

Pittwater Coastal Zone

Flora & Fauna Study

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Executive Summary

The authors were engaged by Council to undertake a flora and fauna study of the Coastal Zone. The objectives of this report, which will be incorporated into the Coastal Management Plan, is to provide in depth information on flora and fauna within Pittwater's Coastal catchments that will assist in the area's management.

After undertaking the study, it is considered that, on the whole, the Coastal Zone's terrestrial flora and vertebrate fauna and their habitats are reasonably well understood. However, further information, particularly new records of significant species, will assist in management. Ongoing research and monitoring of intertidal areas is also greatly expanding our knowledge of these important habitats and man's impact upon them. Although there is information on some taxa of terrestrial invertebrates, further research in this field - especially on ecology and conservation status of component species - is required.

From the study, it can be concluded that Pittwater's Coastal Zone has a high degree of biodiversity. This has resulted from the amount and variety of remnant bushland, the mild climate and the interface between land and sea. Many flora and fauna species and habitats of regional, state and national conservation significance occur in the Coastal Zone.

Active management is required to maintain and enhance the significant ecological values of the Coastal Zones. Council, its staff and volunteers have shown a high degree of commitment in this regard.

Issues of particular concern in the Coastal Zone are:

- Rock Platforms
- Fauna Habitat Improvement including weed control and bush regeneration
- Headland Management
- Cliff Erosion
- Bicentennial Coastal Walkway
- Stormwater Disposal
- Beach Management including Visitor Use, Access, Erosion and Dune Stabilisation
- Fire Management
- Cliff Erosion

Recommendations are made in regard to appropriate responses and performance measures in relation to these issues.

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1. Introduction

The authors were engaged by Pittwater Council to undertake a coastal flora and fauna study to assist in the future management of the council's coastal zone. The coastal zone covers the area east of Pittwater and Barrenjoey Roads from Narrabeen Bridge in the south to Barrenjoey Headland and includes intertidal areas (Figure 1).

The aim of this study is to

- provide a detailed floristic and faunal survey of the study area
- conduct searches for rare, threatened or significant species and identify areas of high conservation value
- define priorities and objectives for the conservation of dune systems, headlands, rock platforms and unvegetated beach areas.

2. Methodology

Flora

Site inspections were undertaken to map weed infestations and refine previous vegetation mapping which was undertaken as part of the Urban Bushland Plan of Management.

Specific searches were done for flora species of conservation significance. This was done on the basis of previous records and the provision of suitable habitat.

Fauna

A survey of the vertebrate fauna of the study area was carried out during May 1997. This included targeted surveys for threatened fauna species as well as general surveying of protected fauna. The following methods were used in respect of each taxon.

Mammals

Mammals were surveyed by a combination of spotlight survey and tree trapping. In the case of the Squirrel Glider, tree trapping was undertaken over three nights at Bangalley Headland. Spotlight surveys were undertaken at Bangalley Headland, Bilgola Bends and Bushrangers Hill. Specific food trees of the Koala were inspected for signs of use.

Birds

Diurnal bird species were surveyed opportunistically during habitat inspections and surveys for other fauna. Particular attention was paid to near-shore, beach and rock platform habitats as these were not surveyed during the Bushland Plan of Management Study.

Surveys of nocturnal birds were undertaken concurrent with spotlight surveys of mammals. As the study area is already known to be occasionally used by the Powerful Owl, it was considered inappropriate to use playback tapes of this species during its breeding season. However, call back responses of the threatened Masked Owl (*Tyto novaehollandiae*) and regionally significant Barking Owl (*Ninox connivens*) were broadcast from just outside the study area in Ingleside Park on two nights in June.

Herpetofauna

Reptiles and frogs were searched in typical habitat and shelters including creeks, waterholes, bark, rocks, leaf litter, hollow and fallen logs and man-made debris. Due to the onset of cooler weather during the survey period, herpetofauna activity was minimal.

Invertebrates

Records of intertidal species occurring between Port Jackson and Broken Bay were kindly supplied to the author by Isobel Bennet AO, a local resident, intertidal expert and co-author of *Australian Seashores* (Dakin & Bennet, 1987). Phil Colman of the Australian Museum kindly supplied information on Molluscs. These sources, in conjunction with general information in Edgar (1997) and Jansen (1995), were used to compile a database on the distribution of intertidal invertebrates.

Information on terrestrial invertebrates was gained by reviewing information in Haines, (1972), Harcobian (1995), Moulds (1990), Common and Waterhouse (1981) and Williams and Adam (1994). Max Moulds of the Australian Museum kindly supplied information on cicadas and access to Haines' collection of moths and butterflies held by the Museum.

3. Flora

3.1 Description of Plant Communities

Spotted Gum Forest (PC01)

Spotted Gum Forest occurs on lower slopes at Hordern Park and Wiltshire Park, Palm Beach. The plant community is associated with Newport formation geology on soils of the Watagan soil landscape unit (Chapman and Murphy 1989). The dominant tree species is Spotted Gum (*Corymbia maculata*), with associated species including Grey Ironbark (*E. paniculata*) and Bangalay (*E. botryoides*). Tree height is generally over 20 metres tall with individuals reaching 30 metres. The canopy density in some areas has been reduced due to dieback over the years. This problem appears to be continuing and is exacerbated by nutrient enrichment and invasion by exotic tree, shrub and vine species.

There is a layer of tall shrubs and small trees of medium to high density. The most common species include Forest Oak (*Allocasuarina torulosa*), Cheese Tree (*Glochidion ferdinandii*), Blueberry Ash (*Elaeocarpus reticulatis*) and Sweet Pittosporum (*Pittosporum undulatum*). Other associated species include Mock Olive (*Notelaea longifolia*), Hop Bush (*Dodonaea triquetra*) and the introduced plant, Lantana (*Lantana camara*).

The ground layer is dense and in wet areas dominated by ferns. Elsewhere grasses and sedges are common. Frequent ground layer species include Bracken Fern (*Pteridium esculentum*), False Bracken (*Calochlaena dubia*), Common Maidenhair Fern (*Adiantum aethiopicum*), Bordered Panic (*Entolasia marginata*), Variable Sword-sedge (*Lepidosperma laterale*), Spiny Mat-rush (*Lomandra longifolia*), Kangaroo Grass (*Themeda australis*) and the introduced plant *Asparagus (Protasparagus aethiopicus)*. Common climbers include Wonga Vine (*Pandorea pandorana*), Sweet Sarsaparilla (*Smilax glycyphylla*) and *Morinda jasminoides*.

Spotted Gum Forest was formerly widespread on the lower slopes of the western side of the Barrenjoey Peninsula. The extent of this community has been greatly affected by urban development, but examples remain in McKay Reserve, Angophora Reserve and Stapleton Park. Spotted Gum Forest of the type present in McKay Reserve is only found on Newport Formation geology. Barrenjoey Peninsula was formerly a significant part of its distribution. Other examples occur on Scotland Island, the western shores of Pittwater and at Burley Griffin Lodge, Avalon, a property owned by the National Trust. All remaining examples have conservation significance at a state level.

Cabbage Tree Palm Forest (PC03)

Sheltered gullies of eastern aspect support Cabbage Tree Palm Forest. The structural formation is Closed-forest with Cabbage Tree Palm (*Livistona australis*) being the dominant species. Associated tree species include Bastard Rosewood (*Synoum glandulosum*), Forest Oak (*Allocasuarina torulosa*) and Veiny Wilkiea (*Wilkiea huegeliana*). Emergent Broad-leaved White Mahogany (*Eucalyptus umbra*) trees are also present.

Headland Open-scrub (PC10)

At Mona Vale Headland and parts of Turimetta Headland the native vegetation consists of an open-scrub formation dominated by Scrub She-oak (*Allocasuarina distyla*) and Coastal Teatree (*Leptospermum laevigatum*). Shrub height is generally between 2 and 3 metres. Associated shrub species include Coast Rosemary (*Westringia fruticosa*), Rusty Petals (*Lasiopetalum ferrugineum*) and Coast Wattle (*Acacia sophorae*).

There is a ground layer of medium to high density dominated by grasses and sedges. Ground layer species include Kangaroo Grass (*Themeda australis*), *Ptilothrix deusta*, *Xanthosia tridentata*, Spiny Mat-rush (*Lomandra longifolia*) and *Dianella caerulea* var. *producta*.

Kangaroo Grass also dominates much of the mown grassland areas at Mona Vale Headland.

Coastal Scrub (PC11)

Shale soils associated with headlands and sheltered areas on dunes support an open-scrub dominated by Coast Banksia (*Banksia integrifolia*), Coast Rosemary (*Westringia fruticosa*) and Coastal Teatree (*Leptospermum laevigatum*). Associated shrubs include Black She-oak and Rusty Fig (*Ficus rubiginosa*).

There is a ground layer of medium density, with a range of grasses, vines and grass-like plants. These include Kangaroo Grass (*Themeda australis*), Sea Rush (*Juncus kraussii*), Dusky Coral Pea (*Kennedia rubicunda*), *Dianella revoluta*, Spiny Mat-rush (*Lomandra longifolia*), Scented Marsdenia (*Marsdenia suaveolens*) and Old Man's Beard (*Clematis aristata*).

Exotic weeds are common, particularly in disturbed areas or those affected by nutrient charged run-off. Weed species present include Mirror Plant (*Coprosma repens*), Gazania (*Gazania rigens*), Madeira Vine (*Anredera cordifolia*), Blackberry (*Rubus ulmifolius*), Fern Asparagus (*Protasparagus aethiopicus*), Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera*), Kurnell Curse (*Hydrocotyle bonariensis*) and Mother-of-Millions (*Kalanchoe tubiflora*).

Examples of this community occur towards the southern end of Mona Vale Beach and South Mona Vale Headland Reserve.

Coastal Closed-Heath (PC12)

Stabilised dunes behind Mona Vale, Avalon and Bungan beaches support a closed-heath community dominated by Coast Wattle (*Acacia sophorae*). The dominant shrub layer varies between 1 and 2 metres in height. Tree Broom-heath (*Monotoca elliptica*), *Breynia oblongifolia* and Black She-oak (*Allocasuarina littoralis*) are associated shrub species.

The ground layer is of low density and dominated by herbs and creepers. Common species include Beach Fan Flower (*Scaevola calendulacea*), Kidney Weed (*Dichondra repens*), Spinifex (*Spinifex hirsutus*) and Guinea Flower (*Hibbertia scandens*).

Exotic species are common. These include Gazania (*Gazania rigens*), Bitou Bush (*Chrysanthemoides monilifera*), Fern Asparagus (*Protasparagus aethiopicus*), Lantana (*Lantana camara*) and Kurnell Curse (*Hydrocotyle bonariensis*).

This plant community was not identified as occurring in the Pittwater area by Benson & Howell (1994). This was due to its limited extent which made it not possible to map at the broader scale of their survey.

Cliff-face Open-heath (PC13)

Areas on cliff-faces of Hawkesbury Sandstone along the coast support an open-heath community dominated by Coast Rosemary (*Westringia fruticosa*) and Coast Wattle (*Acacia sophorae*).

Associated native shrub species include Scrub She-oak (*Allocasuarina distyla*), Coastal Teatree, Hop Goodenia (*Goodenia ovata*) and Sweet Pittosporum (*Pittosporum undulatum*). Ground layer species include Kangaroo Grass (*Themeda australis*) and Spiny Mat-rush (*Lomandra longifolia*).

Table 1 - Plant Community Distribution in the Pittwater Coastal Zone

Plant Community	Location
Spotted Gum Forest (PC01)	Hordern Park, Wiltshire Park
Cabbage Tree Palm Forest (PC03)	Bilgola Beach
Headland Open-scrub (PC10)	Mona Vale Headland, Turimetta Head
Coastal Scrub (PC11)	Mona Vale Beach, South Mona Vale Headland Reserve.
Coastal Closed-Heath (PC12)	Mona Vale Beach, Bungan Beach, Avalon Beach
Cliff-face Open-heath (PC13)	Bungan Head

3.2 Profiles of Significant Plant Species

Common Acronychia (*Acronychia oblongifolia*)

Description : Common Acronychia is a small tree which grows in rainforest communities.

State Distribution : The species extends along coastal New South Wales.

Pittwater Distribution : Bilgola Beach, Stapleton Park, Bayview

Habitat : Rainforest, including littoral rainforest and dry rainforest, and rainforest margins.

Pittwater Plant Communities : Cabbage Tree Palm Forest

Fire Response : Killed outright

Threats : Competition with weeds such as Lantana and Small and Large-leaved Privet; High Fire Frequency

Significance : Uncommon in Sydney region

Wild Quince (*Alectryon subcinereus*)

Description: Wild Quince is a tall shrub or small tree to about 8 metres in height. It has compound leaves with 4 to 6 leaflets.

State Distribution: Coastal New South Wales extending inland to the Central Tablelands and Central Western Slopes (e.g. Jenolan Caves and the Liverpool Range)

Pittwater Distribution: Crown of Newport Reserve

Habitat: Rainforest and rainforest margins, including dry rainforest

Pittwater Plant Communities: Coachwood Forest

Fire Response: May resprout from base

Threats : Low population; weed competition

Significance : Uncommon in Sydney region

Drooping She-oak (*Allocasuarina verticillata*)

Description : A tall shrub or small tree to 10 metres in height. This species has drooping branches and dark, fissured bark.

State Distribution : South and central coast, southern tablelands, western slopes and plains

Pittwater Distribution : Newport, Bungan Beach, Mona Vale.

Habitat : Coastal headlands on shale soils

Pittwater Plant Communities : Coastal Closed-Heath; Headland Open-Scrub

Fire Response : Killed outright

Threats : Competition with weeds, High fire frequency

Significance : Restricted distribution along coast

Blechnum camfieldii

Description : A fern whose fronds grow in clumps. The fronds grow to 100cm in length and new growth is pinkish.

State Distribution : North along the Coast from Clyde Mountain to the Queensland border.

Pittwater Distribution : Irrawong Reserve

Habitat : Low-lying coastal wetlands.

Pittwater Plant Communities : Swamp Mahogany Forest

Fire Response : Resprouts from rhizome

Threats : Water pollution, weed competition.

Significance : Rare local population.

Red Olive Plum (*Cassine australis* var. *australis*)

Description: Red Olive Plum is a small tree with broad, opposite leaves. The fruit is an orange-red berry which ripens in autumn and winter.

State Distribution : Coastal New South Wales north from Tuross Heads and inland to the upper Hunter Valley.

Pittwater Distribution : Barrenjoey Headland, Bungan Beach, Bilgola Beach, Bayview, Mona Vale Headland Reserve

Habitat : Rainforest, including littoral rainforest and sub-tropical rainforest

Pittwater Plant Communities : Cabbage Tree Palm Forest, Coastal Closed-Heath

Fire Response : Not known

Threats : Weed competition including Lantana and Small and Large-Leaved Privet

Significance : Rare local populations

Diplazium dilatatum

Description : A short-trunked rhizomatous fern to 60cm in height.

State Distribution : North Coast

Pittwater Distribution : Irrawong Reserve

Habitat : Rainforest and coastal wetlands

Pittwater Plant Communities : Swamp Mahogany Forest

Fire Response : Not known

Threats : Water pollution, weed competition.

Significance : New southern limit, not previously recorded south of Wauchope.

Eriostemon buxifolius ssp. buxifolius

Description : This waxflower is a low shrub usually less than 1 metre in height.

State Distribution : Jervis Bay to central coast

Pittwater Distribution : Turimetta Head

Habitat : Coastal scrub and heath communities on shale or sandstone.

Pittwater Plant Communities : Headland Open-Scrub

Fire Response : Possibly resprouts from base

Threats : Inappropriate fire regime

Significance : Rare local population, northern limit

Bolwarra (Eupomatia laurina)

Description : Bolwarra is a shrub with straggling branches and grey-green, glossy leaves. The fruit is an oval-shaped edible berry.

State Distribution : Coastal New South Wales and the Blue Mountains

Pittwater Distribution : Hewitt Reserve, Bilgola Beach, Stapleton Park, Crown of Newport Reserve, Bayview, Mona Vale Headland Reserve

Habitat : Rainforest and rainforest margins

Pittwater Plant Communities : Cabbage Tree Palm Forest, Coachwood Forest

Fire Response : Resprouts from base

Threats : Competition from weeds such as Lantana and Small and Large-leaved Privet

Significance : Locally uncommon

Whip Vine (Flagellaria indica)

Description: Whip Vine is a sturdy climber with grass-like leaves. It can climb over trees or sandstone cliffs.

State Distribution : Coastal New South Wales north from the Hacking River

Pittwater Distribution : Barrenjoey Head

Habitat : Rainforest and rainforest margins

Pittwater Plant Communities : Cabbage Tree Palm Forest

Fire Response : Not known

Threats : Low population in Pittwater, Competition from weed species

Significance : Only recorded location between Broken Bay and Port Hacking

Guioa (*Guioa semiglauca*)

Description: Guioa is a small tree to 6 metres in height with compound leaves.

State Distribution : Coastal New South Wales north from Batemans Bay (Murramarang National Park)

Pittwater Distribution : Crown of Newport Reserve, Brown Bay, Crescent Reserve

Habitat : Rainforest, rainforest margins and headlands

Pittwater Plant Communities : Coachwood Forest

Fire Response : Not known

Threats : Competition from weed species

Significance : Locally uncommon

Snow-wood (*Pararchidendron pruinosum*)

Description : Snow-wood is a tree with large, white to greenish yellow flowers. It has large bipinnate leaves to 40 cm long.

State Distribution : Coastal New South Wales north from Nowra and inland to Muswellbrook

Pittwater Distribution : McKay Reserve, Dark Gully Park, Barrenjoey Head, Crown of Newport Reserve

Habitat : Rainforest including sub-tropical and littoral rainforest

Pittwater Plant Communities : Coachwood Forest

Fire Response : Not known

Threats : Competition from weeds

Significance : Locally uncommon

***Pomaderris* sp. B**

Description : *Pomaderris* sp. B is a shrub of 1 to 2 metres in height. It has narrow leaves and white flowers in late winter or spring.

State Distribution : Bulli area and North Narrabeen to Newport

Pittwater Distribution : Bushrangers Hill, Bungan Beach, Mona Vale Headland, Turimetta Headland

Habitat : Coastal headlands on shale soils

Pittwater Plant Communities : Headland Open-Scrub

Fire Response : Some plants killed, most apparently resprout

Threats : High fire frequency, Competition from weeds

Significance : Restricted distribution. Northern limit.

Rough Mint Bush (*Prostanthera denticulata*)

Description : Rough Mint Bush is a small shrub which rarely reaches 1 metre in height. It has small ovate to lanceolate leaves and violet to lilac flowers.

State Distribution : Restricted to the central coast

Pittwater Distribution : Stapleton Park, Bilgola Beach, Bayview, Bungan Beach

Habitat : Sheltered forest

Pittwater Plant Communities : Red Bloodwood - Scribbly Gum Woodland (PC07), Hawkesbury Sandstone Open-forest (PC05)

Fire Response : Not known

Threats : Inappropriate fire regime, Weed competition

Significance : Local endemic

Rulingia hermannifolia

Description : *Rulingia hermannifolia* is a low, spreading shrub with small, wrinkled leaves.

State Distribution : South and central coast from Jervis Bay to Broken Bay (Bouddi National Park)

Pittwater Distribution : Bangalley Head

Habitat : Coastal heath

Pittwater Plant Communities: Headland Open-Scrub

Fire Response : Germinates rapidly from soil stored seed

Threats : Low population

Significance : ROTAP 3RCa, restricted distribution in Pittwater, Near northern limit.

Magenta Lilly Pilly (*Syzygium paniculatum*)

Description : Magenta Lilly Pilly is a small tree with lanceolate leaves to 9 cm in length. It has white flowers and pink, red or purple edible fruit.

State Distribution : Coastal New South Wales from Jervis Bay to Bulahdelah

Pittwater Distribution : Browns Bay, Scotland Island

Habitat : Sub-tropical and littoral rainforest and rainforest margins or stabilised sand dunes

Pittwater Plant Communities: Coachwood Forest

Fire Response : Killed outright

Threats : High fire frequency, Weed competition

Significance : ROTAP 3vci

Gosford Wattle (*Acacia prominens*)

Description : Gosford Wattle is a small tree with phyllodes to 5 cm in length. The flowers are globular and bright lemon-yellow in racemes

State Distribution : Mulgoa to Wollemi. Core area is the Gosford District

Pittwater Distribution : Bilgola Bends

Habitat : Rainforest and Tall Open-forest.

Pittwater Plant Communities: amongst *Acacia saligna* scrub on fill

Fire Response : unknown

Threats : The species has probably been introduced to the Bilgola Bends in fill from Middle Harbour

Significance : Formerly a ROTAP (2RCa); restricted distribution in Pittwater

3.3 Weed Issues/Threats

Spread of exotic weed species is a problem in all coastal habitats including dunes, headlands and rainforests. Each habitat type has its own characteristic suite of weed species. Several of the weed species are listed as noxious plants in the Pittwater Council area.

There are other plants which are significant environmental weeds in coastal habitats, but which are not currently declared as noxious weeds. It is recommended that Pittwater Council review weed problems along the Pittwater coast and where necessary recommend further species for declaration as noxious weeds. It is further recommended that Mirror Bush (*Coprosma repens*) be nominated by Council for declaration as a noxious weed under category W2.

Table 2 - List of Noxious Weeds Present in Pittwater Coastal Zone

Turkey Rhubarb (<i>Acetosa sagittata</i>)	W4c
Moth Vine (<i>Araujia hortorum</i>)	W4c
Bitou Bush (<i>Chrysanthemoides monilifera</i>)	W2
Morning Glory (<i>Ipomoea indica</i>)	W4c
<i>Ipomoea carioca</i>	W4c
Lantana (<i>Lantana camara</i>)	W2
Large-leaved Privet (<i>Ligustrum lucidum</i>)	W4b
Small-leaved Privet (<i>Ligustrum sinense</i>)	W4b
Japanese Honeysuckle (<i>Lonicera japonica</i>)	W4c
Ochna (<i>Ochna serrulata</i>)	W4b
Asparagus Fern (<i>Protasparagus aethiopicus</i>)	W4c
Blackberry (<i>Rubus ulmifolius</i>)	W2
Rhus Tree (<i>Toxicodendron succedaneum</i>)	W2

KEY

W2 The weed must be fully and continuously suppressed & destroyed

W4b Shall not be sold, propagated or knowingly distributed. Established plantings must be prevented from flowering & fruiting.

W4c Shall not be sold, propagated or knowingly distributed. Occupier must prevent spread to adjoining property.

4. Fauna

179 species of vertebrate fauna are known or likely to occur in the Coastal Zone. Of these eight are considered threatened at a State level. Three of these threatened species, Osprey, Pied Oystercatcher and Sooty Oystercatcher are confined to coastal environments.

It is not known how many invertebrate fauna species occur in the Coastal Zone and there is a need for further research in this area. However, considering the range of habitats present from intertidal areas to beaches, heaths and forests there is likely to be a high diversity.

4.1 Invertebrates

4.1.1 Intertidal Invertebrates

The influence of the prevailing north-south current along the coast and the variety of microhabitats available on the rock platforms (eg crevices, boulders, flat areas) has resulted in their occupation by a diversity of invertebrate species. Surveys undertaken as part of the Ocean Rescue 2000 project at Little Head by the Institute of Marine Ecology have revealed the presence of 93 marine invertebrate species. From a review of literature and information supplied by Isobel Bennet as many as 200 species may occur (Appendix A), though many of these may only be ephemeral or opportunistic.

4.1.2 Terrestrial Invertebrates

Butterflies

Although information on other terrestrial invertebrates is lacking, there is adequate information on butterflies in Pittwater. Due to the area's mild climate and relatively high soil fertility, it is estimated that at least 100 species occur in Pittwater (Harcobian, 1995). The diversity of butterflies in the area is probably also a function of the range of vegetation types and plant species, particularly rainforest species.

Another factor affecting the suitability of the coastal zone as butterfly habitat is the presence of a number of elevated vegetated ridges. A number of insect species, including male butterflies of some species, exhibit "hill-topping", behaviour, in which they aggregate at crests or ridge-tops (Common & Waterhouse, 1981; Rushworth, 1996). Usually such sites are small in size and on pointed hills (Moulds pers comm). A local example of this is Bushrangers Hill, which is a known hill-topping site.

A number of species of conservation significance have been recorded in the Pittwater area (Haines, 1972; Harcobian, 1995). Table 3 lists those species whose known larval food plants and distribution fall within the coastal zone. (Common and Waterhouse, 1981).

Table 3 Butterfly Larvae Host Plants Known to occur in the Coastal Zone

Key

S - southern limit of distribution; **U** - regarded as uncommon **H** - hilltopping species

Plant Species	Occurrence	Butterfly Species
Cabbage Palm (<i>Livistona australis</i>)	Bilgola northward	Orange Palm Dart (<i>Cephrenes augiades</i>)
Laurel <i>Cryptocarya sp</i>	Mackay Res.	Blue Triangle (<i>Graphium sarpedon</i>) H
<i>Acronychia oblongifolia</i>	Bilgola	Orchard Swallowtail (<i>Papilio aegus</i>)
Snow-wood (<i>Pararchidendron pruinosum</i>)	"	Tailed Emperor (<i>Polyura pyrrhus</i>) H
Fern-leaved Wattles (<i>Acacia irrorata, A.terminalis</i>)	forests	Double-spotted Line-blue (<i>Nacaduba biocellata biocellata</i>), Tailed Emperor, Fiery Jewel (<i>Hypochrysops ignitus</i>), Imperial Blue (<i>Jalmenus evagoras</i>)
Hickory (<i>Acacia implexa</i>)	throughout	Imperial Blue, Blue Jewel (<i>Hypochrysops delicia</i>) U
Tuckeroo (<i>Cupaniopsis anacardioides</i>)	hind-dunes & headlands, forests	Glistening Blue (<i>Theclinesstes scintillata</i>) S Hairy Line Blue (<i>Erysichton lineata</i>) S , Fiery Jewel, Felder's Line Blue (<i>Prosotas felderi</i>), Pencilled Blue (<i>Candalides absimilis</i>), <i>Deodorix epijarbas</i>
Mistletoe (<i>Muellerina celastroides</i>)	Careel Headland Res.	Green-banded Blue (<i>Danis hymetus taygetus</i>) S
Native Peach (<i>Trema aspera</i>)	Mackay Reserve	Speckled Line Blue (<i>Catopyrops florinda</i>)
Bush-pea (<i>Bossiaea spp</i>)	Careel Headland Res	Fringed Blue (<i>Neolucia agricola</i>)
<i>Pomaderris spp</i>	throughout	Byzos Blue (<i>Hypochrysops byzos</i>)
Christmas Bush (<i>Ceratopetalum gummiferum</i>)	Mackay, Careel	A Blue (<i>Candalides consimilis</i>)
<i>Polyscias sambucifolius</i>	"	<i>Candalides consimilis</i>
Rice-flower (<i>Pimelea linifolia</i>)	"	Yellow-spot Blue (<i>Candalides xanthospilos</i>)
Common Silkpod (<i>Parsonsia straminea</i>)	"	Common Australian Crow (<i>Euploea core corinna</i>)
Figs (<i>Ficus rubiginosa</i> and <i>F.coronata</i>)		Common Australian Crow
Mock-olive (<i>Notelaea longifolia</i>)	forests	Eastern Flat (<i>Netrocoryne repanda</i>)
Mat-rushes (<i>Lomandra sp</i>)	throughout	Skippers (<i>Trapezites symmumus, T. praxedes, T. Petalia, T.eliana</i>) H
Saw-sedges (<i>Gahnia spp</i>)	"	Swordgrass Butterfly (<i>Tisiphone abeonna</i>), Skippers (<i>Hesperilla donnysa, H.picta, H.ornata, H.masteri</i>), Large Dingy Skipper (<i>Toxidia peron</i>)
Kangaroo Grass	"	Common Brown (<i>Heteronympha merope</i>)
Couch (<i>Cynodon dactylon</i>)	headlands, dunes	Skipper (<i>Ocybadistes wlakeri sothis</i>)
Bladey Grass (<i>Imperata cylindrica</i>)	throughout	Evening Brown (<i>Melanitis leda bankia</i>) S <i>Telicota ancilla ancilla</i>
<i>Wisteria sp *</i>	gardens	<i>Hasora khoda haslia</i> (S)
Weeping Meadow Grass (<i>Microlaena stipoides</i>)	headlands, forests	Doubleday's Skipper (<i>Toxidia doubledayi</i>)
Broom Heath (<i>Monotoca elliptica</i>)	headlands	Mathew's Blue (<i>Neolucia mathewi</i>)
Bush-pea (<i>Pultanaea daphnoides</i>)	Careel Headland Res.	Mathew's Blue
Whip Vine (<i>Flagellaria indica</i>)	Barrenjoey	Pencilled Blue (<i>Candalides absimilis</i>)
Tick-trefoil (<i>Desmodium sp</i>)	Forests	Common Grass-blue (<i>Zizina labradus labradus</i>)
Devil's Twine (<i>Cassytha spp</i>)	throughout	<i>Candalides hyacinthus</i> H
Burrawang (<i>Macrozamia communis</i>)	Bilgola north	<i>Theclinesstes onycha onycha</i>

Cicadas

Although most of the cicada species that occur in the Pittwater area are common, they are all sensitive to habitat removal or modification and local populations can be threatened by inappropriate land use. For instance, the proliferation of hard surfaces such as paving and bitumen under host trees can prevent adults from emerging from the underground burrows in which they metamorphose.

Three of the species occurring locally (See Table 4) are reliant on dunal vegetation for their survival. Disturbance to this habitat type at Avalon lead to localised extinctions of these species (M. Moulds pers comm). Restoration of this area may have resulted in recolonisation of the species.

Table 4 Locally Occurring Cicada Species (based on Moulds, 1990)

Scientific Name	Common Name	Habitat
<i>Hemicopsaltria eydouxii</i>	Razor Grinder	Open Forest, rainforest; nymphs feed on Spotted Gum
<i>Psaltoda harrissi</i>	Yellowbelly	woodland on medium sized eucalypts and Coast Banksia; sporadically common.
<i>Psaltoda plaga</i>	Black Prince	She-oaks
<i>Abrieta curvicosta</i>	Floury Baker	<i>Melaleuca</i> spp, <i>Callistemon</i> spp
<i>Cicadetta labeculata</i>	Double Spotted	Sydney Golden Wattle and Coast Wattle
<i>Cicadetta arenaria</i>	Sand Fairy	Dunes; reliant on Spinifex
<i>Cicadetta akites</i>	-	Dunes; reliant on Spinifex
<i>Arunta perulata</i>	White Drummer	Dunes; reliant on Coast Banksia
<i>Thopha saccada</i>	Double Drummer	Large smooth-barked gums; probably rare on peninsula

Moths

The Australian Museum holds a collection of moths and butterflies bequeathed to it by the late amateur entomologist Mr L.C. Haines. A number of these specimens were collected at his home at Locquat Valley in Bayview. Although not yet quantified, perusal of the collection indicated a high degree of diversity. The reasons for the diversity of species at Bayview are the frost-free climate and the presence of rainforest vegetation (Moulds pers comm). A number of sites in the Coastal Zone (eg Bilgola, Whale Beach) which have similar characteristics could be expected to have the same degree of diversity in moth fauna.

Rainforest Plant Pollination by Insects

The coastal zone contains a number of areas of littoral rainforest. A number of "rainforest" plant species adapted to drier environments also occur in scrubs, heaths and forests. An important factor affecting the viability of these rainforests is the ability of plants to cross-fertilise and maintain genetic variation. Pollination, the method of cross-fertilisation in plants, is achieved by a number of vectors including wind, birds, bats, and insects. The following discussion, based on a paper by Williams and Adam (1994), concentrates on the role of insects in rainforest and implications for management of Pittwater's rainforests and component species.

Invertebrates are particularly important in rainforest pollination due to the lack of bird pollination. Most rainforest plants have unspecialised flowers. This indicates that they can be pollinated by a variety of insect species rather than one specific insect.

However, there are exceptions to this where particular plant species have a pollinator relationship with an insect taxon. Some of these plant species occur in the coastal zone. For example, the shrub Bolwarra (*Eupomatia laurina*), which is regarded as locally significant in Pittwater, relies on a Weevil (*Elleschodes* spp). Bolwarra has a relatively short flowering episode (2-3 weeks) in which flowers open in the hours before dawn. Pollen is transported by Weevils picking it up as they emerge from flowers at dusk. They then deposit it as they enter flowers the following dawn.

Sandpaper Fig (*Ficus coronata*) and Port Jackson Fig (*F.rubiginosa*) are patchily distributed through the coastal zone. The flowers of these plants are borne on the inner wall of what is generally regarded as the fruit. Pollen is picked up by adult wasps which have matured from eggs laid in the "fruit". They then emerge and carry the pollen to other "fruits" thus ensuring cross-fertilisation (Fairley, 1989).

Williams and Adam (1994) recommend that rainforest sites should be managed to maximise the diversity of the pollinator guild. The aim of this approach is to maintain biodiversity and reduce the risk of losing particular plant/pollinator relationships that may not as yet be fully understood. Structural diversity of the vegetation is important in this regard. Council should therefore manage remnant rainforest vegetation with the aim of restoring and maintaining diversity of plant species and strata.

Currently, Council is involved in the removal of invasive *Acacia saligna* and other weeds from the Bilgola Bends area. The cleared land is being revegetated with locally occurring native plant species including a number of rainforest plants. This will improve the viability of this important rainforest stand and its component plant and insect species. Weed control programmes need to be extended elsewhere in the Bilgola area and at smaller remnants such as Wiltshire Park, Palm Beach.

It is also recommended that Council inform residents of the beneficial role of invertebrates and encourage reduction in the use of harmful chemical pesticides. With the reported increase in mosquito-borne diseases in the Sydney Region, there is likely to be pressure on councils such as Pittwater to conduct control programmes. It is recommended that Council investigate the use of non-chemical agents (eg hormonal or biological controls) to reduce impacts on non-target species.

Table 4 Examples of Likely Plant-Insect Pollinator Relationships in the Coastal Zone

Taxon	Plant Species
<i>Elleschodes hamiltoni</i> (a weevil)	Bolwarra (<i>Eupomatia laurina</i>)
<i>Pleistodontes</i> spp (Fig-wasp)	Figs (<i>Ficus rubiginosa</i> , <i>F.coronata</i>)
Hymenoptera (Bees)	Lilly Pilly (<i>Acmena smithii</i>), Guinea Flowers (<i>Hibbertia scandens</i> & <i>H.dentata</i>)
Thysanoptera (Thrips)	Muttonwood (<i>Rapanea</i> spp), Native Sarsaparilla (<i>Smilax</i> spp), <i>Wilkiea huegiana</i> , <i>Breynia oblongifolia</i>
Diptera (Flies)	Ground Orchids (<i>Pterostylis</i> , <i>Acianthus</i> , <i>Corybas</i>)
Lepidoptera (Butterflies)	Snow-wood (<i>Pararchidendron pruinosum</i>), Common Silkpod (<i>Parsonsia straminea</i>)
Coleoptera (Beetles), Brachycera	Lilly Pilly

4.2 Vertebrate Species of Conservation Significance occurring in the Coastal Zone

4.2.1 Threatened Species

Osprey

Habitat

Coastal waters inlets, estuaries and offshore islands where it preys on fish. This species appears to be recovering in NSW (Morris & Burton, 1994)

Records in Coastal Zone/habitat areas:

There are a few records of this species from Narrabeen Lake during the past decade, including March of this year (Morris & Gladwin, 1997). It is also frequently observed north of Broken Bay (NPWS database). The Osprey is likely to occasionally use the area for hunting fish along beaches and rock platforms.

Conservation:

The existing level of human activity and disturbance has probably deterred the Osprey from using much of the area on a regular basis. If roost or nests sites are identified within the study area then Council should undertake measures to protect them.

Sooty Oystercatcher

Habitat

This species is strictly coastal and endemic to Australia. The NSW population is estimated to be only 200 individuals. The Sooty Oystercatcher inhabits rocky shores in summer where it feeds on a wide range of prey including molluscs, crustaceans and sea worms. In winter, it is also reported to forage on washed-up seaweed on beaches - due to reduced period for exposure of intertidal feeding sites. The Sooty Oystercatcher breeds on off-shore islands (Smith, 1990).

Records in Coastal Zone/habitat areas:

This species is known to inhabit rock platforms locally eg at Bilgola Beach and Bangalley rock platform (A. McBride, P. Thompson, D. Campbell pers comm). Other potential habitat areas are Turimetta Headland, Mona Vale Headland and the area between Palm and Whale Beaches (see Figure 2 - Rock Platforms). The level of human disturbance (ie visitors and mechanical removal of seaweed) at local beaches may discourage the winter foraging reported elsewhere.

Conservation:

As this species preys on intertidal invertebrates its conservation locally is intrinsically bound to the protection of intertidal habitats from over exploitation by humans. Furthermore, it does not move long distances (unlike other waders) Therefore, as it is localised and reliant on rock platforms, the success of Intertidal Protected Areas and Project Aware are vital to the continued presence of this species in the area. To encourage habitation of beaches, maintenance staff should be directed to allow seaweed to remain on beach foreshores during winter.

Pied Oystercatcher

Habitat

This species is also entirely coastal and favours ocean beaches, estuarine sand and mudflats. It nests on beaches or occasionally in saltmarsh or grass. The NSW population is estimated at 250 individuals (Smith, 1990).

Records in Coastal Zone/habitat areas:

The Pied Oystercatcher has been recorded nearby at Long Reef and the north side of Broken Bay. It may occasionally inhabit quieter beaches or the mouth of Lake Narrabeen.

Conservation

This species has declined in the Sydney region due disturbance to beach nest sites. Visitor usage makes local conservation of this species difficult to realise. Any identified nest sites should be protected.

Powerful Owl

Habitat

Forests and woodlands where it preys on arboreal mammals

Records in Coastal Zone/habitat areas:

Recorded at Bungan Beach (1994) and Newport (1980). Rarely uses forests of Coastal Zone for foraging.

Conservation

Identify and conserve nesting and roosting sites and prevent disturbance around their habitat. Retention of forest cover.

Squirrel Glider

Habitat

Eucalypt forests and woodlands; key habitat components are tree hollows and reliable winter flowering trees in coastal zone these are Coast Banksia and Spotted Gum. To a lesser extent Grey Ironbark and Smooth-barked Apple are important.

Records in Coastal Zone/habitat areas:

Trapping was undertaken at Careel Headland Reserve over three nights during field survey work carried out for this project. No Squirrel Gliders were captured. The species has been confirmed from just outside the study at Palmgrove Road, Avalon. It may also still occur in the North Avalon to Palm Beach area where habitat components are present.

Conservation:

Planting of Coast Banksia and Spotted Gum and installation of nest boxes in the North Avalon-Whale Beach-Palm Beach area would assist this and other arboreal mammal species Publicity re the threat cats represent to this and other arboreal mammals is needed.

Koala

Habitat

Eucalypt forests containing suitable feed trees. In the coastal zone these are Swamp Mahogany (*Eucalyptus robusta*), Grey Gum (*E.punctata*) and Scribbly Gum (*E.haemastoma*).

Records in Coastal Zone/habitat areas

There are number of records of this species from the coastal zone in the 70s & 80 (Higgs & Campbell, 1993) and several in Ruskin Rowe, Avalon. Scats of the species have recently been collected from Angophora Reserve (C. Bates pers comm) which is just outside the coastal zone. Potential habitat areas occur in and around Mackay Reserve and Mona Vale Golf Course. Barrenjoey and Pittwater Roads are likely to act as major barriers to movement of this species.

Conservation: Planting of feed trees; publicity re threat of dogs and patrolling of stray dogs; traffic controls and signs.

Common Bent-wing Bat

Habitat:

The Common Bent-wing Bat uses caves, old mines, and a variety of structures as diurnal roosts. It is typically found in well timbered areas where it forages above the tree canopy on small insects.

Records in Coastal Zone/habitat areas:

Recorded McKay Reserves (Turton, 1996) and is likely to forage over forested parts of the coastal zone eg Bangalley/Careel Head Reserves, Bilgola. It may have previously roosted in the "ovens" (coastal caves) near Whale Beach (Ecotone, 1995).

Conservation:

Retention of forest cover and protection of caves. Publicity re threat of insecticides

Greater Broad-nosed Bat

Habitat:

This species forages for insects in open areas on the edges of forests or along tree-lined creeks. It utilises tree hollows as diurnal roosting sites.

Records in Coastal Zone/habitat areas: Bilgola Beach in 1982 (Long, 1983) and may forage throughout the forested areas.

Conservation:

Protection tree hollows; Publicity re threat of insecticides

4.2.2 Regionally Significant Species

Little Penguin

Habitat

Roosts in burrows, under vegetation amongst rocks etc. Forages in inshore waters, harbours and estuaries (Morris et al, 1981; Pizzey, 1991),

Records in Coastal Zone/habitat areas

No recent records within the coastal zone though there may be historical records. Established colonies occur at Lion Island and Manly, where the local population has been declared endangered under the Threatened Species Conservation Act. It is possible Little Penguins occasionally roost on quieter beaches such as Bungan and Turimetta.

Conservation:

Continued policing of beaches for dogs would help other seabirds (eg terns) and may incidentally assist this species. Should a Little Penguin sighting be reported, Council could undertake protective measures eg fencing of burrow areas.

Eastern Reef Egret

Habitat:

Rock platforms, beaches and tidal flats where it feeds on fish, marine invertebrates and insects. Like the Sooty Oystercatcher it is sedentary or part nomadic. It is regarded as scarce in NSW (Morris et al, 1981; Blakers et al, 1984).

Records in Coastal Zone/habitat areas:

Recorded on rock platforms from Newport to Whale Beaches (A. McBride pers comm)

Conservation

As for Sooty Oystercatcher

Peregrine Falcon

Habitat:

Recorded in a range of habitats but particularly favours cliffed areas; preys on small birds and pigeons.

Records in Coastal Zone/habitat areas:

Recorded at Bangalley and Bungan Beach; cliffs of coastal zone represent habitat particularly due to presence of roosting pigeons

Conservation:

As the clifflines suffer little from human disturbance, the peregrine falcon is probably secure in Pittwater as long as prey remains plentiful.

Barking Owl

Habitat:

Woodlands and forests where it prey on diurnal birds, insects and small mammals.

Records in Coastal Zone/habitat areas:

Recorded calling in Avalon in 1978 (Debus, 1997). Much of the remnant bushland and parkland (eg golf courses) represents potential habitat.

Conservation:

Identify and conserve nesting and roosting sites and prevent disturbance around their habitat. Retention of forest cover. Due to its rarity and decline, and threats to remaining core habitat, this species has been recommended for listing as threatened in NSW (Debus, 1997).

Topknot Pigeon

Habitat:

This large pigeon inhabits rainforests and wetter open forest and feeds on fruits in the canopy. It is highly nomadic and is most conspicuous between April and November (Morris et al, 1981).

Records in Coastal Zone/habitat areas:

Recorded at nearby Palmgrove Reserve (M.Macrae pers comm) and is likely to use Bilgola Bends and other littoral rainforest areas.

Conservation:

Planting of locally-occurring rainforest plants eg Cabbage Tree Palm, Port Jackson Fig, Lilly Pilly, Laurels, *Acronychia oblongifolia*

Long-nosed Bandicoot

Habitat:

Forest heaths and woodland where it feeds on invertebrates and plant tubers and roots. Also ventures into suburban backyards.

Records in Coastal Zone/habitat areas:

There are a number of records in the coastal zone (see Higgs & Campbell, 1993)

Conservation:

Pittwater and Barrenjoey Roads represent major barriers to the ability of individuals in coastal zone to interbreed with those to the west. Publicity re threat of cats and dogs. Encourage retention of understorey in public and private land.

5. Areas of High Conservation Value

Table 5 summarises information presented in the above sections on areas of particular ecological significance within the coastal zone.

Table 5 Areas of High Conservation Value

Area	Significance
Rock Platforms	Marine Invertebrates; Sooty Oystercatcher, Reef Egret habitat.
Bangalley and Careel Headland Reserves	diversity of vegetation structure and flora and fauna species.
Bilgola Bends Reserves	rainforest and rare plant species; significant for mammals and birds and possibly Squirrel Glider
Bushrangers Hill	known butterfly hilltopping site
Bungan Beach and Headland	rare plants, dunal vegetation sequence; possible Osprey, Pied Oystercatcher & Little Penguin habitat
Mona Vale Headland	rare plants; restricted plant community
Wiltshire and Hordern Reserves	Spotted Gum Forest and Rainforest; Possible Squirrel Glider habitat; range of birds
Turimetta Headland	rare plants and spp diversity
Mona Vale Golf Course	habitat node/fauna corridor

6. Coastal Zone Management Issues

Rock Platforms

Due to the influence of currents and temperatures, the New South Wales coast has a particularly diverse intertidal fauna assemblage. Pittwater is no different in this regard (Chapman pers comm). The Pittwater Council area has the highest number of rock platforms of any Metropolitan Local Government area. Four of the ten rock platforms are gazetted as Intertidal Protected Areas (IPAs) under NSW Fisheries jurisdiction. The IPAs are Barrenjoey Headland, Bungan Headland including Little Reef, Mona Vale Headland and Narrabeen Headland (Figure 2). They were chosen by NSW Fisheries for biological and ecological reasons (Pittwater Council, 1995).

As the coastal zone's rock platforms are adjacent to a heavily urbanised area and within easy reach of Sydney's suburbs, they are subject to pressures which threaten their viability.

One immediate threat to the rock platforms is their proposed use as sites for stormwater run-off. This was proposed in the Warringah Shire Coastal Management Strategy to avoid the impact beach outfalls were having on sand movement (WSC, 1985). Although this Strategy took into account the risk this policy had in terms of human health (ie due to pathogens entering swimming pools) it did not consider the impacts on the ecology of rock platforms. Damage to habitats during construction and the introduction of increased nutrients and sediment to the intertidal area has the potential to alter both the abundance and diversity of flora and fauna on the rock platforms. Therefore, the policy should be dropped and alternative methods for stormwater disposal should be investigated.

Another problem is the use of chlorine at beach pools to control algal growth and reduce the risk of people slipping and being injured. Elevated levels of chlorine are toxic to many intertidal species and are likely to result in localised reductions in diversity. Relevant staff should be instructed to reduce the use of chlorine or adopt an alternative method to reduce the risk of human injury.

A more complex question is how to manage the human usage of the rock platforms. In the early 1990s harvesting of intertidal invertebrates for bait or food was recognised both by scientists and the public, as a threat to the biodiversity and sustainability of the platforms (Kingsford et al, 1991; Underwood, 1993; Chapman, 1996). In response to this NSW Fisheries established a committee to address the problem. The result of this was the establishment of twelve Inter-tidal Protected Areas in the Sydney Region, four of which are in Pittwater.

In an IPA the collection of marine invertebrates is prohibited. Council Rangers have been trained and empowered as Fisheries Officers under the Fisheries Management Act to apprehend people collecting in IPAs or exceeding bag limits in rock platform areas not listed as IPA. Council has also erected regulatory signs supplied by NSW Fisheries at all major access points to the IPAs. Interpretive signs have been installed in some locations and more are currently being prepared for other rock platforms.

The success of the IPAs is being monitored by Dr Tony Underwood and colleagues of the Institute of Marine Ecology (Sydney University). This is done by analysing and interpreting data (distribution, size, abundance and diversity of species) at the IPAs and, for comparative purposes, at non-IPA control points.

Pittwater Council has undertaken a community awareness programme "Project Aware - On the Rocks!". Community volunteers are trained in this programme in ecology, awareness and conservation of rock platform habitats and component species and threats to their survival. In association with the IPA monitoring programme, students, staff and volunteers organised by Council under *Project Aware - On the Rocks* undertake summer and winter surveys of anglers and foragers using the rock platforms. The aim of this survey is to quantify user behaviour, identify user groups and canvass and increase their understanding of user impacts.

To date, the IPA monitoring programme has indicated that there is no significant difference in the abundance of marine invertebrates in IPA and non-IPA areas. This either indicates that not enough time has elapsed to allow recolonisation of the IPAs; or, more likely, that the IPAs are not fulfilling their function as quasi-reserves for inter-tidal invertebrates. If the latter is true, then the focus of the inter-tidal awareness campaigns will have to be adjusted to better target harvesters of inter-tidal invertebrates.

The user surveys conducted by Project Aware have indicated that a large percentage of foragers were from non-English speaking background (particularly Chinese and Korean) and come from the North Shore, Hills and Parramatta districts (C. Hemery pers comm). Locally-concentrated public education may therefore be largely preaching to the converted. Educative effort should therefore be targeted in those areas, by way of local papers or the ethnic press. This could be achieved with assistance from the Hawkesbury-Nepean Catchment Management Trust which liaise with groups in some of these areas.

Terrestrial Habitat Improvement

In some areas remnant terrestrial fauna habitat has been degraded by weed invasion, loss of hollow-bearing trees, modification of wetlands and changed fire regimes. In dune and headland areas the removal of Bitou and other weeds and their replacement with native plant species will assist in the improvement in fauna habitat. Other areas that require particular attention are Bilgola Bends and Wiltshire and Hordern Reserves.

Mona Vale Golf Course is a large fauna habitat area that could be improved with some simple strategies. It is recommended that Council encourage Mona Vale Golf Club to intensify tree planting (especially of Swamp Mahogany and Coast Banksia) along fairway edges. The club should also be encouraged to allow aquatic vegetation (Cumbungi etc) to grow in and around its large pond. This would improve frog and aquatic bird habitat as well as water quality.

Intensified street planting is also required in the Warriewood-North Narrabeen area. The aim of this to provide a link between Warriewood wetland coastal habitats and to provide a food resource for nomadic/migratory spp eg lorikeets & honeyeaters.

Invertebrates

Information on invertebrates in Pittwater is somewhat limited. However, it is known that a number of butterfly species are at their southern geographical limit in the area and that insects are important pollinators for a number of rainforest and sclerophyllous plant species. To encourage the conservation of terrestrial invertebrates in the area, Council should promote the reduction in use of harmful pesticides. This would also be beneficial to insectivorous bats which forage locally. Council's planting programme and residents could also be encouraged to propagate plants relied on by certain butterfly larvae.

Some species are known to have weak flight and can be affected by habitat fragmentation. This has implications for retention of bushland in reserves, private land, roadsides and for planting of wildlife corridors. Appropriate food plants for butterflies should be included in such plantings

Headland Management

Many of the headlands have high significance for flora conservation with several regionally significant plant species being associated with headland vegetation. In particular, Bangalley Head, Mona Vale Headland, Turimetta Head and Barrenjoey Head support regionally significant plant species and/or communities. Stands of Kangaroo Grass at Mona Vale Head are regionally significant.

There is a need to ensure these areas are managed to maintain biodiversity. In particular, there needs to be a review of mown areas at Mona Vale Headland and investigation of adjustment to mowing height to encourage the native Kangaroo Grass stands rather than exotic grass species.

Fire Management

Several unplanned fires have occurred in headland vegetation within the Pittwater Council area over the past five years. These fires have apparently been deliberately lit. The fires have damaged coastal vegetation, including rare plants. Whilst the natural fire regime for these coastal headland communities is poorly known, there is some evidence that the frequency of fires is threatening the regeneration of some plant species including rare species. For example, at Mona Vale Headland, it has been observed that there is poor regeneration of Scrub She-Oak (*Allocasuarina distyla*) in areas which previously were dominated by the species. Similarly the regeneration of *Pomaderris* sp. B appears to be poor in some patches affected by the fire. Over frequent fire also endangers populations of Heath-leaved Banksia (*Banksia ericifolia*) an important nectar resource for migratory and resident birds.

Council needs to take measures to ensure that the incidence of unplanned fire in coastal headlands is reduced. This should involve increased patrolling of headland areas during times of high fire risk. The impact of fires on coastal vegetation should be monitored as part of the bush regeneration program for coastal parks.

Bush Regeneration

The current bush regeneration program needs expansion to ensure the maintenance of the significant flora conservation values of Pittwater's headlands and beaches. In particular there needs to be a focus on bush regeneration at Avalon Beach, Bungan Beach and Head, Mona Vale Headland, Turimetta Headland and Bangalley Head. The current programme at Bilgola also requires expansion to bushland adjacent to the Serpentine

Bicentennial Coastal Walkway

The Bicentennial Coastal Walkway is maintained by Council's bush regeneration team. The team is responsible for track maintenance and bush regeneration along the length of the Track within the Pittwater Council area. There is a need to upgrade signposting and improve provision of information regarding the Track. There is also a need for systematic monitoring of the impacts of track usage. For instance the Bangalley Headland section of the track is affected by erosion.

Beach Management

Beach Access

Recreational use of beach areas and associated infrastructure contribute to the pressure on beach systems. Access to beaches across sand dunes has resulted in erosion of dunes and a proliferation of tracks in the past. To some extent erosion problems have been addressed by formalisation of access routes across dunes, fencing of dunes and erection of signposting indicating access routes. Some beaches have a plethora of access routes and there appears to be a need for further rationalisation of beach access. Monitoring of impact of beach use is an ongoing responsibility of Council.

Stormwater

Stormwater entering beaches is the primary source of beach pollution on most of the beaches in the Pittwater area (Pittwater Council 1995). Apart from the public health risk stormwater pollution may be contributing to weed invasion into beach vegetation in some areas and is likely to be affecting beach ecology. Stormwater discharge is contributing to dune erosion and scouring and hence damaging dune vegetation. Stormwater discharge structures need to be reviewed to direct stormwater flows away from sensitive beach areas and dune systems.

Beach Erosion

Beach erosion is a natural coastal process which is influenced by weather and water level conditions (Pittwater Council 1995). Coastal vegetation and dune systems may be subject to damage or destruction during extreme erosion events. Development within the beach zone may exacerbate the problem where it has altered the natural profile of the foredune or vegetation removal has reduced the natural stability of the dune system. Beaches most susceptible to damage in the Pittwater Council area include Palm Beach, Whale Beach, Bilgola Beach, Newport Beach and Mona Vale Basin Beach.

Any development within the active beach zone must consider the likely impacts of development on beach erosion. This applies to access tracks and fencing as well as structures.

Dune Stabilisation

All of Pittwater's beaches undergo a program of beach grading to establish a stable beach profile consistent with natural coastal processes. Dune regeneration areas are generally fenced to protect vegetation from disturbance. This is complimented by a program of Bitou Bush eradication, diversification of dune vegetation and fertilisation of dune grasses. This program should continue to be implemented but requires ongoing review to determine success and fine-tune techniques.

In particular, the diversity of dune plantings at present is fairly restricted. An increase in native plant species diversity in dune systems should be a performance target for dune stabilisation programmes.

Cliff Erosion

The natural processes of erosion of coastal cliffs may be providing a niche for invasion of cliff-face vegetation by exotic species such as Mirror Bush (*Coprosma repens*). Monitoring of cliff-face areas should be undertaken to determine the extent of the problem. The monitoring should take the form of the establishment of photo-points along the coast, which are photographed annually in late autumn.

7. Priority Actions/Performance Measures

The following table summarises the main actions that should be undertaken in respect of conservation of the Coastal Zone.

Table 6 - Management Issues and Responses

Issue	Response	Performance Measures
Rock Platforms	Continue and refocus Project Aware. Continue policing of IPA and other areas. Reduction of Chlorine use at pools Scrap proposed stormwater outfall strategy	Decreased infringements; increased public awareness Maintenance and improvements in intertidal ecology
Fauna Habitat Improvement	Street and Park planting, bush regeneration	Maintain Populations
Invertebrates	Further survey and research; Reduce pesticide use Propagate food plants	Maintain diversity & increase public awareness
Beach Access	Formalisation of access routes across dunes, fencing of dunes, signposting of access routes, rationalisation of access routes	Reduction of beach erosion, eradication of informal tracks
Noxious Weeds	Review weed problems & consider nomination of additional species. Nominate Mirror Bush for declaration as a noxious weed and upgrade coding of Asparagus Fern.	Reduced weed species populations
Mowing of Headland Grasslands	Review of mowing extent and height	Increase in area of native grassland
Fire in Headlands	Monitoring of headland vegetation, Patrolling headlands during times of high fire risks	Diversity of headland vegetation, Abundance of rare headland plants
Bush Regeneration	Expand bush regeneration program in headland and beach reserves	Reduced weed species populations, improved fauna habitat
Bicentennial Coastal Walkway	Improved signposting and provision of information, monitoring of usage impacts	Increased usage of Walkway
Stormwater Disposal	Redirect stormwater away from sensitive beach environments & dune systems. Drop strategy of headland outfalls.	Reduced weed species populations. Avoid unnecessary impacts on rock platforms
Beach Erosion	Control development within active beach zone, including structures, access tracks & fencing	Reduced beach erosion
Visitor Use	Monitor impacts	Reduce impacts

Table 6 (cont)

Issue	Response	Performance Measures
Dune Stabilisation	Beach grading, fencing of dune regeneration areas, Bitou Bush eradication, diversification of dune vegetation and fertilisation of dune grasses. Review of program to determine success	Stable dunes with a diverse plant community
Cliff Erosion	Monitor cliff-faces by establishment of photo-points	Reduction of weed densities

Other Issues

Issues that are more general to the Pittwater Council area and therefore should be addressed as part of the Bushland Plan of Management include:

- publicity re conservation of Koalas, Squirrel Gliders and Bandicoots
- review of Habitat and Wildlife Corridors Strategy. There are some potential corridors in the coastal zone and elsewhere which were overlooked in that study eg Warriewood Beach and Avalon Beach
- trapping of foxes. It is recommended that in co-ordination with NPWS North Metropolitan Office a programme to reduce the numbers of foxes occurring in Pittwater and adjacent areas of Garigal and Ku-ring-gai Chase National Parks should be undertaken.
- Control of domestic cats and dogs. These animals represent a major threat to fauna populations in the area particularly of Koalas and Bandicoots. It is recommended Council consider curfews or increased policing of current regulations.
- Survey work on terrestrial invertebrates and collation of Haines' records held by the Australian Museum
- Implementation of a programme to encourage the community to forward unusual fauna and flora records

References

- Blakers, M., Davies, S.J.J.F., & Reilly, PAN., (1984), *The Atlas of Australian Birds* Royal Australasian Ornithologists Union, Melbourne University Press.
- Chapman M.G. (1996) Scientific and (versus?) community roles in intertidal conservation.
- Chapman, G.A. & Murphy, C.L. (1989) *Soil landscapes of the Sydney 1:100 000 map sheet*. Soil Conservation Service of NSW.
- Common, I.F.B. & Waterhouse, D.F., (1981) *Butterflies of Australia: Revised Edition*. Angus & Robertson.
- Dakin, W.J. & Bennet, I (1987) *Australian Seashores*. Revised Edition. Angus and Robertson, North Ryde.
- Debus, S.J.S. (1997) The Barking Owl in New South Wales. *Australian Birds* Vol 30 (3).
- Edgar, G.J. (1997) *Australian Marine Life*. Reed Books, Sydney.
- Fairley, A (1989) *Native plants of the Sydney district*. Kangaroo Press.
- Haines, L.C. (1972) Some interesting butterfly captures made at Bayview, NSW. *Australian Entomology Magazine* Vol (1).
- Harcobian, B (1995) The local butterflies of Pittwater. *Pittwater Natural Heritage Assoc.Inc. Newsletter* No. 4.
- Higgs, P. And Campbell, D. (1993) *Endangered Species Household Survey 1993*. Pittwater Council.
- Jansen, P (1995) *Seashells of Coastal New South Wales*. Published by the author.
- Kingsford, M.J, Underwood, A.J. & Kenelly, S.J. (1991) Humans as predators on rocky reefs in New South Wales Australia. *Marine Ecology Progress Series* Vol 72 pp1-14.
- Long, A. (1983) Observations on carnivory by *Nycticeius ruepellii*. *Aust Bat Research News* 19 pp 9-10.
- Morris, A.K. & Burton, A (1994) 1992 New South Wales bird report. *Australian Birds*
- Morris A.K & Gladwin, C (1997) Unusual records for March and April, 1997. *NSW FOC Newsletter* Issue no.161.
- Morris, A.K., McGill, A.R., & Holmes, G. (1981), *Handlist of Birds in New South Wales*. NSW Field Ornithologists Club, Sydney.
- Moulds, M.S. (1990) *Australian Cicadas*. University of NSW Press, Kensington.
- Pittwater Council, (1995) *State of the Environment Report 1995*. Pittwater Council, Warriewood.
- Pizzey, G. (1991) *A field guide to the birds of Australia*. Angus and Robertson, North Ryde.
- Rushworth, D (1996) *The entomological significance of the Cook Trig site*. Focal. Summer 1996-97
- Smith, P. (1991) *The biology and management of waders (suborder Charadrii) in NSW*. Species management Report no.9. NSW National Parks and Wildlife Service, Hurstville.
- Turton, M (1996) *Chiropteran Survey of Five Bushland Reserves in Pittwater*. Report prepared for AES as part of Urban Bushland Survey.
- Underwood, A.J (1993) Exploitation of species on the rocky coasts of New South Wales (Australia) and options for its management. *Ocean & Coastal Management* Vol 20.
- Warringah Shire Council (1985) *Coastal Management Strategy*.
- Williams, G & Adam A.P (1994) A review of rainforest pollination and plant -pollinator interactions with particular reference to Australian sub-tropical rainforests. *Australian Zoologist* Vol 29.

Appendix A Intertidal Species

Key

^ recorded at Barrenjoey Headland; * recorded at Mona Vale (Pittwater Council, 1995); # recorded at Little Head (Underwood & Chapman pers comm)

	Species	Habitat
Plants		
Phylum Chlorophyta (Green Algae)		
Family Ulvaceae	<i>Ulva lactuca</i> (Sea lettuce) ^*#	low; exposed
	<i>Enteromorpha intestinalis</i> *#	upper; exposed
Family Codiaceae	<i>Codium fragile</i> #	low; exposed
Family Cladophoraceae	<i>Cladophora</i> sp #	
Unclassified - Green Branching, Green Feathers, Green Filamentous, Green Turf, Green Laurencia (all #)		
Phylum Phaeophyta (Brown Algae)		
Family Hormosiraceae	<i>Hormosira banksii</i> (Neptunes Necklace) ^#	low-upper; exposed
Family Scytosiphonaceae	<i>Colpomenia sinuosa</i> (Bubble Weed) ^#	low sheltered
	<i>Padina pavonea</i> (Ribbed Fan) * #	low; rock pools, fringes of platform
Family Dictyocaceae	<i>Dictyota dichotoma</i> #	
	<i>Dilophus marginatus</i> #	
	<i>Zonaria crenata</i> #	
Family Sargassaceae	<i>Sargassum</i> sp #	low
Family Scytosiphonaceae	<i>Scytosiphon simplicissimus</i> #	low
	<i>Petalonia fascia</i> #	
	<i>Ralfsia verrucosa</i> #	
Unclassified	Brown Filamentous #, Brown Sticks #	
Phylum Rhodophyta (Red Algae)		
Family Corallinaceae	<i>Corallina officinalis</i> ^*#	low; exposed
	<i>Amphiroa anceps</i> #	low exposed
Family Ceramiaceae	<i>Ceramia</i> sp #	low; exposed
	<i>Griffithsia monilis</i> #	low; exposed
Family Champiaceae	<i>Champia</i> sp #	low; sheltered & exposed
Family Gelidiaceae	<i>Gelidium pusillum</i> #	
	<i>Pterocladia capillacea</i> #	low; exposed on steep slopes
Family Rhodymeniaceae	<i>Rhodymenia australis</i> #	low; shaded
Family Gracillariaceae	<i>Gracillaria secundata</i> #	low; exposed
Family Hypneaceae	<i>Hypnea</i> sp #	low; on other seaweeds
Family Rhodomelaceae	<i>Laurencia</i> sp #	low
Family Delesseriaceae	<i>Martensia fragilis</i> #	
Family Peyssonneliaceae	<i>Peyssonnelia capensis</i> #	
Family Bangiaceae	<i>Poryphora columbina</i> #	mid; exposed
	<i>Polysiphonia</i> sp #	
	<i>Hildenbrandia rubra</i> #	
	Non-geniculate red coralline #	
	Orange encrusting #	
Unclassified	Long Red Tubular, Red Branching, Red DD, Red Filamentous, Red Glob, Red Parsley, Red Pointy, Red Sausage Red Sticks, Red Ulva (all #)	
Cyanobacteria (Blue-green algae)		
	<i>Aphanothece australis</i> #	
	<i>Oscillatoria erythroa</i> #	
	<i>Lyngbaea</i> sp #	
	Unidentified blue-green #	
Invertebrates		
Phylum Porifera (Sponges)		
	<i>Haliclona</i> sp #	
	unidentified sponge #	
Phylum Cnidaria		
Class Anthozoa		
Order Actinaria (Anemones)	<i>Actinia tenebrosa</i> # * (Waratah Anemone)	mid-lower; shore pools under rocks
	<i>Actinia australis</i> <i>Oulactis muscosa</i> ^*#	mid-lower; pools wet crevices

	Species	Habitat
Order Actinaria (cont)	Cnidopus verater ^{^*#}	r/pools; lower
	Aulactinia veratra	under rocky ledges v. low
	Anthothoe albocincta [#]	very low tide levels
	Phlytecnanthus australis	on macroalgae
	Phlytecnanthus tuberculosa	
Order Corallimorpharia (Jewel Anemones)	brown anemone [#]	
	Corynactis australis	exposed v low
Order Scleractinia (Stony Corals)	Plesiastrea versipora	low tide level & below
Order Hydroida	Culicia tenella (quinaria)	stones at low water level
	Halocordyle disticha	low tide level & below
	Solandaria fusca	"
	Tubularia sp	
	Stereotheca sp	on seagrass & macroalgae
	Plumularia sp	deeper water
<u>Phylum Platyhelminthes</u> (Flatworms)	Callioplana marginata	under stones
	Notoplana australis	low
	Thysanozoon sp	low
<u>Phylum Nemertea</u> (Ribbon Worms)	Gogonorhynchus repens	under stones
<u>Phylum Annelida</u> (Segmented Worms)		
Class Polychaeta (Tube Worms)		
Family Polynoidae (Scale Worms)	Lepidonotus melanogrammus	under stones
	L.bowerbanki	
Family Amphinomidae	Eurythoe complanata	"
Family Terebellidae	Eupolymnia koorangia	"
Family Sabellidae	Sabelistarte sp [*]	Exposed to current
Family Onuphidae	Diopatra sp [#]	sandy substrate
Family Eunicidae	Eunice aphroditois	under rocks; v.low tide
Family Ophelidae	Armandia intermedia	sandy substrate
Family Serpulidae	Galeolaria caespitosa (Sydney Coral) ^{* #}	mid-tide
Family Nereidae	Perenereis amblyodonta (Ragworm)	low
	Idanthyrsus pennatus	low; under stones
Family Spirorbidae	Spirorbis spp [#]	surfaces of rock, macroalgae & crustacea
	Salacina sp	
	Vermilea rosea	
	Pilograna implexa	
<u>Phylum Sipincula</u> (Peanut Worms)	Phascolosoma nodiliferum	sandy substrate under rocks
<u>Phylum Arthropoda</u> (Arthropods)		
<u>Sub Phylum Crustacea</u> (Crustaceans)		
Class Cirripedia (Barnacles)		
	Ibla quadrivalvis	mid-intertidal; sheltered and mod expo
	Chamaesipho tasmanica ^{*#}	mid to high; exposed
	Austromegabalanus nigrescens [#]	low exposed
	Austrobalanus imperator ^{*#}	low; sheltered
	Catomerus polymerus ^{^*#}	mid; exposed (near Galeolaria)
	Tessaroporea rosea ^{^*#}	"
	Tetraclitella purpurascens [#]	any level; sheltered
	Chthamalus attenuatus [#]	mid-high; exposed
	Epopella simplex	low; exposed
Class Isopoda	Ligia exotica	high; under rocks
Class Decapoda		
Family Callinassidae	Trypaea australiensis (Ghost Shimp)	low; muddy substrates
Family Rhynchocinetidae (Hinge-back Shrimps)	Rhynchocinetes rugulosus	extreme low; crevices
Family Hippolytidae	Hippolyte australiensis (Weed Prawn)	near low; amongst weed
	Alope australiensis	low; rockpools
	Species	Habitat
Family Alephidae	Alpheus novaezealandiae	sheltered

(Snapping Shrimps)

Family Palaemonidae	Palaemon serenus	rockpools
	Macrobrachium intermedium	low; seaweed
Family Palinuridae (Lobsters, crabs)	Jasus verreauxi (Rock Lobster)	extreme low; immersed in crevices
Family Majidae	Naxia tumida (Spider Crab)	general
Family Menippidae	Ozius truncatus [#]	lower; under rocks
Family Grapsidae	Leptograpsus variegatus (Swift-footed Rock Crab)* [#]	general
	Cyclograpsus audonii	mid to high; under rocks
	Pachygrapsus transversus	sheltered
	Plagusia chabrus (Red Bait Crab) * [#]	low; sheltered (rocks weeds)
	P.glabra [#]	low; pools, crevices
Family Paguridae (Pagurid Hermit Crabs)	Pagurus spp	general
Family Diogenidae (Diogenid Hermit Crabs)	Clibinarius virescens	"
	Paguristes squamosus	"
	Eupagurus lacertosus	"
	E.sinatus	"
	Dardanus setifer	"
	Cancellus typus	"

Phylum Mollusca (Molluscs)

Class Polyplacophora (Chitons)

Family Chitonidae	Rhyssoplax jugosa	low; under rocks
	Chiton jugosa [#]	low; under rocks
	Chiton pelliserpentis [#]	mid to low
	Onithochiton quercinus [#]	low; exposed
Family Isnochitonidae	Isnochiton australis [#]	low; under rocks
	Isnochiton elongatus	mid- low; under rocks
	I.variegatus	
	Callistochiton crocinus [#]	low; under rocks
Family Mopaliidae	Plaxyphora albida [#]	low exposed
Family Acanthochitonidae	Cryptoplax mystica	low; under rocks

Class Gastropoda (Gastropods)

Family Haliotidae	Haliotis rubra (Abalone)* [#]	low; crevices
Family Fissurellidae	Scutus antipodes (Elephant Snail)	low; crevices, under rocks
	Amblychilepas nigrita (Keyhole limpet)	low; under rocks
	Diodora lineata	"
Family Patellidae (True Limpets)	Patella peroni [#]	low; between rocks
	Patella chapmani	low; exposed
	Clypidina rugosa [#]	mid-low; amongst Cunjevoi & Galeoaria
	Cellana tramoserica * [#]	general
	Cellana sp [^]	
Family Acmaeidae	Notoacmea petterdi [#]	high; vertical rock faces
	Patelloida latistragata [#]	mid-high; flat rock surfaces
	Patelloida alticostata [#]	low; bare rocks
	Patelloida mufria [#]	
Family Trochidae	Austrocochlea constricta (Zebra Periwinkle) [^] * [#]	mid-high; exposed
	Austrocochlea concamerata [^]	mid; protected
	Austrocochlea porcata [#]	mid; rockpools
	Cantharidella picturata	
	Stomatella impertusa	low; under stones
	Granata imbricata	low; under stones
Family Turbinidae (Turbans)	Astraliium tentoriformis* [#]	mid-low; pools
	Turbo undulatus [^] * [#]	shore pools; boulders
	Turbo torquatus [^] * [#]	low levels in sheltered pools
	T.imperialis [#]	
Family Columbellidae	columbellids [#]	
	Species	Habitat
Family Neritidae	Nerita atramentosa* [#] (Black Periwinkle)	mid-high; exposed
Family Littorinidae (Periwinkles)	Nodilittorina unifasciata [^] * [#]	high, in slight depressions
	Nodilittorina pyramidalis [^] * [#]	above high

	Bembicum nanum* [#]	high
	Littorina acutispira [#]	
Family Cassidae	Phalium labiatum	
Family Muricidae	Agnewia tritoniformis [#]	low; under rocks
	Morula marginalba ^{^*#} (Mulberry Shell)	low-high
	Thais orbita ^{^*}	low; exposed
Family Conidae	Conus peronianus	low; under rocks
(Cone Shells)	Conus papilliferus	"
Family Mitridae	Mitra carbonaria	low; crevices, under rocks
Family Siphonariidae	Siphonaria denticulata ^{*#}	low-high
	Siphonaria zelandica (?virgulata [#])	mid-high
	Tugalia cicatricosa [#]	
	Small brown Siphonaria [#]	
Family Onchidiidae	Onchidella patelloides (damelli)	mid; sheltered
Family Chromodoriidae	Hypselodoris bennetti	low; under stones, algae
	Glossodoris atramarginata	rock pools under stones
	Ceratostoma brevicaudatum	"
Family Fissurellidae	Amblychilaps nigrita [#]	low; under rocks
Family Cypraeidae	Cypraea caputserpentis	low; amongst rocks
(Cowries)		
Family Cymatidae	Cabestana spengleri ^{^*#}	low
	Charonia rubicunda [#]	low
	Ranella australasia [#]	low
	Cymatium (Septa) parthenopeum ^{* #}	low
Family Nassariidae	Nassarius particeps	sheltered sand, mud; low
Sub-class Ophostobranchia		
(Sea slugs)		
Family Bullinidae	Bullina lineolata	low; sandy substrates
Family Pleurobranchidae	Pleurobranchus maculata	"
	Berthellina citrina	low; pools
Family Aplysidae	Aplysia sp [#]	rock pools
	A.sydneyensis [*]	
	Dolabrifera dolabrifera [#]	low; under boulders
	unidentified nudibranch [#]	
Family Ubraculidae	Ubraculum sinicum	pools
Family Facelinidae	Austraeolis ornata	"
Family Chromodoridae	Chromodoris splendida	low
Class Bivalvia (Bivalves)		
Family Arcidae	Barbatia pistachia	low; under stones
Family Mytilidae	Mytilis edulis (Mussel)	low exposed
	Trichomya hirsuta [#]	low; under rocks; amongst <i>Galeolaria</i>
Family Pectinidae	Scaechlamys lividus (Scaly Scallop) ^{*#}	low
Family Limidae	Lima lima (nimbifer)	low among rocks
	Limatula strangei	"
Family Ostreidae	Saccostea glomerata (Sydney rock Oyster) ^{* #}	mid; sheltered
	Crassostrea gigas (Pacific Oyster)	low; sheltered
Family Anomiadae	Anomia trigonopsis	low under stones
Family Lucinidae	Codakia rugifera	sheltered sand
	Kellya solida	under stones
Family Veneridae	Irus crenatus	in rocks
Family Erycinidae	Lasaea australis	mid-low; boulders, stones, weeds
Class Cephalapoda		
Family Octopodidae	Hapalochlaena fasciata (Blue-ringed Octopus)	rock pools
	Octopus sp ¹	"
<u>Phylum Bryozoa</u>	Species	Habitat
	Waterispora arcuata [#]	rock pools
	Membranipora membranacea	on kelp
	Celleporaria sp	low rock surfaces
	Tricellaria porteri	low exposed
	Bugula sp [#]	

¹ this common species is still undescribed (Phil Colman pers comm)

encrusting bryozoan[#]

Phylum Echinodermata

Class Crinoidea (Feather Stars)

Family Comosteridae Cenolia trichoptera low; crevices; rocks
 C.tasamaniae

Class Asteroidea (Seastars)

Family Oraesteridae Nectria ocellata low;pools
Family Asteropseidae Petricia vernicina low;pools
Family Ophiasteridae Promia polypora "
Family Asterinidae Patiriella calcar (8-armed Seastar)^{^*#} mid-low;pools
 Patiriella exigua (5-armed stubby Seastar)^{*#} mid; pools
 Patiriella gunni[^] low; under rocks
 Patiriella brevispinna[^] low; shletered
Family Asteriidae Paranepanthia grandis low; under rocks, crevices
 Uniofora granifera low; shletered
 Astrostole insularis pools
 Coscinasterias calamaria[#] low; under rocks but also in open
 Allostichaster polyplax low; under rocks

Class Ophiuroidea (Brittle Stars)

Family Ophiotrichidae Ophiotrix spungicola low under rocks
Family Ophionereidae Ophionereis schayeri low under rocks
Family Ophiomyxidae Ophiomyxa australis low; under stones, debris, pools
Family Ophiodermatidae Ophiorachnella ramsayi low; under stones with sand/gravel
Family Ophiocomidae Clarkcoma pulchra spp low; under stones with sand/gravel
 unidentified brittle star[#]

CI Echinoidea (Sea urchins)

Family Cidaridae Phyllacanthis parvispinus low; nocturnal feeder
Family Diamematidae Centrostephanus rodgersii[#] low
Family Echinometridae Heliocidaris erythrogramma^{^*#} low in rock hollows or under rocks
 (Common Urchin)^{*}
 Heliocidaris tuberculata[#]
 (Lord Howe Urchin)^{*} low in rock hollows
 Holopneustes pycnotilus[#] low; sheltered
 Pripneustes gratilla

CI Holothuroidea (Holothurians)

Family Synaptidae Letosynapta dolabrifera under rocks withsand/gravel
Family Stichopodidae Stichopus mollis low; sandy silty areas
 Chirodota gigas

Phylum Chordata (Chordates)

CI Ascidiacea

Family Pyuridae Pyura stolonifera (Cunjevoi)^{^*} low exposed
 P.gibbosa "
 Herdmania momis "
Family Didemnidae Didemnia moseleyi[#] submerged
Family Stylidae Botrylloides sp[#] under boulders
Unclassified Black Ascidian[#]
 Golf Ascidian[#]
 Orange Ascidian[#]
 Purple Ascidian[#]
 Red Ascidian[#]
 Solitary Ascidian[#]

Phylum Hemichordata

Ptychodera flava sandy substrates under stones

Appendix B Coastal Zone Vertebrate Fauna Species List

Key

- Coastal species; **bold print** - threatened species

Common Name	Scientific Name	Habitat
Birds		
• Little Penguin	<i>Eudalypta minor</i>	coastal waters, roosts at Lion Island
• Great Cormorant	<i>Phalacrocorax carbo</i>	coastal waters
• Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>	coastal waters
Masked Plover	<i>Vanellus miles</i>	Parks, beaches
• Pied Oystercatcher	<i>Haematopus longirostris</i>	Rock platforms beaches
• Sooty Oystercatcher	<i>Haematopus fuliginosa</i>	Rock platforms beaches
• Ruddy Turnstone	<i>Arenaria interpres</i>	Rock platforms beaches
White-faced Heron	<i>Egretta novaehollandiae</i>	wetlands, shores, grassland
• Reef Egret	<i>Egretta sacra</i>	Rock platforms beaches
Black Duck	<i>Anas superciliosa</i>	wetlands, shores, dams
Mallard	<i>Anas platyrhynchos</i>	wetlands, creeks
Blue-winged Shoveller	<i>Anas rhynchotis</i>	wetlands, creeks
Maned Duck	<i>Chenonetta jubata</i>	wetlands, forests, dams
• Osprey	<i>Pandion haliaetus</i>	coastal waters
Pacific Baza	<i>Aviceda subcristata</i>	wet forests
Black-shouldered Kite	<i>Elanus notatus</i>	headlands, dunes
• White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	coast, waterways
• Whistling Kite	<i>Haliastur sphenurus</i>	coast, waterways
Australian Kestrel	<i>Falco cenchroides</i>	headlands, dunes
Peregrine Falcon	<i>Falco peregrinus</i>	headlands, escarpments
Lewin's Rail	<i>Rallus pectoralis</i>	rank vegetation eg Narrabeen Lake
Buff-banded rail	<i>Rallus phillippensis</i>	"
Baillon's Crake	<i>Porzana pusilla</i>	"
Spotless Crake	<i>Porzana tabuensis</i>	"
Brown Quail	<i>Coturnix australis</i>	grassy headlands
Stubble Quail	<i>Coturnix pectoralis</i>	grassy headlands
Eurasian Coot	<i>Fulica atra</i>	wetlands, creeks, dams eg MVGC
Dusky Moorhen	<i>Gallinula tenebrosa</i>	"
Purple Swamphen	<i>Porphyrio porphyrio</i>	"
• Silver Gull	<i>Larus novaehollandiae</i>	beaches, dunes, parks
• Caspian Tern	<i>Sterna caspia</i>	beaches
• Crested Tern	<i>Sterna bergii</i>	beaches
• Common Tern	<i>Sterna hirundo</i>	beaches
• Sooty Tern	<i>Sterna fuscata</i>	recorded once near Barrenjoey
Feral Pigeon	<i>Columba livia</i>	parks, cliffs
Spotted Turtle-dove	<i>Streptopelia chinensis</i>	urban, bushland edges, grassland
Topknot Pigeon	<i>Lopholaimus antarcticus</i>	wet forests
Brown Cuckoo-Dove	<i>Macropygia amboinensis</i>	wet forests
Crested Pigeon	<i>Ocyphaps lophotes</i>	open areas
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	woodlands, forests, gardens
Little Correla	<i>Cacatua sanguinea</i>	woodlands, forests, gardens
Long-billed Corella	<i>Cacatua tenuirostris</i>	parks gardens
Galah	<i>Cacatua roseicapilla</i>	woodlands, forests, gardens
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	woodlands, forests with she-oaks
Australian King-Parrot	<i>Alisterus scapularis</i>	forests
Crimson Rosella	<i>Platycercus elegans</i>	woodlands forests
Eastern Rosella	<i>Platycercus eximius</i>	woodlands, grasslands
Musk Lorikeet	<i>Glosopsitta concinna</i>	forests; vagrant
Little Lorikeet	<i>Glosopsitta pusilla</i>	forests; vagrant
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>	forests; vagrant
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	woodlands forests, gardens
Fan-tailed Cuckoo	<i>Cuculus pyrophanus</i>	woodlands forests; resident/nomad
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>	forest; summer migrant
Common Koel	<i>Eudynamys scolopacea</i>	forests, woodlands, gardens
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	forests, woodlands, gardens

Common Name	Scientific Name	Habitat
Southern Boobook	<i>Ninox novaeseelandiae</i>	all habitats
Powerful Owl	<i>Ninox strenua</i>	woodlands forests; rare visitor
Barking Owl	<i>Ninox connivens</i>	woodland/grassland
Barn Owl	<i>Tyto alba</i>	woodlands, grassland
Tawny Frogmouth	<i>Podargus strigoides</i>	woodlands forests, gardens
Spine-tailed Swift	<i>Hirundapus caudacutus</i>	aerial - summer
Azure Kingfisher	<i>Ceyx azureus</i>	wetlands, creeks - summer
Kookaburra	<i>Dacelo novaeguinea</i>	all habitats
Sacred Kingfisher	<i>Halcyon sancta</i>	woodlands forests - summer
Dollarbird	<i>Eurystomus orientalis</i>	woodlands forests, gardens
Noisy Pitta	<i>Pitta versicolor</i>	wet forests - vagrant
Fairy Martin	<i>Cecropis ariel</i>	open areas
Welcome Swallow	<i>Hirundo neoxena</i>	open areas
Richard's Pipit	<i>Anthus novaeseelandiae</i>	grassy headlands
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	forests, gardens
Cicadabird	<i>Coracina tenuirostris</i>	forests; summer
Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	disturbed areas
Eastern Yellow Robin	<i>Eopsaltria australis</i>	woodland forests
Rose Robin	<i>Petroica rosea</i>	woodland forests; winter
Golden Whistler	<i>Pachycephala pectoralis</i>	woodland forests
Rufous Whistler	<i>Pachycephala rufiventris</i>	woodland forests; summer
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	woodland forests
Leaden Flycatcher	<i>Myiagra rubecula</i>	forests; summer
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	forests woodlands summer migrant
Black-faced Monarch	<i>Monarcha melanopsis</i>	forests - summer migrant
Grey Fantail	<i>Rhipidura fuliginosa</i>	forests, woodlands
Willie Wagtail	<i>Rhipidura leucophrys</i>	grasslands
Rufous Fantail	<i>Rhipidura rufifrons</i>	forests - summer
Eastern Whipbird	<i>Psophodes olivaceus</i>	forests; thick coastal scrub
Clamorous Reed-warbler	<i>Acrocephalus stentoreus</i>	wetlands
Little Grassbird	<i>Megalurus gramineus</i>	"
Tawny Grassbird	<i>Megalurus timoriensis</i>	"
Brown Songlark	<i>Cincloramphus cruralis</i>	Grasslands; wetlands, heaths
Superb Fairy-wren	<i>Malurus cyaneus</i>	all habitats
Variegated Wren	<i>Malurus lamberti lamberti</i>	forests woodlands
White-browed Scrubwren	<i>Sericornis frontalis</i>	heaths forests scrub
White-throated Warbler	<i>Gerygone olivacea</i>	woodlands forests - summer
Brown Warbler	<i>Gerygone mouki</i>	wet forests- summer
Striated Thornbill	<i>Acanthiza lineata</i>	forests canopy
Yellow Thornbill	<i>Acanthiza nana</i>	woodlands forests gardens
Brown Thornbill	<i>Acanthiza pusilla</i>	woodlands forest understorey
White-throated Treecreeper	<i>Climacteris leucophaea</i>	woodlands forests
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	all habitats
Red Wattlebird	<i>Anthochaera carunculatus</i>	all habitats
Little Wattlebird	<i>Anthochaera chrysoptera</i>	all habitats
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	woodland forests heaths
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	woodlands forests
Brown Honeyeater	<i>Lichmera indistincta</i>	woodlands forests
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>	woodlands forests gardens
Noisy Miner	<i>Manorina melanocephala</i>	woodlands forests gardens
Lewin's Honeyeater	<i>Meliphaga lewinii</i>	wet forests
White-naped Honeyeater	<i>Melithreptus lunatus</i>	woodland forests heaths
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	woodlands forests
Noisy Friarbird	<i>Philemon corniculatus</i>	woodlands forests
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>	all habitats
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	all habitats
Mistletoebird	<i>Dicaeum hirundinaceum</i>	woodlands forests
Spotted Pardalote	<i>Pardalotus punctatus</i>	woodlands forests
Striated pardalote	<i>Pardalotus striatus</i>	woodlands forests
Silvereye	<i>Zosterops lateralis</i>	all habitats

Common Name	Scientific Name	Habitat
Red-browed Finch	<i>Emblema temporalis</i>	woodlands forests, grasslands
House Sparrow	<i>Passer domesticus</i>	disturbed areas
Common Mynah	<i>Acridotheres tristis</i>	disturbed areas
Common Starling	<i>Sturnus vulgaris</i>	grasslands
Olive-backed Oriole	<i>Oriolus sagittatus</i>	woodlands forests; summer
Figbird	<i>Sphecotheres viridis</i>	wet forests; vagrant
Spangled Drongo	<i>Dicrurus hottentotus</i>	wet forests- summer
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	wet gullies; unconfirmed
Dusky Woodswallow	<i>Artamus cyanopterus</i>	woodlands, grasslands
Australian Magpie Lark	<i>Grallina cyanoleuca</i>	open areas
Grey Butcherbird	<i>Cracticus torquatus</i>	all habitats except dunes
Australian Magpie	<i>Gymnorhina tibicen</i>	"
Pied Currawong	<i>Strepera graculina</i>	"
Australian Raven	<i>Corvus coronoides</i>	all habitats
Mammals		
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	woodlands forests
Sugar Glider	<i>Petaurus breviceps</i>	woodlands forests
Squirrel Glider	<i>Petaurus norfolcensis</i>	forests on peninsula
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	woodlands forests; common Bilgola
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	woodlands forests
Koala	<i>Phascolarctos cinereus</i>	Forests
Long-nosed Bandicoot	<i>Perameles nasuta</i>	forests woodlands gardens
House Mouse	<i>Mus domesticus</i>	disturbed areas
Bush Rat	<i>Rattus fuscipes</i>	woodlands forests
Black Rat	<i>Rattus rattus</i>	disturbed areas
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	flowering and fruiting trees
Chocolate Wattled bat	<i>Chalinolobus morio</i>	all habitats
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	all habitats
Freetail bat	<i>Mormopterus sp (loriae)</i>	forests
Common Bent-wing Bat	<i>Miniopterus schreibersii</i>	forests
Greater Broad-nosed bat	<i>Scoteanax ruepelli</i>	forests
Pale Eptesicus	<i>Vespadelus vulturnus</i>	all habitats
Fox	<i>Vulpes vulpes</i>	all habitats
Rabbit	<i>Oryctolagus cuniculus</i>	grassland disturbed bushland
Reptiles		
Blind Snake	<i>Ramphotyphlops nigrescens</i>	woodlands forests
Green Tree Snake	<i>Dendrelaphis punctulatus</i>	wet forests
• Black-bellied Swamp Snake	<i>Hemiaspis signata</i>	wetlands
Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>	woodlands forests wetlands
Yellow-faced Whip Snake	<i>Demansia psammophis</i>	woodlands, forests, heaths
Brown Snake	<i>Pseudonaja textilis</i>	woodlands forests
Eastern Water Dragon	<i>Physignathus leseurii</i>	woodlands forests near creeks
Jacky Lizard	<i>Amphibolurus muricatus</i>	woodlands forests
Leaf-tailed Gecko	<i>Phyllurus platurus</i>	woodlands forests with sandstone outcrops
Eastern Water Skink	<i>Eulamprus quoyii</i>	all terrestrial habitats
Red-throated Skink	<i>Eulepis platynota</i>	woodlands forests
White's Skink	<i>Egernia whitei</i>	woodlands forests
Cunninghams Skink	<i>Egernia cunninghamii</i>	woodlands forests
Striped Skink	<i>Ctenotus robustus</i>	woodlands forests
Copper-tailed Skink	<i>Ctenotus taeniolatus</i>	woodlands forests
Grass Skink	<i>Lampropholis delicata</i>	woodlands forests, gardens
Garden Skink	<i>Lampropholis guichenoti</i>	woodlands forests, gardens
Three-toed Skink	<i>Saiphos equalis</i>	woodlands forests
Weasel Skink	<i>Saproscincus mustelina</i>	woodlands forests
Blue-tongued Lizard	<i>Tiliqua scincoides</i>	woodlands forests, gardens
Eastern Long-necked Tortoise	<i>Chelodina longicollis</i>	creeks

Common Name	Scientific Name	Habitat
<u>Frogs</u>		
Common Eastern Froglet	<i>Crinia signifera</i>	anywhere with freshwater
Brown-striped Frog	<i>Limnodynastes peronii</i>	"
Eastern Banjo Frog	<i>Limnodynastes dumerilii</i>	wetlands boggy grass areas
Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>	wetlands boggy grass areas
Green Tree Frog	<i>Litoria caerulea</i>	forests woodlands gardens
Eastern Dwarf Tree Frog	<i>Litoria fallax</i>	wetlands dams
Peron's Tree Frog	<i>Litoria peronii</i>	forests woodlands
Leaf Green Tree Frog	<i>Litoria phyllochroa</i>	wet forests
Whistling Tree Frog	<i>Litoria verreauxii</i>	dams woodlands