

YESSABAH NATURE RESERVE
PLAN OF MANAGEMENT

NSW National Parks and Wildlife Service

Part of the Department of Environment and Conservation (NSW)

May 2004

This plan of management was adopted by the Minister for the Environment on 13 May 2004.

For additional information or enquiries on any aspect of the plan, contact the NPWS Mid North Coast Regional Office at 152 Horton Street, Port Macquarie NSW 2440 or by phone on (02) 6586-8300.

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FOREWORD

Yessabah Nature Reserve covers 10ha and is located 15 km west-south-west of Kempsey in the lower Macleay Valley on the mid north coast of NSW.

Yessabah Nature Reserve was originally set aside in 1890 as a reservation for Public Recreation and the Preservation of Caves. It encompasses a substantial portion of Yessabah Hill, an outcrop of the Yessabah Limestone Belt. The limestone on the reserve has the highest concentration of caves in northern NSW, which are used for speleological and educational purposes. The caves also have palaeontological and guano-dependent biota values and are a habitat for cave dependant bats.

The reserve contains excellent examples of dry and subtropical rainforest on its western margin and wet sclerophyll forest on its eastern margin. This distribution is unusual and might be attributed to the presence of limestone, karst landforms and related soil types on the western side of the reserve. The subtropical rainforest is one of only two lowland communities in the Macleay area and contains a small population of the small-leaved laurel (*Cryptocarya williwilliana*), a rare endemic to the Macleay Valley.

The *National Parks and Wildlife Act 1974* requires that a plan of management be prepared for each nature reserve. A plan of management is a legal document that outlines how the area will be managed in the years ahead. The procedures for the adoption of a plan of management for a nature reserve are specified in the Act.

A draft plan of management for Yessabah Nature Reserve was placed on public exhibition for four months from 15th November 2002 until 24th February 2003. The exhibition of the plan of management attracted 4 submissions which raised 6 issues. All submissions received were carefully considered before adopting this plan of management.

This plan of management aims to protect the caves and karst system, protect the dry and subtropical rainforest including significant species such as the small-leaved laurel, enhance the values of the reserve through protection of adjoining vegetation, wildlife and karst areas in co-operation with neighbours, and encourage further scientific investigation into the values of the reserve.

This plan of management establishes the scheme of operations for Yessabah Nature Reserve. In accordance with section 76 of the *National Parks and Wildlife Act 1974*, this plan of management is hereby adopted.

BOB DEBUS
MINISTER FOR THE ENVIRONMENT

1. NATURE RESERVES IN NEW SOUTH WALES

1.1 LEGISLATIVE AND POLICY FRAMEWORK

The management of nature reserves in New South Wales (NSW) is in the context of a legislative and policy framework, primarily the *National Parks and Wildlife Act 1974* (NPW Act), the NPW Regulation, the *Threatened Species Conservation Act 1995* (TSC Act) and the policies of the National Parks and Wildlife Service (NPWS). Section 72AA of the NPW Act lists the matters to be considered in the preparation of a plan of management. The policies arise from the legislative background and internationally accepted principles of park management. They relate to nature conservation, Aboriginal and historic heritage conservation, recreation, commercial use, research and communication.

Other legislation, international agreements and charters may also apply to management of the area. In particular, the *Environmental Planning and Assessment Act 1979* (EPA Act) requires the assessment and mitigation of the environmental impacts of any works proposed in this plan.

A plan of management is a statutory document under the NPW Act. Once the Minister has adopted a plan, no operations may be undertaken within Yessabah Nature Reserve except in accordance with the plan. This plan will also apply to any future additions to Yessabah Nature Reserve. Where management strategies or works are proposed for the reserve or any additions that are not consistent with the plan, an amendment to the plan will be required.

1.2 IUCN GUIDELINES FOR CAVE AND KARST PROTECTION

The International Union for Conservation of Nature and Natural Resources (IUCN), also known as the World Conservation Union, is an inter-governmental agency of which Australia is a member. IUCN seeks to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.

In 1997 the World Commission on Protected Areas, a commission of the IUCN, produced *Guidelines for Cave and Karst Protection* (Watson et al., 1997). These guidelines were developed to increase awareness of cave and karst protection issues and the special management considerations essential for the protection of cave and karst areas. They were designed to provide a guide for planners, managers and users of karst. This plan of management is based on the IUCN guidelines, although not all are specifically mentioned and some strategies have been modified where appropriate to better apply to the management of the reserve.

1.3 GENERAL MANAGEMENT OBJECTIVES

Nature reserves are reserved under the NPW Act to protect and conserve areas containing outstanding, unique or representative ecosystems, species, communities or natural phenomena.

Under the Act, nature reserves are managed to:

- conserve biodiversity, maintain ecosystem functions, and protect geological and geomorphological features and natural phenomena;
- conserve places, objects, features and landscapes of cultural value;
- promote public appreciation, enjoyment and understanding of the reserve's natural and cultural values; and
- provide for appropriate research and monitoring.

Nature reserves differ from national parks in that they do not have as a management principle to provide for visitor use.

1.4 SPECIFIC OBJECTIVES FOR YESSABAH NATURE RESERVE

In addition to the above objectives, the following specific objectives apply to the management of Yessabah Nature Reserve:

- * protection of the caves and karst system including its geological, palaeontological and guano-dependent biota values and as a habitat for cave dependant bats;
- * protection of the dry and subtropical rainforest, particularly significant plant species including small-leafed laurel (*Cryptocarya williwilliana*);
- * enhancement of the values of the reserve through protection of adjoining vegetation, wildlife and karst areas in co-operation with neighbours, including the rehabilitation of the adjoining quarry; and
- * encouragement of further scientific investigation into the values of the reserve.

2 YESSABAH NATURE RESERVE

2.1 LOCATION, GAZETTAL AND REGIONAL SETTING

Yessabah Nature Reserve (hereafter called “the reserve”) is located 15 km west-south-west of Kempsey in the lower Macleay Valley on the mid north coast of NSW. The reserve was gazetted on the 4th of April 1996 and covers an area of 10 hectares (see map).

The reserve was originally set aside in 1890 as a reservation for Public Recreation and the Preservation of Caves. The reserve encompasses a substantial portion of Yessabah Hill - an outcrop of the Yessabah Limestone Belt where the limestone is massive and pure enough to support cave and karst development (Spate, 1994).

The reserve is bounded by a disused quarry to the north, freehold farming land to the east and west, and contiguous forest on freehold land to the south. A fireworks testing and manufacturing site is located to the north-east of the reserve.

The disused quarry is on part of a Reserve for Public Recreation (R12999). A series of Mining and Mining Purpose Leases were granted over the Recreation Reserve and parts of the surrounding private lands from the 1920's until the early 1990's.

The reserve is within the Kempsey Local Government area.

2.2 LANDSCAPE CONTEXT

Natural and cultural heritage and on-going use are strongly inter-related and together form the landscape of an area. Much of the Australian environment has been influenced by past Aboriginal and non-Aboriginal land use practices, and the activities of modern day Australians continue to influence bushland through recreational use, cultural practices, the presence of introduced plants and animals and in some cases air and water pollution.

The geology, landform, climate and plant and animal communities of the area, plus its location, have determined how it has been used by humans. In the past, parts of Yessabah Hill have been quarried for limestone and bat guano and this has impacted on the landscape and other values of the reserve.

Both Aboriginal and non-Aboriginal people place cultural values on natural areas, including aesthetic, social, spiritual, recreational and other values. Cultural values may be attached to the landscape as a whole or to individual components, for example to plant and animal species used by Aboriginal people. This plan of management aims to conserve both natural and cultural values. For reasons of clarity and document usefulness natural and cultural heritage, non-human threats and on-going use are dealt with individually, but their inter-relationships are recognised.

2.3 NATURAL AND CULTURAL HERITAGE VALUES

Geology and Geomorphology

The reserve has a range of karst and cave landforms which represent features typical to both cool-temperate and tropical karsts. Karst features include: limestone pinnacles; solution flutes; solution spikes; rainpits; solution bevels; grikes; karst wells; and solution pans typical of cool-temperate areas. Karst features more typical of tropical karsts include: larger scale solution runnels; rain solution runnels; and bogaz like features (Houshold, 1989).

The reserve also has the highest concentration of caves in northern NSW with about 60 known caves and 90 entrances (Taylor, 1985). In June 1992 the Yessabah Caves were entered onto the Commonwealth's Register of the National Estate in recognition of their intrinsic natural values. The caves are also of state wide significance for their scientific and educational values.

The Yessabah Limestone is of Permian age and extends almost continuously over a distance of some 60km from Yessabah to Kunderang Brook (Spate, 1986). It is part of the Kempsey Block of the New England Fold Belt. The limestone consists of a basal calcareous mudstone, a central unit of bioclastic crinoidal limestone and a discontinuous member (the Mount Pleasant Limestone) of reefal and siliceous limestones. The caves are found in the central unit. The formation varies in thickness from 6m to more than 500m at Willi Willi, Stony Creek and Yessabah (Lindsay, 1964 and 1969).

The limestone exposed on Yessabah Hill dips towards the east at an angle of approximately 30-60° and on the whole is fairly massively bedded although solutional etching reveals much thinner bedding in some parts of the outcrop. The limestone varies greatly in colour but is uniform in composition and is largely made up of crinoidal remains (Spate, 1986). The limestone is generally underlain by the Kullatine Formation (pebbly mudstone, conglomerate, lithic sandstone and mudstone) or the Carboniferous Boonanghi Beds (mudstone, sandstone and conglomerate). It is conformably overlain by mudstone, sandstone and rare conglomerate of the Warbro Beds and Kempsey Beds (Houshold, 1989).

The northern and western sides of the reserve have much less soil mantle and are steeper than the eastern and southern aspects. As a result, most of the enterable caves are situated on the northern and western aspects of the reserve.

Geomorphologically, the reserve is a disjunct remnant of the eastern escarpment of the New England Tableland, truncated as the scarp slowly retreated westwards after uplift of the highlands in the early-mid Tertiary (Houshold, 1989). The reserve presents a classic limestone residual exposure typical of strong seasonally moist-warm climates (Spate, 1986). As it is near the southern limit of the summer-wet/winter-dry climatic zone, the Yessabah karst is important in understanding the effects of Australia's north-south climatic gradient on solutional erosion processes (Houshold, 1989).

Voisey (1936) suggested that the steep slopes on the northern and western slopes of the reserve are the result of faulting. Alternatively, Houshold (1989) suggests that the lack of evidence for late Cainozoic tectonics indicates that these slopes are more likely due primarily to the operation of karst processes, where most water is channelled underground, and comparatively little surface erosion occurs - generating cliffed rather than gently graded landscapes.

It is possible that the wide valleys surrounding the reserve are past courses of either Dungay Creek or the Macleay River. The area's location near the emergence of the streams onto the coastal plain makes it likely to experience comparatively rapid lateral movements in stream courses. Low outcrops of limestone and exposures in dolines in these valleys indicate planation by fluvial processes rather than solution alone. If this is the case, Yessabah Hill is a remnant of combined karst/fluvial processes, with old stream beds being slowly dissected by small incipient streams (Houshold, 1989).

Catchment and Hydrology values

The reserve has little catchment area and there is rapid run-off to Dungay and Commonong Creeks which drain into the Macleay River below the intake for the domestic water supply of Kempsey. Water from these streams is used for watering domestic stock outside the reserve.

Yessabah Hill appears to be hydrologically isolated and hydraulically "higher" than the surrounding lands. Only two caves appear to have any hydrological interest (Houshold 1989) although during the wetter part of the year, and after storms, many small streams are found within caves and flowing as springs on the surface.

The Bat Cave (YE1) contains a minor, non-perennial stream running from a joint into the cave and sinking through sediment. There may be an intermittent spring running from this cave on the hillside quite some distance above the swampy creek to the west of the reserve. However, it is likely that most water sinking into Yessabah Hill and the Bat Cave stream rises as seepage springs along the length of the swampy creek draining northwards along the western flank of the hill (Spate, 1998).

Water Cave (YE50) is immediately south of, but not on the reserve, and appears to be the only cave containing permanent water on Yessabah Hill. It is a steeply dipping cave on the upper part of the footslopes to the hill; it finishes in a deep pool which appears to be perched above the level of the swampy creek to the west of the reserve. Although it has been sampled without result for aquatic fauna on two occasions, it is of both geomorphic and hydrologic interest and may yet contain biological values (Spate, 1998).

Palaeontologic Values

The reserve is an important sub-fossil site with a number of bone deposits found in the caves. The most common are owl roost deposits - mounds of bones of small mammals built up as refuse heaps under roosting sites (Houshold, 1989). These bones indicate the presence of many species in the caves throughout their history, some of which are either extinct or no longer occur in the area. The ghost bat

(*Macroderma gigas*) which is now restricted to northern Australia, was recorded in bone deposits taken from Yessabah Caves (Anon., 1958).

Information gained from sub-fossil deposits contributes to our knowledge of the evolution and distribution of Australian animals. Bone breccias and sediment deposits in the caves have a high potential for providing information on past environmental changes and changes in the faunal composition of the area.

Native Plants

The distribution of vegetation within the reserve clearly demonstrates the relationships between landforms, soils and vegetation. Wet sclerophyll sub-tropical rainforest and dry rainforest are the dominant vegetation associations in the reserve.

A survey of rainforest vegetation (Floyd, 1983) found 36 rainforest tree species in the reserve as well as a number of rainforest shrubs, herbs, vines and epiphytes. The most frequently occurring rainforest species include: actephila (*Actephila lindleyi*); yellow tulip (*Drypetes australasica*); orange kamala (*Mallotus phillipensis*); giant stinging tree (*Dendrocnide excelsa*); and shining-leaved stinging tree (*Dendrocnide photinophylla*).

The reserve contains excellent examples of dry and subtropical rainforest on its western margin and wet sclerophyll forest on its eastern margin. This distribution is the reverse of the usual pattern of rainforests which generally prefer the cooler, more sheltered southern and easterly aspects (Houshold, 1989). This unusual distribution might be attributed to the presence of limestone, karst landforms and related soil types on the western side of the reserve (Houshold, 1989). A small population of the small-leaved laurel (*Cryptocarya williwilliana*), a rare endemic to the Macleay Valley, is also preserved within the subtropical rainforest on the western side of the reserve.

The subtropical rainforest is one of only two lowland communities in the Macleay area, and is dominated by giant stinger (*Dendrocnide excelsa*), shiny-leaved stinger (*D. photinophylla*), yellow tulip (*Drypetes australis*), rosewood (*Dysoxylum fraserianum*) and Port Jackson fig (*Ficus rubiginosa*). This community is restricted to the lower north-western facing slopes where soils are deeper and moister (Kendall, 1997a).

The dry upper north-western slopes of the reserve support dry rainforest dominated by shatterwood (*Backhousia sciadophora*), shiny-leaved stinger (*Dendrocnide photinophylla*), yellow tulip (*Drypetes australis*) and fig (*Ficus* species). A southern occurrence sub-form of this dry rainforest sub-alliance occurs in two small pockets on privately owned land to the south and east of the reserve. This sub-form is dominated by white cedar (*Melia azedarach*).

The eastern side of the reserve supports a wet sclerophyll forest association. The upper strata is dominated by white mahogany (*Eucalyptus acmenoides*), small-fruited grey gum (*E. propinqua*), tallowwood (*E. microcorys*), grey ironbark (*E. siderophloia*) and pink bloodwood (*Corymbia intermedia*). The mid strata contains a variety of mesic species of which red kamala (*Mallotus phillipensis*), native olive

(*Olea paniculata*) and lantana (*Lantana camara*) dominate. The lower strata is dominated by *Poa labillardieri* and *Lepidosperma laterale*.

Nine significant plant species have been recorded in the reserve. The reserve represents the southern limit of occurrence for many of these species and for others an important intermediary refuge between other populations (refer table 1). Models developed as part of the comprehensive regional assessment (CRA) process have also predicted *Callistemon acuminatus*, a rare bottlebrush, as occurring in the reserve.

Table 1 Significant plants known to occur within the reserve.

Common name	Scientific name	Significance
hairy alectryon	<i>Alectryon tomentosus</i>	Disjunct population
corky prickle-vine	<i>Caesalpinia subtropica</i>	Southern limit
small-leafed laurel	<i>Cryptocarya williwilliana</i>	Southern limit
a vine	<i>Deeringia arborescens</i>	Near southern limit
veinless silkpod	<i>Parsonsia rotata</i>	Southern limit
zig zag vine	<i>Rauwenhoffia leichardtii</i>	Southern limit
deep yellowwood	<i>Rhodosphaera rhodanthema</i>	Southern limit
caustic vine	<i>Sarcostemma brunonianum</i>	Near southern limit
stinging vine	<i>Tragia novae-hollandiae</i>	Southern limit

Native Animals

A vertebrate fauna survey of the reserve (Kendall & Kendall, 1997) identified five significant species (refer table 2). Suitable habitat also exists for a number of regionally significant or threatened species that are predicted to occur in the reserve (refer table 3).

Table 2 Significant animals known to occur within the reserve.

Common name	Scientific name	TSC status and Significance
Mammals		
spotted-tailed quoll	<i>Dasyurus maculatus</i>	Vulnerable ^r
eastern horseshoe-bat	<i>Rhinolophus megaphyllus</i>	Regionally significant
common bent-wing bat	<i>Miniopterus schreibersii</i>	Vulnerable ^r
little bent-wing bat	<i>Miniopterus australis</i>	Vulnerable ^r
Birds		
wompoo fruit dove	<i>Ptilinopus magnificus</i>	Vulnerable

Vulnerable = schedule 2 under the TSC Act
^r recovery plan in preparation.

The cave system in the reserve plays an important role in the life cycles of the little bent-wing bat and the common bent-wing bat. Thousands of bats gather in the Bat Cave each winter to roost and stage prior to travelling further up the limestone belt to breed and rear their young in a bat maternity site in the Willi Willi Caves Nature Reserve (Dwyer 1966). The eastern horseshoe bat also utilises the cave system in the reserve and together with the bent-wing bats are highly vulnerable to human disturbance.

Table 3 Significant animals predicted by modelling to occur within the reserve.

Common name	Scientific name	TSC status
Mammals		
brush-tailed phascogale	<i>Phascogale tapoatafa</i>	Vulnerable
common planigale	<i>Planigale maculata</i>	Vulnerable
koala	<i>Phascolarctos cinereus</i>	Vulnerable ^r
squirrel glider	<i>Petaurus norfolcensis</i>	Vulnerable
Yellow-bellied glider	<i>Petaurus australis</i>	Vulnerable ^r
Yellow-bellied sheath-tail-bat	<i>Saccolaimus flaviventris</i>	Vulnerable ^r
Beccari's freetail-bat	<i>Mormopterus beccarii</i>	Vulnerable
eastern freetail-bat	<i>Mormopterus norfolkensis</i>	Vulnerable
hoary wattled bat	<i>Chalinolobus nigrogriseus</i>	Vulnerable
greater broad-nosed bat	<i>Scoteanax rueppellii</i>	Vulnerable ^r
Large-eared pied bat	<i>Chalinolobus dwyeri</i>	Vulnerable
eastern cave bat	<i>Vespadelus troughtoni</i>	Vulnerable
Birds		
red goshawk	<i>Ephippiorhynchus asiaticus</i>	Endangered
Square-tailed kite	<i>Lophoictinia isura</i>	Vulnerable
Rose-crowned fruit-dove	<i>Ptilinopus regina</i>	Vulnerable
glossy black-cockatoo	<i>Calyptorhynchus lathami</i>	Vulnerable
swift parrot	<i>Lathamus discolor</i>	Endangered [#]
turquoise parrot	<i>Neophema pulchella</i>	Vulnerable
superb fruit-dove	<i>Ptilinopus superbus</i>	Vulnerable
masked owl	<i>Tyto novaehollandiae</i>	Vulnerable ^r
powerful owl	<i>Ninox strenua</i>	Vulnerable ^r
barking owl	<i>Ninox connivens</i>	Vulnerable
sooty owl	<i>Tyto tenebricosa</i>	Vulnerable
barred cuckoo-shrike	<i>Coracina lineata</i>	Vulnerable
Reptiles		
three-toed snake-tooth skink	<i>Coeranoscincus reticulatus</i>	Vulnerable [*]
white-crowned snake	<i>Cacophis harriettae</i>	Vulnerable
pale-headed snake	<i>Hoplocephalus bitorquatus</i>	Vulnerable
Stephens' banded snake	<i>Hoplocephalus stephensii</i>	Vulnerable
white-crowned snake	<i>Cacophis harriettae</i>	Vulnerable

* also listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*

also listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*

r recovery plan in preparation.

NPWS is required by the TSC Act to prepare and implement recovery plans for all listed threatened species. These are progressively being prepared and will be used to guide management of threatened species in the area.

The cave system also supports a diverse range of cave invertebrate fauna including a number of new species of spiders and land snails (Spate, 1994). Some of these species are cave dependent and are known only to occur in the Yessabah Hill caves.

The invertebrate fauna of the reserve are likely to be very significant. Eberhard and Spate (1995) collected a large number of specimens, many of which are still to be determined taxonomically, some of which may be new species.

Aboriginal Heritage

Aboriginal communities have an association and connection to the land. The land and water biodiversity values within a landscape are central to Aboriginal spirituality and contribute to Aboriginal identity. Aboriginal communities associate natural resources with the use and enjoyment of foods and medicines, caring for the land, passing on cultural knowledge and strengthening social bonds. Aboriginal heritage and nature are inseparable from each other and need to be managed in an integrated manner across the landscape

The reserve lies within the Dunghutti tribal area, and within the area of the Kempsey Local Aboriginal Land Council. It is unknown what significance the original custodians to the area placed on Yessabah Hill. The sharp nature of the limestone surface would have made it challenging for the Dunghutti people to traverse the rock outcrops. Four Aboriginal sites have been recorded in the Yessabah Hill area: two bora/ceremonial sites, a stone arrangement, and a burial site. It is thought that a spring on the western side of the hill may have a traditional Aboriginal story attached to it (Kelly, pers. comm., 1997).

A preliminary archaeological investigation was conducted in the Small Slide Cave in 1989 to determine whether an ash deposit in the cave was of anthropogenic origin. The results of this investigation were not demonstrably significant for their Aboriginal cultural content, although they are informative for scientific purposes (Gollan, 1989).

Non-Aboriginal heritage

Most of Yessabah Hill was set aside as a Recreation Reserve in 1890, however, between 1920 and 1991 the northern section of the hill was intermittently quarried for limestone. The limestone was crushed and used for building and agriculture. In the early 1920s some of the caves were mined for bat guano for use as a plant fertiliser (Spate, 1998). This was one of very few guano mining activities in NSW (Hamilton-Smith, 1998).

The area has also been of interest to speleological groups, research scientists, and members of the local community since the early part of the twentieth century.

2.4 VISITOR USE

Recreational opportunities in the reserve are limited as there is no formal public access to the reserve. The current road access is through the mining lease and there are concerns about public safety issues relating to the quarry and rehabilitation works. The steep, rugged nature of the reserve's terrain also poses public safety problems. Additionally, NPWS has not promoted general recreational use of the reserve because of concerns about visitor impacts on cave and karst values including bats, invertebrates, bone deposits and cave and karst features.

The NPWS acknowledges the past use of the caves by speleological groups, in particular Kempsey Speleological Society, and caving enthusiasts and appreciates their input into the current knowledge of the caves within the reserve and into the Draft Visitation Guide prepared for Yessabah Caves (NPWS 1998). Future access to the caves and karst in the reserve will require approval by the NPWS and private landholders (if intending to walk over private property), and will only be granted for speleological, educational and scientific purposes consistent with the above guidelines.

2.5 RESEARCH

A number of studies have been undertaken on the natural heritage values of the reserve. These have included research into the vegetation, fauna, karst landforms, geology and geomorphology, ash deposits, biology of cave fauna including bats and invertebrates, and palaeontology of the reserve.

Further research would enhance the knowledge of the natural and cultural heritage of the reserve and would assist in the future management of the reserve. Particular areas that would benefit from further research include: studies of the cave bone deposits and fossil breccia; biology of cave fauna including bats and invertebrates; aquatic fauna; and karst processes.

2.6 THREATS TO THE RESERVE'S VALUES

Fire

Details of the fire history are limited, however the presence of charcoal within breccias in the caves indicates the past occurrence of fire on the reserve. There have been no recorded wildfires in the reserve for the past twenty-five years, although hazard reduction burning has been undertaken in the wet sclerophyll forest on the eastern side of the reserve.

While there is potential for grass fires to spread into the reserve from surrounding cleared farmland, a number of natural and man made barriers inhibit the spread of fire. To the north and east of the reserve the quarry face and access road provide some protection to the northern boundary although this protection will be reduced as revegetation of the quarry occurs. A small stream near the northwestern edge of the reserve provides limited protection along this boundary.

The south-eastern slopes of the reserve which are dominated by wet sclerophyll forest are more adapted to fire than the rainforest, however, the wet sclerophyll forest contains a well developed mesic understorey, and in the absence of fire the rainforest species are likely to become more common possibly extending the rainforest boundary.

The north-western, western and south-western perimeters of the reserve are most vulnerable. The potential for fire to damage the rainforest is high and repeated fire is likely to cause the rainforest to retract. During drought when leaf fall is heavy and soil moisture is low a fire could spread through the rainforest, however the reserve's numerous rock outcrops and cliff lines would inhibit the fires progress in all but extreme conditions and fires would be expected to go out or burn slowly in a complex mosaic pattern (Kendall, 1997a).

Significant rainforest species identified in table 1 are likely to have a poor response to any fire although the majority of these plants are scattered throughout the reserve's rainforest and are likely to be safe from most fires. The stinging vine (*Tragia novae-hollandiae*) also occurs commonly in the wet sclerophyll forest which is more likely to carry fire. The small-leafed laurel (*Cryptocarya williwilliana*) is particularly vulnerable to fire as the majority of the population is confined to the lower north-western part of the reserve below the lowest series of cliffs and close to the boundary of naturally vegetated land. This location offers no protection from fire by the numerous cliff lines and rocky areas.

Fire also has the potential to damage the limestone karst features within the reserve. In particular, high fire intensities and/or long duration events (e.g. a log smouldering away in direct contact with bedrock) can cause destruction of the features via a number of mechanisms including spalling and calcining (Holland, 1994). Fire, even at low intensities, rapidly destroys crustose lichens and similar lower plants growing on limestone surfaces (Spate, 1998).

Any fire event will remove leaf litter and understorey vegetation with possible implications for the significant molluscan and other invertebrate fauna of the limestone outcrop (Cooper, 1999). Excluding fire from the reserve would maintain detritus food chains and microclimates at ground level, and also protect habitat provided by old growth trees, logs and dead trees.

Fire may also have an adverse impact on the bat communities which utilise the cave system. Starvation is an important cause of mortality in common bent-wing bats and changes in fire regime may well be among the contributing causes (Dwyer, 1966a & 1966b). Hazard reduction burning toward the cooler months of the year could result in changes to the availability of flying invertebrates at a time when bats need to build up fat reserves for winter (Spate, 1999). In addition, whilst juveniles are beginning to fly and exploit their environment in late summer and early autumn very large numbers of individuals may need to forage over a small area (Spate, 1999).

The NPWS approach to fire management planning emphasises the protection of life and property, as well as providing direction for the protection of natural and cultural heritage. To achieve these objectives the NPWS uses a system of zones which are compatible with the system adopted by the Bushfire Coordinating Committee for use in District Bushfire Management Committee bushfire risk management plans.

NPWS has assessed the reserve for fire management planning purposes and has zoned the reserve as a Heritage Area Management Zone (HAMZ). The primary fire management objectives for this zone are to prevent the extinction of all species that are known to occur naturally within the reserve, and to protect culturally significant sites. The reserve has been designated as a HAMZ because of the sensitivity of rainforest vegetation, limestone karst features, invertebrate fauna and bat communities.

The HAMZ does not require intensive management and focuses on those actions appropriate to conserve biodiversity and cultural heritage including exclusion of fire from the reserve.

Introduced Plants

A total of 22 weed species have been recorded in the reserve, although most of these species except lantana (*Lantana camara*) occur as a minor component of the natural vegetation. The major weed infestations are confined to the upper north-eastern part of the reserve, adjacent to the quarry, and along the boundaries between the reserve and private properties.

Lantana, along with fire, poses the greatest threats to native vegetation in the reserve. In the north eastern section of the reserve lantana forms a virtually impenetrable dense thicket. Lantana also occurs in the wet sclerophyll forest and rainforest areas, where it assumes a vine habit and is a potential threat to native species.

The adjacent quarry mining lease area is heavily infested by numerous species of weeds including lantana. Giant Parramatta grass (*Sporobolus fertilis*) is an increasing problem on adjacent cleared pasture land and in the mining lease area. Weed control and revegetation programs have recently been undertaken in the quarry area.

Care needs to be taken when undertaking control programs that a stable vegetation cover is maintained to prevent soil erosion and that herbicides used to control introduced species do not affect water quality and hence cave invertebrates.

The application of herbicides by spraying should not be undertaken (or at least only undertaken under very tightly controlled operational conditions) on the karst terrains in the north western part of the reserve, because of the lack of soil and the high degree of integration between surface and subsurface waters (Spate, 1998).

Introduced Animals

Wild dogs (*Canis familiaris*) as well as foxes (*Vulpes vulpes*) and cats (*Felis catus*) were reported in survey of landholders in the vicinity of the reserve in 1998 (RLPB/NPWS 1998). Other pest animals likely to occur in the reserve are the rabbit (*Oryctolagus cuniculus*), house mouse (*Mus musculus*), black rat (*Rattus rattus*), and the brown hare (*Lepus capensis*).

A 1080 aerial baiting program for dogs and foxes was carried out in 1999 cooperatively with State Forests NSW and the Kempsey RLPB. Ground baiting is now the preferred method of pest animal control and this will require cooperation between neighbours, the Kempsey RLPB and the NPWS.

Access

Existing road reservations to the reserve are impracticable for road construction due to steep slopes, and construction of trails within the reserve would cause very significant environmental damage

There are also conservation concerns regarding visitor access which may disturb cave fauna, especially bats, and the potential for damaging other important values of the reserve such as karst features and bone deposits. In the past sub-fossils have been removed from caves in the reserve.

Modification of Surrounding Lands and Fragmentation of the Reserve

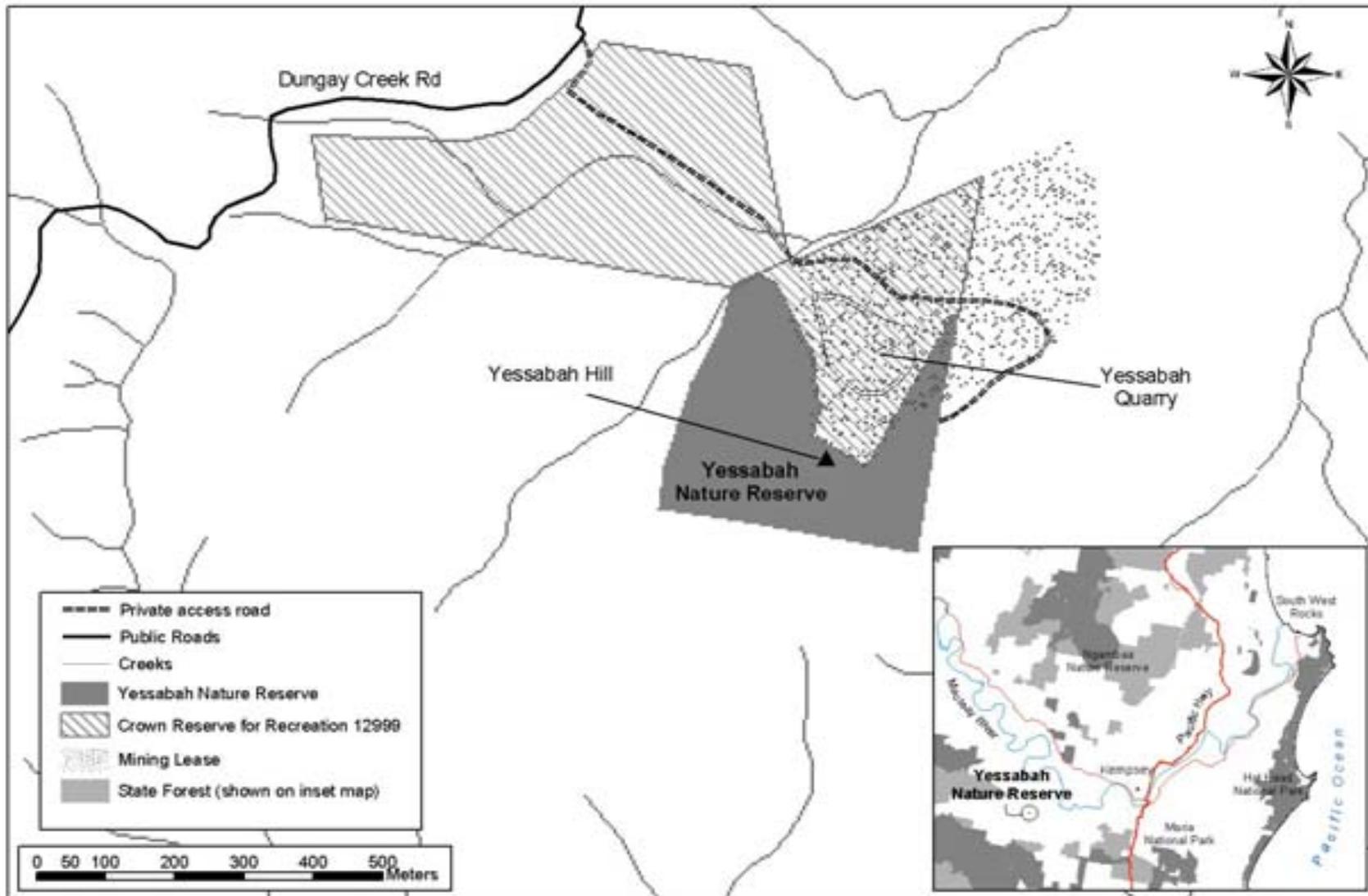
The area of the reserve does not include all of the limestone and karst features on Yessabah Hill and its environs nor does it adequately encompass all of the complex karst hydrology of the site (Spate, 1998). Thus, management of adjacent lands is important for protection of these features.

The fireworks manufacturing and testing site to the north-east of the reserve is not considered to directly impact on the reserve's values as its activities are undertaken within identified bunkers and during the day when bat activity is minimal.

Most of the surrounding lower lying lands have been cleared. Clearing of vegetation in the area has resulted in fragmentation of habitat. Long term conservation of biodiversity within the reserve depends upon protection, enhancement and connection of remaining habitat across the landscape, involving public and private land remnants. The population of small-leaved laurel that occurs outside the reserve on privately owned land may also be threatened by grazing and habitat loss.

The Yessabah limestone quarry north of the reserve is no longer mined. There are several precipitous quarry faces adjacent to and just within the reserve which may be a concern for public safety. Due to the scale of the quarry faces, little can be done to rehabilitate the topography of the quarry. Over time the visual impact of rock exposures will be reduced.

3. RESERVE MAP



4. MANAGEMENT ISSUES AND STRATEGIES

Current Situation	Desired Outcomes	Strategies	Priority
<p>Geology, Geomorphology and Hydrology</p> <p>The reserve contains a significant karst system and the highest concentration of caves in northern NSW. The cave and karst system is important for its geological, palaeontologic and guano-dependent biota values and as a habitat for cave dependant bats. Human disturbance can threaten these values.</p>	<ul style="list-style-type: none"> • Caves, karsts and associated features are protected from human disturbance and natural processes are allowed to continue. • There is no decline in the quality or change to natural water flows in the reserve. 	<ul style="list-style-type: none"> • Design and carry out all works within the reserve to minimise impact on the geology, geomorphology, soils and natural drainage of the reserve. • Manage the reserve as far as possible to ensure continuation of the various karst, biological and microbiological process operating either on the surface or within the cave and karst system. • Visitor access to the caves and karsts will be restricted to minimise impacts (refer Visitor Use). 	<p>High</p> <p>Medium</p> <p>High</p>
<p>Palaeontology</p> <p>Significant sub-fossil bone deposits occur within the caves and are potentially important as indicators of past environmental changes and evolution. In the past some sub-fossils been removed without adequate approval and documentation.</p>	<ul style="list-style-type: none"> • Palaeontological values, including bone deposits and sub-fossils, are protected from human disturbance unless for authorised scientific purposes. 	<ul style="list-style-type: none"> • Ensure all visitors are aware that the removal of bone deposits and other material is prohibited without NPWS consent. • Identify the individuals and organisations who currently hold collections of bone material from the reserve and establish a protocol to ensure that all bone materials are adequately identified and documented. 	<p>High</p> <p>Medium</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Native plant and animal conservation</p> <p>Nine significant plants and uncommon rainforest alliances are known to occur within the reserve. Rainforest in the reserve is sensitive to fire. Four significant animal species also occur.</p> <p>The caves provide habitat for unique cave dependant invertebrates found only at Yessabah caves. The caves are a significant winter roosting site for threatened species of bats and are highly vulnerable to human disturbance.</p>	<ul style="list-style-type: none"> • That the full range of native plant and animal species found in the reserve is conserved. • Emphasis is placed on protecting the habitats of animals listed as vulnerable in the Threatened Species Conservation Act 1995 and other species of conservation concern found in the reserve. 	<ul style="list-style-type: none"> • Exclude fire from rainforest communities in the reserve (refer Fire Management). • Implement recovery plans for significant species as prepared. • Restrict visitor access and allow access for speleological groups, educational and scientific purposes only to protect cave and karst values (refer Visitor Use). • Access to the caves will not be permitted between 1 May and 31 August, unless for scientific purposes related to bat conservation and subject to NPWS approval. • Seek the cooperation of neighbouring landholders and other landuse planning and management authorities in the protection of important wildlife habitats in the vicinity of the reserve (refer Modification of Surrounding Lands and Fragmentation of the Reserve). 	<p>High</p> <p>High</p> <p>High</p> <p>High</p> <p>High</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Introduced plants</p> <p>Lantana is the major weed species in the reserve and threatens rainforest and can be invasive in disturbed areas. Cave and karst features may be threatened by inappropriate spraying of herbicides and exposure of soils during control programs. A Pest Management Strategy has been prepared for the reserve.</p> <p>There is a need for rehabilitation of the vegetation in the reserve and the adjoining Public Recreation Reserve.</p>	<ul style="list-style-type: none"> • That lantana infestations and other introduced species are controlled, or where possible eradicated from the reserve and neighbouring lands. • That areas of severe lantana infestation are regenerated to native species. 	<ul style="list-style-type: none"> • Control and where possible eradicate weeds in accordance with the Yessabah Nature Reserve Pest Management Strategy. • Undertake combined weed control and revegetation programs in the reserve and the adjoining Public Recreation Reserve. • Support the development of a volunteer group to undertake bush regeneration within the reserve following weed control. • Use weed control techniques which minimise soil exposure and potential for herbicides to infiltrate into cave and karst systems in the reserve. 	<p>High</p> <p>High</p> <p>High</p> <p>High</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Introduced animals</p> <p>Foxes, feral cats and wild dogs have been reported in the reserve. Other pest species such as the house mouse may also occur. Ground baiting is used to control dogs and foxes. A Pest Management Strategy has been prepared for the reserve.</p>	<ul style="list-style-type: none"> • Introduced animals are controlled and where practicable eliminated. • Control of introduced animals uses techniques which have minimal impact on native species. 	<ul style="list-style-type: none"> • Control introduced animals in accordance with the Yessabah Nature Reserve Pest Management Strategy. • Continue the baiting program to control foxes and dogs in the reserve in cooperation with the Kempsey RLPB and neighbours. • Monitor the occurrence of house mouse in the reserve, and implement a control program if necessary. 	<p>High</p> <p>High</p> <p>Medium</p>
<p>Fire Management</p> <p>Rainforest, limestone karst features, bats and invertebrate fauna in the reserve are sensitive to fire.</p> <p>A fire management plan has not yet been prepared for the reserve.</p>	<ul style="list-style-type: none"> • Fire is excluded from the reserve. • Persons and property within and adjacent to the reserve are from protected from fire. 	<ul style="list-style-type: none"> • Manage the reserve as a Heritage Management Zone. • Prescribed burning will not be undertaken on the reserve unless research indicates that fire is necessary to protect biodiversity values. • Maintain liaison and develop co-operative strategies with the Kempsey Shire and local brigades about fire management in the reserve and on adjoining lands. • Liaise with adjoining neighbours and local Bushfire brigade about constructing a perimeter trail around the border of the naturally vegetated land on Yessabah Hill, particularly along the north-western, western and south-western boundaries of the reserve. This trail will also provide access for NPWS management purposes. 	<p>High</p> <p>High</p> <p>High</p> <p>High</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Cultural Heritage</p> <p>Although there are no known Aboriginal sites within the reserve, four sites have been recorded in the nearby area. An assessment of cultural heritage values has not been undertaken in the reserve.</p> <p>Minor relics of European origin are found at a cave entrance.</p>	<ul style="list-style-type: none"> • Cultural features are appropriately conserved and managed. • That the Aboriginal community is involved in the management of, and research into their heritage and culture. 	<ul style="list-style-type: none"> • Undertake an archaeological survey and cultural assessment prior to all works with the potential to impact on sites or places of cultural significance. • Encourage the participation of the Dunghutti Elders and the Kempsey Local Aboriginal Land Council in the management of Aboriginal heritage. • Ensure that any research involving Aboriginal heritage is carried out in consultation with the Aboriginal community. Provide copies of any research findings on Aboriginal cultural heritage to the Land Council. • Record historic relics at cave entrance and protect from disturbance. 	<p>High</p> <p>High</p> <p>High</p> <p>Medium</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Visitor Use</p> <p>Speleological groups are the main visitors to the reserve and have accessed the caves for many years through private property by agreement with adjoining landholders.</p> <p>The reserve does not have a history of other visitor use.</p> <p>Cave and karst values in the reserve may be threatened by disturbance to cave fauna, bone deposits and damage to cave and karst features.</p> <p>There are concerns for public safety in regard to adjacent quarry cliffs and the sharp limestone surfaces in the reserve.</p>	<ul style="list-style-type: none"> • Visitor access does not threaten cave and karst values. • Access to the reserve is limited to recognised speleological groups, scientific purposes and educational visits. • The values of the reserve are available as an educational off-site resource. 	<ul style="list-style-type: none"> • Access to the reserve will be limited to recognised speleological groups and for educational and scientific purposes only, and will require consent from the NPWS and relevant private land holders. • Speleological visits and underground research will be permitted with NPWS consent between 1 October and 31 May. A maximum of 2 recreational speleological group visits and a maximum of 10 people per caving party will be permitted each caving season. Permission to access caves with high karst conservation values or to access caves outside this period will be only approved for research projects that justify such access. • Cave users must be acquainted with, and abide by, the Australian Speleological Federation Inc. (ASF) Code of Ethics and Conservation, Safety Code and Minimal Impact Caving Code. • Information on the caves will be developed and available on request to local schools, TAFE and other education bodies. • Commercial and other general recreation access to the reserve will not be permitted. 	<p>High</p> <p>High</p> <p>High</p> <p>Medium</p> <p>High</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Research</p> <p>Vegetation and vertebrate fauna surveys have been undertaken in the reserve. Research has also been undertaken into the reserve's cave and karst system.</p> <p>Further scientific study would improve understanding of the reserve's natural and cultural heritage, the processes that affect them and the requirements for management.</p>	<ul style="list-style-type: none"> • Research improves knowledge of the resources of the area and assists management of the reserve. 	<ul style="list-style-type: none"> • Permit research which causes minimal disturbance to the natural and cultural values of the reserve, unless the expected results of the research offer significant benefits for improvement of management programs or knowledge of natural and cultural resources. • Encourage research into fire behaviour, fire hazard and fire risk, and the impact of fire on the reserve's plant and animal communities and karst landforms. • Encourage research into the cave and karst system including bone deposits, cave sediments, bats and other cave organisms. • Require all speleologists and others granted permission to access the reserve to maintain a detailed and accurate information base on the caves • Prepare a list of potential research opportunities for research institutions. 	<p>High</p> <p>High</p> <p>Medium</p> <p>Medium</p> <p>Low</p>

Current Situation	Desired Outcomes	Strategies	Priority
<p>Modification of surrounding lands</p> <p>The reserve does not include all of the limestone and karst features on Yessabah Hill. Clearing of vegetation in the area has also resulted in fragmentation of habitat in the area.</p> <p>Management of adjacent lands is important for protection of the caves and karst system and native vegetation in the reserve.</p> <p>A disused quarry adjoins the reserve and is part of a Reserve for Public Recreation. A rehabilitation committee has been formed to co-ordinate activities involving mine rehabilitation and pest plant control on the Reserve for Public Recreation.</p>	<ul style="list-style-type: none"> • Values of the reserve are enhanced by adjacent land management. • The reserve is of sufficient size to protect the entire Yessabah caves and karst system. • That reserve neighbours support conservation of remaining areas of privately owned native vegetation near the reserve. 	<ul style="list-style-type: none"> • Work with relevant neighbours to encourage conservation of remnant native vegetation and revegetation in the area. • Work with the rehabilitation committee to ensure safe and effective rehabilitation of the quarry on the northern boundary of the reserve and of the overburden on the reserve. • Seek inclusion of the Reserve for Public Recreation into the reserve. • If opportunities arise, seek additional lands for inclusion into the reserve where they have conservation values or for management purposes. • Encourage retention of native vegetation on adjacent lands through instruments such as Voluntary Conservation Agreements. • Liaise with surrounding landholders to protect significant plant species and communities on their land, particularly from fire, grazing and habitat loss. 	<p>High</p> <p>Medium</p> <p>Medium</p> <p>Medium</p> <p>Medium</p> <p>Medium</p>

High priority activities are those imperatives to achievement of the objectives and desired outcomes. They must be undertaken in the near future to avoid significant deterioration in natural, cultural or management resources.

Medium priority activities are those that are necessary to achieve the objectives and desired outcomes but are not urgent.

Low priority activities are desirable to achieve management objectives and desired outcomes but can wait until resources become available.

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GLOSSARY

ACRONYMS

EP&A Act	NSW <i>Environmental Planning and Assessment Act</i> (1979)
NPW Act	NSW <i>National Parks and Wildlife Act</i> (1974)
NPWS	NSW National Parks and Wildlife Service
RLPB	Rural Lands Protection Board
TSC Act	NSW <i>Threatened Species Conservation Act</i> (1995)

SELECTED DEFINITIONS

Biodiversity	Biological diversity, namely the variety of life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem.
Bogaz	A deep grike or cleft
Breccia	Angular fragments of rock and/or fossils cemented together or with a matrix of finer sediment.
Cave	A natural cavity in rock large enough to be entered by man.
Cave system	A collection of caves interconnected by enterable passages or linked hydrologically or atmospherically a cave with an extensive complex of chambers and passages.
Crinoidal limestone	Limestone formed from the deposition of crinoid corals, Crinoids are fern or lilly shaped echinoderms.
Cultural heritage	Encompasses past and present cultural associations of all people in Australia, including tradition, knowledge and customs. It can be tangible (i.e. have physical manifestations in the form of art, buildings etc.) or intangible (i.e. spiritual or social associations, songs, stories and cultural practices). Cultural significance includes values that are social, spiritual, aesthetic, historic and scientific. When natural resources acquire meaning for a particular group, they become cultural resources as well.
Fauna	Any mammal, bird, reptile or amphibian. NPWS has responsibility for the conservation of fauna. Note this definition excludes fish or invertebrates.
Fire Management	Includes all activity associated with the use and control of fire in bushland designed to achieve stated objectives for the protection of life and property, and the maintenance of wildlife communities.
Grikes	Solutionally enlarged joints are common on the north-west side of the hill. They are the early stages of pinnacle karst, and are found best developed in the areas of pinnacles. An excellent example of this is the fissure entrance of Cleft Cave. Less well developed grikes are found over much of the remaining outcropping limestone.
Introduced species	A species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities. Also known as exotic or alien species.
Karren	Sculpture of limestone by solution.

- Karst** Terrain with special landforms and drainage characteristics on account of greater solubility of certain rocks in natural waters than is common.
- Karst wells** Vertical pipes often forming at the junction of joint sets. These may be several metres deep. A particularly fine example of this feature is found at the entrance of YE 22, Wishing Well Cave.
- Limestone pinnacles** These projections of rock are remnants of the former surface, heavily dissected through solution, containing many grikes. Pinnacles are very exposed to rainfall and often have excellent examples of the smaller scale solution features superimposed on them. Excellent pinnacle karst is found to the west of Small Slide Cave, and over Daylight Cave.
- Policy** A statement of attitude and courses of action, directed toward the attainment of NPWS corporate goals and/or objectives.
- Rain pits** Small circular pits in fields, often separated by sharp points. These are generally found on the flatter limestone surfaces and in solution pans, merging with solution flutes as slopes increase.
- Rain solution runnels** Vertical grooves, often 2-3 times the width of solution flutes, of constant width for their full length. These may be several metres in length, with best examples found in the depression near the entrance to Small Slide Cave, and on the northern face of the hill near the quarry.
- Recovery plan** A document, prepared under the TSC Act, that identifies the actions to be taken to promote the recovery of a threatened species, or endangered population or ecological community.
- Solution bevels** Nearly flat surfaces at the base of sets of solution flutes.
- Solution flutes** Often very densely spaced and up to several metres in length, these features are very common on the pinnacles and ridges of limestone around Small Slide Cave and Daylight Cave. They are usually found at the tops of limestone outcrops, and may merge into solution runnels further down slope.
- Solution pans** Flat-floored, dish shaped closed depressions, often surrounded by rain solution runnels. Their floors often contain a bed of moss and soil which aids solution of the pan. Where the floor is bare rock rainpits may be present. These features are common in the area of small slide cave.
- Solution runnels** Vertical but increasing width grooves produced by concentration of runoff. These are probably the most common karren type found at Yessabah, occurring on most of the exposed rock surfaces on the northern and western sides of the hill.
- Solution spikes** Sharply pointed projections often on the ridge crests, extending downwards for up to 0.5m, then coalescing into solution flutes or solution runnels, these features are common on most exposed limestone, particularly in the northwest side of Yessabah Hill.
- Speleology** The exploration, description and scientific study of caves and related phenomena.