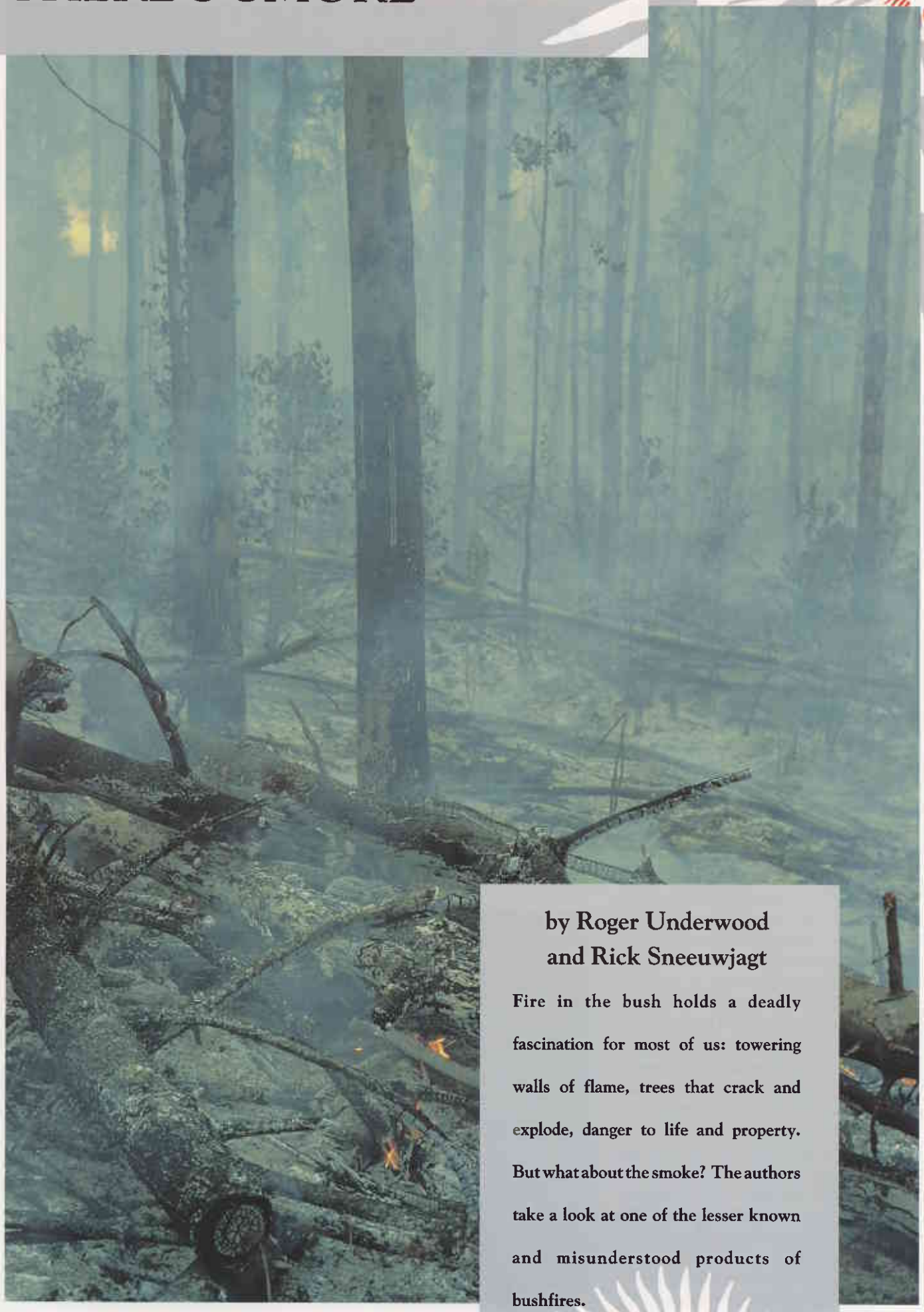
WHERE THERE'S FIRE

THERE'S SMOKE



by Roger Underwood
and Rick Sneeuwjagt

Fire in the bush holds a deadly fascination for most of us: towering walls of flame, trees that crack and explode, danger to life and property. But what about the smoke? The authors take a look at one of the lesser known and misunderstood products of bushfires.

'Oh, to be in Western Australia, now that spring is there!' is a line which the poet Browning may well have written had he lived in Perth instead of London. Springtime in WA means blue skies and warming weather after the cold, wet days of July and August. The first violet hoveas and scarlet-flowered kennedias appear to herald the annual wildflower riot in the bush; magpies are nesting and swooping; whales are migrating; snakes are awakening; and, on some clear mornings, nostrils are twitching - as the first whiffs of bushfire smoke, carried on south-easterly winds, puff into the suburbs of Perth.

The aroma of bushfire smoke from eucalypt forests is as Australian as billy tea and a slouch hat. No Australian expatriate, catching a whiff of burning gum leaves in some corner of a foreign land, can avoid the nostalgia such an aroma evokes. And even those who never leave our shores find the smell attractive, and richly evocative of our bush heritage.

The smell and sight of bushfire smoke have long been part of the Australian environment. Before European settlement, fires caused by lightning ran naturally through the bush unconstrained by firefighters or firebreaks, and often burned for months on end. The Aborigines regularly set fire to the bush for hunting and other purposes. The journals of nearly all the early explorers who visited WA contain references to smoke hanging over the bushland, and in a famous set of engravings by Lieut. Robert Dale showing a panorama of the Albany hinterland at the time of early exploration, the flames of around half a dozen fires are visible, and the smoke from even more can be seen in the distance.

In the early days of urban and agricultural development in WA, fire was the main clearing tool. Generations of country people grew up with the smell of the burning bush in their nostrils. Sometimes it was the dangerous smell of a bushfire beyond the ranges, hinting of trouble ahead; but more often it was the smell of clearing burns, the burning up of heaps, windrows and scrub to make way for new farms, roads and towns. The smell of burning in those days was the smell of progress.

Today, most Western Australians live in cities and are far removed from either the threat of bushfires or the need to light fires for bushland clearing, regeneration or protection. Even in the farming districts, the emphasis is now more on planting trees than clearing them. These days, that first aromatic whiff of bushfire smoke on a spring morning is a source of alarm. And on those rare days when bushfire smoke enters the city for a few hours, reducing visibility and mixing with exhaust fumes from vehicles, the population is understandably concerned.

WHAT IS BUSHFIRE SMOKE?

At least 200 chemical compounds have been identified in the smoke from burning wood and vegetation. (As a comparison, there are more than 1 200 different compounds identified from tobacco smoke.)

Some combustion products are gases, such as carbon monoxide, hydrocarbons and small quantities of nitrogen oxides. More than 90 per cent of the total mass of smoke from a bushfire is composed of two primary products -

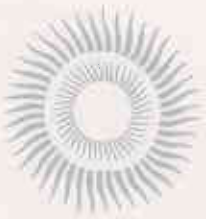
Previous Page
Left: Wildfire takes hold in eucalypt woodland near Ravensthorpe.
Right: Smoke rises from the smouldering aftermath of fire in young karri forest.
Photos - Lachlan McCaw

Above: CALM firefighter extinguishing a smouldering tree.
Photo - Cliff Winfield

Below: Heavy smoke from an intense wildfire in mallee near Esperance.
Photo - Lachlan McCaw

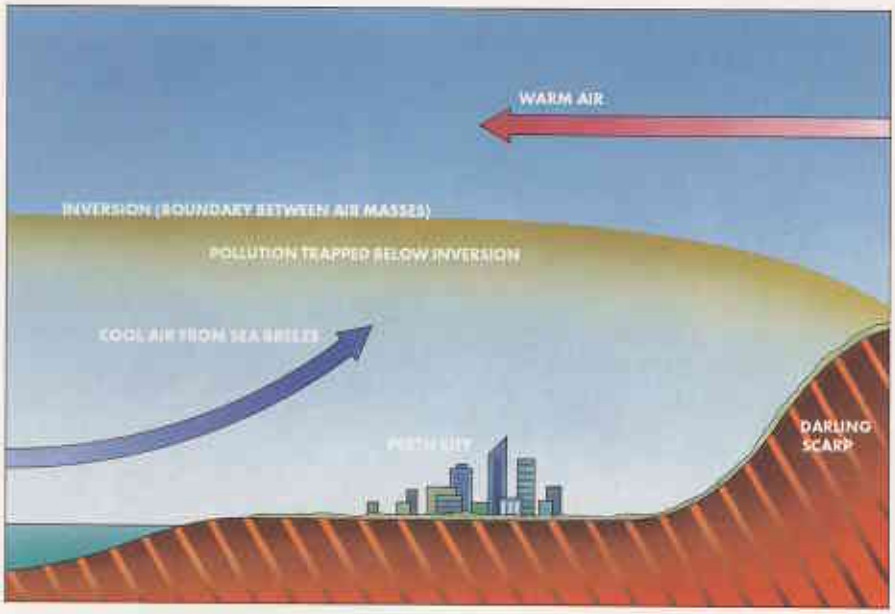
carbon dioxide and water. The rest, however, take the form of small particles (particulates) of ash, partly consumed fuel, liquid droplets, and steam, which reduce visibility. The quantity of particulates put into the air depends on the amount of fuel consumed, fuel moisture content, rate of fire spread, and the type of firing technique used.The rate of smoke dispersal depends mainly on atmospheric stability and wind speed.

Although some of the smoke from a bushfire leaves as a wind-blown plume near ground level, much of it is lifted up in the convection column of the fire to a considerable height before being transported downwind by the upper-level winds. The amount of smoke taken up in the convection lift is determined by fire intensity, wind velocity, and atmospheric stability. Unstable conditions, or the absence of a strong temperature inversion in the lower atmosphere, can encourage rapid smoke dispersal into the upper atmosphere. On the other hand, stable conditions or a strong temperature inversion in the lower atmosphere will keep smoke near the ground. The latter conditions are most suitable for safe, effective fuel-reduction burning.



Above: Monitoring air quality at Caversham in the Perth area.
Photo - Jiri Lochman

Occasionally, pollution gets trapped under a temperature inversion and can hang above the city for several days.



WHERE DOES BUSHFIRE SMOKE COME FROM?

In the south-west of Western Australia, bushfire smoke comes from two different sorts of fire - *wildfire* and *prescribed burns*.

Wildfires are caused by lightning, arson or accident, usually on hot, windy days in summer and autumn. When a wildfire occurs, fire attack forces swing into action and suppress the fire as quickly as possible. Large, intense wildfires (especially those burning heavy forest fuels) can generate a huge amount of smoke. However, it is quite rare for forest wildfire smoke to enter big cities like Perth and Bunbury. This is because the great bulk of these fires occur on north-easterly and north-westerly winds, so the smoke is carried south away from population centres and out across the Southern Ocean. Occasionally smoke from small scrub and grass fires in and around the city will cause temporary problems of visibility, but Perth has never experienced the sort of smoke blackout which occurred in Melbourne, Adelaide and many large provincial cities in Victoria and South Australia at the time of the 1939 Black Friday fires and the 1983 Ash Wednesday fires.

The other sort of fire which occurs, especially in forest country in WA, is the managed fire, usually referred to as a *prescribed* or *controlled* burn. These fires may be lit for a variety of reasons, including wildlife habitat management and forest regeneration. But by far the most common is to reduce the quantity of dead leaves and twigs on the forest floor, and therefore starve a future wildfire of much of its fuel. The intensity of a wildfire is influenced by a range of factors such as temperature, wind, humidity, steepness of terrain and amount of fuel. Of these, the only one that can be managed is the amount of fuel, and this can be reduced most economically by burning off during relatively mild weather conditions.

Prescribed burning generates smoke, but because the fires are so much less intense, there is usually less smoke than from summer wildfires. The problem, however, is that the safest condition under which to light prescribed fires is with south-easterly and south-westerly winds, and these can bring the smoke straight from the forest into the city. Any 'pollution problem' associated with bushfire smoke in Perth is therefore more related to prescribed burning than to wildfires.

MANAGING THE SMOKE

Smoke from prescribed burning is managed primarily by scheduling burns in favourable weather. Unfortunately, the conditions that are normally suitable for a safe fuel-reduction burn in the forest are most often the same that lead

PHOTOCHEMICAL SMOG

The smoke haze from bush fires and planned burns is often confused with toxic air pollution from vehicles and industrial emissions and with the photochemical pollution which regularly fouls the air of European countries and North America.

Europe is commonly regarded as being highly polluted, primarily because of sulphur dioxide emissions from the combustion of fossil fuels, chiefly coal and oil. Whilst Europe also suffers in varying degrees from photochemical pollution, North America has a far larger component of photochemically induced gases and aerosols. This form of pollution occurs primarily in urban areas as the product of several interacting factors. These include a combination of high densities of cars and trucks, producing large quantities of nitrogen oxides; plentiful sunlight; and a local air mass contaminated with hydrocarbon compounds, which concentrates the emission products instead of dispersing them.

Photochemical pollutions form the most significant threat to the air environment in the Perth metropolitan area. Where nitrogen oxides and hydrocarbons develop in high concentrations, such as from car exhausts on congested highways, and where low wind speeds and limited vertical mixing resulting from temperature inversion prevents the gases from being rapidly dispersed, a series of chemical reactions takes place under the influence of the ultraviolet component of sunlight. Among the end-products are some highly reactive and potentially toxic substances. Nitrogen dioxide and ozone dominate and are considered the best indication of photochemical pollution. In the presence of hydrocarbon emissions these end-products interact further to produce what has become known as 'photochemical smog'.

Above left: *Smoke from a bushfire in Kings Park covers West Perth. Although such smoke is not toxic it can severely reduce visibility. A more serious threat to health comes from motor vehicle exhausts.*
Photo - West Australian Newspapers

Left: *Industrial emissions are a major source of air pollution.*
Photo - Jiri Lochman

Above: A burnt-out house at Anglesea, Victoria - a tragic aftermath of the 1983 Ash Wednesday wildfires.
Photo - Bill Bachman

Above right: Forest workman commencing a low-intensity prescribed burn in the karri forest.
Photo - Lachlan McCaw

Right: Firefighters caught in smoke.
Photo - Brian Downs/Lochman Transparencies

to poor smoke dispersal and high smoke accumulation - low wind speeds, stable atmospheric conditions, and relatively moist fuel conditions. There are relatively few days each year when conditions suit both the prescribed burning objectives and the air quality objectives.

The Department of Conservation and Land Management (CALM) has managed smoke in the northern jarrah forest, within 100 kilometres of Perth, for nearly 20 years. Based on smoke distribution studies by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in the 1970s, a computer model was developed to make accurate predictions about the fate of the smoke plume from a planned fire. The model has been used to determine the maximum size of an area that can be burned at a predetermined distance from Perth so that the air quality in the metropolitan area is not significantly affected. If the model predicts a potential problem with smoke, the burn is deferred until more favourable conditions arise. The application of this predictive model has ensured that the incidence of smoke accumulations from prescribed burns in the northern forest has been limited to the very rare occasions when actual wind directions were opposite to what had been forecast earlier in the day.

More recently, smoke management has been extended to the southern forests as well. The challenge in the south is different; smoke from the southern burns is often blown out over the Indian Ocean and then returned inland on the sea breeze the same evening, sometimes reaching Perth.

CALM's management of the smoke from southern burns has been based on a number of strategies: identifying suitable meteorological conditions for the rapid dispersal of smoke (requiring monitoring of atmospheric inversion via radiosonde readings by the Bureau of Meteorology); reducing the total area to be burned throughout the southern forest on any one day; dispersing burn jobs so that there is maximum separation of large burning areas; modifying burn prescriptions to reduce the incidence of re-ignition and smouldering; and maximising use of upper winds from the north and west which blow smoke away from Perth or other major centres.

Smoke management is well advanced, but it is not perfect. Unpredicted weather events can still surprise the weather forecasters, and the best-laid plans can go astray. For example, in October 1992, an unusually intense inversion over the Swan Coastal Plain trapped smoke from wildfires and private burning operations

to the north of Perth for three days. CALM cancelled all its burning operations during this period to avoid contributing to the problem.

SMOKE EFFECTS ON HUMANS

Occasional brief exposure to low concentrations of bushfire smoke is more a temporary inconvenience than a health problem. Studies in the United States and Canada indicate only a remote risk of aggravation of respiratory illness, or the development of cancer, from occasional exposures to bushfire smoke.

On the other hand, firefighters are often exposed to high smoke concentrations for hours at a time in wildfires, and can suffer eye and respiratory irritations. Under some circumstances, continued exposure to high concentrations of carbon monoxide in the combustion zone can result in impaired alertness and judgement, but this is highly unlikely to happen at a prescribed fire.

Many particulate emissions from bushfires are small enough to enter the human respiratory system. Repeated, lengthy exposure to smoke can contribute to respiratory problems, although the risk of developing lung cancer from exposure to bushfire smoke has been estimated by United States scientists to be less than one in a million.

Public perception appears to be that the medical evidence linking bushfire smoke haze with various health problems is more conclusive than it actually is. Nevertheless, this public perception in itself is sufficient to justify efforts to minimise potential impacts, and CALM takes seriously its responsibility to deliver fire protection services with minimum inconvenience to the public.

Since the introduction of CALM's smoke management system to the entire forest area in 1991, the incidence of undesirable smoke haze from CALM burning activity has been reduced dramatically. In the spring of 1992, for instance, approximately 100 000 hectares of forest were prescribed-burned by aerial ignition with 60 separate lightings. Smoke haze from these burning operations exceeded the national standard (as monitored by the Environmental Protection Authority's instruments) on only one occasion, and then only briefly during the night.

HISTORY OF PRESCRIBED BURNING

Fuel-reduction burning began in State forests in the mid-1950s, but has been extensively applied throughout the forest lands only since 1961. The practice was stepped up following recommendations of a Royal Commission set up to inquire into the destructive wildfires which burnt huge tracts of forests and farmlands in the south-west, completely burning out the townships of Dwellingup, Nanga Brook, Holyoake and Karridale.

The fuel-reduced areas which result from prescribed burning have enabled firefighters to suppress many potentially serious forest wildfires, to the extent that there have been very few major fires in the past 32 years in the jarrah forests. Unlike other Australian States, during this time no firefighter has been burnt to death in a forest fire in WA, nor has there been any loss of civilian life within the forest zone.

The majority of CALM's broadscale prescribed burning occurs in the south-west forest zone. Although the focus of these operations tends to be on those areas adjacent to the highest values, such as towns and farms, areas vulnerable to serious fire damage such as regrowth forests and pine plantations are also protected.

Top: *Light smoke from a low-intensity prescribed burn in forests near Perth. Photo - Wade Hughes/Lochman Transparencies*

Above: *Mild flames from a similar burn. Photo - Jiri Lochman*

For more information on prescribed burning, see 'Seasoned with Fire' in *LANDSCOPE*, Autumn 1990.

A study is being undertaken by CALM in conjunction with the Bureau of Meteorology to develop more accurate means of predicting appropriate smoke dispersal conditions, and for predicting the path of smoke plumes emitted anywhere throughout the south-west of the State.

Whilst the very stringent application of smoke management guidelines and burning prescriptions will help to minimise the occurrence of smoke haze over Perth, there is no guarantee that it can be eliminated altogether. The complete cessation of prescribed burning may have short-term impact on the incidence of smoke haze, but will inevitably create another social problem: the cost and tragic impact of destructive wildfires on communities and forest ecosystems in the south-west. It is not considered acceptable to put rural communities and our natural assets at risk to wildfire damage and destruction in an attempt to eliminate occasional bushfire smoke from the city. ■

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LANDSCOPE

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'Where there's fire there's smoke'. We look at one of the lesser known and misunderstood products of bushfires on page 10.

The disappearance of the Zuytdorp *remained a mystery for many years. The story of its rediscovery and the formation of the Zuytdorp Nature Reserve is on page 42.*

Banksias and blackboys are normally associated with the sandplains of the coast and wheatbelt rather than the Great Victoria Desert. See page 22.

The mountains of the Stirling Range are a refuge harbouring many ancient species of spiders. Spider expert Barbara York Main shows us some of them on page 28.

A new book, Perth Outdoors, *aims to encourage people to get outdoors and enjoy nature and to learn more about Perth's unique natural communities. See page 35.*

FEATURES

REGULARS

COVER

*The palisade spider (*Neohomogona stirlingi*) is endemic to the Stirling and Porongurup Ranges. It builds a shallow burrow with an open entrance surrounded by a palisade, or collar of leaves and twigs, which may project several centimetres above the ground or litter.*

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