Bushfires that have left a deep and lasting lesson and teaching legacy across Australia over the last 70 years, the 1961 bushfires in SW Western Australia

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Contents

Bushfires that have left a deep and lasting lesson and teaching legacy across Australia over the last 70 years, the 1961 bushfires in SW Western Australia

1 Introduction

The author identified and reviewed bushfires that have left a deep and lasting lesson and teaching legacy.

The author reviewed key lesson capture of effective fire and bushfire experience, expertise, and mitigation across Australia over the last 70 years and has identified a limited number of high standard example lesson/ teaching event case studies, especially in relation to effective mitigation capture combined with long term mitigation application longer than 10 years, bushfire suppression learnings, improved research and other areas of fire management.

A large number of cases and lessons were considered. This included individual Australian bushfire disasters and management lessons; bushfire extent, suppression and fire behaviour lessons; bushfire commissions, inquiries or reviews; effective research and science; effective capture of bushfire mitigation and suppression research; development and utilisation the science of prescribed burning from the air; prescribed burning, mechanical treatment, active and adaptive management and grazing, as well as fire trail installation, water supply installation and cooperative mitigation approaches; and assessment of these cases and with post bushfire mitigation application, at least for 10 years.

Continuous improvement in bushfire management comes from capturing and applying knowledge gained from experience, and good applied science. For a variety of institutional, political, and cultural reasons, fire and land management agencies do not always learn or capture lessons and knowledge from past experiences, and do not always effectively engage in the operationalisation of fire science. It is also true that not all fire science is useful, relevant or beneficial to fire managers. Here, I review key lessons captured from experience, expertise, bushfire mitigation and bushfire research across Australia over the last 70 years. I have identified a small number of standout case studies, especially in relation to effective mitigation capture combined with long term mitigation application longer than 10 years, bushfire suppression and other areas of fire management.

In relation to most of the bushfires that have occurred in Australia, the lessons were not effectively captured or learnt and retained over the longer term. In a small number of cases, additional fire mitigation was proposed in bushfire commissions, inquiries or reviews, but then didn't eventuate or mitigation dwindled to inadequate levels, often in a short space of time.

Of all the major bushfires in Australia's history, the author believes none has left such a deep and lasting teaching legacy as the 1961 bushfires in Western Australia. They were not the deadliest fires Australia has seen but they were among the most influential. The 1961 Dwellingup fire in particular became an important case study for how bushfire was understood, managed, and mitigated in the decades that followed. It is no exaggeration to call it the single most important "teaching event" in the history of bushfire management in Australia.

Two Annexures are included in this review, to assist in long term capture of information and reduce unnecessary text in the main review.

2 Major lesson and teaching event: the 1961 bushfires in SW Western Australia, especially in relation to effective mitigation lesson capture, long term mitigation application and effective bushfire suppression

Major lessons from the 1961 bushfires in Western Australia, especially in relation to effective mitigation lesson capture, effective management and research and long term mitigation application and bushfire suppression, are outlined in Sections 2.1 to 2.7 below.

2.1 The SW WA 1961 bushfires, a great lesson and teaching event

The 1961 WA bushfires provide a classic, rare case study where the recommendations of a Royal Commission and lessons learnt by firefighters were taken seriously by the government, and land and

fire management agencies, in particular the WA Forests. Over time, virtually all of the and recommendations and lessons learnt were implemented. This resulted in significant decline in the annual area burnt by bushfires, and consequent bushfire losses.

Of all the major bushfires in Australia's history, the author believes none has left such a deep and lasting legacy as the 1961 bushfires in Western Australia. They were not the deadliest fires Australia has seen but they were among the most influential. The 1961 Dwellingup fire in particular became an important case study for how bushfire was understood, managed, and mitigated in the decades that followed. It is no exaggeration to call it the single most important "teaching event" in the history of bushfire management in Australia.

2.2 Broad 1961 SW Western Australia bushfire details

Wikipedia (2025) provides important detail in relation to the 1961 Western Australian bushfires:

In early 1961, a series of bushfires burned in the south-west region of Western Australia.[1] The devastating fires burned large areas of forest in and around Dwellingup from 20 to 24 January, at Pemberton and in the Shannon River region between 11 and 15 February,[1] and in the Augusta-Margaret River area in early March. There were also major fires which burned in the Darling Scarp around Kalamunda. The towns of Dwellingup and Karridale were largely destroyed by the fires, as were a number of smaller railway and mill settlements. There was no loss of human life.

As outlined within Dwellingup Where trails met (web 2025) further detail is provided in relation to the 1961 Dwellingup bush fires. Despite the massive multiple fire situation, Dwellingup forces had almost controlled the 9 strikes on Thursday, before the next 10 strikes outflanked much of their established firelines. With so much smoke around the region, the tower-based fire detection system became almost useless. The fire was eventually brought under control on Wednesday after heavy rain fell and the weather cooled considerably. Final fire size was about 150,000 ha. Of all the towns destroyed in the 1961 fires, only Dwellingup was rebuilt.

West Australian Vista (2025 web) noted the 1961 bushfires burnt out 160 buildings and cost $35 million in lost homes, businesses and livestock.

2.3 Prescribed burning constraints and forest landscapes at risk in SW WA before 1961

Prior to the mid-1950s, the forest fire management policy was essentially one of bushfire suppression burning narrow buffers around assets such as town ships and forest regrowth. This resulted in heavy fuel accumulation over large tracts of forest. In the mid-1950s, the policy changed to include broad area burning. But as noted by Carter and Sneeuwjagt (2011), prior to the 1961 fires, little burning was actually achieved. An ability to implement the new policy was constrained by difficulties associated with attempting to burn long unburnt fuel, lack of technical expertise, limited fire behaviour knowledge, unreliable weather forecasts and a lack of resources and trained/ experienced staff.

Whole forested landscapes were at risk.

Further detail is outlined in Carter and Sneeuwjagt (2011).

2.4 Lessons and responses from the 1961 Western Australia Dwellingup bushfire, including the Royal Commission and Forest Department reviews

The author considers the 1961 WA bushfires are the priority Australian example case study of a major bushfire where mitigation lessons were learnt, captured and implemented over a long period, over 60 plus years. Credit for this belongs to the professional forestry and other personnel involved, the WA Government and key government agencies.

1961 Royal Commission inquiry

Rodger (1961) prepared the report of the Royal Commission to enquire into and report upon the bush fires of December, 1960 and January, February and March, 1961 in Western Australia.

The summary report covers fires in Chittering, Gidgegannup, Dwellingup, Augusta-Margaret River (Karridale), Pemberton, Denmark, Gleneagle, Kalamunda and Gooseberry Hill, South Coogee,

Mandurah, Lesmurdie-Kalamunda-Bickley, and also on the coastal plains north of Perth, and elsewhere such as Balladonia)

The 27 Royal Commission recommendations are well worth a read, addressed on pages 58 to 60. they are logical recommendations. It is apparent that the conductance of the Inquiry by Forester GJ Rodger and the assistance of AG McArthur to the Inquiry were both very valuable in the success of this commission.

Key responses following the 1961 WA bushfires

West Australian Vista (2025 web) outlines key responses following the 1961 bushfires.

As a result of the fires the State Government ordered a Royal Commission into the fire management issue. The Commissions in its findings recommended that there be amendments to the Bush Fires Act. The local government would take more fire management responsibilities. Provisions were made for more resources for the Bush Fire Boards and an upgrade of forest management to lessen the threat from wildfires.

The response from the Forests Department was firstly to invest in better equipment, radio communications and weather forecasting. Secondly they commenced a fire behaviour research program to understand more about fire behaviour and to find improved techniques for prescribed burning.

The major changes resulted in turning the fire situation around following the 1961 bushfires, truly major and positive changes.

Effective lesson capture following the 1961 bushfires

Underwood (1961) outlined teaching event memories of the 1961 bushfires.

Key lessons learned and outcomes were improved coordination between government and volunteer firefighters, the use of modern radios and equipment, a new emphasis on fuels management and stimulating the development of fire behaviour research.

And in relation to the fact that not one life was lost while four townships burned and firefighters confronted ferocious crown fires. There are two explanations: first, the forest firefighters of the time were tough, practical and fire-wise. When the threat reached a certain point, they simply moved out, seeking safe places where they waited out the fire storm and, although towns such as Dwellingup were surrounded by forest, the forest did not dominate within the town.

Attempts to fight a crown fire burning in heavy fuels under bad weather conditions will always fail—the intensity and spot fires generated make firefighting hopeless.

There is another lesson: communities in bushfire—prone areas must have a 'Plan B'—the capacity to move quickly and calmly to safe places well in advance of intense, fast-moving fires. This is especially critical these days as so many people who live in bushfire-prone areas have little bushfire experience.

Peet and Williamson (2025 web) also outlined extensive lessons in relation to the Dwellingup Fire, and these are outlined in Annexure 1.

Key lessons in relation to the 1961 Dwellingup Fire are summarised, one was the intensive post-fire review that brought about major changes in fire management policy and procedures and provided some fundamental lessons in forest fire management that are just as relevant today. Another key lesson, it’s the personnel on the ground that extinguish bushfires and bulldozers that could then be called upon for firefighting. Another is that there is a false sense of security, and a naïve faith in the fire suppression paradigm.

Peet and Williamson (2025 web) further noted that while the fire plans indicate that 40% of the forest in the area near Dwellingup had been burnt in the previous 6 years, the burns were generally small in

size, were extremely patchy due to concerns over damage to regeneration, and there were large areas of heavy fuel up to 20 years old still remaining between burnt forest.

A post-fire review team, led by noted forester WH Eastman, undertook an intensive study of the management of the fire and of the fire effects in the forest (and other information from the numerous other severe fires in that year). The conclusions they reached with respect to fire behaviour are outlined in Peet and Williamson (2025 web) and outlined in Annexure 1, retained there as an important record.

They outlined the importance of fuel age maximums, sound fuel reduction programs and scale/ size, improved fire detection and firefighting equipment and suppression and improved communication.

2.5 Ongoing development of sound fire mitigation policies in WA post 1961

Department of Conservation and Land Management (1994) provides detail on early fire and post 1961 WA policies, outlined below and in more detail in Annexure 2.

Detailed operational and research developments in the wake of the Dwellingup fires is also outlined Department of Conservation and Land Management (1994) outlined in Annexure 2.

Department of Conservation and Land Management (1994) noted that the Royal Commission's recommendations were adopted in full by the Government of the day, and have not been rescinded over the intervening years. This is a critical point.

There is further useful information on fire management on CALM lands within the SW of WA within the document Department of Conservation and Land Management (2000) and the attached link https://library.dbca.wa.gov.au/FullTextFiles/020299.pdf
Underwood et al. (1985) assessed the contribution of prescribed burning to forest fire control in Western Australia and the link:

https://bushfirefront.org.au/prescribed-burning/the-value-of-prescribed-burning/

The current approach is based on the premise that since fire occurrence is inevitable, the aim must be to minimise undesirable consequences. Stemming from this philosophy two complementary management systems have emerged.

The first involves maintenance of an efficient fire detection system, backed up by effective firefighting forces stationed throughout the forest zone. This system has a proven capacity for rapid location and suppression of the fires, which break out under mild to average summer weather conditions.

The second system involves the systematic reduction of inflammable fuel on the forest floor by a programme of rotational prescribed burning. The aim of this programme is to help firefighters cope with fires starting under severe weather conditions or when many fires occur simultaneously. Under such circumstance the suppression task can rapidly exceed firefighting resources, leading to large, intense forest fires, and consequent social and economic damage. Current estimates show that the organisation required to suppress a large forest fire burning under severe conditions can cost up to $40,000 a day. Such a fire may take 5 or more days to be fully contained.

Experience over a wide range of weather conditions has shown that direst attack on forest headfires is not likely to succeed when flame heights are more than three metres or where fires are moving faster than 100 metres per hour. Fire behaviour is directly affected by the amount of fuel, and so long as inflammable fuel weights are maintained at less than about 8 tonnes per ha in the Jarrah (E.marginata) forests or about 15 tonnes per ha in the Karri (E.diversicolor) forests, there is a good chance that direct attack on the flanks of the fire will succeed with eventual control of the headfire by pincer action from the flanks. This applies even under severe weather conditions. Furthermore, areas of light fuel throughout the forest provide anchor points for suppression lines, refuge areas for threatened crews or civilians, and improved access for men and equipment working on a fire edge or suppressing spot fires ahead of the main front.

There have been no major fires since 1961 in the Jarrah forest, where a prescribed burning programme commenced in 1954, or since 19969 in the Karri forest where the fuel reduction policy

became effective in the late 1960s (Underwood and Christensen 1981). During this time no single firefighter has been burnt to death in a forest fire in WA, – nor have there been any losses of life of civilians living in or near the forest zone. This contrasts with the "Ash Wednesday" fires in Victoria and South Australia in February 1983, which resulted in 70 deaths and hundreds of serious injuries.

The points made are clear and concise, and of critical importance in the ongoing development of a sound fire management system.

Peet (1965) outlined a fire danger rating and controlled burning guide for the northern jarrah (E. marginata Sm) forest of Western Australia.

Sneeuwjagt and Peet (1979) outline Forest Fire Behaviour Tables for Western Australia in considerable detail.

Burrows (1984) developed predicting blow-up fires in the jarrah forest.

Other key detail in relation to forest fire management in Western Australia is outlined in Underwood and Christensen (1981).

These improvements also highlight the ongoing development of a sound fire management system.

2.6 Reinforcement of the 1961 WA lesson capture approach by the 1978 Dwellingup Fire and 2023 bushfires SE of Perth

Two case studies further highlight the ongoing success of lesson capture and implementation following on from the WA Dwellinup1961 bushfire, one in 1978 and one in 2023.

December 1978 bushfire case study

The first case study is provided by Brass and Skillen (2024), which outline twenty-seven fires on one weekend, a December 1978 replay of the 1961 Dwellingup Fire.

The Neville Brass' story is included here as a shortened version:

Two fires already started on Friday and then we got another 25 new fires over the next two days, all started by the one lightning storm on the Friday afternoon, but because there had been a spot or two of rain, most of them only started to show up on the Saturday. Several were still "sleeping" until after lunch on Sunday when the temperature started to rise. This meant that over the two days we had new fire reports coming in all the time, one after the other.

Luckily, the weather was hot and the bush was dry, but it was not too windy. Had there been strong winds, things might have been different. Secondly, nearly all of the State forests in the Dwellingup district in those days were subject to regular fuel reduction burning, so there were no areas of heavy fuels. Some of the fires were in such light fuels that they just trickled around. Thirdly, this was after the adoption of spotter aircraft by the Forests Department.

They only had to use a bulldozer on one of them. This was the last fire detected on Sunday in the Mt Saddleback timber reserve out near Boddington. Every other fire was controlled by the crews on the ground using rakes and knapsack sprays, and the Heavy Duties for mopping up.

Most of the fires were well away from roads, but we were able to use the spotter planes to guide crews into the fires.

Things went pretty well, as by late on Sunday we had every fire contained and mopped up.

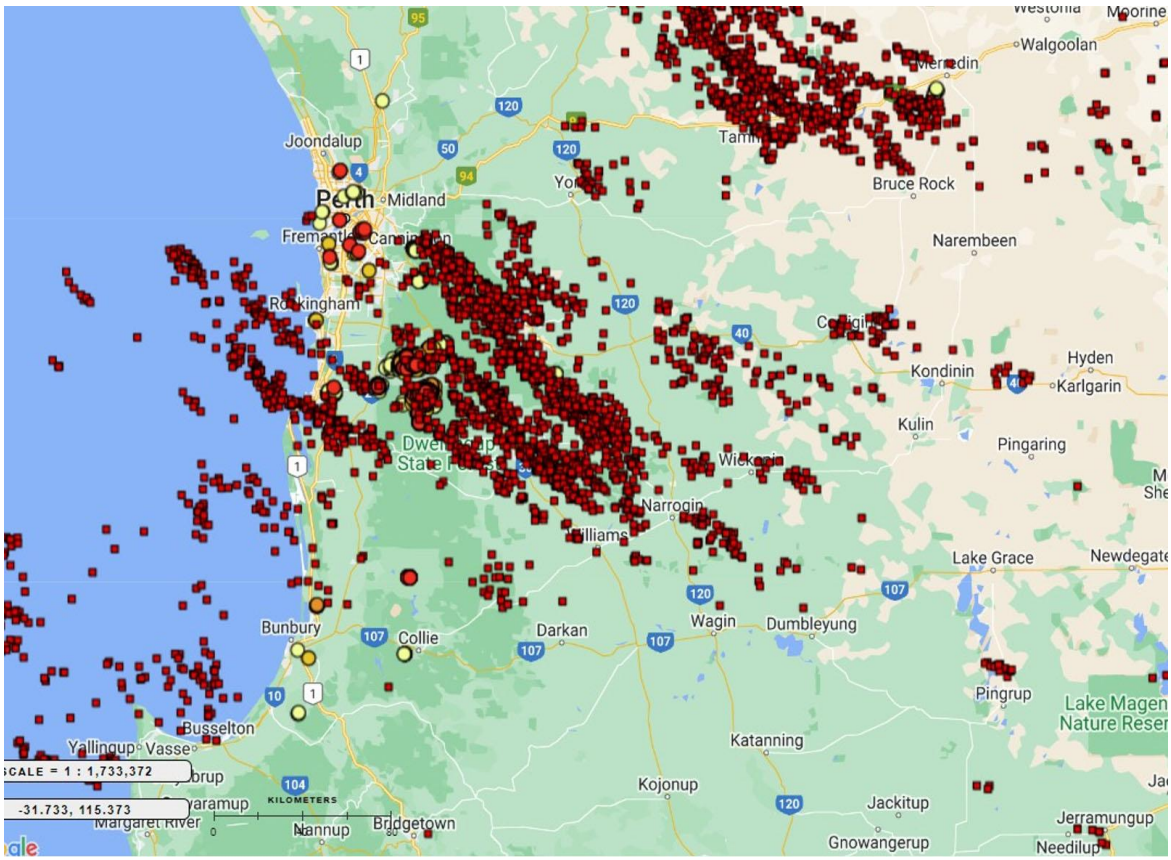
In about half the district, fuel ages were 3- years-old or less, and the oldest fuels were only 6-7 years old, maybe the odd area with 10-year-old fuel. We were always confident we would win.

The web link to the full article is included with the Brass and Skillen (2024 reference.

Late 2023 case study

The second case study is provided by Batini (2023) in relation to a series of bushfires in late 2023:

The weekend of 4/5 November 2023 was eerily similar to my experiences as a 20 year old fire-fighter at the disastrous 1961 Dwellingup fire, which burnt 200000 hectares of forest and destroyed several towns. Fortunately, despite several near-misses, no lives were lost. Multiple lightning strikes, dry, heavy fuels and strong winds eventually overwhelmed all fire-fighting efforts. Control was only achieved with the onset of cooler weather and rain.



Pattern of lightning strikes, 4-5 November 2023.

High temperatures, dry fuels, strong winds and multiple "dry-lightning" strikes earlier this month were also cause for concern. The next day, the spotter aircraft reported 26 smokes within the forests south-east of Perth. The Incident controller plotted the location of these fires onto his fuel-age plans and was relieved to find that, of the 26 fires, 20 were burning in fuels that were less than four years old, so could initially be left unattended. He then concentrated all fire-fighting efforts on the six fires burning in heavier fuels. These were brought under control, with a total of only 6000 hectares of forest burnt.

In summary, in the 1978 bushfires, fuel ages were 3- years-old or less, and the oldest fuels were only 6-7 years old. In the 2023 bushfires, 20 were burning in fuels that were less than four years old, so could initially be left unattended whilst priority areas were tackled. Fuel management is critical in managing wildfires.

2.7 Ongoing development of evidenced based prescribed burning and bushfire extent information and decline in mitigation treatment

The Bushfire Front Why Prescribed Burning publication outlines the continuing importance of prescribed burning on the web (2025 web) and the links:

- https://bushfirefront.org.au/prescribed-burning/why-prescribed-burning/

The document and link includes a 67 year graph of the area of prescribed (fuel reduction) burning is shown in green, and the area of bushfires (wildfires) in red, from 1950/51 to 2016/17. The graph clearly highlights that prescribed burning has been very successful in reducing bushfire extent.

The link also outlines that over 60% of the forest area of the southwest contains fuel loads at which direct attack will fail under only moderately severe weather conditions and also highlights the longer response times to get to a fire outbreak. The critical issue of safety of firefighters is also considered, the higher the fuel load the greater the fire intensity and the more erratic fire behaviour becomes, putting firefighters further at risk. The author considers that these areas need further action to optimise community, fire fighter and forest safety and wellbeing.

Other WA Bushfire Front links in relation to the importance of prescribed burning include:

- https://bushfirefront.org.au/prescribed-burning/the-science-behind-prescribed-burning/
- https://bushfirefront.org.au/landscape-prescribed-burning-a-south-west-australian-perspective/

Peet and Williamson (2025 web) raised more recent forest fire management system decline concerns. They noted that the lessons learned from the Dwellingup fire provided the basis for a highly successful forest fire management system for Western Australia for nearly 40 years and WA has avoided any large scale wildfires. They noted that the system has been allowed to decline and next time WA may not be so lucky in avoiding loss of life.

The points made by Peet and Williamson (2025 web) are valid and evident in the above 67 year graph of the area of prescribed (fuel reduction) burning is shown in green, and the area of bushfires (wildfires) in red, from 1950/51 to 2016/17. Since the early 1990's the decline in annual prescribed burning has resulted in an increase in annual bushfire extent. The area of forest treated by prescribed burning per year as a percentage of forest area is still way ahead of all other southern states.

3 Conclusions

The Dwellingup fire was a tragedy, but it was also a gift of hard-won wisdom. It showed Australians the futility of relying on suppression alone, the necessity of prescribed burning, and the importance of organisation, planning, and scientific research.

The 1961 WA bushfires provide a classic, rare case study where the recommendations of a Royal Commission and lessons learnt by firefighters were taken seriously by the government, and land and fire management agencies, in particular the WA Forests. Over time, virtually all of the and recommendations and lessons learnt were implemented. This resulted in significant decline in the annual area burnt by bushfires, and consequent bushfire losses.

Of all the major bushfires in Australia's history, the author believes none has left such a deep and lasting legacy as the 1961 bushfires in Western Australia. The 1961 Dwellingup fire in particular became an important case study for how bushfire was understood, managed, and mitigated in the decades that followed. It is no exaggeration to call it the single most important "teaching event" in the history of bushfire management in Australia.

A large number of very important lessons were learnt in and following the 1961 WA bushfires; a critical lesson being the optimisation of fuel reduction/ prescribed burning to reduce the build-up of undergrowth, such as leaves and twigs, on the forest floors. It was noted that under severe weather conditions (i.e., high temperature and strong winds), fuel ages greater than 5 years in the western jarrah forest, and 7 years in the eastern forest, would carry a crown fire, and thus be virtually uncontrollable. It was also noted that areas of fuel-reduced forest caused the crown fire to descend to the litter, but did not stop major fire runs unless the burn was less than a year old, however, it was possible to fight a fire in litter less than 5 years old. Fuel-reduced area of forest needed to be at least 3 km in depth (say, 3 km) to enable a running fire to be contained.

Important lessons were captured in relation to the optimisation of bushfire suppression equipment, radio communications and weather forecasting.

Other lessons learned included suppression has limits, crown fires under extreme conditions are hopeless to fight; people must have a Plan B; organisation and equipment are vital; and with the fire

detection system, based on towers, failing due to smoke, radios malfunctioned in the weather and trucks and tankers were inadequate.

Another key lesson that was captured was the establishment of a fire behaviour research program to understand more about fire behaviour and to find improved techniques for prescribed burning.

Other information highlights major lesson issues in relation to the WA 1961 Dwellinup bushfire, including difficulty of containing lightning strikes in heavy fuels; the number of lightning strikes and difficulty of containment; quick bushfire attack and good attack methodology and the importance of effective town bushfire protection.

It is apparent that the conductance of the Inquiry by Forester GJ Rodger and the assistance of AG McArthur to the Inquiry were both very valuable in the success of this commission. Foresters need to be much more involved in fire management and review.

The lesson capture has clearly worked in relation to better protecting communities and fire fighters.

A warning for the future, bushfire systems require maintenance. When that discipline lapses, fuel builds again, knowledge fades, and the cycle resets. If the lessons of 1961 are forgotten, another Dwellingup is inevitable. And next time, WA may not be so lucky in avoiding loss of life, property and damage to ecosystems.

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Annexure 1 Peet and Williamson (2025 web) provide extensive lessons in relation to the Dwellingup Fire:

Peet and Williamson (2025 web) provide extensive lessons in relation to the Dwellingup Fire:

Introduction

Why go back to a fire that occurred over half a century ago? What can it tell us that is relevant to our situation today? Unfortunately, it can tell us a great deal, as our forest estate is now in a similar condition to what it was just before the fire. The stage is the same. All we need is a similar combination of weather and multiple ignitions, and we are certain to be faced with a similar disaster.

The Dwellingup fire was a pivotal event for the Forests Department of the day. The intensive post-fire review brought about major changes in fire management policy and procedures and provided some fundamental lessons in forest fire management that are just as relevant today.

Some may argue that we have far better fire suppression capability these days – better communications, better detection systems, better on-ground equipment and airtankers. True, we do have those improvements, but, crucially, we do not have twice the number of very experienced fire crews that were available in 1961, nor do we have the large pool of timber industry workers who could be used to back up Forests Department resources. As all firefighters know, its not the media-attractive airtankers that extinguish forest fires, it's the men on the ground. Furthermore, we do not have the ready availability of large numbers of bulldozers that could then be called upon for fire fighting. The undoubted improvement in suppression capability in these ways, plus the paucity of large forest fires in recent years, has lulled many into a false sense of security, and a naïve faith in the fire suppression paradigm.

Background

The overall fire management policy of the Department, at the time, is described by McKinnell in another paper at this seminar. Suffice it to say here that, while the fire plans indicate that 40% of the forest in the area near Dwellingup had been burnt in the previous 6 years, the burns were generally small in size, were extremely patchy due to concerns over damage to regeneration, and there were large areas of heavy fuel up to 20 years old still remaining between burnt forest. Knowledge of fire behaviour was rudimentary at that time so the approach to prescribed burning was very cautious. Much of the burning in the previous 6 years had also been located in forest east of Dwellingup, rather than in the main forest belt.

Events as They Unfolded

At its height, something like 1000 men were engaged in combating the fire, with personnel from the timber industry, local farmers, bulldozing contractors and even the Army involved.

Post-fire Review

A post-fire review team, led by noted forester W H Eastman, undertook an intensive study of the management of the fire and of the fire effects in the forest. Actually they also included information from the numerous other severe fires in that year. The conclusions they reached with respect to fire behaviour were as follows:

Under severe weather conditions (i.e., high temperature and strong winds), fuel ages greater than 5 years in the western jarrah forest, and 7 years in the eastern forest, would carry a crown fire, and thus be virtually uncontrollable.

Areas of fuel-reduced forest caused the crown fire to descend to the litter, but did not stop major fire runs unless the burn was less than a year old, however, it was possible to fight a fire in litter less than 5 years old.

A fuel-reduced area of forest needed to be at least 2 miles in depth (say, 3 km) to enable a running fire to be contained. Such buffer zones need to be oriented more or less east-west across the forested zone of the State to arrest the run of a major fire.

Fire damage to trees and other forest values was in direct proportion to the fuel load. The higher the fuel load the more severe the damage and the more difficult it was to control the fire.

The more general conclusions for forest fire management were:

To protect the forest estate, a much more focused program of fuel reduction burning should be undertaken, aiming to ensure that most of the forest estate carried fuels no greater than X tonnes/ha in jarrah and Y tonnes /ha in karri forest. The only exceptions should be areas held to protect regeneration before it could withstand fire, and certain research sites.

Knowledge of fire behaviour in fuel reduction burning was deficient and a fire behaviour research program was urgently needed so that burns could be carried out safely at the required low intensity.

Planning of burning programs need to be upgraded, with larger individual burns, pre-burn inspections to develop precise prescriptions for each burn. Small burns reduced bush crew prescribed burning productivity and were easily outflanked by a large wildfire.

Prescribed burning activities needed to given absolute priority during periods of suitable weather.

Thought needed to be given to ways of increasing the productivity of crews carrying out burning activities, especially in southern forests where access was more difficult.

Improving quality control of fuel reduction burns was required, with more crew training in burning techniques.

On fire suppression, the findings were:

The fire detection system needed improvement (this led to the establishment of the fire spotter aircraft fleet).

Fire fighting equipment needed upgrading, with better tanker trucks, standardised pumper units, etc

The HF radio communications system had failed badly (due to the weather conditions) and should be replaced by a VHF system that was insensitive to weather conditions.

Better pre-planning of fire suppression was required, with the roles of each staff member defined, and training provided for each defined role.

Better information systems were required, covering fire equipment and human resources, and much more accurate recording of the results of prescribed burning activities.

However, it was acknowledge that no matter what improvement of fire fighting equipment took place, the key to successful mitigation of fire damage was control of fuel loads in the forest.

As a result of the review, major investments were made in a VHF radio system, improved burn planing , better crew trucks and equipment, and a major new fire research program was initiated. Over the next 10 years about 400 experimental fires were measured in jarrah and in karri forest to quantify fire intensity with variations in fuel and weather. A joint program with CSIRO produced a world first in aerial burning,

Conclusions

The principal conclusion from the review was that the key to avoidance of major forest fires in WA forests was maintaining the forest in a generally low-fuel condition. Despite the obvious need for improvements in several aspects of the fire suppression system, it was recognised that under severe weather conditions no amount of high technology equipment could control a major forest fire. Subsequent experience here and overseas confirmed this finding. Even in the USA, where the resources available are very large indeed, the fire suppression paradigm has failed. On a visit to the USA in 1978, there were over 30 ex military bombers at one airfield in San Diego fitted for water bombing. Many others were at other airfield in California. A Large Fire Organisation with these resources, which could also muster 6000 firefighters, has repeatedly failed to prevent high property damage in several disasters over the last 30 years. There is now a belated recognition there of the importance of forest fuel reduction.

The lessons learned from the Dwellingup fire provided the basis for a highly successful forest fire management system for Western Australia. For nearly 40 years we have avoided any large scale wildfires, but the system has been allowed to decline, as described elsewhere in this seminar. If we allow this situation to continue, it is certain that we will pay for it with another major conflagration. This time we may not be so lucky in avoiding loss of life.

Annexure 2 Department of Conservation and Land Management (1994)

Department of Conservation and Land Management (1994)
https://library.dbca.wa.gov.au/FullTextFiles/015497.pdf

Early fire policies

The policy of restricting the use of broad scale burning and improved fire suppression saw heavy fuels accumulating in most forest areas by the 1940s. From the late 1930s onwards, fires had started to become very large and difficult to control. There were major fires in the jarrah forest in 1949/50 (Wallace, 1965) and in the jarrah and the karri forests in 1937 and in 1950/51. In the long protected compartments fires became uncontrollable once they exceeded about a hectare in size, even under quite mild weather conditions.

The situation in the northern jarrah forest in the decade after World War II has been graphically described by Havel (1987) who was a forestry worker at Gleneagle at the time:

"The Gleneagle bush (like most of the jarrah forest) at this time had been fully protected from fire for over two decades, and the resultant accumulation of leaf litter and debris was so immense, that firefighting in summer was almost hopeless. Even the newfangled bulldozers the Department brought in after 1950 could make little impression. Once a fire started in these heavy fuels it was almost impossible to make a stand against it. Usually we had to hold our attack until the hours between midnight and dawn, when the temperature dropped - but if a strong easterly, or a no'wester was blowing, you could forget about it. The firefighting strategy of the time was thus retreat and then more retreat, often for days and nights at a time, until the cool change came through from the west and a massive containment and mop-up operation could be mounted.

The prescribed burning of those days was concentrated on gulleys and buffers between the protected compartments. Even this operation was extremely chancy. No matter how mild the day, the long unburnt forest we were trying to protect always burnt much better than the fuel-reduced buffer strips we were trying to burn, so that every hop-over rapidly became an emergency."

Also at about this time there were massive fires in the southern forest national parks, notably the Walpole-Nornalup park, where whole hillsides of karri trees were killed. The remnants of these dead trees, and the regrowth forests which developed under them, can still be seen near Nomalup today.

In 1953 there was a change in Forests Department policy and broadscale prescribed burning for fuel reduction was introduced. Because of the massive fuels in most of the areas to be burnt, implementation of the policy was cautious and slow at first. Most of the initial burning in the northern jarrah forest was actually done in the winter. There were also technical deficiencies, especially lack of fire behaviour information on which to base burning prescriptions, and a lack of trained staff to undertake the work. Little effective burning could be undertaken in the dense southern forests, principally because of lack of access and problems with predicting fire behaviour in complex karri and karri-tingle fuels.

The early development of fire policies and their implementation is summarised by McCaw and Burrows (1989).

The Dwellingup watershed

The culmination of early fire policies for West Australian forests came in the summer of 1960/61. Massive fires swept through the forests of the south-west. The town of Dwellingup was burnt, as were the smaller settlements of Holyoak, Nanga Brook and Karridale. There were serious losses of pasture, stock and fencing. Fortunately no one died in the fires, but many were injured, and the cost to the community was enormous.

A brief summary of the fires is given in Stewart (1969), from which the following extract is taken:

" ..... after weeks of hot dry weather, on a "dangerous" day on 19 January with a temperature of 1040F, a series of lightning strikes occurred between 5.30 and 6.00 pm dispersed over some 20 000

hectares of State forest within 15 to 32 kilometres of Dwellingup. Six fires were reported that evening and a further four between 5 .15 am and 1.15 pm the following day. Strikes also occurred in Gleneagle and Harvey Divisions.

Gangs were promptly despatched and most fires were held, but by the time the tenth fire erupted, about 1.15 pm on 20 January in century temperatures with an easterly wind, all gangs were committed. It was out of control before emergency forces could launch an attack, and made a run of six kilometres by 6 pm, throwing spot fires ahead. That night a further series of lightning strikes occurred in Dwelling up, Collie and Harvey Divisions, thus requiring retention of forces in the two latter divisions which could otherwise have assisted at Dwellingup.

Despite reinforcements from southern divisions, timber industry personnel and farmers, there were insufficient resources over the next few days to contain the numerous outbreaks which eventually linked into one vast burn with an extremely long and irregular perimeter. With 'dangerous' weather again on Tuesday 24, a temperature of 106° F and freshening wind from the north and north-west, many breakaways occurred and units were recalled to Dwelling up for regrouping. The wind had dropped towards evening and with a fire front two miles north of the town, forces were deployed on threatened flanks and throughout the village although no immediate danger was then apparent. About 8 pm winds of gale force from the north showered burning debris on Dwellingup long before the ground fire reached the town perimeter. Numerous fires were set both in the open and to buildings. Women and children were quickly assembled in bare open spaces .... The Dwellingup fires covered 146 200 hectares, destroyed 132 dwellings, a hospital, two sawmills, two service stations, three general stores, offices, outbuildings and 74 motor vehicles to a total value of some $2 million." In the wake of the 1961 fires, a Royal Commission was held. The report of this Commission (Rodger, 1961) contains numerous recommendations concerning measures necessary to prevent and control bushfires. From the point of view of the Forests Department, recommendation 20 was the most significant. It read:

"The Forests Department [is to] make every endeavour to improve and extend the practice of control burning to ensure that the forests receive the maximum protection practical consistent with silvicultural requirements."

This did not represent a redirection of policy for south-west forests, rather it unambiguously endorsed the policy which had been adopted in 1953.

The Royal Commission's recommendations were adopted in full by the Government of the day, and have not been rescinded over the intervening years. The recommendation only applied to the Forests Department. The other government agencies involved in management of forests in the south-west, i.e. the Fisheries and Fauna Department and the National Parks Board, were not directed to follow the same path as the Forests Department. The areas of land they managed in the south-west at the time were relatively small. Nevertheless, both agencies undertook prescribed burning for fuel reduction in the areas they managed, as their meagre resources permitted.

Operational and research developments in the wake of the Dwellingup fires

The decision to use fire to fight fire in Western Australia generated a wide range of scientific work and technical development. Major progress was made in the following areas:

• Fire behaviour research and prescribed burning guides

Over a period of about 30 years, forest research scientists have developed a profound understanding of fuel accumulation rates and the effects on fire intensity and rate of spread of different temperatures, wind speeds, relative humidity, fuel dryness and slope for the jarrah and karri forests. This information was incorporated into a fire behaviour prediction system and a prescribed burning guide which is used by field staff in planning and implementing prescribed bums. (The information is also used when planning wildfire suppression strategies, but is less reliable, i.e. the current model tends to underestimate rate of fire spread at higher intensities, because of lack of experimental data in this range.)

• The rationale for prescribed burning

In conjunction with the work on fuels leading to improved prescribed burning techniques, a quantitative assessment of the relationship between fuel loading and ease of fire suppression was developed. Using a combination of knowledge of fire intensity and flame heights and the practical experience of expert firefighters, threshold levels of fuels have been set for the main forest types, and these represent the rationale for cyclic prescribed burning. The threshold levels of available fuel for the jarrah forest have been set at eight tonnes/hectare and for the karri forest at 17 tonnes/hectare. These limits are set because: (i) they represent the level of fuels above which headfires cannot be successfully attacked under average summer conditions; (ii) they are the upper limit of fuel quantities beyond which fire intensity will cause unacceptable damage to young trees and will generate crown fires and spotting.

These threshold fuel levels are also used as the basis for setting prescribed burning return times ("rotations") for the forest where fuel reduction for wildfire mitigation is the policy. The time taken for fuels to build up to eight tonnes per hectare in the jarrah forest or 17 tonnes per hectare in the karri forest varies considerably, depending on climate, site fertility and forest structure. The average is five to seven years in the jarrah, 7-10 years or more in the eastern jarrah/wandoo and six to eight years in the karri forest.

(Incidentally, the rate of fuel accumulation after fire is much more rapid in the karri than in the jarrah forest. Conditions are also more mesic in the karri forest, and the fire season is shorter and generally much Jess severe. This is why a higher threshold level for fuels is considered acceptable; to maintain fuels below eight tonnes per hectare in the karri forest would require a two to three year burning rotation, which would be impractical and probably unacceptable ecologically).

In practice, prescribed burning rotations are determined by actual measurement of fuel accumulation, not years elapsed since last burn.

• Fire effects studies

Studies into the effects of fires on soil physical and chemical properties, flora, fauna, water resource values and forest regeneration commenced in the early 1960s and have continued ever since. This work has resulted in a major increase in knowledge about forest ecosystems and their response to fire disturbance. This work is described in more detail later in this submission.

• Aerial burning

During the late 1950s and early 1960s, it became apparent that available resources of staff and number of suitable days were insufficient to enable the prescribed burning policy to be implemented by the traditional method of strip burning by gangs walking through the forest. As a result, a technique for lighting prescribed fires in jarrah forests from aircraft was conceived and pioneered in Western Australia. This work was done jointly by the Forests Department and the CSIRO, and it reduced the cost and increased the effectiveness of prescribed burning. In the late 1960s this technique was extended to the karri forest, the delay being caused by the need for further research into karri scrub classification, fuel drying rates and fire behaviour.

Other Developments

The high profile of CALM's prescribed burning policy has tended to obscure the fact that prescribed burning is only one of the measures employed in attacking the wildfire problem in the south-west forests.

In parallel with the developments described above, a number of other related and very significant fire management developments took place in Western Australia in the aftermath of the great 1961 fires.

These included:

• the development of highly reliable prediction systems of fuel moisture content, fire behaviour and fire effects parameters;

• the replacement of the old "bush telephone" and HF radio system with VHF and UHF radio systems;

• the introduction of spotter aircraft to augment and partly replace the fire detection system based on lookout towers;

• the use of fire retardants to help with fire attack and mopping up, thus greatly increasing the efficiency of fire fighters;

• the first inter-agency agreements for cooperative fire management with Shires, Bush Fire Brigades and other organisations;

• formal and structured fire training systems for CALM staff and volunteers;

• the development of structured and pre-planned fire command systems (the "Large Fire Organisation", "Red Action" and, most recently the Interagency Incident Control System which is standard for all bushfire authorities in Australia) aimed at ensuring that arrangements and procedures for responding to and coping with fire emergencies are effective, timely and appropriate;

• the introduction of computers for mapping, fire behaviour computation and for aiding decision-making and fire management planning;

• provision of an updated vehicle and pumper fleet in the field;

• development of aerial and ground function systems for the safe, accurate and cost effective function of planned burns;

• the development of Wildfire Threat Analysis as an objective way of identifying, ranking and mapping values to be protected so that priorities and procedures for fire prevention and fire suppression works can be agreed on and implemented with the resources available;

• the identification of "strategic buffers" in the forest - areas where fire protection would take priority over other forest uses, and incorporated through integrated planning across tenures.

Taken as a whole, in conjunction with the use of fire to reduce fuels in the forest, these measures provided a total approach to fire management on crown land forests in the southwest.

In addition, good working relations with Shires and the Bush Fires Board have been achieved to ensure integration of CALM's approach with the approach taken on neighbouring lands.