GOVERNMENT OF WESTERN AUSTRALIA
Department of **Biodiversity, Conservation and Attractions**
THE UNIVERSITY OF WESTERN AUSTRALIA

CONFLICTING EVIDENCE

PRESCRIBED BURNING: WHEN 'EVIDENCE' IS NOT THE REALITY

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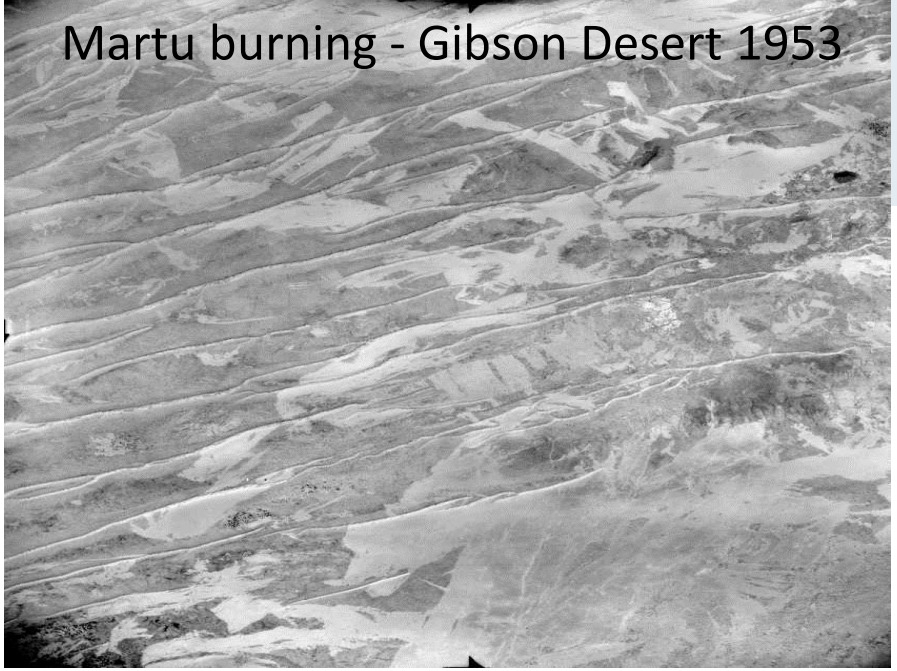
Prescribed burning: Since 60,000 years bp

- Aboriginal people used fire frequently, skilfully and purposefully
- The oldest land management practice by the oldest culture on the oldest continent
- In many landscapes, they were the predominant ignition source
- A new dynamic equilibrium established following their arrival
- Likely a fine-scale mosaic of diverse seral stages (fuel ages)
- Megafires were probably rare events

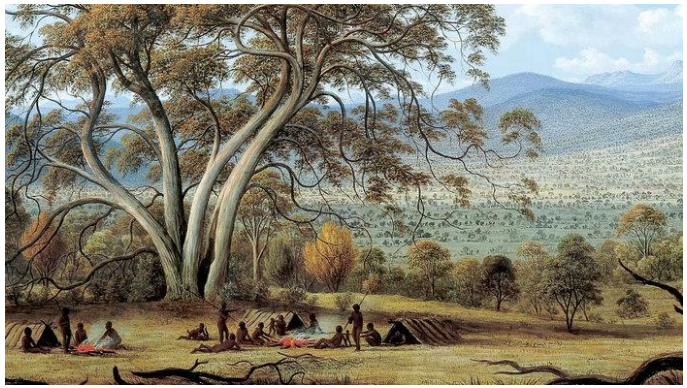

Martu burning - Gibson Desert 1953

European colonisation

- Aboriginal people displaced, burning practices disrupted
- Europeans 'pyrophobic'
- First Bushfire Ordinance in Swan River Colony 1847:

  "...boys under the age of 16 and aborigines to be publically flogged with any number of lashes not exceeding 50 for lighting fires..."

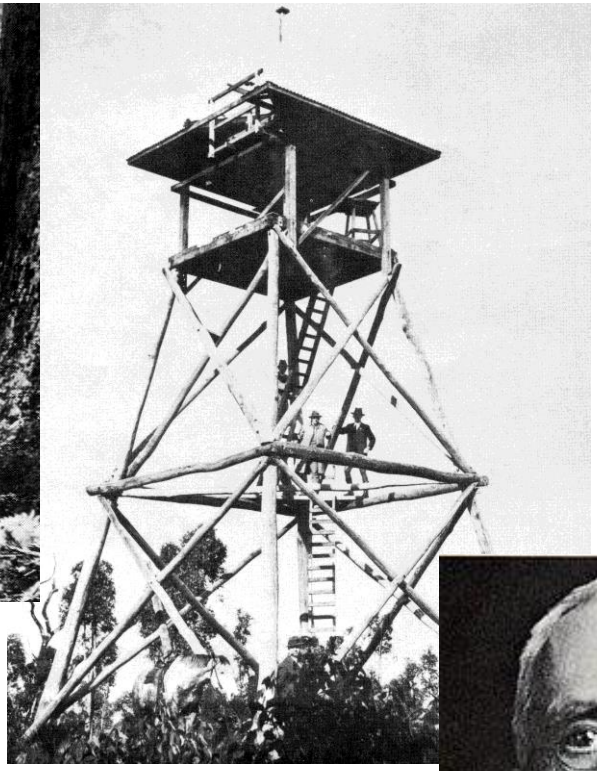
- By 1860s, Aboriginal burning virtually extinguished in southern Australia
- By 1960s, Aboriginal burning in central and northern Australia extinguished or significantly disrupted

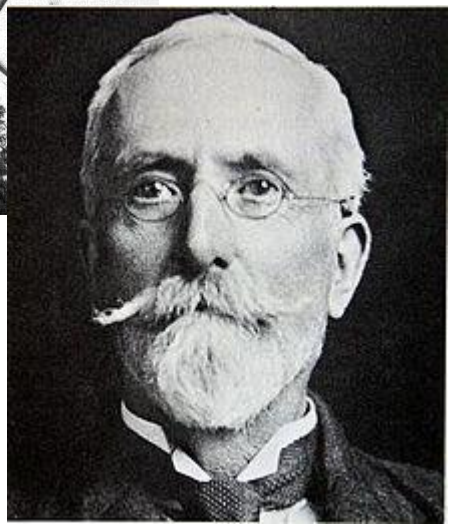


- Fire regimes changed

The European solution – southern Australia

fire exclusion, prevention and suppression policy – early 1900s-1950s





DE Hutchins

1961 - A turning point

1961
WESTERN AUSTRALIA

Report

OF THE

ROYAL COMMISSION

Appointed to Enquire into and Report upon the

Bush Fires of December, 1960 and January, February and March, 1961 in Western Australia.

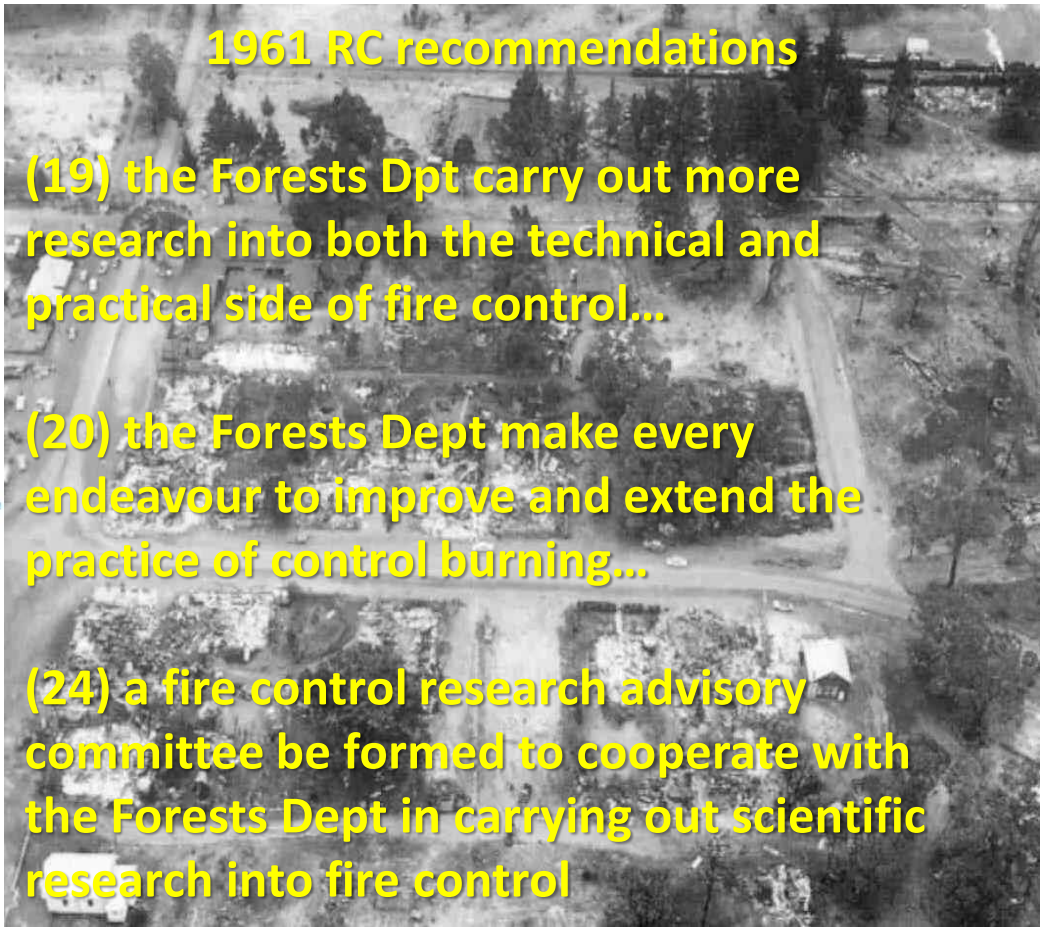
The Measures Necessary or Desirable to Prevent and Control Such Fires and to Protect Life and Property in the Future.

AND

The Basic Requirements for an Effective State Fire Emergency Organisation.

By
G. J. RODGER, Esq., B.Sc.
Royal Commissioner

PRESENTED TO BOTH HOUSES OF PARLIAMENT



1961 RC recommendations

(19) the Forests Dpt carry out more research into both the technical and practical side of fire control…

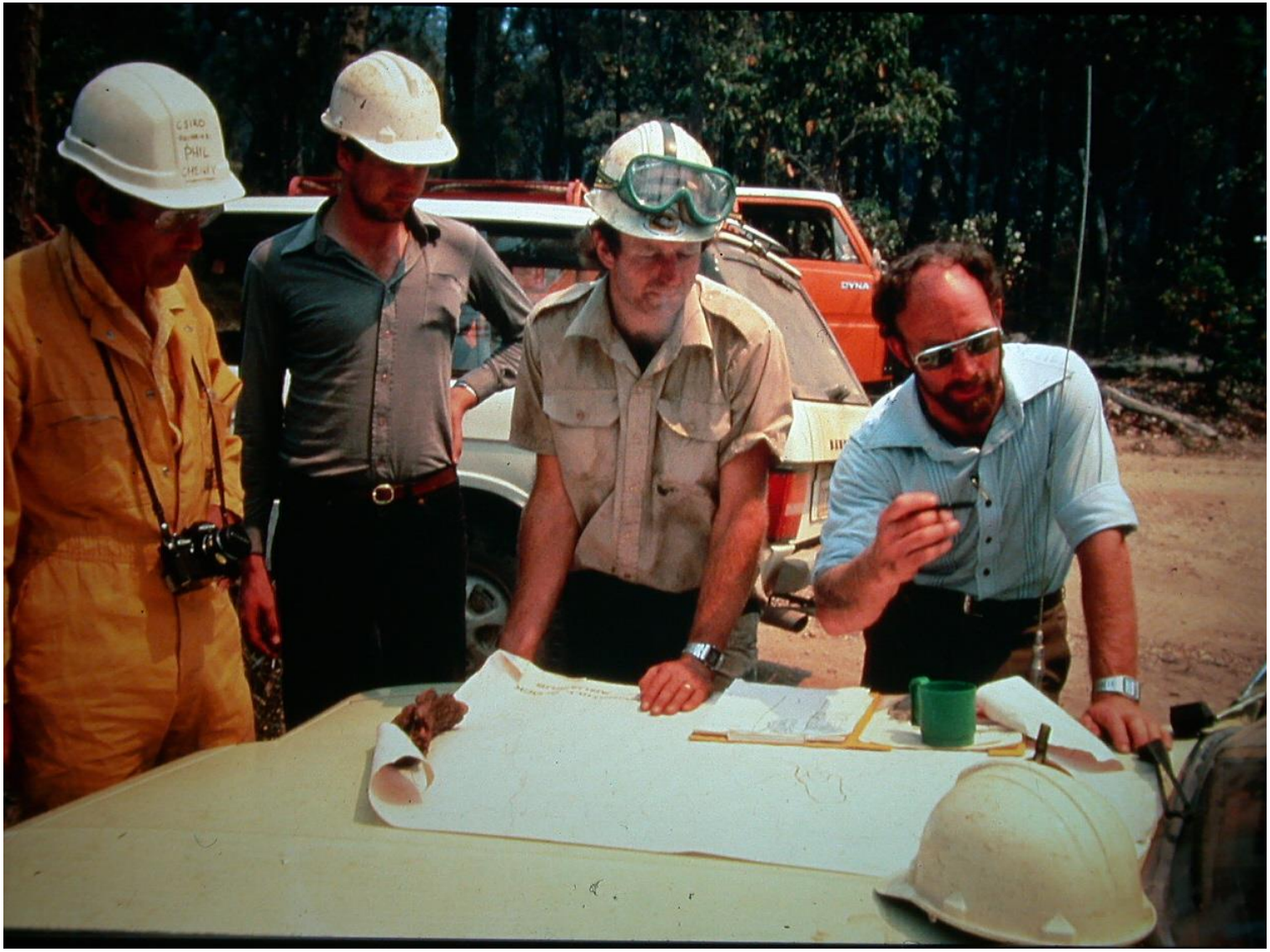
(20) the Forests Dept make every endeavour to improve and extend the practice of control burning…

(24) a fire control research advisory committee be formed to cooperate with the Forests Dept in carrying out scientific research into fire control

Prevention and suppression policy changes

Includes prescribed burning; recognises that:

- If fuels are allowed to accumulate over large areas, suppression will be dangerous, difficult or impossible under all but mild weather conditions - large, damaging bushfires will result
- Reducing fuel load and flammability reduces the speed and power of bushfire, reducing damage potential and suppression difficulty
- Does not prevent bushfire, but greatly assists in safer suppression and synergises community preparedness


CSIRO
PHIL
CHENEY
DYNA

Conflicting opinions

Pro prescribed burning

Prescribed burning in the broader landscape is critical to managing the bushfire threat.

Prescribed burning for bushfire mitigation is compatible with biodiversity conservation. There is no evidence that prescribed burning in forests has caused any loss of biodiversity.

Old fuels are more hazardous than young fuels; frequent burning reduces landscape flammability and buffers the bushfire cycle.

Fuel load directly effects firefighter safety and suppression success, even under severe fire weather conditions.

Anti prescribed burning

Burning within 100 m of the urban fringe can have a strong protective effect, but burns away from communities have little or no protective effect.

Burning for bushfire mitigation is incompatible with biodiversity conservation. Frequent burning in eucalypt forests and woodlands can eliminate native species.

Old fuels are less hazardous than young fuels; frequent fire increases landscape flammability and creates a bushfire cycle.

Fuel load is irrelevant to suppression success under severe fire weather conditions

The conflict

(media report following bushfires in the Albany region earlier this year)

"A group of WA university professors has called for a total overhaul of the State's prescribed burning program, claiming the practice of broad-scale burn-offs was endangering biodiversity and lives."

"Professor …claimed the "industrial scale" burning cost about $50 million a year and delivered no scientifically proven benefit in controlling the extent and intensity of wildfires".

"Professor … said the Government needed to look at other options such as creating green belts and parklands around key towns and assets, strategic irrigation lines and discrete prescribed burning around assets that needed to be protected, instead of large-scale burns".

Conflicting evidence

For

- Fire behaviour science
- Operational experience
- Historical evidence and case studies
- Biodiversity – fire ecology studies (space-for-time studies, monitoring, long term longitudinal studies)

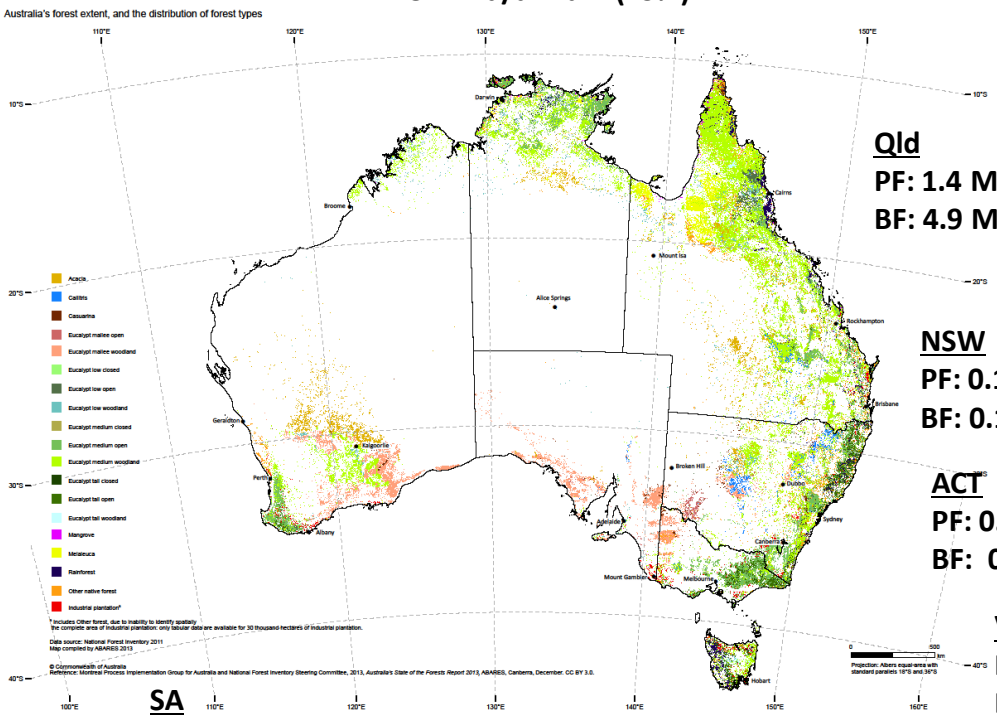
Against

- Computer simulations of prescribed burn scenarios and bushfire mitigation effects
- A case study (s-e Australia)
- Biodiversity – some fire ecology studies, PVA modelling and computer simulations based on plant life histories and vital attributes

Mean annual forest / woodland area burnt by prescribed fire (PF) and bushfire (BF) by jurisdiction (2006-2016)

(source: Australia's State of Forests Reports - ABARES)

NT
PF: 1.6 M ha / annum (10.5%)
BF: 4.5 M ha/annum (29%)



Qld
PF: 1.4 M ha/annum (2.7%)
BF: 4.9 M ha/annum (9.6%)

NSW
PF: 0.12 M ha/annum (0.5%)
BF: 0.16 M ha/annum (0.7%)

ACT
PF: 0.0028 M ha/annum (1.6%)
BF: 0 ha / annum (0%)

Vic
PF: 0.13 M ha/annum (1.6%)
BF: 0.22 M ha/annum (2.7%)

WA south-west
1953-2016
PF: 0.22 M ha/annum (8.9%)
BF: 0.02 M ha/annum (0.9%)

(2006-2016)
PF: 0.128 M ha (5.5%)
BF: 0.08 M ha/annum (3.1%)
(DBCA)

SA
PF: 0.02 M ha/annum (0.4%)
BF: 0.13 M ha/annum (2.9%)

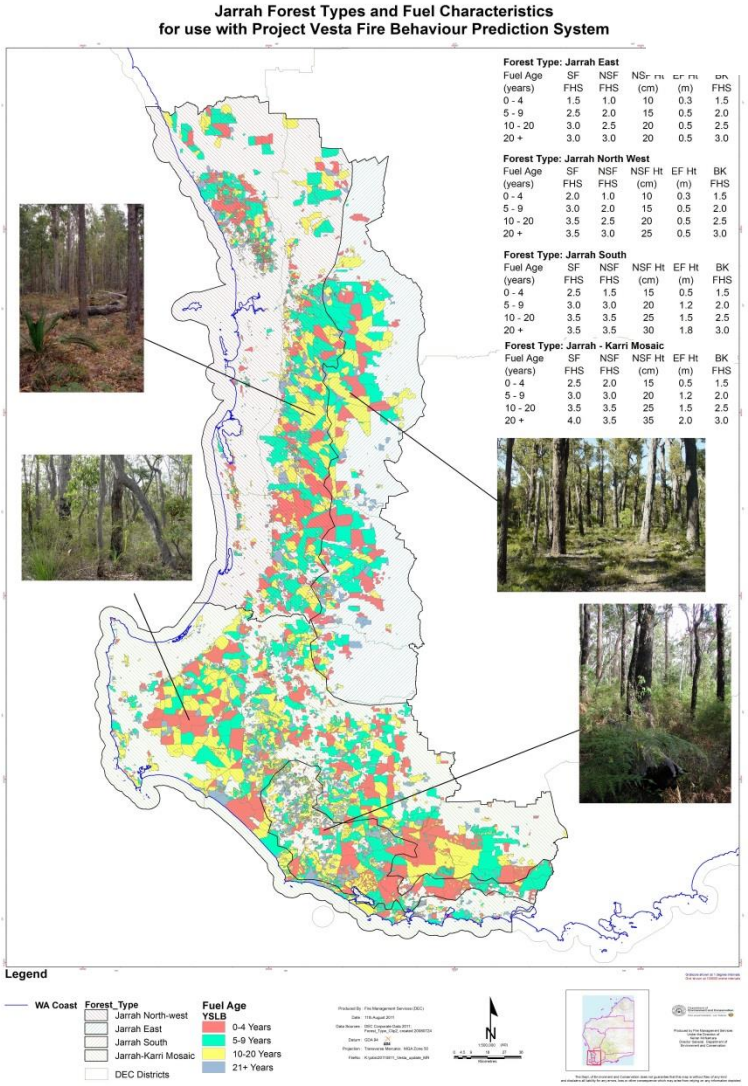
Tas
PF: 0.013 M ha/annum (0.4%)
BF: 0.025 M ha/annum (0.7%)

The claim:

"In forests, prescribed fire intervals less than 4 years, the juvenile period of fire sensitive plants, will result in local extinctions. Prescribed fire intervals greater than 4 years will not mitigate the wildfire threat. There is a clear conflict".

The reality:

- Burning ~8% per annum equates to 12 a year rotation, sufficient time for fire sensitive plants to recover
- About 50% of the landscape carries ≤ 6 yo fuels and about 33% ≤ 4 yo fuels
- Low intensity fires under mild weather conditions are patchy and are unlikely to adversely effect fire sensitive species and habitats
- Smart design of fuel age distribution (not random) has proven to be effective at mitigating bushfires without causing loss of biodiversity
- In addition to compliance with bushfire law regarding firebreaks, fuel on private property, building standards, etc (local government)

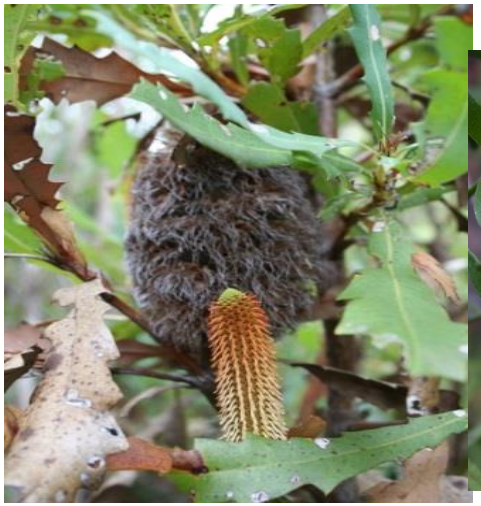


The claim (cont'd):

"In forests, prescribed fire intervals less than 4 years, the juvenile period of fire sensitive plants, will result in local extinctions. Prescribed fire intervals greater than 4 years will not mitigate the wildfire threat. There is a clear conflict".

The reality (cont'd)

- Under mild prescribed burn conditions, it is not possible to *entirely burn out* forests at intervals <4 years
- Fires will be low intensity and very patchy because fuels are sparse and patchy
- Species with long juvenile periods (6 yrs) persisted under an experimental fire regime of introducing fire into the landscape every 2 years because;
  - their habitats did not burn every time fire was introduced, or
  - they survived the low intensity fires



Banksia quercifolia

Lambertia rariflora

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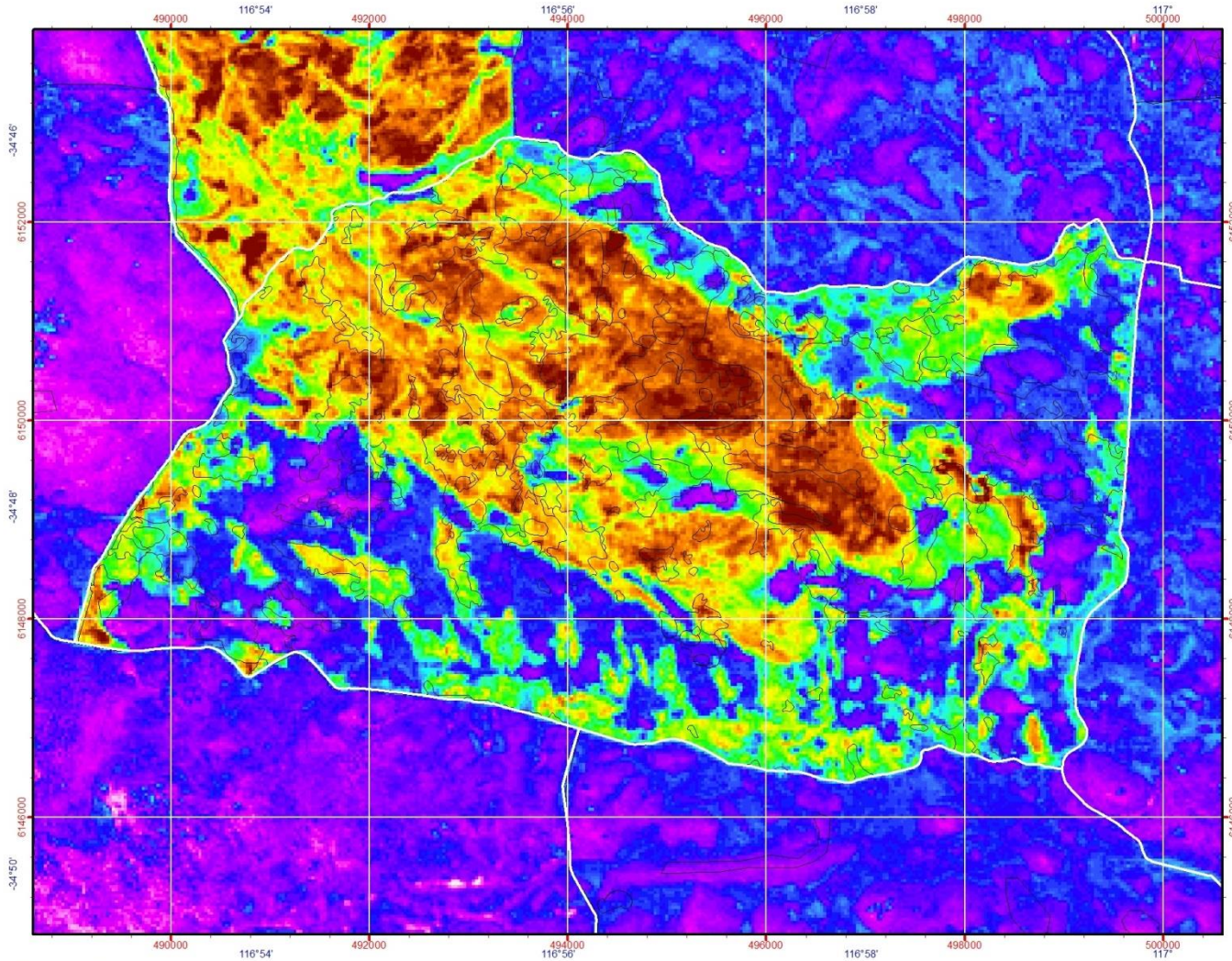


London Block dNBR October 2015

Map produced at 0837, Nov 11, 2015

dNBR 21Oct 2015

Value

Highest

Lowest

Fuel Age

The difference normalised burn ratio (dNBR) was calculated from the Landsat 8 images from the 14 May 2015 and 21 Oct 2015. It is an indication of the proportion of biomass decrease due to a fire event

N

0 0.5 1 2

Kilometres

1:50,000 (A4)

Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94

Produced by Paul Rampant, Remote Sensing and Spatial Analysis Section Department of Parks and Wildlife

Graticule shown at 2 minutes intervals

Grid shown at 2000 metre intervals

Department of Parks and Wildlife

Fire sensitive ecosystems surrounded by flammable, fire resilient ecosystems

Monadnocks Conservation Park

Mt Cooke Fire January 2003

Photo Kristian Pollock

Plants with long juvenile periods can survive low intensity prescribed fire, but can be damaged and killed by bushfires (Val Densmore 2018 *in prep.*)

- *B. attenuata* and *B. menziesii* have long juvenile periods and can be killed by intense fire
- Fruits (seeds) important food source for the endangered Carnaby's cockatoo
- Large, intense bushfires damage and kill plants, disrupting seed supply for many years
- Regular low intensity burns don't kill the trees and reduce bushfire severity, resulting in reduced disruption to seed supply

The claim:

Based on computer simulations, prescribed burning is not effective. Under extreme fire weather conditions, fuel load is of negligible importance (because fires exceed controllable intensity).

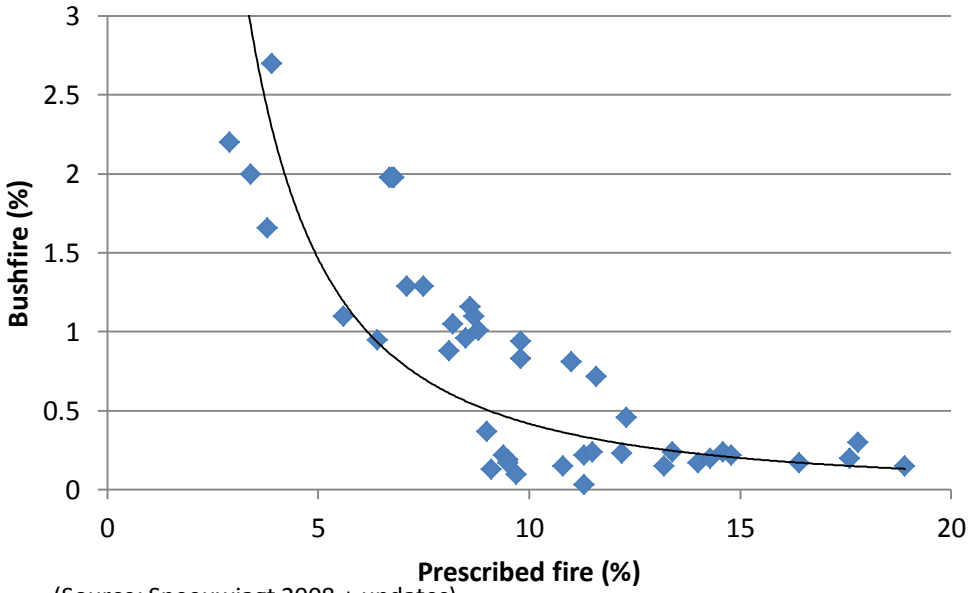
The reality:

Prescribed burning is very *effective if done:

- ❑ At appropriate temporal and spatial scales
  - ❑ Large cells
  - ❑ At least 8% treated each year
  - ❑ At least 45% ≤ 6 years old
- ❑ To appropriate standards of fuel reduction
- ❑ In the right places

(*effective: <1% per annum burnt by bushfire, acceptable residual risk, acceptable losses)

Proportion of SW forest region (2.5 M ha) burnt by prescribed fire (mean of 4 yrs) with proportion burnt by bushfire (mean of succeeding 4 yrs)



(Source: Sneeuwjagt 2008 + updates)

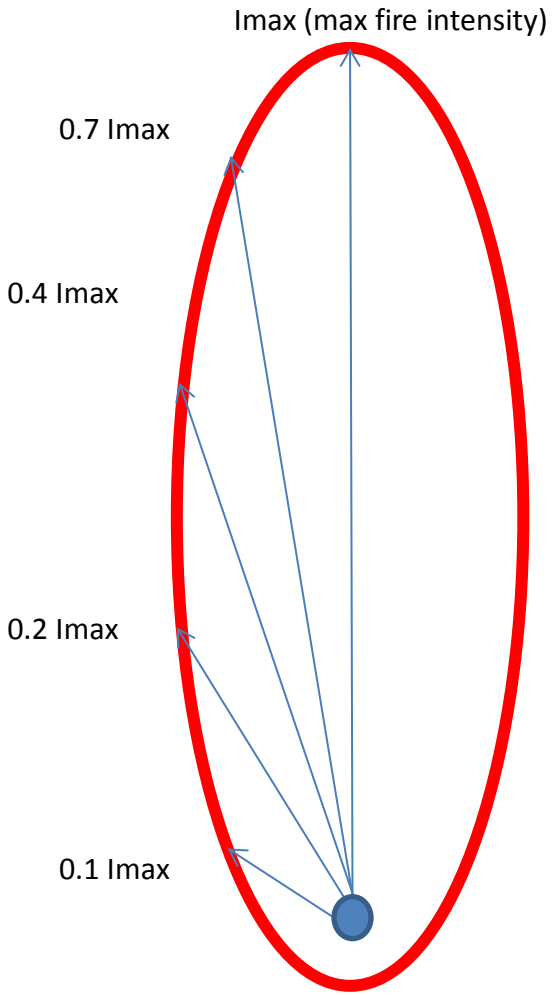
The claim (cont'd):

Based on computer simulations, prescribed burning is not effective. Under extreme fire weather conditions, fuel load is of negligible importance (because fires exceed controllable intensity).

The reality (cont'd)

Prescribed burning greatly assists fire suppression and synergises community preparedness under. Computer simulations are simplistic in this regard:

- Fuel load / age have a major direct effect on fire speed, growth rate and fire intensity around the perimeter, hence on safer suppression options
- Simulations don't consider the variety of available suppression strategies and windows of opportunity provided by spatial and temporal variability of fire intensity. These windows widen in a landscape that has adequate prescribed burning
- Simulations don't account for the many advantages that low fuel areas in the landscape provide to firefighters
- Slower fires, lower intensity fires buys time for fire fighters and the community



Catchpole et al. 1992

Fuel load does matter

- Fuel load directly influences fire intensity around the perimeter and windows of opportunity for safer suppression.
- In forest fuels, doubling fuel load results in a four-fold increase in fire intensity
- Fuel load burning behind the flame zone is critical because total heat output acts in a number of ways that impacts suppression difficulty and firefighter safety.
- Other computer simulation shortcomings:
  - Unrealistic ignition pattern
  - Unrealistic spatial arrangement of fuel management/ prescribed burning

The claim 3:

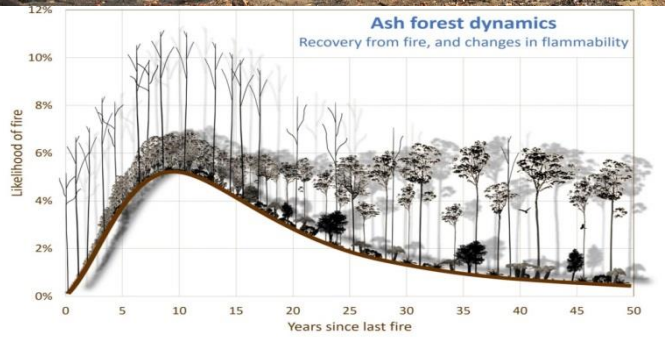
The least flammable parts of the (alpine) landscape are mature, long unburnt ash forests. Therefore we should minimise fire occurrence in these landscapes

The reality

- Big difference between post fire recovery of vegetation and fuel structure following severe bushfire and low intensity prescribed burn
- Unlike bushfires, low intensity prescribed burns produce relatively small changes in stand structure
- Prescribed burns lower the flammability of mature forests by reducing dead fuel load
- Prescribed burns reduce the risk of severe, stand replacement fires
- Regular prescribed burns can buffer the bushfire cycle

Bushfire

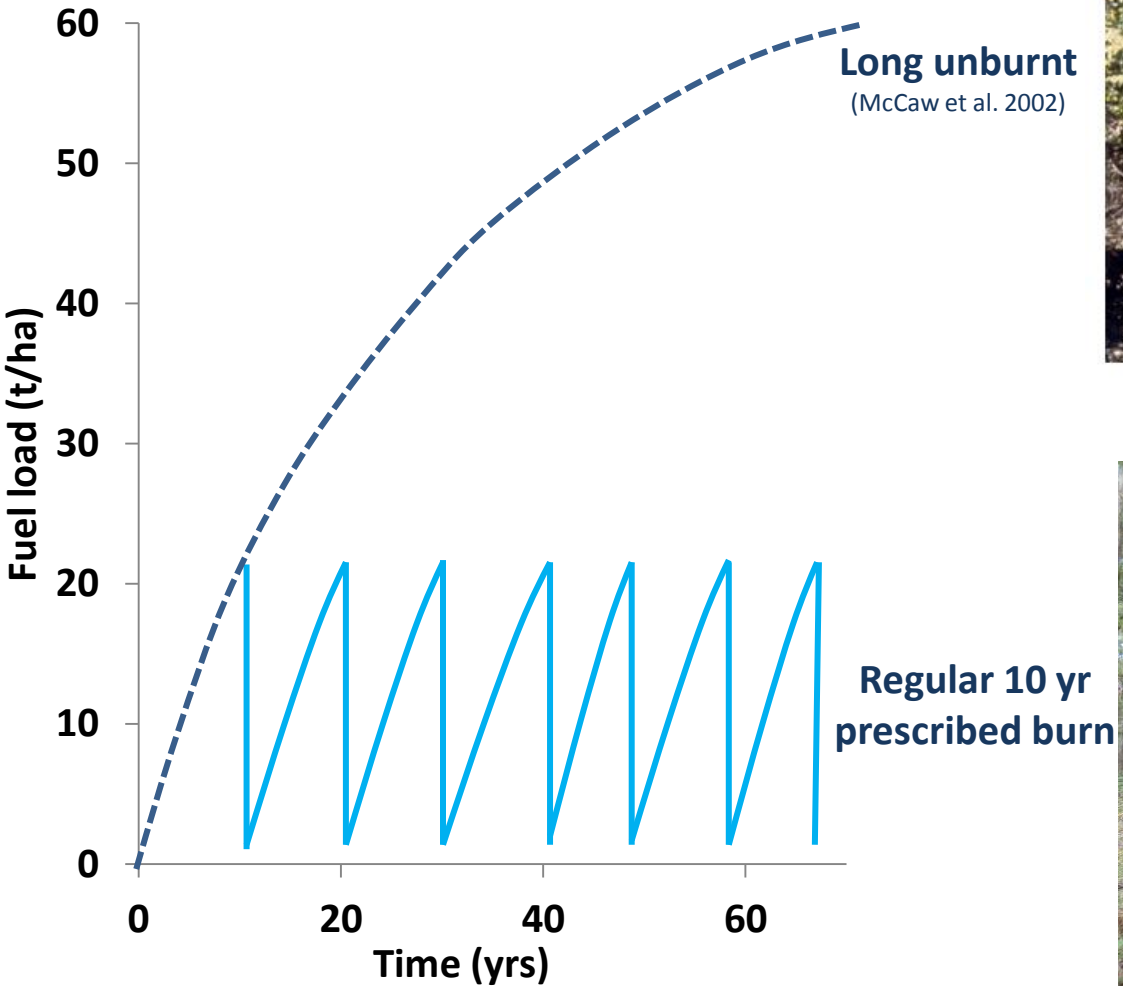
Bushfire recovery



Graphic from - The Conversation; Ecological Society of Australia

Prescribed fire

Dead fuel load with time since fire - karri forest



The claim:

It is only necessary to reduce fuel hazard in the immediate vicinity of the urban fringe (100 m) - broad-area burning beyond this is ineffective.

The reality:

- A system of 100 m buffers (5-chainers) was tried in sw-WA last century and failed
- Buffers would need to be > 1 km deep to be effective
- Buffer system ignores values outside the urban fringe beyond the buffers
- Endangers firefighters and the community
- Is it feasible?
- Need to manage the fuel hazard around settlements / homes AND in the broader landscape.

Photo Mark Giblett

Assets beyond the buffers at risk

- Areas of transient population density
- Threatened species and ecological communities with low resilience to bushfire.
- Critical infrastructure of state or national significance without redundancy
- Rural industries and infrastructure.
- Other significant built, natural or cultural assets

Concluding remarks

- ‘Evidence’ against prescribed burning arises out of a lack of understanding of, or a lack of ability to adequately model;
  - fire behaviour variability
  - Relationship between fire behaviour and fuel dynamics
  - prescribed burning
  - fire suppression
- Prescribed burning comes at a cost and it is not without risk.
- But inadequate levels of prescribed burning will be costly in more than dollar terms, and high risk.

Observe bushfire to understand bushfire

watch it, feel it, smell it, hear it, measure it, ponder it

repeatedly and over a long time

Concluding remarks

To bushfire scientists:

- Observe - spend time in the bush
- Understand fire behaviour – its great variability and variable effects on ecosystems and fuel dynamics
- Understand the art, craft and science of prescribed burning and bushfire suppression
- Consult professional fire and land managers

To science journal editors:

- Include professional fire and land managers in the peer review process

To fire and land managers:

- Question the science

THANK YOU

(Prescribed aerial burn, London forest, WA)

Conflicting Evidence

Prescribed burning: When 'evidence' is not the reality

Neil Burrows, AFAC, Perth, September 2018

Title Slide

Thank you for the introduction and can I thank the conference organisers for giving me this opportunity.

Given that I'm about to retire after almost 42 years working as a bushfire scientist, it might have been appropriate to reflect on how far we have come in bushfire science and management in Australia over that time. I'm not going to do that, but I will make some general observations.

In the last 40 years, there has been upwards of 800 bushfire-related scientific papers published, so we know a lot more; we have much better equipment today; we have technology that we could not have imaged 40 years ago; our firefighters are better trained and better equipped, and there are more of them.

Despite these advances, the area burnt by bushfire has increased in most jurisdictions - and at best has remained unchanged in others. The climate has changed and the population has grown by 11 million – factors beyond the control of fire and land management agencies. And in the last 40 years, the area burnt by prescribed fire, which can be controlled, has decreased in most jurisdictions, and at best, has remained unchanged in others.

Making evidence-based decisions about the efficacy of prescribed burning as a pivotal hazard mitigation tool is extremely important because it effects community and firefighter safety, and the health of our natural environment. For these reasons, I doubt there is a more important land management practice. And for these reasons, I am concerned that there is conflicting evidence about the efficacy of prescribed burning.

Of course, I come from a Western Australian perspective but I believe my comments are relevant to all fire-prone environments.

Slide 2

Not only is prescribed burning important, but it's perhaps the oldest land management practice in the world, pre-dating European settlement of Australia by thousands of years. Use of fire by the first Australians was widespread, purposeful and skilful. Fire was essential for their physical and spiritual well-being. While we have a pretty good understanding of how and why Aboriginal people burnt - and still burn - the northern and central Australian grasslands, our understanding of the intricacies of prehistorical fire regimes of southern Australia is less clear.

Slide 3

It was relatively recently, with the arrival of Europeans, that there was, after thousands of years, a significant reduction, and in many places, a cessation of prescribed burning. Aboriginal people were displaced from their land and their ancient fire practices were outlawed. Within a relatively short time, fire regimes flipped. For example in the Western Desert, the fire regime changed within about 15 years of the cessation of traditional burning. Today most of the desert is gripped by an uncontrolled, damaging bushfire cycle.

Slide 4

In the early 1900s following the establishment of various state forest departments, the fire policy was one of Prevention and Suppression. Prevention amounted to taking measures, including punitive measures, to eliminate the causes of bushfires, but it also included some 'controlled burning'. The foresters of the day were mixed in their views about fire. For example in 1916, DE Hutchins, a European- trained forester and colonial Conservator of Forests, wrote that, "*It is repeated fires at short intervals that destroys the forest*". Others blamed frequent burning by Aborigines for the low nutrient status in forest soils.

However, others were of the view that controlled burning was the key to the bushfire prevention and suppression policy. The 1927 WA Foresters Manual noted that if the forest fuels were no older than 3 years, then there would be no damaging bushfires – the manual went on to suggest burning the entire 2.5 M ha or so of forest on a 3 year rotation.

Of course, the manual is right – if the forest region was burnt every 3-4 years, there would be no damaging bushfires – but of course it was, and is, impractical on many levels, so for pragmatic and other reasons, controlled burning in the early days was largely restricted to so-called 5-chainers, which were 100 m strips, or green belts as they were also called, around towns, mill settlements, major transport corridors and regrowth forests.

On reading some of the early accounts of fighting forest fires in south west Australia, I'm somewhat bemused by how the fires were so readily contained by simple means. The usual procedure for fighting a forest fire is described by Forester George Brockway in a paper he published in 1923, from which I quote:

"Unless a fire is particularly fierce, it can usually be suppressed by direct beating with bushes. For this purpose, healthy redgum branches are preferable".
He then goes on to describe the best fire beating technique, conjuring up images of John Cleese and the car that wouldn't start.

So why today do we need bulldozers, heavy duty appliances and water bombers when a redgum branch would do the job? I can only assume that most of the fires they fought 100 or more years ago, were in young, light fuels– probably a legacy of Aboriginal burning, burning by early settlers who grazed stock in the forests, and burning by timber millers.

Slide 5

By the late 1940s and 1950s in south-west WA, cracks began to appear in the prevention and suppression policy, with a spate of damaging bushfires. This culminated in the so-called 'Dwellingup Fire' in 1961, and subsequent Royal Commission.

The Royal Commission was a watershed for fire management in the south-west. While a prescribed burning policy was introduced in the 1950s, not much happened by way of on-ground action largely because of lack of capacity, resources and knowledge, and also I think – a lack of commitment to the policy because of the forester's divergent views on prescribed burning.

However, this changed after 1961 – driven by the Royal Commission recommendations, there was a surge of effort into applied bushfire science, both fire behaviour and fire ecology – specifically aimed to support a program of broad area prescribed burning to mitigate the bushfire menace. Most of the early research was done by the then Forests Department scientists in partnership with CSIRO.

Slide 6

While planning and implementing a prescribed burning program is quite complex, the rationale for doing so is quite simple. Experience and science show that if fuels are allowed to accumulate over large areas, summer bushfires will be severe, damaging and difficult or impossible to control. In forest fuels, doubling the fuel load results in a four-fold increase in

fire intensity. Reducing fuel load and flammability by regular prescribed burning reduces the speed and intensity of bushfires, providing a wider window of opportunity for safer suppression. After almost 60 years, organised and systematic prescribed burning has without question significantly reduced the bushfire losses in the south-west forest regions of WA – without ecosystem collapse or biodiversity loss.

Slide 7

Today, across the country, there is less bushfire research done by fire and land management agencies and more done by universities, CSIRO and the CRC. There are fewer bushfire scientists in state land management agencies, but I'm pleased to say that here in WA we have managed to maintain an in-house bushfire research capability since the 1960s.

There are some important benefits of having scientists embedded in fire and land management agencies. Apart from generating or otherwise acquiring the science necessary to underpin agency policies, scientists in, or working in close partnership with land management agencies, understand the bigger picture of community expectations and of fire and land management; they understand the challenges and they share the responsibility on agencies to protect our communities and our assets from destructive bushfires; they understand the complex operational aspects of prescribed burning and bushfire suppression; they participate in policy development, problem solving, fire management planning and fire operations, including prescribed burning and fire suppression. In short - they have 'skin in the game'.

They are also available for responding to PQ's and Ministerials that fire management, especially prescribed burning, generates - a part of the job I won't miss.

Slide 8

When it comes to the benefits or otherwise of prescribed burning, there is clearly conflicting evidence, and differing opinions, somewhat split along professional roles and responsibilities.

Many scientists, mostly from academia where science is increasingly a theoretical enterprise, have published papers claiming that, variously worded, prescribed burning:

- Done at the spatial and temporal scales necessary to mitigate the bushfire threat, threatens biodiversity.

- Is ineffective at mitigating the bushfire threat under severe fire weather conditions – when fuel load is unimportant and it's all about weather.
- Is only beneficial when carried out within 100 m or so of the urban fringe, or other assets.
- It can increase rather than decrease the fuel hazard.

On the other hand, most fire practitioners and fire scientists embedded in, or who work closely with fire and land management agencies, are convinced that the scientific and experiential evidence supports the case that prescribed burning done at appropriate scales, is very effective at mitigating the bushfire threat – in fact is critical to the cause - and does not pose a long term threat to biodiversity. They, and I am one of them, claim that:

- Together with managing fuels on private property, around homes and at the urban fringe, broad area prescribed burning of the wider landscape is critical to mitigating the bushfire threat.
- Prescribed burning for bushfire mitigation is compatible with biodiversity conservation. There is no evidence that prescribed burning in forests has caused any loss of biodiversity.
- Old fuels are more hazardous than young fuels; frequent burning reduces landscape flammability and breaks or buffers the bushfire cycle.
- Fuel age/load affects fire speed and intensity, so will strongly influence the success or otherwise of suppression actions and community preparedness, including under severe fire weather conditions.

Slide 9

Opposition to broad area prescribed burning is summed up by this statement made to the media by a local academic following bushfires near Albany earlier this year – some of which were escapes from prescribed burns.

(see slide - Dixon's comments to the media)

Once again we see it claimed by academics who, in this case have little or no fire management experience, and are not recognised as bushfire experts, that prescribed burning endangers biodiversity, is expensive but delivers no benefit and that fuel

management should focus on green belts around towns and other assets rather than prescribed burning.

Slide 10

The pro-burners, if I can call them that, base their case largely on:

- Bushfire behaviour science - which demonstrates that reducing fuel load and simplifying fuel structures significantly reduces fire behaviour so makes fires less damaging and easier and safer to suppress, including under severe fire weather conditions.

- They also base their case on experience - occasionally published as case studies - where adequate prescribed burning has 'saved the day'. Each year in the south-west our fire fighters are called out to hundreds of bushfires and in most cases they are able to contain them relatively quickly because they are assisted by young fuels in the landscape resulting from prescribed burning. Unfortunately, few of these case studies are published – perhaps a post-retirement job?

- They also base their case on history – almost 60 years of historical data for the south-west forest region shows an inverse relationship between area of prescribed burning, and area burnt by wildfire.

- With respect to biodiversity, studies have shown that fire, including prescribed burning, causes changes in species abundance and composition, but there is no evidence that it has caused species losses in forest ecosystems.

The anti-burners, if I can call them that, base their case largely on:

- Theory, modelling and computer simulations of prescribed burning scenarios and subsequent bushfire mitigation outcomes.

- They base their case on a case study in south-eastern Australia, but where the area that was prescribed burnt was less than 2% of the region per annum – this work doesn't prove prescribed burning is ineffective, as the authors claim - in fact it is entirely consistent with the historical evidence and experience, that demonstrates that at least 8% per annum of a bushland region needs to be burnt to be effective.

- They base their case on at least one space – for – time fire ecology study in shrublands, which showed that frequent fire caused the loss of some plant species. But the landscape being studied had experienced a prescribed burn and several bushfires at frequencies greater than what would normally be implemented under a managed prescribed burning program.

- They base their case on population viability modelling, theory and computer simulations based on plant or animal life histories and vital attributes, such as the juvenile period of fire sensitive, slow maturing, obligate seeders. Basically, if the fire interval is less than the juvenile period, then extinction is likely.

Slide 11

As a bushfire scientist in a land management agency, I have spent many days in the field - lighting, observing and studying experimental fires and their effects - and many days observing and studying prescribed burns and bushfires - and many days in LFOs and pre-formed IMTs helping to put fires out - and many days trekking through fire-blackened landscapes with a notebook, a compass, a clinometer and a GPS attempting to reconstruct the origin, cause, behaviour and path of damaging bushfires.

From these experiences, I am convinced beyond any doubt that the cornerstone to mitigating the bushfire threat, not preventing bushfires, but lessening their impact, including in an era of a changing climate, is prescribed burning. So I am curious to examine more closely, the case made against prescribed burning, because it does not accord with my knowledge and experience.

Slide 12

But before I do, I want to put prescribed burning into perspective. Given the attention it receives, you could be forgiven if you thought that each fire season, the country was ablaze with prescribed fires. Commentators have often referred to prescribed burning as ‘a common and widespread practice' and recently it was referred to as an ‘obsession’ by one academic.

For temperate forests and woodlands of southern Australia, the truth is, very little prescribed burning is done – overall, about 1% per annum on average. And therein lies a problem. There is obviously variation between jurisdictions and with forest and woodland types, but to obtain a finer scale breakdown than what is shown on the slide is a job for another day.

Slide 13

I now want to take a closer look at the most recurrent published claims against prescribed burning and the evidence to support these claims.

The first claim is that:

"In forests, p*rescribed fire intervals less than 4 years will result in local plant extinctions. Prescribed fire intervals greater than 4 years will not mitigate the wildfire threat.*

The suggestion here is that we need to burn at intervals less than four years for prescribed burning to be effective – but doing so will cause extinctions, so we have a conflict, or an impasse.

This sounds logical, but it's not, because it demonstrates a lack of understanding of the temporal and spatial design of effective prescribed burning programs. It is neither necessary, feasible, nor desirable to burn the entire forest on a 3-4 year rotation to substantially mitigate bushfire impact. Local government has a role in ensuring compliance with bushfire law regarding fuels on private land, and with bushfire construction requirements etc.

Public land managers have an obligation to manage fuels on the lands they administer, and to this end in the south-west, the aim is to burn about 8% of the forest region each year. So nominally, this means about a 12 year rotation for a 3,000- 5,000 ha fire management cell, ample time for fire sensitive plants to recover. Because of the patchy nature of prescribed burns, parts of the management cell often remain long unburnt.

It also means that at any one time, about 45-50% of the region is carrying <6yo fuels, and about third is carrying <=4 year old fuels. The burning is spatially strategic, not random. Sixty years of experience demonstrates that this has been very effective at reducing bushfire losses primarily because it has significantly assisted suppression operations – and I'll expand on this later.

Slide 14

In the south-west, fire sensitive plants and animals mostly occur in the less flammable parts of the landscape, such as riparian zones, broad valley floors with discontinuous fuels and on rock outcrops. These habitats rarely burn under mild prescribed burn conditions – so often remain long unburnt. However, they are vulnerable to summer bushfires in the absence of regular burning in the surrounding, more flammable forest fuels.

Slide 15

This slide shows the patchy nature of a 5,000 ha low intensity aerial prescribed burn in forests north of Walpole in the south west. The blue patches are unburnt, or areas burnt by very low fire intensity due to flammability differentials in the landscape at the time of burning. Much of this is habitat of so-called fire sensitive species - plants and animals that require longer fire intervals. It is very difficult to obtain a patchy result in old fuels, so in the prescribed burn cycle, these areas burn about every second or third cycle.

Slide 16

Rock outcrops are another case in point. They provide a refuge for a suite of fire sensitive and fire independent organisms because of the discontinuous fuel structure on outcrops. They can best function as a fire refuge if the surrounding flammable, fire resilient forests are regularly burnt by low intensity fire.

On the other hand, they fail as fire refuges if the fuels in the surrounding landscape build up to high levels because the inevitable summer bushfire will be so intense that it will overwhelm the refuge characteristics of the outcrop, impacting and killing everything on the rock. In exactly the same way a 100 m fuel buffer around the urban fringe will eventually fail if fuels are allowed to accumulate in the surrounding landscape.

Slide 17

Some plants are killed by moderate to high intensity fire, but can survive low intensity fire. The relationship between banksia woodlands, the endangered Carnaby's cockatoo, and fire is an interesting case study that one of my colleagues has been working on. Because these banksias have a relatively long primary juvenile period - about 6-7 years - and because they can be killed by fire and rely on seed for regeneration, it was proposed by some that prescribed burning intervals should be more than 15 years to maintain seed supply for the cockatoos.

This sounds logical on the surface. However, it treats all fire as lethal – so that if the woodlands burn, then the banksias are killed. Intense summer bushfires burning in old fuels, damage and kill many trees over a large area, resulting in a long period of low seed supply while the plants regenerate from seed and mature. However, frequent low intensity fires are far less damaging and lethal to the trees, the severity of bushfires is reduced and there is far less disruption of seed flow for the cockatoos.

Slide 18

Turning to the second claim:
Based on a number of published computer simulations, prescribed burning is not effective unless unrealistically large areas are treated very frequently. Based on computer simulations, it is also claimed that under extreme fire weather conditions, fuel load is not important because fires will exceed controllable intensities regardless of fuel load.

This does not accord with historical evidence, the experience of fire fighters and my experience. So what is the historical and real-world evidence? There is only one jurisdiction in southern Australia that has been able to implement and maintain a prescribed burning program in forest landscapes at the temporal and spatial scales necessary to reduce the damaging effects of bushfires – and that is here in south-west WA.

Some 60 years of experience has taught us that at least 8% of the region must be burnt each year, that the burn cells must be large, burns must remove a high proportion of the dead fuel, and the burns must be strategic – that is, in the right place.

Slide 19

It is often stated that prescribed burning is done to protect communities and other assets. It's actually firefighters, community preparedness, building code compliance, police, legislation, etc. that protects communities. By that I mean if all we did was prescribed burning and none of these other things, communities would still be at risk – unless the bush was burnt every 3-4 years.

However, prescribed burning done at appropriate scales, massively assists suppression operations and significantly synergises community preparedness and other risk mitigation measures, so through this, prescribed burning greatly enhances community protection.

Computer simulations have a number of serious shortcomings and limitations in this regard. That is, they fail to adequately account for the benefits of prescribed burning to fire suppression and community preparedness, leading to erroneous and dangerous conclusions about the efficacy of prescribed burning.

- Simulators deal simplistically and inadequately with bushfire suppression – in simulations, if the maximum fire intensity in a small simulation cell exceeds 4,000 kW/m, then the fire is considered uncontrollable or unmanageable.

- The reality is different - the process of wildfire suppression and pre-suppression is much more complex and sophisticated. Simulations ignore the variety of suppression strategies and tactics that can be used in space and time, depending on weather conditions, fuels, topography, fire behaviour, fire shape and fire position in the landscape, and intensity around the fire's perimeter. The headfire of most bushfires exceeds 4,000 kW/m, so fire fighters rarely make a direct attack on the headfire. Instead, they implement other strategies including a variety of direct and indirect attack, or defensive strategies – so a fire is not considered uncontrollable or unmanageable because its maximum intensity exceeds 4,000 kW/m.

- Fire intensity varies around the fire's perimeter, and there will almost always be somewhere on the fire perimeter that can be attacked, either directly or indirectly – even under severe fire weather conditions - and if fuel loads are low, this window of opportunity widens and the likelihood of containment and suppression success increases.

- Most damage is done when the wind shifts and the long flank fire becomes a wide headfire. Therefore, containment work on the flank is critical and is more likely to succeed in low fuel conditions when flank fire intensity is relatively low, even under severe weather conditions.

- Also, simulators don't take account of suppression advantages when part of the fire is burning with low intensity in light fuels, so can be ignored while resources are diverted to higher priority areas around the perimeter or to other fires.

- Simulators ignore the 'anchor points' or 'tie in' points, being the low fuel areas available to fire fighters in a landscape that has been adequately prescribed burnt. These are very important for indirect suppression strategies including back burning. Attempting to back burn in old heavy fuels against old, heavy fuels is a slow, resources demanding, risky process. And the speed at which containment lines can be safely constructed is extremely important in the battle against a growing bushfire.

- Fire suppression is a race in terms of rate of fireline construction and containment verses rate of perimeter growth of the bushfire. Fires burn slower in younger, lighter fuels, not only improving the likelihood of rapid suppression, but increasing the odds of fire fighters getting the upper hand in terms of constructing containment lines.

- With computer simulations, fires are only simulated to spread for relatively short periods of time - usually 6-12 hours, ignoring important diurnal variation in fire behaviour – peak fire weather conditions don't last very long in the life cycle of a bushfire – when diurnal conditions ease, and if the fire is burning in light fuels, there is a greater window of opportunity for safe suppression, than if its burning in heavy fuels.

- Simulations do not account for the synergistic effects of prescribed burning on community preparedness and bushfire response plans. That is to say, the success of these measures will be greatly enhanced if the bushfire is less severe.

Slide 20

Regardless of fire weather conditions, to firefighters, fuel load does matter. It directly effects fire intensity around the fire's perimeter, and the size of the suppression windows in space and time. Also, containment line break outs such as hop overs and spot fires, are much easier to control in light fuels than in heavy fuels.

The fuel load burning behind the flame zone, which is greater in older, heavier fuels, is critical for suppression difficulty because total heat output acts in a number of ways:

- It is an input to convection which increases wind speeds in the flame zone, boosting spotting and fire behaviour.
- It increases the likelihood of high energy release rates and deep flaming, conditions that can trigger a transition to a plume-driven fire and the development of dangerous PyroCb events.
- It increases the likelihood of re-ignition of unburnt fuel and breaching of the containment line by burning across it or by blown embers or by hop-overs.
- Radiation from glowing combustion adds to the heat load on firefighters and substantially increases the time before the burnt ground can be used for safe refuge.
- It substantially decreases the effectiveness of water and other suppressants applied from the ground or from the air.

- Heavy fuel also hinders fire line construction and in some fuels make it impractical or impossible.

- Ignition patterns assumed in computer simulations are highly artificial, often a grid ignition at relatively close spacing. Similarly, the small fuel management scales used in simulations are unrealistic – in reality, fuel is managed at much larger scales.

- Simulations apply an unrealistic spatial arrangement of fuel management including prescribed burning – the truth is, it is not random. Professional fire managers carefully consider many factors when planning the spatial design of a prescribed burning program, including assets at risk, cross-graining the prevailing wind directions that generate the worst fire weather, ignition risk, detection and suppression capability, burn scales that are commensurate with the landscape and with historical bushfires, the need to break the continuity of old, heavy fuels, and how best to utilise and leverage previous prescribed burns and bushfires.

- Another benefit of landscape prescribed burning is that lightning strikes, and other ignitions in fuels that are less than 4 years old, usually do not take hold and become fires. This is important because there is a significant increase in the incidence of summer lightning storms in the south-west over recent decades.

Slide 21

Claim 3;

It is claimed that in alpine landscapes, the least flammable parts are old growth, long unburnt ash forests with the early post fire stages being the most flammable. Therefore, fire should be excluded for long periods in these landscapes.

Actually, this is not quite right - following a severe fire, the ash forests are least flammable immediately post-fire!

That aside, this claim is based on a vegetation and fuel post-fire fuel recovery trajectory following a severe, high intensity bushfire that reduces the forest to black sticks and hits the reset button, as shown by the graphic. As the forest regenerates, it progress through a stage of high fuel hazard rating due to the structure of the regeneration. I would add that not only is the forest fuel hazardous at this stage, but if it is reproductively immature, it is also quite vulnerable to fire.

So what the author actually means is that severe stand replacement bushfires in these landscapes increases their flammability for some time until they become old growth, and

creates a bushfire feedback loop, so we need to ensure that severe bushfires are few and far between.

This can be best achieved by regular low intensity prescribed fire. Low intensity fire, fire that removes a proportion of the dead fuel without killing the overstorey, does not cause such a dramatic re-structuring of the forest – the forest essentially retains its old growth structure but its flammability will be reduced by a reduction in dead fuel load, buffering the landscape against damaging, stand replacement bushfires.

In his discussion, the author of this particular paper noted in passing that lower intensity fires may not give rise to the flammability feedback scenario depicted in the graphic on the previous slide. To fire managers, this is a most important finding, but its significance was apparently lost on the author and on the reviewers.

Slide 22

So the reality is, the best way to reduce the likelihood of large, severe, stand replacement fires in the landscape is to actually introduce more low intensity fires.

Slide 23

Claim 4:
It has been claimed that, based on computer simulations, it is only necessary to reduce fuel hazard in the immediate vicinity - 100 m or so - of the urban fringe and around assets, and that burning beyond this is ineffective. It's what firefighters often refer to as the 'ring of confidence'.

The reality is this:
A system of 5 chain buffers, or green belts, was tried in the sw of WA early last century and failed under severe fire weather conditions. Granted, today we have better equipment and suppression systems, but what hasn't changed is the fuel – it still accumulates and burns as hot is it did 100 years ago.

Unless the buffers are at least 1,000 m deep, a large well developed fire, perhaps a plume driven fire burning in heavy, long unburnt forest fuels under severe fire weather conditions will send fireballs, hot gas and smoke, and a blizzard of embers across the narrow buffers, besieging the urban areas. If the bushfire approaching the buffer is moderate to low intensity as a result of low fuel loads and / or low fire danger rating, the buffer might hold up.

Secondly, this strategy places everything outside the urban fringe buffer at great risk.

Slide 24

So beyond settlements, towns and subdivisions, we are talking about critical infrastructure of state-level significance and with no redundancy, such as major transport corridors, infrastructure associated with power and energy generation and distribution, water supply catchments, pipelines and pumping stations, major TELCO cables and towers, major waste water treatment sites and so on.

We are also talking about locations where bushfires may have a significant impact on the livelihood of individuals or community economic sustainability, such as infrastructure of local or regional significance, agricultural land, major industries such as mines, refineries, manufacturing plants, and native and plantation timber industries.

Other significant built, natural or cultural assets, such as areas of transient population density and low resilience to bushfire including holiday homes, hobby farms and recreation and camping sites, fire vulnerable Aboriginal or European heritage sites, significant ecological communities or species habitats, and natural areas with specific fire regime requirements.

Fire fighters will be expected to fight fires beyond the peri-urban buffers. Fires burning in long unburnt heavy fuels will be dangerous and difficult to control, even under moderate fire weather conditions, and impossible to control under more severe conditions.

Given that there are thousands of km of convoluted interface, how feasible is it to install and maintain a system of 100 m fuel reduced buffers to a standard that they will stop a running fire?

The reality is, we need to do both – manage fuels as best we can in and around settlements, around homes, AND in the broader landscape.

Slide 25

While modelling and computer simulations testing the efficacy of prescribed burning are technically sophisticated, and can provide some insights, they do not represent the complexities of the real world of fire behaviour and fire management, so the conclusions can't be trusted. Fundamentally, their unreliability is due to a lack of understanding by the modellers of the complex nuances and variability of fire behaviour and how this influences

fire ecology, fuel dynamics and fire suppression; and a lack of understanding of the complex art, craft and science of prescribed burning and suppression operations.

Even if these complex aspects were well understood by the modellers, it would be very challenging to incorporate them into models and simulators because most of it cannot be distilled down to an algorithm.

Yes, prescribed burning comes at a cost - and it is not without risk. But society and the environment will pay a much higher price, in more than just dollar terms, as a consequence of bushfires in the absence of adequate prescribed burning.

Slide 26

All good science starts with astute observations of the physical or natural world. Understanding bushfire and being a bushfire scientist means, as the name suggests, spending many days in the bush observing, thinking about and interpreting fire and its nuances, and observing and interpreting the way species and ecosystems responded to fire.

I would argue that to be a good bushfire scientist requires many hours and days in the field lighting fires (legally of course) and helping to put fires out. I am strongly of the view that science done without this prerequisite - without this sensory, physical and intellectual immersion in the world of real fire, is likely to lead to the wrong hypotheses being tested, flawed assumptions, unintentional bias, wrong inferences and interpretation of data, and erroneous conclusions.

Slide 27

In finishing - to bushfire scientists in the audience I say this:

In addition to the usual skills necessary to be a good scientist, you must also have a firm knowledge and understanding of fire behaviour – its variability and variable effects on ecosystems and on fuel dynamics; and you must have a firm understanding of the art, craft and science of prescribed burning and bushfire suppression. Consult with professional fire managers before commencing your research and before submitting your paper. They will be able to add value to your work.

To science journal editors I say this:

Include professional fire managers in the peer review process. Most are tertiary trained - many have post-graduate qualifications – and they are experienced in the real world of fire policy and management. They are very capable of, and should be involved in, reviewing scientific papers that could influence what they do and what impacts this will have on the broader community and the environment.

To fire and land managers, I say this:

Don't be intimidated by scientists or science – if it doesn't accord with your knowledge and experience, question it.

Then we will get closer to the truth about prescribed burning.

Last slide

Thank you