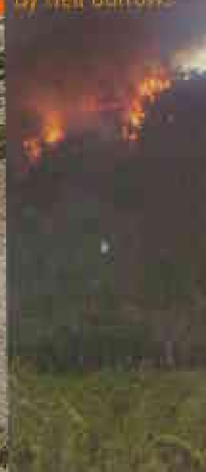
Fire for life

Fire science has advanced as a result of research, including studies on fire behaviour and its effects on natural ecosystems, over the last four decades. How has this knowledge changed the way fire is managed in Western Australian bushland?

by Neil Burrows



The subdued natural landscapes of the south-west of Western Australia belie a diversity of wildflowers (many of them found nowhere else) so remarkable that the region is recognised as one of the world's 25 hotspots of biodiversity, and the only one in Australia.

Flammable vegetation and hot dry summers have ensured that fire is a natural environmental factor, which, together with climate, landform and soils, has helped to forge this mega-biodiversity over thousands of years. Before European settlement, fires were started by lightning, but more frequently by Nyoongar Aboriginal people, who used fire with confidence, purpose and skill, as a tool with which to manage and manipulate the landscape, so that it provided the physical and spiritual necessities of life.

Left Most orchids, including this helmet orchid (*Corybus recurvus*), flower within 12 months of a fire. Research is needed to understand better the effects of fire on orchids.
Photo – Neil Burrows

Living with fire

Native plants, animals and ecosystems have evolved in this fire-prone environment. Many plant species reproduce or regenerate after fire (some cannot reproduce without a fire). Many plant communities need particular fire regimes to maintain their floristic and structural diversity. Fires, in a particular sequence or scale, are needed to provide diversity of habitat for many animals. However, the way in which species and ecosystems respond to fire varies. Some are quite resilient, returning to their pre-fire condition relatively quickly, while others can take decades to recover. No fire regime, or history of fire interval, season, intensity, patchiness and scale, is optimal for all species. Fire diversity can promote biodiversity, but some fire regimes can threaten biodiversity, especially in fragmented habitats or where introduced pests and diseases are present.

Before European settlement, burning by Nyoongar people most likely maintained a patchwork-quilt of vegetation at different stages of post-fire development—from recently-burnt patches to long-unburnt patches. This fire mosaic contained the spread and intensity of wildfires. Large and intense wildfires were not in the best interests of Aboriginal people, and were probably rare. In many parts of Australia, where Aboriginal fire management has ceased and attempts have been made to exclude fire, the fire regime often becomes feral. Feral fire regimes are characterised by infrequent, large and intense wildfires, ignited by lightning or arsonists, that cause substantial environmental, social and economic damage.

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Main Regeneration of *Paraserianthes lophantha* from soil-stored seed after a fire.
Photo – Jiri Lochman
Insets (top) A honey possum (*Tarsipes rostratus*) using an old bird nest. The species depends on flowers for its food so prefers mature vegetation.
Photo – Babs and Bert Wells/CALM
(below right) An intense lightning-caused wildfire began near Mt Cooke, about 75 kilometres south of Perth, in January 2003.
Photo – Kristian Pollock

Above (far left) Intense wildfires cause severe damage to forest ecosystems, which take many decades to fully recover, and **(left)** can cause devastation to granite outcrops.

Left Even granite outcrops, such as this one, provide little protection from intense wildfires burning under hot, dry and windy conditions.
Photos – Neil Burrows

Above A hairy jugflower (*Adenanthos barbiger*) resprouts and flowers three months after an intense wildfire. About 75 per cent of forest species resprout after fire.
Photo – Jiri Lochman

Today, in our fragmented, urbanised and settled landscapes, wildfires can threaten people, property and conservation values. The rapidly expanding rural-urban interface is most vulnerable, but wildfires also threaten rural towns, farms and other infrastructure. The job of managing fire in regional areas, including containing bushfires, falls largely to volunteer brigades and to fire crews from the Department of Conservation and Land Management, the Forest Products Commission and the Fire and Emergency Services Authority.

On lands managed by the department, the aim is to manage fire to conserve biodiversity, and to ensure an acceptable level of protection to human life and property. Fire management is complex and potentially dangerous, and requires the skilful combination of art and science. Fire science has advanced as a result of ongoing research, including studies on fire behaviour and its ecological effects on natural ecosystems, undertaken by a range of organisations and individuals over the last four decades. Although our knowledge is incomplete, fire management must be underpinned by fire science.

A fire symposium, attended by some 350 fire scientists, academics, fire managers, volunteer conservationists, volunteer fire fighters and interested community members, was held in Perth in April 2002. The scientific proceedings of this symposium have been published as a book containing 20 chapters written by expert fire managers and scientists. This synthesis of the latest fire science and technology is helping the department to develop and adapt its fire management further. A revised fire management policy and framework is being developed, based, in part, on 12 key scientific principles (see box on page 26).

Setting objectives

Setting clear, workable and measurable fire management objectives for the conservation of biodiversity is of key strategic importance. It will assist with developing fire management plans and standards, with determining strategies and tactics and with assessing the acceptability or otherwise of the environmental impacts of fire as they are understood from research and monitoring.

To what extent should perceived wildfire threats to human life and property override biodiversity conservation objectives? One approach being taken by the department is to develop fire regimes that aim to conserve biodiversity, then to carry out a systematic wildfire risk analysis to determine the threat posed by these regimes to life and property. Fire management can then be modified where the threat is unacceptable.

Not all biodiversity can be conserved all of the time. However, to ensure the best possible outcomes, managers set objectives at three different scales: bioregional, landscape and fire management unit scales.

Bioregional scale

The Australian environment has been divided into 80 broad biogeographic regions, which provide a framework for the development of a national reserve system and other natural resource management decisions. A bioregion is a large geographic area with similar climate, geology, landforms, broad vegetation types, wildlife and land use. There are seven bioregions in the south-west of Western Australia, ranging in size from about 15,000 square kilometres to 90,000 square kilometres.

Bioregion fire management objectives include the need to conserve the biodiversity of the bioregion while providing a sufficient level of protection to fire-sensitive ecosystems and to societal values. A key strategy to achieve this is to maintain a mosaic of interlocking patches that represent a diversity of fire regimes with varying intervals between fires and on varying scales. Where a wildfire risk analysis—to determine the threat to fire-sensitive species and communities, and to life and property—has shown an unacceptable risk of wildfire damage, measures to reduce the risk at this scale could include enhanced detection and suppression capacity; community education and awareness; and regional planning to minimise the exposure and vulnerability of life and property.

Climate models predict increasing aridity for the south-west, due to Greenhouse-induced climate change. At the bioregional scale, this will most likely extend the fire season and change the ways in which ecosystems respond to fire. Decreased rainfall will probably result in previously non-flammable, damp ecosystems becoming dry and flammable; slower rates of post-fire recovery; and reduced rates of fuel accumulation. There may also be a need to decrease the frequency of fires, due to the decrease in productivity. Current understanding of the ways in which ecosystems respond to fire may not be applicable under a changed climate, so the effects of climate change on fire response will need to be carefully monitored.

Landscape scale

Within a bioregion, there are likely to be many different landscapes. Several attributes—including weather, soil types, assemblages of local plants and animals, and disturbance regimes—tend to be similar across the area.

Above left Holly-leaved banksia (*Banksia ilicifolia*) resprouts and flowers within two to three years of a fire.

Left Within four weeks of fire, drumsticks (*Kingia australis*) has numerous flowers. *Photos – Neil Burrows*

Landscape-scale fire management objectives include maintaining biodiversity; maintaining diverse ecosystem structures, post-fire states and habitats; and protecting relatively fire-sensitive ecosystems and niches from frequent fires and from large and intense wildfires.

Management strategies to achieve these objectives could include maintaining an interlocking mosaic of recently-burnt and long-unburnt patches of vegetation, and patches burnt in different seasons. Managers also need to reduce the likelihood of large-scale, intense and damaging wildfires by incorporating fuel reduction, fire detection and suppression strategies into the overall mosaic. Wildfires that do occur can be incorporated into the mosaic, but their size and frequency need to be limited.

Vital attributes of key plants and animals can be used to estimate the range of desirable fire frequencies within a landscape. For instance, certain plants, known as obligate seeders, only regenerate from seed that is usually stored in the soil or in woody capsules on the plant. For many of these species, fire is necessary to stimulate and promote seed germination and development. If a fire occurs before these plants are mature enough to produce adequate seed reserves, these species are likely to decline. Conversely, if the bush in which such species occur goes for too long without a fire, some plants will be equally disadvantaged. It is also vital for managers to consider habitat requirements of key animal species, especially threatened species and those that have special habitat requirements such as long-unburnt vegetation.

To ensure that scientists are able to monitor the effects of fire, protectable, manageable and representative 'no planned burn' and 'regularly burned' scientific reference areas should be retained, where possible, as part of the mosaic.

The fire management unit scale

A fire management unit is an area within a landscape. It could be a (sub) catchment or a mapped management boundary, such as a forest block, and it could contain a representation of landforms, ecosystems and vegetation complexes common to the landscape unit. Fire management units can be sinks or sources of recolonisation and can vary in size from a few hundred hectares to a few thousand hectares.

Various plants and animals will come and go, depending on the interval since the last fire and the structural development of the vegetation. Maintaining diverse fire regimes that vary in season, frequency, intensity and patchiness will provide a range of habitats and opportunities for organisms, given that no single fire regime is optimal. A key objective at this scale is to protect fire-sensitive ecosystems and habitats, such as riverside vegetation, some swamps, wetlands and rock outcrops, from frequent fires or large and intense wildfires. Occasional summer or autumn fires may be needed to regenerate these ecosystems and habitats.

Top Larger macropods, such as the western brush wallaby, thrive in recently burnt, open vegetation.
Photo – Jiri Lochman

Above The noisy scrub-bird prefers long-unburnt vegetation. It has poor dispersal ability so is favoured by small, patchy fires rather than large, intense fires.
Photo – Babs and Bert Wells/CALM

Strategies to achieve these objectives include varying the fire regime applied to a fire management unit over time: that is, varying the season, frequency and interval of fire based on vital attributes and life histories of key fire-sensitive species. The implementation of mostly patchy burns will create a mosaic within a mosaic, further adding to diversity of habitat at the landscape scale. Burn patchiness and protection of fire-sensitive habitats is best achieved by

Top Some species such as red swamp banksia (*Banksia occidentalis*) are readily killed by fire so occur in less flammable areas . Fire triggers the release of seed from protective woody capsules.

Above Fire promotes the development of numerous red swamp banksia seedlings, which take about four years to mature.
Photos – Neil Burrows

Key scientific principles of fire management

Principle 1 Fire is an environmental factor that has influenced, and will continue to influence, the nature of south-west landscapes and biodiversity.

Principle 2 Species and communities vary in their response to, and reliance on, fire. Knowledge of the life histories of organisms or communities and their relationship to fire should underpin the use of fire in natural ecosystems.

Principle 3 Following fire, environmental factors such as landforms, topography and life histories of various species, and random climatic events, often drive ecosystems towards a new transient state with respect to species composition and structure. This may prevent scientists from identifying which changes are specifically attributable to fire.

Principle 4 Fire management is required for two primary reasons, which are not necessarily mutually exclusive: a) to conserve biodiversity and b) to reduce the occurrence of large, intense wildfires. Fire management should consider both ecological and protection objectives in order to optimise outcomes.

Principle 5 The damage potential, suppression difficulty and biological impact (killing power) of a fire and the rate of recovery following fire are in direct proportion to the fire's intensity and size.

Principle 6 Fire diversity promotes biodiversity. An interlocking mosaic of patches of vegetation—representing a range of biologically-derived fire frequencies, intervals, seasons, intensities and scales—need to be incorporated into ecologically-based fire regimes if they are to optimise the conservation of biodiversity at the landscape scale.

Principle 7 Avoid applying the same fire regime over large areas for long periods of time, and avoid extreme regimes, such as very frequent or very infrequent fire intervals, over large areas.

Principle 8 The scale of the fire-induced mosaic should a) enable dispersal of young native animals b) optimise boundary habitat and c) optimise connectivity, or the ability of animals to move through the landscape.

Principle 9 All available knowledge, including life histories, attributes of native plants and animals and knowledge of Nyoongar fire regimes should be used to develop ecologically-based fire regimes for a landscape unit or a vegetation complex.

Principle 10 Fire history, vegetation complexes and landscape units should be used to develop known and ideal mix of time since last fire.

Principle 11 Wildfire can damage and destroy both conservation and societal values, so a systematic and structured approach must be used to identify and manage the consequences of such an event.

Principle 12 Fire management should adapt to changing community expectations and new knowledge gained through research, monitoring and experience.

low intensity fire set under moist conditions in spring, when variation in moisture content across the landscape will result in patchy burn patterns. Of course, there is a risk associated with this because the vegetation could re-ignite as it dries out over summer. Alternatively, there is some evidence that Nyoongar people burnt parts of the landscape very frequently in summer and autumn, which, over time, resulted in a level of patchiness. Occasional intense fires under dry summer or autumn conditions will stimulate regeneration across the landscape. However, because intense fires under dry conditions are less patchy and burn more habitat elements such as hollow logs and dead trees, such fires should not be too frequent. Relatively fire-sensitive ecosystems are best protected by burning the more flammable and fire-resilient ecosystems in which they are embedded.

Based on our knowledge of the fire ecology of south-west ecosystems, we can apply a 'seven way test' to fire management, to check whether it is environmentally and socially friendly:

- Does fire management restrict the size, intensity, frequency and impact of wildfires?
- Does the fire regime maintain a fire-induced mosaic at an appropriate scale and provide a range of post-fire states?
- Does the fire regime include seasonal diversity?
- Does the fire interval allow seed banks to replenish?
- Does the fire regime include a sufficient fire-free interval to allow all habitat types to mature?
- Does the fire regime protect 'fire sensitive' ecosystems or allow them to regenerate?
- Does the fire management provide an acceptable level of protection to life and property?

If the answer to each of these questions is 'yes', we are well down the path to maintaining the south-west's mega-biodiversity, while at the same time being able to live with fire.

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