expertise in using aircraft for firefighting roles. The roles include, but are not limited to:

- Aerial reconnaissance / fire mapping
- Fire detection
- Insertion of remote area firefighting teams
- Transport of people and equipment
- Command and control
- Dropping of aerial incendiaries
- Dropping of water, foam, gel and retardant onto, or in front of, flame fronts.

(NAFC 2020)

For decades, up until and including the 2009 Black Saturday fires, only small fixed wing aircraft (predominantly 802 Air Tractors carrying 3,200 litres), small, medium and large helicopters were used. The large helicopters, predominantly Erikson Aircranes carrying 9,000 litres, were all sourced from North America on lease.

After the 2009 fires, both the NSW and Victorian governments trialed the use of LATs (carrying 12-15,000 litres), and a VLAT (DC10 jet aircraft carrying 45,000 litres, later reduced to 35,000 litres). The trials were deemed to be successful and the National Aerial Firefighting Centre (NAFC), an entity created by the national council for fire and emergency services, AFAC, managed funds from the Australian Government and State and Territory governments to arrange and manage lease arrangements as well as managing movement of a variety of other fixed and rotary wing aircraft comprising a shared national fleet of firefighting aircraft. In addition to the shared assets, several states and territories own or lease additional aircraft according to their own assessed needs.

7.3 Funding

Funding for a national fleet of specialised firefighting aircraft was agreed between all governments and fire agencies after the 2003 Canberra fires. Prime Minister Howard agreed on a dollar for dollar joint funding arrangement in acknowledgement that air assets could be moved around Australia according to priorities and needs and therefore

constituted a strategic national resource. The national council for fire agencies, AFAC, formed the NAFC in July 2003 to procure and manage a national fleet of aircraft. The national fleet augmented aircraft owned and leased by states and territories (NAFC 2020).

In subsequent years the states and territories escalated their contribution to the joint funding arrangement and expanded the aerial fleet, but successive Federal Governments did not. In recognition of the growing need for a large strategic aerial firefighting capability given worsening bushfire conditions and extreme weather events nationally, AFAC developed a detailed business case for additional annual Australian Government funding in 2018; a modest ask for about $11M pa. The business case detailed how inflation and escalating costs were being borne solely by the states and territories, and how large aircraft are a strategic national resource because of their ability to rapidly travel long distances (NAFC 2018).

Prior to this AFAC and NAFC made a detailed submission to a Senate Inquiry into the 2016 Tasmanian Bushfires on behalf of all Australian fire services, requesting Commonwealth backing for development of a national fleet of large firefighting aircraft, stating: “Large fixed-wing airtankers are likely to be an important component of enhanced bushfire suppression capability in Australia. A shared, national large fixed-wing airtanker capability is logical and is an attractive strategy.” (NAFC 2016). The NAFC submission was cognizant of deteriorating climatic conditions leading to more widespread and intense bushfires and increasing overlap with fire seasons in the northern hemisphere, limiting access to leased aircraft. The Federal Government rejected the recommendation, stating that it was a “State and Territory responsibility”, ignoring the established agreement that recognised that individual jurisdictions cannot afford large aerial platforms alone, and the strategic benefits outlined in the NAFC submission.

Emergency Leaders for Climate Action sought to meet with the Prime Minister from April 2019 to raise this and other issues but were unsuccessful. Funding for additional firefighting aircraft was strongly recommended in letters to the PM and via the media but was continually rejected.

Ultimately after significant media, political and community pressure, the Prime Minister agreed to provide an additional $11M on a one-off basis mid-way through December 2019. NAFC had difficulty sourcing appropriate aircraft at short notice, resulting in premium prices and varying delivery times. The additional aircraft sourced using the additional funds were not yet available when NSW experienced significant property loss and deaths in the last 2 weeks of December 2019.

On 4 January 2020 the PM held a press conference at which he stated that the $11M would now be provided on an ongoing basis in accordance with the 2018 AFAC Business Case, and that the Government would immediately provide an additional $20M to NAFC. Fire agencies were not consulted about this and other announcements concerning callout of the ADF made by the PM, as made clear by NSW RFS Commissioner Shane Fitzsimmons in various media interviews on that day (The Guardian 2020b).

Again, NAFC had to make rapid contact with overseas suppliers, and to pay premium rates due to the short notice. Four large jet aircraft were sourced, but ultimately arrived after fires had started to be controlled – so the $20M was effectively wasted.

7.4 Strategic and tactical use of aircraft

Small, medium and large helicopters as well as small fixed wing water bombers generally drop their loads directly onto flames in order to immediately reduce fire intensity and reduce rate of spread, usually in conjunction with firefighters on the ground. A reduction in fire intensity, particularly when close to buildings and other assets, can allow firefighters who otherwise would have had no prospect of controlling a fire, the opportunity to mount a direct attack and gain a measure of control.

LATs and VLATs are generally used differently. Their larger payloads usually comprise of a mixture of water and "PhosChek", a fire retardant with a trademark red colour that adheres to vegetation. Retardant is usually applied ahead of, not directly onto, fire fronts. The theory is that retardant lines create a fire break, slowing down or halting the progress of the fire front.

In practice there are significant issues with this. Australian eucalypt vegetation is renowned internationally because it generates spot fires ahead of fire fronts; during the 2019-20 season up to 12 kilometres ahead. This limits the effectiveness of LATs and VLATS on the worst fire danger days as fires easily cross retardant lines.

LATs and VLATs require a large airport runway with room for infrastructure (portable tanks and pumps) to conduct rapid refilling. In practice this often limits them to commercial airports capable of taking large passenger jets, and large air force bases. This can result, depending on fire location in relation to airport location, in long aircraft cycle times between drops, reducing effectiveness further.

Another limitation on all firefighting aircraft is wind velocity. On days of Severe, Extreme and Catastrophic fire danger, many firefighting aircraft have to be grounded due to high wind velocities. Whilst LATs and VLATs are less restricted in this respect, they are unable

to deploy without a “lead” aircraft that flies ahead and indicates where to drop the retardant load. On days of high winds, the lead aircraft are unable to fly.

7.5 Research into the use of firefighting aircraft

Very little research has been conducted in Australia into the effectiveness of various types of firefighting aircraft, limiting current understanding and development of aerial firefighting capabilities, strategies and tactics.

Existing research strongly suggests that as fires intensify (under the influence of climate change), use of aircraft in a first attack / rapid attack role, will be crucial (Keating et al. 2012; Plucinski 2012; Waters & Fuller 2020). This forms the basis of aerial firefighting strategies in Europe, Canada, and the USA, but is not practiced routinely in Australia other than in the Adelaide Hills and parts of Gippsland where it has been very effective, albeit relatively expensive.

Opinions about the use of LAT and VLAT aircraft vary, however there appears to be a consensus that they are a particularly valuable strategic tool, for example in assisting to establish containment lines and reducing fire intensity around assets. Research conducted for the United States Forest Service clearly outlines roles in which large fixed wing aircraft are most useful, but found that smaller, more agile aircraft had greater operational flexibility and were more cost effective (Keating et al. 2012)

The 2016 bushfire season and then the 2018 season in Tasmania resulted in significant skepticism in that state about the use of LATs. Four LATs were deployed to fires in World Heritage Areas in 2016 (NAFC 2016). However, there was nowhere suitable in Tasmania for the aircraft to land – they were instead required to fly from Victoria, make their drop, fly back to Avalon across the Bass Strait, land, reload, then fly back. This resulted in long delays between drops, and a lack of effectiveness as fires simply burned around the retardant lines. There was a similar experience in 2018. The Tasmanian Government received a hefty bill for retardant and jet fuel on both occasions.

A different type of aircraft, amphibious water-scooping water bombers, would arguably have been far more effective and far less costly in the Tasmanian situation given the availability of large bodies of water, numerous airports capable of supporting the smaller aircraft, and no costs for retardants. Despite having a smaller payload (6,000 as opposed to 12-15,000 litres), the operational and cost effectiveness of a scooping aircraft would have been greater due to shorter turnaround times resulting in a much larger volume of water being dropped (Keating et al. 2012). These types of aircraft were unfortunately not

available in Australia because they have been excluded from consideration due to prescriptive NAFC tender specifications (NAFC 2018).

7.6 Water-scooping aircraft complementary

The types of aircraft used by Australian fire services have been broadly outlined previously and are detailed on the NAFC website (NAFC 2020).

Together with an urgent need for research into the use and efficiency of firefighting aircraft in Australia, there should also be a rapid re-think on the growing reliance on very expensive LATs and VLATs to the exclusion of other large firefighting aircraft which can complement their specific capabilities. A purpose-built water scooping aircraft used in other bushfire-prone countries around the world, the CL415, is unable to be used in Australia at present due to a contractual requirement that any aircraft put forward for tender must carry a minimum of 6,800 litres, automatically excluding the CL415 from consideration as its capacity is just over 6,000 litres (NAFC 2018).

It is possible that there is lingering prejudice against this type of aircraft within some fire and land management agencies due to what was perceived at the time as an aggressive and unwelcome marketing campaign by the then manufacturer, Bomabardier, in the late 1990s. An evaluation of the aircraft at that time that rejected their use can no longer be considered valid given the subsequent acceptance of LAT and VLAT aircraft in Australia. The few arguments that continue to be put forward against this type of aircraft appear to be ill-informed, based on hearsay and non-current information. The CL415, which is capable of direct attack at low altitudes with faster cycle times than LAT and VLAT, can play a role that is currently not being fulfilled in Australian aerial firefighting.

Australia uses small aircraft, then jumps to large and very large. Failure to include a medium sized, more cost effective and flexible option limits strategic and tactical options, impacts on costs, and ultimately the effectiveness of response strategies (for example the 2016 Tasmanian experience). There is clearly a need for all types and sizes of aircraft in Australia's aerial firefighting fleet in order to maximise flexibility, and limit costs.

The Viking (formerly built by Bombardier) CL415 "Super Scooper" carrying 6,000 litres is used throughout Europe, in Canada, Malaysia, and California and is the only purpose-built firefighting aircraft in the world, as opposed to all LAT and VLAT which have seen previous lengthy commercial or military service. They have an enviable safety record with no recorded crashes. A converted jet powered water scooping aircraft carrying 12,000 litres, the Be200, is used in Russia. The Be200 does not yet have clearance to fly in Australia and little is known about these converted aircraft. The advantages of a CL415 are:

- Purpose-built firefighting aircraft, in contrast to LAT and VLAT which are all converted from previous military or civilian service.
- Amphibious and multi-purpose: eg Malaysia uses their aircraft for maritime border patrol.
- Similar operating concept to 802 Fire Boss aircraft, but faster, greater range, and nearly twice the payload.
- No need to land to refill – can scoop water from rivers, dams, lakes and the ocean, and refill in about 18 seconds.
- No need for special airport facilities (which limit LAT and VLAT significantly). Not restricted to large airports, so able to be based regionally - can land on water or on small regional airstrips.
- Can be refilled on the ground if no large body of water available: significant advantage is that this can be done locally, reducing turnaround time.
- Ideal aircraft for rapid response and rapid attack: the Gospers Mountain fire near Sydney could have been attacked by CL415 aircraft, had they been available, scooping from the Hawkesbury River. Depending on the number of aircraft assigned, the fire may have been able to be controlled in the early stages. LAT were ultimately ineffective on this fire.
- Lower air and stall speeds than LAT and VLAT, therefore able to operate at lower altitude with greater maneuvering capability to drop directly on flames.
- More cost effective than LAT and VLAT aircraft because of the ability to drop greater amounts in a shorter time (shorter return cycles), and less onerous maintenance requirements.

Figure 3: Canadair CL415 "Super Scooper". Note ability to carry out low altitude drops, increasing effectiveness.

The costs are similar to a LAT, however increased cost effectiveness can be demonstrated in most scenarios because of greatly reduced cycle times between drops, higher volumes delivered as a result, and therefore greater firefighting effectiveness. To properly

determine comparative cost-effectiveness, it is necessary to compare volumes of water able to be delivered in a given timeframe in realistic scenarios (Keating et al. 2012).

The 2012 Rand Corporation study concluded that "This type of aircraft (CL415) combines some of the advantages of fixed-wing aircraft, such as speed, with the shorter cycle times associated with rotary-wing aircraft" (Keating et al. 2012 p.34). Further, that in consideration of the identified operational and productivity advantages, the optimum mix for the US Forest Service would be a large fleet of CL415 aircraft with a smaller number of LAT reserved for specific strategic tasks. It rejected criticism of CL415 aircraft on the basis of alleged non-availability of bodies of water for scooping, finding instead that most settled areas where direct attack would be crucial had natural or man-made bodies of water nearby, and in any case, unlike LATs, a CL415 could land and be filled locally by tankers at small airports (Keating et al. 2012). The research clearly explained the superior cost effectiveness of a CL415 compared to a LAT, based on gallons able to be delivered. The findings have direct application to the Australian environment.

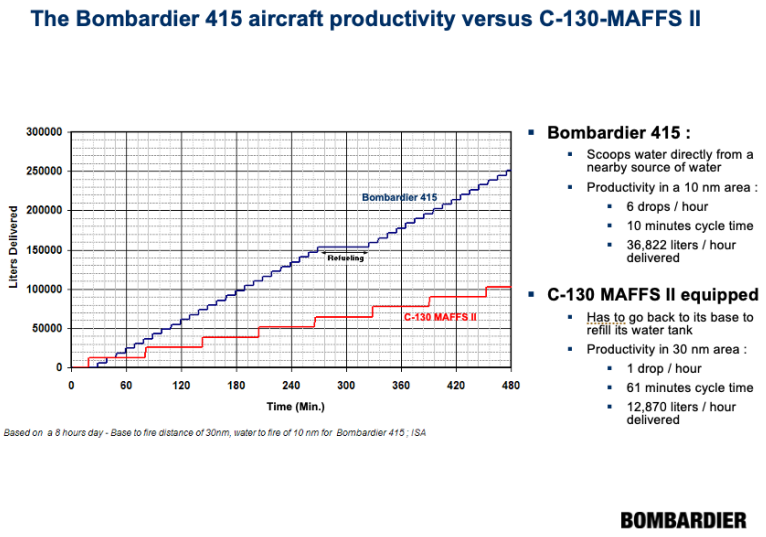

Figure 4: Comparison between drop efficiency between a 415 water scooping aircraft and a converted C130 Hercules aircraft. (Source: Bombadier)

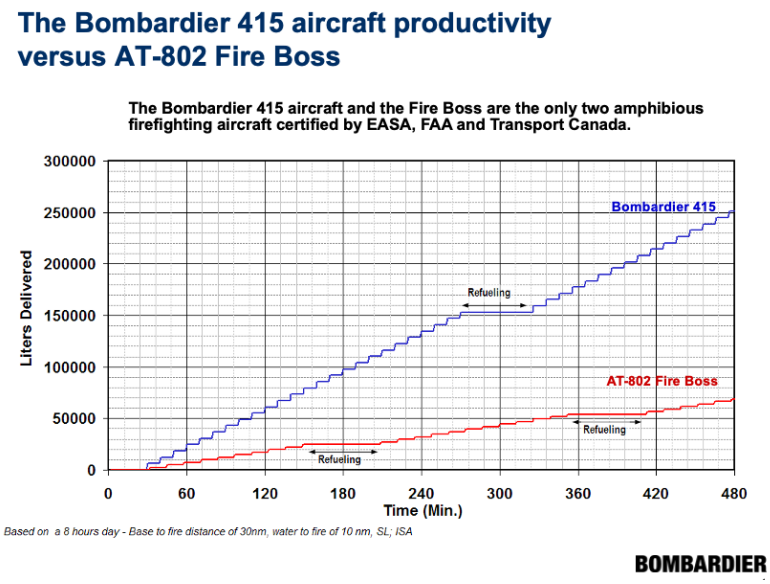

Figure 5: Comparison between drop efficiency between a 415 water scooping aircraft and a 802 Fire Boss scooping aircraft. (Source: Bombardier)

Recommendation 11: The Victorian Government should conduct a trial, in consultation with AFAC and NAFC, of amphibious water-scooping aircraft in a first attack / direct attack firefighting role (CL415). Australian fire services at present use small and large fixed wing water bombers, but not medium sized. Given the success of 3,200 litre single engine air tankers (SEAT), a twin engined purpose-built aircraft with significantly greater air speed, range, flexibility and twice the payload may prove to be a useful addition to current arrangements. They are used extensively and successfully throughout the world in other fire-prone countries

8. Building standards in bushfire-prone areas

Australian Standard 3959 (construction of buildings in bushfire prone areas) is a national standard that was reviewed and updated after the Black Saturday bushfires in 2009. The standard details construction standards and elements aimed at making homes more likely to withstand a bushfire. It classifies different bushfire intensity levels that a home might experience during a bushfire. These are known as Bushfire Attack Levels (BAL) and there are 6 levels ranging from BAL Low to BAL-FZ (Flame Zone) (See Figure 6; Standards Australia 2018). Each level is determined by a variety of factors including the location of

premises, the type of vegetation around the premises and its proximity as well as the slope of the property. The BAL designates requirements for construction including building materials and other factors aimed at mitigating bushfire risk- for example building in BAL Flame Zone has much stricter construction requirements and all materials and components must be fire tested (Bell 2019). The purpose of these standards and building requirements are to reduce the risk of ignition from a bushfire, flames, burning embers, radiant heat and intensity of bushfire attack (Loveridge 2020).

BAL	Description
BAL-LOW	There is insufficient risk to warrant any specific construction requirements.
BAL- 12.5	There is a risk of ember attack.
BAL- 19	Ember attack plus burning debris ignited by windborne embers, plus radiant heat.
BAL- 29	Increasing levels of ember attack and burning debris ignited by windborne embers, plus increased radiant heat (19 – 29 kW/m2).
BAL- 40	Much increased risk from ember attack and burning debris ignited by windborne embers, plus higher level of radiant heat and some likelihood of direct exposure to flames (29 - 40 kW/m2).
BAL- FZ (Flame Zone)	Highest risk of ember attack plus direct exposure to heat (> 40 kW/m2) plus flames from the fire front. The standard notes that Authorities may require additional measures, other than construction requirements.

Figure 6: Bushfire Attack Levels (Standards Australia 2018)

The updated 2009 AS 3939 is a national standard which applies to all bushfire-affected construction from the 1st of May 2019, with some variations on a state by state basis. For example, in Victoria the Integrated Planning and Building Framework for Bushfire in Victoria prioritised human life over other policy provisions through the Planning Scheme Amendments VC83 (Bell 2019).

An additional issue related to home construction in bushfire prone areas was brought into stark relief in the 2003 ACT fires, the 2009 Black Saturday fires, and the 2019/20 fires – fire storms, fire tornadoes and gale force winds on days of Catastrophic fire danger damaged or tore off roofs: leaving the interior exposed to ember attack and rendering the

home useless as a refuge. More research needs to be conducted into this facet with possible introduction of roofing construction standards based on cyclone categories.

Australia's building standards must also be reflective of climate change and be appropriately stringent; in some cases there may be new areas across Australia that are no longer safe to build in due to the growing bushfire threat. With varying legislation and building codes across states and territories a more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical (Norman et al. 2014).

Innovative approaches may be needed. For example, in some areas, similar to approaches taken in tornado-prone areas in the USA, thought might be given to relaxing building standards with the knowledge that they will not withstand a serious bushfire, BUT ONLY if a suitable bushfire bunker is available adjacent to the home. Victoria has led the way with research into bushfire bunkers, and could assist other states and territories with its learnings.

Some small communities, in certain conditions, are not defendable or safe. They are often remote and leaving by vehicle can prove to be fatal. Consideration might be given to building local dual-use facilities, such as a sporting / community hall, that is constructed to also act as a community refuge able to withstand a major fire.

Recommendation 12: In the wake of the devastating 2019/20 fires, and recognising that climate change continues to drive an increase in Australia's bushfire threat, it is critical that building and planning regulations and standards be reviewed, particularly Australian Standard 3959.

Recommendation 13: Roof design and strength is a critical factor in future bushfire design of homes and other buildings. Requirements need to be increased to reflect increasing wind velocities fueled by climate change, and fire storms and fire tornadoes caused by pyroconvective events that damage and remove roofs. If a roof is damaged or destroyed survivability of the structure and its ability to act as a refuge are greatly reduced.

Recommendation 14: With varying legislation and building codes across states and territories a more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical. As fire danger indices and fire paths from 2019/20 are analysed, locations might be identified where rebuilding should not occur due to excessive levels of fire and life risk.

Recommendation 15: Consideration should be given in remote communities or communities deemed to be at extreme risk with limited egress, to providing dual-purpose community buildings capable of providing all community members with refuge in an extreme bushfire situation.

9. Use of Australian Defence Force capabilities

Climate change is placing increasing pressure on the Australian Defence Force (ADF) in three key areas.

Firstly, climate change increases the need for the ADF to respond in Humanitarian Aid and Disaster Relief (HADR) and Defence Aid to Civil Community (DACC) capacities. This is occurring internationally, regionally (Indo-Pacific), and domestically. For example, from 2005-06 to 2012-13 Defence assisted in 275 domestic emergencies, with this number likely to be higher (ANAO 2014). The ADF support to the 2019/20 bushfires (Operation Bushfire Assist) saw the largest peacetime deployment of the ADF involving more than 6,400

personnel, including 2,500 reservists, 350 international service personnel, and more than 13 fixed wing aircraft, 20 rotary wing platforms and 2 naval vessels (AusDoD 2020).

Secondly, and closely coupled with the increase of HADR / DACC missions, climate change will require changes to ADF force structure, training, doctrine, planning, interoperability, and other inputs to capability. Operation Bushfire Assist provided numerous lessons learnt. For example, the need to include improved pre-crisis scenario planning with state government authorities (especially around how to best integrate and connect ADF units with local authorities); improvements in inter-agency communications for 'on-ground units' between the ADF and emergency services and clarity around call-out procedures between Federal and State governments. Climate change will also drive careful consideration by the ADF regarding the types of capability that are needed for future operations in a world increasingly shaped by climate change impacts. Better consultative processes with states and territories and emergency services could help shape future strategic capability enhancements and procurements, with an emphasis on interoperability and complementarity.

Thirdly, as recognised by the Chief of the Defence Force, General Angus Campbell, climate change will increasingly drive a fundamental re-think of Australia's key national security drivers and how—as a country—we need to confront the 21st century security dynamic (ABC 2019). ELCA suggests that this will require a much broader approach to future White Papers to embrace wider and deeper concepts of security, including a consideration of climate change and its impacts, such as more frequent natural disasters that are increasingly stretching or overwhelming state and territory capabilities to respond and recover. In the interim, acknowledgement of the increased pressure that climate change will place on the ADF, as well as a plan for how the ADF will support relevant emergency services and recovery agencies in the future, must be acknowledged in key Defence policy and planning documents. This includes any assessment of the strategic underpinnings of the 2016 Defence White Paper, or reviews on how the ADF can be more responsive to changing circumstances or updates to the DoD's force structure plan (The Australian 2019; Hellyer 2019).

Fire and emergency services are not advocating for development of a separate emergency response capability within the ADF. The array of logistical and engineering capabilities that already exist can be readily adapted to a range of emergency and recovery management contexts provided there are adequate consultative processes to ensure that appropriate elements of capability are deployed. During the fires sections of the media and come politicians called for the ADF to be deployed to fight fires. This would have been neither practical nor safe, as the minimum training required for a volunteer or career firefighter to

safely deploy is around 3 months. The best approach is to utilise the ADGF strengths in logistics and engineering.

ELCA tried to suggest to the Prime Minister several times in 2019that the cumbersome arrangements for seeking and deploying Defence Assistance to the Civil Community level 2 (DACC2) should be examined and simplified. The lack of an overall plan for the ADF to support civilian operations and civilian emergency services in response and recovery ultimately proved to be an impediment to their eventual deployment. The focus should initially be on simplifying processes for requesting, approving and sustaining support, and simplifying DACC2, which essentially is always an ad hoc arrangement. It is time to modernise the processes and increase interaction with state and territory emergency services as a routine role for the ADF.

Recommendation 16: The Victorian Government should request that the Federal Government conduct a fundamental review of longstanding Defence Assistance to the Civil Community (DACC) arrangements in view of heightened and worsening natural disaster risk driven by climate change. The arrangements can be cumbersome and slow, and levels of understanding between the ADF and emergency services about respective capabilities, needs, and arrangements must be improved. The ADF should focus on utilisation of existing capabilities for civil defence roles under the control of emergency services and state and territory governments, rather than developing new capabilities that might serve to duplicate state and territory capabilities and ultimately cause confusion and inefficiencies.

References

ABC (Australian Broadcasting Commission) (2019). Climate change could stretch our defence capabilities, Defence Force chief speech warns. Accessed at: https://www.abc.net.au/news/2019-09-25/australian-defence-force-angus-campbell-climate-change-speech/11543464

ABC (Australian Broadcasting Commission) (2020). Victorian fire chief says calls for more fuel reduction burns are an 'emotional load of rubbish'. Accessed at: https://www.abc.net.au/news/2020-01-07/fuel-reduction-burn-debate-rubbish-says-vic-fire-chief/11849522

Andrews D, Premier (2020) 'Immediate Support For Victoria's Wildlife And Biodiversity', media release, 23 January. Accessed at https://www.premier.vic.gov.au/immediate-support-for-victorias-wildlife-and-biodiversity/.

Abatzoglou, J. T., & Williams, A. P. (2016) Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences, 113(42), 11,770–11,775. https://doi.org/10.1073/pnas.1607171113.

ACT Government (2020) State of Emergency Declared for ACT (media release, 31/01/2020). Accessed at: https:// www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/barr/2020/state-ofemergency-declared-for-act.

ANAO (Australian National Audit Office) (2014) The Auditor-General, Audit Report No. 24 2013-14 Performance Audit: Emergency Defence Assistance to the Civil Community, ed. Department of Defence. Canberra: Commonwealth of Australia.

Arriagada NB, Palmer AJ, Bowman D, Morgan GG, Jalaludin BB, and Johnston FH (2020). Unprecedented smoke-related health burden associated with the 2019/20 bushfires in Eastern Australia. Accessed at: https://www.mja.com.au/journal/2020/213/6/unprecedented-smoke-related-healthburden-associated-2019/20-bushfireseastern?utm_source=tiles&utm_medium=web&utm_campaign=homepage

AusDoD (Australian Department of Defence) (2020) Operation Bushfire Assist 2019/2020. Accessed at https://news.defence.gov.au/national/operation-bushfire-assist-2019/2020

Bell N (2019) Development in Australian bushfire prone areas. *Environment.* Australian Institute of Architects. Issue 05: Oct 19. Accessed at https://www.architecture.com.au/wp-content/uploads/Development-in-Australian-bushfire-prone-areas-Australian-Institute-of-Architects.pdf

Blanchi R, Leonard J, Haynes K, Opie K, James M and de Oliveira FD (2014) Environmental circumstances surrounding bushfire fatalities in Australia 1901-2011. *Environmental Science and Policy*, 37: 192–203.

Boer MM, Resco de Dios V and Bradstock RA (2020) Unprecedented burn area of Australian mega forest fires. Nature Climate Change, 10, pages171–172. Accessed at: https://www.nature.com/articles/s41558-020-0716-1.

BoM (2019a) Victoria in 2019: warmer and drier than average. Accessed at http://www.bom.gov.au/climate/current/annual/vic/archive/2019.summary.shtml.

BoM (2019b) Australia in December 2019. Accessed at: http://www.bom.gov.au/climate/current/month/aus/archive/201912.summary.shtml.

BoM (2020a) Climate change — trends and extremes. Accessed at: http://www.bom.gov.au/climate/change/ index.shtml#tabs=Tracker&tracker=timeseries&tQ=gr aph%3Dtmax%26area%3Daus%26season%3D0112%26a ve_yr%3D0.

BoM (2020b) Australia in December 2019. Accessed at: http://www.bom.gov.au/climate/current/month/aus/ archive/201912.summary.shtml.

BoM (2020c) Australia in Spring 2019. Accessed at: http:// www.bom.gov.au/climate/current/.

BoM (2020d) Special climate statement 72 – dangerous bushfire weather in spring 2019. Accessed at http://www.bom.gov.au/climate/current/statements/scs72.pdf

BoM (2020e) Annual climate statement 2019. Accessed at: http://www.bom.gov.au/climate/current/annual/aus/.

Broome RA, Johnston FH, Horsley J and Morgan GG (2016) A rapid assessment of the impact of hazard reduction burning around Sydney, May 2016, Medical Journal of Australia, 205 (9): 407-408.

Buxton M, Haynes R, Mercer D and Butt A (2011) Vulnerability to bushfire risk at Melbourne's urban fringe: The failure of regulatory land use planning. *Geographical Research*, 49: 1–12.

CalFire (2020) California Department of Forestry and Fire Protection. Accessed at: https://www.fire.ca.gov/media/5511/top20_destruction.pdf

Canberra Times (2020) Australia's 2019-20 bushfire season. O'Mallon F and Tierman E, 10 January 2020. Accessed at https://www.canberratimes.com.au/story/6574563/australias-2019-20-bushfireseason/?cs=14231.

Climate Council (2019a) Australia not prepared for new overlapping bushfire seasons. Accessed at: https://www.climatecouncil.org.au/resources/australia-not-prepared-fornew-overlapping-bushfire-seasons/

Climate Council (2019b) This is not normal: climate change and escalating bushfire risk. Accessed at: climatecouncil.org.au/wp-content/uploads/2019/11/cc-nov-Bushfire-briefing-paper.pdf

Climate Council (2020a) Summer of Crisis. Accessed at: https://www.climatecouncil.org.au/resources/summer-of-crisis/

Climate Council (2020b) Setting the Record Straight on Hazard Reduction: fact sheet. Accessed at: https://www.climatecouncil.org.au/wp-content/uploads/2020/01/CC_MVSA0211-Fact-Sheet-Hazard-reduction-Fuel-Loads-Bushfires_BElla-Edit-A4.pdf

CSIRO and BoM (2016) State of the Climate 2016. CSIRO and Bureau of Meteorology, Melbourne, 22pp. Accessed at: http://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/.

CSIRO and BoM (2018) State of the Climate 2018. Accessed at: http://www.bom.gov.au/state-of-the-climate/State-ofthe-Climate-2018.pd

Dowdy, A. J. (2015) Large-scale modelling of environments favourable for dry lightning occurrence. 21st International Congress on Modelling and Simulation, Gold Coast, Australia, 29 Nov to 4 Dec 2015 www.mssanz.org.au/modsim2015.

Dowdy AJ and Pepler A. (2018). Pyroconvection risk in Australia: climatological changes in atmospheric stability and surface fire conditions. *Geophysical Research Letters*, doi:10.1002/2017GL076654

Dowdy A *et al.* (2019). Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports*. 9: 10073. Accessed at https://www.nature.com/articles/s41598-019-46362-x

DELWP (Department of Environment, Land, Water and Planning) (2020) Victoria's bushfire emergency: Biodiversity response and recovery Preliminary report - Version 1.

Accessed at https://www.wildlife.vic.gov.au/__data/assets/pdf_file/0034/449746/Victorias-bushfire-emergency-Biodiversity-response-and-recovery-Version-1-23-January-2020.pdf.

DSE (Department of Sustainability and Environment Victoria) (2005). Report of the investigation into the future of cattle grazing in the Alpine National Park. Alpine Grazing Taskforce. Accessed at: http://environment.gov.au/epbc/notices/assessments/victoria-alpine-national-park/pubs/b6-alpine-grazing-taskforce-2005.pdf

Earl N., Love P., Harris R., Remenyi T (2019) Dry lightning has set Tasmania ablaze and climate change make it more likely to happen again. The Conversation 7 February 2019 https://theconversation.com/dry-lightning-has-set-tasmania-ablaze-and-climate-change-makes-itmore-likely-to-happen-again-111264

Earth Systems and Climate Change Hub (2019). Bushfires and climate change in Australia. Accessed at http://nespclimate.com.au/wp-content/uploads/2019/11/A4_4pp_brochure_NESP_ESCC_Bushfires_FINAL_Nov11_2019_WEB.pdf.

FFMV (Forest Fire Management Victoria) (2019) History and incidents. Past bushfires. A chronology of major bushfires in Victoria from 2013 back to 1851. Accessed at: https://www.ffm.vic.gov.au/history-and-incidents/past-bushfires

Gergis J and Carey G (2020) Some say we've seen bushfires worse than this before. But they're ignoring a few key facts, The Conversation. Accessed at: https://theconversation.com/some-say-weve-seen-bushfires-worse-than-thisbefore-buttheyre-ignoring-a-few-key-facts-129391.

Greens (Australian Greens Party) (2020). Bushfires, Hazard Reduction ad Backburning. Accessed at: https://greens.org.au/bushfires

Hellyer M (2019) Defence's strategic reassessment: squaring the circle with tied hands. Accessed at https://www.aspistrategist.org.au/defences-strategic-reassessment-squaring-the-circle-with-tied-hands/

ICA (Insurance Council of Australia) (2020) CAT195 Australian Bushfire Season (2019/20) NSW, QLD, SA, VIC. Accessed at: https://disasters.org.au/current-catastrophes/2019/11/13/november-bushfires.

Keating *et al.* (2012). Air Attack Against Wildfires. Understanding US Forest Service Requirements for Large Aircraft. Rand Homeland Security and Defense Centre. Sponsored by the United States Forest Service. Rand Corporation. Santa Monica. California. USA.

Loveridge RW (2020) Australian building codes don't expect houses to be fire-proof- and that's by design. The Conversation. Accessed at https://theconversation.com/australian-building-codes-dont-expect-houses-to-be-fire-proof-and-thats-by-design-129540

Luke H, McArthur A (1978) Bushfires in Australia. Australian Government Publishing Service. Canberra

LVIN (2020) Latrobe Valley Information Network. Accessed at: https://lvin.org/about-lvin.html

McRae RHD, Sharples JJ & Fromm M (2015) Linking local wildfire dynamics to pyroCb development, Natural Hazards and Earth System Sciences, 15: 417–428.

Mariani M, Holz A, Veblen T, Williamson G, Fletcher M-S, Bowman D (2018) Climate Change Amplifications of Climate-Fire Teleconnections in the Southern Hemisphere, Geophysical Research Letters, DOI: 10.1029/2018GL078294.

Matthews S, Sullivan AL, Watson P and Williams RJ (2012) Climate Change, fuel and fire behaviour in a eucalypt forest. Global Change Biology, 18: 3212–3223

NAFC (National Aerial Firefighter Centre) (2016). Submission of the National Aerial Firefighting Centre to the Senate Environment and Communication References Committee Inquiry into the response to, and lessons learnt from, recent bushfires in remote Tasmanian wilderness. Accessed at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Tasmanian_Bushfires/Submissions

NAFC (2018) Brief on NAFC Business Case for additional funding to support national capability

NAFC (2020) National Aerial Firefighting Centre. Information. Accessed at: http://www.nafc.org.au/

NCC (Nature Conservation Council) (2020). Bushfire Program. Accessed at: https://www.nature.org.au/healthy-ecosystems/bushfire-program/

News.com.au (2019) The myths around Australia's horror fire season debunked. Accessed at: https://www.news.com.au/technology/environment/climate-change/the-myths-around-australias-horror-bushfire-season-debunked/news-story/199c41bf9eb5af07a75575fea278c1f8

Norman B, Weir KJ, Sullivan K and Lavis J (2014) Planning and bushfire risk in a changing climate. Bushfire CRC, Australia. Accessed at https://www.bushfirecrc.com/sites/default/files/urban_and_regional_planning.pdf

NSW RFS (2020). 2019/20 Bush Fire Season Overview. Bush Fire Coordinating Committee. 19 March 2020.

Plucinski, M (2012) Factor affecting containment area and time Australian forest fires featuring aerial suppression. Accessed at: http://dx.doi.org/10.5849/forsci.10-096

Romps, D., Seeley, J., Vollaro, D., and Molinari, J. (2014) Projected increase in lightning strikes in the United States due to global warming, Science, 346(6211): 851-854.

SBS (2020) Labor's Kim Carr says funding for bushfire research centre must be secured past next year's deadline. Accessed at: https://www.sbs.com.au/news/labor-s-kim-carr-says-funding-for-bushfire-research-centre-must-be-secured-past-next-year-s-deadline

Sharples A, Hilton J and Sullivan A (2019) Pyroconvective interactions and spot fire dynamics. Bushfires and Natural Hazards CRC. Accessed at https://www.bnhcrc.com.au/hazardnotes/61

SMH (Sydney Morning Herald) (2019a) The economic cost of bushfires on Sydney revealed: up to $50 million a day and rising. Accessed at: https://www.smh.com.au/national/nsw/the-economic-cost-of-bushfires-on-sydney-revealed-up-to-50-million-a-day-and-rising-20191212-p53jbq.html.

SMH (Sydney Morning Herald) (2019b) The Monster: A short history of Australia's biggest forest fire. Accessed at: https://www.smh.com.au/national/nsw/the-monster-a-short-history-of-australia-s-biggest-forest-fire-20191218-p53l4y.html

Standards Australia (2018) Australian Standard AS 3959:2018 Construction of buildings in bushfire-prone areas, 14 November 2018.

Steffenson, V (2020) Fire Country. Hardie Grant Travel, a division of Hardie Grant Publishing. Melbourne and Sydney

Styger, J., Marsden-Smedley, J., & Kirkpatrick, J. (2018) Changes in Lightning Fire Incidence in the Tasmanian Wilderness World Heritage Area, 1980–2016. Fire, 1(3), 38. https://doi.org/10.3390/fire1030038

The Australian (2019) Out-of-date-strategies in defence white paper. Accessed at https://www.theaustralian.com.au/nation/defence/outofdate-strategies-in-defence-white-paper/news-story/3e871d6322765aa33b72123b28b21d70

The Australia Institute (2019) High Carbon from a Land Down Under: Quantifying CO2 from Australia's fossil fuel mining and exports. Accessed at: https://www.tai.org.au/content/high-carbon-land-down-under-quantifying-co2-australia-s-fossil-fuel-mining-and-exports.

The Guardian (2019) Scientists fear surge in supersized bushfires that create their own violent thunderstorms. Accessed at: https://www.theguardian.com/environment/2019/dec/20/scientists-fear-surgeinsupersized-bushfires-that-create-their-ownviolentthunderstorms.

The Guardian (2020a) Hazard reduction burns are not a "panacea" for bushfire risk, RFS boss says. Accessed at: https://www.theguardian.com/australia-news/2020/jan/08/hazard-reduction-is-not-a-panacea-for-bushfire-risk-rfs-boss-says

The Guardian (2020b) Australian fires: RFS commissioner not told of Scott Morrison's call-up of ADF reserve. Accessed at: https://www.theguardian.com/australia-news/2020/jan/05/australia-fires-rfs-commissioner-not-told-of-scott-morrisons-call-up-of-adf-reserve

University of Sydney (2020) More than one billion animals killed in Australian bushfires. Accessed at: https://www.sydney.edu.au/news-opinion/news/2020/01/08/australian-bushfires-more-than-one-billion-animals-impacted.html.

Victorian Government (2020) Research Papers. Bushfires 2019-20. Parliament of Victoria. Accessed at https://www.parliament.vic.gov.au/publications/research-papers/download/36-research-papers/13904-bushfires-2019-20#_ftn16.

Wallace-Wells, D (2019) Los Angeles Fire Season is beginning again. And it will never end. A bulletin from our climate future. Intelligencer. Accessed at: https://nymag.com/intelligencer/2019/05/los-angeles-fire-season-will-never-end.html

Waters, K and Fuller, S (2020) The impact of utilizing Aerial Tankers in fighting forest fires. Prepared for Global Super Tanker Services. Virginia, USA

Williams, E. (2005) Lightning and climate: A review. Atmospheric Research, 76(1-4), 272–287. https://doi.org/10.1016/j.atmosres.2004.11.01.

Ximenes F, Stephens M and Brown M (2017) Mechanical fuel load reduction in Australia: a potential tool for bushfire mitigation, Australian Forestry, 80: 88–98, DOI: 10.1080/00049158.2017.1311200.