The Department of Environment and Conservation (WA)

DEC is the lead agency responsible for conserving Western Australia's rich diversity of native plants, animals and natural ecosystems, and many of its unique landscapes. It is also responsible for regulating protection of the environment including the quality of air, water and soil. Under the *Conservation and Land Management Act 1984* (CALM Act), DEC manages more than 27 million hectares of lands and waters, including national parks, marine parks, conservation parks, regional parks, State forests and timber reserves, nature reserves, and marine nature reserves.

Fire management for biodiversity conservation and community protection is a key responsibility of DEC. DEC has direct statutory management responsibility for lands under the CALM Act, and also has fire preparedness responsibility on a further 89 million hectares of unallocated Crown land and unmanaged reserves in the State.

Prescribed fire is used as a tool for fuel hazard reduction and wildfire mitigation and for ecosystem management. Planned fires are used to maintain and enhance nature conservation values (eg. protecting and regenerating a diversity of wildlife habitats; rehabilitating degraded areas; creating a diversity of post-fire seral stages, etc), and maintaining ecosystem processes such as nutrient cycling. Fire is also used to achieve land management objectives such as catchment management and the regeneration of native forests and understorey vegetation associations after disturbance by timber harvesting. In many cases, planned burns are undertaken at landscape scales to achieve both protection and ecological management objectives by varying the seasons, fire intensities, and the interval between fires. The Department has an obligation to ensure that the condition of the public land which it manages does not pose a threat to human life and property as a consequence of wildfires.

Fire management in the forested region of south-west Western Australia

Like many Australian ecosystems, the combination of flammable vegetation and climate, together with lightning and humans as ignition sources, has ensured that fire has been an environmental factor that has shaped these ecosystems over many thousands of years. Consequently, native species and ecosystems have evolved physical and behavioural traits that enable them to not only persist with fire, but in many cases, depend upon certain fire regimes.

The bushfire hazard in the south-west of Western Australia is as severe as any region in the world. It is one of the few regions in the world that has the combination of tall forests, which shed tonnes of highly flammable material each year, and a strong Mediterranean-type climate with cool wet winters and warm to hot dry summers. Vegetation is flammable for three to six months each year during which there are periods of high temperatures, low humidity and high winds generated by unstable frontal movements, intense low pressure systems (cyclone remnants), deep coastal troughs and strong land and sea breezes. This gives rise to days of High, Very High and Extreme fire danger.

Each year more than 300 wildfires start on the public lands managed by DEC in the south-west of Western Australia. Weather conditions occur under which many of these fires, if not quickly contained, have the potential to develop into fast spreading, intense, uncontrollable wildfires that threaten lives, damage property and the environment, and are costly to the community. Each year, DEC staff and volunteer firefighters are called upon to protect the community and its valued assets from the impacts of intense summer wildfires in the forests, woodlands and heaths of the south-west.

Fire management is, ecologically and socially, one of the most complex and challenging issues facing land managers. Prescribed burning, or the deliberate use of fire set under specified conditions of fuel and weather to achieve management outcomes, is also controversial. As a land management agency, DEC recognises that in fire-prone environments, proactive fire management is integral to, not incidental to, good conservation and land management. If wildfires cannot be managed, then it is unlikely that other land management objectives will be achieved.

DEC's fire management role

DEC has the lead role in responding to and suppressing fires on DEC-managed lands across the State. In the south-west forest regions and in the Midwest and the South Coast regions, DEC is supported by officers of the Forest Products Commission and the bushfire brigades of the Local Government Authorities. In other parts of Western Australia, DEC has more limited fire management resources. DEC works with the Fire and Emergency Services Authority (FESA) and local governments in fire management.

Fire management is an integral component of DEC carrying out its statutory functions.

Departmental management structure

The work of the department is carried out through six service (program) divisions and five operational and support divisions. Inputs to the direction of fire management works are provided by three divisions – Nature Conservation; Parks and Visitor Services; and Sustainable Forest Management. Science Division provides research and technical support to fire management programs which are implemented by the Regional Services Division. DEC's Fire Management Services Branch is located within the Regional Services Division, together with the department's nine regions. Fire management programs are developed and carried out collaboratively between regions, Fire Management Services Branch, Science Division and the three service divisions.

Fire Management Policy and Code of Practice

DEC's fire management business is guided by a comprehensive policy document (Policy Statement No. 19; see Appendix 1). The policy contains the fire management objectives for DEC-managed lands and policy statements pertaining to safety and risk; use of fire; fire suppression; wildfire prevention; liaison; and research. Also included in the policy are a set of Principles for Fire Management and the requirements for policy implementation. The policy was updated in October 2005 following a comprehensive round of public consultation and review by the Environmental Protection Authority (EPA). Further amendments to the policy are currently under consideration.

DEC has also prepared a Code of Practice for fire management which provides a framework for fire management and procedures on lands managed by the department (DEC-managed lands).

Early fire policies

There is considerable evidence that, prior to European settlement of WA in 1829 (Swan River), Nyoongar Aborigines used fire widely and frequently for a range of reasons, although the actual frequency with which Aboriginal people burnt the forests is uncertain. Following European settlement, there was little attempt to deal with bushfires in the south-west until after the passage of the Forests Act in 1918 and the establishment of the Forests Department in 1919. Early foresters were concerned by the extent of fire damage from the severe forest fires that were allowed to run unchecked as a result of the cessation of Aboriginal burning and uncontrolled logging during the 1800s and early 1900s. From 1924 onwards there was an attempt to apply a fire exclusion policy to most of the cutover jarrah forests.

The development of bushland fire policy saw opposing forces in conflict over the use of fire from the very beginning. Many of the European-trained professional foresters who were appointed to the new Forests Department were unfamiliar with fire and so were opposed to prescribed burning. On the other hand, field foresters with long experience in the Australian bush were in favour of it.

During the 1920s and 1930s fire management involved the subdivision of the forest into areas which had been cut over for timber and regenerated, and those which had not. Attempts were made to completely protect cutover forests from all fire. Some limited prescribed burning to create "firebreaks" (narrow strips of forest between two tracks) was undertaken in the remainder of the forest. These narrow "firebreaks" did little to prevent wildfires burning much of the forest in these early years.

The policy of restricting the use of broadscale planned burning and improved fire suppression saw heavy fuels steadily accumulating with time in most forest areas by the 1940s. From the late 1930s onwards, wildfires had started to become very large and difficult to control as fuels accumulated across the region. There were major fires in the jarrah forest in 1949/50, and in the jarrah and karri forests in 1937 and in 1950/51. In the long unburnt compartments with heavy fuel loads, fires became uncontrollable once they exceeded about one hectare in size, even under mild weather conditions.

Also at about this time there were large, intense fires in the southern forest national parks, notably the area that is now the Walpole-Nornalup National Park and adjoining areas, where whole hillsides of karri and tingle trees were killed. Few, if any, people were killed by these fires because these areas were sparsely populated at the time.

Recognising that the attempted fire exclusion policy was failing, and as foresters better understood the role of fire in the environment, the Forests Department changed its policy and, in 1953, introduced a policy of broadscale prescribed burning to manage fuel build-up. Because of the heavy fuels in most of the areas to be prescribed 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 winter. There were also technical constraints, especially lack of fire behaviour knowledge on which to base planning and burning prescriptions, and a lack of trained staff to undertake the work. Little effective burning was 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 Dwellingup watershed

The inevitable consequence of the early policy of fire exclusion culminated in massive wildfires in the summer of 1960/61. Preceded by drought, ignited by numerous lightning strikes and fanned by strong hot winds, intense wildfires burnt 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 houses, buildings, infrastructure, pasture, stock and fencing. Fortunately no one died in the fires, but many were injured, and the cost to the community was enormous.

In the wake of the 1961 fires, a Royal Commission was held. The report of the Commission (Rodger, 1961) contains many 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 complete 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.

Fire research and development

The decision to expand the use of low intensity planned fire to manage wildfire in Western Australian forests initiated a program of scientific research and technical development to underpin fire operations. This research, much of which has been recently summarised in a book, "*Fire in ecosystems of south-west Western Australia: impacts and management*" (Abbott and Burrows, eds.), published in 2003, focussed on the following themes:

Fire behaviour and prescribed burning guides

Over a period of about 30 years of research, fire scientists developed a firm understanding of how forest fires behave (their speed and intensity) under different conditions of fuel quantity and type, fuel moisture content, weather and topography. They also developed fuel accumulation and fuel moisture models. This knowledge was incorporated into a fire behaviour prediction model and a prescribed burning guide, which is used by field staff in rating fire danger, planning and implementing low intensity prescribed burns and in the suppression of wildfires.

Fire ecology

Studies into the effects of forest fires on soil physical and chemical properties, flora, fauna, water resource values and forest regeneration commenced in the early 1960s and have continued since. This work has resulted in a major increase in knowledge about forest ecosystems and their response to fire. While knowledge is incomplete, there is an adequate knowledge base to devise and implement fire regimes that are likely to be beneficial to the environment.

Aerial prescribed burning

In the 1960s it was apparent that there were insufficient personnel and other resources to undertake the amount of prescribed burning that needed to be done during the limited number of suitable burning days by the traditional method of strip burning by teams of people walking through the forest. A technique for lighting prescribed fires by dropping incendiaries from aircraft under specific conditions of fuel and weather was conceived and developed in Western Australia. Not only did this allow more area to be prescribed burnt under the desired (prescribed) fuel and weather conditions, it was much safer and less expensive than using ground crews.

Other developments

The high profile of DEC's successful prescribed burning policy has tended to obscure the fact that prescribed burning, although very important, is only one of the strategies employed in managing the wildfire threat 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 destructive 1961 wildfires. Over the years these have included:

- The introduction of spotter aircraft to augment and partly replace the fire detection system based on lookout towers;
- Better firefighting equipment;
- The development of inter-agency agreements for cooperative fire management with Local Government Authorities, Bush Fire Brigades, FESA and other organisations;
- Formal and structured fire training systems for DEC staff and volunteers;
- The development of structured and pre-planned fire command systems (the Inter-agency Incident Control System which is standard for all bushfire authorities in Australia) which ensures that arrangements and procedures for responding to and coping with fire emergencies are integrated, effective, timely and appropriate;
- The development of a Wildfire Threat Analysis framework 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; and
- In recent years the introduction of an aerial suppression capability (water bombers) to rapidly contain small initiating wildfires which has proven to be effective where the aircraft have been able to apply the water/foam drops within 30 to 45 minutes of a fire starting.

Building on a foundation of planned fire to reduce fuels in the forest, these fire control measures provided an integrated approach to fire management on Crown land forests in the south-west. In addition, good working relations with Local Government Authorities and with FESA have been achieved to ensure the integration of the department's approach with the approach taken on neighbouring lands.

Fire and biodiversity

As discussed above, flammable vegetation, seasonal or periodic drought, and lightning and humans as ignition sources, have ensured that fire has been an environmental factor that has shaped the ecology of most Australian landscapes over thousands of years. Ecosystems and species have developed a variety of physical and behavioural traits to enable them to persist with and, in many instances, depend upon fire.

While knowledge is incomplete, there is a large body of scientific literature dealing with how Australia's biodiversity responds to fire and to various fire regimes. In general, and for most flammable ecosystems, extreme fire intervals such as very frequent fire and very infrequent fire can lead to reductions in vegetation structural diversity, changed species abundances and in some case, reduced species diversity. Very large and intense wildfires cause high levels of mortality and damage to native plants and animals, and irreversible loss of topsoil. Post-fire recovery may take many decades, or even centuries where old-growth forests have been killed. On the other hand, low intensity, patchy fires have little long-term impact on the biota, which recovers relatively quickly from such events.

The use of planned fire (prescribed burning) is controversial, with opponents claiming that it can be environmentally damaging. While some fire regimes can be harmful to the environment, especially in combination with other factors such as fragmentation and invasive species, there is no evidence that current prescribed burning for fuel management and other purposes has resulted in any species losses or environmental degradation. In fact there is growing evidence that, implemented correctly (appropriate interval, intensity, season and scale), prescribed burning can benefit biodiversity at the landscape scale by providing diverse habitats (seral stages) and by reducing the size and intensity (severity) of damaging wildfires.

The following scientific principles, which in various forms have been embraced by a number of Australian conservation and land management agencies, are applied to guide fire management in south-west Western Australian biomes:

1. The vegetation and climate of south-west Australia make it highly prone to bushfire. Native species and communities have developed a variety of physical and behavioural adaptations to many, but not all, fire regimes.

2. Fire should be regarded as an environmental factor that has and will continue to influence the nature of many south-west Australian landscapes and associated biodiversity. Proactive fire management, including planned burning, is integral to conservation and land management.

3. Species and communities vary in their adaptations to, and reliance on, fire. Knowledge of the temporal and spatial scales of fires in relation to the life-histories of organisms or communities involved underpins the planned use of fire in natural resource management.

4. Following fire, environmental factors such as landform, topography and species' life history attributes, and random events such as climatic events, often drive ecosystems towards a new transient state with respect to species composition and structure.

5. The planned use of fire is necessary for two primary reasons, which are not mutually exclusive:

   - to reduce the occurrence of large, damaging wildfires; and

   - to conserve biodiversity and protect the environment.

6. The biological impact (killing power) of a single fire event and the rate of recovery (of bushland and/or of human communities) is proportional to the intensity and size of the fire.

7. Fire management should be both precautionary and adaptive, considering ecological and protection objectives in order to optimise outcomes.

8. Fire diversity (diversity of frequency, intensity, season and scale) benefits biodiversity at the landscape scale. A mosaic of patches at different seral stages from recently burnt to long unburnt will provide greater habitat diversity than large homogenous tracts of either long unburnt or recently burnt vegetation.

9. Avoid applying, or allowing, the same fire regime over large areas for long periods of time and minimize seral and structural homogenisation by not treating large areas with extreme regimes such as very frequent or very infrequent fire intervals.

10. The scale, or grain size of fire mosaics should aim to: a) enable natal dispersal; b) optimise boundary habitat; c) optimise landscape connectivity; and d) assist wildfire suppression.

11. All available knowledge, including life histories and vital attributes of flora and fauna, and Aboriginal knowledge, should be utilised to develop ecologically-based fire regimes.

12. Wildfire can damage and destroy both conservation and societal values, hence risk management must be based on a systematic and structured approach to identifying and managing the consequences of such an event.

13. Fire management should adapt to changing community expectations and to new knowledge gained through research, monitoring and experience.

Effectiveness of prescribed burning in the control of wildfires

The south-west of Western Australia, with a Mediterranean-type climate of hot, dry and windy weather during the summer months and highly flammable forest fuels, is highly prone to bushfires. It is therefore not surprising that about 300 forest fires are started by lightning, arson or mischance each year.

This combination of weather, fuels and ignition sources could be expected to result in the regular occurrence of large uncontrollable wildfires that threaten lives, destroy properties and severely damage forests, plantations, water catchments and ecosystems.

On the contrary, the forest region of south-west Western Australia has experienced few large fires (greater than 10,000 hectares) since the implementation of broadscale prescribed burning and the implementation of other fire control measures following the 1961 bushfires. Since that time there have been no forest fires greater than 30,000 hectares, no lives lost in forest fires, few injuries, and only one instance of multiple property losses. In the past 20 years, the average annual area burned by wildfires in the south-west forest regions is about 20,000 hectares, which is less than one percent of the forested landscape managed by DEC.

This contrasts with the severity and extent of wildfires in the forests of south-east Australia, where many very large bushfires have occurred on a regular basis resulting in loss of life, very significant damage to property, infrastructure and the environment, and a substantial expenditure of resources in fire suppression and post-fire recovery.

Differences in fire management in south-east and the south-west Australia that contribute to these markedly different wildfire statistics

In Western Australia the topography is subdued, making it easier to undertake rapid attack on initiating fire and to implement prescribed burning. It could also be argued that south-west forest ecosystem are more fire resilient and so are more amenable to prescribed burning. However, this is not the case for all south-west forest ecosystems. Apart from differences in topography and associated moisture differentials, there is no practical difference in the structure and flammability of the forest fuels. The fire behaviour in long unburnt forests can be just as severe and destructive in Western Australian forests (as described earlier in relation to the Dwellingup fires in 1961 and fires during the 'fire exclusion' period) as they are in south-east Australian forests.

The main difference in approach to fire management between the south-west and south-eastern Australian States is the scale and frequency of prescribed burning undertaken by land management agencies. In Western Australia six to eight percent of the forested Crown lands are prescribed burned each year, compared with considerably lower areas in other States.

The extent of prescribed burning undertaken over more than 48 years in south-west Western Australia has enabled fire managers to achieve a high level of protection for community assets and natural values on and near the lands managed by DEC. There have been numerous examples where the fuel reduction burning program has resulted in relatively rapid containment of wildfires and significant 'saves', even under extreme fire weather conditions.

Forest fire managers who are directly involved in fire control operations have no doubt about the value of fuel reduced areas in reducing the intensity of bushfires and in providing safe conditions to apply effective fire suppression tactics. There is also no doubt that wildfires burning in low fuel levels cause significantly less environmental damage than fires burning in heavy, long unburnt fuels.

While the contribution of prescribed burning to wildfire control may be obvious to fire practitioners and many fire scientists, some commentators continue to question its value and call for the need to have statistical evidence to validate the effectiveness of prescribed burning. Some critics of prescribed burning offer anecdotal accounts of severe bushfires burning through recently prescribed burned areas and have concluded that in order to be effective against major conflagrations burning under extreme weather conditions, fuel reduction burning has to be repeated every two or three years.

Contrary to the claims made by some critics of prescribed burning, there exists in Western Australia a body of scientific and experiential evidence of the effectiveness of prescribed burning in ameliorating the wildfire threat.

Fire behaviour studies

Live and dead vegetation (fuel) powers a bushfire. The fundamental relationship between fuel structure and quantity, and the speed and intensity of a forest fire, has been well established since the 1960s. Doubling the quantity of fuel doubles the speed of the fire and increases its intensity (killing power) four-fold. Reducing the amount of fuel over a significant proportion of the landscape by prescribed burning will significantly reduce the potential speed, intensity and damage potential of wildfires and greatly improves opportunities for safe suppression. This is the rationale behind prescribed burning.

The effect of fuel conditions on fire behaviour has been most recently investigated by Project Vesta. This national study involving CSIRO and a variety of fire and land management agencies was conducted in the dry eucalypt forests of Western Australia, and examined the relationship between fuel age and fire behaviour by quantifying age-related changes in fuel attributes and fire behaviour in dry eucalypt forests typical of southern Australia. More than 100 experimental fires were lit under dry summer conditions of moderate to high fire danger at two sites with different understorey vegetation types ranging in age from two to 22 years since fire.

This research demonstrated that the forward rate of spread of a fire is directly related to characteristics of the surface fuel bed and understorey layers, with the near-surface fuel layer having the strongest effect on rate of spread. The near-surface layer provides a common fuel descriptor for a wide range of dry eucalypt forest types that are visually very different because of the characteristics of the understorey shrubs. Experimental data also confirmed the influence of understorey shrub height on flame height, and the contribution of bark characteristics and surface fire intensity to the spotting process.

The Project Vesta experiments indicate that fires in fuels older than about seven years will prove difficult to control under average summer conditions of moderate to high fire danger in open eucalypt forest. This finding is consistent with the conclusions of the Victorian study by McCarthy and Tolhurst (2001) which found that forests with an overall fuel hazard above the high category offered little prospect of assisting wildfire suppression.

Based on the Project Vesta experiments, Gould *et al.* (2007) concluded that hazard reduction by prescribed burning will reduce the rate of spread, flame height and intensity of a bushfire, as well as the number of spot fires, by changing the structure of the fuel bed and reducing the total fuel load. The persistence of this effect will be determined by the rate of change in fuel characteristics over time, but is likely to be at least 15 years in forest with fibrous-barked trees and a shrubby understorey.

Case studies of effectiveness of prescribed burning

There have been numerous examples when the fuel reduction program has enabled forest fire managers to control major fire events and prevent serious impacts on lives, properties and environmental values.

The most outstanding example of the contribution of fuel reduction burning in controlling intense forest fires in Western Australia occurred in 1978 following Cyclone Alby which caused 92 fires to burn out of control in and near forests. Wind speeds of up to 130 km/hour caused fires to spread at speeds of up to 8,000 metres per hour with extensive spotting. Although the total area burnt by the wildfires was more than 54,500 hectares, the rate of spread in the State forests where fuels were kept at low levels by prescribed burning was so reduced that only about 7,000 hectares of native forests were burnt. Most of the fires were allowed to burn in the low fuel areas, while fire suppression resources were directed at those fires which posed a greater threat to communities and other high values.

The effectiveness of prescribed burning in wildfire control has been documented for nine case studies in the south-west of WA by Underwood *et al* (1985). These case studies were drawn from fire records maintained by the WA Forests Departments over the period 1969 to 1984. The case studies selected included a wide range of forest fuel types in which major fire runs as well as smaller fires with high damage potential had run into areas that had been prescribed burned in past six years or less. The study projected each fire in the absence of fuel reduction burning based on the weather prevailing at the time. The study clearly demonstrated that in every case a much larger and more intense fire would have led to serious social and economic costs to the community. A similar finding was made in a case study by McCaw (1988) on two wildfires that posed a severe threat to property and community assets near Perth.

There have been several published case studies in the eastern States that have clearly demonstrated the contribution to wildfire control made by prescribed burning for fuel reduction. These include Billings (1981), Rawson (1983), Rawson *et al.* (1985) and CSIRO (1987).

Case studies of recent wildfires

While there are published examples of case studies that demonstrate how fuel-reduction burning has modified wildfire behaviour under average summer conditions, there are also examples of where the behaviour of wildfires burning under extreme weather conditions has been significantly modified by fuel reduced areas. For example during the 2006/07 Victorian fires, the extreme weather conditions drove the fires into areas burnt previously in the 2002/03 fires in the Victorian Alps. Fire intensity and the rate of spread were clearly observed to be significantly reduced as the bushfire burned through these areas. Regrettably there were no fire fighting resources available to take advantage of the lowered fire behaviour to contain the bushfire, so the fire continued to spread.

Two recent case studies involving very high intensity forest fires burning under severe weather conditions in south-west Western Australia are presented below.

Mt Cooke Fire – January 2003

The Mt Cooke fire in the Monadnocks Conservation Park on DEC-managed land about 70 kilometres south-east of Perth resulted from a lightning strike. For various reasons, fire had been deliberately excluded from large sections of this reserve for 17-20 years, so the wildfire burnt as an intense crown fire under the severe weather conditions (maximum temperature 36°C; low humidity; gusty north-west winds from 25 to 35 km/hr). The fire burnt fiercely up the slopes and along the spine of Mt Cooke and southwards for about 25 kilometres and eventually burnt out 18,000 hectares in 24 hours. The fire defoliated and killed a vast majority of the mature jarrah and marri trees within the long unburnt forests (Burrows 2004). This wildfire has simplified the mosaic of vegetation and habitat structures over a large area. The deaths of most of the overstorey will mean that it may take more than 100 years for the forest to return to its former structure.

Some of the deleterious impacts such as loss of topsoil and siltation of watercourses caused during the subsequent winter rains are likely to be irreversible.

When the headfire reached forest blocks that had been prescribed burnt between one to seven years before, the fire intensity reduced considerably and fire fighting forces equipped with bulldozers were able to attack the flanks of the fire. Even though the weather conditions remained severe, the fire was able to be contained when it slowed after reaching areas that had been prescribed burnt for fuel reduction three to five years before.

A spatial analysis of the impact of the Mt Cooke fire on the forest canopy and understorey vegetation based on Landsat satellite data (Figure 1) clearly demonstrates the reduction in fire intensity and crown damage within fuel reduced areas.

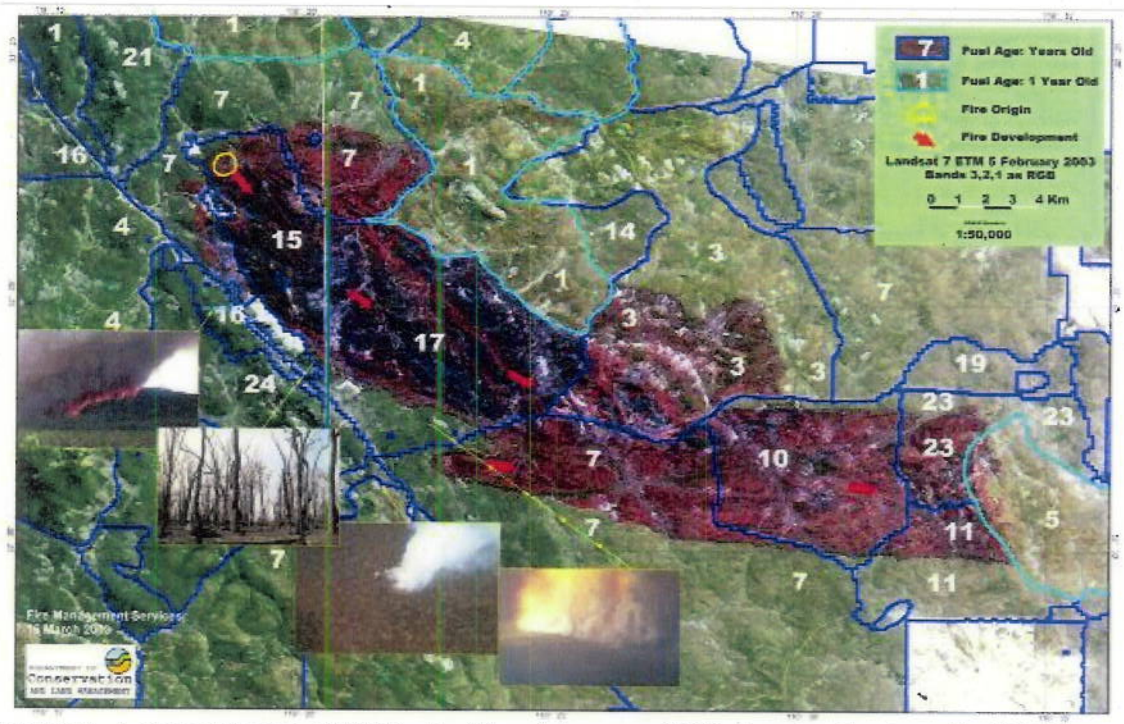

Figure 1. Landsat image of Mt Cooke Fire of January 2003 showing the benefit of DEC's prescribed burns in controlling this very intense wildfire.

Mundaring-Karragullen Wildfire – January 2005

The Mundaring-Karragullen fire which burnt during 15-25 January 2005 is another example of a high intensity forest fire that was eventually contained with the assistance of prescribed burns. The fire was the result of seven arson-caused ignitions on land managed by DEC east of Karragullen and within 20 kilometres to the east of the Perth Hills suburbs.

A study of the fire behaviour of the Mundaring-Karragullen fire was undertaken by former CSIRO fire scientist Phil Cheney (2008 in prep) to reconstruct the fires during the initial westerly and south-westerly spread on 15-17 January 2005. Three major tongues of the escalated fire travelling at an average rate of spread of 900 m/hour burned towards the Brookton Highway and the Hills suburbs of Roleystone and Araluen. When it crossed the Brookton Highway the fire ran into two and four year old fuels resulting from fuel reduction burns, where its spread was either stopped completely or checked to such a degree that suppression was straightforward and safe. Figure 2 shows the fire boundaries in relation to the previously burned prescribed burns and the Perth Hills suburbs.

Cheney found that the fuel reduction program carried out by DEC in the preceding years enabled the suppression forces to safely contain the fire before it burnt into the Hills suburbs of Roleystone and Gosnells.

Case studies can also provide insight into how the final shape of a wildfire may be influenced by the pattern and extent of prescribed burning, and by suppression activities. For example, the spread of fire can be modelled for different fuel situations and the difference between the predicted and observed final fire shape and values impacted used as a measure of the difference attributable to fuel treatment. This approach was used by Cheney who was able to reconstruct the projected fire perimeter of the Mundaring-Karragullen fire in the absence of fuel reduction burning in the past 20 years. Such a scenario was commonly encountered in the ACT, NSW and Victorian fires of 2003 and the Victorian fires of 2006 and 2009. Under the 20 year old fuel scenario, Cheney estimated that the fire would have burnt westwards over the Darling escarpment and into the suburbs of Roleystone, Armadale and Gosnells in less than 24 hours after ignition, causing significant damage and possibly loss of life.

This case study demonstrated that if fuel reduction burning is to be effective under severe summer conditions, spatial and temporal scale thresholds of fuel management must be exceeded. Burning must be regularly undertaken within large blocks throughout the forested landscape and not just immediately adjacent to high value assets such as private land and townsites, and a significant proportion of the landscape must be treated (at least seven to nine percent per annum).

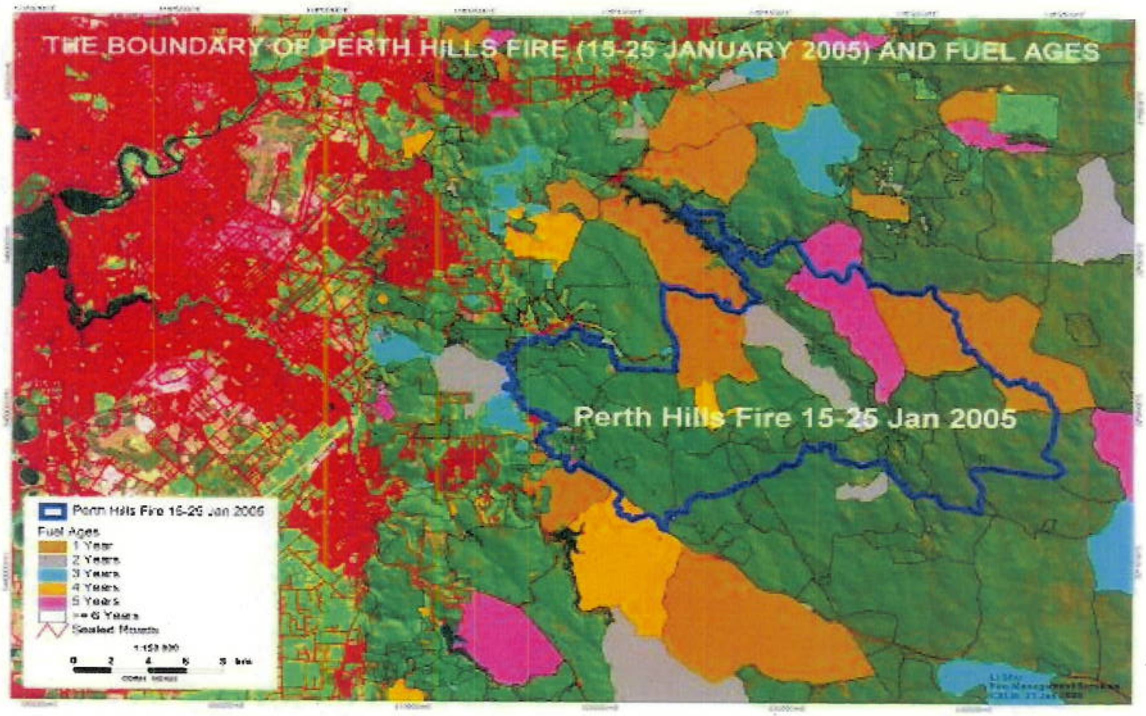

Figure 2. Plot of the perimeter of the Mundaring-Karragullen fire of January 2005 showing the fire in relation to the DEC prescribed burns and the Perth residential areas.

Quantifying the effectiveness of prescribed burning at a landscape scale

Quantifying the effectiveness of fuel management by prescribed burning at a landscape or regional scale is clearly a matter of great importance to agencies responsible for rural fire protection and management of public lands, as well as to governments and the broader community. This is not an easy task, nor one necessarily amenable to conventional scientific approaches. Cheney (2008) noted that the problem with any landscape-scale trial is that, for prescribed burning to be really effective, it has to be applied right across the landscape and on such a scale that it is impossible to have an adequate experimental control. Despite these limitations, Lang (1997) was able to demonstrate a significant relationship between the extent of prescribed burning and wildfires in the south-west jarrah forests of the Collie area, with a notable decline in the area burnt by wildfire once the extent of prescribed burning exceeded about seven percent per annum (10, 000 ha yr^{-1}) of the entire study area. See Figure 3.

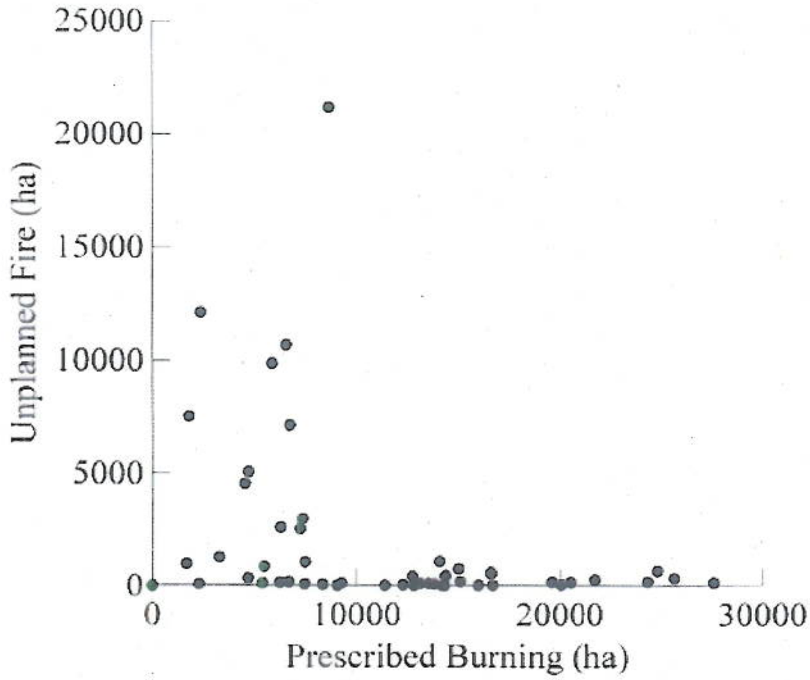

Figure 4.5 *A scatterplot plotting area burned by unplanned fires per year against area burned by prescribed burns per year.*

Figure 3. taken from study by Lang (1997) on the relationship between the annual area of forest prescribed burned and area of unplanned fires (wildfire) within the Collie forest district from 1937 to 1987.

The contribution of prescribed burning to fire control is likely to persist for several years and any comparison between the areal extent of prescribed burning and wildfire areas should include a spread of years. An investigation into the possible relationship between the areal extent of prescribed burning in preceding years and the unplanned fires over subsequent years was undertaken on the south-west forest data from 1961/62 to 2007/08.

This period covers the start of the application of prescribed burning to broad areas, with high levels in the 1960's and 1970's and gradual reductions as the burn program became more refined and targeted to achieve integrated biodiversity conservation and community protection objectives. The variations in the extent of the annual prescribed burning programs over the 47 years of this study provide sufficient data to determine whether the different levels of annual burning have an impact on the total area of wildfires that occur in subsequent years.

See Figure 4 for the prescribed burn areas achieved in the south-west forest regions from 1961 to present.

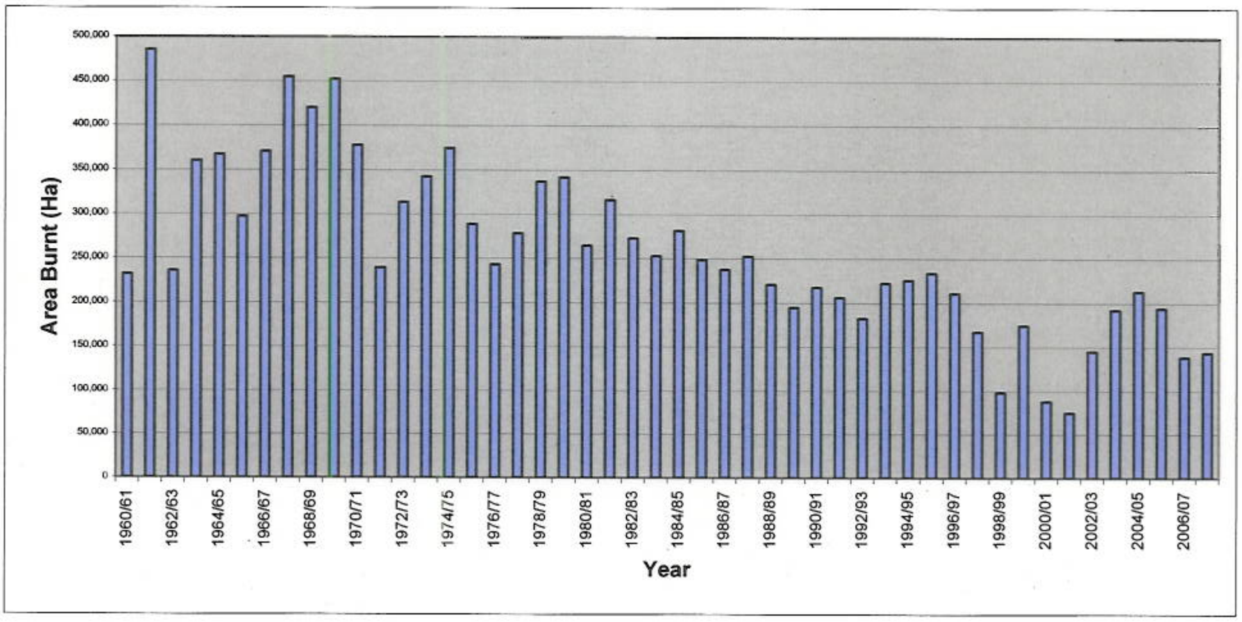

Figure 4. Area of prescribed burns undertaken each year in south-west forest regions from 1961 to present showing the trend over the past 48 years.

The analysis that was undertaken examined the relationship between the area of prescribed burning achieved over multiple years, against the total areas of wildfires that occurred in a series of the following years. This approach was taken to test the hypothesis that the contribution of prescribed burning to fire control persists over multiple years.

The results of this analysis indicate that the area of wildfires is influenced by the amount of prescribed burning that has been achieved in the preceding period. A strong correlation exists between the area of prescribed burning achieved in one year and the accumulated area of wildfires averaged over the following five years (R^2=0.77). This correlation, as expressed as a polynomial relationship, is remarkably strong despite the inherent variations from year to year in wildfire areas that may be due to confounding influences other than the amount of fuel reduced areas that is present across the landscape (see Figure 5).

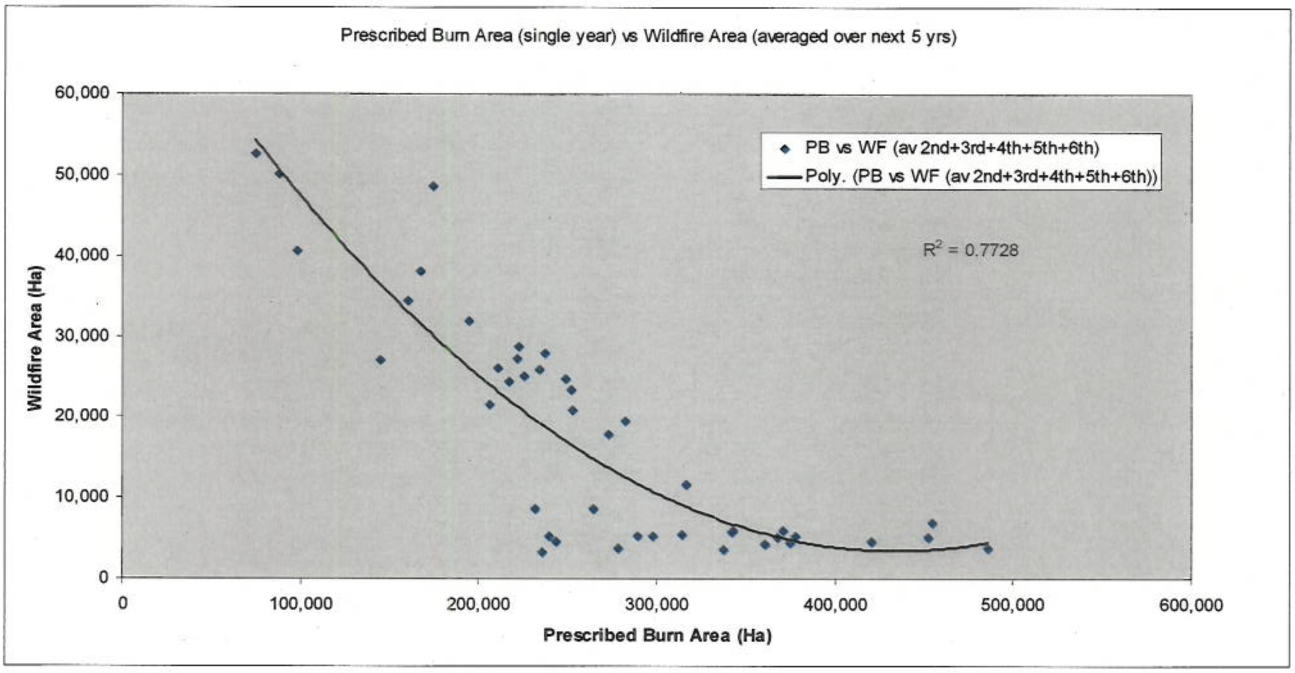

Figure 5. Correlation between the Average Annual Area of Prescribed Burns in a single year, and the Average Area of Wildfires over the following four years in south-west forest regions of WA.

In addition, a strong correlation exists between the area of prescribed burns averaged over four years, and the area of wildfires averaged over the subsequent four years (see Figure 6).

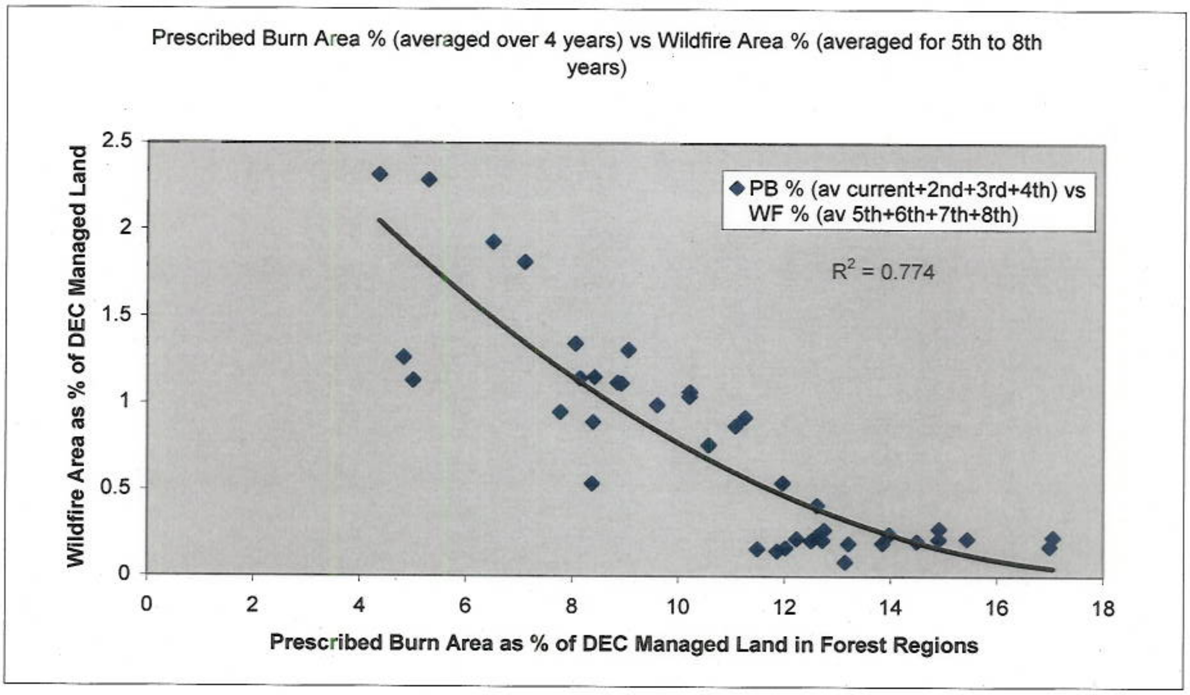

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Figure 6. Strong Correlation between the Annual Area of Prescribed Burns averaged over 4 years and the Area of Wildfires averaged over the following four years in south-west forest regions of WA.

The role of prescribed burning in reducing incidence of wildfires

A study by McCaw *et al.* (2008) demonstrated that prescribed burning will also reduce the incidence of fires by maintaining areas of sparse fuel that are less likely to remain alight following ignition. Lightning-caused fires should be randomly distributed at a landscape scale, making the expected incidence of ignition directly proportional to the area of each fuel age. Analysis of fire statistics for forests in the south-west of Western Australia between 2000 and 2006 shows that lightning-caused fires are less likely to be sustained in areas where the fuel is less than five years old.

Under the burning program undertaken by DEC in recent years, the area with fuel less than five years old makes up around 30 percent of the forest estate. The fact that there are very few fires occurring in this area, and those that do are easily suppressed, makes a very substantial difference to the total fire workload during lightning storms when suppression forces can be easily overwhelmed by a large number of almost synchronous fires.

Fuel management can also have important benefits to fire suppression that are subtle and difficult to quantify, such as increasing the safety, efficiency and effectiveness of suppression strategies. In this situation the lack of fuel management decreases the probability of first attack success under increasing fire weather conditions.

In conclusion, the WA analysis indicates that in order to restrict the extent of wildfires to impacting less than one percent of the landscape each year, the proportion of the landscape that needs to be fuel reduced is between seven to nine percent per year (or 35 to 45 percent over five years). In the case of south-west WA, the annual prescribed burning target of 200,000 hectares, which equates to about eight percent of the DEC-managed estate, is likely to result in average wildfire extent of less than about 30,000 hectares per year and more importantly, to significantly reduce loss of life and property and reduced environmental damage.

Statistical analysis shows that the contribution of a well designed prescribed burning program makes to the reduction in the area of unplanned fires is very significant and can persist for at least eight years. The current level of annual burning that is applied by DEC to restrict unplanned fires to present levels in south-west WA presents about eight percent of the DEC-managed estate, and if this is maintained over time, the area of unplanned fire is likely to remain at low levels of between 0.5 and 1.5 percent of the total estate.

The importance of prescribed burning in relation to DEC's broader land management responsibilities

Catchment protection and water production values

Prescribed burning has been an important aspect of catchment protection in the surface water catchments of Perth's water supply reservoirs for many decades. There have been few instances where intense wildfires have caused detrimental impacts such as sedimentation and turbidity in these catchments. This is due to the mosaic of fuel ages that ensures that the size and intensity of wildfires is minimised. The notable exceptions to this general pattern occurred following the Mt Cooke wildfire in 2003 and the Mundaring-Karragullen wildfire in 2005, both described above. The winter rains that followed these two fires produced significant erosion and sedimentation impacts in parts of the catchments of the Serpentine and Mundaring reservoirs.

There have been no recorded instances where broadscale low intensity prescribed burning has caused erosion, sedimentation or turbidity in Perth's catchments.

Research and operational trials have shown that there can be significant increases in streamflow and surface water yields where strategic prescribed burning is carried out in forested catchments compared with leaving catchments in a long unburnt state. Western Australia's water supply authority, the Water Corporation, and the water regulator, the Department of Water, are both strong advocates of DEC's prescribed burning program. This support is founded on the contribution to both catchment protection and water production. The Water Corporation makes a financial contribution towards the completion of several strategic burns in Perth's catchments each year.

Regeneration and protection of native forest and plantation timber values

Prescribed burning is used to regenerate native jarrah and karri forests following timber harvesting in the south-west. The benefits include the stimulation of seedfall, seedbed preparation and the removal of logging debris that could increase the risk of future damage to the regenerated trees.

Regular prescribed burning also plays a part in the thinning of sub-dominant seedlings and young regrowth trees and in maintaining the health of the forest ecosystem through understory regeneration and nutrient cycling.

One of the most important contributions of prescribed burning in areas of State forest is the protection afforded to fire-vulnerable young regenerated forests through the creation of low fuel buffers or by mild in-forest burning in regrowth stands.

The Forest Products Commission, which is the manager of the commercial aspects of production forestry in WA, makes a significant contribution to DEC's prescribed burning program in production forest areas and adjoining State-owned timber plantations.

Recreation and tourism values

The forested areas of south-west WA are widely used for a range of recreational pursuits. These include camping, bushwalking, cycling, picnicking, orienteering, rogaining, motor sports and fishing. There are several "icon" tourist facilities in the forest areas, including the Tree Top Walk and the Valley of the Giants near Walpole, the Gloucester Tree near Pemberton and the Bibbulmun Track which runs from Perth to Albany through the forests. DEC has a duty of care to provide for the safety of the visitors on DEC-managed lands.

One aspect of visitor risk management is the reduction of forest fuels, which if left unburnt could result in a wildfire that causes loss of life and property. DEC implements buffer burns around high use recreation sites, but an equally important action is the mosaic of burning carried out more broadly throughout the forest areas, that will reduce the incidence of high intensity and fast moving wildfires.

A business case for high priority investment in broadscale prescribed burning

The application of fuel reduction burning to a significant proportion of the dry forest and woodland landscapes in Australia each year is essential to achieve effective wildfire management and ecosystem management. In Western Australia's forests, the application of a comprehensive prescribed burning program requires a significant investment by DEC through the allocation of staff time and operational funds.

In order to achieve effective outcomes, the following parameters must be adhered to:

- The planning and implementation of the program must be undertaken by a team of competent and qualified staff;
- Fire management must be based on science and experience;
- Fire management must be based on principles of environmental care;
- Fire management must be undertaken in accordance with clearly developed guidelines and procedures that provide for safe work practices;
- The fire management regime must be part of an overall strategic plan that is aimed at meeting management objectives for the area;
- Operations must comply with legal requirements and meet Departmental standards; and
- Outcomes must be monitored and recorded.

In order to meet these commitments DEC has allocated a significant budget within its Regional Services; Nature Conservation; Sustainable Forest Management; Parks and Visitor Services and Science Divisions.

For the 2008/09 financial year, the total budget for the planning and implementation of prescribed burns is approximately $9 million. The annual direct cost of suppression of wildfires on DEC-managed lands in the south-west has varied in the past five years from $7.7 million and $15 million.

There are many costs associated with wildfires that are over and above the suppression costs. A full accounting of the impacts of wildfires needs to include the indirect and long-term costs of impacts to individuals, communities, ecosystems, timber assets, water catchment values, infrastructure, businesses, and the local and national economies. Specifically these costs include property losses, post-fire impacts (such as flooding, erosion and diminished water quality), air quality, damage to property, injuries and fatalities, health care costs, infrastructure shutdowns (highways, powerlines, rail), lost revenue to farms, tourism, local businesses, and a loss of timber and other forest products.

In a recent study of the full cost of wildfires in western USA by the Western Forestry Leadership Coalition (2009) involving the analysis of six large wildfires, it was determined that the fire suppression costs were a small fraction of the total true costs. The report revealed a range of the total wildfire costs from two to 30 times the reported suppression costs.

It is clear from the US study, and from the experience in Western Australia over the past 48 years of application of a comprehensive prescribed burning program, that investing in active fire management across the landscape will significantly increase the public benefits gained from healthy forest ecosystems and will contribute significantly to a reduction in the broader costs and losses associated with wildfires.

The operating costs of reducing fuel loads through prescribed burning may be high in complex terrain. However, when non-market values and potential losses are considered, fuel reduction programs can be shown to be cost-effective. Investing in the maintenance of healthy forests through a proactive prescribed burning program well before wildfires occur is a prudent course of action. As an alternative to prioritising expenditure on the response to inevitable wildfires with costly suppression and rehabilitation efforts, funding of well designed prescribed burning programs will serve to minimise costs across the full spectrum of fire-associated impacts.

This submission recommends that a full accounting of the costs associated with wildfires should be adopted nationally as this will provide a better understanding of the value of investing in fuel reduction and other fire prevention activities. The improved awareness of the complete costs associated with wildfires will enlighten the search for sustainable solutions.

Conclusion

Bushfires will continue to occur in Australia as they have for millennia. For at least 40,000 years, people have, to some extent, 'controlled' fire by regularly and deliberately setting fires for a variety of reasons. Today, for the benefit of biodiversity and of people, we have choices about whether we wisely use planned fire to achieve a variety of contemporary outcomes, or allow wildfires to determine outcomes, many of which will be harmful.

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