LEGISLATIVE COUNCIL
ENVIRONMENT AND PLANNING COMMITTEE

Inquiry: Inquiry into ecosystem decline in Victoria

Hearing Date: 26 August 2021

Additional questions

Directed to: Mr David Packham OAM and Mr John Cameron

1. Ms BATH – by email

Question asked.

Have the science and the models, particularly in relation to fuel load, fire intensity and weather conditions (including soil moisture) that you presented to our EPC Committee been superseded over the last decade by climate science?

Response by Mr Cameron and Mr Packham:

The science and the models underlying the presentations by Mr Packham and Mr Cameron have not been superseded by climate science, they are fundamental models relevant under any climate scenario. The science and the models underlying the two presentations are based on measurement of the relationship between fire intensity and fuel load, climate and weather variables, taken from measurement of hundreds of experimental fires, prescribed fires and wild fires over about 60 years, and apply proven laws of physics, chemistry and mathematical statistics.

Early research resulted in the McArthur Fire Behaviour Tables incorporated in the Forest Fire Danger Meter (FFDM)[1] later formatted as equations[2]; and the Forest Fire Behaviour Tables for Western Australia (FFBT)[3] and also formatted as equations[4].

Subsequent substantial research over many years such as Project Aquarius[5] and Project Vesta fire research programs have resulted in improved understanding of the impact fuel load, fuel structure and fuel moisture content on fire behaviour, including under higher intensity fires[6] [7]. For the models used, predictions of fire behaviour have been tested against observed fire

[1] McArthur, A.G., (1973). Forest Fire Danger Meter Mark V. Commonwealth of Australia Forestry and Timber Bureau, Canberra, ACT.
[2] Noble, I.R., Bary, G.A.V., Gill, A.M., (1980). McArthur's fire-danger meters expressed as equations. Aust. J. Ecol. 5, 201-203.
[3] Sneeuwjagt, R.J., Peet, G.B., (1985). Forest Fire Behaviour Tables for Western Australia. Department of Conservation and Land Management.
[4] Beck, J.A., (1995). Equations for the forest fire behaviour tables for Western Australia. CALM Science. 1,325-348.
[5] Gould, J.S., Cheney, N.P., Hutchings, P.T., Cheney, S., 1996. Prediction of bushfire spread IDNDR Project 4/95. CSIRO Forestry and Forest Products unpublished report.
[6] Cheney, N.P., Gould, J.S., McCaw, L., (1998a). Project Vesta: Research initiative into the effects of fuel structure and fuel load on behaviour of wildfires in dry eucalypt forest. In: Proceedings 13th International Conference of Forest Fire and Meteorology. International Association of Wildland Fire, pp. 375-378.
[7] McCaw, L.W., Gould, J.S., Cheney, N.P., Ellis, R.M.F, Anderson, W.R., (2012). Changes in behaviour of fire in dry eucalypt forest as fuel increases with age. For. Ecol. Manage. 271, 170-181.

behaviour and rates of spread in independent experimental fires and wildfires[8] [9]. The ongoing research has permitted refinement of strategies and tactics for prescribed burning and suppressing wildfires, however, unfortunately some of these improvements have not been implemented in Victoria.

This fire research has been undertaken by internationally recognised fire and climate scientists such as Alan McArthur, Phil Cheney, David Packham, Rick Rick Sneeuwjagt, Neil Burrows, Lachlan McCaw, Rod Incoll and others. The research has been published in scientific journals and subject to peer review. The research shows the amount and characteristics of forest fuel have a considerable impact on fire intensity and as Mr Packham mentioned in his address to the committee:

"reduce the fuel load from 36 tonnes per hectare to 8 tonnes per hectare, the bushfire intensity decreases by 20 times and all fires can be controlled, environmental damage is reduced and no lives are lost"

Application of low intensity prescribed fire developed and implemented by George Peet, David Packham, Roger Underwood, Rod Incoll, Barrie Dexter and others is cost-effective for mitigating disastrous wildfires and asset damage[10] and has been used with considerable success in South West WA for over 60 years[11] and has been used with success in Victoria[12] [13].

In fact the fire models support the need to better manage fuel under climate change scenarios. Most climate change scenarios indicate the main impact will be on frequency or intensity of drought and days with high temperature, low relative humidity and high wind. The combined impact of climate change on these factors have and continue to be taken into account by the Weather Bureau in their daily calculation of Forest Fire Danger Index. The Forest Fire Danger Index (FFDI) incorporates climatic impact on drought and the dryness of the fuel, and other metrics impacted by climate change such as temperature, relative humidity and wind.

For convenience, and to assist fire management decisions these 'climate metrics' are incorporated into the FFDI which is shown as the horizontal axis of Figure 2 of Mr Cameron's presentation to the Inquiry on 26 August (and Figure 3 of Mr Cameron's submission No 471). This Figure shows that the **combined impact** of all these climate change variables on fire intensity is relatively smaller than the **sole impact** of fuel load on fire intensity. This figure also shows that as the FFDI gets worse under more severe climate or weather conditions that may be attributed to climate change or other phenomena such as Rossby waves, it is even more important to have relatively low fuel loads. This holds true across weather events that can lead to very intense fires.

[8] Rawson, R., Billing, P., Duncan, S., 1983. The 1982-83 forest fires in Victoria. Aust. For. 46, 163-172.
[9] McCaw, L et al (2009). Victorian Bushfire Research Response, Final Report Oct 2009.
[10] Florec, V. (2016). Economic analysis of prescribed burning in the South West of Western Australia. PhD Thesis. UWA April 2016.
[11] Sneeuwjagt, R. (2011). The Effectiveness of Prescribed Burning in the Control of Large Eucalypt Forest Fires. 5th International Wildland Fire Conference, South Africa.
[12] VBRC (2009). Volume II: Fire Preparation, Response and Recovery, Chapter 7 Land and fuel management.
[13] Cameron, J.N. (2020). Ecologically sustainable management of Victorian native forests. Submission No 471 to LC EPC Inquiry (p13-14).

The most catastrophic fires in recent history in southern Australia have been associated with Rossby waves where extreme cold fronts (maximum temperature at 2 m is at least 17◦C lower on the day following the front). An anticyclone, which precedes the cold front, directs very dry northerlies or north westerlies from the interior of the continent across the region. The passage of the cold front is followed by strong southerlies or south westerlies[14]. This phenomena may be independent of man induced climate change.

Fires can create their own weather conditions including updrafts, dynamic fingering and rotating columns near the fire front which can intensify to tornado strength and can result in rapid and strong increases in the fire spread rate[15]. These phenomena are more prevalent under heavy fuels. The behaviour and spread of fires like the 2009 Kilmore East fire were predictable when long-range spotting (which is worse in heavy fuels) was included and the atmospheric and fire models were coupled[16] i.e. both atmospheric and fire (fuel) variables were taken into account.

Also from a management perspective the fuel load is something that Forest or Park Managers can control within their area and within reasonable timeframes, whereas, reversing climate requires long term international political decisions or global action well outside the control of the Forest/Park Manager. Another point to make is that when it comes to forests and fire, we only have two choices under any of the reported climate change scenarios - **either implement sufficient low intensity prescribed fire** or **have too much damaging hire intensity wildfire (because you cannot completely exclude fire)**.

The science and the models underlying Mr Packham's and Mr Cameron's presentations have not been superseded by ecological science. There is a large body of research and expert opinion that supports the use of well-planned and managed low intensity fire to serve two principle purposes. The first purpose is to protect the forest from high intensity wildfire which is known to be bad for the ecology of our forests (see figure 10 of Mr Cameron's submission 471 and Dr Burrows Information Sheet 17 / 2009 Science Division, DEC appended below).

The second purpose is to use low intensity fire in a way that conserves biodiversity at a landscape scale and patch scale[17] and also enhance ecosystems[18]. We protect biodiversity and conserve our environment firstly through protecting it from high intensity wildfire. Science based on the physics and chemistry of fire behaviour shows that for most landscapes in Victoria we do that through skilful use of fuel reduction, of which low intensity prescribed burning is currently the most cost effective.

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[14] Reeder, M. J., T. Spengler, and R. Musgrave (2015) Rossby waves, extreme fronts, and wildfires in south eastern Australia, *Geophys. Res. Lett.*, *42*, doi: 10.1002/2015GL063125.

[15] Clark, T. L. Jenkins, M.A., Coen, J.L. and Packham, D.R. (1996). A Coupled Atmosphere-Fire Model: Role of the Convective Froude Number and Dynamic Fingering at the Fireline. Int. J. Wildland Fire 6(4): 177-190.

[16] Toivanen, J., Engel, C. B., Reeder, M. J., Lane, T. P., Davies, L., Webster, S., et al. (2019). Coupled atmosphere-fire simulations of the Black Saturday Kilmore East wildfires with the Unified Model. Journal of Advances in Modelling Earth Systems.

[17] Burrows, N.D. and Armstrong, R. (2003). Managing bushfire in a biodiversity hotspot. In 3rd International Wildland Fire Conference & Exhibition. Incorporating 10th Annual Australasian Fire Authorities Council Conference: Urban and Rural Communities Living in Fire Prone Environments: Managing the Future of Global Problems: Conference Proceedings: 3-6 October 2003, Sydney Convention and Exhibition Centre, Sydney, Australia.

[18] Jurskis, V. (2015). Firestick Ecology: Fairdinkum science in plain English. Connorcourt Publishing.

The high intensity wildfires that occur after insufficient fuel reduction are indiscriminate and they destroy sensitive rainforest, montane communities and riparian strips causing stream sedimentation and degradation of waterways. The use of low intensity prescribed fire to reduce fuel loads avoids those undesirable ecological outcomes. Wildfires release huge amounts of carbon dioxide including from carbon stored in the soil that can take hundreds of years to restore. Wildfire contributes 5-10% of global CO_2 emissions each year and are a significant contributor to greenhouse gas. The CO_2 released from low intensity prescribed fire is very small and replenished within 5 to 10 years.

2. Ms BATH – by email

Question asked.

Is action on climate change one of the most significant actions we can take to reduce biodiversity loss?

Response Mr Cameron and Mr Packham:

The answer to this question depends on who **'we'** are and **the time frame involved**. If 'we' are DELWP and Parks Victoria, whatever action those organisation take on climate change will have a tiny impact with an exceptionally long lead time. Action on climate change requires global action, an international effort with long lead times to measurable favourable impacts. These are not reasons to not take action on climate change. However, this Inquiry into Ecosystem Decline can achieve far more if it focused on the larger impacts that DELWP /Parks Victoria can make on Victoria forests within a shorter lead time. Focus is a cornerstone of successful strategies.

Clearly substantially reducing the impact of high intensity wildfires such as the 2019-20 wildfire (and other mega fires over the last 20 years) should be a priority. It has been shown that wildfire is one of the greatest threats to our ecosystems and it has been demonstrated that we can do a substantially better job of reducing the frequency, intensity and scale of wildfires in the future, under all forecast climate scenarios.

This can be achieved under future climate scenarios by scrapping the failed 'Safer Together' policy and implementing the Victorian Bushfire Royal Commission recommendations. This includes doing substantially more 'best practise' fuel reduction and implementing earlier fire detection, more rapid initial attack and mounting fire suppression with sufficient force using proven methods.

Effective bushfire preparation and damage mitigation requires sufficient prescribed burning to deliver a mosaic of areas containing low fuels. Damage mitigation also requires very early detection, rapid installation of fuel reduced containment lines using dozers, or skidders and back-burning to contain the size and perimeter of the fire (best done at night), accompanied by tankers and ground crews to cool and mop up the fire. Attempting to control fires by just using water and retardant delivered from tankers or large aircraft is relatively futile. The use of water

tankers and aerial bombers must be accompanied by 'fuel reduction', both pre-season fuel reduction and creating fuel reduced containment lines around the perimeter of wildfires[19].

One of the most unfortunate things to come after the Black Saturday Bushfires was the use of Climate Change as an excuse for the disasters. This has 'papered over the cracks', and hidden the substantial shortcomings of the forest and park land managers and fire services from the scrutiny required, if we are to deliver improvement and avoid similar ecological and human disasters in the future.

Unfortunately the Victorian Black Summer fire was described as unprecedented when in fact it was not. Black Summer of 2019-20 burnt 1.5 million hectares and killed 5 people. Similar occurrences include Black Thursday in 1851 burnt 5.0 million hectares and killed 12 people; Black Friday in 1939 burnt 2.0 million hectares and killed 71 people; the 1944 fire burnt 1.0 million ha and killed 15-20 people; and the 1951-52 bushfires burnt 5.0 million hectares and killed 11 people. These early fire losses have been attributed to a reduction in the area burnt annually resulting in increased fuel and more severe and damaging bushfires following colonisation[20].

Another issue is that some modelling of bushfire scenarios have used simplistic or dubious assumptions on fire behaviour and suppression which has led to some misguided and ineffective fire policies, strategies and practises that may be 'easier to implement' but dangerous.

3. Ms BATH – by email

Question asked.

The 2009 Victorian Bushfire Royal Commission made a recommendation in relation to a rolling target on prescribed burns, if this was implemented, what difference could it have made on the loss of 1.5 million hectares of burnt landscape?

Response Mr Cameron and Mr Packham:

The short answer is that if the 2009 Victorian Bushfire Royal Commission (VBRC) recommendations were followed, the area burnt by wildfire in the 2019-20 fire would have been less than a few thousand hectares (not 1.5 million hectares) and no lives would have been lost nor homes destroyed, and the adverse impact on ecosystems would have been substantially averted.

If the government had prescribed burnt on average at least 5% of the forest since 2009 or 400,000 hectares per year, then by 2019 there would have been about 4 million hectares or half the 8 million hectares of public forest with fuels less than 10 years old and 25% with low fuels

[19] The Bushfire Front (2021). Submission to the Independent Enquiry into the Wooroloo bushfire. Sep 2021.
[20] King, A.R. (1963). Report on the Influence of colinization on the forests and the prevalence of bushfires in Australia. CSIRO Division of Physical Chemistry, October 1963.

less than 5 years old. Under 'Safer Together' only about one third of the VBRC target area was prescribed burnt.

If VBRC recommendations were followed, then during the Black Summer fire many of the dry lightning strikes would have been within or near areas that had been fuel reduced and their fire intensity and rate of spread would have been substantially lower. This would have made the fire much easier to control, even with 'below par' initial attack and suppression.

4. Ms BATH – by email

Question asked.

Has climate change reduced the window of opportunity under which prescribed burning can be conducted?

Response Mr Cameron and Mr Packham:

The short answer is that climate change has not reduced the window under which prescribed burning can be conducted. However, it may have pushed part of the window into winter as indicated by DELWP in their 2018-19 annual report where they were able to complete prescribed burning in June.

Fire experts have indicated that certain parts of the forest, such as some north facing slopes, may be prescribed burnt in July or August on favourable days in dryer winters. The best fires you will 'control' are with your pullover on.

I would also like to make the point that the objective with best practise prescribed burning is to only burn about 80% of the area within the coupe, avoiding sensitive areas and minimise scorching the canopies of the trees. This requires people with skill and the ability to take advantage of optimum conditions as they occur. This requires prescribed burning outside 9 to 5 on Monday to Friday. Better to do the 'outside hours' work on low intensity prescribed fire under favourable conditions than fighting high intensity wildfire under unfavourable conditions.

I find it amazing that DELWP/Parks Victoria can marshal huge resources 24/7 at great expense to fight wildfires yet report difficulty marshalling the resources to implement best practise prescribed burning which can be undertaken at a fraction of the cost. Suboptimal allocation of resources to support field work may be caused by over resourcing some head office functions that do not 'add value'.

Prescribed burning can substantially reduce the overall impact of smoke on communities because it can be conducted under favourable wind direction, unlike wildfire where we have no control over the smoke and suffer a considerably larger smoke impact. Also the 'white' smoke of low intensity prescribed fire is substantially less hazardous to health than the 'black' smoke from high intensity wildfire.

Department of Environment and Conservation
Our environment, our future

Information Sheet 17 / 2009
Science Division

Wildfires can be bad for biodiversity

by Neil Burrows, DEC Science Division, (08) 93340463, neil.burrows@dec.wa.gov.au

Background

Granite rock outcrops are the remains of an ancient land surface that was thought to have been stripped away some time between the Middle Jurassic and the early Eocene, some 60 million to 150 million years ago. These outcrops are of immense biological importance because they are often 'islands' that comprise a small proportion of the entire landscape, so are uncommon and unusual compared with other landforms. Consequently biotic assemblages on rock outcrops are also uncommon and unusual landscape elements. Rock outcrops in the south-west forest region display high levels of plant endemism and species assemblages that contrast with the surrounding landscape as a result of strong environmental gradients, particularly associated with substrate and moisture regime. A significant proportion (~11 per cent) of all Declared Rare Flora in the south-west region occurs on or around rock outcrops.

Mt Cooke monadnock before the 2003 wildfire. A 'refuge' for fire sensitive and fire intolerant species and communities such as *Acacia ephedroides* (yellow flowers), moss swards (foreground left photo) and *Borya* meadows (foreground right photo).

The 2003 wildfire – based on extent of tree death, probably the most intense fire on Mt Cooke in ~250 years. Photo: Kristen Pollock.

The unusual rock outcrop environment gives rise to a fire environment that is also unusual compared with the surrounding forests. In forests, live and dead vegetation, or fuel, is more-or-less continuous and can reach heavy loads if unburnt for long periods. On rock outcrops, vegetation is usually fragmented, often sparse and does not reach the same high fuel loading as surrounding forests. Because of the nature of the fuels, rock outcrops are less flammable and it is not surprising to find assemblages of plants that are either 'fire sensitive' (readily killed by fire but will readily regenerate from seed) or 'fire intolerant' (harmed by fire, which appears to play no beneficial role). *Acacia ephedroides* and *Calothamnus rupestris* are examples of fire sensitive plants while moss rock swards and *Borya* meadows are examples of fire intolerant communities.

Rock outcrops have been referred to as 'fire refuges'. For this reason, the fire management strategy for the Monadnocks Conservation Park, an area of high concentration of outcrops some 70 km south-east of Perth, was to limit or exclude fire from the Park. This was successful for almost 20 years until January 2003 when a lightning strike started a fire in the Park in jarrah forest near Mt Cooke, one of the largest outcrops in the Park. Under hot, dry windy weather, a high intensity wildfire quickly developed in the heavy forest fuels. The fire burnt 18,000 ha and was brought under control when, some 25 km from its origin, it ran into forest that was recently prescribed burnt. The wildfire provided an opportunity to investigate the response of rock outcrops to fire, their role as 'fire refuges' and to add to our knowledge of how best to manage fire in these landscapes.

Findings

- All vegetation on and around Mt Cooke (and other outcrops) was either severely burnt or charred by the wildfire. Rock outcrops can't function as 'fire refuges' when they are surrounded by long unburnt forests capable of sustaining large, high intensity wildfires.
- Fire sensitive plants were killed but regenerated prolifically from seed following the fire. Others resprouted.
- Numerous animals, including mammals, reptiles, invertebrates and even some birds, were observed to have been killed by the fire.
- In the first few years after fire, there was a high diversity of plants, with the co-existence of fire ephemerals and long-lived species.
- Rock moss swards were killed by radiant heat and burning embers and showed no signs of recovery six years after fire.
- *Borya* meadows were killed or damaged by radiant heat and burning embers but are slowly recovering where the shallow topsoil overlaying the rock has not been eroded.
- Rocks cracked and flaked due to the extreme heat.
- A large volume of the thin topsoil vital for plant growth was eroded by rain following the wildfire and resulted in high levels of sedimentation in creeks.
- Forest and woodland trees on and around the outcrops were severely impacted with numerous large, old trees killed suggesting that this may have been the most intense fire for ~250 years.
- Most younger trees survived, regenerating from basal sprouts or epicormic shoots. Fire promoted dense seedling regeneration.
- Prior to the wildfire, there existed a diverse mosaic of habitat ages ranging from about 20 to 50 years since last fire. The wildfire simplified this to a single seral stage.
- Prescribed burning significantly aided containment and suppression of this wildfire.

All vegetation on the outcrop was burnt or charred by wildfire – there were no 'refuges'.

Forest and woodland trees on and around rock outcrops take many decades to recover following an intense wildfire.

Herbs and shrubs regenerated from seed or by resprouting and will recover relatively quickly.

Management Implications

Attempting to exclude fire from large areas will ultimately fail. The inevitable wildfires burning in heavy, long unburnt forest fuels will be unstoppable at their peak and will cause soil erosion and long term or irreversible changes to forests, woodlands and fire sensitive components in the landscape such as rock outcrop communities. Regular introduction of low intensity, patchy fire into surrounding fire resilient forests and under mild weather conditions in spring or late autumn is necessary to:

- improve protection of rock outcrop communities from lethal wildfires and to allow them to function as fire refuges;
- provide habitat diversity at appropriate scales;
- Reduce the size, intensity, damage potential and suppression difficulty of wildfires.

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