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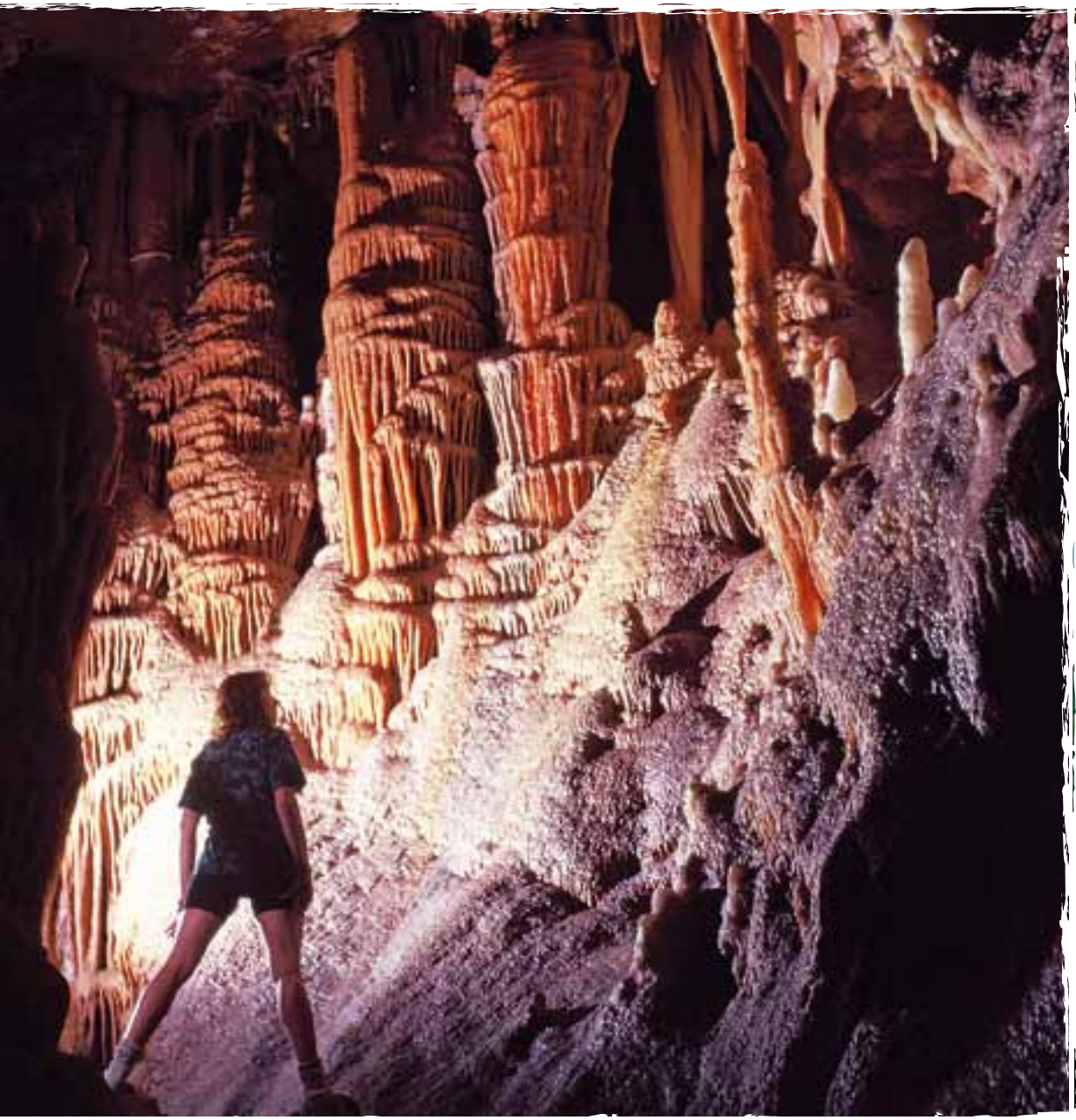
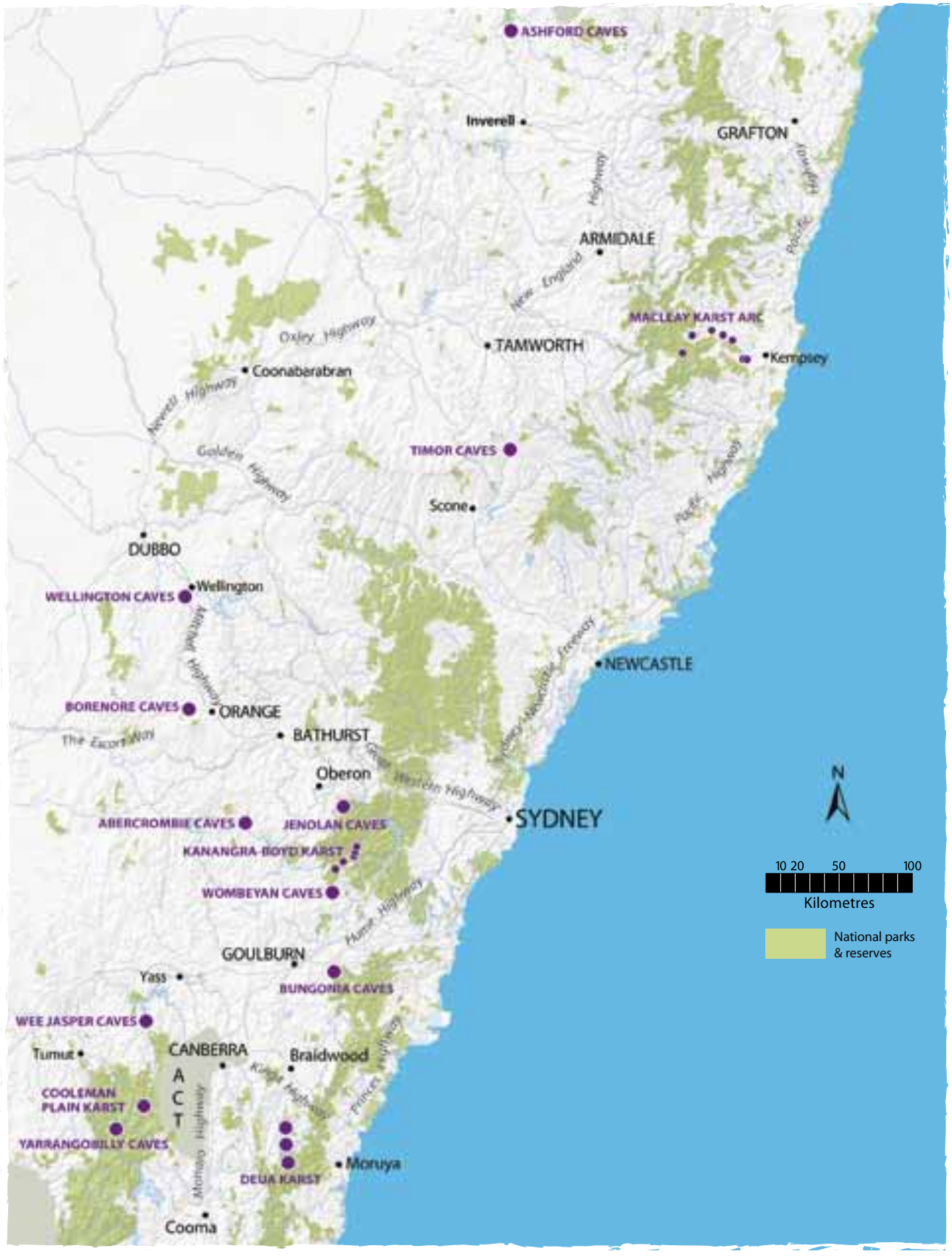
Office of Environment & Heritage

NSW National Parks & Wildlife Service



Guide to New South Wales Karst and Caves

Karst and cave locations



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Overview

New South Wales boasts a wide diversity of rock types ranging in age from over 2.5 billion years to those currently forming along our coastlines. These many different rocks are represented in a range of geological structures, including major faulting and folding zones, extinct volcanoes, ancient glacial formations and, importantly, karst and caves.

These landforms, features and processes – our *geodiversity* – are the backbone of many NSW national parks and form the outstanding scenic elements of areas such as the Blue Mountains, the Warrumbungles and other northern NSW volcanic sites, the Great Eastern Escarpment, the glaciated areas of Kosciuszko National Park, and the coral reefs around Lord Howe Island.

Value of karst

A significant and often undervalued element of geodiversity is *karst*, a term which describes the suite of landforms produced by the action of natural waters on soluble rocks, most commonly, limestone and dolomite.

Karst landforms include caves and their contents, gorges, closed depressions and minor surface features, reflecting the often complex relationships between surface waters and groundwaters. These landforms are part of the rich geodiversity upon which we live and are highly regarded for their natural, cultural, scientific, recreational, socio-economic and aesthetic values.

Karst landforms act as important refuges for plants and below-ground organisms; some karst caves are capable of preserving bones extremely well with sites like Wellington producing fossils of national and international significance.

Like other Southern Hemisphere continents, there are limited areas in Australia able to host the development of karst and caves. NSW, with over one hundred areas of limestone and other carbonate rocks spread across the state, has a major role to play in conserving Australia's scarce karst heritage.

Karsts are truly 'living landscapes' as they are the outcome of the complex interplay over time of climate, topography, soils, hydrology and biology. These developmental processes are enhanced by the

Devils Coach House, Jenolan Caves. Photo: S. Babka

acidification of water by atmospheric carbon dioxide and, even more importantly, from elevated carbon dioxide levels in the soil as a result of root and animal respiration, the decay of organic matter and other sources.

Role of topography

The presence, scale, type and complexity of karsts are influenced by topography. In NSW the dominant topographic feature is the Eastern Australian Highlands (the 'Great Dividing Range'), a series of plateaus that extend virtually uninterrupted for the entire length of the eastern seaboard. The state's seven topographic zones are commonly recognised as:

Coastal Plain – This narrow plain extends from the Tasman Sea to the foot of the Eastern Escarpment and grades into the escarpment through increasingly hilly terrain. The only major karst in this zone is inland from Kempsey at Yessabah with a minor area at sea level at Myall Lakes.

Eastern Escarpment – This zone marks the rapid change in topography between the coastal plain and the mountain ranges, tablelands and dissected plateaus of the Great Dividing Range. Karsts at Deua National Park, Bungonia National Park, the Jenolan and Wombeyan karst conservation reserves, Colong, Timor, Stockyard Creek and others near Kempsey and Wombeyan, have formed in, or beside, deep valleys cut into the escarpment.

Broken Column, Lucas Cave. Photo: courtesy JCRT

Highland Plateaus – This broad series of plateaus range in elevation from 800 to 1300 metres and form the crest of the Great Dividing Range. Karsts located on the Highland Plateaus include Rosebrook and Kybean.

Western Slopes – These are the western flank of the Highland Plateaus, containing important karsts such as Cliefden, Wellington and Borenore.

Western Plains – This extensive area of low-lying land incorporating the Murray and Darling Riverine plains contains little or no karst development.

Western Uplands – Carbonate rocks have been reported in this zone in the area north of Broken Hill, but no integrated karst systems or caves are known. Small-scale solution features (*karren*) have been found at a number of sites including Mount Arrowsmith, while there are probable 'fossil' karst features north of Broken Hill at Torrowangee.

Western Incised Zone – On the western side of the highlands, this zone includes karsts such as Abercrombie, Wee Jasper, Cooleman and Yarrangobilly, which are situated in the steep, upper tracts of westward-flowing streams. The last two karsts occur at relatively high elevations where they currently experience sub-alpine conditions and, previously, alpine conditions in the last Ice Age.

Brush-tailed rock wallaby. Photo: courtesy JCRT

Bath of Venus, Pool of Cerberus Cave, Jenolan Caves. Photo: courtesy JCRT

The management and maintenance of karsts requires attention to overlying soils and vegetation as well as hydrologic regimes. It also depends on a sound understanding of topographic influences and the adoption of a whole-of-catchment approach, which identifies and manages the impacts of human activity on a broader scale.

NSW karst and caves

One of the more obvious and commonly recognised karst landforms are caves or features that are large enough for humans to enter and explore using some form of lighting. The vast majority of these caves are only a few metres in length. However, the interconnections between them may be microscopic suggesting that most, or all, of the caves within a particular karst environment are interlinked (or at least have been in the past).

Casteret Cave. Photo: courtesy JCRT

In NSW there are more than 2000 caves in approximately one hundred karst environments. These include show or developed caves at Abercrombie, Jenolan, Wee Jasper, Wellington, Wombeyan and Yarrangobilly, which provide enhanced opportunities for visitors to appreciate this important element of the state's geodiversity. Show caves are also important from a socio-economic perspective, generating income for regional communities and providing employment opportunities.

Cave exploration is a pastime enjoyed by many, including organised speleological clubs who have contributed significantly to our understanding and appreciation of these special environments. Therefore, caves and karst environments generally can be looked upon as an important educational resource and a 'textbook' for explaining the Earth's development. Some caves may also be associated with the Dreamtime stories important to local Aboriginal people.

In a biotic sense, caves are important in providing habitat for a variety of highly evolved plants and animals. These include what are often referred to as 'living fossils': cave-adapted invertebrate species, which closely resemble their ancient ancestors and in many cases have no eyes or pigmentation. Cave-dependent animals can provide critical clues in understanding the evolution of life, while the bats that live and breed in caves in their tens of thousands are useful in controlling insect pests.

Other karst landforms in NSW may be less spectacular than its caves, but features such as the limestone gorges at Yarrangobilly, Cooleman, Bungonia and Marble Arch are also well worth a visit. Similarly, small-scale limestone sculptures, called *karren*, are found almost everywhere on limestone and are often very beautiful.

Cave research. Photo: courtesy JCRT

In addition to its karst caves, the state also hosts some fine examples of karst-like features such as the impressive Big Hole south of Braidwood (30 metres across and 100 m deep), the Hilltop Natural Tunnel and the beehive-like domes of Monolith Valley in Budawang National Park. These features all formed in rocks other than limestone. There are also hundreds of sea caves along our rocky coasts.

Compared with many other countries, Australia has a relatively limited range of karst and cave resources, with NSW having a large proportion of the nation's more important sites. These include:

- the world-class show caves of the Jenolan Karst Conservation Reserve (within the Greater Blue Mountains World Heritage Area), which is said to have the oldest known caves open to the surface
- the mammalian fossils from Wellington Caves, which are important for their contribution to palaeontology as a science and thought by many to have influenced Charles Darwin's thinking on the origin of species and his Theory of Evolution.

In addition to these notable mentions, the caves at Wellington, Yarrangobilly, Wee Jasper and Wombeyan karst conservation reserves are of national significance from geological, biological and palaeontological perspectives. Other potential candidates for listing in this category include Cooleman Caves and the Macleay Limestone Belt, which are both highly regarded for their significant biotic and abiotic values. Many other karst environments throughout NSW are also important for their cave-dependent fauna, their contribution to the understanding of landscape evolution, and their past and current meaning to Aboriginal and non-Aboriginal people.

Caring for karst

Fortunately, almost all of the state's significant cavernous karst environments are within national parks and nature reserves, which are under the care of the Office of Environment and Heritage or administered by the Department of Primary Industries. Most have their entire catchments within formally protected areas which allows for proper management of the water, soil and vegetation that are essential for the health of karst ecosystems. Other areas, largely on private lands, may be less well protected, meaning that those areas under public management are best placed for future generations to use and enjoy.

It is also important to note that limestone is a mineral used daily for a variety of purposes. However, exploiting it must always be balanced against the other benefits provided by karst limestones, such as the maintenance of groundwater quality and quantity, spiritual and emotional well-being and an enhanced understanding of climate change and the rates and modes of evolutionary processes.

Victoria Arch stream passage, Wombeyan Caves. Photo: G.K.Smith

Responsible caving

Caving is an activity that involves inherent risks. Cave environments may contain areas of little or no natural light, uneven and slippery surfaces, unstable areas, cold water, deep pools, foul air from elevated carbon dioxide levels, sudden and unfenced drops, and other natural hazards.

In some cases, the risks associated with caving can be reduced to more acceptable levels but they can never be completely eliminated. So it is important to be aware at all times and consider the following suggested steps to minimise risks:

- When caving, adopt an attitude of self-reliance, responsibility and preparedness. In practical terms this means careful planning, competent organisation, appropriate provisioning and thorough training.
- Undertake caving in parties of at least four. This is generally considered to be the smallest sized group that is able to muster sufficient physical resources for effective self-rescue and provide adequate care should a member become injured or incapacitated.
- Ensure at least one member of the party holds an approved first aid certificate and that all participants know basic emergency procedures in case of an accident.
- Before every trip:

  determine the known and potential hazards that exist in the caves to be visited

  decide on the communication procedures that will be used while underground

  ensure all participants have the necessary qualifications, competencies and experience needed to undertake the proposed activities and safely navigate and manage the conditions and hazards that can reasonably be expected.

For more tips and information on staying safe in national parks, visit the park safety webpage at **www.environment.nsw.gov.au/parksafety/**

Always remember to check with the local Parks and Wildlife office or visitors centre listed in this guide about the conditions and requirements for accessing caves.

The responsible caving message above incorporates elements of the Australian Speleological Federation Inc. Cave Safety Guidelines *(2011).*

Abercrombie
Karst Conservation Reserve

Location

Located in the Central Tablelands of NSW, Abercrombie Karst Conservation Reserve lies approximately 80 kilometres south-west of Bathurst and 129 km north-west of Goulburn. The reserve is 1434 hectares in size and forms part of the Bathurst Local Government Area.

History

Archaeological evidence suggests that Aboriginal people (including the Wirradjuri and Gundungurra groups) frequented Abercrombie Caves and surrounding areas some 2000 years ago. While the extent and nature of this use is largely unknown, it is likely the caves were at some point used for refuge and the surrounding areas as a source of food and water.

From a European perspective the reserve has a rich history. This is thought to have commenced in the early 1820s when locals referred to the area as 'The Bridge', a reference to the large natural arch spanning Grove Creek. In 1830 this association became more pronounced when a group of escaped convicts, known as the 'Ribbon Gang' and led by Ralph Entwistle, robbed homesteads and terrorised the district, using the caves as hideouts.

Tourism was first recorded in the area in 1834 when the owner of 'Bald Ridges', a nearby property, escorted visitors through Abercrombie Caves. However, they were not officially 'discovered' until 1842 by then NSW Surveyor General Walker Davidson.

A slightly later discovery in the region was gold in 1851, leading to an influx of miners who, on learning of the reserve's caves, constructed a small dance platform in the Archway around 1860. A bigger dance platform, built in 1880, can still be seen in the Archway today. Miners were also responsible for coining the name Abercrombie Caves, which until then had been referred to by several names including, as previously mentioned, 'The Bridge', along with 'Grove Creek Caves' and 'Burragylong Caverns'.

Over time, many of the caves' delicate formations were damaged by the activities of miners, leading to the appointment of Samuel Grosvenor as the site's first official caretaker in 1889.

Access issues and floods limited early visitation to the reserve and, following the largest known flood in April 1950, the caves were closed for two years while high-level suspension bridges were constructed. On re-opening, the caves were shown for the first time using electric lights.

Today the reserve continues to attract large numbers of visitors each year with its caves regularly used for concerts and weddings.

Goldminers' dance platform in the Hall of Terpsichore. Photo: courtesy JCRT

Geology and geomorphology

Abercrombie Karst Conservation Reserve's caves have developed in a regionally metamorphosed limestone (marble) that locally forms part of the Upper Silurian Kildrummie Formation and, on a broader scale, the Hill End Synclinorial Zone. Metamorphism in the caves has been considerably more intense than at other major NSW karst areas, resulting in extensive re-crystallisation of the limestone.

Abercrombie Caves contains an abundance of features formed by erosion or weathering (*speleogens*), as well as an excellent example of a cut-off subterranean meander. The caves also feature significant vertebrate deposits, including the skeletal remains of marsupial megafauna.

Limestone at the reserve is underlain by layers of basic volcanics and shales and overlain by a series of sandstones, shales and greywackes. Following deposition of these sediments, the region surrounding the reserve was intensely folded and eroded.

The reserve's karst is impounded with its body of limestone entirely surrounded by impervious rocks. Despite this, it contains a well-developed karst system in a relatively restricted area of limestone. The main feature is the Grand Arch, a through-cave approximately 200 metres long, an average 40 m wide and with a maximum height of 32 m.

Ecology

Abercrombie Karst Conservation Reserve contains a significant area of intact remnant vegetation in a region which has been extensively cleared. Within this are several species of rare or threatened flora, notably *Bossiaea fragrans*, a shrub recently classified as critically endangered and known only to occur in the reserve.

The reserve is inhabited by a diverse range of fauna. Above ground, this includes the vulnerable peregrine falcon (*Falco peregrinus*) and the regionally uncommon sugar glider (*Petaurus breviceps*). Below ground, its caves provide roosting and maternity sites for a number of bat species: the vulnerable eastern bent-wing bat (*Miniopteris shriebersii oceanensis*), as well as the eastern horseshoe bat (*Rhinolophus megaphyllus*) and little mastiff bat (*Mormopterus planiceps*).

Many cave-adapted invertebrate species have been recorded at the reserve including at least eight species of spiders. Among these is the cave shawl spider (*Badumna socialis*), which is known only to occur in the large arches of the Abercrombie and Jenolan cave systems.

Abercrombie Archway. Photo: courtesy JCRT

Speleothems in Archway Cave. Photo: A.Baker

Access and services

Access to Abercrombie Karst Conservation Reserve is by Trunkey Creek–Goulburn Road, which is unsealed in sections from Crookwell.

The reserve provides excellent opportunities for guided and self-guided cave tours, bushwalking, fishing, swimming and fossicking.

A kiosk is open daily and offers light refreshments. Camping and cabin accommodation is also available, and there are amenities blocks with hot showers, toilets and a laundry on-site.

Ashford Caves

Location

Ashford Caves lies within Kwiambal National Park, which is located in the North West Slopes and Plains of NSW approximately 220 kilometres north of Armidale and 90 km north of Inverell. The 1301-hectare park forms part of the Armidale Dumaresq Local Government Area.

History

Ashford Caves is within the traditional area of the Kwiambal People (pronounced Kigh-am-bal), who used its abundance of water, food and materials for year-round living and subsistence. Tragically, many of the indigenous group were killed by gangs of armed ex-convicts, who worked in the area following the arrival of Europeans in 1830.

It is likely that Europeans became aware of the area's caves shortly after their arrival. From 1916 to 1967, at least three caves were sporadically mined for their phosphate-rich bat droppings (*guano*), which was used as a fertiliser. The current entry to Ashford Main Cave is the result of excavation of 1-2 metres of guano from the cave floor and tunnelling through bedrock.

In 1915, land encompassing most of the caves in the area was declared a Recreation Reserve and ever since this has been a popular destination for visitors. Kwiambal National Park was dedicated in April 2000 following the purchase of local property leases by the NSW Government. Several adjoining Crown reserves, including Ashford Caves, were also incorporated into the new park.

Geology and geomorphology

Ashford Caves occurs on the northern edge of a limestone outcrop, which stretches for 10 kilometres along Limestone Creek. The area's limestone is Carboniferous in age (about 330 million years old) and was metamorphosed into marble by the heat and pressure generated when nearby volcanic and igneous rocks formed.

Ashford Main Cave has approximately 560 metres of horizontal passage, with two main entrances and a number of smaller openings. However, while relatively large in size, the cave only has a limited number of intact decorations because of past mining activity and dissolution by guano and bat urine.

Eastern horseshoe bat. Photo: G.K.Smith

Four types of fossil bone-rich sediments have been discovered in Ashford Caves. While the age of these sediments is unknown, they are considered palaeontologically significant as they lie between the Late Tertiary deposits of the Darling Downs and Riversleigh areas in Queensland (15 to 1.8 million years in age) and the 30,000-year-old Quaternary deposits found at Wellington in NSW. The sediments are also thought to have the high potential to provide valuable information on past environmental conditions and the make-up of local fauna, although to date their use for these purposes has generally been limited.

While locally significant, the limestone caves of Kwiambal National Park are to some degree overshadowed by the Macintyre and Severn rivers. These rivers are framed by spectacular, steep-sided gorges in their lower sections, and contain numerous waterfalls such as the popular Macintyre and Severn River falls. Surrounding and complementing these features is a landscape dominated by huge granite boulders and rugged hills.

Ecology

Ashford Caves provides important habitat for a variety of cave fauna, including a viable population of the eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), which is listed as vulnerable under the *Threatened Species Conservation Act 1995*, and the eastern horseshoe bat (*Rhinolophus megaphyllus*).

Thousands of these bat species migrate to Ashford Main Cave over the summer months to give birth and raise young. Visitor access to the cave is restricted over this period as disturbance of maternity colonies can result in the abandonment and mortality of infant bats.

Sixteen species of invertebrate fauna have been recorded in Ashford Caves, including a new endemic species of beetle (*Speotarus princes*), which had never been previously recorded in caves. Prior to disturbance from guano mining and public visitation, it is also likely that the caves have provided habitat for many other invertebrate species.

Ashford Main Cave. Photo: G.K.Smith

On a broader scale, Kwiambal National Park is one of the largest areas of remnant woodlands on the intensively farmed and cleared north-western slopes of NSW. Common tree species include the white cypress pine (*Callitrus glaucophylla*) and silver-leaved ironbark (*Eucalyptus melanophloia*). The park also includes approximately 200 hectares of rare dry rainforest.

The flora communities of the park, together with its rivers, rocky outcrops and cliff overhangs, provide habitat for a diverse range of native fauna, including 101 birds, 32 reptiles, 11 frogs and 30 mammals.

Access and services

To reach Ashford Caves, follow the signs from Ashford Village for approximately 28 kilometres. From this point access to other parts of Kwiambal National Park is via sealed and unsealed road.

The area immediately surrounding Ashford Caves contains picnic tables and public toilets. Ashford Main Cave is horizontal, allowing easy access for visitors outside of the summer bat maternity season.

Kwiambal National Park offers spectacular waterfalls, walks and camping areas and provides excellent opportunities for swimming and fishing in a number of locations.

Macintyre River, Kwiambal NP. Photo: S.Reilly/OEH

Borenore
Karst Conservation Reserve

Location

Borenore Karst Conservation Reserve is located in Central NSW, approximately 17 kilometres west of Orange and 70 km west of Bathurst. The reserve is 136 hectares in size and forms part of the Cabonne Local Government Area.

History

Borenore Karst Conservation Reserve is within the traditional lands of the Wirradjuri People. While there is little detailed knowledge about their use of the reserve, it contains at least one site known to be highly significant to local Aboriginal women.

The first recorded European visitor to the reserve was John Henderson in 1830 who inspected its caves and associated features during geological reconnaissance work in the region. The next notable visit was by famed Australian explorer Major Thomas Mitchell in 1836 who visited the reserve's caves as part of a larger expedition through NSW.

In 1878, Borenore was declared a Water Reserve and formed part of a travelling stock route. This resulted in the reserve becoming more widely known, contributing to its current popularity as a local and regional tourist destination.

In 1898 or thereabouts, Frank Rusconi, a monumental stonemason born in Australia but who learnt his trade in Italy, recognised the rich quality of the reserve's marble, which was later acknowledged as some of the world's finest and quarried for approximately 30 years. A sample of the famous Borenore 'red marble' is on display at Jenolan Caves House, two hours' drive away.

Borenore was initially declared a Public Recreation Reserve in 1959. This was repealed in 1997 with the dedication of Borenore Karst Conservation Reserve under the *National Parks and Wildlife Act 1974* in recognition of the area's significant karst and cave values.

Geology and geomorphology

Borenore Karst Conservation Reserve's caves formed from limey muds and coral reefs, which originated from volcanic islands located on the east coast of Australia about 410 million years ago. Its limestone (and accompanying rocks) is highly faulted and folded, with lower-lying levels rich in fossils such as crinoids, corals and trilobites of high scientific value.

Borenore Arch. Photo: S.Woodhall/OEH

The reserve's limestone is overlain by young volcanic basalt rock that formed from lava flows from nearby Mount Canobolas approximately 10 to 13 million years ago. At this time, or possibly earlier, the heat from volcanic activity metamorphosed some of the limestone into the high quality marble which was later quarried. Today the limestone is found as outcrops in a two-kilometre-wide strip that extends in an irregular pattern for five kilometres along Boree Creek.

The reserve's karst is listed on the Register of the National Estate for its significant diversity of karst features, sediments and fossils. Many of these, including caves, a karst bridge and small arch, cliff lines, a blind valley, *dolines* (funnel- or saucer-shaped sinkholes in the limestone), springs and small surface solutional features, can be seen within a short distance of the main visitor picnic area.

The reserve's ancient caves contain a number of preserved bone-bearing deposits, which have yielded valuable information on past ecosystems and biota. Arch Cave is the most commonly visited and, even though many of its features have been damaged over time, intact stalagmites and flowstones can still be found. The 250-metre-long Tunnel Cave is also popular with visitors and a good example of a stream cave above a water table containing formations and sediments.

Ecology

Borenore Karst Conservation Reserve is characterised by natural, partially undisturbed, open woodlands which provide habitat for a diverse range of endemic fauna. It is also important as one of the few remaining areas of white box (*Eucalyptus albens*) and yellow box (*E. melliodora*) grassy woodlands in the region.

Fauna species include the eastern grey kangaroo (*Macropus giganteus*), swamp wallaby (*Wallabia bicolor*), brushtail possum (*Trichosurus vulpecula*), ringtail possum (*Pseudocheirus peregrinus*) and the vulnerable spotted-tailed quoll (*Dasyurus maculatus*). Tunnel Cave is used as a roosting and hibernation site by the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) and is closed to the public over winter.

Over 50 species of birds are attracted to the reserve, including the uncommon peregrine falcon (*Falco peregrinus*).

Boree Creek passes through the reserve and has been degraded by nutrients and soil erosion from over a century of farming within the catchment. Weed species found in the reserve are managed through an annual control program.

Karren feature. Photo: G.K.Smith

Access and services

Access to Borenore Karst Conservation Reserve is by Orange–Forbes Road, which is sealed. The access road to the picnic area is an all-weather gravel road.

The reserve contains picnic facilities, including tables and gas barbecues, and public toilets. Well-maintained walking tracks traverse the area, providing an opportunity for visitors to explore Arch Cave, a variety of protruding limestone outcrops and the remnant stand of threatened white box–yellow box woodland.

Camping is not permitted at the reserve which closes at 7 pm daily.

Speleothems. Photo: R.Commins/OEH

Bungonia
National Park

Location

Bungonia National Park is located in the Southern Tablelands of NSW, approximately 180 kilometres south-west of Sydney and 35 km east of Goulburn. The 3977-hectare reserve forms part of the Goulburn Mulwaree Local Government Area.

History

Bungonia lies within the traditional lands of the Njunawal People, adjacent to the north-western corner of the Wandandian Tribal Territory and the southern boundary of the Gandangara Tribal Territory. Little is known of the area's traditional significance, although the remains of historic campsites indicate it was used in the past for tool manufacturing. The presence of bone deposits also suggests the use of at least one of the caves as a burial site.

The first recorded European discovery and exploration of a cave at Bungonia (probably the entrance to Drum Cave) was by botanist Alan Cunningham in April 1824. Soon after, the caves became popular with recreational groups and this, combined with their relative proximity to major centres, led to the declaration of the Bungonia Caves Reserve in 1872.

In 1889, local property owner and unofficial tour guide Louis Guymer was appointed the first and only caretaker of Bungonia, a position he held until 1909. Guymer is credited with discovering many of Bungonia's caves and was also responsible for much of their early development.

The formation of numerous caving clubs in the 1950s led to more extensive exploration of Bungonia's caves. This period also saw an increase in visitation mainly due to the development of more advanced abseiling equipment, which allowed greater access to the caves. Today, Bungonia is one of the most popular recreational caving areas in NSW with over 15,000 people making the trip each year.

Geology and geomorphology

Bungonia is regionally placed on the Lachlan Fold Belt adjacent to the south-western edge of the Sydney Basin. Its caves have developed in the Bungonia Group, which consists of shallow marine sediments containing three limestone units plus volcanic rock, sandstone, siltstone and shale.

Deposition of the Bungonia Group was highly complex. In the Late Silurian and Early Devonian periods, marine sediments that would eventually form the Lookdown Limestone were laid down in the eastern margin of the

Bungonia Gorge. Photo: M.Van Ewijk/OEH

Wollondilly Basin. This was followed by influxes of sediment (the Cardinal Shale) which hindered reef development until favourable conditions allowed carbonate-producing organisms to deposit what is now the Folly Point Limestone.

Following this period of development, limestone deposition was further interrupted by influxes of fine mud (efflux siltstone), before marine organisms re-flourished to produce the sediments of the Sawtooth Ridge Limestone.

Subsequent volcanic activity covered this marine life with sediment (the Tangerang Formation) before the sequences were folded to almost vertical.

The most conspicuous and striking local feature is the slot canyon on Bungonia Creek, which at nearly 300 metres deep is one of the best examples of a limestone gorge in Australia. Bungonia also contains numerous below-ground features of state and national significance, including its caves which are some of the deepest on mainland Australia.

Abseiling. Photo: S.Babka

Compared with many other areas, the caves at Bungonia contain relatively few decorated *speleothems*, the cave formations formed by the deposition of minerals, mainly calcite. However they do boast a diverse range of bedrock fossil deposits, yielding several new species.

Ecology

The geology and landforms at Bungonia provide for a wide range of flora and communities, including several rare and threatened species such as the orchid (*Pterostylis calceolus*) and shrub (*Pimelea axiflora* subsp. *pubescens*), both of which have not been recorded elsewhere.

Bungonia is habitat for a wide variety of fauna, including kangaroos, wombats, possums, gliders and a population of koalas found in the southern part of the reserve, along with evidence of the continued existence of the vulnerable spotted quoll (*Dasyurus maculatus*).

Bungonia is home to a regionally significant population of the vulnerable eastern bent-wing bat (*Miniopteris shreibersii oceanensis*) and the eastern horseshoe bat (*Rhinolophus megaphyllus*), both of which use Drum, Grill, Chalk and other caves for roosting and maternity purposes. In addition, more than 50 invertebrate species inhabit Bungonia's caves including NSW's only known cave-dependent silverfish (*Trinemura anemone*), and a rare beetle (*Notospeophonus jasperensis vicinus*) and pseudo-scorpion (*Paraliochthonius cavicolus*).

Access and services

Access to Bungonia National Park is by Lookdown Road via the town of Bungonia, 25 km east of Goulburn.

Bungonia is one of the state's most popular areas for recreational caving (which operates via self-registration or permit). Bushwalking, canyoning and rock climbing are also popular activities which require self-registration.

Bungonia has three lookouts – two of them accessible by wheelchair – as well as picnic facilities and a camping ground.

Rock pool in gorge. Photo: OEH

Cooleman Plain Karst

Location

Cooleman Plain is located on the north-eastern boundary of Kosciuszko National Park, approximately 77 kilometres from Canberra and 88 km from Tumut. The karst at Cooleman Plain is between 1700 and 2000 hectares in size and forms part of the Tumut Local Government Area.

History

Aboriginal people, including the Bidewal, Ngunnawal, Walgalu and Wiradjuri, have inhabited and shared the resources of the Snowy Mountains high plains for at least the last 20,000 years. The Walgalu people are the traditional custodians of much of the area surrounding Kiandra and Long Plain, which once formed part of a major travel route through the mountains to the coast. Archaeological records also indicate that local Aboriginal people used the limestone cliffs and caves in many parts of the Snowy Mountains for shelter and burial places.

By the early 19th century, the arrival of European settlers and subsequent spread of disease caused the fragmentation and decline of local Aboriginal clans. However important strands of their culture, including their sense of identity and association with the local landscape, remain intact today.

By 1850, pastoralists of European origin were grazing thousands of stock on Cooleman Plain. A restored homestead complex on the road to Cooleman Plain Karst is a magnificent relic of past grazing in the area.

In 1944, the Kosciuszko area (incorporating much of Cooleman Plain) was declared a State Park. This was extended to National Park in 1969, which saw the phasing out of cattle grazing and other activities considered to be damaging the park and greater recognition of the area's natural beauty.

Geology and geomorphology

The limestone at Cooleman Plain formed approximately 420 million years ago, when it was thought to have collapsed into a marine *caldera*, the huge depression left by an explosive volcanic eruption. The large circular outcrop of limestone surrounded by mainly volcanic rock that remains today is evidence of this event.

Cave and karst features developed on the limestone following its uplift above sea level around 400 million years ago, before it was once again covered by the ocean and a layer of sedimentary rock.

Upon lifting above sea level a second time, it took many millions of years of erosion to remove the sedimentary rocks overlying the limestone, re-exposing it some 65 million years ago. Since this time, most of

Nicole Gorge, Cooleman Plain, Kosciuszko National Park. Photo: A.Baker/OEH

the caves and features evident today have developed, although some landform elements associated with the first land-forming phase 400 million years ago can also be discerned.

Cooleman Plain Karst contains an outstanding collection of features, including dry valleys, springs, stream sinks and more than one hundred caves. It is commonly regarded as one of the most beautiful karst areas in NSW and can be viewed from walking tracks winding through limestone gorges and over ridge tops, revealing striking rock formations, open limestone plains, springs, rivers, waterfalls and caves.

Brachiopod shell fossils. Photo: A.Baker/OEH

Four of the main caves – Murrays, Barbers and the left and right Cooleman Caves – are predominantly horizontal and can be explored by torchlight. Though heavily souvenired in the 19th and 20th centuries, these and other caves at Cooleman Plain contain a wide range of cave formations formed by the deposition of minerals, mainly calcite (*speleothems*) and excellent examples of marine fossils, visible in many of the cave's bedrock walls.

Ecology

Landscapes of Cooleman Plain Karst range from broad grassy plains pockmarked with sinkholes and rimmed by timbered hills to dramatic limestone gorges and waterfalls.

The plains of Cooleman Karst are dominated by tussock grass with occasional patches of woody shrubs. Rising from the plains, its broad valleys drain cold air, creating frost hollows where winter temperatures drop to a point where trees are unable to survive. On the edges of the plains, woodlands presided over by snow gums (*Eucalyptus pauciflora*) are common, while the area's higher country is more heavily timbered with species such as the manna gum (*E. viminalis*), narrow-leaved peppermint (*E. radiata*) and alpine ash (*E. delegatensis*). In some areas of the plains the weeping gum (*E. lacrimans*) can also be found.

Cooleman Plain Karst provides habitat for a variety of fauna, including platypus, water rats and possums. Its caves, in particular, support a rich diversity of cave-adapted invertebrates and a roosting site for the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), one of only two such sites in Kosciuszko National Park.

Feral horses are common to the area and are causing erosion and damage to micro-solutional features on exposed limestone surfaces. A program to remove the horses is currently in place.

Access and services

Access to Cooleman Plain Karst is by Long Plain Road via the Snowy Mountains Highway. For safety reasons, Long Plain Road is unsealed and closed between the June and October long weekends. This period may be brought forward or extended due to weather conditions.

Two camping grounds and a car park are located near Blue Waterholes, the starting point for exploration of the area's gorges and caves. Fishing, bushwalking and bike riding are also popular activities.

Clarke Gorge. Photo: A.Baker/OEH

Deua Karst

Location

A number of karst environments occur in Deua National Park, which is located in southern NSW near the townships of Braidwood, Moruya and Cooma. The park is 122,000 hectares in size and straddles the Eurobodalla and Palerang local government areas.

History

The Yuin People (including a number of tribal groups) are the traditional custodians of the park and have a long association with its karst environments. Creation stories told by the Walbanga Tribe speak of the formation of the caves, while it is widely believed that local Aboriginal people used the spring waters emerging from Bendethera and Wyanbene caves for healing purposes.

European association with the park commenced around 1860 when Bendethera Valley was leased for pastoral purposes by Joseph George. Public awareness increased in 1880 following the discovery of Bendethera Cave by George's son Benjamin, leading to part of the valley being declared a Public Recreation Reserve in 1896.

In the north-west of the park, a cave within the Wyanbene Limestone is thought to have been used as a refuge for the Clarke brothers, bushrangers who frequented the area before eventually being captured in 1867.

Wyanbene Cave, the best-known limestone feature of the north-western area of the park, is reported to have been used for public displays during the early 1930s, most likely in conjunction with visits to nearby Big Hole. Wyanbene continues to be popular with both visitors to the area and members of the local community.

Geology and geomorphology

Deua National Park consists of some of the most isolated and rugged mountain ranges in south-eastern NSW. It also contains significant limestone deposits, which formed in the Late Silurian period, approximately 420 million years ago.

Subsequent geological periods have seen the creation of a diverse and complex geology. During a period of volcanism and folding, large granite bodies formed under the Silurian rocks in the north of the park, metamorphosing much of the area's limestone into coarse red and white marble. In the park's south, faulting tore apart the limestone at Bendethera, leaving three exposed outcrops approximately 500 metres apart.

Aragonite anthrodites, Wyanbene Cave. Photo: A.Baker

In the north-west of the park, a small canyon and natural arch (Marble Arch) have formed in the limestone. Nearby, and equally impressive, is Big Hole, a vertical shaft approximately 114 metres deep and 30–50 m in diameter. Situated in sandstone and conglomerate, this spectacular feature is believed to have formed when surface rock collapsed progressively into a cavity formed within the limestone or mineralised rocks.

Other karst features of interest include Bendethera Main Cave, which consists of large bell-shaped chambers rising high in the mountains and giant flowstone formations stained by bat droppings. Also significant is the kilometre-long River Cave (part of the Wyanbene Cave system), which contains extensive formations, including large masses of flowstone and unusual *helictites*, twig-like lateral projections of calcite that take the appearance of curving quills.

Ecology

The rugged and more isolated areas of the park contain animal communities which have been largely undisturbed by Europeans. These include some of the area's larger marsupial species such as the swamp wallaby (*Wallabia bicolour*), echidna (*Tachyglossus aculeatus*), greater glider (*Petauroides volans*) and the threatened brush-tailed rock wallaby (*Petrogale penicillata*).

Over 106 species of birds have been recorded in the park, including the sooty owl (*Tyto tenebricosa*), which often roosts and nests in the area's limestone cliffs and overhangs and is listed as vulnerable under the *Threatened Species Conservation Act 1995*.

The park's caves contain cave-dependent invertebrate populations of regional and state significance along with colonies of eastern bent-wing (*Miniopterus schreibersii oceanensis*) and eastern horseshoe (*Rhinolophus megaphyllus*) bats, which typically use the darker regions of the caves for maternity and roosting purposes.

The rugged, mountainous terrain of the park is covered by Dry Sclerophyll Forest (Eucalyptus), creating a dense and visually spectacular landscape. In the coastal areas of the park, heathlands with freshwater wetlands associated with the Deua and Shoalhaven river systems are common.

The limestone outcrops at Bendethera are dominated by a single species of wattle, *Acacia covenyi*, commonly known as Bendethera wattle or blue bush. This species is endemic to the Bendethera limestone and has adapted to the soils, climate and general environmental conditions peculiar to this geological unit.

The Big Hole. Photo: A.Baker

Access and services

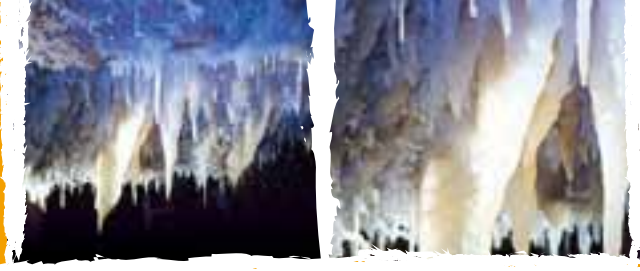
Access to the Big Hole, Marble Arch and Wyanbene Cave is via linked walking tracks, which commence at the head of the Berlang and Wyanbene tracks.

A four-wheel drive vehicle is required to reach Bendethera Valley. It is advisable to check on the condition of access roads prior to visiting in winter and wet periods. On reaching the valley floor, a walking track provides access to Bendethera Main Cave.

A permit is required to access all caves in the park, with the exception of Bendethera Main Cave, the first 200 m of Wyanbene Cave and the karst features of Big Hole and Marble Arch.

Wyanbene stream passage. Photo: Olaf Theden/National University Caving Club

Jenolan
Karst Conservation Reserve



Location

Jenolan Karst Conservation Reserve is located on the western spur of the Blue Mountains, approximately 180 kilometres west of Sydney and 30 km south-east of Oberon. The reserve is 2422 hectares in size and forms part of the Oberon Local Government Area.

History

The Gundungurra and Wiradjuri Peoples have a long association with the reserve and its surrounding lands as evident by the numerous stone artefacts found in its valleys, ridge lines and limestone overhangs.

European history is thought to have commenced in 1838 when runaway convict James McKeown used the isolated Jenolan Valley and two of its caves as hideouts for approximately three years. James Whalan, a local pastoralist, captured McKeown in 1841 and was the first to report the presence of caves in the area.

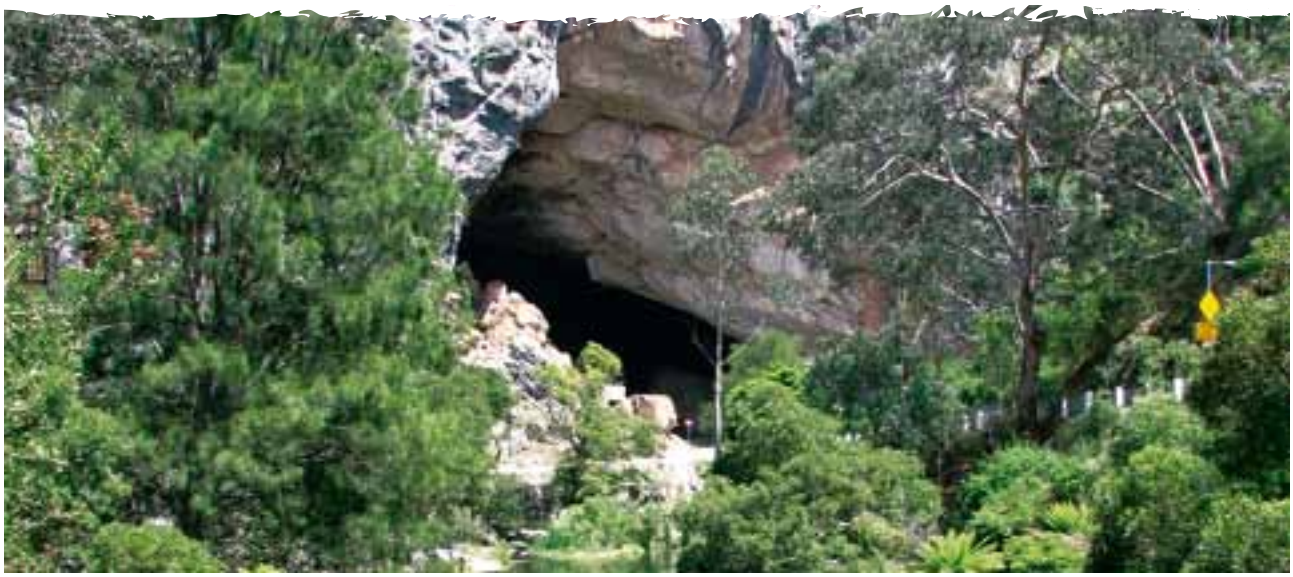
Initially only a small number of people made the arduous trip to the area's caves. However, by 1864 the souveniring of cave decorations had become so commonplace that local Member of Parliament John Lucas sought their formal protection. This led to the area being declared a 'Reserve for the protection of caves and leisure'.

Between 1890 and 1927, the culturally significant and visually imposing Jenolan Caves House was constructed along with such visitor facilities as cave pathways and lighting. In 1997, the area was declared a Karst Conservation Reserve confirming its continuing status as one of the state's premier visitor destinations.

Geology and geomorphology

Since its formation 420 million years ago, the limestone at Jenolan has been shaped by multiple periods of folding, marine inundation, uplift, erosion and cave-forming processes. The once horizontal bed of limestone was turned on its edge and now outcrops on the surface as a 260-metre-wide strip that extends almost continuously over nine kilometres through the centre of the reserve.

The Jenolan limestone is honeycombed with caves, the main system containing over 40 kilometres of connected passage formed by three creek systems draining through springs at Blue Lake. There is evidence that some of the caves were formed 350 million years ago, followed by ongoing development of new caves and modification of older ones up to the present.



Blue Lake across to Grand Arch, Jenolan Caves. Photo: courtesy JCRT

Located near Blue Lake is a group of three spectacular karst bridges – the Grand Archway, Devils Coach House and Carlotta Arch – all resulting from ancient river flows eroding and cutting through the limestone.

The developed visitor caves feature some of the most beautiful and exceptional natural decorations in the world; they are renowned for their range and profusion of secondary mineral cave deposits of calcite (*speleothems*), including examples of less common forms such as *helictites* (flower-like lateral projections of calcite) and sub-aerial *stromatolites* (accretions of calcareous algae in the shape of domes and columns).

The caves at Jenolan Karst Conservation Reserve contain a wide range of river sediments and surface soil infills, which are related to the different environmental conditions that have occurred over millions of years. Consequently, they can provide valuable information about past climate, vegetation and land formation processes. Some sediments also contain fossil bone deposits, providing an indication of the type and range of animal species previously found in the area.

Ecology

Declaration of the reserve in 1866 preceded by other protective actions has meant that most of the area's endemic flora and fauna has remained intact, although introduced weed species are noticeable in some areas.

The reserve's highly dissected mountain terrain supports a mosaic of eucalypt woodland, open forest and tall shrubland vegetation communities, while its limestone and rock outcrops provide living conditions for tree species such as the grevillea, bursaria and kurrajong, which have adapted to survive in the area's calcium-rich soils. Jenolan Karst Conservation Reserve contains 29 different species of limestone-dependent mosses and liverworts (bryophytes).

Over 367 species of animals have been recorded in the reserve, 21 of them listed as threatened or vulnerable. These include the threatened brush-tailed rock wallaby (*Petrogale penicillata*), sooty owl (*Tyto tenebricosa*) and a diverse range of lizards, which use the precipitous limestone cliffs and cave entrances as havens and for breeding.

The reserve's caves contain a rich cave-dependent invertebrate fauna, including many species that have not been recorded elsewhere, as well as cave-dwelling bat species of regional and state significance.

Pool of Cerberus, Jenolan Caves. Photo: P.Woodward

Access and services

Access to Jenolan Karst Conservation Reserve is by Edith Road, via the town of Oberon, or Jenolan Caves Road, via Hartley. Both roads are sealed.

The reserve offers a range of guided and self-guided cave tours and opportunities for adventure caving. It also has many walking tracks which lead to a variety of natural attractions and historic buildings.

The visitor precinct at the reserve includes Jenolan Caves House and a range of other accommodation types. Meals and light refreshments can be purchased at Caves House and picnic and barbecue facilities are also available.

Tour group, Imperial Cave circa 1890. Photo: courtesy JCRT

Kanangra-Boyd Karst

Location

A number of karst environments occur in Kanangra–Boyd National Park, which lies within the Greater Blue Mountains World Heritage Area, approximately 180 kilometres south-west of Sydney. The park is 69,500 hectares in size and forms part of the Oberon Local Government Area.

History

Kanangra–Boyd National Park is within the traditional lands of the Gundungurra (and possibly Wiradjuri) Aboriginal People, with studies of nearby areas suggesting an Aboriginal prehistory dating back 20,000 years.

The park's karst environments were first discovered by Europeans in the 1890s. While initially of only minor prominence, the area grew in popularity following the discovery of Colong and Tuglow caves around the same time. This new-found fame led to the damage of many of the caves, prompting inspection by Oliver Trickett, the NSW Government Geologist, whose assessments resulted in the formal protection of Colong, Church and Billys Creek caves.

In the 1920s, conservationist Myles Dunphy proposed reservation of Kanangra and surrounding areas as National Park and this, along with other actions, saw much of the area declared a Fauna and Flora Reserve in 1937.

During the 1950s and 60s, mining companies sought to quarry limestone from a number of sites in the area. In a protracted campaign, the Colong Committee (representing the interests of the Australian Speleological Federation, National Parks Association and other community groups) successfully lobbied to halt the proposal.

In 1969, Kanangra–Boyd National Park was created, providing long-term security for some of NSW's most outstanding karst and cave locations.

Geology and geomorphology

All of the limestone deposits in the park (and the nearby Wombeyan and Jenolan limestone) formed in the Silurian Period about 410 million years ago. At this time the Australian landmass was situated close to the equator and had a coastline fringed by coral reefs and lime-rich mud.

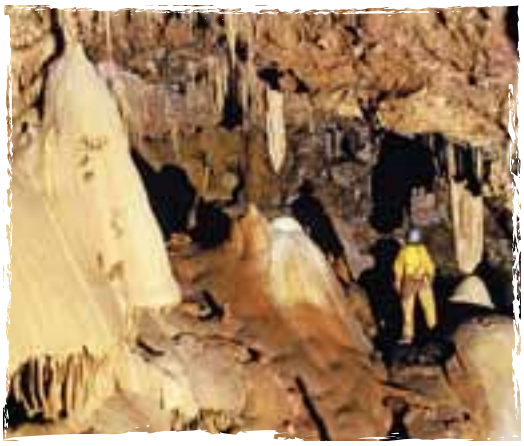
Since their initial formation, the limestones of Kanangra and surrounding areas have experienced numerous episodes of uplift, folding and faulting. Consequently, many of these now outcrop as north-south elongated lenses of steeply dipping limestone, set in highly mountainous terrain incised by deep

Rim pools, Tuglow Caves. Photo: A.Baker

creeks. The area's limestone lenses have also eroded to form spectacular karst landscapes, which include several cave systems of importance to science, conservation and recreation including:

- Tuglow Cave, which has an extensive stream cave system containing a large stream and waterfall and is one of the best examples of this type of cave in NSW
- Colong Cave, which features a large *ramified* cave system – 6000 metres of highly branched passageway – and a series of volcanic rock dykes intersecting the cave and controlling its development
- Billys Creek Caves, which contain numerous cave features and sandstone fills which contribute to an understanding of karst-forming processes.

There are numerous other smaller caves in the park. In many cases these contain outstanding formations or fossil bone deposits that have accumulated over tens of thousands of years. It is also likely that the park's rugged and isolated terrain hides many other caves of potentially high scientific value.



Colong Cave. Photo: S.Babka

Ecology

The karst environments of Kanangra–Boyd National Park provide living conditions for a variety of fauna species with many endemic to the area. Examples include the endangered brush-tailed rock wallaby (*Petrogale penicillata*), which have historically used the rocky limestone outcrops at Church Creek caves for habitat, and the vulnerable sooty owl (*Tyto tenebricosa*), which uses the park's numerous cave entrances and cliffs for roosting and breeding.

Six species of bat have been recorded in the park's caves, including the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), which uses the caves at Church Creek for maternity purposes, one of only five such sites in NSW.

Similar to other karst environments, the park's caves host a range of invertebrate fauna, which, although poorly studied, are all of scientific and conservation significance. These include the cave cricket (*Orthoptera rhaphidophoridae*), a spider (*Pholcidae physocyclus*) and the guano mite (*Urobovella coprophila*).

The park's limestone outcrops contain distinctive vegetation assemblages which are a contrast to others in the surrounding area. These include a diverse range of acacia and grevillea species and a scattering of kurrajong trees (*Brachychiton populneum*) which dominate the surface karst area. On the higher, relatively frost-free points of the limestone cliffs at Colong, a range of orchids including *Dendrobium speciosum* can be found growing on fig trees (*Ficus rubiginos*) and moss-covered rock.

Helictites. Photo: S.Babka

Access and services

The karst environments of Kanangra–Boyd National Park are located in steep, rugged country, which is subject to extremes of weather. It is recommended that visitors to the park exercise a high level of care.

A permit is required for all caving activities. Access to the caves is by marked and unmarked walking tracks, which require a high level of personal fitness.

Macleay Karst Arc

Location

The Macleay Karst Arc lies inland of the Mid North Coast centre of Kempsey and extends almost unbroken for approximately 60 kilometres within the Kempsey and Armidale Dumaresq local government areas. Karst environments included are those at Carrai, Crystal Hill, Moparrabah, Mount Sebastopol, Stockyard Creek, Yessabah and Willi Willi.

History

The Macleay Valley is the traditional home of the Dunghutti People who have six to eight dialect groups, including the Nulla-Nulla, Conderang and Anaiwain.

In 1818, explorer John Oxley was the first European to visit the lower Macleay Gorges, followed in 1826 by Captain Samuel Wright who reported the presence of valuable timber and river access from the coast to the ranges.

Cedar loggers and settlers moved to the area in the 1830s resulting in violent confrontations with the Dunghutti and other local Aboriginal groups. However by the late 1860s, attempts to quash European settlement had been largely quelled and Aboriginal people were employed as station hands and shepherds. Later, in 1997, the Dunghutti gained a place in Australian history as the first on the Australian mainland to be granted native title.

In 1890 most of Yessabah Hill was set aside as a Recreation Reserve although, strangely, between 1920 and 1991 its northern slope was intermittently quarried for limestone. In the early 1920s, the caves at Yessabah were mined for bat guano, which was used as plant fertiliser.

Many of the remaining karst environments in the Macleay Karst Arc are located on private property, or in isolated areas within the ranges. Consequently, they have had few visitors except for some locals, cavers and researchers.

Geology and geomorphology

The limestone of the Macleay Karst Arc is of Permian age (around 285 million years old) and extends almost continuously over a distance of some 60 km from Yessabah to Kunderang Brook. It is part of the Kempsey Block of the New England Fold Belt.

Mount Sebastopol and rainforest slopes. Photo: S.Reilly/OEH

The karst extends over a range of landscapes, climates and altitudes, from the coastal plains up through steeply rising ranges of the Great Dividing Range to the tablelands and incised ranges draining west.

The limestone of the Macleay Karst Arc consists of a basal calcareous mudstone, a central unit of *crinoidal* limestone (made up of the fossil skeletons of marine echinoderms such as sea cucumbers and sea urchins) and a discontinuous member of reefal and siliceous limestones. Most caves are found in the central unit, which is composed of the purest limestone and varies in thickness from 6 metres to more than 500 m at Willi Willi, Stony Creek and Yessabah.

The Macleay Karst Arc includes the 10-hectare Yessabah Nature Reserve, which has the highest concentration of caves in northern NSW: about 60. It also contains a wide range of karst and cave landforms, representing features typical of both cool temperate and tropical karst, including limestone pinnacles, solution flutes, solution spikes, rainpits, solution bevels, karst wells and solution pans.

An impressive feature of the Macleay Karst Arc is the natural bridge located at the base of the Macleay Ranges and the spectacular limestone cliffs associated with Mount Sebastopol. Hundreds of caves have been discovered within the Macleay Karst Arc and Macleay Valley generally, and the predominance of thick vegetation and steep slopes suggest that more discoveries are likely.

Ecology

The Macleay Karst Arc extends from the coast to the high country and provides a wide range of environmental conditions, processes and features.

The sub-tropical rainforest at Yessabah Nature Reserve is one of only two remaining lowland communities in the Macleay Valley and contains a population of rare, small-leafed laurel (*Cryptocarya williwilliana*). Uncommon grass trees and cycad shrublands can also be found on the slopes and top of Mount Sebastapol.

Caves within the Macleay Karst Arc are habitat for the eastern horseshoe bat (*Rhinolophus megaphyllus*) and the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*). In winter, thousands of eastern horseshoe bats gather in Bat Cave at the Yessabah Nature Reserve, prior to departing for Willi Willi Cave where they give birth and raise young.

Surveys of caves within the Macleay Karst Arc indicate a rich diversity of cave-adapted invertebrate fauna, with a significant number of new and endemic species identified such as the land snails, *Letomol contortus* and *Coenocharopa yessabahensis*. The fact that many of the area's caves remain unstudied and relatively undisturbed also potentially makes them some of the most significant habitats for invertebrate fauna in NSW.

Grass tree-cycad karst vegetation. Photo: S.Reilly/OEH

Rainforest–fig tree-covered karst. Photo: R.Commins/OEH

Access and services

Many of the karst environments which form the Macleay Karst Arc are located on private property or surrounded by private land. Permission is required to access these environments.

Willi Willi Caves, Stockyard Creek and Kunderang Brook are located in remote settings and involve treks through rugged bushland.

Timor Caves

Location

Timor Caves is located in the Upper Hunter Valley approximately 200 kilometres north-west of Newcastle and 120 km south of Tamworth. The majority of the area's larger caves are within the Timor Caves Reserve, which is part of the Upper Hunter Local Government Area.

History

The original inhabitants of the Timor area were members of the Geawegal Tribe, who occupied the northern tributaries of the Hunter River alongside their neighbours, the Wonnarua of the mid-Hunter Valley. Unfortunately, the structure of Aboriginal tribes in the Hunter Valley is largely unknown and thus the importance of the Timor karst to Aboriginal people is an area for further study.

It is not known when Timor Caves was first discovered by European settlers. The name 'Timor' appears to have first been used in the *Wells Gazette* of 1848, although it had probably been in use for some time before this date.

In 1852, the Reverend William Clarke, a surveyor with the NSW Government, reported the occurrence of limestone at the Isis River, although notably there was no mention of caves. Early signatures suggest that locals knew of the caves from the mid-1850s and certainly by the 1870s they were locally well known, with an article about them in *The Murrurundi Times* in 1875.

In the 1970s, Murrurundi Shire Council considered a proposal to use Timor Caves for tourism purposes. Although this proposal was deemed to be unfeasible, the caves continue to be popular with members of the local community and a wide range of user groups.

Geology and geomorphology

The limestone at Timor formed approximately 370 million years ago in a shallow marine environment. At this time, the marine life was highly dynamic with new species superseding and burying their predecessors. As a result, the limestone contains a number of different horizons, each exhibiting distinctive fossil assemblages.

An intensive period of volcanic activity buried the soft marine with volcanic debris (the Tamworth Series). The combination of weight, pressure and temperature compressed the limestone into its present hard

Timor limestone landscape. Photo: G.K.Smith

form. Such forces also twisted, folded and faulted the rocks to create the steeply dipping beds which are visible today.

Weathering along bedding planes has produced numerous clefts and solution holes, while surface solution features such as small sharp parallel limestone ridges (*rillenkarren*) are common in the karst at Timor. Another surface feature found are *tufa* deposits, the alluvial calcite deposits over logs, twigs, leaves and earth which form mounds or terraces in above-ground streams.

The majority of the area's larger caves are *phreatic* systems, those formed primarily below the water table. Although relatively small in size compared with many other NSW karst areas, more than 80 caves have been found at Timor. Several of these contain significant fossil and sub-fossil deposits, subterranean lake systems and habitat for a range of fauna.

Ecology

The valley floors at Timor have been extensively cleared of native vegetation and replaced with exotic cereal and pasture crops. However, many of the surrounding slopes and ridges have remnant vegetation of varying quality, ranging from highly degraded to relatively intact.

Much of Timor's surface area is covered by grass trees (*Xanthorrhoea glauca* subsp. *angustifolia*), which commonly reach a height of between 3 and 5 metres. Although this species is often found growing on other limestone slopes in NSW, it is rarely as dense or extensive as at Timor.

The remnant vegetation at Timor provides habitat for native birds, including breeding grounds for the regionally significant musk lorikeet (*Glossopsitta concinna*) and the vulnerable speckled warbler (*Chthonicola sagittata*) and diamond firetail (*Stagonopleura guttata*). At least nine species of forest micro-bats are also found at Timor.

Below ground, Timor Caves provides habitat for a number of cave-adapted fauna. Main Cave is an important roosting site for eastern bent-wing bats (*Miniopterus schreibersii oceanensis*) during winter. Eastern horseshoe bats (*Rhinolophus megaphyllus*) have also been recorded in Belfry and Hill caves and less frequently in several other caves.

A small number of caves located on private property have large numbers of invertebrates, most likely due to the presence of bats (and their guano) and permanent lakes. Of notable mention is a type of syncarid, a 'living fossil' that belongs to a new family in the crustacean order Anaspidacea.

Main Cave, Timor. Photo: G.K.Smith

Squeeze. Photo: S.Reilly/OEH

Access and services

Appropriately equipped groups can access the four major caves (Main, Belfry, Helictite and Hill) in the Timor Caves Reserve via Isaacs Creek–Sargents Gap Road, which is unsealed in sections.

Basic bush camping sites (no facilities) are available on the banks of Isaacs Creek, which is located on private property. The property owner charges a fee for camping and permission is required to access the campground.

Wee Jasper Caves

Location

The village of Wee Jasper is located in the Goodradigbee Valley, approximately 35 kilometres north-west of Canberra and 54 km south-west of Yass. The village and surrounding karst environments form part of the Yass Local Government Area.

History

The Wiradjuri People are the traditional custodians of the Wee Jasper Valley. Many of the large Wiradjuri population were displaced or decimated by disease following the discovery of the area in 1824 by explorers Hamilton Hume and William Hovell and the subsequent arrival of European settlers.

The valley received a substantial influx of visitors in 1860 when people, en route from Sydney to the newly discovered goldfields at Kiandra in the Snowy Mountains, passed through the tiny village of Wee Jasper.

It is not known who first explored the area's caves. However, it is considered likely that the more visible caves were visited by early European settlers, while those less conspicuous were probably used by Aboriginal people for thousands of years before that.

The impressively decorated Careys Cave was discovered in 1875 by John Carey who carved his name and the discovery date on one of its formations. Careys Cave was developed and opened for guided tours in 1968 and is one of the area's major visitor attractions.

Interest in Wee Jasper's caves was sparked in 1957 when the spine of a large extinct wombat was discovered. Following this, many of the area's caves were explored, mapped and studied, with most of the work done by the Canberra Speleological Society.

Geology and geomorphology

The sculptured limestone outcrops of the Wee Jasper Valley are highly scenic and have significant scientific and educational values associated with their structural geology, caves and diversity of marine fossils.

The predominantly sedimentary rocks at Wee Jasper have been folded significantly. The Wee Jasper Valley is cut into the western arm of a huge U-shaped synclinal fold, while the complex folding of the limestones is clearly visible in extensive rock exposures, which are obvious when entering and leaving the valley.

Folded limestone beds. Photo: S.Reilly/OEH

Wee Jasper has two different types of limestone: Taemas Limestone, overlying non-carbonate rock units, and Cavan Limestone. Both of these formed about 400–415 million years ago in the Devonian period, when they were laid down in shallow marine waters populated by species of lungfish, predatory fish and an abundance of *trilobites* (extinct arthropods) and molluscs. Some of the world's most significant and best preserved Devonian fossils have come from the Wee Jasper limestones.

The area's best known cave is Careys, with its seven decorated chambers located just north of Wee Jasper Village. Other large caves include Dip, Dogleg, Punchbowl and Signature. A privately owned site in the area known as the Thermal Paddock has caves containing thermal springs. These are rare in NSW and, besides Wee Jasper, occur only at Cliefden and Yarrangobilly caves.

The construction of Burrinjuck Dam in 1956 inundated much of the area, resulting in what is now referred to as Cave Island, a partially submerged limestone pinnacle, which contains caves that are occasionally visited by divers.

Ecology

Due to the broadscale clearing of vegetation for farming and the development of Burrinjuck Dam, nearly all of the area's surface vegetation has been disturbed. As a result, the remaining vegetation is considered to be highly significant and includes remnant shrubs and small trees, which live in the shallow soil containments of the area's rocky outcrops.

Flora species of note include the kurrajong tree (*Brachychiton populneum*), and the Wee Jasper grevillea (*Grevillea iaspicula*) and limestone brittle-moss (*Orthotrichum cupulatum*), both of which have not been recorded elsewhere.

In terms of fauna, Church Cave within Wee Jasper Nature Reserve is one of only six known maternity sites in NSW for the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*). Over summer, thousands of this species gather in the cave to give birth and raise their young.

Church Cave and other caves in the area also contain a diverse number of endemic, cave-adapted invertebrate species, including those able to live in karst groundwater (*stygobionts*). Based on the number of species identified, the caves of Wee Jasper are recognised as one of the three most important sites in eastern Australia.

Speleothems, Dip Cave. Photo: J.Rutledge

Access and services

Yass–Wee Jasper Road provides a scenic 53-km route to Wee Jasper. From Canberra, Wee Jasper Road is accessed via Uriarra Road, a slightly circuitous 86-km drive.

Guided tours of Careys Cave are conducted four days a week and during peak times and a kiosk and picnic area are available.

Camping grounds are located beside the Goodradigbee River, Micalong Creek and the Hume and Hovell Walking Track. Wee Jasper also has a range of farm stay accommodation and a restaurant and tavern with cabin accommodation.

Limestone 'reef mass' outcrop. Photo: S.Reilly/OEH

Wellington Caves Reserve

Location

Wellington Caves Reserve is located in Central NSW, approximately 7 kilometres south of Wellington and 58 km south-east of Dubbo. The reserve is 155 hectares in size and forms part of the Wellington Local Government Area.

History

Wellington Caves Reserve is within the lands of the Wiradjuri People who used the resources of the region for food and shelter over thousands of years.

The first recorded European entry into the reserve's caves was in 1826 by the artist Augustus Earle, whose sketches depict the interior of Cathedral Cave. This was soon followed by an exploration of the cave in 1828 by Charles Sturt and Hamilton Hume as part of a broader expedition to the region.

The reserve has an important place in science history. In 1830, while exploring one of its caves, local resident George Ranken discovered the first fossil bones found in Australia. These bones were of extinct mammals related to living species and study of them influenced theories on how life developed.

The reserve was officially declared in 1893, largely in response to the unregulated and excessive souveniring of fossil bones that occurred after their initial discovery in 1830. The development of guided tours of the caves followed soon after. Phosphate was mined from a number of the caves between 1914 and 1918 and relics of this activity play a role in visitor education and interpretation programs.

The reserve is currently managed by Wellington Council on behalf of the Department of Primary Industries.

Geology and geomorphology

The caves at Wellington have formed in a bed of north-south-trending limestone that, along with mudstones and other rocks, makes up the Garra Formation, which originated 350–400 million years ago in the Devonian period.

Wellington's limestone beds and strata of the adjoining Garra Formation are internationally significant. Rich in Devonian marine fossils, these rocks provide a standard from which the age of other rocks can be compared or identified.

Cathedral Cave. Photo: courtesy Wellington Caves Reserve

There are over 40 caves at the reserve. While many of these are relatively small-scale, others are more significant including Cathedral Cave, which is used for public exhibitions and was formed by the unusual process of water dissolving the rock upward to form a large domed chamber.

In addition to its more well-known caves, the reserve contains an extensive network of water-filled caves. These include relatively complex formations and fossil bones indicating that they were flooded by a rising water table sometime after they were formed.

The reserve's caves are one of the most significant sites for mammal fossils in the world and house the largest deposit of Pliocene–Pleistocene mammal fossils in Australia, ranging in age from 30,000 to 4 million years. Fossilised bones of extinct megafauna, such as the giant kangaroo, marsupial lion and seven-metre-long carnivorous goanna, have also been discovered in and around the caves.

The reserve's fossils have been highly significant in global science history, with studies commencing in 1830 and attracting the attention of some of the world's greatest palaeontologists and scientists. They included naturalist Charles Darwin who many believe confirmed his Theory of Evolution after viewing the ancient thylacine, kangaroo and wombat fossils from Wellington Caves while visiting Australia in the 1830s. Studies of the reserve's fossils continue today and a range of fossil deposits can be seen in a limited number of its caves.

Ecology

The vegetation of Wellington Caves Reserve has been greatly modified by human activities, including its main limestone ridge, which was once a grassy box woodland. As a result, a variety of weed species are now present although the reserve's current manager, Wellington Council, has recently made inroads into restoring the natural vegetation cover and composition.

Fauna at the reserve includes lace monitor lizards, red-necked wallabies, eastern grey kangaroos, greater glider possums and a range of native birds, skinks and lizards. In addition, the Phosphate Mine and a limited number of other caves are used intermittently for roosting by the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*).

The reserve's labyrinth of water-filled caves is home to a highly significant invertebrate community which includes species of microscopic shrimp-like crustaceans, including syncarids and amphipods. Many of these are considered 'living fossils' totally dependent on the reserve's caves for their survival.

Gaden Coral Cave. Photo: courtesy Wellington Caves Reserve

Access and services

Access to Wellington Caves Reserve is by the Mitchell Highway via the cities of Dubbo or Orange.

Guided tours of Cathedral Cave, Gaden Coral Cave and the Phosphate Mine are conducted daily. A surface tour (self-guided) has also been developed, providing visitors with an opportunity to view some of the area's diverse marine fossils.

A range of accommodation, including camping and a caravan park, and a kiosk are located in the reserve.

Phosphate Mine. Photo: courtesy Wellington Caves Reserve

Wombeyan
Karst Conservation Reserve

Location

Wombeyan Karst Conservation Reserve is located in the NSW Southern Highlands, approximately 190 kilometres south-west of Sydney and 77 km north of Goulburn. The reserve is 571 hectares in size and forms part of the Wingecarribee and Upper Lachlan local government areas.

History

Wombeyan Karst Conservation Reserve is within the traditional territory of the Gundungurra and Wiradjuri people. A Gundungurra Dreaming story tells of a running battle between two spirit creatures, which created the rivers and some of the large limestone depressions that are located in or near the reserve.

There is little record of the reserve's early European history with the first official report by explorer John Oxley in 1828, when he sighted its caves during an expedition in search of grazing land. A clergyman by the name of Denning is credited with the first official entry into the deeper sections of the caves in 1842, while lesser excursions were undertaken in the same year by Reverend JS Hassall and associates.

In 1865, a 650-acre section of the reserve was set aside for the protection of caves and leisure, making Wombeyan Caves one of the first protected cave areas in the world. At the same time, Charles Nicholas Chalker was appointed caretaker of the caves and is credited with many of the early cave discoveries.

Geology and geomorphology

The reserve's karst is surrounded by intrusive igneous rock, which was once covered by volcanic rock. The heat and pressure from these rocks then metamorphosed the 420-million year old limestone into coarse crystalline marble.

The landscape and landforms (including caves) at the reserve have been shaped by geological events and weathering processes, which have taken place over the past 350 million years. These have produced one of the most cavernous karst areas in NSW with over 500 known caves in an area of less then 600 hectares.

Wombeyan Karst Conservation Reserve has a wide range of surface karst features, including funnel- or saucer-shaped sinkholes in the limestone (*dolines*), blind valleys, deposits of calcite around springs (*tufa*), surface solutional formations (*karren*) and a beautiful limestone canyon.

Mares Forest Creek Gorge. Photo: S.Babka

A number of the reserve's caves contain unusual sediments, fossilised bone deposits and volcanic rock fills that are thousands or millions of years old. These provide valuable insight into past climate and fauna communities, the evolution and development of the landscape and Earth's history generally.

Many of the reserve's caves are highly decorated with four of the largest and most decorative developed for visitors. Figtree Cave, containing large chambers and an active stream canyon, has been developed as a self-guided attraction.

The value of the reserve's marble for ornamental and building stone was first recognised in 1915 and from that point was continuously mined under different leases until 1997. Over time the mining of marble ceased, mainly because of decreasing demand and environmental concerns.

Ecology

Wombeyan Karst Conservation Reserve was officially proclaimed in 1865, preceding the declaration of the world's first national park at Yellowstone in 1872.

The rocky limestone landscape and terra rossa soils common to the reserve host specialised vegetation associations and species, which are often of limited distribution, such as Chalkers wattle (*Acacia chalkeri*). Grassy and shrubby woodlands cover much of the reserve and are dominated by apple box (*Eucalyptus bridgesiana*), yellow box (*E. melliodora*) and kurrajong (*Brachychiton populneum*) species, while remnants of grassy box woodland, a threatened vegetation community, are also present.

Following its initial recording by Europeans in 1828 through to the 1950s, much of the reserve's main visitor precincts have been planted with exotic trees and shrubs reflecting the aesthetic tastes of the time.

The reserve's caves contain some of the most interesting and diverse cave invertebrate communities in NSW, leading to its status as a biodiversity 'hotspot'. A total of 23 cave-adapted species have been discovered in 18 surveyed caves and approximately two-thirds of these are restricted to these caves alone.

Many subterranean streams and caves at the reserve are inhabited by bats, including maternity and hibernation colonies of regional and state significance. Threatened eastern bent-wing bats (*Miniopterus schreibersii oceanensis*) and eastern horseshoe bats (*Rhinolophus megaphyllus*) can be found roosting in many of the reserve's caves at different times throughout the year.

Speleothems, Junction Cave. Photo: S.Babka

Streamway into Victoria Arch. Photo: G.K.Smith

Access and services

Access to Wombeyan Karst Conservation Reserve is by Wombeyan–Mittagong or Wombeyan–Goulburn roads, which are unsealed in sections. The road from Mittagong is particularly scenic, although it is extremely winding and narrow in parts.

Guided cave tours are conducted daily and a self-guided tour of Figtree Cave may be undertaken year round.

Accommodation at the reserve includes self-contained cabins, serviced cottages and dormitory-style accommodation. Numerous shady camping spots are also provided. A communal kitchen, dining room and kiosk are available for the use and enjoyment of all visitors.

Yarrangobilly Caves

Location

Yarrangobilly Caves are within Kosciusko National Park, which is located on the NSW Southern Tablelands, approximately 77 kilometres south-east of Tumut and 110 km north-west of Cooma. The park is 673,542 hectares in size and forms part of six local government areas including Tumut.

History

Yarrangobilly Caves is significant to the local Aboriginal people and the presence of large numbers of stone flakes and stone tools close to the caves is indicative of early Aboriginal occupation. Aboriginal bones were also removed from the caves by early European visitors.

According to local folklore, the first European to discover Yarrangobilly Caves was John Bowman (circa 1834) who, while looking for stray cattle and sheltering from a thunderstorm, came across the entrance to the Glory Hole Arch.

Regular excursions to Yarrangobilly Caves commenced in the early 1860s and coincided with the arrival of large numbers of people to the nearby Kiandra Goldfields. In 1887 James Murray was appointed the first caretaker of the caves.

In the early 1890s a flurry of exploration resulted in the discovery of five significant caves, including Jersey Cave, named after the NSW Governor Lord Jersey who officially opened the cave in 1892. A subsequent increase in visitor numbers to the caves led to the construction of Yarrangobilly Caves House in 1901, one of the earliest government-sponsored tourist destinations in NSW.

Yarrangobilly Caves remains a popular visitor destination due to its well-decorated show caves, dramatic scenery, thermal pool and cultural heritage.

Geology and geomorphology

The limestone at Yarrangobilly is of Late Silurian age and formed approximately 440 million years ago. The limestone occurs in a belt that is approximately 14 km long and 1.5 km wide and is overlain by slates, shales, sandstones and conglomerates of the Ravine Beds.

The Yarrangobilly karst contains an outstanding collection of features, including gorges, arches, blind valleys, springs, pinnacle fields and over 250 caves. Six of its caves have been developed and are open for public viewing, including South Glory, North Glory, Jersey, Jillabenan, Harrie Wood and Castle.

Glory Arch. Photo: G.K.Smith

Many of Yarrangobilly's caves are well-decorated. Several caves contain sections of rockfall and rock fills thought to be related to ice-wedging associated with previous ice ages. In Jersey Cave, thick flowstone sequences span half a million years and provide the longest continuous fire history record from a single site in Australia.

Significant sub-fossil deposits have been found in the caves at Yarrangobilly. These include the remains of the vulnerable broad-toothed rat (*Mastacomys fuscus*), endangered smoky mouse (*Pseudomys fumeus*) and long-footed potoroo (*Potorous longipes*), and the extinct thylacine (*Thylacinus cynocephalus*).

An obvious and well-loved feature at Yarrangobilly Caves is its thermal pool. Water seeps through porous rock to a depth of approximately 760 metres where it is heated and then forced up through cracks to emerge as a warm spring. The spring discharges at approximately 100,000 litres per hour and a constant temperature of 27°C. A bathing pool was first constructed at the thermal spring in the late 1890s and the present pool is 20 m long and up to 2.5 m deep.

Ecology

Tall, open eucalypt forest is the dominant vegetation community at Yarrangobilly and includes alpine ash (*Eucalyptus delegatensis*), ribbon gum (*E. viminalis*), snow gum (*E. pauciflora*) and candle bark gum (*E. rubida*) tree species. Threatened flora species, including the vulnerable shining anchor plant (*Discaria nitida*) and austral toadflax (*Thesium australe*), and the endangered rough eyebright (*Euphrasia scabra*), also occur in the area.

Caves House. Photo: A.Baker/OEH

The sheltered valleys and grassy slopes at Yarrangobilly support a variety of vertebrate fauna, such as the eastern grey kangaroo (*Macropus giganteus*), red-necked wallaby (*Macropus rufogriseus*), swamp wallaby (*Wallabia bicolour*) and wombats (*Vombatus ursinus*).

Threatened fauna have been reported close to the area's caves and include the vulnerable olive whistler (*Pachycephala olivacea*), powerful owl (*Ninox strenua*) and the greater long-eared bat (*Nyctophilus timoriensis*), and the endangered smoky mouse (*Pseudomys fumeus*). In addition, the caves at Yarrangobilly provide crucial habitat for the vulnerable eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), while studies of subterranean invertebrates have identified at least 33 taxa, of which 10 are able to complete their entire life cycle in a cave (*troglophile*) and one which is completely cave-dependent (*troglobite*).

Access and services

Access to Yarrangobilly Caves is via a 6-km-long signposted road (unsealed) off the Snowy Mountains Highway, approximately 45 km south-east of Talbingo.

Guided and self-guided tours of caves are available daily and there is wheelchair access through the Jillabenan Cave. Access to the non-developed caves requires consent via a written permit.

A visitor centre is open daily and offers souvenirs and light refreshments. Picnic facilities and amenities are located nearby. Accommodation is available at Caves House and bookings can be made through the Tumut Visitor Centre.

Yarrangobilly Caves includes numerous opportunities for bushwalks and picnics. The thermal pool is a popular place for swimming with change rooms and toilets located nearby.

East Deep Creek Cave. Photo: G.K.Smith

Other areas

In addition to the state's larger, more prominent karst environments, there are an abundance of smaller, lesser known areas which are also important from a scientific, recreational and cultural perspective.

An excellent example is the limestone belt in Central NSW. This relatively small deposit contains numerous limestone outcrops at a variety of locations, including Cumnock, Kandos, Molong and Stuart Town. Typically under private ownership, these and similar outcrops often contain small caves and other cavities, which are used by native animals for refuge or habitat, and sedimentary deposits of a potentially high scientific value.

In addition to these values, lesser known karst environments can also contain extensive and well-developed karst features, like those at Cliefden and Walli. In some cases these features are of regional and state significance, highlighting the importance of all karst environments, whether publicly or privately managed.

Sea caves

Non-karst caves in seaside cliffs are usually formed by wave action and salt eroding rocks, especially where rock strata contains joints, bedding planes, dykes, faults or other zones of weakness that are more susceptible to erosion.

Over 200 sea caves are found along the NSW coastline. The state's Far South Coast contains numerous sea caves, with at least 19 used by the threatened eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) and eastern horseshoe bat (*Rhinolophus megaphyllus*). These and other sea caves can often contain a rich diversity of terrestrial and subterranean fauna, including bats and invertebrate species.

A popular place to view sea caves is Caves Beach at Swansea on the NSW Central Coast, which contains a variety of caves at its southern end. Nearby, Munmorah State Conservation Area also contains numerous sea caves which are available for public viewing, with guided tours conducted on an occasional basis: for details, phone (02) 4320 4205 or visit www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0605.

Gosangs Tunnel, Currarong. Photo: A.Baker

Sandstone arches and caves

Sandstones are essentially granular rocks composed of silica grains that are cemented together by calcite, clays, iron oxides or silica. The solution of silica and/or the cement along joints, faults and fissures, combined with physical erosion, can lead to the formation of arches, caves and canyons.

Sandstone overhangs (commonly referred to as 'caves') are found throughout much of NSW. Slot canyons are also well represented in many parts of the state, including the Greater Blue Mountains World Heritage Area, sometimes containing tunnels and overhangs which provide habitat for a limited range of native fauna.

True sandstone caves are relatively uncommon in southern Australia. One of the best examples is the Natural Tunnel at Hilltop, south of Sydney. This cave is approximately 85 metres in length and contains a dark zone and a small perennial stream. Another example is the Nangwarry Sandstone Caves near Nowra (south of Sydney), which comprise a series of rifts that run in a largely parallel direction to the main cliff line. Eastern horseshoe bats (*Rhinolophus megaphyllus*) and a number of species of large-horned invertebrates, including cave wetas, have been reported in these caves.

Pilchers Mountain, in the Hunter Valley north of Newcastle, contains a series of sandstone caves, of two distinct types: *tectonic* caves, which were formed by the movement of large blocks of bedrock, and *talus* caves, which consist of voids among large breakdown boulders and rocks. Sandstone chasms are also common to the area.

Pilchers Cave provides crucial habitat for a range of fauna. Bat Cave contains an important roosting site for a colony of vulnerable eastern bent-wing bats (*Miniopterus schreibersii oceanensis*), while a number of other caves are also used by eastern horseshoe bats (*Rhinolophus megaphyllus*) and a variety of invertebrate species.

Basalt caves

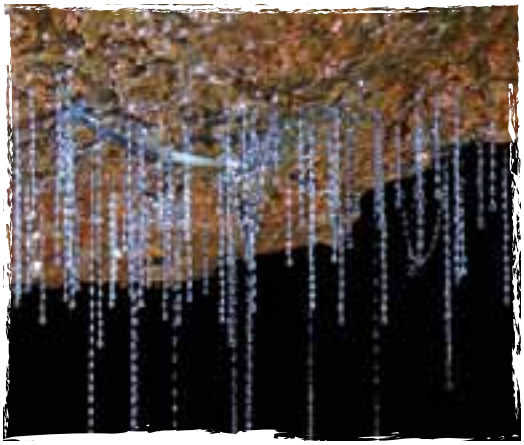
Several basalt caves are found in Coolah Tops National Park in Central NSW. The largest is approximately 100 m long and is thought to have been formed by the groundwater dissolving zeolite-rich basalt containing mineral-filled cavities. The caves are frequently used by wombats, bats and birds including fairy martins (*Hirundo ariel*).

The Natural Arch, Hill End. Photo: A.Baker

Collapse features

While relatively commonplace in limestone, collapse shafts are rarely found in quartz sandstones and conglomerate. An unusual exception is Big Hole, located south-west of Braidwood in Deua National Park. This circular, vertically walled shaft has formed in Devonian sandstones and conglomerate, and is approximately 114 m deep and ranges from 30 to 50 m in diameter.

It is generally accepted that Big Hole formed when the surface rock collapsed into an underlying void. However, the process in which the void formed is unclear, although several theories exist. These include the occurrence of a limestone void (although limestone has not been detected in the immediate vicinity), the removal of a mineralised ore-body in the underlying bedrock, or solutional weathering of quartz sandstone.



Glow worms, Gloucester Caves. Photo: G.K.Smith

Further information

Abercrombie Karst Conservation Reserve

Abercrombie Visitors Centre: phone (02) 6368 8603

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0350

Ashford Caves

Parks and Wildlife Tenterfield Office: phone (02) 6736 4298

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0156

Borenore Karst Conservation Reserve

Parks and Wildlife Macquarie Area Office: phone (02) 6332 7640

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0353

Bungonia National Park

Bungonia National Park Office: phone (02) 4844 4277

Email: bungonia@environment.nsw.gov.au

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N1142

Cooleman Plain Karst

Parks and Wildlife Tumut Area Office: phone (02) 6947 7025

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0018

Deua Karst

Parks and Wildlife Narooma Area Office: phone (02) 4476 0800

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0047

Jenolan Karst Conservation Reserve

Jenolan Caves Visitors Centre: phone (02) 6359 3911

Email: reception@jenolancaves.org.au

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0351

www.jenolancaves.org.au

Kanangra–Boyd Karst

Parks and Wildlife Oberon Area Office: phone (02) 6336 1972

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0016

Macleay Karst Arc

Kunderang Brook – Parks and Wildlife Armidale Area Office: phone (02) 6738 9100

Macleay karst areas – Parks and Wildlife Macleay Area Office: phone (02) 6566 6621

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0042

Timor Caves

Crown Lands Maitland Office: phone (02) 4973 9300

Or visit: www.nhvss.org.au/ – provides details on *Timor Caves*, a publication prepared by the Newcastle and Hunter Valley Speleological Society

Wee Jasper Caves

Wee Jasper Reserves Trust: phone (02) 6227 9626

Email: enquiries@weejasperreserves.com.au

Or visit: www.weejasperreserves.com.au

Careys Cave: phone (02) 6227 9622

Email: information@weejaspercaves.com

Or visit: www.weejaspercaves.com/index.html

Wellington Caves Reserve

Wellington Caves and the Phosphate Mine: phone (02) 6845 2970

Email: caves@visitwellington.com.au

Or visit: www.visitwellington.com.au/bwWebsite/followon.aspx?PageID=4558

Wombeyan Karst Conservation Reserve

Wombeyan Caves Visitors Centre: phone (02) 4843 5976

Email: wombeyan.caves@environment.nsw.gov.au

Or visit: www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N0352

Yarrangobilly Caves

Yarrangobilly Caves Visitors Centre: phone (02) 6454 9597

Or visit: www.environment.nsw.gov.au/NationalParks/parkShowCaves.aspx?id=N0018

Caves House accommodation – Tumut Visitors Centre: phone (02) 6947 7025

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Front cover: Orient Cave, Jenolan Caves. Photo: S.Babka
Cave pool, Bullio Cave, Wombeyan Caves. Photo: G.K.Smith
Mount Sebastopol, summit view, Macleay Karst. Photo: G.K.Smith
Straw stalactite. Photo: G.K.Smith
Inside back cover: The White Altar, Baal Cave, Jenolan Caves. Photo: P.Woodward
Back cover: Glenrock Karst Area. Photo: G.K.Smith

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