NSW GOVERNMENT
Environment, Climate Change & Water
National Parks & Wildlife Service

Jervis Bay National Park & Woollamia Nature Reserve

Plan of Management

JERVIS BAY NATIONAL PARK

AND WOOLLAMIA NATURE RESERVE

PLAN OF MANAGEMENT

NSW National Parks and Wildlife Service

Part of the Department of Environment, Climate Change and Water

February 2011

This plan of management was adopted by the Minister for Climate Change and the Environment on 15th February 2011.

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.

NPWS specialists, the Regional Advisory Committee, the Shoalhaven Historical Society, the Jerrinja Aboriginal community and members of the public provided valuable information and comments.

Those sections of the plan relating to Lake Wollumboola were written in association with a community reference group, whose members had detailed knowledge of the area's values and community use.

The natural and cultural resource information contained in the plan has been sourced from numerous documents and reports, some funded by NPWS, but many produced as a result of numerous studies undertaken in the Jervis Bay region by other individuals and organisations. These documents and reports are referenced at the end of this plan.

Cover photo of Greenfields Beach Jervis Bay National Park by Beth Boughton, NPWS.

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For additional information or enquiries about these reserve or this plan, contact the NPWS South Coast Region Office at 55 Graham Street Nowra (PO Box 707 Nowra 2541) or by phone on (02) 44232170.

FOREWORD

Jervis Bay National Park is located 20 kilometres southeast of Nowra around the northern and western shores of Jervis Bay. Woollamia Nature Reserve is located immediately west of the national park. The national park covers an area of 5,247 hectares while the nature reserve is 452 hectares in size.

Jervis Bay National Park contains forests, woodlands, heathlands and wetland communities as well as beaches and estuaries. Eight endangered ecological communities, 14 rare or threatened plant species and 34 species of threatened fauna have been recorded in the park, including breeding sites for the little tern and significant populations of the endangered eastern bristlebird. Lake Wollumboola, the largest shallow saline lagoon on the NSW south coast, supports large populations of waterbirds. The park has high Aboriginal social values and contains 15 recorded Aboriginal sites.

Woollamia Nature Reserve contains forest and wetland vegetation communities and habitats for forest dependent threatened fauna. The Endangered Ecological Community 'Swamp Sclerophyll Forest' occurs along drainage lines in the reserve.

The New South Wales *National Parks and Wildlife Act 1974* requires that a plan of management be prepared for each national park and nature reserve. A plan of management is a legal document that outlines how an area will be managed in the years ahead.

A draft plan of management for Jervis Bay National Park and Woollamia Nature Reserve was placed on public exhibition from 16th November 2007 until 10th March 2008. The submissions received were carefully considered before adopting this plan.

This plan contains a number of actions to achieve the State Plan priority to "Protect our native vegetation, biodiversity, land, rivers and coastal waterways", including implementing recovery actions for threatened species, as far as possible maintaining a natural entrance opening at Lake Wollumboola, expanding the four knot speed limit areas in Lake Wollumboola, control of weeds and pest animals, and fire management. The plan also contains actions to help achieve the State Plan priority to "Promote our parks", including maintenance of picnic and camping facilities, development of a plan for a walking track network for the southern part of the park, and improved information about the park and reserve.

This plan of management establishes the scheme of operations for Jervis Bay National Park and Woollamia Nature Reserve. In accordance with Section 73B of the *National Parks and Wildlife Act 1974*, this plan of management is hereby adopted.

Frank Sartor MP
Minister for Climate Change and the Environment

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1. MANAGEMENT CONTEXT

1.1 LEGISLATIVE AND POLICY FRAMEWORK

The management of national parks and 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). The matters to be considered in the preparation of a plan of management are listed in Section 72AA of the NPW Act. NPWS policies relate to nature conservation, cultural heritage conservation, recreation, commercial use, research and information provision.

Other legislation, 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.

The plan of management is a statutory document under the NPW Act. Once the Minister has adopted a plan, the plan must be carried out and no operations may be undertaken within Jervis Bay National Park or Woollamia Nature Reserve except in accordance with the plan. The plan will also apply to any future additions to the national park or nature 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.

Regional Forest Agreements

Woollamia Nature Reserve and parts of Jervis Bay National Park added in January 2001 are covered by the Southern Regional Forest Agreement (RFA). RFA's are one of the principle 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 were undertaken of the natural, cultural, economic and social values of forests. These assessments formed the basis for negotiation of Regional Forest Agreements that provide, amongst other things, for Ecologically Sustainable Forest Management.

1.2 MANAGEMENT PURPOSES AND PRINCIPLES

National Parks

National parks are reserved under the NPW Act to protect and conserve areas containing outstanding or representative ecosystems, natural or cultural features or landscapes or phenomena that provide opportunities for public appreciation and inspiration and sustainable visitor use.

Under the Act, national parks are managed to:

- conserve biodiversity, maintain ecosystem functions, protect geological and geomorphological features and natural phenomena and maintain natural landscapes;
- conserve places, objects, features and landscapes of cultural value;
- protect the ecological integrity of one or more ecosystems for present and future generations;

- promote public appreciation and understanding of the park's natural and cultural values;
- provide for sustainable visitor use and enjoyment that is compatible with conservation of natural and cultural values;
- provide for sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to conservation of natural and cultural values; and
- provide for appropriate research and monitoring.

Nature Reserves

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 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 nature reserve's natural and cultural values; and
- provide for appropriate research and monitoring.

1.3 ABORIGINAL OWNERSHIP OF NATIONAL PARKS

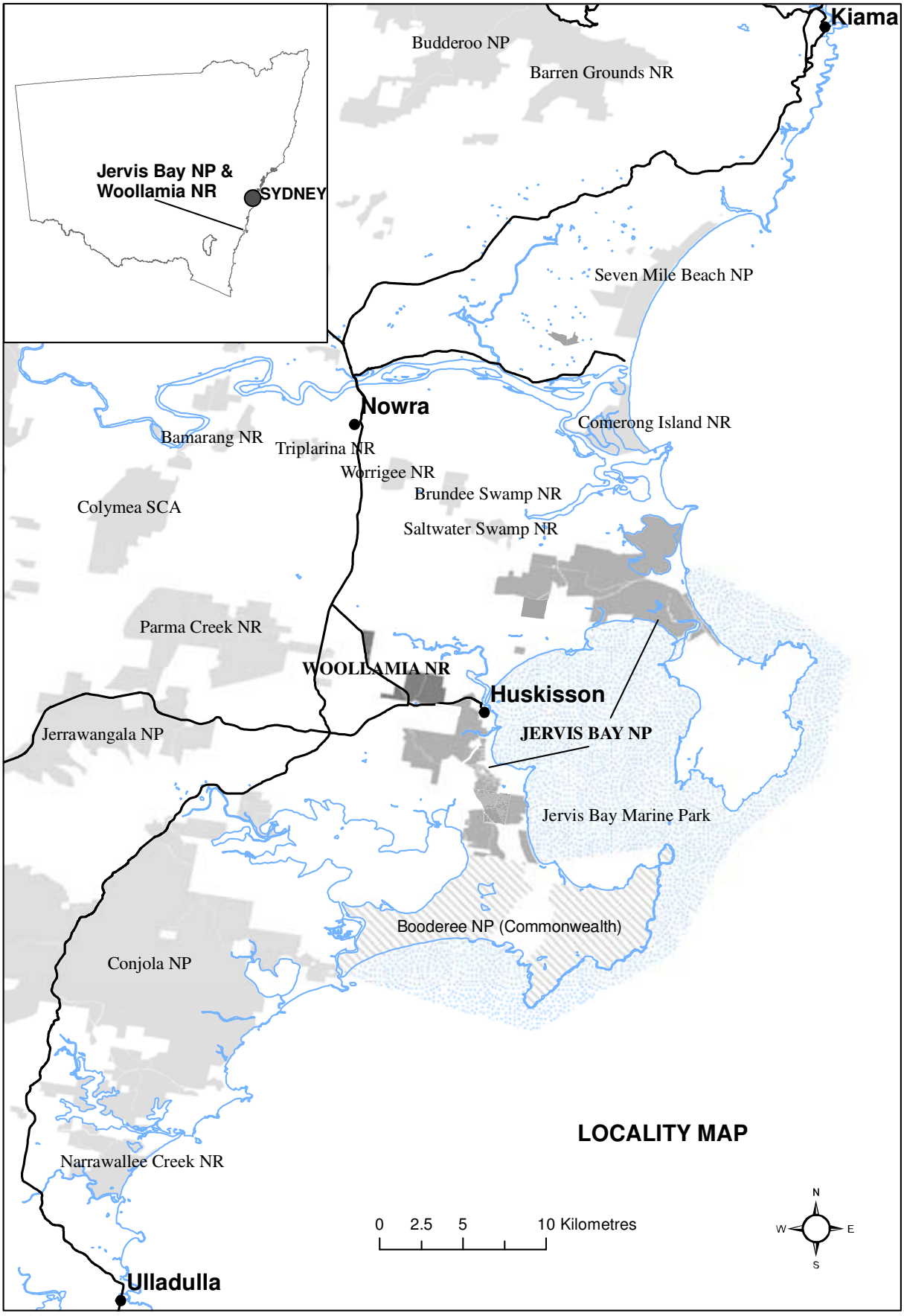
The NSW Government recognises the right of Aboriginal people to own lands that are of cultural significance to them and has legislated to allow for Aboriginal ownership of certain national parks and reserves. Aboriginal ownership is recognition that certain reserved lands are of cultural significance to Aboriginal people in terms of their traditions, observances, customs, beliefs or history. Jervis Bay National Park is one of eight parks and reserves that are subject to the Aboriginal ownership provisions of the NPW Act. These provide an opportunity to:

- return ownership of selected national parks and reserves to traditional owners;
- ensure that parks are managed by Aboriginal people in partnership with NSW NPWS; and
- return Aboriginal relics and remains.

The Aboriginal owners who have a close association with the lands around Jervis Bay and the Jerrinja Local Aboriginal Land Council will determine if and when they wish to initiate the return of ownership of the park and to jointly manage the park with the NPWS. Should agreement be reached, a lease will be signed and a Board of Management appointed. At that time ownership of the park will be transferred.

The Board of Management will determine how the park will be managed and draw up a plan of management which will replace any current plan. The Board will have 11-13 members, with a majority being traditional Aboriginal owners, and one representative each from the Jerrinja Local Aboriginal Land Council, NPWS, a local conservation group, local government and from adjoining landholders.

The NPWS, in partnership with the Board, will have joint management responsibilities for the park when it is handed back to Aboriginal people. The Government will pay rent to the traditional owners into a special account to be used for the management of the park.


Jervis Bay NP &
Woollamia NR
SYDNEY
Kiama
Budderoo NP
Barren Grounds NR
Seven Mile Beach NP
Nowra
Comerong Island NR
Bamarang NR
Triplarina NR
Worrigee NR
Brundee Swamp NR
Colymea SCA
Saltwater Swamp NR
Parma Creek NR
WOOLLAMIA NR
Huskisson
JERVIS BAY NP
Jerrawangala NP
Jervis Bay Marine Park
Booderee NP (Commonwealth)
Conjola NP
LOCALITY MAP
Narrawallee Creek NR
0 2.5 5 10 Kilometres
N
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S
Ulladulla

2. THE PLANNING AREA

2.1 LOCATION, GAZETTAL AND REGIONAL SETTING

The park and reserve are located in the City of Shoalhaven on the south coast of New South Wales, roughly 20 kilometres southeast of Nowra (see below). They lie around the northern and western shores of Jervis Bay and the park includes the bed of Lake Wollumboola.

The park has been progressively reserved since 1995 and has a current area of 5,247 hectares. It consists of several blocks of land in two main groups. Where the park abuts the coast it is declared to mean high water mark. The bed of Lake Wollumboola is declared to 0.86 metres Australian Height Datum (AHD) where it adjoins other land tenures, except along Moona Moona Creek where the park includes the creek bed and intertidal areas.

The plan of management includes four areas of Crown land, at Huskisson, Currarong (2 parcels) and Myola, proposed for addition to the park in the Jervis Bay Regional Environmental Plan. Two of these areas are currently subject to Aboriginal land claims. If added to the park, these lands will be managed to provide for conservation and visitor use as set out in this plan of management.

The nature reserve was created in 2001 as a result of the Southern Forest Agreement and has an area of 452 hectares. It consists of two blocks of land west of the park.

Booderee National Park, located in the Commonwealth Jervis Bay Territory and owned by the Wreck Bay Aboriginal Community, lies to the south of the park while Department of Defence land on Beecroft Peninsula lies to the east. The villages of Culburra Beach, Callala Beach, Huskisson, Vincentia, Hyams Beach, Erowal Bay and Wrights Beach abut the park. Other surrounding land uses include rural residential, forestry, grazing and small areas of other agricultural enterprises.

Jervis Bay Marine Park adjoins the national park and covers the waters of the Bay and adjacent ocean areas (see Summary Map, centre pages) except for the Commonwealth waters of Booderee National Park. The marine park has as its primary objective the protection, conservation and management of Jervis Bay and its adjacent waters, in order to maintain their marine biodiversity, productivity and integrity, while at the same time allowing for sustainable commercial and recreational use. The plan of management includes a number of policies and actions which reflect an integrated approach to management of the marine and terrestrial components of Jervis Bay.

History of Park Establishment

The waters and beaches of Jervis Bay have long been a popular tourist destination and an important recreation area for the people of the Shoalhaven. From the 1960s there was increasing community pressure for protection of the significant natural and cultural values of the Jervis Bay area, including proposals from a number of conservation groups. In 1992, following public consultation, the NSW Government and Shoalhaven City Council released the discussion paper “Our Heritage, Our Future”. The paper highlighted the strong public demand to achieve a balance between development and protection of Jervis Bay and its catchment, and delineated a land area of intrinsic value which formed the basis for the future Jervis Bay National Park.

In March 1995 the NSW Government gazetted the first stage of the national park (1,155 hectares) over some vacant crown lands and the former Gurumbi Nature Reserve. Previously it had commenced negotiations with the principal landholder in the area to purchase a large area of freehold land to be included in the park. In January 1997 a Regional Environmental Plan for Jervis Bay formally zoned these and other freehold lands and certain crown lands as proposed national park 8(b).

Subsequent additions to the park estate were:

- 2,625 hectares of private land added in September 1999 and a further 131 hectares gazetted in 2006;
- 463 hectares of crown land added to the park (and 452 hectares of crown land gazetted as Woollamia Nature Reserve) in January 2001 under the Southern Forest Agreement;
- 643 hectares comprising the bed of Lake Wollumboola and part of its dunal sand barrier, gazetted in November 2002 in response to the Healthy Rivers Commission of Inquiry into Coastal Lakes; and
- 230 hectares known as the "Pacific City Estate" purchased from Shoalhaven City Council in 2006.

The remaining lands proposed for addition to the park and zoned "8(b) - proposed national park" under the *Jervis Bay Regional Environmental Plan 1996*, are mainly areas that were formerly subject to Aboriginal Land Claims. Five of the land claims were resolved in favour of the Jerrinja Local Aboriginal Land Council in February 2008 with the exception of part of one claim near Huskisson which is still Crown land. Three land claims by the State Land Council were rejected but new claims have since been made over two of these areas.

The Regional Environmental Plan stipulates that the 8(b) lands should be managed in such a way as to protect natural heritage and to provide opportunities for future Aboriginal ownership. As stated in section 1.3, Jervis Bay National Park has been identified for handback to the traditional owners and, should they elect for this to occur, will be jointly managed as a national park under the direction of a Board of Management.

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.

Jervis Bay National Park and Woollamia Nature Reserve have a fairly flat topography but together include diverse landscape features such as forests, heathlands, rock platforms, dunes, wetlands, streams and estuaries and a unique shallow coastal lake. These natural features are juxtaposed with a number of towns and villages around the shores of Jervis Bay and Lake Wollumboola.

The geology, landform, climate and plant and animal communities of the area, plus its location, have determined how humans have used it. Jervis Bay has been a focus of human activity for at least 5,000 years and has an Aboriginal cultural heritage that is remarkable for its diversity, richness and significance to Aboriginal people. For the past 200 years, the area has been used for a variety of primary industries, particularly fishing, logging and grazing, and for recreational activities.

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.

3. KEY VALUES AND MANAGEMENT DIRECTIONS

3.1 VALUES OF THE AREA

Jervis Bay National Park and Woollamia Nature Reserve protect a number of parcels of land around the northern and western sides of Jervis Bay, plus the bed and parts of the shore of Lake Wollumboola and its south-western catchment. For their total size the park and reserve protect a wide range of habitats and geomorphological features of national and international significance, and the park has high Aboriginal social value. These values are detailed below.

Natural Values

The area covered by the park and reserve has a relatively flat topography but the landscape is nevertheless diverse, including features such as dunes, beaches, rock platforms, wetlands, estuaries and the unique Lake Wollumboola. Estuarine wetlands are a prominent feature near the mouths of all the small streams entering Jervis Bay and are particularly extensive around Carama Creek. The park's interface with the waters of St Georges Basin and Jervis Bay add to its landscape diversity.

Lake Wollumboola is the largest shallow saline lagoon on the New South Wales south coast. The Healthy River Commission's Independent Inquiry into Coastal Lakes (2002) determined that Lake Wollumboola is one of only a few NSW coastal lakes warranting the highest level of protection. The lake is unusual in regard to the high natural variability of its processes and ecosystems.

A major feature of the landscape of the park and reserve is the diversity of native plant communities. Of the thirty distinct vegetation types defined by Mills (1993) for the Jervis Bay region, twenty-four can be found in the park and reserve, ranging from a small area of rainforest to coastal heathland. There are thirteen distinct woodland/forest communities in the park and reserve and the wetland communities include freshwater, brackish and saline wetlands.

At least fourteen rare or threatened plant species have been recorded in the park, eight of which are listed on the schedules of the Threatened Species Conservation Act. In addition the park and reserve contain eight endangered ecological communities listed under the Act (see section 4.2 and Appendices).

Over two hundred species of birds, forty-two native mammal species, seventeen species of frog, fifteen species of lizard, thirteen species of snake and one tortoise species have been recorded in the Jervis Bay region, and the park and reserve contain habitat suitable for most of these species. Of particular interest is the large number of species of insectivorous bats (at least fifteen species) which have been recorded (Wise and Spencer 1997 and Gaia Research Pty Ltd 1999a).

The estuaries of Currambene Creek, Moona Moona Creek and Carama Creek and particularly Lake Wollumboola are important roosting and feeding areas for wading birds. The diverse habitats of Lake Wollumboola provide a significant over-wintering ground for migratory waders and a drought refuge for waterbirds. Thirty-three bird species protected under the Japan-Australia and China-Australia Migratory Birds Agreements (JAMBA and CAMBA) use the lake and its habitat variations. It regularly supports large numbers of waterfowl and the highest number of black swan (*Cygnus atratus*) of any coastal wetland in NSW. There have been regular recordings of between 6,000 and 18,000 individuals of waterfowl on the lake at any one time, and, together with shorebirds, it is estimated through surveys that over 20,000 waterbirds have used the lake on occasions over the past twelve years.

The park and reserve contain a number of animal species listed on the TSC Act: - twenty-one bird species, eleven mammal species (six of which are bats) and two frog species. Of these, the endangered eastern bristlebird (*Dasyornis brachypterus*) and vulnerable ground parrot (*Pezoporus wallicus*) have significant populations in Jervis Bay National Park and in the adjacent Booderee National Park. The vulnerable eastern chestnut mouse (*Pseudomys gracilicaudatus*) reaches its southern geographical limit of distribution in the Jervis Bay area. The forested areas north of Hare Bay and in the catchment of Coonemia Creek/Lake Wollumboola support significant populations of the powerful owl (*Ninox strenua*), glossy black-cockatoo (*Calyptorhynchus lathami*) and yellow-bellied glider (*Petaurus australis*). The sand bar between Lake Wollumboola and the ocean provides important breeding sites for the endangered little tern (*Sterna albifrons*), and the endangered green and golden bell frog (*Litoria aurea*) has been recorded in several places around the lake's northern edge. Ten threatened species of waders and other water birds have been recorded on Lake Wollumboola and estuaries around the bay.

Cultural Values

Jervis Bay as a whole has been a focus of human activity for at least 7,000 years and has an Aboriginal cultural heritage that is remarkable for its diversity, richness, significance to Aboriginal people and level of research potential. The whole bay and immediate hinterland, particularly around Hare Bay, Lake Wollumboola and Currambene Creek have high Aboriginal social value because of occupation in traditional and recent times, and continuing use for food gathering, ceremonial activities and the passing on of storylines through. The majority of the more than 300 known Aboriginal sites occur outside the national park, on Beecroft and Bherwerre Peninsulas, but there are fifteen known sites in the park including middens, artefact scatters, earth mounds, axe grinding grooves and a burial.

There are few identified European heritage items in the park and reserve.

Scenic Values

The natural scenery, clean white beaches and clear, clean waters give Jervis Bay an outstanding aesthetic appeal and it is inspirational for artists and photographers. Lake Wollumboola is also considered a highly appealing landscape by both local residents and visitors. Particular scenic attributes of the park and reserve include:

- hinterland forests with a great variety of canopy trees in the catchments of Coonemia and Carama Creeks and west of Huskisson;
- the open heathlands with many flowering plants south of Vincentia;
- expansive and impressive wetland environments along Carama Creek and to a lesser extent Wowly Gully and Moona Moona Creek;
- the waters, shores and often prolific birdlife of Lake Wollumboola and the Coonemia Creek wetlands;
- the white sandy beaches in the Greenfield - Hyams Beach section which have an attractive forested backdrop;
- the rock platforms; and
- the forested shores of St Georges Basin.

Recreation, Tourism and Educational Values

The park and reserve are located close to the major population centres of Sydney, Wollongong and Canberra, and the regional centres of Nowra and Huskisson-Vincentia. It is estimated that nearly three million people visit the Jervis Bay area each year and many visitors explore the national park and/or use the park facilities. Recreation opportunities include picnicking, bushwalking, beach activities, fishing, canoeing, nature study, and boating and swimming at Lake Wollumboola. The recreation opportunities in Jervis Bay National Park complement activities in the

Jervis Bay Marine Park and facilities in the adjacent Booderee National Park and on Beecroft Peninsula.

The internationally significant environments of Jervis Bay and Lake Wollumboola have the potential to attract increasing numbers of domestic and inbound eco-tourists. The proximity of the park and reserve to a significant regional population also allows for very accessible education activities about the well-researched natural and Aboriginal heritage of Jervis Bay and Lake Wollumboola.

3.2 MANAGEMENT DIRECTIONS

Jervis Bay National Park will be managed to protect the park's natural and cultural heritage while continuing to provide visitor opportunities and recognising the potential future ownership of the park by the traditional Aboriginal owners. Woollamia Nature Reserve will be managed to protect the reserve's natural and cultural heritage and will provide opportunities for education and scientific study.

Greenfield Beach will be managed as the prime visitor focus for the park, for picnicking, beach activities and walking. Basic day use facilities will be maintained at Hammerhead Point and Red Point in the northern sections of the park and low key walk-in camping will be permitted east of Red Point. Existing formal walking opportunities will be maintained and additional opportunities will be investigated on lands recently added to the park.

Management of Lake Wollumboola will acknowledge the importance of the lake for its existing social values such as swimming, boating and fishing, while also protecting its high conservation values. The Lake will continue to be available for these activities but speed limits will apply in some parts in order to reduce impacts on waterbirds.

Aboriginal sites, biodiversity, threatened plant species and the habitat of threatened animal species will be protected largely by control of visitor use, control of introduced species and appropriate fire management. Specific programs will be undertaken where needed to protect threatened species, such as fencing to assist little tern breeding success. Restoration of degraded areas in the park and reserve has commenced and will continue, with priority given to rehabilitation of badly eroded trails and sites of rubbish dumping.

Ongoing development and the extensive interface between the park and reserve and urban and rural residences are likely to result in increasing impacts from habitat fragmentation, stormwater pollution and introduced species. Ongoing management and education will be needed to reduce these impacts and address encroachments, refuse dumping, responsible control of domestic animals by village residents and the impacts of recreational use. There will be a need for active and strategic fire management and education of the local community in order to provide enhanced protection of life and property from bush fire.

In 1998 NPWS received Commonwealth Government funding to develop a model for managing Jervis Bay through a cooperative approach amongst relevant agencies and the community. The cooperative approach identified issues of mutual interest and concern and developed processes for discussion and resolution. Management of the park and reserve will be integrated with management of the Jervis Bay Marine Park and Commonwealth Booderee National Park, and undertaken in co-operation with agencies responsible for management of adjacent lands and villages. Management will aim to involve the local community in promoting and maintaining natural habitat beyond the boundaries of the park and reserve. This will assist wildlife

to move between the different parts of the park and reserve and from there to other areas of natural habitat on publicly owned lands to the west of Jervis Bay.

This plan of management takes account of the importance of integrated management by, as much as possible, proposing management actions based on the conservation and recreation needs of the Jervis Bay/Lake Wollumboola area as a whole. An example of this approach has been the investigation of the feasibility of a 'round the bay' walking track system.

Lake Wollumboola and the park's other wetlands and their catchments will be managed as far as possible as whole systems through cooperation and partnership arrangements with the relevant public authorities and communities. The Estuary Management Plan prepared for the former Shoalhaven City Council Estuary Management Task Force will continue to inform management of Lake Wollumboola, as will the Healthy Rivers Commission Coastal Lakes Enquiry 2002 and the Coastal Lakes Strategy Sustainability Assessment and Management Plan once finalised. Other documents such as the South Coast Regional Strategy and South Coast Sensitive Urban Lands Review will also inform management.

As stated in section 2.1, there are four parcels of Crown land that are zoned for addition to the park under the Jervis Bay Regional Environment Plan and included in this plan of management on that basis. These lands are Abrahams Bosom Reserve east of the village of Currarong, land along Currarong Beach west of Currarong, an area adjacent to the Lady Denman Museum and land at Myola along Callala Beach and the Currambene Creek sandspit. Should these areas be added to the park they will be managed in accordance with the provisions of this plan. The existing visitor access at Myola will be formalised and access needs at Currarong Beach will be considered in relation to environmental and safety issues. The picnic area at Abrahams Bosom Reserve will be re-designed to reduce its impact on littoral rainforest and creek bank vegetation. A walking track and boardwalk on the land adjacent to the Lady Denman Museum will be retained.

4. CONSERVATION OF NATURAL AND CULTURAL HERITAGE

4.1 GEOLOGY, LANDFORM AND CLIMATE

Jervis Bay and its catchment lie within the southern part of the Sydney Basin, a late Palaeozoic to early Mesozoic sedimentary basin occupying a semicircle of about 150 kilometre radius centred on Sydney. At Jervis Bay the Permian sediments of the Sydney Basin are intruded by igneous rocks and overlain by Tertiary and Quaternary sediments (*Kowari* 1995). The bay itself is a syncline (a downward-curving fold), as evidenced by the upward slanting of the rock strata along the eastern shore at Beecroft Peninsula and the western shore south of Vincentia.

Jervis Bay National Park consists of two fairly distinct landscape units, south and north of Vincentia. South of Vincentia, Permian sediments represented by the Snapper Point Formation give rise to the highest and most strongly dissected topography of the park. A high ridge, which reaches 100 metres elevation, is flanked by heavily vegetated gullies to the east, such as Greenfield Gully and Duck Gully, and to the west by Stony Creek which flows into St Georges Basin. The Snapper Point Formation is the oldest rock unit outcropping at Jervis Bay and comprises fine-grained to coarse-grained, often pebbly sandstones with minor interbeds of shale and siltstone. In places it also contains large boulders of metamorphic and granitic rocks. The Snapper Point Formation contains abundant fossils locally including bivalves, gastropods, bryozoans and crinoids.

The park sections around and north of Huskisson, plus the nature reserve, have a low lying, flat to gently undulating and mildly dissected topography. The lithology here is Wandrawandian Siltstone overlain in places by Quaternary deposits. The Wandrawandian Siltstone consists of grey siltstones and fine-grained silty sandstones. Large erratics of exotic rocks are scattered throughout the Formation and these are attributed to decomposition from icebergs. The Wandrawandian Siltstone has many fossils including an abundance of bivalves, crinoids and gastropods.

The Quaternary deposits in the park and reserve include alluvial sands and muds along Coonemia Creek, Carama Creek, Wowly Gully and Moona Moona Creek; estuarine dark coloured reduced sands and muds at the estuaries of these creeks; aeolian white sands on the coastal dunes north of Hare Bay, Warrain Beach and Hyams Beach (which here are backed by aeolian sand sheets and dunes); and the marginal marine sands of the beaches.

Jervis Bay formed when the sea level began to rise about 15,000 years ago and flooded an old river system. The beaches are formed from sand that has been reworked by waves over many thousands of years. Unstable and soft minerals have broken down leaving pure silicon, which is clear or white. This accounts for the famous whiteness of the sands.

Several streams flow through the park into Jervis Bay, St Georges Basin and Lake Wollumboola. None of the streams flowing into Jervis Bay are large enough to carry significant quantities of silt or sand and for this reason the waters of the Bay are very clear.

Lake Wollumboola has been shaped both by remnants of the ancient coastline from 125,000 years ago, and flooding of a former river valley which was closed by sand barriers formed by rising sea levels following the end of the last glacial period. The ancient coastline remnants comprise outcroppings of bedrock and coastal cliffs that border the previously eroded valleys, and between these outcrops are slowly infilling

embayments. These embayments, the sand dunes along the eastern shore and the creek valleys are made up of Quaternary deposits. The lake itself includes marine sands and estuarine muds. The sands on the western shores are ancient fossil sands eroded from Permian sediments. These sediments derive from the other geomorphic units of the catchment, namely the Wandrawandian Siltstone throughout the catchment and Nowra Sandstone in the upper reaches of the catchment (Umwelt (Australia) Pty Ltd 1999).

Lake Wollumboola is a saline coastal lake that is intermittently closed and open to the ocean (ICOLL) in response to variations in catchment flow and evaporation. Littoral drift processes result in closure of the lake entrance and maintenance of the sand berm. Within the national park the lake has a surface area of up to 7 square kilometres and is shallow, between 0.5 and 4 metres deep. The lake experiences large variations in water level, nutrient concentrations and salinity. Sixty percent of the lakebed is above sea level and most of the water drains out when the entrance opens. The lake collects runoff from three main tributaries: Coonemia Creek, Downs Creek and Wattle Corner Creek. The berm adjacent to the lake is largely unvegetated, mobile and made up of unconsolidated sand. Studies of berm heights at coastal lagoon entrances in NSW predicted a maximum berm height for the Lake Wollumboola entrance of 2.9 metres AHD (Hanslow *et al* 2000).

Lake Wollumboola is considered to be well advanced in its evolution, due to its shallow nature, making it an example of an estuary in the latter stages of sediment infill. It conforms to the general model of evolution for a saline coastal lake, and may fill with sediment and form a freshwater wetland within 800 to 3200 years (Baumber 2001). In this time the lake may become increasingly channelised, more frequently open to the ocean and covered by organic muds and peat with freshwater reed communities. The potential impact of climate change on the lake's evolution is unclear.

The scenic values of the park and reserve are outlined in section 3.1. These scenic values are a vital part of the attraction of Jervis Bay for both locals and tourists and will be protected.

Climate

Due to their coastal location, the park and reserve have a climate characterised by warm summers and mild winters and could be classified as temperate maritime. This climate makes the area suitable for all year round visitor use.

Recorded temperatures range from an average maximum of 24 degrees C in January to 15 degrees C in July. Recorded average annual rainfall is around 1250mm and rainfall tends to be highest from late summer to early winter when winds from the east and south bring humid air to the east coast of Australia. Drier and often strong westerly airflows predominate from July to September. However major rainfall events and prolonged dry periods can occur at any time of the year.

Climate change has been listed as a key threatening process under the Threatened Species Conservation Act 1995 and needs to be taken into account when assessing future management requirements for the park and reserve. Climate change projections for NSW include higher temperatures and greater temperature extremes, higher sea levels and water temperature, elevated CO_2, more intense but possibly reduced annual average rainfall and higher evaporative demand. These changes are likely to lead to greater intensity and frequency of fires, more severe droughts, reduced river runoff and water availability, regional flooding, increased erosion and ocean acidification.

Associated ecosystem effects may include changes in productivity and nutrient

cycling, increasing threat to freshwater ecosystems and progressive decoupling of species interactions (for example plants and pollinators). The rate and extent of predicted climate change is likely to exceed the ecological tolerances of many species. Shifts in distribution and local extinction are likely but the ability of species to shift their range may be compromised by loss, fragmentation and isolation of natural habitats. Another complicating factor is likely to be increased invasion by opportunistic, weedy or highly mobile species, especially into sites where local populations of existing species are declining.

Since much of the park is low-lying and it includes beaches, estuaries and wetlands, the park's environments, natural processes and ecology, scenic and recreational values could be significantly affected by raised sea levels and other aspects of climate change. While many of these effects can't be directly addressed, programs to reduce the pressures arising from threats such as habitat fragmentation, invasive species, bushfires and pollution will help reduce the severity of the effects of climate change and are detailed in this plan.

Desired Outcomes

- Geological and geomorphological features and natural processes are protected.
- Scenic values and in particular the features listed above are protected.

Strategies

- *Protect significant physical features such as estuaries, wetlands and rock platforms from damage by human activities.*
- *Locate all facilities to minimise visual intrusion on scenic features and from vantage points.*
- *Monitor and maintain natural processes and features associated with morphology, sedimentation pattern and rate in Lake Wollumboola. Encourage research in this area.*

4.2 NATIVE VEGETATION

The vegetation of the Jervis Bay region has been fairly well studied and Mills (1993) identified 30 distinct vegetation communities in the region. Of these, 24 occur within Jervis Bay National Park and Woollamia Nature Reserve. The most common structural formations are forest and woodland and they are represented by 13 distinct communities. The park also has extensive wetland communities and floristically rich heathlands.

Forest and woodland communities

A common community in the catchments of Coonemia and Carama Creeks, the area west of Huskisson, Woollamia Nature Reserve and behind Greenfield Beach, is an open forest dominated by blackbutt (*Eucalyptus pilularis*). This forest grows on sandy to clayey soils of the Wandrawandian Siltstone and includes red bloodwood (*Corymbia gummifera*), white stringybark (*E. globoidea*), grey gum (*E. punctata*), grey ironbark (*E. paniculata*), turpentine (*Syncarpia glomulifera*) and rough-barked apple (*Angophora floribunda*) as subdominant trees. A smaller tree layer includes black sheoak (*Allocasuarina littoralis*) and, in gullies, rainforest trees. The understorey can be dense and includes a variety of shrubs.

A tall forest of blackbutt also grows in protected locations on the deep sand dunes in

the sections of the park south of Hyams Beach and just north of Moona Moona Creek. At the latter location it gives way to an open forest of bangalay (*E. botryoides*) closer to the shoreline. Associated with the blackbutt are red bloodwood, turpentine and old man banksia (*Banksia serrata*). Dense thickets of tree broom-heath (*Monotoca elliptica*) and Sydney golden wattle (*Acacia longifolia*) occur in places and rainforest elements are sometimes found close to drainage lines.

On more clayey soils close to Coonemia Creek, near Huskisson and also in the northern section of the nature reserve, there occurs an impressive open to tall open forest of spotted gum (*Corymbia maculata*) occasionally in association with grey ironbark, blackbutt and turpentine. Grasses, bracken and the spiny-headed mat rush (*Lomandra longifolia*) commonly form the ground cover. A community growing on the most sandy soils of the Wandrawandian Siltstone and common north of Red Point and in Woollamia Nature Reserve is an open forest/woodland of scribbly gum (*E. sclerophylla*) and red bloodwood with in some places a dense subcanopy of black sheoak. A scribbly gum - red bloodwood woodland - open woodland is common on the Snapper Point Sandstone soils particularly south from Vincentia. Occasionally silvertop ash (*E. sieberi*) is an associated canopy species while old man banksia commonly occurs as a medium sized tree. This community usually contains a dense and diverse understorey of sclerophyllous shrubs and sedges.

Narrow bands of a bangalay (*E. botryoides*) open forest/woodland occur on sand inland of the foredunes behind Warrain Beach and Hare Bay. The understorey is often a dense stand of shrubs and small trees, and in places consists of rainforest species such as lilly pilly *(Acmena smithii*), cheesetree (*Glochidion ferdinandi*), blue olive-berry (*Elaeocarpus reticulates*), mock olive (*Notelaea longifolia*) and water vine (*Cissus hypoglauca*). The understorey of one area behind Hare Bay has been reduced largely to bracken fern probably because of frequent fires.

Open forest/woodland communities occur on both poorly drained sands and clayey alluvial soils and are dominated by swamp mahogany *E. robusta* or woollybutt (*E. longifolia*) and several tree paperbark *Melaleuca* species. One such habitat in Woollamia Nature Reserve has many red mahogany (*E. resinifera*), a tree which reaches its southern limit in the Jervis Bay area. These communities have an understorey of wetland plants including swamp paperbark (*Melaleuca ericifolia*) and sedges.

The only area of pure rainforest in the park, a warm temperate rainforest of coachwood (*Ceratopetalum apetalum*), ironwood (*Backhousia myrtifolia*), callicoma *(Callicoma serratifolia*) *and* water gum (*Tristaniopsis laurina*), occurs in a moist sandstone gully (Duck Gully) near Hyams Beach.

Shrubland, heathland and grassland communities

Coast banksia *(Banksia integrifolia*) and coast tea tree (*Leptospermum laevigatum*) tall shrubland covers the extensive foredunes behind Hare Bay and Warrain Beach and forms a distinct boundary with a coastal wattle (*Acacia sophorae*) shrubland which dominates the lower foredunes. Parts of the Lake Wollumboola sand berm are covered in sparse spinifex (*Spinifex sericeus*) grassland. The extent and coverage of the sand berm vegetation changes in response to natural sand movement and lake levels.

A heathland-shrubland community is common in the sections of park on the sandstone plateau south of Vincentia. This community is rich in species and is dominated by heath-leaved banksia *(Banksia ericifolia*), sheoak (*Allocasuarina distyla*), tea-trees *Leptospermum* species and the Port Jackson mallee (*E. obstans*). Several nationally rare species of plants occur here (see appendices)
A quite floristically distinct heathland on clayey soils of the Wandawandrian Siltstone

occurs on a small area north of Carama Creek and near Wowly Gully in the Hare Bay/Warrain Beach section of the park. This heathland varies from relatively tall and dense heath vegetation dominated by *Callistemon linearis,* to a low open type with *Allocasuarina paludosa*.

Wetland and aquatic communities

Along Carama and Moona Moona Creeks, Wowly Gully and the margins of Lake Wollumboola is an estuarine complex that can be represented by three distinct communities including saltmarsh herbland-shrubland, mangrove (*Avicennia marina-Aegiceras corniculatum*) shrubland-woodland and swamp oak (*Casuarina glauca*) woodland. The mangrove community (absent from Lake Wollumboola) often occurs in a mosaic with saltmarsh which is characterised by the species beaded glasswort *(Sarcocornia quinqueflora*), salt couch (*Sporobolus virginicus*), austral seablite (*Suaeda australis*) and narrow-leaf wilsonia (*Wilsonia backhousei*). *W. rotundifolia* and Tasmanian dodder (*Cuscuta tasmanica*) are two uncommon plants found in the small areas of saltmarsh on the margins of Lake Wollumboola. The estuarine complex is most extensive in Carama Creek where up to eight separate saltmarsh communities have been recognised (CSIRO 1994).

Two types of freshwater swamps supporting heathland-sedgeland communities can be found in the park. A swamp paperbark community occurs on sandy alluvial soils and coastal sand flats upstream of saltwater influences (eg margins of Lake Wollumboola), while in depressions and broad drainage basins on sandstone soils south of Hyams Beach is a sedgeland-heathland characterised by cutting grass *(Gahnia* spp), button grass (*Gymnoschoenus sphaerocephalus*), flat cord-rush (*Restio complanatus*), roundheaded bristle-rush (*Chorizandra sphaerocephalus*), golden spray (*Viminaria juncea*), slender wattle (*Acacia elongate*), dog rose (*Bauera rubioides*) and swamp baeckea (*Baeckea linifolia*).

The submerged fresh to brackish water seagrass *Ruppia megacarpa* dominates the shallow areas around the majority of the shoreline of Lake Wollumboola, with extensive beds occurring in the north-eastern sector. Its distribution is reliant on the water depth and salinity, generally in water less than one metre deep. When water levels are high it grows in the shallower portions of the lake; the edges, and the north east and southern sectors. When the lake opens and water levels are low, the shallow beds are exposed and die. However with greater access to light, the seagrass then grows in the “deeper” sections of the lake. The macroalga *Lamprothanmium papulosa* is found throughout the lake, whilst other green algal species including *Cladophora, Chaetomorpha* and *Enteromorpha intestinalis* have been recorded in the shallow areas of the lake (Kinhill 2000). The seagrass and algae are the basis of the food chain in the lake and its abundant waterbird populations.

Significant species and communities

Mills (1993) recorded ninety-six plant species of botanical significance in the Jervis Bay region, and many of these are known or expected to occur within the park.

Communities and areas of particular significance include:

- The rainforest site at Duck Gully.
- The extensive estuarine wetlands of Carama and Moona Moona Creeks, Lake Wollumboola and Wowly Gully, which contain three threatened plant species: *Wilsonia backhousei, W. rotundifolia* and the grass *Distichlis distichophylla.* Two endangered ecological communities (EECs) listed under the Threatened Species Conservation Act are represented in these wetlands: Coastal Saltmarsh and Swamp Oak Floodplain Forest.

- Freshwater swamps along the lower reaches and mouth of Coonemia Creek and in near coastal depressions and broad drainage basins, representing the EECs Sydney Freshwater Wetlands and Freshwater Wetlands on Coastal Floodplains.
- The middle reaches of Moona Moona Creek adjacent to Naval College Road, where there occurs the only known population of the threatened plant *Melaleuca biconvexa* in the park and reserve.
- *E. robusta and E. longifolia* swamp forest/woodland with several tree paperbark *Melaleuca* species, an example of the EEC Swamp Sclerophyll Forest on Coastal Floodplains.
- The low open heathland on clayey soils which is an unusual community in which the threatened leek orchid *Prasophyllum affine* and austral toadflax (*Thesium australe*) occur. The leek orchid, which is listed as endangered on Schedule 1 of the TSC Act, is known only from the Jervis Bay area. It was first discovered in the park (in two areas of the Hare Bay/Warrain Beach section) in November 2001.
- The open woodland and heathland-shrubland communities on the sandstone soils. These provide habitat for a number of nationally rare or threatened plant species including *Acacia subtilinervis, Grevillea macleayana, Leptospermum epacridoideum, Platysace stephensonii, Pultenaea villifera* and *Rulingia hermaniifolia* and the endangered orchid *Calochilus pulchellus* for which Jervis Bay is one of only three known locations for this very rare species.
- The coastal shrubland/woodlands behind Hare Bay and Warrain Beach, which contain rainforest plants, the endangered herb *Chamaesyce psammogeton* and may support the threatened magenta cherry (*Syzygium paniculatum).* The Bangalay Sand Forest EEC and elements of the Littoral Rainforest EEC are represented here.

Under the TSC Act, strategies for promoting the recovery of threatened species, populations and ecological communities are set out in the Threatened Species Priorities Action Statement (PAS) and in recovery plans. The purpose of the PAS is to identify those actions required to promote the recovery of a threatened species, population or ecological community to a position of viability in nature. Specific management actions, survey and research that are identified in the PAS and any recovery plan may be carried out within the park and reserve for protection of individual populations of threatened species and to monitor the effectiveness of management programs.

Vegetation disturbance

There is evidence of past disturbance to most of the vegetation communities in Jervis Bay National Park and Woollamia Nature Reserve. Selective logging and frequent burning have occurred in some areas. Quarries have caused destruction of native vegetation on the ridge south west of Vincentia and near the boundary of the park on Beecroft Peninsula. Uncontrolled recreational vehicle use including access to fishing areas has led to creation of many tracks while firewood collection and rubbish dumping have occurred in the forest communities. Dune systems behind Hare Bay and Warrain Beach have been damaged by off-road vehicle use as have the estuarine wetlands at Carama Creek and Wowly Gully in particular. On-going disturbance of vegetation and habitats is likely as further development occurs on adjacent lands and in nearby areas.

Restoration of native vegetation cover on these disturbed areas is a high priority, particularly where threatened species occur. NPWS has erected fences and barriers to protect the Wowly Gully wetland and restrict access to Warrain Beach. The Bherwerre Landcare Group has undertaken some successful restoration work at the quarry behind Greenfield Beach.

An area on the northern boundary of the park on the western side of Lake

Wollumboola has had a long history of grazing and is largely pasture. The northern boundary of the park between Coonemia Road and Lake Wollumboola has been fenced to prevent cattle entering the park and to facilitate re-establishment of native vegetation on pastured areas.

Existing easements for water, sewage, power and telephone lines have caused linear disturbances through some vegetation communities. Access tracks along some of these easements will need to be retained for management purposes.

Desired Outcomes

- The full range of native plant species found in the park and reserve is conserved.
- Vegetation structural diversity and habitat values are conserved, and are restored where subject to past clearing or vehicle use.
- The significant and restricted communities are conserved.
- The habitat and populations of all threatened plant species, biogeographically significant species and endangered ecological communities are protected and maintained.
- Neighbours support conservation of remaining areas of privately owned native vegetation near the park and reserve.

Strategies

- *Implement appropriate strategies and actions from the PAS and any recovery plans prepared for threatened species and endangered ecological communities that occur in the park and reserve. This may include survey and monitoring of suitable habitat for threatened species and mapping of endangered ecological communities.*

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

- *Monitor natural revegetation on old quarries and implement active revegetation programs if necessary.*

- *Monitor vegetation and habitat disturbance and other impacts from adjacent urban development. Work with Southern Rivers Catchment Management Authority, Shoalhaven City Council and community groups to minimise habitat disturbance.*

4.3 NATIVE ANIMALS

The park and reserve have a rich assemblage of native animals. The broad range of forest community types and wetland habitats are the major reasons for the richness of bird species in particular.

Terrestrial habitats

Typical animals of the taller and moister forests (e.g. blackbutt and spotted gum open forests) are the brown antechinus (*Antechinus stuartii*), swamp wallaby (*Wallabia bicolor*), greater glider (*Petauroides volans*), yellow-bellied glider (*Petaurus australis*), common ringtail possum (*Pseudocheirus peregrinus*), large forest bat (*Vespadelus darlingtoni*), little forest bat (*V. vulturnus*), Gould's long-eared bat (*Nyctophilus gouldi*), gang-gang cockatoo (*Callocephalon fimbriatum*), king parrot (*Alisterus scapularis*), fan-tailed cuckoo (*Cacomantis flabelliformis*), eastern yellow robin (*Eopsaltria australis*), golden whistler (*Pachycephala pectoralis*), brown

thornbill (*Acanthiza pusilla*), Lewin's honeyeater (*Meliphaga lewinii*), and satin bowerbird (*Ptilonorhynchus violaceus*).

A number of animals are common to all forest and woodland communities in the park and reserve. These include short-beaked echidna (*Tachyglossus aculeatus*), sugar glider (*Petaurus breviceps*), chocolate wattled bat (*Chalinolobus morio*), bush rat (*Rattus fuscipes*), yellow-tailed black-cockatoo (*Calyptorhynchus funereus*), crimson rosella (*Platycercus elegans*), southern boobook owl (*Ninox boobook*), Australian owlet-nightjar (*Aegotheles cristatus*), laughing kookaburra (*Dacelo novaeguineae*), grey shrike-thrush (*Colluricincla harmonica*), grey fantail (*Rhipidura fuliginosa*), superb fairy wren (*Malurus cyaneus*), red wattlebird (*Anthocaera carunculata*), eastern spinebill (*Acanthorynchus tenuirostris*), jacky lizard (*Amphibolurus muricatus*), grass skink (*Lamphropholis delicate*) and red-bellied black snake (*Pseudechis porphyriacus*).

The heathland-sedgeland communities harbour some of the birds, ground dwelling mammals and reptiles found in forest and woodlands but also contain several bird species which generally prefer this habitat. These include brown quail (*Coturnix australis*), southern emu-wren (*Stipiturus malachurus),* beautiful firetail (*Emblema bella*), tawny crowned honeyeater (*Phylidonyris melanops*) and three threatened species; the ground parrot (*Pezoporus wallicus*), eastern bristlebird (*Dasyornis brachypterus*) and eastern chestnut mouse (*Pseudomys gracilicaudatus*).

Wetland habitats

The significant swamp mahogany and woollybutt forest and woodlands on seasonally inundated areas provide a rich source of food for birds and mammals which feed on nectar or the insects attracted to the flowers. Though not as yet recorded in the park, these winter flowering communities may attract the threatened regent honeyeater (*Xanthomyza Phrygia*) and turquoise parrot (*Neophema pulchella*).

Coonemia Creek and freshwater wetlands at its mouth and behind Huskisson provide habitat for swamp rat (*Rattus lutreolus*), black swan (*Cygnus atratus)*, herons, egrets and bitterns, several duck species, moorhen and coot, eastern water skink (*Eulamprus quoyii*) and the eastern snake-necked turtle (*Chelodina longicollis*). Frogs commonly occurring in or near areas of freshwater are the brown-striped frog (*Limnodynastes peronii*), common eastern froglet (*Crinia signifera*), bleating tree-frog (*Litoria dentate*), leaf green tree frog (*L. phyllochroa*), Verreaux's tree frog (*L. verreauxii*) and Peron's tree frog (*L. peronii*).

The estuarine wetlands and mudflats of Carama Creek, Moona Moona Creek and Wowly Gully, and the shores of Lake Wollumboola provide habitat for many species of wading birds which include godwits, knots, sandpipers and plovers, and the white-bellied sea eagle (*Haliaeetus leucogaster*). Lake Wollumboola provides a valuable waterbird refuge with seventy different species recorded including a significant proportion of the NSW black swan population. When water levels are low the lake is estimated to support at least 20,000 birds with waterfowl, particularly black swan, chestnut and grey teal making up the largest numbers. Among the bird species recorded on the lake and wetlands, ten are listed under the TSC Act and thirty three species are protected under the Japan-Australia and China-Australia Migratory Birds Agreement (JAMBA and CAMBA).

Twelve different waterbird habitat categories are represented in Lake Wollumboola and on its foreshores. These range from deep open water, shallow open water, sedge, sandbanks and mudflats to casuarina forest (Keating & Pegler 2003). The importance and use of these different habitats varies for species, season and water level. In response to the lake's complex system the waterbirds exhibit a diversity of

foraging modes, breeding habits and behaviour. For example, when the seagrass is exposed and dies, the decomposing vegetation attracts littoral invertebrates, such as seaweed flies and crustaceans for reproduction. The eggs and larvae attract the large numbers of shore and wading birds. Likewise the seagrass and algae are vital feed for the black swans, which graze on the grass and on the algae oospores.

Black swan preferentially move across the lake between habitat areas rather than fly. Monitoring indicates that the southern part of the lake and parts of the NE corner are the most valuable habitats (Keating & Pegler 2003). The latter area has the highest bird diversity as its flats are used extensively by waders at low lake levels. The former area also has shallows that are used by waders, but its principal use is by waterfowl. Freshwater soaks throughout the lake are extremely important for the health of swans and other waterfowl (J Pegler pers. comm. February 2004). Management of boating to minimise impacts on use and breeding by waterbirds is addressed in the Recreation Opportunities section.

A better understanding of the complex relationships that exist between waterbird populations and the ecological and physical characteristics of Lake Wollumboola will enable effective conservation management and visitor appreciation, and enhance the lake's importance status on a regional, state, national and international level.

An independent scientific assessment commissioned by the Department of Environment and Climate Change indicates that Lake Wollumboola meets five criteria for nomination as a wetland of international importance under the Ramsar Convention. The strength of the assessment lies in the lake's unique hydrological dynamics and importance as a waterbird habitat, particularly for threatened shorebirds and the large population of black swan that use the lake during the critical stage of post-breeding moult. Listing as a Ramsar Wetland would require management of the lake to ensure 'sustainable utilisation for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem'. Ramsar listing also requires monitoring to indicate any changes to the ecological character of a wetland.

Monitoring

A baseline fauna monitoring program along fixed transects in a range of fauna habitats in the park was established in 1995 (Capararo and Murphy 1995). This fauna survey was repeated in 1998 and showed a slight increase in the populations of small to medium sized mammals in the Jervis Bay region (Gaia Research Pty Ltd 1999a and 2002). A review of this program in early 2006 recommended changes to the survey method including a stronger focus on sampling of species which are preyed upon by red fox. The modified survey will be repeated at regular intervals to monitor any changes to those fauna species, particularly in response to fox control programs (Wildlife Assessment and Management 2006).

Threatened species

The park and reserve provide habitat for a number of threatened fauna species. These include:

- the endangered eastern bristlebird which occurs in heathland and other plant communities adjacent to heath in the park south of Vincentia. This area is one of the major habitat areas for the eastern bristlebird and it will be managed to give priority to protection of this species. A cooperative program between NPWS, University of Wollongong and the Commonwealth Departments of Environment and Water Resources and Defence translocated forty-five eastern bristlebirds from the park to Beecroft Peninsula in 2003-2005 as part of the recovery plan for the species;

- the endangered little tern (*Sterna albifrons*) on the sand berm at Lake Wollumboola which has historically been one of the largest and most successful breeding sites for this species in NSW. NPWS has been intensively managing the site through a recovery program designed to increase breeding success since the early 1990s;

- nine vulnerable species of wading birds mainly recorded from the mudflats on Lake Wollumboola, but having suitable habitat on the estuaries of Carama and Moona Moona Creeks. These are: great knot (*Calidris tenuirostris*), large sand plover (*Charadrius leschenaultia*), lesser sand plover (*C. mongolus*), sooty oystercatcher (*Haematopus fuliginosus*) (also on rock platforms at Greenfield Beach), pied oystercatcher (*H.longirostris*), broad-billed sandpiper (*Limicola falcinellus*), black-tailed godwit (*Limosa limosa*), sanderling (*Calidris alba*) and terek sandpiper (*Xenus cinereus*);

- the glossy black-cockatoo (*Calyptorhynchus lathami*) which feeds almost exclusively on the seeds of *Allocasuarina littoralis* and *A. distyla* in the Jervis Bay region. Surveys conducted in 1998 showed evidence of extensive feeding by this cockatoo in the northern sections of the park in the catchments of Coonemia and Carama Creeks. Extensive suitable feeding habitat also occurs in Woollamia Nature Reserve;

- the ground parrot which occurs in the same heathland-sedgeland as the eastern bristlebird;

- the powerful owl (*Ninox strenua*). The existence of tree hollows is critical for the long-term survival of this species in the park and reserve;

- six species of insectivorous bats. These are the yellow-bellied sheathtailed-bat *(Saccolaimus flaviventris*), eastern little mastiff-bat (*Mormopterus norfolcensis*), common bent-wing bat (*Miniopterus schreibersii*), eastern false pipistrelle (*Falsistrellus tasmaniensis*), large-footed myotis (*Myotis adversus*) *(*with significant colonies at Duck Gully near Hyams Beach and on Coonemia Creek) and greater broad-nosed bat (*Scoteanax ruppellii*). Maintenance of tree hollows for roosting and maintenance of water quality in the case of the large footed myotis which feeds on fresh water insects, are critical management requirements;

- the yellow-bellied glider which requires a diverse range of forest resources including dens, winter flowering eucalypts, eucalypt sap-site trees, invertebrates within decorticating bark, honeydew, manna and occasionally Acacia gum. Locally it prefers mature forest containing spotted gum, red bloodwood, blackbutt and grey gum. It appears to be widespread in the northern section of the park (Gaia Research Pty Ltd 1999b);

- the recently recorded eastern chestnut mouse (*Pseudomys gracilicaudatus*) in tall heath/shrubland south-west of Vincentia where the species is at the southern geographical limit of its distribution. Animals have only been recorded in this area where fire has occurred in the previous five years and vegetation presently consists of sedges, grasses and re-sprouting low shrubs. It appears that this species is exploiting an early successional stage in post-fire wet heath communities. The Jervis Bay population should be considered a separate metapopulation and is perhaps the most vulnerable population of this species in the state (Townley 2007);

- the green and golden bell-frog (*Litorea aurea*), which has been recorded in the wetlands on the northern shores of Lake Wollumboola and in Woollamia Nature Reserve (Atlas of NSW Wildlife). Several dams in the northern part of the park near Lake Wollumboola provide suitable breeding habitat for the green and golden bell frog but are currently infested with mosquito fish or plague minnow (*Gambusia holbrooki*), which is known to prey upon tadpoles. Predation by *G. holbrooki* is a key threatening process under the TSC Act and a draft Threat Abatement Plan has been prepared for this fish (NPWS 2002). Although the dams are an artificial feature they may be essential for breeding by the frog in the park and therefore should be retained. Removing mosquito fish from the dams could enable individuals from the nearby Culburra Beach population of this endangered frog to colonise these dams (Grenadier and Mahony 2000) and is provided for in section 5.2; and

- the giant burrowing or eastern owl frog (*Heleioporus australiacus*) which occurs in the upper reaches of creeks that run through heathland and woodland and has been recorded in the park near Vincentia.

One of the most important factors in the management of threatened fauna species and their habitats in the park and reserve is appropriate fire regimes and fire suppression strategies that minimise felling of mature trees. Frequent fire is listed as a key threatening process under the TSC Act. Baker (1998) has recommended a number of strategies relating to fire management in order to maintain optimum habitat requirements for the eastern bristlebird in the park. Other threats include predation and competition from introduced animals, deterioration of water quality and habitat damage by recreational vehicles.

As for threatened plants, strategies for promoting the recovery of threatened species and populations are set out in the Threatened Species Priorities Action Statement (PAS) and may also be included in recovery plans for individual species.

Fish and invertebrates of Lake Wollumboola

Through the then NSW Fisheries Aquatic Reserve Consultation Paper, an expert panel identified Lake Wollumboola as the site of highest uniqueness and biodiversity in the Batemans Shelf Marine Bioregion. A total of 27 commercial fish species and 15 small non-commercial species were recorded during sampling from 1984 to 1988 (Kinhill 2000). Six of the species were freshwater species and included the introduced plague minnow.

Fish population and species richness fluctuations in ICOLLs occur in a complex response to changes in their physical condition, particularly the entrance status, but the relationships and processes are not fully understood. One effect that requires further study in Lake Wollumboola because of management implications, is what happens when the entrance opens and water is released after a prolonged period of inundation. The water release results in the death of seagrass and algae that had been growing in the water column, followed by its decomposition. The consequent deoxygenation of the remaining water results in fish kills.

Protection and management of fish is the responsibility Industry and Investment NSW and NPWS will seek their advice for fish related issues.

Information on the invertebrate fauna of Lake Wolllumboola is limited and future studies will be encouraged because macroinvertebrates are useful indicators of estuarine health. They feed on organic material, performing a filtering role, and are a food source for waterbirds and fish. In addition the threatened green and golden bell frog and the large-footed myotis feed primarily on aquatic insects.

Lake users have reported bites from lice, especially skiers using the southern sections of the lake or swimmers during southerly wind events that blow pelican and swan feathers into the northeast corner. The problem is not possible to manage as lice and other parasites are part of the natural biodiversity of estuarine and marine ecosystems. It may be feasible to warn lake users about the potential for irritation if information can be obtained on patterns of abundance.

Desired Outcomes

- The full range of native animal species found in the park and reserve is conserved.
- The habitat and populations of all threatened and regionally significant fauna species are protected and maintained.

Strategies

- *Implement priority recovery actions for populations of the threatened little tern, eastern bristlebird, glossy black-cockatoo, ground parrot, eastern chestnut mouse, green and golden bell-frog, giant burrowing frog, threatened species relying on tree hollows for breeding and/or roosting (i.e. six species of insectivorous bat, yellow-bellied glider, powerful owl, gang-gang cockatoo) and wading birds of Lake Wollumboola and the estuarine wetlands.*

- *Continue to undertake protective measures for little tern breeding sites, including the use of barriers or fencing. Ensure that as far as possible the fencing doesn't prevent public access to Warrain Beach and the Lake Wollumboola shoreline. Monitor breeding success.*

- *Monitor known populations of the eastern chestnut mouse and survey for additional populations. If numbers in a known population site are approaching zero after some years without fire, implement burning programs for tall heath/shrubland, taking account of the requirements of the eastern bristlebird which occurs in similar habitat and which, because of its endangered status, has a higher priority for conservation in the park.*

- *Implement relevant actions from the Management Plan for the green and golden bell frog key population within the Crookhaven River floodplain that apply to the park and reserve.*

- *Encourage inventory and research into habitat requirements, status and distribution of native animals in the park and reserve, particularly of threatened species.*

- *Monitor populations of the long-nosed bandicoot, ring-tailed possum, eastern pygmy-possum, eastern bristlebird, ground parrot and little tern in response to any fox control program.*

- *Protect and document the habitats of the thirty three bird species at Lake Wollumboola covered under the international agreements CAMBA (China - Australia) and JAMBA (Japan - Australia) for international migratory bird species. Erect advisory signage to draw public attention to the presence of waders around the lakeshore and their needs.*

- *Continue monitoring waterbird distributions and abundances in response to water levels, lake opening regimes, food resources, drought, flooding and recreational impacts at Lake Wollumboola.*

- *Actively advance the nomination of Lake Wollumboola as a Ramsar Wetland of International Significance including the conduct of any further research that may be required to support the nomination.*

- *Seek the advice of Industry and Investment NSW for fish related issues and encourage studies and research on the fish at Lake Wollumboola.*

- *Obtain information on the aquatic and terrestrial invertebrates of Lake Wollumboola related to their role as indicators of a healthy system and as a food source for many threatened species.*

- *Document as much as possible bird lice species and other parasites, their role in the Lake Wollumboola ecosystem and their relationship with their hosts and human lake users. If appropriate, provide information to lake users about the presence of lice and other parasites.*

4.4 ABORIGINAL HERITAGE

Jervis Bay is situated within the lands of the South Coast (Yuin) Aboriginal people of the Dharawal-Dhurga language group. Occupation of the area by Aboriginal people in traditional and recent times and continuing use today for food gathering, educational and ceremonial activities has given the area high Aboriginal social value. Many of the traditional storylines linking different elements of the landscape are still recounted and spiritual ties to the land are maintained through stories, on-going use and the passing on of knowledge through the generations. In recognition of the unbroken and continuing association of local Aboriginal people with the Jervis Bay area and its cultural significance to Aboriginal people the park has been identified under schedule 14 of the NPW Act for handback to the traditional owners (see section 1.3).

Although Aboriginal people have utilised the resources of the south coast for at least 20,000 years it was not until the continental glaciers of the last Ice Age melted and the sea levels rose that Jervis Bay assumed its present configuration and people came to live on its shores. Archaeological research has estimated that Aboriginal occupation of the Jervis Bay area extends back possibly as far as 7,000 years (Egloff *et. al.* 1995) and has demonstrated that the bay is remarkable for its diversity, richness and significance to Aboriginal people.

Jervis Bay has been the subject of considerable archaeological and anthropological research over the last three decades (Lampert 1971, Collier 1975, Blackwell 1980, Cane 1988, Paton and McFarlane 1989, Navin 1990, Officer 1991, Silcox 1992, Egloff 1995, Feary and Gray 1996, Wellington 1997, Feary 1997, Dibden and Kuskie 1999). The research has recorded more than three hundred archaeological sites (Egloff 1995) and illustrated that the Jervis Bay area has the highest density and most diverse range of archaeological site types anywhere on the south coast (Feary 1988). The most common archaeological sites around the bay are coastal middens and scatters of stone artefacts. Other sites to be found are rock shelters containing art and cultural deposits, burials and axe grinding grooves. In addition, elders refer to a Bunan ground adjacent to Carama Creek that was used for initiation ceremonies. While the scope of this plan is limited to Jervis Bay National Park and Woollamia Nature Reserve it recognises the significance and connectivity to people and places beyond the park.

Within the park there are fifteen recorded archaeological sites, particularly middens and artefact scatters along the ocean, Jervis Bay and Lake Wollumboola shoreline. However, this distribution of sites may be a reflection of where surveys have been undertaken rather than an accurate record of how Aboriginal people occupied the

land. The landscape, and the plants, animals and physical features within the landscape are all an integral part of Aboriginal cultural heritage, and places significant to Aboriginal people may or may not contain physical evidence of use or occupation.

Middens occur within and close to some of the high visitation sites of the park, including picnic areas and walking tracks. It will be important to protect these midden sites and monitor the impacts of park visitors on them and other Aboriginal archaeological sites within the park and reserve. In the Vincentia – Huskisson area of the park axe grinding grooves and artefact scatters are found within and around a small creek line that was being affected by an informal trail (Feary 1997). Restoration works have been completed to protect the axe grinding grooves from further disturbance.

A site has been identified at the northern end of the park for secure reburial of Aboriginal ancestral remains that were previously held by institutions. Occasional community vehicle access will be required to the site.

Desired Outcomes

- Aboriginal sites and places are protected from damage by human activities.
- Aboriginal people are involved in management of Aboriginal cultural values in the park and reserve.
- Ownership of Jervis Bay National Park is returned to the traditional owners and the park is jointly managed by Aboriginal people and NPWS.

Strategies

- *Consult and actively involve Aboriginal community organisations in all aspects of management of Aboriginal sites and values in the park and reserve.*

- *Promote and undertake research and information gathering about Aboriginal heritage places and landscapes within the park and reserve.*

- *Wherever possible, protect Aboriginal sites from disturbance or damage by human activities. If protection is not possible carry out appropriate salvage and recording.*

- *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, holders of local traditional knowledge and other relevant Aboriginal community organisations 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 will be interpreted to promote public knowledge and appreciation of Aboriginal culture.*

- *Progressively undertake oral history recording with Aboriginal elders to develop a better understanding of the pre and post contact use and values of the area.*

- *Work with the Aboriginal community to monitor Aboriginal archaeological sites, especially sites in high visitation areas.*

- *Permit reburial of Aboriginal ancestral remains at a designated site in the park, and associated vehicle access, with prior consent, on existing trails.*

- *Enter into handback negotiations for the park should the Jerrinja LALC and traditional owners wish to do so.*

4.5 HISTORIC HERITAGE

The first recorded European contact with Jervis Bay occurred in 1770 when Captain James Cook noted the entrance to the Bay and named Cape St. George and Long Nose Point. Twenty one years later Europeans first entered the Bay when Lieutenant Bowen in the transport ship *Atlantic* named it Port Jervis in honour of his former naval commander, Sir James Jervis.

Although subsequently visited a number of times, it was not until 1812 that a more thorough exploration was undertaken by Surveyor George William Evans. The need for further land brought a suggestion from Governor Macquarie in 1817 that Jervis Bay be made available for settlement and the possibility of finding an overland route between the highlands and Jervis Bay was seriously pursued by Charles Throsby, James Meehan and John Oxley.

Maps of Lake Wollumboola and adjacent area were produced in 1805 by Assistant Surveyor General Meehan and in 1822 by William Edwardson, who travelled with Alexander Berry when he sailed to the Shoalhaven looking for good quality land. A report in the Sydney Gazette of 17 April 1813 describes an excursion by a party from the brig Matilda, assisted by Aboriginal guides (Campbell 2001).

Jervis Bay has supported an array of industries over the past two hundred years including grazing and dairying, fishing, timber extraction, ship building, whaling, naval training and tourism.

The generally low nutrient soils of the Jervis Bay area has resulted in no large scale clearing outside the villages, except for on alluvial soils along Currambene Creek and the deeper soils at Copper Cup Point, clearing for pine plantations west of Huskisson (now abandoned) and some selective clearing for grazing purposes and forestry activities elsewhere. As well as clearings, a number of fence lines and dams in the northern part of the park are reminders of past agricultural activities.

The only well-documented evidence of non-Aboriginal habitation in the park is at Greenfield Beach. A property there was occupied by Colin Greenfield from 1942 until the early 1970s and then by the Voss family until 1977 when the land was resumed by the NSW Government. Local Lions Club branch members then demolished the house and the area was managed by Shoalhaven City Council as a picnic area (Shoalhaven Historical Society 1995). A row of pine trees planted by Greenfield to mark his property boundary and an old fence line remain. Although still healthy, the pine trees are reaching the end of their lives.

Information collected during a community Oral History day in 2003 provided a good understanding of the pattern of water levels, openings and recreational activities at Lake Wollumboola dating back to the 1920s. This indicated that since that time, Lake Wollumboola has been used for fishing and a variety of recreational activities when water levels have been suitable.

Desired Outcomes

- Historic features are appropriately conserved and managed.

Strategies

- *Manage the historic places of the park and reserve in accordance with the Burra Charter.*
- *Precede all work involving ground disturbance in the park and reserve by a check for historic places.*
- *Interpret the former settlement at Greenfield Beach to promote public understanding and appreciation of its history.*
- *Retain the pine trees at Greenfield Beach while they are alive and healthy. Do not replace them with Pinus or other exotic species. A row of native species with a comparable form to Pinus may be planted in the future, if it becomes necessary to provide shade or delineate the boundary of the picnic area.*
- *Photograph and record historic places, assess their significance and develop appropriate management strategies.*
- *Encourage research into the land use history and social values of the park and reserve using existing historical records and oral history from the families of the early settlers in the Jervis Bay area.*

5. PARK PROTECTION

5.1 SOIL EROSION, WATER QUALITY AND LAKE ENTRANCE MANAGEMENT

Soils

The soils in the park and reserve are generally sandy in nature and relatively infertile. On the gentle slopes of the areas of *Wandrawandian Siltstone*, yellow podzolic soils and solodic soils occur, while the sandstone plateaus have deep regolith and lateritic yellow earths and peaty swampland. Flood plains and adjacent terraces have weakly developed prairie soils and weakly to strongly developed podzolic soils respectively. Present day beaches typically consist of weakly calcareous beach sands while behind these the dune systems show varyingly developed podzol profiles.

In general the soils are highly erodable but major erosion has been minimal due to the relatively flat topography. Where vegetation in the park and reserve has been removed in the past as a result of activities such as quarrying and uncontrolled vehicular access, measures may be required to minimise soil erosion.

Water quality

The different sections of the park and reserve provide some catchment protection for Currambene, Carama and Moona Moona Creeks, which flow into Jervis Bay, for Coonemia Creek which flows into Lake Wollumboola and for Stony Creek flowing into St Georges Basin. Most of the Jervis Bay catchment is dominated by surface runoff processes with groundwater of minor importance except in areas of Quaternary dunes such as around Lake Wollumboola. The clear waters of the bay are potentially very vulnerable to the impacts of land-use change in the catchment *(Kowari* 1995).

The Southern Rivers Catchment Management Authority covers the Jervis Bay area and works to ensure the protection and sustainable development of land, vegetation and water resources within the catchment. Shoalhaven City Council carries out water quality monitoring at a number of sites around Jervis Bay, at Lake Wollumboola and in Currambene Creek. The results indicate that water quality is good to excellent, attributable in part to the high proportion of native vegetation in the catchment.

Stormwater enters the national park from a number of adjacent villages, particularly Huskisson and Culburra Beach, and the long-term effects of this relatively high nutrient load have begun to be assessed by NPWS. Some early studies have shown the effects to be fairly localised with the establishment of introduced plants close to drain outlets causing the most concern (Harris 1997).

The sediments in Lake Wollumboola store significant concentrations of nutrients, at a level considerably greater than the annual inputs from the catchment (Kinhill 2000). This indicates that nutrients in the bed have accumulated over a long period of time. Nutrients are utilised by the vegetation and can be released into the water column under certain conditions such as low oxygen levels. Any increase in nutrient inputs to the system from the catchment would be likely to affect nitrogen cycling processes and therefore water quality and the ecology of the lake.

Climatic conditions also influence water quality by determining the level of Lake Wollumboola. Water levels fluctuate significantly, along with salinity and nutrient concentrations, influencing what can grow and causing changing rates of decomposition. Differences in salinity, pH, temperature and dissolved oxygen have

been observed between the surface water and the bottom waters on the bed of the lake, indicating that Lake Wollumboola is stratified most of the time. Surface pH levels are very high for a natural estuarine environment and it is possible these high levels are the result of the large algal productivity within the water column (Haines 2002).

Lake Wollumboola odours

Hydrogen sulphide is produced naturally within the sediments of Lake Wollumboola and under certain conditions occasionally can be released to the atmosphere. This can then be detected by the human nose as a rotten egg gas smell. Sulphate-reducing bacteria present in the sediments of the lake break down organic matter using the sulphate ion from water to form hydrogen sulphide and other compounds. This process only takes place in the absence of oxygen at the interface of the sediments and water column.

Under normal circumstances hydrogen sulphide is prevented from reaching the atmosphere. There are two circumstances when this is not the case. Normally the waters of the Lake are stratified and hydrogen sulphide remains at the base of the water column. When destratification occurs (usually wind generated) the bottom waters are mixed through the entire water column, placing massive demand on oxygen to oxidise hydrogen sulphide back to sulphate. If there is insufficient oxygen the gas escapes to the air and produces odours. Secondly, 60% of Lake Wollumboola is above sea level and when the lake opens, water drains from the lake exposing sediments directly to the air and hydrogen sulphide is released into the atmosphere producing odours (Haines 2002).

The processes associated with the generation of hydrogen sulphide from Lake Wollumboola are natural, but when the gas escapes the lake, nearby residents are likely to detect the unpleasant odour. This odour can be detected at very low concentrations and affects individual olfactory systems differently. Severe health effects can be caused by hydrogen sulphide but these are confined to industrial situations, where levels are many orders of magnitude above the levels that can be detected by the human olfactory system (Illawarra Public Health Unit advice and brochure).

A number of management options for minimising the impact of the odour have been investigated including harvesting of macroalgae, maintaining high water levels in the lake, oxygenation of lake waters through natural tidal flushing or through water re-circulation plants or bubbler systems and preventing stratification of the lake (Kinhill 2000 and Haines 2002). Recent research by Geoscience Australia has indicated that microscopic algae rather than macroalgae are the major source of organic matter in the lake (Murray 2003). It is likely that the principal source of odour is sulphate-reducing bacteria acting on microalgae and thus it would be futile to remove macroalgae to reduce odours. Other options have been raised such as the use of iron to neutralise the hydrogen sulphide or introduction of large numbers of mullet to reduce the organic detritus. If not ineffective these options are either financially prohibitive, unachievable or may have significant environmental impacts.

Management options will continue to be considered, but until a scientifically and environmentally sound and feasible one becomes available the emphasis will be on continued education of the local residents and engaging with them in monitoring the odours. Shoalhaven City Council and the NPWS, with contributions by the Illawarra Public Health Unit have produced a brochure outlining health effects of hydrogen sulphide, and an information sign about the source of the odour has been installed at the main access point to the lake.

Lake Wollumboola entrance management

Lake Wollumboola has a history of both natural and artificial openings along the length of the beach berm. The entrance of the lake will breach naturally after periods of high rainfall if the initial lake levels are quite high. Records indicate that since 1959 the lake has opened approximately 25 times. Just fewer than 40% of the openings are likely to have occurred without human intervention, while over 60% were probably artificial (Kinhill 2000 and Campbell 2001). The lake can remain closed for several years during dry periods. The longest period the lake has been closed is for nearly 8 years from August 1998 until July 2006 when a trench was illegally dug across the berm. On average, the lake remains open for just less than 12 weeks at a time.

Maintenance of natural lake entrance behaviour is consistent with NPWS policy and legislation, Industry and Investment NSW policy and the recommendations of the Healthy Rivers Commission and the Lake Wollumboola Estuary Management Plan. Artificial opening of coastal lakes below their natural opening levels can cause significant long term impacts. At Lake Wollumboola these could include entrance shoaling, damage to adjacent wetlands, changes to the abundance of fish and other aquatic species and increases in the frequency of fish kills and hydrogen sulphide odours.

Any interference with the Lake Wollumboola entrance should only be to alleviate significant asset damage or public safety issues that cannot otherwise be reasonably overcome. Any decision to breach the lake's entrance will only be made in the above circumstances and will follow a set of guidelines that have been approved under the Review of Environmental Factors (REF) process. Shoalhaven City Council has sealed the sewer inspection covers that lie below 2.75m AHD in the catchment at Culburra Beach. This will allow the lake's water level to reach 2.75m AHD, at which point the lake could be opened for flood mitigation purposes if necessary. Property owners will be informed of any possible entrance opening proposals and close contact will be kept with Council during flood mitigation operations.

Desired Outcomes

- Human induced soil erosion in the park and reserve is minimised.
- Catchment values and the water quality and health of park and reserve streams, wetlands and Lake Wollumboola are maintained and where necessary improved. As far a possible there should be no net increase in nutrients, sediment or other pollutants.

Strategies

- *Design and implement all works carried out in the park and reserve to minimise interference with natural drainage patterns and prevent soil erosion and water pollution.*
- *Undertake appropriate control measures where erosion has been accelerated by human activity or is threatening significant habitats or other values.*
- *Liaise with local government and other authorities to maintain and improve the water quality of the park and reserve catchments. Ensure appropriate water quality monitoring programs are in place in order to build on existing baseline data.*

- *Continue to undertake studies to determine the present and future impacts of urban stormwater, their significance and what, if any remedial measures are required to protect the park and reserve, and the marine park. If needed approach Shoalhaven Council to implement remedial works and strict controls through their stormwater plan, to minimise the impacts of urban stormwater.*

- *Support any proposals to replace/realign sewerage infrastructure in environmentally sensitive areas of the park catchments, in association with Shoalhaven City Council and the Southern Rivers Catchment Management Authority.*

- *Close and rehabilitate trails not required for public access, utility maintenance or management purposes.*

- *Continue liaison with Council, health authorities and scientific institutions regarding odour from Lake Wollumboola. Support continuation of qualitative and quantitative monitoring by the Culburra Beach community.*

- *Improve community understanding of the aquatic plants and vegetation communities of Lake Wollumboola and the interactions with the terrestrial, physical and fauna variations of the lake.*

- *Record Lake Wollumboola entrance openings and encourage research into past entrance-opening regimes, positions and geomorphological history.*

- *Maintain a natural entrance opening at Lake Wollumboola unless alleviation of severe social hardship or public safety issues cannot be reasonably overcome through other asset protection measures. Regularly monitor the height of the lowest point of the sand berm. If natural lake opening does not occur before the lake height has reached 2.75 AHD, consider artificially opening the lake entrance when there is a real threat of flooding at the floor level of houses or when lake levels are close to affecting higher sewer inspection points on East Crescent, and the forecast is for continued rain.*

- *Any artificial opening of Lake Wollumboola will be located at the lowest point on the berm, unless further studies show opening at the southern end to be more appropriate or safety of machinery operators indicates a preferred location. If little terns are breeding then the opening location will be placed away from the breeding colony, where the opening will not disturb their nesting sites.*

- *Erect signs to indicate that unauthorised opening of the Lake Wollumboola entrance is prohibited. Include information about lake opening height, ecological reasons for natural opening and the illegality of unauthorised opening in interpretive programs and other material where appropriate.*

5.2 INTRODUCED SPECIES

An introduced species is defined in this plan as any plant or animal species not native to the park or reserve.

Introduced plants

Introduced plant species within the park and 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.

Several noxious weeds, which include most of those described below, occur in the park and 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 major problem plant in the park is bitou bush (*Chrysanthemoides monilifera* ssp *rotundifolia*). Invasion of native plant communities by bitou bush has been identified as a Key Threatening Process under the TSC Act and a Threat Abatement Plan has been produced for this weed. Bitou bush is most common along the dunes behind Hare Bay and to a lesser extent behind Warrain Beach and at Copper Cup Point on the western side of Lake Wollumboola. Some control work was undertaken on the worst affected areas by the Culburra Beach Dunecare Group prior to them becoming park and NPWS has continued spraying the weed in these areas. The control works have had some success in suppressing the plants. The spraying will continue on an annual basis and results will be monitored.

Two introduced plants that are common close to the coast behind dunes and on more fertile soils are lantana (*Lantana camara*) and arsenic bush (*Senna septremtrionalis*). Lantana is a weed of national significance and it poses a serious threat to swamp oak woodland (an Endangered Ecological Community) between Carama Creek and Warrain Beach. Arsenic bush is found at several unlawful rubbish dumping sites from which it appears to be spreading into surrounding undisturbed forest. Initial assessment of their distribution indicates that control measures to eradicate these plants from the park may be possible.

Garden escapes and illegal depositing of garden refuse by neighbours is a potential source of further infestations of introduced plants and is likely to increase as urban development proceeds. Refuse dumping will be discouraged and sites where this occurs will need to be monitored for weed establishment and subsequent control requirements.

Two very invasive weeds that have the potential to become established in forested areas of the park and reserve are crofton weed (*Ageratina adenophora*) and mist-flower (*A. riparia*). At present these species are confined to moist areas with relatively high nutrient levels e.g. along parts of Coonemia Creek.

Adjacent to the mouth of Carama Creek is a group of coral trees (*Erythrina* x *sykesii*), which was probably planted by early European inhabitants but is not considered of historical significance. The noxious fire weed (*Senecio madagascariensis*) occurs on former grazing land at Copper Cup Point.

The invasive marine plant (*Caulerpa taxifolia*) threatens coastal ecosystems in NSW. It is declared Class 3 noxious marine vegetation under the *Fisheries Management Act 1994*. If it established at Lake Wollumboola it could quickly take over a large area and over-run seagrass because of its rapid growth and competitive abilities and could severely alter the aquatic habitat. In conjunction with Industry and Investment NSW, NPWS will develop and implement a strategy for early detection mechanisms (i.e. regular monitoring) and eradication procedures. Industry and Investment NSW will be notified in the first instance if there is reasonable suspicion that *Caulerpa* has been introduced to Lake Wollumboola.

Sea spurge (*Euphorbia paralias*) is a recent coloniser of sandy beaches in the Shoalhaven and is now well dispersed along the coast from Lake Wollumboola southwards. NPWS will need to work with Shoalhaven City Council, the Land and Property Management Authority and landcare groups to tackle infestations and prevent further spread of sea spurge.

SUMMARY MAP

- Canoe launching
- Picnic area
- Trackhead
- Walk-in camping area
- Woollamia Nature Reserve
- Jervis Bay National Park
- Other NPWS Estate
- Walking Track
- Road
- Sealed Road - On Park
- Unsealed Road - On Park
- Management Trail

N W E S

0 0.5 1 2 Kilometres

Comerong Island NR
Culburra Beach
Culburra Rd
Saltwater Swamp NR
Coonemia Rd
Lake Wollumboola
Coonemia Creek
Currarong Rd
Forest Rd
Bull Hole
Warrain Beach
Carama Ck
Wowly Gully
Red Point
Hammerhead Point
Callala Bay
Hare Point
Currarong
Currambene Creek
Callala Beach
Myola
Huskisson Rd
Huskisson
Moona Moona Ck
Jervis Bay Marine Park
BEECROFT PENINSULA
Vincentia
The Wool Road
pipeline
Navel College Rd
Greenfield Beach
Erowal Bay
Hyams Beach
ST GEORGES BASIN
Booderee National Park (Commonwealth)

Introduced animals

Introduced mammals known to occur in the park and reserve are the rabbit, fox, cat, black rat, house mouse, and feral and domestic dogs. Rabbits are usually associated with grassed picnic areas and some dune areas and their impact on native flora and fauna in the park and reserve is unknown. Foxes and cats probably pose the greatest risk to native fauna, particularly to frogs and reptiles, ground-nesting birds and small mammals. Because of the proximity of urban areas, domestic cats possibly pose as great a threat as feral cats to small native animals. Black rats (*Rattus rattus*) are present in many parts of the park and reserve.

Both the red fox and feral cat are listed as key threatening processes under the TSC Act, and a Threat Abatement Plan has been prepared for the fox (NPWS 2001). A fox control program has been identified as a high priority in the TAP to protect the breeding colony of little terns at Lake Wollumboola and is likely to be having a beneficial effect on native fauna in the area generally. Fox control has been undertaken along Warrain Beach and in eastern bristlebird habitat near Vincentia and Hyams Beach to complement control by the managers of the Beecroft Peninsula Range Facility and Booderee National Park respectively. This may be extended to cover larger areas of the park if the fauna monitoring described in section 4.3 shows any decline in native mammal populations.

Introduced birds such as spotted turtledove, house sparrow, common myna and starling are largely associated with the villages and their impacts on the reserves' native fauna is largely anecdotal. Mynas and starlings are known to compete with native birds for nest sites.

As discussed in section 4.2, the introduced plague minnow which is known to prey on eggs and larvae of the green and golden bell frog has been recorded throughout the Lake Wollumboola catchment (Grenadier & Mahony 2000) and at times when the water is sufficiently fresh it is also found in the lake. It is an aggressive species that reproduces rapidly, disperses quickly and preys on other native species such as fish and macro-invertebrates, as well as frogs in general (NPWS 2002). Predation by gambusia is a key threatening process under the TSC Act. Gambusia is very difficult to eradicate from a water system and the Threat Abatement Plan recommends an integrated targeted strategy with some control, public education and ecological rehabilitation (NPWS 2002).

Desired Outcomes

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

Strategies

- *Assess and monitor weed and pest animal populations and implement control programs as needed with the aim of eradication where possible. Give priority for treatment to those introduced species that:*
  - *have been declared noxious;*
  - *are subject to Threat Abatement Plans;*
  - *have a significant environmental impact including damage to threatened species and endangered ecological communities;*
  - *may affect neighbouring lands or are considered of high priority by the community;*
  - *have a high capacity for dispersal; and/or*
  - *are new isolated occurrences.*

- *Implement control programs:*
  - *in cooperation with other authorities, adjoining landholders and community groups where appropriate;*
  - *in accordance with best management practice, to deliver optimal biodiversity outcomes; and*
  - *in such a manner as to minimise the impact on non-target species.*

- *Continue to control bitou bush, lantana, arsenic bush, fireweed, sea spurge and any occurrences of other noxious weeds.*

- *Liaise with Industry and Investment NSW to develop an early detection and eradication strategy for Caulerpa taxifolia in Lake Wollumboola. Notify Industry and Investment NSW if there is reasonable suspicion that Caulerpa has been introduced to Lake Wollumboola so they can enforce the powers under their legislation.*

- *Prepare and implement a weed control plan providing for inventory, mapping, monitoring and treatment of noxious and environmental weed species with emphasis on bitou bush, lantana, arsenic bush and crofton weed.*

- *Promote community awareness of the threat of weeds and pest animals and the need for their control, and liaise with neighbours as needed to reduce the incidence of illegal dumping of garden refuse.*

- *Control introduced animals as far as is practicable where they significantly compete with or prey on native animals, threaten the regeneration of native plant communities or cause erosion. Design control programs to avoid impact on non-target species.*

- *Continue the current fox baiting programs at the sand spit on Lake Wollumboola, along Warrain Beach and in eastern bristlebird habitat adjacent to Booderee NP. Seek community support for the authorisation of increased and alternative fox control programs around the northern shores of Lake Wollumboola and educate the community to keep an eye out for fox dens and notify NPWS.*

- *Drain dams in the northern part of the park during the winter to rid them of mosquito fish and provide opportunities for recolonising by the endangered green and golden bell frog. Destroy any introduced yabbies (Cherax destructor) that are found during this process.*

- *Maintain and if necessary enhance cooperation with Shoalhaven City Council, Booderee National Park management, Department of Defence, the Livestock Health and Pest Authority and park neighbours in implementing control programs.*

- *Continue to liaise with Shoalhaven City Council about prohibiting or at least discouraging cat ownership in new developments adjacent to the park and reserve.*

5.3 FIRE MANAGEMENT

Fire is a natural feature of the environment of Jervis Bay National Park and Woollamia Nature Reserve and is essential to the survival of some plant communities. Frequent or regular fire, however, can cause loss of particular plant and animal species and communities. Fire can also damage some types of Aboriginal sites, historic sites and recreation facilities and threaten visitors and neighbouring land and developments.

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

Fire history and bushfire environment

The pre-European fire history of the park and reserve is not known. Traditional fire practices of Aborigines in south-eastern NSW have not been well researched and are therefore poorly understood. From research conducted elsewhere it appears likely that the frequency and intensity of fire now is different from traditional Aboriginal burning practices.

The Jervis Bay region including the park and reserve has a recorded fire history since 1938/39. The fire history is reasonably accurate for larger fires but many smaller fires, particularly in earlier years, were not recorded. The final fire perimeter of most fires is known, but important factors such as fire intensity or unburned areas within fire perimeters are unavailable. Variations in fire behaviour along with fire suppression strategies create patches of unburned areas that are of significant consequence for biota and of interest for the protection of assets.

Wildfires account for 90% of the area burned since 1938/39, while prescription burns account for 10%. Local fire authorities regard illegal causes as the major cause of wildfire in the Jervis Bay region. The majority of the fires have been less than 5 hectares in size and mostly occur in the months of August and September. However, extreme fire weather conditions are most likely when strong and gale force winds occur over the summer coinciding with the higher drought indices of these months. Such was the case for the intense bush fire of the 2001/02 mid-summer period.

Because of the relatively flat topography in the park and reserve (no slopes more than 10 degrees and most less than 2 degrees), fire pathways are largely determined by wind and the pattern of vegetation. Vegetation communities with high available fire fuel (mainly tall heathland) are common in many sections of the park south of Currambene Creek, leading to medium bushfire behaviour potential in these areas. Nevertheless the potential for a fire of intensity capable of igniting houses exists in the Jervis Bay region in most years and so the issue of fire threat to life and property is a major consideration in management of sections of the park that are close to or surround villages.

Fire Management for Life and Property Protection

Fuel reduction by strategic prescription burning is a traditional and widely used method of minimising the fire threat to property. It provides an initial period of lower fuel loads that assist in reducing fire intensity at least in the period immediately after burning. Broad area burning (fire applied over a wide area) is not sustainable (Bradstock *et al* 1995). To prevent uncontrollable fires, fine fuel loads must be kept below about 7 tonnes/hectare over a reasonably large area. Given that total fine fuel can reach 7 t/ha in 1-2 years in many of the vegetation communities in the park and reserve, most of the park and reserve would need to be burnt every 1-2 years for adequate property protection. Such a practice would be both impractical and ecologically unsustainable.

Fire attack on houses is by four major modes: flame contact, radiant heat, burning debris and wind. Flame contact and radiant heat attack can be eliminated if flame is absent within areas near to the property requiring protection and this can be achieved by a fuel free zone adjoining and on the property (asset protection zone or APZ). Attack from burning debris can also be reduced by a fuel free zone. Thus a

strategic approach to property protection in the park will focus on fuel free zones as well as fuel reduced zones maintained by prescribed burning.

Fuel free and fuel-reduced zones also increase the safety for firefighters and enable more controllable backburns during fire suppression. In addition, through cooperative arrangements as outlined below, residents should be encouraged to maintain houses and property and take appropriate action when fire approaches.

Fire Management for the Conservation of Biodiversity

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 is 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 park at any one time. This approach will ultimately result in a mosaic of age classes for each of the vegetation types of the park and reserve.

Bradstock *et al,* 1995 contend there is a threshold in fire regime variability that marks a critical change from high species diversity to low species diversity. For some groups of biota these thresholds separating desirable and undesirable fire regimes can be defined. Management should therefore be targeted toward desirable fire regimes using these thresholds as a guide. The use of biodiversity thresholds provides sound management of fire ecology and a pragmatic method of including biodiversity conservation into fire management decision making.

The fire response of the rare and threatened plants in the park is not known. Many rare plants tend to be fire sensitive, however, and management should aim as far as possible to minimise the effects of fire in areas of rare species until their fire response is known. Where possible, sites in the park and reserve with a concentration of threatened plant species (TSC Act) or rare plant species (ROTAPs) and sites dominated by botanically significant vegetation communities (particularly certain endangered ecological communities) will be subject to prescribed fire only if fire is recommended as an action in any recovery plan for a threatened species.

The protection of habitat for threatened animals is of particular importance. These species are of significant concern because of their vulnerability to extinction and the need to ensure their chances of long-term survival are maximised. In the restricted localities where threatened fauna species are known to occur, fire management guidelines will be developed to augment the management of fire regimes for plant communities. These guidelines will be subject to the provisions of the TSC Act, including priority action statements and any threatened species recovery plans.

As sightings of additional threatened species are recorded and further research information becomes available there may be a need to modify the fire management guidelines accordingly. As a result of extensive studies undertaken by Baker, 1998, the preparation of draft recovery plans under the TSC Act, and recent survey effort by Townley, 2007, more complete fire management guidelines need to be developed for the eastern bristlebird, the ground parrot and eastern chestnut mouse. Because the eastern bristlebird is an endangered species, where the three species co-exist in the park conservation of the eastern bristlebird is to be given higher priority than the ground parrot and eastern chestnut mouse.

Fire management guidelines need to recognise the significance of hollow bearing trees which are critical to the survival of individuals of a number of threatened species including insectivorous bats, two species of gliding possum, glossy black-cockatoo and powerful owl.

A number of permanent vegetation monitoring plots have been established across the park and reserve to monitor recovery from the 2001/02 wildfires and to inform fire management decisions.

Fire Management for the Protection of Cultural Heritage

Scarred trees and rock art sites are vulnerable to fire but low to moderate intensity fires are unlikely to have a significant effect on other types of Aboriginal sites. Even low intensity fires can change the moisture regime within rock shelters, subsequently causing the drying, cracking and other deterioration of painted art. Although no rock art has been recorded in the current area of the park and reserve, as a precaution, all fires (including hazard reduction burns) should be kept well away from rock shelters. A threat that is potentially greater than the direct effects of fire is from fire management practices such as the use of machinery. Threats from machinery use also apply to the few known historic sites in the park and fire management strategies will take account of the need to protect cultural heritage in conjunction with asset and natural heritage protection.

Fire Management Strategies

A fire management strategy has been prepared for the national park and nature reserve. It includes fire management zones and strategies for fuel reduction, fire trails, detection and cooperative arrangements. These will be applied where appropriate to best protect life, property and natural and cultural assets within and adjacent to the park and reserve. In particular, close to boundary areas, fuel management programs and fire trail maintenance systems will be designed and implemented in cooperation with neighbours.

Bush fire suppression operations may require the construction of temporary trails, helipads and firelines. Those not required for further management purposes will be closed and rehabilitated as part of post fire operations.

Co-operative Arrangements

Under the *Rural Fires Act 1997* NPWS is a fire authority that may undertake fire suppression within reserves and under cooperative arrangements with other fire authorities. As a land management agency, NPWS is responsible for managing fire on the park and reserve including activities that contribute to the protection of life, property and community assets both within the NPWS estate and on adjoining lands. In addition to the bush fire risk management works undertaken within reserves, NPWS supports the application of requisite bush fire protection assessment, planning and works for reserve neighbours and nearby developments, and will continue to cooperate with its neighbours in planning and implementation of these works.

An important component of NPWS fire management for the park and reserve is participation in local co-operative 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 basis and is compiling a Bush Fire Risk Management Plan for the City of Shoalhaven that includes general provisions for the Jervis Bay region. NPWS will assist this committee to prepare detailed planning for the villages adjacent to the park and it is envisaged that there will be significant community participation in this process.

The Shoalhaven Bushfire Risk Management Plan and the fire management strategy for the park and reserve will provide a comprehensive means for protecting life and property and providing for community participation in fire management and fire management planning in the Jervis Bay area.

Desired Outcomes

- Bushfire mitigation measures contribute to the cooperative protection of persons and property on or immediately adjacent to the park and reserve.
- Fire regimes are appropriate for long-term maintenance of the reserves' plant and animal communities.
- Aboriginal sites, historic places and culturally significant features are protected from damage by bushfires and fire suppression activities.

Strategies

- *Implement the fire management strategy for the park and reserve. Revise and update the strategy as needed.*

- *Prepare and implement fire management works programs detailing maintenance of slashed breaks and asset protection zones, fuel reduction burns and trail maintenance requirements in accordance with the Fire Management Strategy.*

- *Establish or enhance fuel managed zones adjacent to villages where required in co-operation with residents and local bushfire brigades.*

- *Undertake ecological burning as needed to produce habitat suitable for species with specific requirements. This applies particularly to the heath/sedge/shrubland communities which harbour eastern bristlebird, ground parrot and eastern chestnut mouse. 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.*

- *Incorporate appropriate biodiversity thresholds and threatened fauna species guidelines in the application of fire regimes to ensure species diversity in the park and reserve. Undertake on-going review of the impact of fires on vegetation composition and structure. Modify programs where appropriate to minimise adverse impacts.*

- *Encourage research into the ecological effects of fire in the heathland - shrubland communities, particularly the fire response of rare and threatened plant and animal species including the requirements of the eastern bristlebird.*

- *Maintain and periodically resurvey vegetation fire monitoring plots.*

- *Continue to actively participate on the Shoalhaven District Bush Fire Management Committee. Maintain close contact and cooperation with volunteer bush fire brigades, the Rural Fire Service, the Land and Property Management Authority and Industry and Investment NSW.*

- *Support and promote the application of the statutory land use planning and development processes that address bush fire risk and protection measures as part of developments within bush fire prone areas. Continue to encourage and assist reserve neighbours in mutual bush fire protection planning and works.*

- *In the event of wildfire, give high priority to protecting areas of known eastern bristlebird habitat.*

- *Where possible avoid the use of heavy machinery for fire suppression in areas with rare and/or threatened plants, Aboriginal sites and historic places, swamps, sand dunes and heathland.*

- *As far as possible minimise the felling of hollow-bearing trees during fire suppression activities.*

- *As far as possible rehabilitate areas disturbed by fire suppression operations as soon as practical after the fire.*

6. VISITOR OPPORTUNITIES AND INFORMATION

6.1 PROMOTION, INTERPRETATION AND COMMUNICATION

Promoting public awareness of NPWS conservation responsibilities, the values of the area and recreational opportunities is a major aspect of management of visitor use. It assists the protection of the natural and cultural heritage of the park and reserve and increases the enjoyment and satisfaction of visitors.

Currently the park lacks orientation information for new visitors coming to Jervis Bay and it would be desirable to provide this at one or more major entry sites.

The site best suited to provide comprehensive interpretive information is Greenfield Beach where there are picnicking and walking facilities. This site allows access to a range of natural and cultural features including beaches, rock platforms, woodlands, heathlands and shrublands with many flowering plants, creek environments, tall eucalypt forests with an abundance of native fauna and evidence of an earlier European settlement. Greenfield Beach is also suited to providing environmental education opportunities for larger groups of people. An interpretive plan has been implemented which includes information brochures and interpretive material for the shelter shed and along walking tracks.

Opportunities exist west of Huskisson and at Hammerhead Point and Carama Creek for interpretation of environments different from those above, including estuarine and freshwater wetland and coastal dune habitats. The important habitat of the endangered eastern bristlebird in the southern sections of the park provides an opportunity to promote NPWS work in managing the habitat of an endangered species. Interpretive information should also highlight the significance of Jervis Bay to the traditional Aboriginal owners.

The unique characteristics and values of Lake Wollumboola give it potentially high value for education and for ecotourism, particularly because of the opportunities to easily view large numbers of waterbirds. Shoalhaven City Council in cooperation with NPWS has installed interpretive displays in the picnic area on the north-eastern shore and the public boat ramp, both outside of the national park. Information about little terns and the cause of lake odours is provided in the picnic area and has been expanded with Council's agreement to cover other aspects of the lake's values including Aboriginal cultural heritage values. Council has also liaised with NPWS in the provision of interpretive signage along the walking track between these sites. This signage includes information about the lake's significance as waterbird habitat, lake processes and the green and golden bell frog.

Information brochures will show the visitor opportunities offered by the park together with opportunities for appreciating the natural and cultural features of the adjacent Booderee National Park and Jervis Bay Marine Park.

A variety of locations in the park will continue to be used for the NPWS discovery program, which provides guided activities for visitors to NPWS estate including school and community groups.

Many organisations and individuals have an interest in management of Jervis Bay National Park and Woollamia Nature Reserve, particularly neighbours and local communities with regard to such issues as fire management, weed and pest control, public access and several aspects of management of Lake Wollumboola. On-going communication and cooperative management with a range of individuals, community groups and government agency representatives will be needed.

Desired Outcomes

- There is widespread community understanding and appreciation of the area's natural and cultural values.
- Visitors are aware of the area's recreation opportunities and can find their way to appropriate facilities.
- The park and reserve are a useful educational resource for local schools and community organisations.
- A good relationship is maintained with neighbours.

Strategies

- *Investigate potential sites for providing orientation information for visitors to the park and wider area. If a suitable site or sites can be found, install information about visitor opportunities. In conjunction with such a site in the southern end of the park, install an interpretive display about the eastern bristlebird and other threatened species and, if feasible, infrastructure to provide a view over this part of the park.*

- *Participate in co-operative tourism planning and promotion to assist visitors and ensure that use of the park and reserve is sustainable and consistent with their role in the wider region.*

- *Promote understanding and appreciation of the natural and cultural values of the park by the public. Emphasise the following themes in education and interpretation programs:*
  - *geomorphology and coastal processes, including the potential impacts of climate change.*
  - *inter-relationships between terrestrial and marine environments. This will require integration with interpretive programs for Jervis Bay Marine Park.*
  - *the diversity of vegetation types and the ecology of threatened animal species, particularly eastern bristlebird, eastern chestnut mouse, glossy black-cockatoo, large-footed myotis, green and golden bell frog and little tern and the richness and dynamics of the Lake Wollumboola birdlife.*
  - *the role of fire in the natural environment and the complexities of fire management in a park with such a large urban interface.*
  - *Aboriginal use of the area, including the high Aboriginal cultural significance, proposed future Aboriginal ownership of the park and traditional Aboriginal food sources.*

- *Greenfield Beach will be the major location for provision of interpretive information about the conservation values of Jervis Bay National Park and nearby NPWS areas. Information may be provided at other locations and in brochures to highlight particular features or recreation opportunities.*

- *Continue to work with Council to provide and maintain interpretation and bird watching opportunities along the north-eastern shore of Lake Wollumboola including the picnic area and boat ramp area.*

- *Involve the Aboriginal community in development of education and interpretation programs.*

- *Design promotional material, educational and interpretive programs to promote care for the environment including highlighting the impacts of inappropriate use*

such as off-road vehicles, firewood collection, rubbish dumping, garden waste and domestic animals and hence assist management to protect natural and cultural heritage values. Also highlight the impacts of climate change and that various management programs for the park and reserve aim to reduce the severity of the effects of climate change.

- *Maintain a system of park and reserve identification signs at public entrances to the park and reserve and where through public roads intersect with park and reserve boundaries.*

- *Do not promote Woollamia Nature Reserve apart from signs to delineate the boundaries and indicate use restrictions in the reserve, and provision of information about the role and value of nature reserves.*

- *Promote the coastal walking track within the Greenfield Beach-Hyams Beach section of the park as part of the larger White Sands Walk between Plantation Point and Hyams Beach, using on-site interpretive signs prepared in conjunction with Shoalhaven City Council.*

- *Maintain close liaison with park neighbours and local communities to discuss matters of mutual concern. Encourage community and stakeholder involvement in partnerships and management, including landcare, bushcare or 'Friends' groups.*

- *Encourage school and community involvement in educational programs at Lake Wollumboola.*

- *Work with Shoalhaven City Council, Southern Rivers Catchment Management Authority and local landcare and bushcare groups to deliver community education programs as needed, to reduce the impacts on the park and reserve of adjacent development and unauthorised recreational use.*

6.2 RECREATION OPPORTUNITIES

Overview

The park is located close to population centres around Jervis Bay and Lake Wollumboola and in nearby towns, and is within half a day's drive of the cities of Sydney, Wollongong and Canberra. Jervis Bay has become a popular tourist destination, with the population of the surrounding villages increasing substantially over the summer holiday period. It is estimated that the Bay is visited annually by nearly three million people.

For both visitors and locals the major attractions of the area are the beaches and waters of the Bay and surrounding ocean. Thus within the park the most popular destinations are close to water where facilities such as car parks, toilets and picnic tables have been provided. The park and to a lesser extent the nature reserve are also used by locals for walking and some cycling and horse riding. Lake Wollumboola and surrounds are used by locals and tourists for a number of recreational activities including fishing, boating, swimming, bird watching and walking.

The pattern of recreation use is generally one of large numbers of visitors to the facilities at Greenfield Beach; extensive use of the beaches in the Greenfield-Hyams Beach section and the beaches and waters of Lake Wollumboola; moderate use of Moona Moona Creek in the Huskisson section, Red Point, Hammerhead Point and the St Georges Basin foreshore and relatively low use of trails in other parts of the park and in the nature reserve. There are no visitor facilities in the nature reserve

because of the special management objectives of nature reserves under the NPW Act and the lack of features of recreational interest.

An assessment of similar recreation facilities in the Commonwealth Booderee National Park, Beecroft Peninsula, Shoalhaven City Council managed areas and on private land was undertaken when considering provision of recreation opportunities in the park. Holiday accommodation in the form of caravan parks and camping grounds, units, cabins, guesthouses, motels, a hotel and rural retreats are available in villages and rural areas. Shoalhaven City Council manages a number of picnic areas adjacent to beaches in the villages around the Bay and the shores of Lake Wollumboola. Booderee National Park has three camping areas, a number of picnic areas, an extensive system of walking tracks and the Jervis Bay Botanical Gardens. The Department of Defence owned land on Beecroft Peninsula has a low key camping facility at Honeymoon Bay and a number of parking areas and tracks allowing access to beaches and boat ramps on the western side of the Peninsula.

In many instances the opportunities and access being provided for in the national park relate to public use of Jervis Bay Marine Park. In the investigation of further facilities in the national park, the regulations under the marine park zoning plan were considered.

Vehicle Access

Vehicle access is available to the boundaries of all sections of the park and reserve and to car parks at Greenfield Beach, Hyams Beach, Moona Moona Creek, Coonemia Creek, Hammerhead Point and Red Point. The road Access to Red Point crosses land owned by the Jerrinja Local Aboriginal Land Council and NPWS is working with the Land Council to investigate options for ongoing public access. Adjacent land within the park is too poorly drained for the road to be re-aligned onto the park

Other sections of the park and reserve have old trails, some of which will be retained for management purposes including fire and emergency management, public recreation, utility maintenance and/or access for neighbours (see Summary Map and section 7), while the rest will be closed and rehabilitated. Rehabilitation means allowing the tracks to revegetate and may include remedial works to arrest any erosion.

No vehicle access onto the beaches is permitted through the park except for emergency purposes.

Day use facilities

Greenfield Beach is the prime visitor destination in the park, providing parking, picnicking and walking facilities as well as beach activities. It is well used all year-round and is also popular with locals.

Low-key picnic facilities and beach access have been provided at Red Point and Hammerhead Point, in conjunction with works to keep vehicles away from Aboriginal sites and fragile coastal dune vegetation. The future of the picnic facilities at Red Point is unclear since the access road crosses land now owned by the Jerrinja Local Aboriginal Land Council.

A small parking area and boat ramp have been established at Coonemia Creek along an existing track off Currarong Road in order to rehabilitate a degraded wetland area and provide continuing access for fishers and small boats. A parking area has also been provided off Currarong road south of Kinghorne Point at a popular fishing spot known as the “Bull Hole”.

Walking opportunities

There is a high quality coastal walking track between Greenfield Beach and Hyams Beach and a connecting loop track traverses two distinct open forest communities. The coastal track connects to a longer track on Council managed land north of Greenfield Beach, forming the White Sands Walk between Plantation Point and Hyams Beach. In cooperation with Council the possibility of incorporating this track into a 'round the bay' walk has been investigated and found to be feasible.

All management trails in the park and reserve are available for walking. Those of particular interest are:

- a sandtrack from Red Point to Hare Point;
- a trail past estuarine wetlands along the northern bank of Moona Moona Creek from a small car parking area just off the Huskisson-Vincentia Road;
- several other trails in the Huskisson section of the park suitable for undertaking easy walks through forest areas and to the edge of a freshwater wetland. Access to these is from a locked gate just off the Huskisson Road; and
- a pleasant walk behind the dunes for a kilometre south from Hyams Beach, with a return along the beach.

A number of old vehicle trails, easements and tracks west and south of the Vincentia area are used by local residents for walking and some cycling. Some provide access to the Vincentia Leisure Centre and local schools. Formalisation of some of the tracks, combined with closure and rehabilitation of those that are not needed, could provide linked walking, and possibly cycling, opportunities through the southern part of the park, for both locals and visitors. It would be necessary to resolve ownership of old road reserves in the area before such a track system could be fully implemented.

Walking is popular along the beach adjacent to Lake Wollumboola and on the lake bed when water levels are low. Pets other than trained assistance animals, are generally not permitted in national parks and nature reserves. Pets other than trained assistance animals, are generally not permitted in national parks and nature reserves. Studies have shown that walkers with dogs disturb birds at significantly greater distances than walkers alone, and unleashed dogs can kill birds and destroy nests. The inter-tidal zone along the ocean side of the lake sand berm adjacent to the park, falls under Shoalhaven City Council jurisdiction and under Council's "Access Areas for Dogs" policy, dogs are prohibited within 200 metres of identified shorebird nesting sites. Given the high value of the sand berm and dunes for little terns and other threatened shorebirds, it would be appropriate to liaise with Council to ensure compliance with the prohibition of dogs on the beach in this area. An area for dog walking is available on the beach immediately north of the park.

Camping

Because of existing car-based camping opportunities in Booderee National Park, at Honeymoon Bay on Beecroft Peninsula and in a number of Council and privately managed caravan parks, no car-based camping will be provided in the existing Jervis Bay National Park. Car-based camping has been prohibited in the park at Red Point because of significant vegetation damage but occurs on former Crown land west of Red Point. This land is now owned by the Jerrinja Local Aboriginal Land Council and NPWS will liaise with the Land Council in relation to management of the area.

Walk-in camping at Hare Point, to the east of Red Point, will continue to be permitted. If required in the future, limits will be placed on the number and siting of tents, a booking system may be established and low-key toilet facilities may be provided.

Boating

Moona Moona, Carama and Coonemia Creeks provide pleasant opportunities for canoeing and boating in small vessels. As stated above, a small boat ramp has been provided at Coonemia Creek.

Existing boating activities on Lake Wollumboola when water levels are suitable include canoeing, sailing, sailboarding, waterskiing, fishing, kite surfing and jet skiing. There is potential for new activities such as wake boarding and hovercraft to be introduced, which could have increased environmental impacts.

The large number and diversity of waterbirds using Lake Wollumboola are likely to be in response to the relatively low levels of human use combined with its high natural productivity. Studies show that waterbird disturbance increases with size, speed and noise of boats and that the more frequent the use the greater the decline in birds. Creation of refuges from human disturbance has been found to dramatically increase the number of birds using an area and to improve breeding success. There is an existing 4-knot speed limit in the north-western corner of the lake, north of a line between Swan Point and a point 50 m east of the boat ramp. As the southern part of the lake and the western bay receive relatively low levels of use, boating could be regulated in these areas with little impact on existing users. While birds use the whole lake, large numbers of black swan and other waterfowl have been observed congregating in these areas. Limiting boat speed would be particularly valuable when swans are in their post-breeding moult. A speed limit near the mouth of Coonemia Creek would also help in reducing the erosion that is occurring in this area.

The greatest area of potential conflict between recreational use and birds is in the north-eastern bay of Lake Wollumboola. This bay has significant habitat for the endangered little tern and migratory waders and provides a very important roost for all waterfowl. Most swimming also occurs in the north-eastern bay and it is a favoured area for some types of sailcraft as it receives relatively strong north-easterly winds. Application of a 4 knot zone applying to motorised craft would minimise disturbance to birds and risks to swimmers, as long as sailcraft use does not increase. The impacts of boating activities would need to be monitored and use reviewed if significant impacts were observed.

Access for larger boats to Lake Wollumboola is via the Shoalhaven City Council boat ramp on the northern shore. The boat ramp is predominantly on Council land but as water levels fall boat launching extends onto the lakebed, within the park. It is desirable that there be no significant rise in boating activity on the lake, in order to avoid increases in environmental impacts. The most appropriate way to achieve this would be to have no significant upgrading or increase in boat access facilities, while still allowing works for safe access. Low lake levels allow vehicles entering from the boat ramp to drive along the northern lake edge, with potential compaction of the lake bed, reduction in the number of invertebrates available to feeding waders and damage to adjacent green and golden bell frog breeding habitat. Any redesign of the boat ramp should be done in such a way that vehicle access onto the bed, apart from boat launching, is minimised.

Recreational fishing

Recreational fishing from both the foreshores and from boats is a popular activity in Lake Wollumboola and Coonemia Creek when water levels are high, while prawn netting is undertaken when the lake entrance is open. Management of fishing is the responsibility of the Industry and Investment NSW and is permitted in the park in accordance with Industry and Investment regulations. Recreational fishing is appropriate as long as sustainable fishing practices are demonstrated and it does not cause unacceptable impacts to the lake and the bird life.

Under the zoning plan for Jervis Bay Marine Park fishing is not permitted in Carama Creek or from 50 metres upstream of the road bridge over Moona Moona Creek.

Horse riding and bicycling

Horse riding occurs along a number of the vehicle trails in the park and reserve and it is recognised that many riders enjoy riding along trails in bushland. Horse riding can cause vegetation trampling, track widening, erosion, weed introduction and conflicts with other park users if undertaken in unsuitable locations but most of the locations where riding currently occurs are suitable. It will be permitted on trails that are currently used, which are those west of Coonemia Road and between Currambene Creek and the Wool Road, excluding two trails which traverse wetlands either side of Moona Moona Creek. Horse riding is not generally permitted in nature reserves but can be undertaken along Pritchard Avenue, which is a Crown road that has been excluded from the nature reserve.

Bicycle riding can cause erosion in steep or moist areas. Impacts are low in the generally level topography of the park and reserve but the trails across wetlands either side of Moona Moona Creek are not suitable for riding. Cycling can also pose a danger to walkers and for this reason is not permitted on walking tracks. Under NPWS policy, cycling is permitted in nature reserves only on those trails specifically signposted to that effect. Bicycle riding on the management trails in Woollamia Nature Reserve is considered acceptable given the level topography.

Orienteering

Orienteering is an activity in which walkers/runners often traverse bushland without following trails. It can have unacceptable impacts in some areas or if undertaken regularly in the same area. Orienteering will be considered on a case by case basis for the sections of the park north of Currambene Creek but will not be permitted off designated tracks in the southern part of the park and in Woollamia Nature Reserve.

Other organised group activities

Commercial and community-based tours, which increase public environmental understanding and support for conservation, are appropriate in the park. Of particular relevance are Aboriginal guided tours, which could raise awareness of Aboriginal cultural links to the lands of the park. Organised activities will be considered on a case by case basis, but they are not appropriate for Woollamia Nature Reserve. Tours will be subject to licence conditions. Other organised group activities such as weddings will be permitted in the park but will require a licence when more than 40 people are involved. In general NPWS will impose an upper limit of 100 persons per activity to minimise impact on park values and facilities and other park users. Such activities are not appropriate for Woollamia NR.

Proposed additions

As stated in sections 2.1 and 3.2, areas of Crown land at Currarong and Myola where Aboriginal land claims have recently been resolved are proposed for addition to the park under the Jervis Bay Regional Environmental Plan.

Abrahams Bosom Reserve at Currarong has an existing picnic area and several walking tracks, and also provides beach access. It is located close to a Council picnic area adjacent to the village of Currarong, which provides toilets. The picnic area is located on land that would otherwise be vegetated with littoral rainforest. It would be desirable to reduce its footprint to allow some regeneration of rainforest and creek-bank vegetation, while retaining parking and picnicking facilities.

The proposed addition along Currarong Beach currently has two car parking areas providing access for surfers and fishers. The future of these access points needs to be considered in relation to environmental impacts and safety issues for turning vehicles.

The Myola area is used for parking to access the beach and Currambene Creek. Formalisation is needed to halt the expansion of parking into bushland and to improve amenity.

Desired Outcomes

- A variety of low key visitor opportunities are available that encourage appreciation of the natural environment.
- Facilities are designed and managed to provide a satisfying visitor experience and minimise impacts.
- Visitor use is compatible with the purposes for which the park is reserved and is ecologically sustainable.

Strategies

- *Permit public vehicle use only on the public access roads on the park shown on the Summary Map, and to visitor facilities in the proposed additions at Currarong and Myola.*

- *Explore options for continued public vehicle access to Red Point with the Jerrinja Local Aboriginal Land Council. If closure of vehicle access is necessary, consider partial re-alignment of the road combined with provision of a walking track to the site and down-grading or removal of the picnic facilities.*

- *Maintain day use parking, picnicking, toilet, walking and interpretive facilities for high levels of use at Greenfield Beach, including some that cater for persons with disabilities.*

- *Maintain a low-key picnic area at Hammerhead Point, with toilets and walking access to the beach.*

- *Maintain access tracks and small parking areas off Currarong Road to Coonemia Creek and the "Bull Hole", including the small boat ramp at Coonemia Creek.*

- *Permit walking on all management trails and promote walking on trails behind Huskisson, along Moona Moona Creek, to Hare Point and south of Hyams Beach.*

- *Develop and implement a plan for a walking track network for the park south of Moona Moona Creek, primarily utilising existing tracks. If possible, provide for cycling on some tracks that are of appropriate width and grade. Close and rehabilitate any unnecessary tracks.*

- *Do not permit car-based camping in the park and reserve.*

- *Permit walk-in camping only at Hare Point. Monitor to determine any necessary limits on the camping area extent and numbers. Provide toilets and possibly drinking water if warranted by the amount of use.*

- *Liaise with Shoalhaven City Council to ensure that Council's policy for the prohibition of dogs within 200 metres of shorebird nesting sites is implemented for*

the intertidal strip adjacent to the park and for the northern shore of Lake Wollumboola and direct dog walking to the ocean beach to the north of Lake Wollumboola.

- *Allow recreational activities undertaken on Lake Wollumboola at the time of its addition to the park, to continue at levels of use consistent with other strategies in this plan. Provide information on how these activities should be conducted in a safe and responsible manner.*

- *In consultation with NSW Maritime, manage boating activities and prohibit or regulate any new recreational activities that would be likely to have a significant environmental impact, particularly on waterbirds, or impact on the safety of other users of Lake Wollumboola.*

- *Liaise with NSW Maritime on the implementation of the following: the ongoing application of a 4-knot speed limit for motorised boats in the north-western corner of Wollumboola; the application of a 4-knot speed limit for motorised boats in the western bay (west of a line between Long Bow Point and Copper Cup Point), in the whole of the north-eastern bay and in the southern part of the lake (south of a line between Copper Cup Point and Boalla Point), as set out in the Zoning Map; the extension of speed limits to apply to all watercraft if needed; and in conjunction with Shoalhaven City Council the provision of information relating to the speed limits at main visitor entry points to Lake Wollumboola.*

- *Work with visitors to minimise the impacts of kite-based activities, including designation of set-up and take off points at Lake Wollumboola to minimise impacts on shorebirds and waterfowl and in particular on little tern breeding.*

- *Monitor the location and intensity of recreation use of Lake Wollumboola and any conflicts between different user groups, and assess the environmental impact of recreation use. Review the effectiveness of the recreational zoning after a 3-year period or earlier if necessary. If needed, seek community and user input to any proposed change in regulation of recreational use.*

- *Liaise with Council as needed to ensure that any work on the boat ramp on the northern shore of Lake Wollumboola provides for safe, environmentally sound use consistent with the recreational strategies for the lake.*

- *Permit horse riding on public vehicle access roads throughout the park and on easements and management trails west of Coonemia Road and between Currambene Creek and the Wool Road, except Moona Moona Creek Trail and a short length of trail on the southern side of the creek, which will be signposted. Horse riding will not be permitted in Woollamia Nature Reserve.*

- *Permit bicycle riding on public access roads and management trails in the park and reserve, along easements within the park and on any suitable shared tracks that are formalised as part of the track system in the southern part of the park. Prohibit cycling on walking tracks, on the Moona Moona Creek Trail and on a short length of trail across wetlands on the southern side of Moona Moona Creek. Where needed, signpost tracks and trails to indicate whether cycling is permitted.*

- *Permit organised tour programs by commercial, government and community organisations and other group activities in Jervis Bay National Park subject to the following:*
  - *limits will be placed where needed on group sizes and frequency to ensure that use is environmentally sustainable and safe to other park users;*
  - *use of minimum impact bushwalking and safe practices will be required;*

- *program leaders will be required to have adequate qualifications and experience;*
- *licences will be altered or revoked if unacceptable environmental impacts are found to occur.*

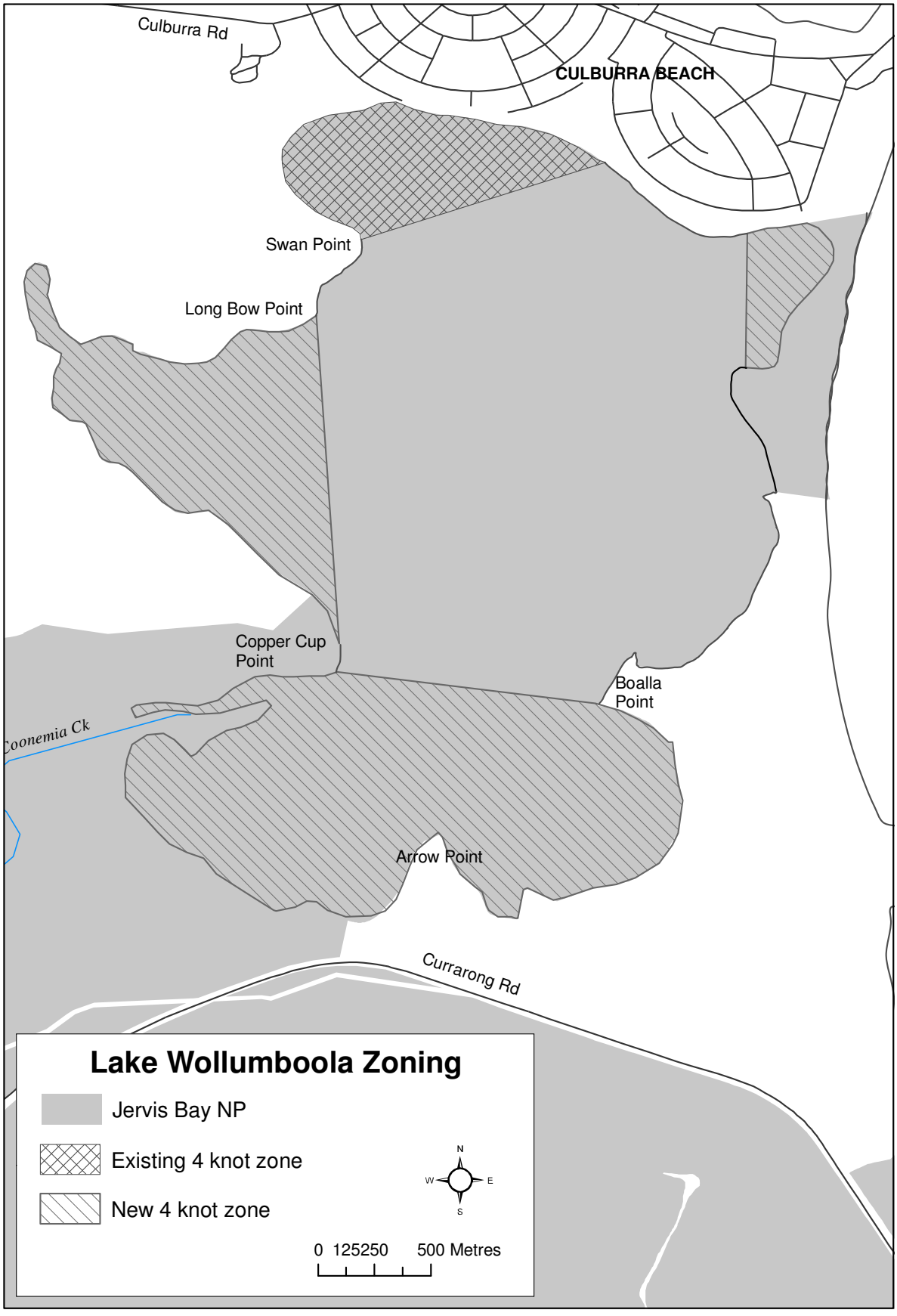
- *Require prior consent for orienteering and permit it in the park throughout the area north of Currambene Creek or on formal tracks and trails elsewhere. Prohibit orienteering in the nature reserve.*

- *Provide rubbish bins only at the major visitor destination of Greenfield Beach. All other day use areas require visitors to take their rubbish home.*

- *Permit wood fires in designated fire places only.*

- *Undertake visitor monitoring programs from time to time at various locations to determine visitor numbers, activities and impacts.*

- *Undertake the following works at Abrahams Bosom Reserve, Currarong Beach and Myola if they are added to the park:*
  - *Abrahams Bosom Reserve: redesign of the picnic areas to reduce its footprint and allow some regeneration of rainforest and creekbank vegetation, repair of degraded sections of walking track and signage improvement where needed, in consultation with Shoalhaven City Council;*
  - *Currarong Beach: investigation of environmental and safety concerns and formalisation of beach access if appropriate;*
  - *Myola: provision of a formal parking area and an unloading area for canoes, installation of toilets if warranted by the number of visitors.*


Culburra Rd
CULBURRA BEACH
Swan Point
Long Bow Point
Copper Cup Point
Boalla Point
Coonemia Ck
Arrow Point
Currarong Rd
Lake Wollumboola Zoning
Jervis Bay NP
Existing 4 knot zone
New 4 knot zone
N
W
E
S
0 125250 500 Metres

7. OTHER USES

Easements

Shoalhaven City Council, Integral Energy and Telstra maintain easements for water, sewerage, power and telecommunications in the park and reserve. Since the park effectively surrounds several villages, it is likely that these utility easements will remain in their current locations indefinitely. These easements will be covered by access licences/agreements to ensure minimal environmental impact and guide any maintenance or upgrading that may be required.

The January 2001 RFA additions to the park were created by the *National Parks Estate (Southern Region Reservations) Act 2000* (NPE (SRR) Act). This Act provides for the acquisition of land by a relevant authority for the widening of Naval College Road through the relevant section of the park gazetted on 1 January 2001. The Director-General of NPWS may authorise a relevant acquiring authority to conduct surveys and investigations for the purposes of determining the location of any addition to or re-alignment of Naval College road. However any such land cannot be acquired unless the acquisition is approved by the Minister administering the NPW Act.

Apiarists

Several apiarists maintain honey bee hives seasonally within the park and reserve. The apiarists were operating on these lands prior to them becoming conservation reserves. Their leases will be allowed to continue in accordance with NPWS policy but no new leases or sites will be permitted. NPWS will establish guidelines to ensure that hives are located in existing cleared areas, such as powerline easements close to the park boundaries.

Commercial Fishing

Commercial fishing is undertaken in Coonemia Creek and Lake Wollumboola; primarily mesh netting, prawn running and eel trapping although a wide variety of techniques are allowed. Generally, intermittently opening lagoons such as Lake Wollumboola are not particularly productive for fish, but the prawn industry can be economically important in some years, with prawns reaching large sizes when the lake has been closed for some time (Kinhill 2000). Recruitment of prawn larvae takes place when the lake is open to the sea but regular openings would degrade the wetland and riparian communities and reduce long-term fisheries production and biodiversity (Lugg 1996). There is a current closure to prawn running nets in the northeast corner of the lake.

Fishers with licences will be allowed to continue using the lake and creek in accordance with Industry and Investment NSW policies and regulations. The NPWS will liaise with the Industry and Investment NSW to seek to ensure that commercial fishing is conducted in an environmentally sustainable manner.

No vehicle access onto beaches for commercial fishing will be permitted through the park. Access to beaches by commercial fishers can be gained from boat ramps in the villages.

Desired Outcomes

- Commercial and other non-park uses have minimal impact on natural and cultural heritage.

Strategies

- *Arrange licences for facilities maintained by other authorities.*
- *Keep apiary activities under review, and if necessary and feasible, relocate occupancies to the park boundary and rehabilitate the former sites.*
- *Continue to permit access to Lake Wollumboola and Coonemia Creek for commercial fishers in accordance with Industry and Investment regulations and policies.*
- *Liaise with Industry and Investment NSW to ensure that commercial fishing is conducted in an environmentally sustainable manner in Lake Wollumboola. Seek introduction of controls on fishing techniques or catches if necessary to protect the aquatic environment and biodiversity.*
- *Ask Industry and Investment NSW to refer to NPWS any proposals related to fish stocking, aquaculture, changes in commercial fishing arrangements, significant increases in commercial fishing activity or other matters affecting Lake Wollumboola. Some of these activities may require NPWS approval under the environmental assessment process.*

8. MONITORING AND RESEARCH

The Jervis Bay region has been subject to a relatively large amount of research compared with other natural environments (see *Kowari,* 1995). Research on the lands covered by Jervis Bay National Park includes (but is by no means confined to) several significant archaeological studies (e.g. Navin, 1991), historical research on Greenfield Beach and surrounding area (Shoalhaven Historical Society, 1995), vegetation studies (Mills, 1993 and Clarke and Kerrigan 1998), studies on the eastern bristlebird (Baker, 1998), insectivorous bat surveys (Wise and Spencer, 1997 and Gaia Research 1999b), reptile and amphibian survey (Daly 1998), green and golden bell frog study (Grenadier and Mahony, 2000), fauna survey of Greenfield-Hyams Beach area (Murphy in NPWS, 1995), glossy black cockatoo foraging survey (Gaia Research 1999a), and the baseline fauna monitoring study (Capararo and Murphy 1995, Gaia Research 1999a and 2002 and Wildlife Assessment and Management 2006). Lake Wollumboola has also been the subject of many studies including geomorphology, water quality, sedimentation, beach berm dynamics, hydrogen sulphide production, fish assemblages, and waterbird assemblages (see References). The Commonwealth Department of Environment and Water Resources and the Department of Defence conducted a number of research projects on terrestrial biota on Booderee National Park and Beecroft Peninsula.

The purpose of scientific study in the park and reserve is to improve understanding of natural and cultural heritage and the processes, which affect them. Research also establishes requirements for management of particular species and communities.

Under the Southern Regional Forest Agreement (RFA) all forest managers 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 ongoing adaptive management. Criteria and indicators of ecologically sustainable forest management have been identified. Monitoring programs are being developed to demonstrate the impact of management actions on ecological values and processes. Remedial management actions will then be undertaken as required.

Research priorities identified under the RFA will be pursued along with topics identified in this plan of management. Opportunities exist through the realisation of integrated management in Jervis Bay, to combine with other organisations in undertaking research projects that assist management of the Jervis Bay environment. Research by outside organisations and students may also provide valuable information for management. A prospectus will be prepared to encourage involvement of other organisations in priority research areas.

Desired Outcomes

- Research is undertaken that enhances the information base and assists management of the reserves.
- Research causes minimal environmental damage.
- Monitoring programs are in place to detect any changes in the status of park and reserve values.

Strategies

- *Make Jervis Bay National Park and Woollamia Nature Reserve available for appropriate research.*

- *Use the principles of Ecologically Sustainable Forest Management to guide management operations and work with other authorities and stakeholders in implementing ESFM principles across the landscape.*

- *Conduct research to provide information on the natural and cultural heritage and on human use in order to facilitate management of the park and reserve, in close consultation with the Marine Parks Authority and the Booderee National Park board of management.*

- *Encourage researchers from other organisations to design programs to provide information that is directly useful for management purposes.*

- *Maintain liaison with researchers to obtain as much mutual information and assistance as possible. Require the results of research to be provided to the managers of the area.*

- *Only permit research that causes minimal disturbance to the values of the park and reserve unless alternative opportunities are not available outside and the results of research can be demonstrated to offer significant benefits for improvement of management programs or knowledge of natural and cultural heritage.*

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

- *Prepare a prospectus in liaison with the Marine Parks Authority, Department of Defence, Commonwealth Department of Sustainability, Environment, Water, Population and Communities and Booderee National Park Board of Management as a guide to preferred research projects in the park and reserve. Preferred topics will be those identified as priorities in the Southern RFA and of direct relevance to management and include:*

  -studies to assist in the long term preservation of Aboriginal sites and understanding of Aboriginal heritage significance;

  -the distribution and ecology of threatened species of plants and animals;

  - *long term studies on impacts of introduced species of plants and animals;*
  - *fire ecology;*
  - *studies on impacts of urban run-off;*
  - *studies that examine how the different water conditions regulate the biotic, physical and chemical elements of the Lake Wollumboola ecosystem;*
  - *the ecology of the vegetation, invertebrate populations and waterbirds of Lake Wollumboola; and*

- *the impact of recreation and other activities on biodiversity and natural processes.*

- *If Lake Wollumboola is listed as a Ramsar Wetland, establish a monitoring program based on indicators identified in the Ramsar Ecological Character Description, to measure any changes to the ecological character of the lake.*

9. PLAN IMPLEMENTATION

This plan of management establishes a scheme of operations for Jervis Bay National Park and Woollamia 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 regional recreation plans, species recovery plans, fire management plans and conservation 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. High priority activities are those considered 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.

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 be modified so as to comply with the environmental assessment outcomes.

Priority	***Activity***	***Plan ref.***
High	Implement appropriate strategies and actions from the Priorities Action Statement and any recovery plans for threatened species and endangered ecological communities.	4.2, 4.3
	Implement priority recovery actions for populations of the threatened little tern, eastern bristlebird, glossy black-cockatoo, ground parrot, green and golden bell-frog, giant burrowing frog, threatened species relying on tree hollows for breeding and/or roosting and wading birds of Lake Wollumboola and the estuarine wetlands. Continue to undertake protective fencing of little tern breeding sites. Monitor breeding success.	4.3
	Monitor known populations of the eastern chestnut mouse and survey for additional populations. If numbers in a known population site are approaching zero after some years without fire, implement burning programs for tall heath/shrubland, taking account of the requirements of the eastern bristlebird.	4.3
	Implement relevant actions from the Management Plan for the green and golden bell frog key population within the Crookhaven River floodplain that apply to the park and reserve.	4.3
	Actively advance the nomination of Lake Wollumboola as a Ramsar Wetland of International Significance, including conducting research required to support the nomination.	4.3
	Work with the Aboriginal community to monitor Aboriginal archaeological sites, especially sites in high visitation areas.	4.4
	Permit reburial of Aboriginal ancestral remains at a designated site in the park, and associated vehicle access, with prior consent, on existing trails.	4.4

High (cont'd)	Liaise with local government and other authorities to maintain and improve the water quality of the park and reserve catchments. Ensure appropriate water quality monitoring programs are in place in order to build on existing baseline data.	5.1
	Close and rehabilitate trails not required for public access, utility maintenance or management purposes.	5.1
	Support any proposals to replace/realign sewerage infrastructure in environmentally sensitive areas of the park catchments, in association with Shoalhaven City Council and the Southern Rivers Catchment Management Authority.	5.1
	Maintain a natural entrance opening at Lake Wollumboola unless alleviation of severe social hardship or public safety issues cannot be reasonably overcome through other asset protection measures. Regularly monitor the height of the lowest point of the sand berm. If natural lake opening does not occur before the lake height has reached 2.75 AHD, consider artificially opening the lake entrance when there is a real threat of flooding at the floor level of houses or when lake levels are close to affecting higher sewer inspection points on East Crescent, and the forecast is for continued rain.	5.1
	Any artificial opening of Lake Wollumboola will be located at the lowest point on the berm, unless further studies show opening at the southern end to be more appropriate or safety of machinery operators indicates a preferred location. If little terns are breeding then the opening location will be placed away from the breeding colony, where the opening will not disturb their nesting sites.	5.1
	Assess and monitor weed and pest animal populations and implement control programs as needed.	5.2
	Continue to control bitou bush, lantana, arsenic bush, fireweed, sea spurge and any occurrences of other noxious weeds.	5.2
	Control introduced animals as far as practicable where they significantly compete with or prey on native animals, threaten the regeneration of native plant communities or cause erosion. Design control programs to avoid impact on non-target species.	5.2
	Continue fox baiting programs at the sand spit at Lake Wollumboola, along Warrain Beach and in eastern bristlebird habitat adjacent to Booderee NP. Seek community support for the authorisation of increased and alternative control programs around the northern shores of Lake Wollumboola. Educate the community to keep an eye out for fox dens and notify NPWS.	5.2
	Drain dams in the northern part of the park during winter to rid them of mosquito fish and provide opportunities for recolonising by the endangered green and golden bell frog. Destroy any introduced yabbies found during this process.	5.2
	Liaise with Industry and Investment NSW to develop an early detection and eradication strategy for *Caulerpa taxifolia* in Lake Wollumboola. Notify Industry and Investment if there is reasonable suspicion that Caulerpa has been introduced to Lake Wollumboola.	5.2
	Promote community awareness of the threat of weeds and pest animals and the need for their control, and liaise with neighbours as needed to reduce the incidence of illegal dumping of garden refuse	5.2
	Implement the fire management strategy for the park and reserve. Revise and update the plan as needed.	5.3
	Prepare and implement fire management works programs including maintenance of slashed breaks and asset protection zones, fuel reduction burns and trail maintenance works in accordance with the fire management strategy.	5.3

High (cont'd)	Establish or enhance fuel free zones adjacent to villages where required in cooperation with residents and local bushfire brigades.	5.3
	Continue to actively participate on the Shoalhaven District Bush Fire Management Committee.	5.3
	Explore options for continued public vehicle access to Red Point with the Jerrinja Local Aboriginal Land Council. If closure of vehicle access is necessary, consider partial re-alignment of the road combined with provision of a walking track to the site and down-grading or removal of the picnic facilities.	6.2
	Maintain day use parking, picnicking, toilet, walking and interpretive facilities for high levels of use at Greenfield Beach, including some that cater for persons with disabilities.	6.2
	Liaise with NSW Maritime on the implementation of the following: the ongoing application of a 4-knot speed limit for motorised boats in the north-western corner of Wollumboola; the application of a 4-knot speed limit for motorised boats in the western bay (west of a line between Long Bow Point and Copper Cup Point), in the whole of the north-eastern bay and in the southern part of the lake (south of a line between Copper Cup Point and Boalla Point), as set out in the Zoning Map; the extension of speed limits to apply to all watercraft if needed; and in conjunction with Shoalhaven City Council the provision of information relating to the speed limits at main visitor entry points to Lake Wollumboola.	6.2
	Monitor the location and intensity of recreation use of Lake Wollumboola and any conflicts between different user groups, and assess the environmental impact of recreation use. Review the effectiveness of the recreational zoning after a 3-year period or earlier if necessary. If needed, seek community and user input to any proposed change in regulation of recreational use	6.2
	Liaise with Shoalhaven City Council to ensure that Council's policy for the prohibition of dogs within 200 metres of shorebird nesting sites is implemented for the intertidal strip adjacent to the park and for the northern shore of Lake Wollumboola and direct dog walking to the ocean beach to the north of Lake Wollumboola.	6.2
Medium	Resolve the future status and use of access roads, tracks and trails to private land holdings through the reserve and that part of the park affected by the NPE (SRR) Act.	7
	Monitor natural processes and features associated with morphology, sedimentation pattern and rate in Lake Wollumboola and encourage research in this area.	4.1
	Monitor natural revegetation on old quarries and implement active revegetation programs if necessary.	4.2
	Document as much as possible bird lice species and other parasites and their role in the Lake Wollumboola ecosystem and the relationship with their hosts and human lake users. If appropriate provide information to lake users about the presence of lice and other parasites.	4.3
	Continue monitoring waterbird distributions and abundances in response to water levels, lake opening regimes, food resources, drought, flooding and recreational impacts at Lake Wollumboola.	4.3
	Monitor populations of long nosed bandicoot, ring-tailed possum, eastern pygmy-possum, eastern bristlebird, ground parrot and little tern in response to any fox control program.	4.3
	Document the habitats of the 33 bird species at Lake Wollumboola covered under international agreements for migratory bird species. Erect advisory signage to draw public attention to the presence of waders around the lakeshore and their needs.	4.3

Medium (cont'd)	Photograph and record historic places, assess their significance and develop appropriate management strategies.	4.5
	Continue to undertake studies to determine the significance of present and future impacts of urban stormwater and identify remedial measures to protect the park and reserve. If needed approach Shoalhaven Council to implement remedial works and strict controls, through their stormwater plan, to minimise the impacts of urban stormwater.	5.1
	Continue liaison with Council, health authorities and scientific institutions regarding odour from Lake Wollumboola. Support continuation of qualitative and quantitative monitoring by the Culburra Beach community.	5.1
	Record Lake Wollumboola entrance openings and encourage research into past opening regimes, positions and geomorphological history.	5.1
	Erect signs to indicate that unauthorised opening of the Lake Wollumboola entrance is prohibited. Include information about lake opening height, ecological reasons for natural opening and the illegality of unauthorised opening in interpretive programs and other material where appropriate.	5.1
	Prepare and implement a weed control plan for the park and reserve providing for inventory, mapping, monitoring and treatment of noxious and environmental weed species.	5.2
	Undertake ecological burning as needed to 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.	5.3
	Maintain and periodically resurvey vegetation fire monitoring plots.	5.3
	Continue to work with Council to provide and maintain interpretation and bird watching opportunities along the north-eastern shore of Lake Wollumboola including the picnic area and boat ramp area.	6.1
	Investigate potential sites for providing orientation information for visitors to the park and wider area. If a suitable site or sites can be found, install information about visitor opportunities. In conjunction with such a site in the southern end of the park, install an interpretive display about the eastern bristlebird and other threatened species and, if feasible, infrastructure to provide a view over this part of the park.	6.1
	Encourage school and community involvement in educational programs at Lake Wollumboola.	6.1
	Maintain a low-key picnic area at Hammerhead Point, with toilets and walking access to the beach.	6.2
	Maintain access tracks and small parking areas off Currarong Road to Coonemia Creek and the "Bull Hole", including the small boat ramp at Coonemia Creek.	6.2
	Promote walking on trails behind Huskisson, along Moona Moona Creek, to Hare Point and south of Hyams Beach.	6.2
	Develop and implement a plan for a walking track network for the park south of Moona Moona Creek, primarily utilising existing tracks. If possible, provide for cycling on some tracks that are of appropriate width and grade. Close and rehabilitate any unnecessary tracks.	6.2
	Provide information on how recreational activities on Lake Wollumboola should be conducted in a safe and responsible manner.	6.2
	Designate set-up and take-off points at Lake Wollumboola for kite based activities.	6.2
	Keep apiary activities under review and if necessary relocate occupancies to the park boundary and rehabilitate former sites.	7
	If Lake Wollumboola is listed as a Ramsar wetland, establish a monitoring program to measure changes to the ecological character.	8

Low	Monitor vegetation and habitat disturbance and other impacts from adjacent urban development. Work with Southern Rivers Catchment Management Authority, Shoalhaven City Council and community groups to minimise habitat disturbance.	4.2
	Encourage inventory and research into habitat requirements, status and distribution of native animals in the park and reserve, particularly of threatened species.	4.3
	Obtain information on the aquatic and terrestrial invertebrates of Lake Wollumboola related to their role as indicators of a healthy system and as a food source for many threatened species.	4.3
	Promote and undertake research and information gathering about Aboriginal heritage places and landscapes within the park and reserve.	4.4
	Undertake an oral history program to develop a better understanding of pre-contact resource use in the park.	4.4
	Interpret the former settlement at Greenfield Beach.	4.5
	Encourage research into the land use history and social values of the park and reserve.	4.5
	Improve community understanding of the aquatic plants and vegetation communities of Lake Wollumboola and the interactions with the terrestrial, physical and fauna variations of the lake.	5.1
	Continue to liaise with Shoalhaven City Council about prohibiting or at least discouraging cat ownership in new developments adjacent to the park and reserve.	5.2
	Incorporate appropriate biodiversity thresholds and threatened fauna species guidelines in the application of fire regimes to ensure species diversity in the park and reserve. Undertake on-going review of the impact of fire on vegetation composition and structure. Modify programs where appropriate to minimise adverse impacts.	5.3
	Encourage research into the ecological effects of fire in the heathland - shrubland communities, particularly the fire response of rare and threatened plant and animal species including the requirements of the eastern bristlebird.	5.3
	Promote the coastal walking track within the Greenfield Beach-Hyams Beach section of the park as part of the larger White Sands Walk between Plantation Point and Hyams Beach, using on-site interpretive signs prepared in conjunction with Shoalhaven City Council.	6.1
	Work with Shoalhaven City Council, Southern Rivers Catchment Management Authority and local land care groups to deliver community education programs as needed, to reduce the impacts on the park and reserve of adjacent development and unauthorised recreational use.	6.1
	Monitor walk-in camping at Hare Point to determine any necessary limits on the camping area extent and numbers. Provide toilets and possibly drinking water if warranted by the amount of use.	6.2
	Signpost the management trails in Woollamia Nature Reserve to indicate that cycling is allowed and signpost those trails in the national park where cycling is not permitted.	6.2
	Undertake visitor monitoring programs from time to time at various locations to determine visitor numbers, activities and impacts.	6.2
	Arrange licences for facilities maintained by other authorities.	7
	Liaise with the Industry and Investment NSW to ensure that commercial fishing is conducted in an environmentally sustainable manner in Lake Wollumboola and seek to have any proposed changes referred to NPWS. Seek introduction of controls on fishing techniques or catches if necessary to protect the aquatic environment and biodiversity.	7

	Conduct research to provide information on the natural and cultural heritage and on human use in order to facilitate management of the park and reserve.	8
	Prepare a prospectus as a guide to preferred research projects in the park and reserve.	8

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APPENDICES

1. Rare and/or threatened flora recorded in Jervis Bay Region

Plants listed on *Threatened Species Conservation Act 1995*

*Arachnorchis tessellata**	A Spider Orchid
Cryptostylis hunteriana	Leafless Tongue Orchid
*Chamaesyce psammogeton**	Sand Spurge
*Distichlis distichophylla**	Australian Salt Grass
*Melaleuca biconvexa**	Biconvex Paperbark
*Prasophyllum affine**	Jervis Bay Leek Orchid
Prostanthera densa	Villous Mint-bush
Syzygium paniculatum	Magenta Lilly Pilly
*Thesium australe**	Austral Toad-flax
*Wilsonia backhousei**	Narrow-leaf Wilsonia
*W. rotundifolia**	Round-leaf Wilsonia

Other ROTAP (Briggs and Leigh 1995)

*Acacia subtilinervis**	A Wattle
*Grevillea macleayana**	Large-leaf Grevillea
*Leptospermum epacridoideum**	A Tea-tree
*Pultenaea villifera**	A Bush-pea
*Platysace stephensonii**	A Platysace
Goodenia glomerata	A Goodenia
*Corybas undulatus**	Tailed Helmet Orchid
Rulingia hermaniifolia	A Rulingia
Typhonium eliosurum	Typhonium

(* recorded in Jervis Bay NP and/or Woollamia NR)

2. Threatened fauna recorded in the Jervis Bay Region (TSC Act)

Australasian Bittern*	*Botaurus poiciloptilus*
Black Bittern	*Ixobrychus flavicollis*
Barking Owl*	*Ninnox connivans*
Black-tailed Godwit*	*Limosa limosa*
Broad-billed Sandpiper*	*Limicola falcinellus*
Common Bent-wing Bat*	*Miniopterus schreibersii*
Eastern Bristlebird*	*Dasyornis brachypterus*
Eastern Chestnut Mouse*	*Pseudomys gracilicaudatus*
Eastern False Pipistrelle*	*Falsistrellus tasmaniensis*
Eastern Little Mastiff-bat*	*Mormopterus norfolkensis*
Eastern Pygmy-possum*	*Cercartetus nanus*
Gang-gang cockatoo*	*Callocephalon fimbriatum*
Giant Burrowing Frog*	*Heleioporus australiacus*
Glossy Black-Cockatoo*	*Calyptorhynchus lathami*
Great Knot*	*Calidris tenuirostris*
Greater Broad-nosed Bat*	*Scoteanax rueppellii*

Greater Sand Plover*	*Charadrius leschenaulti*
Green and Golden Bell Frog*	*Litoria aurea*
Ground Parrot*	*Pezoporus wallicus*
Hooded Plover	*Thinornis rubricollis*
Koala	*Phascolarctus cinereus*
Large-footed Myotis*	*Myotis adversus*
Lesser Sand Plover*	*Charadrius mongolus*
Little Shearwater*	*Puffinus assimilis*
Little Tern*	*Sterna albifrons*
Masked Owl*	*Tyto novaehollandiae*
Osprey	*Pandion haliaetus*
Pied oystercatcher*	*Haematopus longirostris*
Powerful Owl*	*Ninox strenua*
Regent Honeyeater*	*Xanthomyza phrygia*
Sanderling*	*Calidris alba*
Sooty Oystercatcher*	*Haematopus fuliginosus*
Southern Brown Bandicoot	*Isoodon obesuls*
Spotted-tail Quoll	*Dasyurus maculatus*
Square-tailed Kite*	*Lophoictinia isura*
Squirrel Glider*	*Petaurus norfolkensis*
Swift Parrot	*Lathamus discolor*
Turquoise Parrot*	*Neophema pulchella*
Terek Sandpiper*	*Xenus cinereus*
Wandering albatross*	*Diomedea exulans*
White-footed Dunnart*	*Sminthopsis leucopus*
Yellow-bellied Glider*	*Petaurus australis*
Yellow-bellied Sheath-tail Bat*	*Saccolaimus flaviventris*

(* recorded in Jervis Bay NP and/or Woollamia NR)

3. Endangered ecological communities occurring in Jervis Bay National Park and Woollamia Nature Reserve

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions

Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions

Sydney Freshwater Wetlands in the Sydney Basin Bioregion

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Bangalay Sand Forest of Sydney Basin and South east Corner Bioregions

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

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