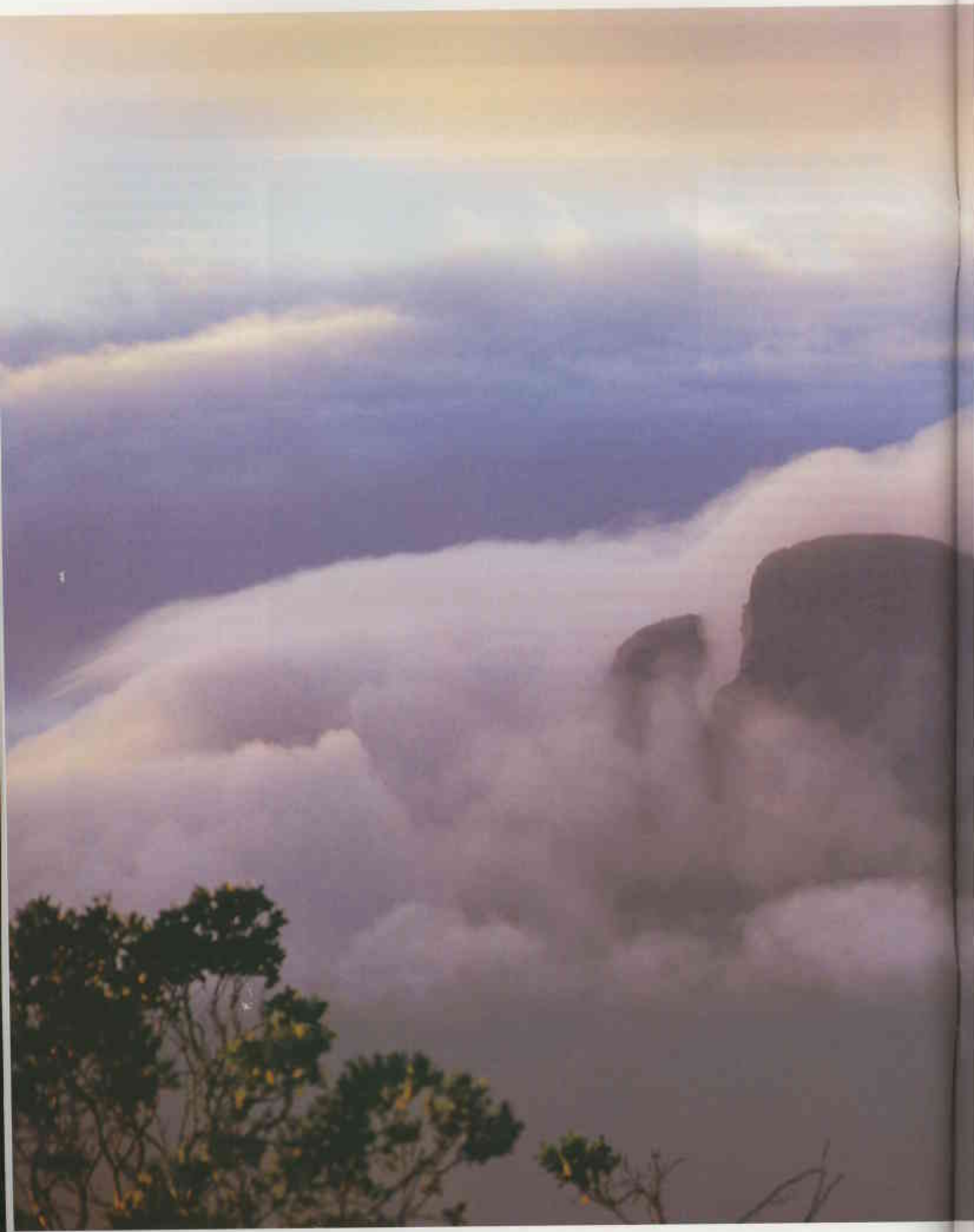


A Stirling climate clouds, snow and fires

The extremes of weather experienced at Stirling Range National Park, north of Albany on the south coast of Western Australia, can be dramatic. The range is renowned for its unusual, and sometimes spectacular, cloud formations. It is one of few places in Western Australia where snow occasionally falls, with falls above five centimetres having been reported on Bluff Knoll. The range has also been subject to bushfires and the effects of cyclones. Cooler, wetter and windier conditions, caused by elevation, influence the unique plant life and allow several threatened species to thrive on the peaks.

by Joe Courtney

The Stirling Range National Park is home to many unique plants and animals. Some of this wildlife has survived from the time when the range was formed, as Australia tore away from Antarctica some 60 million years ago, marking the end of the Gondwana supercontinent. Since then, climatic changes have influenced the diversity of wildlife in the area. Much of the plant life, in particular, has become isolated in the range, due to the cooler, wetter and windier local environments caused by increased elevation—conditions that are found nowhere else in the region.

Previous page
Main: A shallow cloud layer leaves the peak of Bluff Knoll exposed.
Photo – Allan Rose
Insets: Sunrise at Isongerup Peak.
Photo – Alex Bond
Rusty dryandra (*Dryandra ferruginea*).
Photo – Jiri Lochman
Snow on giant andersonia (*Andersonia axilliflora*), which is confined to the highest eastern peaks.
Photo – Allan Rose

Below: Stirling Range with Bluff Knoll in the foreground.
Photo – David Bettini

PAST TO PRESENT

When Australia separated from Antarctica and began to drift towards the Equator, and the continents moved into their present-day positions, it is thought that the world climate began to cool. A deep-water channel formed around Antarctica and the modern circumpolar current developed, effectively abandoning Antarctica to freeze at the South Pole while Eurasia and North America moved towards the North Pole. As more and more land became concentrated at high latitudes, the increasing ice cover led to greater surface reflectivity, cooling the entire globe.

Plant fossils of southern Australia indicate that, before the cooling, there were many floral forms that are now limited to cool, temperate rainforests. These species probably persisted until about 15 million years ago. As temperatures fell, the sea level dropped and Australia's rainfall decreased, forcing species in the south-west to adapt to a drier climate.

By five million years ago, many of the wetlands had given way to grasslands, allowing land animals, particularly mammals, to migrate. Australia collided with south-east Asia, and the exchange of flora and fauna resulted in the introduction of snakes, lizards and bats into the country. As conditions became drier, the range of many species contracted to higher rainfall zones such as the Stirling Range. The south-west developed a Mediterranean climate and the flora evolved into some of its present-day forms.

Within the last million years, in the Quaternary period, the world's climate has fluctuated between warm interglacial and cold glacial episodes.

Above left: Common mountain bell, endemic to the Stirling Range.
Photo – Marie Lochman

Above: Low-level stratified cloud draping over Bluff Knoll.
Photo – Allan Rose

The world is currently experiencing an interglacial period, since the last glacial episode culminated about 18,000 years ago. During glacial periods, water is locked up in ice sheets and sunlight is reflected to space, causing low rainfall and lower sea levels.

As the last glacial episode began about 70,000 years ago, a land bridge was established between Australia and Asia through the Indonesian Archipelago, enabling Aboriginal people and wildlife to migrate southwards. Tropical rainforests were restricted to corridors, due to the extension of arid zones. The south-west appears to have supported diverse mammal fauna able to tolerate variable climatic regimes. However, many species, including the large mammals (megafauna), gradually disappeared, particularly towards the end of this glacial event. When widespread de-glaciation began abruptly about 15,000 years ago, the wildlife had to readjust to a warmer and wetter environment. Sea levels rose dramatically between 12,000 and 10,000 years ago, but have remained relatively static during the last 5,000 years.

Pollen analyses at Boggy Lake near Donnelly River, in the lower south-west of Western Australia, indicate that conditions were relatively wetter about 6,000 years ago. This was followed by a drier trend until 2,500 years ago and again from 1,300 to about 500 years ago, with a slightly wetter trend to the present. Such variations would probably have only subtly influenced the distribution of the flora.

TODAY'S CLIMATE

Today, the Stirling Range and the south-west coastal fringe as a whole has a typical Mediterranean climate of warm, dry sunny summers and cool to mild, wet winters. This is similar to the climate of the Mediterranean basin, southern California, Chile and the western Cape region in South Africa. Indeed, the western Cape has many similar plants to those in the south-west of Western Australia, particularly those in the Proteaceae family.

The weather of south-western Australia is largely controlled by the position and movement of a band of high pressure, which is generally orientated in an east-west direction. This high pressure ridge separates the easterlies to the north from the westerlies, and moves north and south each year in response to solar heating from the tropics. The ridge normally lies north of the Stirling Range in winter and to the south of the range, extending over the Great Australian Bight, in summer. Winter westerly winds are maintained by low pressure systems and associated cold fronts, which typically pass across the south-west several times each week at this time of year. Gales are often experienced with the stronger systems.

The summer weather is strongly modulated by the position and strength of a trough of low pressure that usually extends from the Pilbara southward along the west coast. On the eastern side of a well-developed trough, north-easterly winds from the interior of the continent cause hot, dry conditions, while cooler onshore winds occur on the western side. Afternoon sea breezes frequently arrive over the Stirling Range from the south-east, producing pleasant conditions and often some cloud over the higher peaks.

Although infrequent tropical cyclones can occur in summer and autumn, two notable cyclones have affected the range in the last 50 years—Alby in 1978 and Fifi in 1991. Both brought winds from the north and north-west of greater than 100 kilometres per hour.

Above: Snow fall on Bluff Knoll.
Photo – Allan Rose

Left: Showy dryandra (*Dryandra formosa*) on Mount Trio.
Photo – Alex Bond

RAINFALL

Instrumental records began around the King George Sound at Albany in 1877, then at Mount Barker in 1886. Today, many rainfall stations exist in the surrounding agricultural region, but there are only recent rainfall records from within the park boundaries. The rainfall in surrounding areas during the past 100 years increased in the early years, but has declined since the 1940s.

The Stirling Range lies between the moist, mild areas of the south-west, with annual rainfall exceeding 1400 millimetres near Northcliffe, and the wheat-growing areas to the north, where less reliable rains average around 400 millimetres. Variation within the park is also very high.

Rainfall averages vary greatly with elevation. Rainfall on the exposed southern parts of the eastern peaks may be up to twice that on the surrounding plains. The highest annual rainfall is estimated to be about 1000 millimetres near Coyanarup Peak and Bluff Knoll, with the lowest in certain rain shadows near the northern boundary. Rainfall varies significantly on all of the peaks, and this is reflected in the changing flora types.

The south-west has high winter and low summer rainfall—about three quarters of the annual total falls from May to October. Most of that is a result of moist onshore flow associated with low-pressure systems and cold fronts. Systems bearing the most rain usually derive their moisture from over the warm ocean waters to the north-west.

Periods of drizzle are common throughout the year, especially on the windward side of the higher peaks in the south-easterlies. However, the water droplets are restricted in their growth time and rainfall amounts are not usually significant. The high humidity levels of this flow and the cool winter temperatures may explain the presence of a species of frog on Bluff Knoll (*Pseudophryne nicholsi*), which is otherwise found in the high rainfall karri forests of the south-west.

Due to rapid run-off from the range, gullies and surrounding areas are prone to flash flooding. Although most rainfall occurs in the cooler months, the most significant floods tend to occur in the warmer months and are associated with tropical moisture sources including cyclones. More frequently, deep winter-time lows can bring heavy rains to a

Right: Low cloud on the Bluff Knoll summit.
Photo – Alex Bond

Centre right: The yellow mountain bell (*Darwinia collina*) grows only on Bluff Knoll.
Photo – Marie Lochman

Bottom right: A myrtle (*Hypocalymma myrtifolium*) endemic to the range.
Photo – Jiri Lochman

widespread area, and swampy areas on the southern side of the eastern peaks are usually the first to be affected. At such times, spectacular torrents of water flow off the slopes. Notable heavy rain events occurred in April 1913, January 1918, March 1934, January 1939, April 1947, February 1955, January 1982 and May 1988, causing severe erosion of the lower slopes. At the other extreme, the absence of such rainfall-producing mechanisms can lead to prolonged periods of below average rainfall.

TEMPERATURES

Temperatures vary greatly throughout the year and within the park. On any mountain range, there are different temperature regimes depending on elevation, orientation, shape of mountain slopes, time of year and prevailing weather conditions, such as cloud cover. Average maximum temperatures at sites on the surrounding plains vary from about 27°C in January to about 15°C in July, while recorded extremes range from 47°C to about 8°C. Minimum temperatures vary from 13°C in summer to 6°C in winter, with values below zero at least once a year.

Day-time temperatures on the sun-exposed northern surfaces are higher than those elsewhere. Also, temperature decreases with height, so it is expected that the highest peaks are about 5°C cooler than the surrounding plain. The eastern peaks, in particular, are often shrouded with low cloud, which prevents any significant warming during the day.

The temperature may change dramatically, especially in summer when hot northerlies shift to cooler onshore winds. Such cool changes may drop the temperature by 15°C or more in a very short time. Winter-time changes associated with cold fronts are

Left: Seasonal winter creek below Bluff Knoll.
Photo – Alex Bond

especially hazardous. The rapid deterioration of the weather has often taken unwary walkers by surprise. Extreme changes with hail or snow may occur several times each year. On the higher peaks a more effective measure of conditions, called the wind chill equivalent temperature, equates to -18°C in winds of 60 kilometres per hour and a temperature of 0°C.

CLOUDS

The Stirling Range is renowned for its unusual, and sometimes spectacular, cloud formations. Clouds are produced when air becomes saturated and water condenses. Mountains force the air to rise and cool, so clouds may form about the peaks when the condensation point is reached. Park visitors may notice two types of unusual cloud formations about the peaks, often when the rest of the sky is clear. A shallow, low-level stratified cloud that drapes over the higher peaks is a familiar sight. Another type of shallow cloud layer may leave the higher peaks exposed—a unique sight in WA.

Like the remainder of the south coast region, the onshore winds provide the moisture needed for low-level cloud formation. The topography of the range helps to lift this moist air to the condensation level. Air originating from the north or north-east is usually quite dry, so any cloud that forms usually has a high base. The low-level clouds form on the windward side of the peak, where the maximum rate of condensation occurs with the strong updrafts above the steep terrain. Low-level clouds also form beneath rain clouds, when rain or water on the ground evaporates. This is common in winter with cold fronts or rain-bearing depressions.

A survey, conducted several years ago by former Stirling Range National Park Ranger Allan Rose, of low-level cloud on five of the eastern peaks revealed that they occurred on some of the peaks on about two days out of every three. Cloud cover is heaviest on winter mornings, when temperatures are lowest, but may occur at any time of year. Low cloud in winter corresponds to the high level of atmospheric moisture and rain. The frequent low clouds in summer occur despite the low rainfall, as a shallow moist layer of air generally flows in from the south. Clouds usually dissipate during the morning, as they are heated by the sun, but gradually reappear towards sunset, as temperatures rapidly fall.

SNOW AND HAIL

The Stirling Range is one of few places in WA where snow occasionally falls. Snow probably falls on the highest peaks several times each year. On most occasions, there is only a light dusting or the snow melts on impact. However, falls of five centimetres in depth have been reported on Bluff Knoll. Snow may occur at any time from late autumn through to spring. In 1992, during a period of heavy spring rainfall, people flocked to the park to see the snow.

Snow occurs when a cold, moist airflow, following a cold front, originates from ocean areas well to the south of the continent. It is not uncommon for maximum temperatures on the highest peaks to be only just above freezing. These situations result in strong, icy winds and low cloud about the peaks. Venturing to any of the peaks under these conditions can be extremely hazardous.

Hail is usually associated with cold outbreaks during the cooler months. Although hail is often widespread, the hailstones are not generally as large as those from the less frequently occurring thunderstorms in the warmer months.

BUSHFIRES AND WEATHER

Throughout the south-west, bushfires are a major concern. They are strongly influenced by weather conditions, and are usually associated with hot, dry northerly winds ahead of a trough, which brings a cool south-westerly change. High temperatures, often exceeding 35°C, with strong and gusty winds make firefighting difficult and particularly dangerous. Lightning strikes, from summer thunderstorms, may start these fires, so fire bans are no guarantee that fires won't occur on

Above: Bushfire regrowth area near Mondurup Peak.

Right: Flowering head of drumsticks (*Kingia australis*) in regrowth.
Photos – Bill Bachman

these days. The presence of tropical cyclones to the west may also cause dangerous conditions, although these events are rare. In 1978, Cyclone Alby accelerated down the west coast and the extreme fire weather from it resulted in fires that caused extensive damage throughout the south-west.

THE SURVIVORS

The plants and animals of the Stirling Range have survived many climatic fluctuations. Some species were widespread throughout Australia in wetter climates and retreated to higher elevations during dry glacial episodes, while others have adapted to drier climates.

Two climatic factors influence the plants and animals of the Stirling Range. Firstly, the area provides a wide range of microclimates due to the variation of rainfall, temperature and winds. On the southern side of the higher peaks, rainfall and humidity are high, temperatures are cooler by day, yet warmer than the plains by night, and winds are generally stronger than anywhere else in the park. Near the northern boundary of the national park, temperatures are higher by day yet probably experience lower overnight temperatures; and the area is less exposed to the prevailing winds. This also makes low-lying areas susceptible to frosts. Secondly, the wide-ranging weather extremes, from snow to heatwaves, mean that species must be resilient to survive such conditions. Such variability and extremes of climate have led to relatively high numbers of endemic species.

Joe Courtney is a meteorologist in the Severe Weather Section of the Bureau of Meteorology. He can be contacted on (08) 9263 2222 or by email (j.courtney@bom.gov.au).

Winner of the 1998 Alex Harris Medal for excellence in science and environment reporting.

LANDSCOPE

VOLUME EIGHTEEN, NUMBER 2, SUMMER 2002–2003

The first stage of a long-distance mountain bike trail, that will ultimately lead from Mundaring to Albany, is now open. See page 49.

Discover the underwater wilderness of the Geographe Bay, Leeuwin-Naturaliste, Hardy Inlet area, a potential marine conservation reserve, on page 18.

Little was known about the distribution of the dalgyte, or bilby, in the south-west forests until scientist Ian Abbott interviewed old timers. Turn to page 28.

Older piles of the Busselton Jetty are crowded with marine life, but it was not always so. How do marine animals gradually colonise the piles? See page 34.

The Stirling Range National Park experiences many extremes of weather, from snow falls to bushfires. Find out why on page 10.

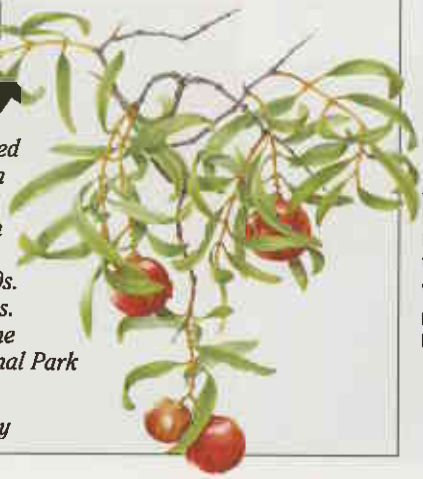
FEATURES

REGULARS

COVER

Quandong (Santalum acuminatum) *is one of the most widespread plants in Australia. This small, upright tree is most easily recognised by its bright red fruits, which are edible and also contain a nutritious nut. It belongs to the same genus as the famous sandalwood, which was one of Western Australia's major exports in the late 1800s and early 1900s. Members of this genus are root parasites. Quandong grows in dense stands in some areas within the Woodman Point Regional Park (see story on page 42).*

Cover illustration by Philippa Nikulinsky



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