NARRAWALLEE CREEK NATURE RESERVE

PLAN OF MANAGEMENT

National Parks and Wildlife Service

Part of the Department of Environment and Conservation (NSW)

July 2006

This plan of management was adopted by the Minister for the Environment on 28th July 2006.

Acknowledgments

This plan of management is based on a draft plan prepared by staff of the South Coast Region of the National Parks and Wildlife Service.

Valuable information and ideas were contributed to the planning process by the South Coast Region Advisory Committee and other members of the community through letters, submissions and meetings.

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FOREWORD

Narrawallee Creek Nature Reserve is located on the mid south coast of New South Wales approximately 7km north of Ulladulla.

Narrawallee Creek Nature Reserve protects a variety of coastal environments, including coastal dunes, forest communities, Pattimores Lagoon and wetlands adjacent to the Narrawallee Creek estuary. Five endangered ecological communities and two regionally significant vegetation communities, and three endangered and eight vulnerable fauna species, have been recorded in the reserve. Aboriginal middens and artefact scatters also occur in the reserve, as do silica deposits that were formed under unusual geological circumstances. The reserve also provides low key educational and recreational opportunities for locals and visitors to the area.

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

A draft plan of management for Narrawallee Creek Nature Reserve was placed on public exhibition from 27 May until 29 August 2005. The exhibition of the draft plan attracted 14 submissions that raised 8 issues. All submissions received were carefully considered before adopting this plan.

This plan provides for conservation of the ecological values of Narrawallee Creek Nature Reserve. Aboriginal sites will be monitored and the Aboriginal community will be involved in any necessary management works. Public access will be controlled to minimise damage and will be oriented towards providing opportunities for enjoying and learning about the area's natural and cultural heritage.

This plan of management establishes the scheme of operations for Narrawallee Creek Nature Reserve. In accordance with section 73B of the *National Parks and Wildlife Act 1974*, this plan of management is hereby adopted.

Bob Debus
Minister for the Environment

RESERVE PROFILE:

GAZETTAL DATE: Dedicated in 1986, with subsequent additions.

AREA: 878ha.

LOCATION: Mid South Coast, 7km north of Ulladulla. Shoalhaven Council LGA.

LANDFORM: Fairly flat, with beaches, sand dunes, low ridges, freshwater lagoons and estuarine wetlands.

GEOLOGY: Primarily Permian sandstone and shale, with Quaternary dunes along the coastline and alluvial deposits adjacent to Narrawallee Inlet.

VALUES: Diverse vegetation types and habitats of forests, woodlands, heathlands and wetlands. Areas of five endangered ecological communities (Coastal Saltmarsh, Swamp Sclerophyll Forest, Swamp Oak Floodplain Forest, Littoral Rainforest and Bangalay Sand Forest) plus stands of significant Coastal Red Gum Grassy Forest and Jervis Bay Lowland Dry Forest. Eleven species of threatened fauna recorded, including breeding sites for the little tern, hooded plover and pied oystercatcher. Several recorded Aboriginal sites and extensive remains from former silica mining during the mid 20th century, including cuttings, mounds and a tramway.

VISITOR USE: Popular with locals and visitors. A walking track and vehicle trails provide attractive walking opportunities and there is a small picnic area at the main entrance. Opportunities for swimming, surfing, cycling, bird watching, scenery viewing and fishing.

ISSUES: The reserve is in good condition but some areas have been disturbed by silica quarrying and grazing. There are occurrences of bitou bush and sea spurge along the coastline. The habitat values of Pattimores Lagoon have been affected by downstream channel enlargement, altering it from mainly fresh to more saline and allowing introduction of pollutants. Adjacent urban development is resulting in increased isolation of the reserve and pressures on its natural values.

MANAGEMENT: The primary management emphasis will be conservation of significant vegetation communities and threatened species through weed control, fox control to protect nesting shorebirds, and appropriate fire regimes. Liaison will be undertaken with Shoalhaven City Council to seek rebuilding of the weir below Pattimores Lagoon. A conservation plan will be prepared for the silica mining features. Existing visitor facilities will be maintained and an interpretation plan will be prepared, providing for information provision at the Conjola Beach car park and possibly the silica mining operation.

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1. MANAGEMENT CONTEXT

1.1 LEGISLATIVE AND POLICY FRAMEWORK

The management of nature reserves in 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). NPWS policies relate to nature conservation, cultural 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. The matters to be considered in the preparation of a plan of management are listed in Section 72AA of the Act. Once the Minister has adopted a plan, the plan must be carried out and no operations may be undertaken within the area covered except in accordance with the plan. The plan will also apply to any future additions to the reserve. Should management strategies or works be proposed in the future that are not consistent with the plan, an amendment to the plan will be required.

1.2 MANAGEMENT PURPOSES AND PRINCIPLES

Nature reserves are reserved under the National Parks and Wildlife 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 function, 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.

1.3 REGIONAL FOREST AGREEMENTS

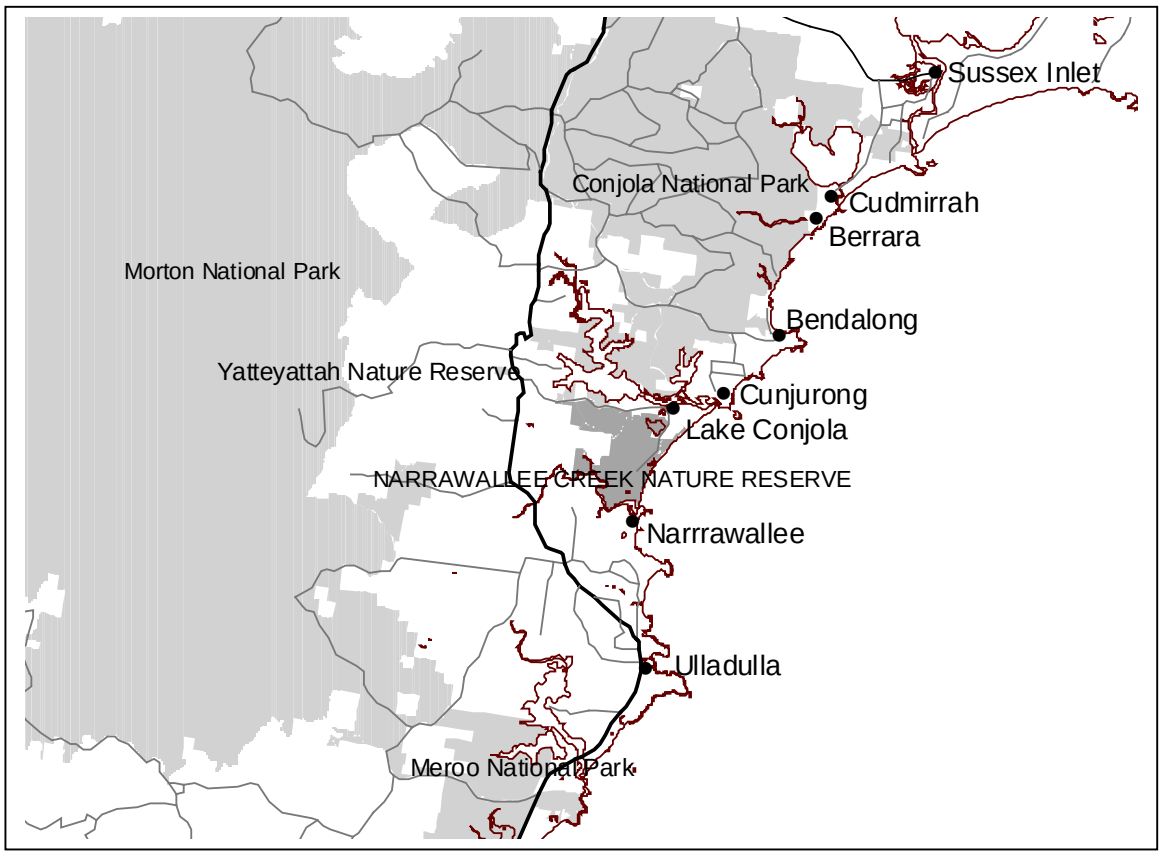
Narrawallee Creek Nature Reserve is covered by the Southern Regional Forest Agreement. Regional Forest Agreements (RFA) are one of the principal means of implementing the National Forest Policy Statement of 1992. Under this Statement Commonwealth, State and Territory governments agreed to work towards a shared vision for Australia's forests. Joint comprehensive regional assessments (CRA) were undertaken of the natural, cultural, economic and social values of forests and these assessments formed the basis for negotiation of RFAs providing for, amongst other things, ecologically sustainable forest management.

2. THE PLANNING AREA

2.1 LOCATION, GAZETTAL AND SETTING

Narrawallee Creek Nature Reserve is located on the mid south coast of New South Wales approximately 7km north of Ulladulla (see Map). It was dedicated in 1986 and subsequent land additions, including areas of Crown land added in 2001 as part of the Southern Regional Forest Agreement, have brought the area to about 878 hectares.

The reserve is located between the townships of Lake Conjola and Narrawallee, with Narrawallee Creek forming the southern boundary. Grazing land adjoins the western boundary of the reserve and Conjola National Park is located adjacent to part of the northern boundary.



2.2 LANDSCAPE CONTEXT

The reserve protects a variety of coastal environments, notably coastal dunes, forest communities, Pattimores Lagoon and wetlands adjacent to the Narrawallee Creek estuary.

Natural and cultural heritage are strongly inter-related and together form the landscape of an area. The geology, landform, climate and plant and animal communities of the reserve, plus its location, have determined how it has been used by humans. Aboriginal people have utilised the resources of the area for at least 20,000 years, especially the estuary and coastline, as is indicated by archaeological sites such as middens. Non-indigenous people have used the area for quarrying, logging, grazing

and recreation use since the 1800s. These uses have affected the vegetation structure, changed the landform in the vicinity of the silica mining and formed the existing network of roads and trails.

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. Cultural values may consist of both physical remains and non-physical manifestations such as knowledge, stories and memories. 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.

3. VALUES AND MANAGEMENT DIRECTIONS

3.1 VALUES OF THE AREA

The reserve is of regional significance for its biological, landscape and cultural values. It is included on the register of the National Estate due to the diversity of its habitats, including mangroves, dune forest, salt and brackish lagoons in good condition, and for its silica deposits formed under unusual geological circumstances (see section 4.1).

Geology and Landform

The reserve contains a variety of landforms and environments including beaches, sand dunes, forested lowlands and ridges, lagoons, estuarine wetlands and foreshores. It includes approximately four kilometres of coastline reserved to high water mark.

The reserve protects most of the catchment and bed of Pattimores Lagoon, part of the catchment and foreshores of Narrawallee Creek and part of the catchment of Conjola Lake. The lower reaches of the Narrawallee Creek estuarine system remain in a near natural state and the geomorphological processes and wildlife supported by this system are of high scientific and conservation value.

Pattimores Lagoon, the shores of Narrawallee Creek and other low lying areas in the reserve are classified as coastal wetlands under State Environmental Planning Policy (SEPP) 14.

A well-preserved stratigraphy on tertiary silica deposits has been exposed by silica extraction over much of the 20th century at the northern end of the reserve. This is an important scientific and educational feature.

Biodiversity

The reserve protects a high diversity of vegetation types and habitats in a relatively small area, including forests, woodlands, heathlands, freshwater and estuarine wetlands. It also helps to protect the adjacent beach and rocky coastline habitats and aquatic habitat for fish, invertebrates and plants in the adjacent Narrawallee estuary. The estuarine communities are particularly significant as extensive vegetated estuarine environments are rare on the mid south coast of NSW.

The endangered ecological communities Coastal Saltmarsh, Swamp Sclerophyll Forest (dominated by swamp mahogany *Eucalyptus robusta*), Swamp Oak Floodplain Forest (dominated by *Casuarina glauca*), Bangalay Sand Forest and Littoral Rainforest are found in the reserve. Swamp mahogany is an important food source for several threatened animal species including the swift parrot (*Lathamus discolor*), regent honeyeater (*Xanthomyza phrygia*), yellow-bellied glider (*Petaurus australis*) and grey-headed flying-fox (*Pteropus poliocephalus*).

Also in the reserve are the restricted Coastal Red Gum Grassy Forest and the regionally significant Jervis Bay Lowland Dry Forest (see section 4.2). Forest red gum (*Eucalyptus tereticornis*) has been cleared from much of its former area of occurrence and is poorly represented in the reserve system.

The vulnerable plant species *Cryptostylis hunteriana* has been recorded to the north and south of the reserve and may occur within it. The ROTAP (national register of rare or threatened Australian plants) listed yellow bush pea (*Pultenaea villifera*) has

been recorded just outside the reserve and may occur within it. Grey gum (*Eucalyptus punctata*) reaches its southern limit within the reserve and the fern *Blechnum indicum* is very close to its southern limit (Ngh environmental 2004).

Although there has been a history of logging, quarrying, wildfire and some grazing, significant areas of old growth forest have been identified particularly at the southern end of the reserve. Old growth forest has high aesthetic and habitat value, particularly for arboreal mammals and birds dependent upon tree hollows.

The number of fauna species recorded in the reserve is high for a small area and is probably due to the diverse habitats in close proximity and their good condition. Pattimores Lagoon is a significant breeding and feeding area for waterbirds and is also likely to provide valuable coastal drought refuge for waterbirds.

The reserve is significant for threatened fauna species. Three endangered and eight vulnerable fauna species (listed in Schedule 1 and Schedule 2 of the Threatened Species Conservation Act) have been recorded in the reserve. Endangered species recorded are the little tern (*Sterna albifrons*), hooded plover (*Thinornis rubricollis)* and green and golden bell frog (*Litoria aurea*). Vulnerable fauna species recorded are the osprey (*Pandion haliaetus*), glossy black-cockatoo (*Calyptorhynchus lathami*), powerful owl (*Ninox strenua*), gang-gang cockatoo (*Callocephalon fimbriatum)*, sooty oystercatcher (*Haematopus fuliginosus*), pied oystercatcher (*Haematopus longirostris*), grey-headed flying-fox (*Pteropus poliocephalus*) and eastern bent-wing bat (*Miniopterus schreibersii oceanensis*). The little tern, hooded plover and pied oystercatcher breed from time to time at Narrawallee Inlet and on Crown land at the entrance to Conjola Lake.

Cultural heritage

Aboriginal middens and artefact scatters occur in the nature reserve. It is likely that the coastline and estuaries were formerly important resource sites.

Evidence of former silica mining exists in the reserve, including cuttings, mounds and a tramway used to transport the silica (see 4.5). The silica industry was formerly of economic and social importance to the region, particularly between the First and Second World Wars.

Scenery

The coastline of the nature reserve is extremely attractive, with a variety of features such as sandy beaches, rock outcrops, wetlands and diverse vegetation communities. The reserve has a sense of peace and isolation because of the adjacent waterways and minimal views of developed areas.

The reserve enhances the scenic amenity of the district by providing a natural backdrop to the important waterway of Narrawallee Inlet.

Educational, tourism and recreational values

The reserve provides low key educational and recreational opportunities (beach activities and bushwalking) for locals and visitors to the area.

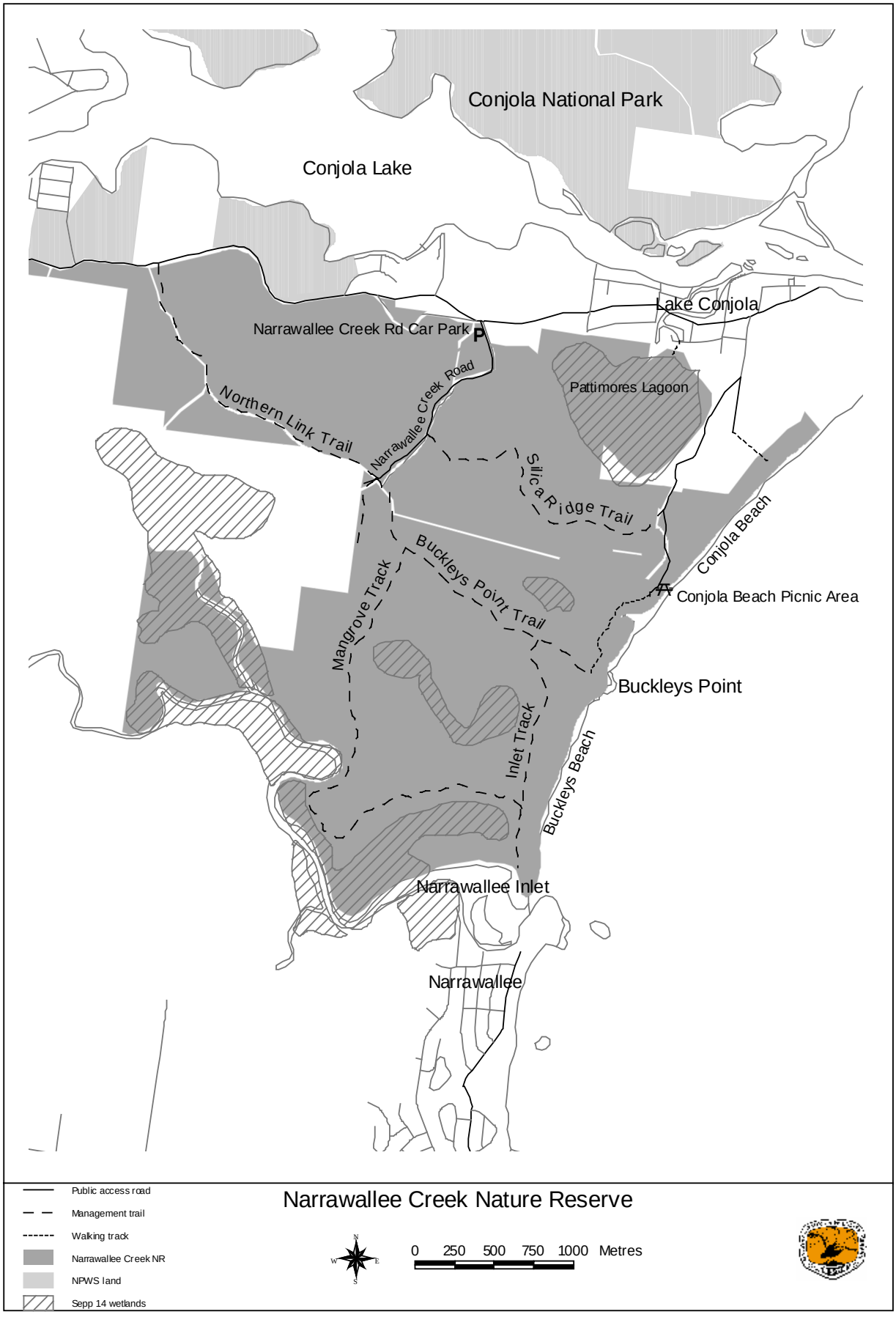
3.2 MANAGEMENT DIRECTIONS

Conservation of the ecological values of the reserve, particularly in relation to maintenance of biodiversity and protection of threatened communities and species will be given highest priority. This will be achieved by:

- survey and monitoring to provide information about the location, status and management needs of threatened species and communities;
- implementation of conservation measures for nesting shorebirds;
- working with Shoalhaven Council to restore a more natural water regime for Pattimores Lagoon;
- control of introduced species, particularly bitou bush and foxes; and
- strategic fire management to protect habitat values.

Significant cultural values will also be conserved. Aboriginal sites at risk from recreation activities will be monitored and the Aboriginal community will be involved in any necessary management works. Recording and assessment will be undertaken for the silica mining remains.

Public access will be controlled to minimise damage and will be oriented towards providing opportunities for enjoying and learning about the area's natural and cultural heritage. A small car park and picnic area will continue to be provided behind Conjola Beach, with walking opportunities along the Buckleys Point Walking Track and management trails. An interpretive strategy will be prepared.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Narrawallee Creek Rd Car Park
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Pattimores Lagoon
Northern Link Trail
Narrawallee Creek Road
Silica Ridge Trail
Conjola Beach
Buckleys Point Trail
Conjola Beach Picnic Area
Mangrove Track
Buckleys Point
Inlet Track
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4. CONSERVATION OF NATURAL AND CULTURAL HERITAGE

4.1. GEOLOGY, LANDFORM AND SCENERY

The underlying geology of the reserve is mainly composed of the Permian Conjola Formation, a series of sandstone and shale units. There are Quaternary sand dunes along the coastline and alluvial deposits adjacent to Narrawallee Inlet.

The sand deposits are extensive, forming dunes along the coastline and flat deposits at the southern end of the reserve. Those in the northern part of the reserve are higher and appear to be older, possibly aeolian and fluvial deposits.

Tertiary silica deposits occur south of Pattimores Lagoon on a low ridge. These deposits were probably formed through hydrothermal agencies from basalt overflows. The silica deposits consist of approximately 4m of dense locally banded white to pink silica. Two small residuals of basalt overlie the silica.

The reserve is fairly flat but landforms include beaches, sand dunes, low ridges, several lagoons and estuarine wetlands. The areas adjacent to Narrawallee Inlet are low lying and poorly drained.

The largest lagoon is Pattimores Lagoon. Its habitat values have been affected by downstream channel enlargement as part of an adjacent canal estate development, altering it from mainly fresh to more saline, possibly lowering water levels and allowing introduction of pollutants (see section 5.2). There are smaller lagoons north of Buckleys Point and at the southern end of the reserve.

Silica quarrying (section 4.5) has resulted in a disturbed area of quarry walls, large mounds, pits and cuttings over a large area north and south of the Silica Ridge Trail. This has significantly altered the original landscape. The quarried areas are stable and have revegetated apart from the floor of a more recently quarried area near the centre of the silica ridge.

The reserve's coastline, estuaries and forests are very attractive. Protection of the foreshore vegetation is important, both for landform stability and scenic value.

Sand extraction and urban development, including the construction of a wastewater treatment plant, are taking place to the north and west of the reserve, with impacts on the area's scenic values, sense of isolation and other values.

Desired Outcomes

- Significant geological and geomorphological features are protected, particularly the sand dunes and wetlands associated with Narrawallee Inlet and Pattimores Lagoon.
- Natural processes are maintained or, in the case of Pattimores Lagoon, restored (section 5.2).
- The scenic values of the reserve, and in particular the relatively undisturbed coastline and foreshores, are maintained.

Strategies

- *Design and undertake all management actions in a manner that avoids damage to the natural landscape, particularly the coastal dune system, estuaries and lagoons, and their associated vegetation.*

- *Leave the former silica quarries, mounds and cuttings as at present and do not reshape.*

- *Promote revegetation of the floor of the recently operated quarry by ripping, brush matting or planting with local species.*

- *Liaise with neighbours and authorities where needed to minimise the impact of adjacent land uses on the scenic values of the reserve.*

4.2 NATIVE VEGETATION

The reserve has a variety of vegetation types as described below.

Herblands on the foredunes include *Spinifex sericeus* and *Lomandra longifolia*, and are backed by low closed scrub with coast wattle (*Acacia longifolia* var. *sophorae*), *Correa alba* and *Leucopogon parviflorus* on the hind-dunes. A small area of heath dominated by *Westringia fruticosa* occurs at Buckleys Point.

Further inland, coast banksia (*Banksia integrifolia*) merges into a bangalay (*Eucalyptus botryoides*), old man banksia *(Banksia serrata*) and burrawang (*Macrozamia communis*) association on the parallel dune system. As stated in section 3.1, this community is listed as an endangered community (Bangalay Sand Forest). Outside reserves it is threatened by clearing, frequent burning and weed invasion.

Well drained areas in the central and western parts of the reserve are covered by tall open forests dominated by blackbutt (*E. pilularis*), red bloodwood *(Corymbia gummifera)* and turpentine *(Syncarpia glomulifera*). These forests have a diverse understorey of flowering shrubs. Large blackbutts are also found on the stabilised areas of flat sand in the southern part of the reserve in association with old man banksia.

The edges of Pattimores Lagoon and other small swampy areas are dominated by swamp paperbark (*Melaleuca ericifolia*) in a low closed scrub with *Baumea juncea*, salt rush (*Juncus kraussii*) and common reed (*Phragmites australis*).

The shores of Narrawallee Creek support saltmarsh, mangroves (*Avicennia marina*) and extensive areas of swamp oak forest (*Casuarina glauca*). These communities are important for foreshore protection and the mangroves have a fish nursery role. There is also an area of swamp oak at Buckleys Point. As stated in section 3.1, Coastal Saltmarsh and Swamp Oak Floodplain Forest are listed as endangered ecological communities under the Threatened Species Conservation Act.

The endangered ecological community Swamp Sclerophyll Forest occurs as a large area of low open forest on low-lying land in the southern part of the reserve and in smaller patches in the north and west. It is dominated by swamp mahogany (*E. robusta*) and has a dense understorey of *Melaleuca* species. This community is vulnerable to weed invasion, inappropriate fire regimes and changes to hydrological conditions but there are no current threats to the stands in the reserve.

The restricted Coastal Red Gum Grassy Forest community occurs in a small area south of Pattimores Lagoon, adjacent to the silica quarry area. It is a medium to tall

forest dominated by forest red gum (*E. tereticornis*) with white stringybark (*E. globoidea*) and rough barked apple (*Angophora floribunda*). The ground cover is *Themeda australis* and *Danthonia longifolia* with scattered shrubs and forbs. The community occurs on relatively fertile soils and is therefore vulnerable to weed invasion (see section 5.3). It appears to have been partially disturbed by silica quarrying operations and possibly has been grazed in the past. An appropriate fire regime is necessary for maintenance of the forest structure (see section 5.4).

The regionally significant Jervis Bay Lowlands Dry Forest community occurs in the western parts of the reserve. It is a medium height forest dominated by grey gum (*E. punctata*), along with other tree species such as red bloodwood, thin-leaved stringybark (*E. eugenioides*) and black she-oak (*Allocasuarina littoralis*). There are no current threats to the stands in the reserve.

There is a small area of the endangered ecological community Littoral Rainforest at Buckleys Point.

As stated in section 3.1 the vulnerable *Cryptostylis hunteriana* and ROTAP species *Pultenaea villifera* may occur in the reserve. Survey is needed to check for their presence. *Pultenaea villifera*, if found, will require protection from too frequent fire.

The vegetation communities in the reserve are in relatively good condition. Parts of the reserve have been subject to selective logging in the past but this has not had a serious detrimental impact on floristic composition or structure. As stated above, silica quarrying and possibly grazing have disturbed the Coastal Red Gum Grassy Forest and other areas in the north eastern part of the reserve. Areas along the western boundary have also been disturbed by grazing from adjacent properties (section 5.3).

Vegetation plots have been established in a number of locations and these may be used for monitoring programs if needed.

Desired Outcomes

- The full range of native plant species found in the reserve is conserved.
- Vegetation structural diversity and habitat values are conserved, and are restored where subject to past disturbance.
- The endangered and restricted vegetation communities are conserved.
- The habitat and populations of all threatened and biogeographically significant species are protected and maintained.

Strategies

- *Monitor the condition of the Swamp Sclerophyll Forest, Swamp Oak Floodplain Forest, Coastal Saltmarsh, Bangalay Sand Forest and Littoral Rainforest and take any steps to address threats if needed.*
- *Survey to determine whether Cryptostylis hunteriana and Pultenaea villifera are present within the reserve.*

4.3 NATIVE ANIMALS

The native fauna of the reserve is diverse and the reserve is an important refuge for local fauna populations. A total of 113 bird species and 11 mammals have been recorded so far but little is known about the reserve's reptile or amphibian fauna.

Bird species recorded comprise water birds, seabirds, raptors and a large variety of birds dependent on open forest/heathland vegetation. As stated in section 4.1, the bird breeding and feeding value of Pattimores Lagoon has been adversely affected by alteration of the lagoon from largely fresh to tidal following adjacent canal development.

Mammals recorded include arboreal mammals, macropods and bats. There may also be populations of small mammal species such as the dusky antechinus (*Antechinus swainsonii*), long-nosed bandicoot (*Perameles nasuta*), bush rat (*Rattus fuscipes*) and common dunnart (*Sminthopsis murina*) which have been recorded to the north in Conjola National Park.

The nature reserve is relatively small and isolated, being mostly surrounded by rural grazing land and urban development. The viability of habitats in the reserve is to a large extent dependent on the continued existence and sympathetic management of remaining adjacent natural areas. Progressive loss of naturally vegetated areas and further isolation could lead to species loss within the reserve and could occur as part of urban and semi-rural expansion taking place to the north and west at Lake Conjola and to the south at Narrawallee.

Narrawallee Inlet potentially contains the threatened Australian grayling (*Prototroctes maraena*) and black cod (*Epinephelus daemiliee*). It may also have populations of protected Syngnathiformes species (seahorses,etc). Management of fish in NSW is the responsibility of the Department of Primary Industries (Fisheries) but where their habitats are located in or adjacent to reserves the Service aims to protect those habitats. The most important requirements for protection of fish habitat in the area are protection of foreshore vegetation and prevention of siltation and turbidity by runoff from roads and trails. Minimising the number of trails within the reserve will also assist protection of water quality.

Threatened species

Threatened species recorded in the reserve are listed in section 3.1. The reserve has also been modelled as containing significant habitat for several threatened species not yet recorded including the long-nosed potoroo (*Potorous tridactylus*), spotted-tail quoll (*Dasyurus maculatus*), smoky mouse (*Pseudomys fumeus*), masked owl (*Tyto novaehollandiae*), sooty owl (*Tyto tenebricosa*), swift parrot and greater broad-nosed bat (*Scoteanax rueppellii*). Future survey may confirm the presence of these species.

The Swamp Sclerophyll Forest provides a relatively large area of suitable habitat for the vulnerable swift parrot (*Lathamus discolor*) and the endangered regent honeyeater (*Xanthomyza phrygia*). Survey is needed to check for the presence of these species when the swamp mahogany is in flower.

The management needs of threatened species will be established as part of any recovery plans prepared under the Threatened Species Conservation Act. Specific management actions may be undertaken to assist the survival of threatened species such as temporary fencing of shorebird nesting areas in conjunction with public education and pest control programs.

Desired Outcomes

- Knowledge of native fauna in the reserve is improved.
- The full range of native animal species in the reserve is conserved.

- The habitat and populations of all threatened species are protected and maintained.

- The impacts on the reserve of adjacent development are minimised and neighbours and land use authorities support conservation of remaining areas of native vegetation near the reserve.

Strategies

- *Conserve the diversity and high quality of habitats for native animals occurring in the reserve through maintenance of natural processes, minimisation of human impacts and specific conservation programs where necessary.*

- *Undertake specific management programs for conservation of threatened species, particularly the little tern, hooded plover and pied oystercatcher. Monitor shorebird nesting, undertake pest management and erect temporary protective fencing and signs as needed.*

- *Implement relevant measures included in any recovery plans prepared for threatened species occurring in the reserve.*

- *Undertake fauna surveys targeting threatened species such as the green and golden bell frog, southern-brown bandicoot, swift parrot and regent honeyeater.*

- *Carry out periodic surveys of threatened species to monitor their status and response to management programs.*

- *Liaise with neighbours and land use authorities to encourage retention of areas of native vegetation close to the reserve.*

4.4 ABORIGINAL HERITAGE

Aboriginal people have utilised the resources of the South Coast for at least 20,000 years and this long association continues. The nature reserve is situated within the lands of the Wanda Wandian speaking people and the Budawang/Murramarang tribes of the Dhurga language group. Today, the nature reserve is in the area of the Jerrinja Local Aboriginal Land Council and the Shoalhaven Elders Group.

It is recognised that the landscape, and the plants, animals and physical features within the landscape are all an integral part of Aboriginal cultural heritage. It is likely that the reserve was an important food gathering area because of the proximity of the Narrawallee Creek estuary, lagoons, Conjola Lake and the ocean.

The reserve area has not been formally surveyed for Aboriginal sites and places but some middens and artefact scatters have been found. It is likely that other sites exist, possibly including stone artefact quarries (if not destroyed by the extensive silica quarrying in more recent historic times) and burials as such sites have been found nearby. Archaeological sites are important to Aboriginal communities as they are a testament to their culture's great antiquity. Aboriginal sites and places are also important to non-Aboriginal people as they provide information about past ways of life.

The known Aboriginal sites are located on the coastline and the shores of Narrawallee Creek and Pattimores Lagoon. As such, they are potentially at risk from natural erosion processes or human use.

While the Service has legal responsibility for the protection of Aboriginal sites within reserves it acknowledges the right of Aboriginal people to make decisions about their

own heritage. It is therefore policy that Aboriginal communities be consulted about decisions regarding the management of Aboriginal sites and related issues and how the Aboriginal culture and history of an area controlled by the Service will be promoted and presented.

Desired Outcomes

- Aboriginal sites and places are protected from damage by visitor and management activities.

- Aboriginal people are involved in management of Aboriginal cultural values in the reserve.

Strategies

- *Consult and actively involve the Jerrinja Local Aboriginal Land Council and other relevant Aboriginal community organisations and individuals in all aspects of management of Aboriginal sites and places in the reserve.*

- *Protect Aboriginal sites and places from disturbance or damage by human activities, in conjunction with the Aboriginal community.*

- *Monitor the condition of Aboriginal sites at risk and undertake protective works if needed to prevent damage by recreational activities.*

- *Undertake a predictive assessment for Aboriginal sites and survey areas where sites may be at risk. Precede all works with the potential to impact on Aboriginal sites by an archaeological assessment.*

- *Do not publicise the location of Aboriginal sites except where:*
  - *the agreement of the Jerrinja Local Aboriginal Land Council and other relevant Aboriginal community members has been obtained;*
  - *a conservation study has been prepared and any management works necessary to protect the site from damage have been implemented; and*
  - *the site is interpreted in consultation with local Aboriginal people to promote public knowledge and appreciation of Aboriginal culture.*

4.5 HISTORIC HERITAGE

Prior to dedication, the reserve was a combination of vacant Crown land and Crown lease. There was little clearing or development apart from some logging, quarrying and grazing.

Selective logging of hardwoods such as blackbutt and turpentine was carried out in the area prior to reservation, probably during the early 1900s. A number of large stumps remain, showing notches where springboards were placed by the axemen. Logging activities modified the structure of the forests and created several vehicle trails.

Substantial deposits of nearly pure silica were mined in the Ulladulla and Bendalong area from as early as 1918 until 1975. At first all the silica mined in the district had to be transported by horse and dray to wharves at Ulladulla and Red Head near Bendalong but timber tramlines were later built and horses pulled iron skips along the lines (McAndrew, 1995).

Extraction began from extensive silica deposits south of Pattimore's Lagoon, now within the nature reserve, in 1926, commencing at the eastern end of the silica ridge.

The silica was broken up by explosives and by hand using spalling hammers. A tramline transported silica spalls from the lease area via a bridge across Narrawallee Inlet to Bannisters Head at Mollymook. The tramline consisted of steel rails on timber sleepers, and followed a relatively straight line from the lease to the Inlet, parallel to the coast. In places the line formation was built up to keep it level. Timber skips were hauled by a locomotive. The silica rock was crushed at Bannisters Head and shipped to Port Kembla or Newcastle for production of high quality refractory bricks for use in the steel furnaces (McAndrew, 1995).

The tramline across Narrawallee Inlet was in use until the start of the Second World War but in 1947, after a lull in extraction, the silica began to be transported by road to a crusher at Yatteyattah, and later directly to Port Kembla. The bulk of the tramline rails were taken up in 1943 and in 1944 the bridge was dismantled (McAndrew, 1995). Most of the bridge posts have rotted but a few remain on the northern side of the Inlet. The raised tramline route is still visible in the reserve and sleepers can be found buried beneath soil and vegetation.

Silica extraction largely ceased at the Pattimores Lease in 1975 although extraction for road construction occurred later from an area to the west of the main quarry, probably during the 1980s and possibly later. As stated in section 4.1, quarries, cuttings and mounds remain from the operations. A metal skip or boiler is located near the quarried area. The significance of this relic is presently unknown. While rusting, it appears to be in reasonable condition.

The tramline formation is stable at present. Fire management considerations for the tramline have been included in the Fire Management Strategy prepared for the reserve (see section 5.4) and a proposed conservation analysis will consider whether any other protective measures are needed.

A small corrugated iron shed is located near the silica quarry. It is thought that this was of recent construction and associated with grazing activity in the former lease area but this has not been confirmed. A water tank and length of barbed wire fence are located nearby. These features are not considered likely to have historic significance but have not been formally assessed.

Part of the silica quarry area was used informally for rubbish dumping during the 1980s until a recycling and waste depot was provided for Lake Conjola village. There is no visible material remaining from this use.

Parts of the western and northern areas of the reserve were formerly used for relief grazing by adjacent property owners in times of flooding and drought.

Desired Outcomes

- Historic features are appropriately conserved and managed.

Strategies

- *Manage historic places in accordance with the Burra Charter.*
- *Record and assess features remaining from silica mining activities, including the metal skip or boiler. Prepare a conservation plan and undertake conservation works if required.*
- *Determine the former use of the corrugated iron shed, fence and water tank and assess their significance. Develop a management strategy if found to be significant or record and remove if not significant.*

5. RESERVE PROTECTION

5.1 SOIL EROSION

Soils in the reserve consist primarily of shallow sandy loams and sands over fine sands and sandy clay subsoils. They are erosion prone and become very unstable when the topsoil is removed. In well-drained flat areas they form good road surfaces but on slopes or wet areas they break down. Parts of the reserve along Narrawallee Creek are subject to inundation, affecting the Mangrove Track management trail.

There are minor dune blowouts along the beach front, primarily as a result of natural processes. Blowouts are of most concern in areas subject to human impact. An area where erosion was being accelerated by sand sliding has been fenced and two pedestrian access points over the dunes (at the northern end of the reserve and at the Conjola Beach car park) have been defined with fencing and board and chain walkways.

The foreshores of Narrawallee Inlet appear to be relatively stable but are potentially at risk of erosion from boating activity or floods, particularly from boats landing on the reserve shore. It will be important to maintain good vegetation cover on the foreshores.

Desired Outcomes

- Human induced soil erosion in the reserve is minimised.
- Significant natural and cultural values are not threatened by erosion.

Strategies

- *Design and undertake all works in a manner that minimises soil erosion.*
- *Take appropriate erosion control measures where erosion has been accelerated by human activity or is threatening significant habitats or other values.*
- *Monitor areas of dune blowout and, if needed, take action to prevent further erosion.*
- *Monitor foreshore areas along Narrawallee Inlet and take action if needed to ensure maintenance of vegetation cover. Discourage recreational use in areas subject to erosion.*
- *Avoid driving on management trails when they are affected by inundation.*

5.2 WATER QUALITY AND CATCHMENT MANAGEMENT

The reserve plays a major role in protection of Narrawallee Inlet, Pattimores Lagoon and several small wetland areas.

Narrawallee Inlet is in relatively good condition with a combination of forest and grazing land in its catchment. The Healthy Rivers Commission Independent Inquiry into Coastal Lakes (Healthy Rivers Commission, 2002) identified Narrawallee Inlet as warranting significant protection.

A natural resource and floodplain management committee has been established by Shoalhaven City Council for Narrawallee Inlet to oversee implementation of the natural resource management plans prepared for the Inlet. The Service is a member of this committee.

Pattimores Lagoon was originally a largely freshwater wetland, receiving a limited tidal exchange only during particularly high tides. Canal development on the creek that leads from the lagoon outside the reserve has altered the natural flow regime and water quality in the lagoon, letting in salt water and pollutants and increasing the rate of sedimentation (Findlay, 1988). This has affected vegetation distribution and waterbird use, with decline in bird numbers, death of swamp oak and establishment of mangroves. Freshwater wetlands are rare on the South Coast whereas tidal and brackish estuaries are relatively common. A weir built to partially deal with the saline incursions has been in disrepair for some years and needs to be reconstructed. This is supported by the Lake Conjola Estuary Management Plan. The Department of Primary Industries supports restoration of the lagoon but would need to be consulted in relation to any impacts of the weir re-building on fish passage.

Rubbish dumping occurs in the reserve along Narrawallee Creek Road, particularly when the adjacent recycling and waste depot is closed, with consequent visual impacts and the potential for pollution and promotion of feral animal populations.

A wastewater treatment plant is planned to be constructed adjacent to the north eastern boundary of the reserve utilising dune exfiltration for management of reclaimed water. Monitoring of water quality in the reserve, particularly at Pattimores Lagoon, would be needed to check for any impacts.

Desired Outcomes

- The reserve's catchment values and the water quality and health of streams and estuaries are maintained.

Strategies

- *Design and undertake all works in a manner that minimises water pollution.*

- *Liaise with local government and other authorities to maintain and improve the water quality of the reserve's catchments and wetlands.*

- *Liaise with Council to seek rebuilding of the weir on the canal development near Pattimores Lagoon, with the aim of returning the lagoon to near natural levels of salinity compatible with restoring natural aquatic communities. Liaise as needed with the Department of Primary Industries, Department of Natural Resources and other relevant agencies. Undertake an education campaign with neighbours to raise understanding of the lagoon's values and support for the rebuilding of the weir.*

- *Undertake research as needed to record the current condition of Pattimores Lagoon and monitor changes following rebuilding of the weir.*

- *Work with Council to explore strategies for minimising rubbish dumping.*

- *Seek water quality monitoring by Shoalhaven Council at Pattimores Lagoon and other locations within the reserve that may be affected by the construction of the wastewater treatment plant and dune exfiltration system at Lake Conjola. The monitoring program should include an assessment of water quality prior to operation of the plant and consideration of inputs from local caravan parks.*

5.3 INTRODUCED SPECIES

An introduced species is defined in this plan as any plant or animal species not indigenous to the area. Introduced species within the reserve and on adjoining land are of concern because they have the potential to have detrimental effects on ecological values and can spread to and from neighbouring land.

Weeds

The occurrence of introduced plant species in the reserve is low. Most of the weeds occur on the sand dunes and on areas that have been disturbed in the past such as the former silica mining area and Buckleys Point. There are occurrences of Cape ivy (*Delairea odorata*), moth vine (*Araujia hortorum*), coral tree (*Erythrina X sykesii*), lantana (*Lantana camara*), arum lily (*Zantedeschia aethiopica*), bridal creeper (*Myrsiphyllum asparagoides*), mist flower (*Ageratina riparia*), smooth senna (*Senna floribunda*) and other weeds in the reserve. Suppression of weeds has occurred in the reserve over many years and remnant weeds are controlled. There are, however, areas of exotic grasses remaining at a number of locations and occurrences of other weeds in disturbed areas.

As previously stated, the significant Red Gum Grassy Forest community is vulnerable to weed invasion. A number of minor weeds have been observed but no formal survey has been undertaken to ascertain the extent of weeds.

The *Noxious Weeds Act 1993* places an obligation upon public authorities to control noxious weeds on land that they occupy to the extent necessary to prevent such weeds spreading to adjoining lands. The only declared noxious weed that is known to occur in the reserve is bitou bush (*Chrysanthemoides monilifera* ssp*. rotundata*).

Bitou bush occurs in the dune system behind Conjola Beach. Infestations have been mapped and occur in medium to low densities. The worst infestations are in the northern section of the reserve. Boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*), a close relative to bitou bush, occurs at Buckleys Point and at low levels on the more clay based soils along Narrawallee Inlet. This could potentially threaten the endangered Swamp Sclerophyll Forest and needs to be monitored (DEC, 2004)

Bitou bush and boneseed are primarily spread from area to area by foxes and birds. Effective and on-going control is essential because of the high ability of these species to spread rapidly into undisturbed bushland and to smother native species. Therefore it is essential to have an integrated approach to control. A bitou bush working group consisting of representatives from NPWS, Dept Lands, Council, Healthy Cities and the local community has operated for a number of years in the Lake Conjola/Mollymook area. This committee oversees a control program that is funded by Coastcare grants and employs a part time coordinator to organise volunteer programs.

Bitou bush control programs in the nature reserve over the past ten years have involved ground and aerial spraying programs and intensive hand pulling by Service staff and volunteers. These efforts have dramatically reduced the occurrence of bitou bush in the reserve.

Spiny rush (*Juncus acutis*) has recently been observed at Pattimores Lagoon. This has the potential to affect native species and habitat values.

There are small occurrences of sea spurge (*Euphorbia paralias*) on Conjola and Buckleys Beaches. This species could threaten seabird breeding success in the reserve. It is an emerging weed in the region, seeds prolifically and can be re-introduced during high sea levels.

A small area of *Caulerpa taxifolia* is found adjacent to the reserve in Narrawallee Inlet. Caulerpa is an invasive marine species that is easily spread by boating and fishing activities as well as wave action. It can rapidly displace native aquatic vegetation such as seagrass and therefore potentially affect the habitat values of estuarine areas.

Introduced Animals

Foxes, rabbits, cats and occasionally wild dogs are present in the reserve. Rabbits are found in low numbers in the dune systems and on the edge of Lake Conjola village. Monitoring is undertaken to check that numbers remain low.

Foxes are the major threat to ground dwelling native animals in the reserve, including breeding success of threatened shorebirds such as the little tern and pied oystercatcher, and are known to spread weeds such as bitou bush. Predation by the Red Fox is a Key Threatening Process under the TSC Act for critical weight range mammals and ground nesting birds. A 1998 survey (Olsen & Latimer) found low to moderate fox activity in the reserve. The survey helped to identify areas that require control programs. Generally fox and wild dog control programs are undertaken at the same time and several have been carried out in the reserve.

Fox control programs will continue and be targeted towards protection of threatened species breeding areas, particularly shorebirds. This accords with the priorities in the Fox Threat Abatement Plan prepared under the TSC Act. Monitoring of native fauna, especially threatened shorebirds, will be used as an indicator of the success of control programs. Because of continual invasion from surrounding land, cooperative control of wild dogs and foxes is needed over a wide area if measures in the reserve are to be successful in the medium term.

Feral cats have been trapped in the reserve in the past. On-going control is desirable but difficult.

The reserve adjoins a number of rural properties and small acreages on the western side. Fencing is currently inadequate and cattle occasionally stray into the reserve, with consequent vegetation and habitat damage. It is important for effective fencing to be established and maintained to prevent stock entering the reserve.

Desired Outcomes

- The impact of introduced species on native plants and animals is minimised.

Strategies

- *Control and if possible eradicate introduced plant species. Give priority for treatment to those species that:*
  - *have been declared noxious;*
  - *threaten the integrity of native communities;*
  - *may affect neighbouring lands;*
  - *have a high capacity for dispersal; and/or*
  - *are new isolated occurrences.*

- *Carry out a weed survey in the reserve, focussing on the former silica quarry, areas adjacent to the recycling and waste depot, the significant Red Gum Grassy Forest community, Pattimores Lagoon and sand dunes. Determine control priorities and strategies.*

- *Continue control programs for bitou bush and boneseed, involving adjoining land managers and landcare groups where appropriate. Treat other priority weeds as required.*

- *Eradicate existing occurrences of sea spurge in the reserve and monitor for new infestations.*

- *Seek the cooperation of other authorities, the community and neighbours in implementing weed control programs.*

- *Continue to support and encourage community volunteer bush regeneration programs in the reserve.*

- *Control introduced animals where they have a significant impact on native species or neighbouring stock. Design programs to avoid impact on non-target species and undertake them in cooperation with the South Coast Rural Lands Protection Board and neighbouring land holders where appropriate.*

- *Carry out fox and wild dog control programs, with priority to protecting threatened shorebirds.*

- *Seek to introduce cooperative feral cat control programs with neighbours.*

- *Encourage effective boundary fencing with neighbouring grazing properties by working closely with neighbours.*

5.4 FIRE MANAGEMENT

Fire is a natural feature of the environment of the nature reserve and is essential to the survival of some plant communities. Too frequent or regular fire, however, can cause loss of particular plant and animal species and communities. Fire could also damage visitor facilities and affect neighbouring land and assets.

Management of fire in the reserve is an important and complex issue. Management must aim to achieve both long term conservation of natural communities and ongoing fire management obligations that contribute to the protection of life and property within and adjacent to the reserve.

Fire history

The pre-European fire history of the area is not known. Traditional fire practices of Aborigines in New South Wales have not been well researched and are poorly understood. Aborigines are likely to have had burning regimes that encouraged grazing plants in areas in which they hunted game and kept corridors open in lands they travelled through but it is not known how this applied to the Narrawallee area. It appears likely, however, that the frequency and intensity of fire now are different from pre-European times.

Most recorded wildfires have occurred as a result of arson within the reserve or escape from neighbouring properties. There have been a number of small wildfires in recent years but there is no record of the whole reserve burning at the one time.

Ecological requirements

Fire frequency, intensity and season of occurrence are major factors influencing the distribution and composition of plant and animal communities. A variety of fire regimes are needed in order to conserve floristic diversity and provide diversity of habitat for

animals. Fire management aims to maintain this diversity by restricting planned and, if possible, unplanned fires to only a part of the distribution of a vegetation type within the reserve at any one time. This approach will result in a mosaic of age classes for each of the vegetation types, although is difficult to achieve in smaller reserves such as Narrawallee Creek Nature Reserve.

Consideration will need to be given to areas of old growth forest in fire management planning and operations. Important factors will be preventing high intensity fires if possible and minimising disturbance during fire suppression operations.

Foreshore vegetation in most places is fire sensitive, including that of the endangered ecological communities Coastal Saltmarsh and Swamp Oak Floodplain Forest. *Casuarina glauca* is often killed in fires. Foreshore vegetation is important for ensuring the stability of foreshores and dunes.

Littoral rainforest is also fire sensitive and the patch at Buckleys Point could be severely damaged if subject to fire.

The endangered Swamp Sclerophyll Forest has a dense, shrubby and highly flammable understorey. Although it is well adapted to recovery from fire, fires should be kept to relatively infrequent intervals to avoid the development of dense thickets of small diameter trees and the loss of obligate seeders (Ngh environmental 2004).

The endangered Bangalay Sand Forest is adapted to a fire frequency of between 5 and 30 years and requires fire for regeneration of its tree and shrub species.

The significant Red Gum Grassy Forest community requires fire at sufficiently frequent intervals to avoid development of a shrubby understorey of black wattle (*Acacia mearnsii*) which could shade out other ground cover species.

Maintenance of vegetative cover and structure within plant communities is essential for conserving viable animal populations. The guidelines above therefore not only apply to plant species but are also appropriate for maintaining habitat for animals. Care is required to avoid unnecessarily severe impact of fire on animals. For example, burning of a large proportion of available habitat or burning during the breeding season prior to the dispersal of young may have a long term detrimental effect on isolated or rare animal populations.

Stands of *Allocasuarina littoralis* in the western part of the reserve could be damaged by inappropriate fire regimes, affecting habitat for the vulnerable glossy black-cockatoo.

Fire monitoring plots have been established in the eastern part of the reserve. It would be useful to extend this system to monitor changes in vegetation in areas more frequently burnt adjacent to Lake Conjola village.

Strategies and cooperative arrangements

A variety of fire management strategies have been developed, including slashed breaks, fuel reduction, designated fire trails, detection and cooperative arrangements. Some, or at times all, of these are applied where appropriate to best protect life, property and natural and cultural assets within and adjacent to the reserve. In particular fuel reduction programs and fire trail maintenance systems will be designed and implemented close to boundary areas in cooperation with neighbours.

Under the *Rural Fires Act 1997* the Service is a fire authority that may undertake fire suppression within reserves and under cooperative arrangements with other fire authorities. As a land management agency, the NPWS is responsible for managing

fire on the reserve including activities that contribute to the protection of life, property and community assets both within the reserve and on adjoining lands. An important part of the Service's fire management for the reserve is participation in local cooperative fire management arrangements as a member of the Shoalhaven District Bush Fire Management Committee. This committee coordinates fire management and fire control on a district wide basis.

Preparation of fire risk and fuel management plans is a requirement of the Rural Fires Act. The Shoalhaven Fire District Bush Fire Risk Management Plan has identified fire management requirements throughout the Shoalhaven. These have been incorporated into a draft Fire Management Strategy for the reserve.

As the reserve does not directly adjoin urban areas of Lake Conjola, the Fire Management Strategy relies on Council managing fuel levels on Council land to the north of the reserve. A Strategic Fire Advantage Zone has been identified in the northern part of the nature reserve to assist in the control of fire. The Fire Management Strategy also provides for additional fuel management works to be carried out such as slashed breaks adjacent to assets.

Heritage Management Zones (HMZ) have been identified over the rest of the reserve. Within the HMZs minimum and maximum fire intervals have been set for flora and fauna conservation and strategies have been determined for protection of threatened species and cultural heritage. A particular consideration in Narrawallee is protection of Aboriginal sites and the silica tramway from damage by use of heavy machinery for fire suppression. The Strategy also provides for avoiding use of heavy machinery where possible in wetlands, areas of waterlogged soil and sand dunes.

Bushfire suppression operations may require the construction of temporary trails and firelines. These are closed and rehabilitated as part of post fire operations.

Desired Outcomes

- Fire regimes are appropriate for long-term maintenance of the reserve's plant and animal communities.
- The incidence of human caused bushfires is minimised.
- The potential for spread of bushfires on, from, or into the reserve is minimised.
- Persons and property on, or immediately adjacent to, the reserve are provided protection from injury or damage by bushfires as far as possible.
- Aboriginal sites, historic places and culturally significant features are afforded protection from damage by bushfires and suppression activities.

Strategies

- *Implement guidelines in the Fire Management Strategy for the reserve when finalised.*
- *Undertake fuel management and other fire management programs as needed, in accordance with the final Fire Management Strategy.*
- *As far as possible exclude fire from foreshores, estuarine communities, swamp forest, littoral rainforest, dunes, stands of Allocasuarina littoralis and other sensitive vegetation communities.*

- *Maintain designated fire trails to an appropriate standard of access, safety and stability.*

- *Undertake ecological burning where needed to maintain the existing array of vegetation communities and produce habitat suitable for species with specific requirements. Prior to any such burning undertake an assessment of vegetation characteristics and the status of key species in the area to determine the need for fire and its likely ecological effect.*

- *Undertake on-going review of the impacts of prescribed burning and wildfires on vegetation composition and structure. Where appropriate, modify programs to minimise adverse impacts.*

- *Rehabilitate areas disturbed by fire suppression operations as soon as practical after fire.*

- *Maintain records and maps of all fires as they occur.*

- *Encourage research into the ecological effects of fire in the reserve, particularly the response to fire of rare and threatened species and communities.*

- *Set up further fire monitoring plots in order to monitor vegetation changes in frequently burnt areas of the reserve adjacent to Lake Conjola village. Periodically resurvey plots.*

- *Continue to actively participate in the Shoalhaven District Bush Fire Management Committee. Maintain close contact, coordination and cooperation with volunteer rural fire brigades with regard to fuel management and fire suppression.*

- *Carry out fuel management in cooperation with neighbours, Council and the Rural Fire Service where directed by the Fire Management Strategy.*

6. VISITOR OPPORTUNITIES AND EDUCATION

The primary purposes of nature reserves are conservation of biodiversity, natural environments and significant cultural features, and scientific research into these values. Educational and recreational uses are appropriate where they do not conflict with conservation but there is an emphasis on promoting public appreciation and understanding of the reserve's values.

The nature reserve has a history of use for walking, fishing and swimming, primarily at Conjola Beach but also along Narrawallee Inlet and the reserve's management trails. It is estimated that there are approximately 5,000 visitors per year to the reserve. The peak visitation is in summer and, while most visitors are probably locals, a significant proportion come from wider afield including Sydney, Canberra and Wollongong. Use is likely to increase as development continues near the reserve and in the district generally.

Coastal recreation opportunities are available in other areas close to the nature reserve, in Conjola National Park to the north, Meroo National Park to the south and a number of Council managed reserves. These opportunities include camping, picnicking, walking and beach-oriented facilities.

Vehicle access to the nature reserve is provided to a car park behind Conjola Beach and another on the western edge of the reserve, at the northern end of Narrawallee Creek Road (see Map). Narrawallee Creek Road is maintained by local residents and for this reason reserve visitors are directed to leave their cars in the car park provided just off Lake Conjola Entrance Road.

All other access to the reserve is by foot, bicycle or boat. Management trails and walking tracks provide opportunities for short and medium length walks through the reserve and enable visitors to experience a variety of forest and estuarine environments.

The main visitor facility is the Conjola Beach day use area, which provides access for beach users and walkers. There is a fenced board and chain walkway across the dunes with a small viewing platform and a walking track leading to Buckleys Point. Picnic tables are located adjacent to the car park but not barbecues. Wood fires are not permitted in the reserve in order to avoid environmental damage by wood gathering and to reduce potential for bushfire ignition.

Access to Conjola Beach is also provided across the reserve via a short walkway from a car park outside the northern boundary. This track may be affected by a wastewater treatment plant to be constructed adjacent to the reserve.

The features of primary interest to visitors, apart from Conjola Beach, are Pattimores Lagoon, the Inlet foreshores, rock platforms, varied vegetation communities, the silica quarry and tramline remains. Provision of information about visitor opportunities and interpretation of the reserve's significant natural values and cultural heritage would be desirable. Information provision assists the protection of natural and cultural heritage, encourages support for conservation and increases the enjoyment and satisfaction of visitors. The most appropriate locations for provision of interpretive information are at the Conjola Beach car park and possibly at the silica quarry.

A low key boardwalk and small viewing platform have been provided across a waterlogged area at the northern end of Pattimores Lagoon, to provide access for bird watching.

Cycling is an occasional activity on the management trails and has little impact because of the relatively flat topography.

Unauthorised horse riding occurs on the fire trails, walking tracks and beaches. Horse riding will continue to be prohibited because of the conservation priorities of nature reserves. Horse riding is also prohibited by Council on Conjola Beach outside the reserve.

Narrawallee Inlet is popular for boating but there is no known boating use of Pattimores Lagoon. The lagoon is small and very shallow and any boating activity could significantly disturb birds using the lagoon.

School educational visits and community or commercial guided tours focussed on promoting understanding and appreciation of natural and cultural values may be appropriate in the reserve. Group size, frequency and other aspects would need to be regulated to minimise impacts. Large groups in particular have the potential to have environmental impact. It is very important for quality interpretive information and promotion of minimal impact use to be included in group programs.

Desired Outcomes

- Visitor use is compatible with the purposes of nature reserves and is ecologically sustainable.
- There is community understanding and appreciation of the reserve's natural and cultural values.
- The reserve is a useful educational resource for local schools and community organisations.

Strategies

- *Continue to allow vehicle access within the reserve to the Conjola Beach car park. Consider allowing vehicle access from the Conjola Beach access road to near the former silica quarry, about 200m along the Silica Ridge Trail as part of an interpretive strategy to be prepared for the reserve (see below).*
- *Maintain the Conjola Beach day use area with a car park, picnic tables, beach access track, viewing platform and walking tracks to Buckleys Point and Narrawallee Inlet.*
- *Maintain the car park at the beginning of Narrawallee Creek Road.*
- *Liaise with Council to determine the future of the beach access track at the northern end of the reserve and the need for re-design following construction of the wastewater treatment plant.*
- *Encourage public understanding and appreciation of the natural and cultural values of the reserve through such means as interpretive signs, brochures or media articles.*
- *Prepare and implement an interpretation plan for the reserve. The plan will provide for provision of information at the Conjola Beach car park and will also consider interpretive signs for the former silica mining operation at the quarry and tramline.*

It may include associated works such as a car park and marked walkway at the silica quarry. The plan will consider information needs and interpretive themes such as:

- *cultural heritage (particularly the silica mining);*
- *biodiversity and significant vegetation communities; and*
- *Pattimores Lagoon and estuarine habitats.*

- *Design information and interpretive programs to promote care for the environment and assist management to protect natural and cultural heritage values.*

- *Permit school, community and commercial tour operations that promote understanding and appreciation of natural and cultural values subject to the following:*
  - *use being confined to existing tracks;*
  - *provision of accurate and adequate interpretive information; and*
  - *limits on group size and frequency of use to minimise environmental impacts and conflict with other users.*

- *Prohibit wood fires but permit visitors to use their own gas barbecues at the Conjola Beach day use area (subject to normal fire restrictions).*

- *Prohibit camping and horse riding in the reserve.*

- *Permit bicycle riding on the Conjola Beach car park access road and management trails including the Mangrove Track but not on the Buckleys Point and Pattimores Lagoon walking tracks.*

- *Prohibit boating on Pattimores Lagoon.*

- *Monitor visitor use and impacts.*

7. OTHER USES

A telephone line along Conjola Entrance Road is partly located in the reserve and a powerline along Narrawallee Creek Road may also be partly in the reserve. Maintenance and access agreements will be arranged for these utilities so that their impact on the reserve's plant communities is minimised.

Access for professional beach fishing occurs along the Buckleys Point Trail and will continue to be permitted in accordance with the Department's Professional Fishing Access Policy.

There are several road reserves running through the nature reserve. Those to the east of Narrawallee Creek Road do not have formed roads or do not lead to private property. Arrangements will be made to have these added to the nature reserve. A section of unconstructed road reserve parallel to the northern end of Narrawallee Creek Road is also not needed and its addition to the nature reserve will be sought.

An addition to the nature reserve on the western side was made under the *National Parks Estate (Southern Region Reservations) Act* 2000. The Act provided for certain park boundary adjustments for public utilities. These are being negotiated with Shoalhaven City Council for boundaries along Lake Conjola Entrance Road.

The Northern Link Trail runs largely along a road reserve through the western addition. It leads to private property but does not provide the primary access to this property. Gating of this trail would prevent illegal activities such as firewood collection from the nature reserve.

Some fencing has been erected on the western reserve boundaries to curb illegal or inappropriate activities such as firewood collecting, rubbish dumping, horse riding and vehicle access.

Desired Outcomes

- Non-reserve uses have minimal impact on natural and cultural heritage.

Strategies

- *Vehicle access will continue to be permitted for authorised professional beach fishers via the Buckleys Point Trail.*
- *Enter into maintenance and access agreements for utilities, with the aim of minimising impact on the reserve's plant communities.*
- *Seek addition to the nature reserve of the road reserves east of Narrawallee Creek Road and the unconstructed road reserve parallel to Narrawallee Creek Road.*
- *Explore options in conjunction with neighbours for controlling vehicle access along the Northern Link Trail.*

8. MONITORING AND RESEARCH

The purpose of scientific study in the reserve is to improve understanding of its natural and cultural heritage values, the processes that affect them and the management needs of specific species and features.

Under the Southern Regional Forest Agreement all forest managers including Forests NSW, Dept of Lands and the Service must demonstrate ecologically sustainable forest management (ESFM). ESFM aims to maintain or increase the full suite of forest values for present and future generations across the NSW native forest estate, including:

- ecosystem biodiversity, health, vitality, productive capacity and functional processes;
- soil and water productive capacity and functional processes;
- long term social and economic benefit; and
- natural and cultural heritage values.

ESFM will be applied to all ecosystem types and implemented primarily through monitoring to provide feedback on management programs and directions for future adaptive management. Criteria and indicators of ecologically sustainable forest management have been identified and monitoring programs are being introduced to demonstrate the impact of management actions on ecological functions. Remedial management actions will be undertaken as required.

Research and monitoring will be undertaken as part of Regional ESFM programs and also for specific purposes as identified in this plan. Service monitoring and research efforts must be directed towards the areas of greatest need and will concentrate on:

- threatened species for which the reserve provides significant habitat;
- endangered ecological communities;
- the condition of Pattimores Lagoon;
- fire management; and
- cultural heritage features.

Additional research programs will be considered where they complement ESFM criteria and indicators. The results of research and monitoring will be used to guide management programs.

Research by other organisations and students plus observations by individuals and groups such as bird watchers may also provide valuable information for management. A prospectus will be prepared to encourage involvement of other organisations in priority research areas.

The Service has begun a program of assessing and reporting on the condition and management adequacy of reserves through the State of Parks Program. This utilises a number of indicators related to the condition of natural and cultural heritage and visitor facilities, information availability and the management of threats such as fire and pests. Assessment of Narrawallee Creek Nature Reserve indicates that overall it is in good condition.

Desired Outcomes

- Research is undertaken that enhances the information base and assists management of the reserve.

- Research causes minimal environmental damage.

- Monitoring programs are in place to detect any changes in the status of reserve values and are used to guide management decisions.

Strategies

- *Apply the principles of Ecologically Sustainable Forest Management to reserve management operations. Develop ESFM monitoring programs where needed and use the results to guide management programs.*

- *Undertake research to provide information about the reserve's natural and cultural heritage and human use in order to assist management. Give priority to research needs identified within this plan of management.*

- *Permit appropriate research by other organisations and individuals and promote research that is directly useful for management purposes, particularly on the topics listed above.*

- *Require any research structures and long term markers to be placed in locations that will minimise their visual impact and require their removal upon completion of the research.*

- *Prepare a prospectus to promote and guide research by other organisations into programs useful for management purposes, in particular targeted flora and fauna surveys and site monitoring for threatened species, Aboriginal sites and silica quarrying.*

- *Encourage bird watchers and similar groups to pass on information gathered in the reserve.*

9. NPWS MANAGEMENT FACILITIES AND OPERATIONS

The only management facilities in the reserve are vehicle trails; both those open to public vehicle use (road to Conjola Beach car park) and those maintained for management purposes such as fire suppression and pest control (management trails). These are shown on the Map.

All management trails are gated and vehicle access is only permitted for management purposes and licensed professional fishers.

A number of organisations and individuals have an interest in management of the nature reserve, particularly neighbours with regard to such issues as fire management, weed and pest animal control, fencing and public access. On-going communication with a range of individuals, community groups and agency representatives will be needed.

Desired Outcomes

- Management facilities adequately serve management needs and have acceptable environmental impact.
- A good relationship is maintained with reserve neighbours.

Strategies

- *Maintain vehicle trails to a stable and trafficable condition as far as resources permit.*
- *Avoid use of the Mangrove Track in wet conditions unless essential for emergency purposes such as fire suppression.*
- *Continue to gate all management trails.*
- *Maintain close liaison with neighbours of the reserve to deal with matters of mutual concern, such as boundary issues and pest and fire management.*

10. PLAN IMPLEMENTATION

This plan of management establishes a scheme of operations for Narrawallee Creek Nature Reserve. It will remain in force until amended or replaced in accordance with section 73B of the NPW Act. The plan is part of a system of management which includes the National Parks and Wildlife Act, management policies, established conservation and recreation philosophies, and strategic planning at corporate, directorate and regional levels. The latter may include development of related plans such as species recovery plans, fire management plans and conservation management plans.

Relative priorities for activities identified in this plan are set out in the table below. These priorities are subject to the availability of necessary staff and funds, and to any special requirements of the Director-General or Minister.

The environmental impact of proposed activities will be assessed at all stages in accordance with established environmental assessment procedures. If the impacts of any activity proposed in this plan are found to be unacceptable, the activity will not be undertaken or will be modified so as to comply with the environmental assessment outcomes.

Strategies

- Undertake an annual review of progress in implementing this plan of management.
- Undertake an assessment after 5 years of the effectiveness of managing the reserve in accordance with this plan and of the degree of success in achieving the plan's objectives and desired outcomes. Base the evaluation on the monitoring programs set out in this plan and any others that may be developed.

Implementation Table

Priority	Activity	Plan reference
High	Monitor shorebird nesting and erect protective fencing as needed.	4.3
	Determine the former use of the corrugated iron shed, fence and water tank and assess their significance. Develop a management strategy if found to be significant or record and remove if not significant.	4.5
	Liaise with Council to seek rebuilding of the weir on the canal development near Pattimores Lagoon, with the aim of returning the lagoon to near natural levels of salinity compatible with restoring natural aquatic communities. Liaise as needed with the Department of Primary Industries, Department of Natural Resources and other relevant agencies. Undertake an education campaign with neighbours to raise understanding of the lagoon's values and support for the rebuilding of the weir.	5.2
	Undertake research as needed to record the current condition of Pattimores Lagoon and monitor changes following rebuilding of the weir.	5.2

	Carry out a weed survey in the reserve, focussing on the former silica quarry, areas adjacent to the recycling and waste depot, the significant Red Gum Grassy Forest community, Pattimores Lagoon and sand dunes. Determine control priorities and strategies.	5.3
	Continue control programs for bitou bush and boneseed, involving adjoining land managers where appropriate. Treat other priority weeds as required.	5.3
	Eradicate existing occurrences of sea spurge in the reserve and monitor for new infestations.	5.2
	Carry out fox and wild dog control programs, with priority to protecting threatened shorebirds.	5.3
	Undertake fuel reduction and other fire management programs as needed, in accordance with the Fire Management Strategy.	5.4
	Undertake ecological burning where needed to maintain the existing array of vegetation communities and produce habitat suitable for species with specific requirements. Prior to any such burning undertake an assessment of vegetation characteristics and the status of key species in the area to determine the need for fire and its likely ecological effect.	5.4
	Maintain fire trails to a satisfactory standard of access, safety and stability.	5.4
	Continue to actively participate in the Shoalhaven District Bush Fire Management Committee. Maintain close contact, coordination and cooperation with volunteer rural fire brigades with regard to fuel management and fire suppression.	5.4
	Maintain the Conjola Beach day use area, including the car park, picnic tables, beach access, viewing platform and walking tracks to Buckleys Point and Narrawallee Inlet.	6
Medium	Survey to determine whether *Cryptostylis hunteriana* and *Pultenaea villifera* are present within the reserve.	4.2
	Monitor the condition of the endangered ecological communities and take any steps to address threats if needed.	4.2
	Undertake fauna surveys targeting threatened species such as the green and golden bell frog, southern-brown bandicoot, swift parrot and regent honeyeater.	4.3
	Carry out periodic surveys of threatened species to monitor their status and response to management programs.	4.3
	Undertake a predictive assessment for Aboriginal sites and survey areas where sites may be at risk.	4.4
	Monitor the condition of Aboriginal sites at risk and undertake protective works if needed to prevent damage by recreational activities.	4.4
	Record and assess features remaining from silica mining activities, including the metal skip or boiler. Prepare a conservation plan and undertake conservation works if required.	4.5
	Monitor areas of dune blowout and, if needed, take action to prevent further erosion.	5.1
	Monitor foreshore areas along Narrawallee Inlet and take action if needed to ensure maintenance of vegetation cover. Discourage recreational use in areas subject to erosion.	5.1

	Seek water quality monitoring by Shoalhaven City Council at Pattimores Lagoon and other locations within the reserve that may be affected by the construction of the wastewater treatment plant and dune exfiltration system at Lake Conjola. The monitoring program should include an assessment of water quality prior to operation of the plant and consideration of inputs from local caravan parks.	5.2
	Encourage effective boundary fencing with neighbouring grazing properties by working closely with neighbours.	5.3
	Continue to support and encourage community volunteer bush regeneration programs in the reserve.	5.3
	Set up further fire monitoring plots in order to monitor vegetation changes in frequently burnt areas adjacent to Lake Conjola village. Periodically resurvey plots.	5.4
	Encourage public understanding and appreciation of the natural and cultural values of the reserve through such means as interpretive signs, brochures and media articles.	6
	Prepare and implement an interpretation plan for the reserve including provision of information at the Conjola Beach car park.	6
	Maintain the car park at the beginning of Narrawallee Creek Road.	6
	Liaise with Council to determine the future of the beach access track at the northern end of the reserve and the need for re-design following construction of the wastewater treatment plant.	6
	Explore options in conjunction with neighbours for controlling vehicle access along the Northern Link Trail.	7
	Maintain vehicle trails to a stable and trafficable condition as far as resources permit.	9
Low	Promote revegetation of the recent quarry floor by ripping, brush matting or planting with local species as required.	4.1
	Liaise with neighbours and land use authorities to encourage retention of areas of native vegetation close to the reserve.	4.3
	Work with Council to explore strategies for minimising rubbish dumping.	5.2
	Seek to introduce cooperative feral cat control programs with neighbours.	5.3
	Undertake on-going review of the impacts of prescribed burning on vegetation composition and structure. Where appropriate, modify programs to minimise adverse impacts.	5.4
	Monitor visitor use and impacts.	6
	Enter into maintenance and access agreements for utilities, with the aim of minimising impact on the reserve's plant communities.	7
	Seek addition to the nature reserve of the road reserves east of Narrawallee Creek Road and the unconstructed road reserve parallel to Narrawallee Creek Road.	7
	Undertake research to provide information about the reserve's natural and cultural heritage and human use in order to assist management.	8
	Prepare a prospectus to promote and guide research by other organisations into programs useful for management purposes, in particular targeted flora and fauna surveys and site monitoring for threatened species, Aboriginal sites and silica quarrying.	8

Legend

High priority activities are those imperative 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.

REFERENCES

Department of Environment and Conservation (2004) *Invasion of Native Plant Communities by Bitou Bush/Boneseed, Draft Threat Abatement Plan.*

Findlay, A.G. 1988 *The Environmental History and Trophic Status of Pattimores Lagoon, Lake Conjola*. University of NSW thesis.

Healthy Rivers Commission (2002) *Independent Inquiry into Coastal Lakes Final Report.*

McAndrew, A (1995) *The Narrawallee Story Retold*. Alex McAndrew, Epping.

Ngh environmental 2004 *Report for Mapping of Forest Ecosystems of Narrawallee Creek Nature Reserve*. Report prepared for NPWS.

Ngh environmental 2004 *Vegetation Response to Fire Monitoring in Narrawallee Creek Nature Reserve, Conjola and Morton National Parks*. Report prepared for NPWS.

NPWS (1992) *Narrawallee Creek Nature Reserve Interim Management Guidelines*.

NPWS (2001) *Predation by the Red Fox (Vulpes vulpes), Threat Abatement Pla*n.

Olsen, R & Latimer, B 1998 *Wild Dog and Fox Survey Report for Cudmirrah and Conjola National Parks*, report to NPWS.

Shoalhaven City Council (1993) *Narrawallee Creek Local Environment Plan*.

Shoalhaven City Council (Undated) *Fuel Management Plan*.

Shoalhaven City Council 1998 *Lake Conjola Estuary Management Plan*.