

**ANGOPHORA RESERVE
AVALON
PLAN OF MANAGEMENT**

PITTWATER COUNCIL

Adopted 21 October 2002

Land-use Planning Table

Permissible Uses Exempt (these may be subject to approval under Part 5 of the EPA Act 1979)	Permissible Uses Requiring Development Consent	Prohibited Uses
Bush regeneration, habitat restoration and weed control	Utility installations and similar	Extractive industries and agriculture
Fire hazard reduction activities	Buildings ancillary or incidental to the reserve	Sporting facilities
Ecological burns	Major public drainage works	Permanent private access across a reserve
Multi-use tracks other than motor vehicle	Major rock / soil stabilization works and earthworks	Commercial signage
Boardwalks and minor bridges	Major facilities (not buildings) being viewing platforms, bridges, educational facilities and the like	Dumping of refuse (including building materials, soil, fill, household wastes, etc.)
Temporary activities or developments requiring a lease or licence under the Local Government Act (1993)	Commercial Eco-tourism Activities	Vegetation removal not in accordance with Councils Tree Preservation and Management Order
Appropriate sustainable low impact recreation activities and facilities (other than buildings)	Vehicle access (emergency access, fire breaks and service trails).	Private alienation or encroachment
Minor public drainage and stormwater works		Introduction of exotic flora and fauna
Minor fences		Playground facilities
Compliance, directional, interpretive, identification and safety signs		Flood structures (damming and reduction of environmental flows)
Environmental education activities		Removal of habitat features such as soil, leaf litter, rocks, stones, pebbles and the like
Any use as permitted under Council's Tree Preservation and Management Order		Recreational motor sports (including 4 wheel driving, motorbike riding, etc.)
Minor rock works and earthworks associated with soil stabilization and erosion control		Domestic drainage outlets
Any activity as defined in Management Plans consistent with the core objectives and management objectives		Horse riding facilities
Feral animal control and eradication.		Unleashed dog exercise areas
Biodiversity recovery and enhancement		Water extraction

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1. Introduction

Angophora Reserve is located in the core of the Barrenjoey Peninsula bordering the suburbs of Avalon, Clareville and Taylors Point. It consists of 18.5 hectares of bushland containing five plant communities. This in turn provides significant habitat values for a range of native fauna species acting as an island and refuge for flora and fauna in the urban environment. It also forms a significant part of Barrenjoey Peninsula's remnant bushland, and as such plays a significant role as part of a wildlife corridor.

This plan provides for the management of this reserve for the conservation of the natural and cultural heritage including habitat for threatened and significant fauna species, populations and ecological communities. It has been prepared as a guide for bushland management in the reserve in the current physical and legislative environment.

2. Planning context

This plan replaces the previous Plan of Management for the reserve (Angophora Reserve and Hudson Park, Plan of Management, Pittwater Municipal Council, May 1993) in light of significant changes in legislation and the significant time period since the production of that plan. The plan encompasses the two reserves formally known as Hudson Park and Angophora Reserve (area of 18.5 hectares) and now referred to under the one title of Angophora Reserve.

2.1. Legal context

Local Government Act 1993

Under Section 36 of this Act the Council is required to prepare a Plan of Management for community land. This plan must identify the following

- (a) the category of the land,
- (b) the objectives and performance targets of the plan in respect to the land,
- (c) the means by which the council proposes to achieve the plans objectives and performance targets.
- (d) the manner in which the council proposes to assess its performance with respect to the plans objectives and performance targets, and may require the prior approval of the council to the carrying out of any specified activity on the land.

Under Section 36 (4) this reserve falls under the categorization of a **natural area** and under Section 36 (5) is further categorized as

- (a) **bushland**
- (c) **escarpment**
- (d) **watercourse**

Figure 1. shows the land applying to these categories.

Environmental Planning and Assessment Act 1979

State Environmental Planning Policy No. 19, Bushland in Urban Areas. This policy was made to provide for the protection of urban bushland in NSW. This policy requires that Plans of Management be produced for areas classified as 6(a) Existing Recreation and Natural area. Circular No. B13 states that the management plan should:

- Describe the bushland in light of the aims and objectives of the policy;
- Include measures to enable the recreational use of bushland where appropriate; and
- Specify the intended methods of bush fire reduction, measures to prevent bushland degradation and restore degraded areas.

SEPP No. 44 – Koala Habitat Protection: In 1995, Pittwater Council resolved to prepare a plan for koala habitat that has adopted as part of the Management Plan for Threatened Fauna and Flora in Pittwater. In addition mapping of Koala Habitat is proposed to be undertaken as part of a vegetation survey of Pittwater.

The Pittwater Local Environmental Plan: Provides guidance to development in the Pittwater area and zones land 6(a) Recreation. For land zoned 6(a) the LEP refers to Plans of Management as the documents to define land uses, activities and developments appropriate in the reserve. These are further defined in the land use planning table attached to this plan.

Threatened Species Conservation Act, 1995

The objectives of the Threatened Species Conservation Act, 1995 are to;

- conserve biological diversity and promote ecologically sustainable development
- protect critical habitat of those threatened species, populations and ecological communities that are endangered
- eliminate or manage certain processes that threatened the survival or evolutionary development of threatened species, populations and ecological communities
- ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed; and
- encourage conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative arrangement.

For Council land that is declared “critical habitat or included in a “recovery plan” or in a “threat abatement plan” there are special provisions for plans of management. There are a number of species in the reserve that are listed in schedules of the TSC Act including the Koala and Squirrel Gliders. Both are listed as vulnerable under schedule 2 and the Koala is a threatened community in Pittwater under Schedule 1 Part 2, but at present there are no declared critical habitats, recovery plans or threat abatement plans that apply to this land.

Habitat and Wildlife Corridors Conservation Strategy

The Pittwater Habitat and Wildlife Corridors Conservation Strategy (1996) identifies habitats and corridors in Pittwater, highlighting areas of priority for future action. Protection and enhancement of habitat and corridors is achieved by identifying and improving of priority areas. Under the LG Act 1993 annual State of Environmental Reports must identify important wildlife and habitat corridors.

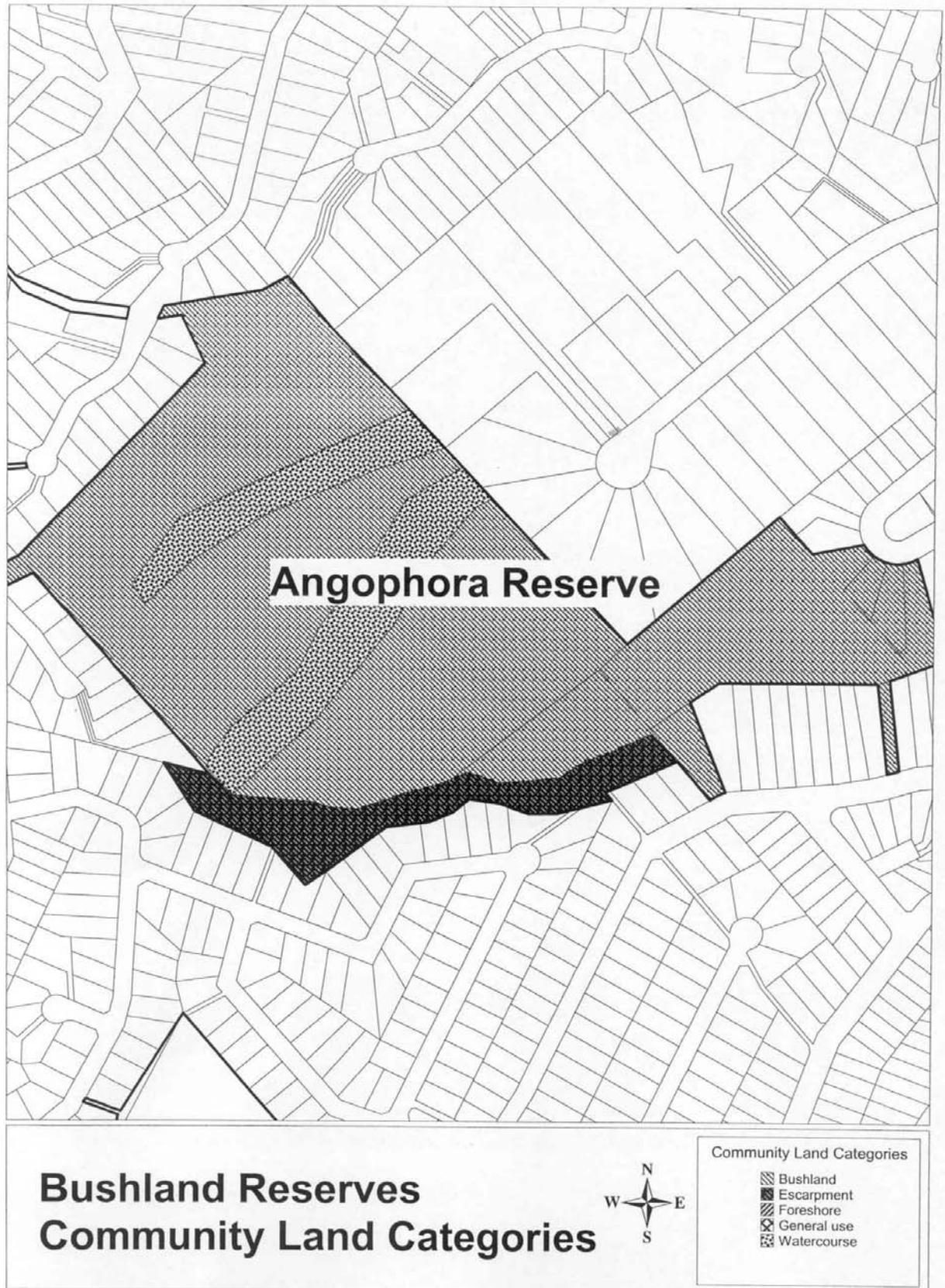
Urban Bushland Plan of Management

This plan acts as an umbrella plan over all plans of management for bushland in Pittwater, and the Plan provides for the fine tuning and tailoring of plans for specific reserves.

2.2. Categorization

Angophora Reserve is categorized as a **natural area** under Section 36 of the Local Government Act and further categorized as **bushland, escarpment and watercourse**. Council is required to meet core objectives for management for these land categorizations.

Figure 1. Land categorisation of Angophora Reserve



3. Reserve Description

3.1. General Description

The reserve consists of 18.5 hectares of urban bushland in Avalon on the Barrenjoey Peninsula. It is dominated by remnant forest and woodland vegetation communities. This reserve provides a small taste of the Peninsula similar to what it was like pre-settlement and provides significant samples of vegetation communities and fauna habitats that are under threat. It is one of the most significant reserves in an area that is now dominated by suburbia and true bushland is restricted to mostly small reserves.

The total area of 18.5 hectares comprises of 3 hectares of Angophora Reserve to the east (volume 4828, Folio 108, Transfer 1. 141993, 26.6.1942, Lots 355, 387, 388, 524, D.P. 16902 Palmgrove Road and the Circle, Avalon) and the 15.5 hectares that was formally known as Hudson Park to the west (volume 84230, Folio 160, Subdivision Reserve in D.P. 13291, off Hudson Parade, Avalon).

3.2. Location and access

Angophora reserve is located in the core of the Barrenjoey Peninsula bordering the suburbs of Avalon, Clareville and Taylors point. As a significant urban reserve of 18.5 hectares its location provides a refuge for urban wildlife and an important sample of the areas vegetation, geology and landscape. The reserve is mostly bordered by residential development and can be accessed through Wandeen Road, Hilltop Road, Chisolm Avenue, Bilwarra Avenue, The Circle and Palmgrove Road. Access to the reserve is primarily by foot via the access points identified in figure 10. The reserve is mainly accessed by exercise walkers, bush walkers and bush regeneration workers. The rugged nature of the reserve makes any access from vehicles nearly impossible.

Figures 4 and 5 provide the location and boundary map for the reserve and figure 10 shows access point into the reserve.

3.3. History

Angophora Reserve was originally purchased by the Wildlife Preservation Society in 1937 as a bushland sanctuary. The reserve was intended especially to preserve a Giant Angophora tree, which still stands today but is now dead. The Lieutenant Governor of N.S.W., Sir Phillip Street, officially opened the reserve on 19th March 1938. W.G. Kelly, W.G. Stead and T.Y Harris were appointed trustees.

Until the 1950's the only adjacent housing (and farmland) were along Palmgrove Road and what is now Ruskin Rowe. The Reserve was bounded to the south and west by extensive areas of natural bushland. Subdivision and settlement of these areas took place during the 1950's and 1960's.

Hudson Park was dedicated as a public reserve in 1957. In 1962 the Wildlife Preservation Society donated Angophora Reserve to Warringah Shire Council and a 530A Committee was formed to oversee the two adjoining reserves. Volunteer workers were active in removing weeds and rubbish, building tracks, planting native species and constructing a small parking area in Palmgrove Road. However, the Committee became inactive after the loss of several key members.

The Committee was reformed in 1968 and included representatives of the then Pittwater Flora and Fauna Society, which had maintained a close interest in the reserve since its formation in 1953, and the newly formed Avalon Preservation Trust. Some of the Committee's activities were construction of a gateway at the Palmgrove Road entrance and planting of Grey Gums as Koala food trees. Suggestions were made for greater development of the reserve, including building a kiosk and charging an entrance fee, but these never received much support.

The Angophora Reserve/Hudson Park Management Committee was formed in 1976 and remained active until it was disbanded along with all other Council management committees following Council elections in September 1991.

An early initiative of this Committee was a preliminary development plan drawn up by Don Irving, a landscape architect and member of the Committee. Various matters were addressed in the plan but chiefly it was a proposal for a network of walking tracks. The main walking track between Palmgrove Road and Wandeen Road was constructed in 1985 as a Commonwealth Employment Program. However, the suggested network of tracks has not been followed up, with the present Committee favouring a policy of more limited development.

In 1983 the National Trust was engaged by Warringah Shire Council at the request of the Management Committee to assess the condition of the reserve and its suitability for their weeding methods. Subsequently, in March 1984, the Trust began a regular program of bush regeneration in the reserve, with a team of four working one day per week. The program has continued to the present under a yearly contract to Council. The team was increased to six in 1987.

On two occasions in 1984 and 1991 the then Metropolitan Water, Sewerage & Drainage Board (Now Sydney Water) installed sewer lines through parts of the reserve. Through the insistence of Council and the Management Committee, the pipes were installed using special machinery and by doing much of the work by hand, to ensure minimal environmental disturbance. The National Trust was engaged to carry out preparation and subsequent regeneration work. The installation of the pipe was a model of sympathetic engineering work in a natural area.

In 1987 Angophora Reserve and Hudson Park were proposed for listing on the Australian Heritage Commission's Register of the National Estate, an inventory of places deemed to be part of Australia's heritage, having special value for future generations as well as the present community. The area was seen as a bushland sanctuary of considerable social, recreational and educational value to the local community and surrounding region. Special features include the Giant Angophora (believed to be the largest of its species), a koala colony within an urban area, and one of the most significant Aboriginal sites in the Sydney region. The application for entry to the Register of the National Estate was approved in 1989.

Previously an Angophora Reserve and Hudson Park Management Committee aided in the management of the reserve. Following the creation of the Pittwater Council, the Pittwater Reserves and Bushland Management Committee replaced this function.

3.4. Topography, Soils and Geology

The Reserve forms part of the northern escarpment of Bilgola Plateau, occupying the steep slopes around the head of the north-east-facing valley down the centre of which runs Ruskin Rowe. The elevation ranges from 30 metres to 120 metres above sea level.

Geologically, the Northern Beaches Peninsula is part of the Hornsby Plateau, a structural unit of the Sydney Basin. Bilgola Plateau, including the upper parts of the reserve, represents a capping of Triassic Hawkesbury Sandstone over the older, though still Triassic, Newport Formation of the Narrabeen Group. The interbedded shales and sandstone of the Newport Formation are the underlying rocks on the lower slopes of the reserve, and over much of the Northern Beaches Peninsula (Geological Survey of N.S.W. 1983; Herbert 1983).

Hawkesbury Sandstone is a medium to coarse-grained quartz sandstone with minor shale and laminite lenses. The Hawkesbury Sandstone sections of the reserve are characterised by extensive sandstone outcroppings in the form of a series of benches or steps. In a couple of places the bench-scars are substantial cliffs but mostly they are only a couple of metres high.

The Newport Formation consists of interbedded laminite, shale and quartz to lithic-quartz sandstone. These rocks weather more readily than the Hawkesbury Sandstone and the lower slopes of the reserve are more even, lacking the characteristic benches of the upper slopes. There are many sandstone boulders on the lower slopes but these are floaters from the Hawkesbury Sandstone above, rather than outcroppings of the Newport Formation.

The soils in the Hawkesbury Sandstone sections of the reserve are shallow, sandy, stony and infertile. They correspond to the Gynea Soil Landscape Unit (Chapman *et al.* 1989; Chapman and Murphy 1989). The complex topography within this unit is matched by a range of different soils: shallow to moderately deep Yellow Earths and Earthy Sands on crests and the inside of benches, shallow Siliceous Sands on leading edges of benches, localised Gleyed Podzolic Soils and Yellow Podzolic Soils on shale lenses, and shallow to moderately deep Siliceous Sands and Leached Sands along drainage lines.

In general, these soils are moderately acid and highly permeable with low available water capacities. They have a low to very low nutrient status with very low phosphorus and nitrogen levels.

The soils on the Newport Formation are generally deeper, more clayey and more fertile than those on the Hawkesbury Sandstone. They correspond to the Watagan Soil Landscape Unit, comprising shallow to deep Lithosols /Siliceous Sands and Yellow Podzolic Soils on sandstones, and moderately deep Brown Podzolic Soils, Red Podzolic Soils and Gleyed Podzolic Soils on shales. The soil materials are strongly acid and have low to moderate available water capacities. The general fertility is low to moderate, with low nitrogen and very low phosphorus levels.

Figures 2 and 3 provide a soils and geology map for the Pittwater area.

Figure 2. Soils Map

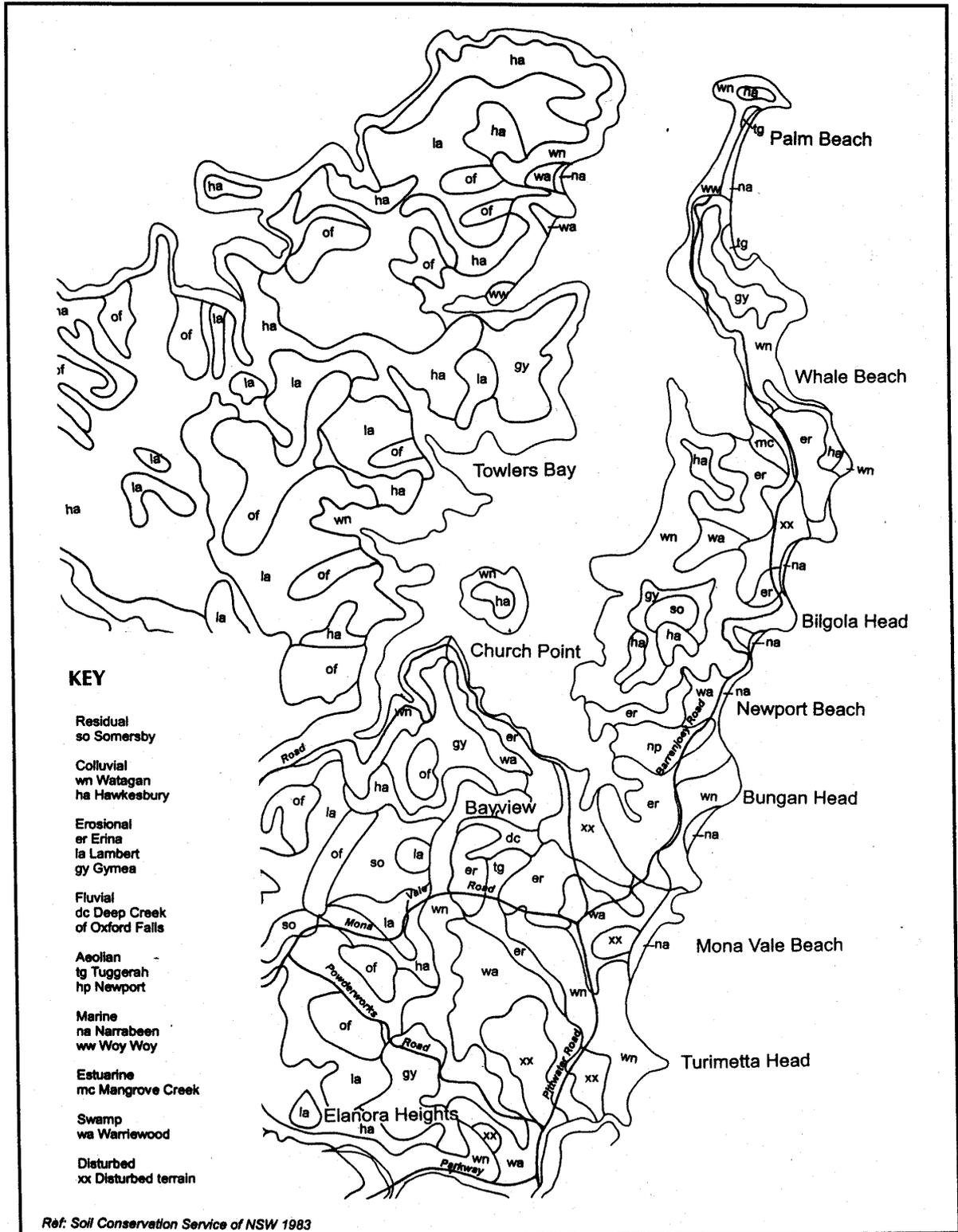


Figure 3. Geology Map

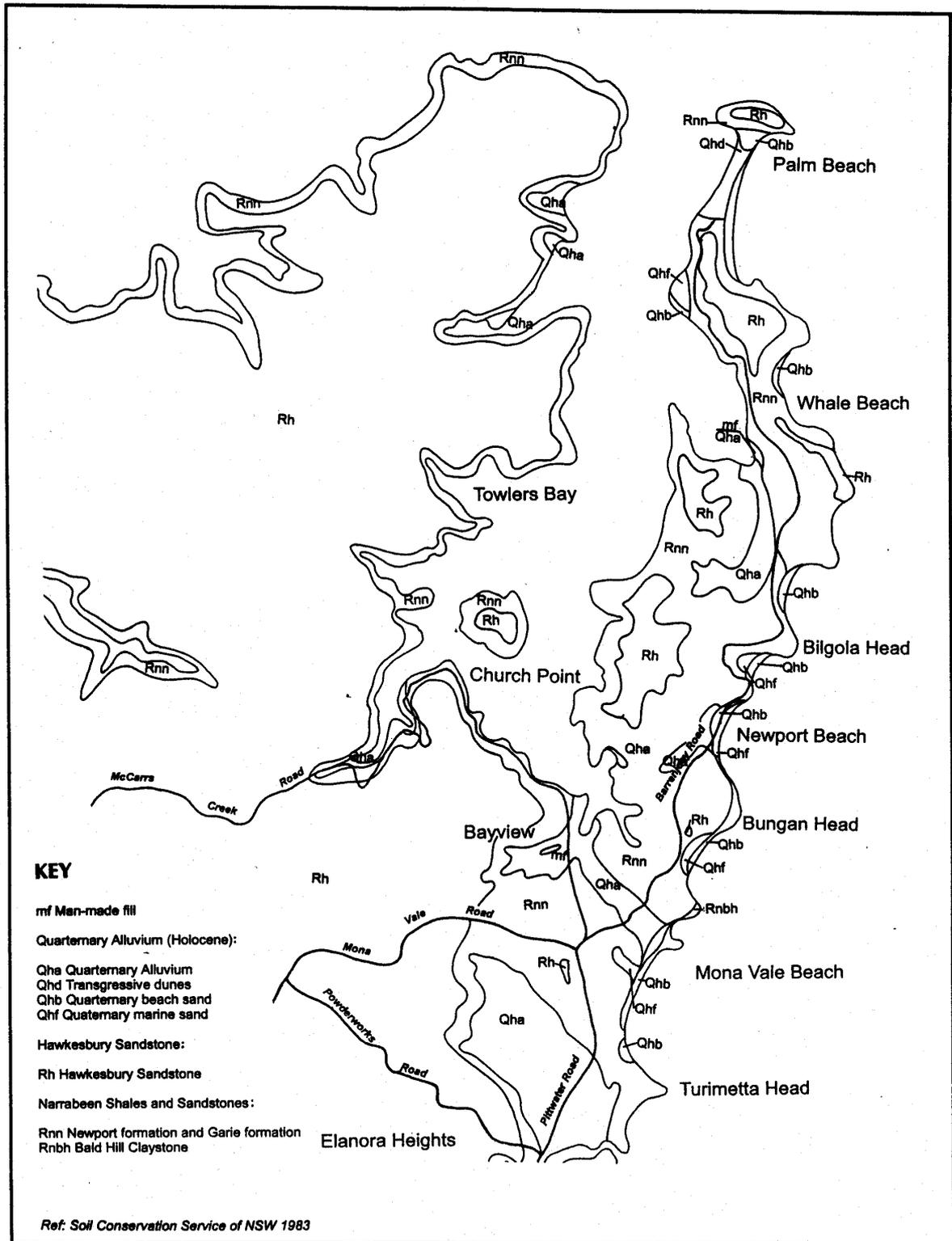
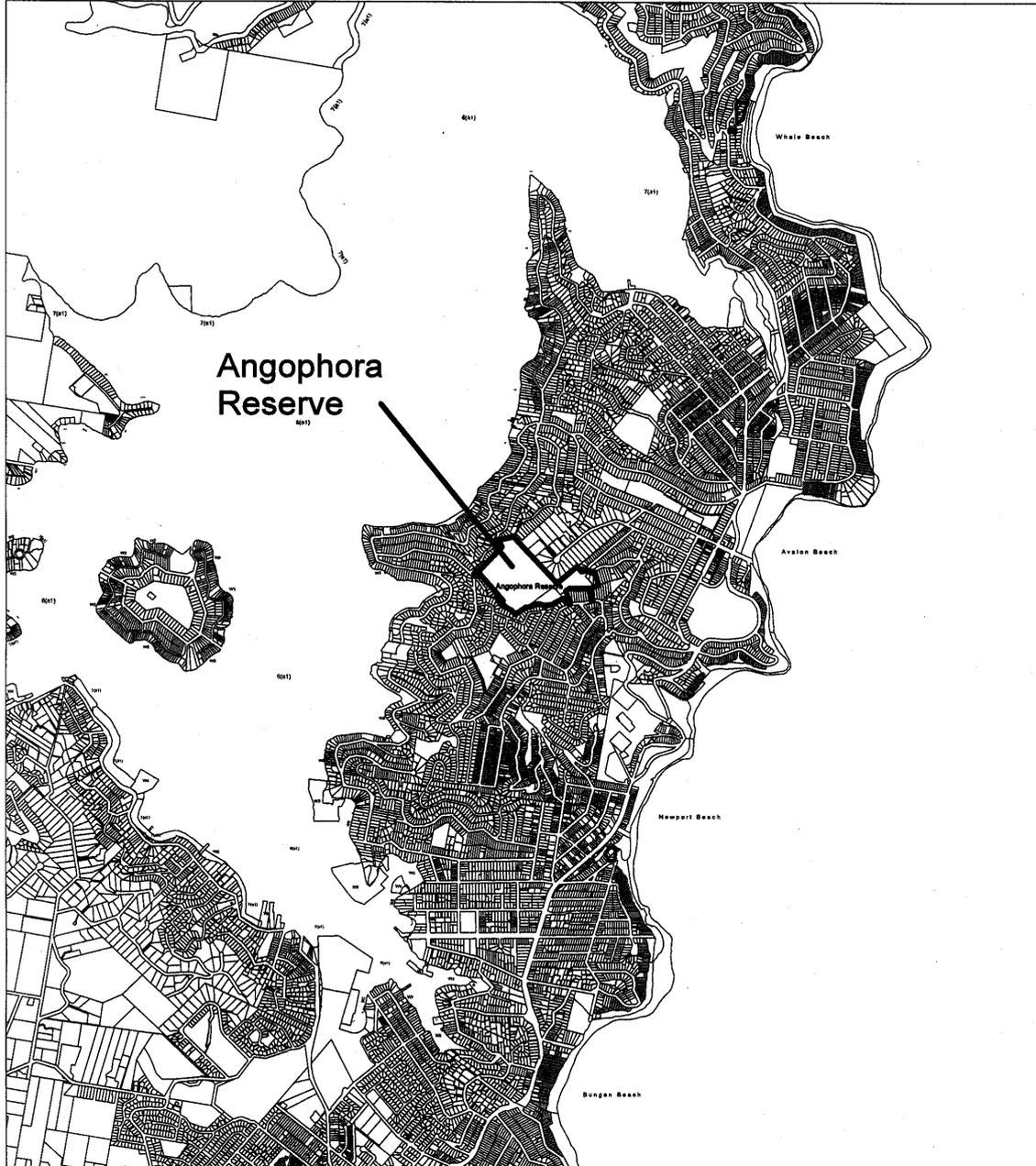
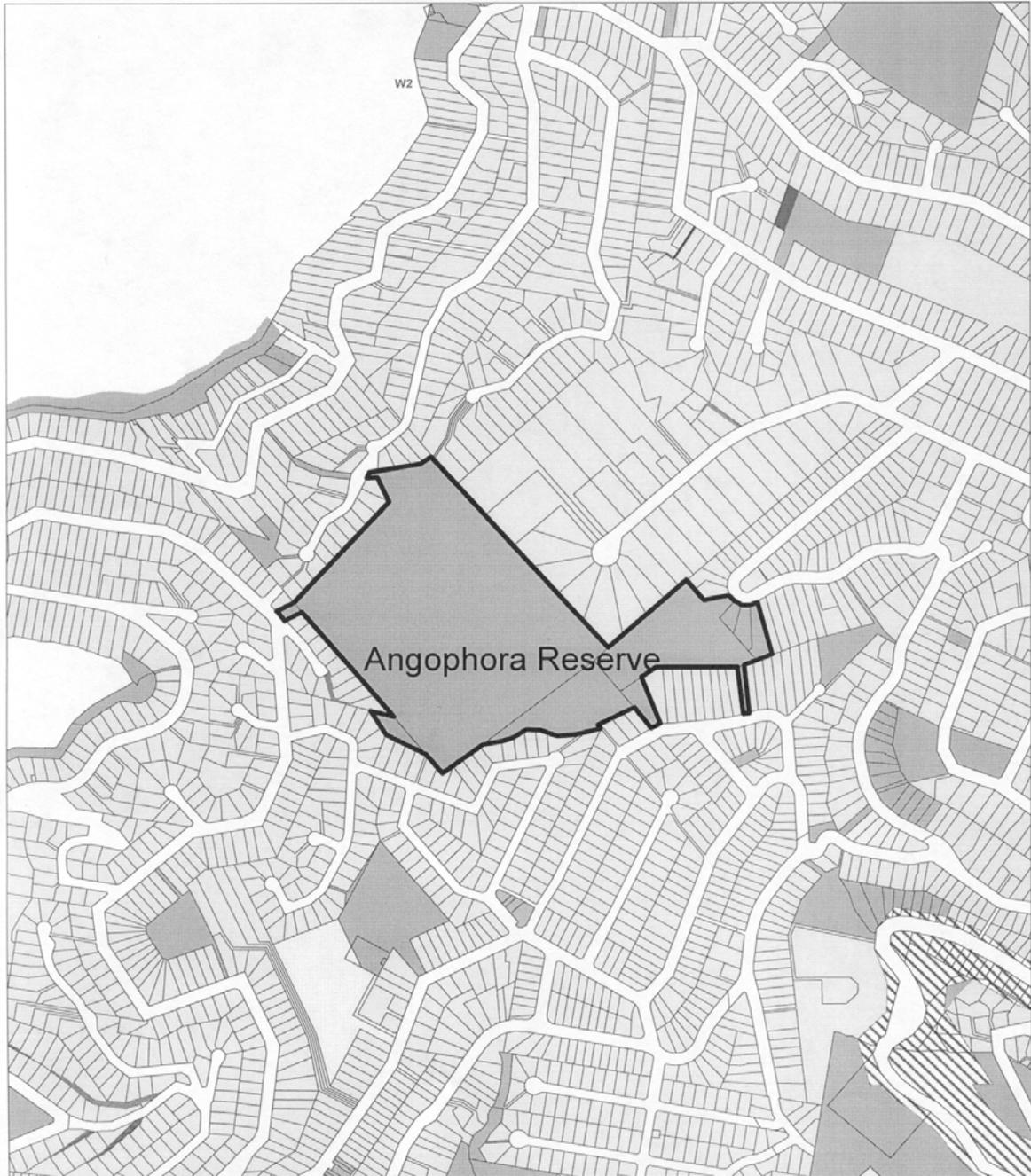


Figure 4. Location Map



Angophora Reserve Plan of Management		
Map: Reserve Location	Date: Feb, 2001	

Figure 5. Reserve Boundaries



Angophora Reserve Plan of Management		
Map: Reserve Area Map	Date: Feb, 2001	

3.5. Vegetation

Species lists and maps of angophora reserve have been collated from a range of sources of varying reliability and age. Therefore species lists and vegetation maps are only indicative of the vegetation and structures present in the reserve and are not considered accurate to any significant level. They are intended only to provide a record and description of the reserve.

A total of 293 species of vascular plants have been recorded from the reserve (Appendix 1). The total comprises 227 native species and 66 introduced species, not including various garden plants seen only on the very edges of the reserve. The number of native species is high for such a small reserve, reflecting the variety of habitats present.

None of the plant species recorded from the reserve is on the Australian National Parks and Wildlife Service's list of Rare or Threatened Australian Plants (Briggs and Leigh 1988). However, the reserve is the only known site around Sydney where the Elbow Orchid *Arthrochilus prolixus* still grows (Reg Angus. pers. comm.). This species is found on the north coast of New South Wales and in Queensland, the Northern Territory and New Guinea. Sydney represents the southern limit of its distribution. A small terrestrial orchid, it occurs at several sites in the reserve, on both Hawkesbury Sandstone and Newport Formation soils.

Five native vegetation types, or plants communities, may be distinguished (Figure 8). These are described below and related to Thomas and Benson's (1985a,b) vegetation classification scheme for Ku-ring-gai Chase National Park and Muogamarra Nature Reserve.

(1) *Angophora costata* – *C. gummifera* Woodland

The Hawkesbury Sandstone of the ridges and upper slopes supports a woodland community dominated by Sydney Red Gum *Angophora costata* (46% of trees in a sample of 150) and Red Bloodwood *C. gummifera* (29%). Other tree species are Sydney Peppermint *Eucalyptus piperita*, Grey Gum *Eucalyptus punctata* (7%), Bastard Mahogany *Eucalyptus umbra* (6%), Scribbly Gum *Eucalyptus haemastoma* (1%) and Turpentine *Syncarpia glomulifera* (1%). The tree layer averages 18 m in height and 15% foliage cover.

There is a mid-dense understorey of low trees, about 8 m high, dominated by Black She-oak *Allocasuarina littoralis* and, to a lesser extent, Old Man Banksia *Banksia serrata*.

The shrub layer is sparse and about 1.5 m high. Shrub species include Prickly Moses *Acacia ulicifolia*, Hairpin Banksia *Banksia spinulosa*, New South Wales Coral Heath *Epacris pulchella*, Pink Spider-flower *Grevillea sericea*, Broad-leaved Geebung *Persoonia levis*, Handsome Flat-pea *Platylobium formosum* and Wreath Bush-pea *Pultenaea elliptica*.

The herb layer varies from mid-dense and about 60 cm high in exposed sites, to dense and about 1 metre in sheltered sites. The ferns, Soft Bracken *Calocitium dubium* and Bracken *Pteridium esculentum*, dominate in sheltered sites. In more exposed sites there is a mixture of ferns, grasses, sedges and other herbs, including Flax Lily *Dianella caerulea*, Bordered Panic *Entolasia stricta*, Blady Grass *Imperata cylindrica*, Scale-rush *Lepyrodia scariosa*, Pale Mat-rush *Lomandra glauca*, Spiny-headed Mat-rush *L. longifolia* and Kangaroo Grass *Themeda triandra*.

This community corresponds to Thomas & Benson's (1985a,b) Community 13, *Angophora costata* – *C. gummifera* - *E. umbra* woodland, which is a common community on Hawkesbury Sandstone in higher rainfall areas of the Hornsby Plateau near the sea. Large areas are conserved in Ku-ring-gai Chase National Park (Thomas & Benson 1985a) Muogamarra Nature Reserve (Thomas & Benson 1985b), Brisbane Waters National Park (Benson & Fallding 1981) and a small area in Bouddi National Park (McRae & Benson 1983). The community covers a total area of about 8 hectares in Angophora Reserve.

(2) *Corymbia maculata* Open-Forest

The Newport Formation of the lower slopes supports an open-forest community dominated by Spotted Gum *C. maculata* (46% of trees in a sample of 150). Other tree species are Sydney Red Gum *Angophora costata* (16%) Red Bloodwood *E. gummifera* (13%), Bastard Mahogany *E. umbra* (9%), Grey Gum *E. punctata* (6%), Grey Ironbark *E. paniculata* (4%), Turpentine *Syncarpia glomulifera* (3%), Bangalay *E. botyroides* (2%) and Rough-barked Apple *Angophora floribunda* (1%). The tree layer averages 26 metres in height and 20% foliage cover. This is, in fact, a woodland structure but is due to extensive dieback of the trees. In a healthy condition the community would form an open-forest with a foliage cover over 30%.

The low tree layer is mid-dense and about 12 metres high, although there may be another layer about 6 metres high. The most common species are Forest She-oak *Allocasuarina torulosa*, Cheese Tree *Glochidion ferdinandi* and Cabbage-tree Palm *Livistona australis*. Also prominent are Black She-oak *Allocasuarina littoralis*, Blueberry Ash *Elaeocarpus reticulatus*, sweet pittosporum *Pittosporum undulatum* and turpentine *Syncarpia glomulifera*. Vines are common, notably Wonga Wonga Vine *Pandorea pandorana*, Water Vine *Cissus hypoglauca*, Scrambling Lily *Geitonoplesium cymosum* and Sweet Sarsaparilla *Smilax glycyphylla*.

There is a sparse shrub layer about 1.5 metre high, including Hop Bush *Dodonaea triquetra*, Burrawang *Macrozamia communis*, Handsome Flat-pea *Platylobium formosum* and Elderberry *Panax Polyscias sambucifolia*.

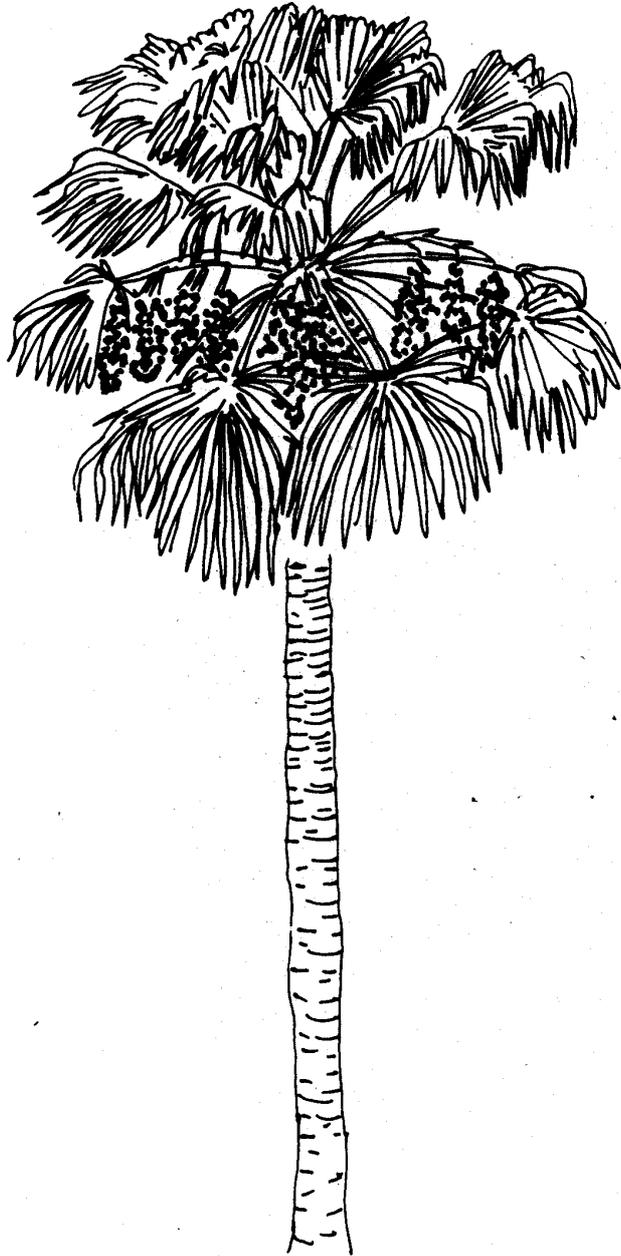
The herb layer is dense, about 1 metre high and dominated by Soft Bracken *Culcita dubia*. Other common herbs are Rusty Tick-trefoil *Desmondium rhytidophyllum*, Flax Lily *Dianella caerulea*, Bordered Panics *Entolasia marginata* and *E. stricta*, Basket-grass *Oplismenus aemulus* and Bracken *Pteridium esculentum*. In the eastern corner of Hudson Park, the shrub and herb layers have been overgrown by dense thickets of introduced Lantana *Lantana camara* 2 to 3 metres high (Map 4).

This community corresponds to Thomas & Benson's (1985a) Community 5, *C. maculata* - *E. paniculata* open-forest, which is closely associated with the Newport Formation. The community, as a whole, has a limited distribution and a poor conservation status (Benson 1980). Its main occurrences are on the Northern Beaches Peninsula, where it has been extensively cleared. It also occurs on Scotland Island and the western shore of Pittwater. Even in the latter site adjacent to Ku-ring-gai Chase National Park, it is poorly conserved, occurring mostly outside the Park boundary (Thomas & Benson 1985a). The area of *C. maculata* open-forest within Angophora Reserve and Hudson Park is about 8 hectares.

Pittwater Spotted Gum Forest has been listed under the *Threatened Species Conservation Act, 1995* as an endangered ecological Community on Schedule 1 Part 3 of the Act. It was determined that the community was very poorly represented in national parks and reserves and that much of its distribution was in urban areas.

Figure 6.

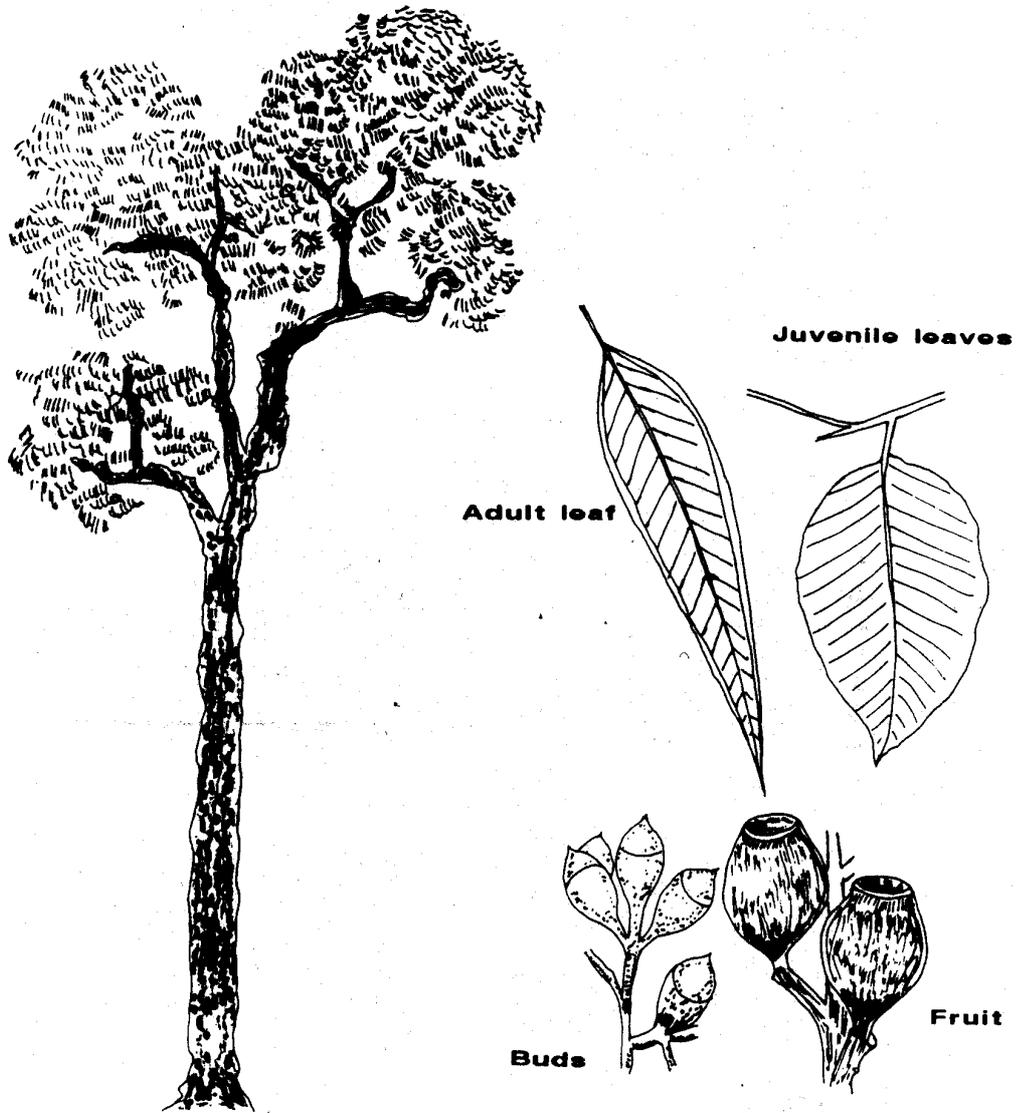
Livistona australis, Cabbage Tree Palm



Seedling

Figure 7.

Corymbia maculata, Spotted Gum



(3) *Livistona australis* Stands

Stands of Cabbage-tree Palms *Livistona australis* occur along drainage lines on the flatter, lower ground at the end of Ruskin Rowe. The palms average 16 metres in height and 20% foliage cover. There are scattered low trees and tall shrubs in and around the stands, especially Forest She-oak *Allocasuarina torulosa*, Cheese Tree *Glochidion ferdinandi* and Small-leaved Privet *Ligustrum sinense* (introduced). Water Vine *Cissus hypoglauca* often grows over these. The understorey consists of dense thickets of introduced Lantana *Lantana camara* 2 to 3 metres high. Herbs are sparse and mainly confined to openings in the Lantana. The most common herbs are Tall Saw-sedge *Gahnia clarkei* and Soft Bracken *Calochlaena dubia*.

This community is not included in Thomas & Benson's (1985a,b) classification. It is a form of littoral rainforest, restricted to the immediate vicinity of the coast and associated particularly with the more fertile soils of the Northern Beaches Peninsula. Its closest equivalent in nearby national parks and nature reserves are the palm stands found in sheltered gullies in Bouddi National Park, but the main palm species there is Bangalow Palm *Archontophoenix cunninghamiana* (McRae & Benson 1983). Cabbage-tree Palms occur sporadically in Ku-ring-gai Chase National Park (Thomas & Benson 1985a) and Brisbane Water National Park (Benson & Fallding 1981) but not in stands.

The area of the palm stands in Hudson Park is about 0.5 hectare. Originally, these stands formed part of a much more extensive stand of palms around the end of Ruskin Rowe. This was a well known local attraction but has suffered greatly from clearing and overgrowth by lantana. As an unusual plant community with scenic appeal and local historical interest, it warrants a program of rehabilitation.

(4) Fern Swamp

Swamp vegetation dominated by ferns covers a small area - only about 500 square metres - atop the main sandstone cliff in Hudson Park. This consists of a dense thicket of Tangle Fern *Gleichenia dicarpa* about 1.5 metres tall, interspersed with clumps of Tall Saw-sedge *Gahnia clarkei*. There is a sparse layer of emergent shrubs up to about 4 metres tall, mostly Crimson Bottlebrush *Callistemon citrinus* and Black She-oak *Allocasuarina littoralis*.

This community is a form of Thomas & Benson (1985a,b) Community 21, sedgeland/shrubland (swamp vegetation), which encompasses a variety of vegetation types associated with poorly drained soils. Buchanan (1980) recognised four distinct but intergrading types of swamp in Ku-ring-gai Chase National Park. The fern swamp in Hudson Park corresponds to her 'swamp: vegetation dense' classification. This is the least common of her swamp types in Ku-ring-gai Chase National Park and appears to be absent from Muogamarra Nature Reserve (Thomas & Benson 1985b), Brisbane Water National Park (Benson & Fallding 1981) and Bouddi National Park (McRae & Benson 1983), although very minor occurrences may have been overlooked.

(5) Sedge Swamp

Another form of swamp vegetation, a sedge swamp, occurs in the southern corner of Hudson Park. It covers an area of only about 500 square metres of shallow, poorly drained soil over a pavement of Hawkesbury Sandstone. It consists of a dense herb layer about 70 cm high dominated by Scale-rush *Lepyrodia scariosa* and Coral Heath *Epacris microphylla*. Other common herbs are Whisky Grass *Andropogon virginicus* (introduced), creeping raspwort *Gonocarpus micranthus* and an unidentified sedge. There is a mid-dense layer of shrubs 1-1.5 metres tall, mostly Fern-leaved Banksia *Banksia oblongifolia*, Crimson Bottlebrush *Callistemon citrinus*, Pink Spider-flower *Grevillea sericea*, Yellow Tea-tree *Leptospermum flavescens* and Conesticks *Petrophile pulchella*.

This community is another form of Thomas & Benson (1985a,b) Community 21, sedgeland/shrubland. It corresponds to Buchanan's (1980) 'swamp: vegetation mixed'

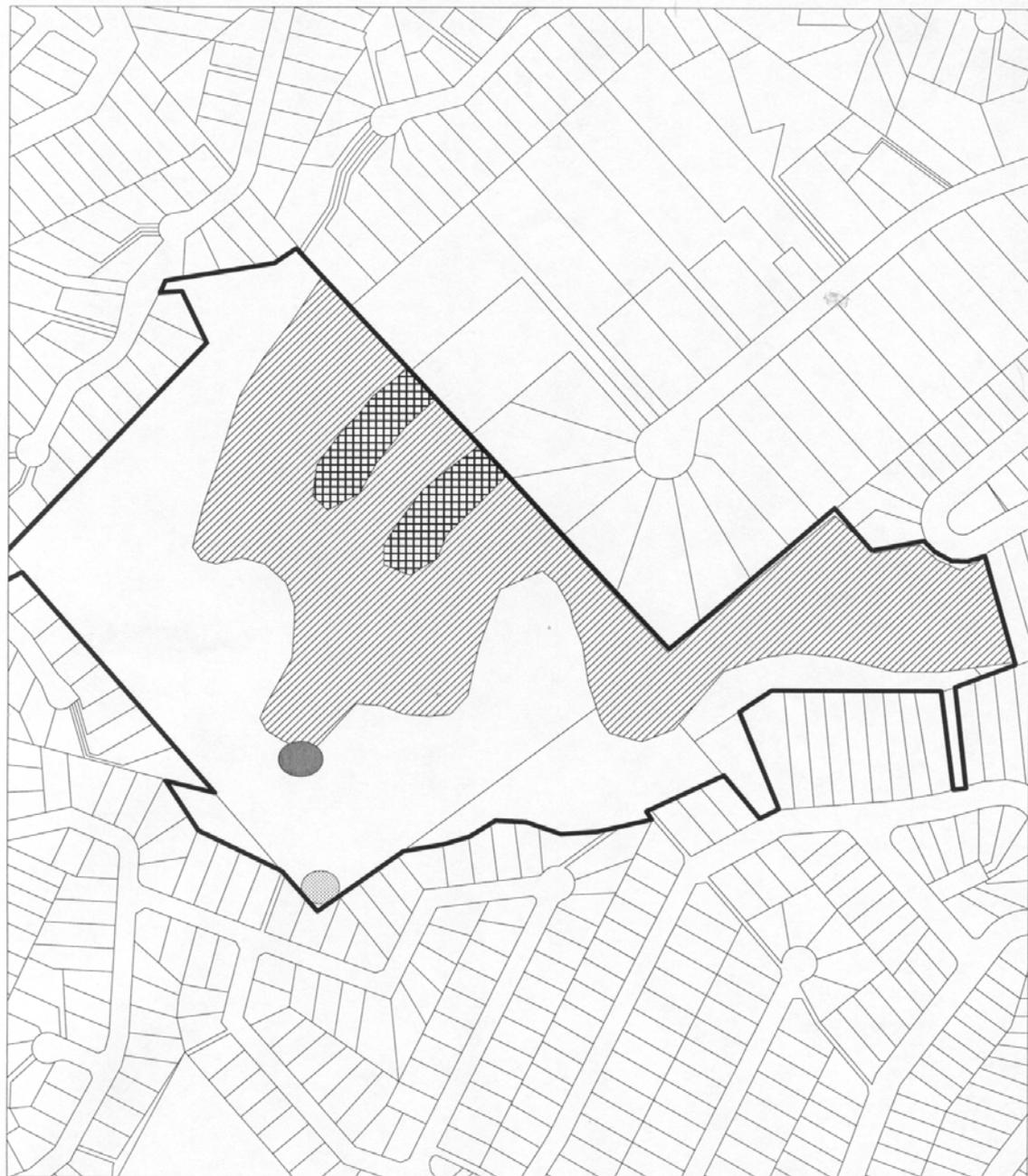
classification. This type of 'swamp' is subject to widely fluctuating and generally drier soil moisture conditions than other swamps, including the fern swamp described above. Similar vegetation occurs extensively in Ku-ring-gai Chase National Park (Thomas & Benson (1985a)) and Brisbane Water National Park (Benson & Fallding 1981).

The tiny patch of sedge swamp in Hudson Park represents the relict tip of a much larger area of sedge swamp (1 to 2 hectares) evident on aerial photos taken in 1951, before the area was developed for housing.

The Giant Angophora

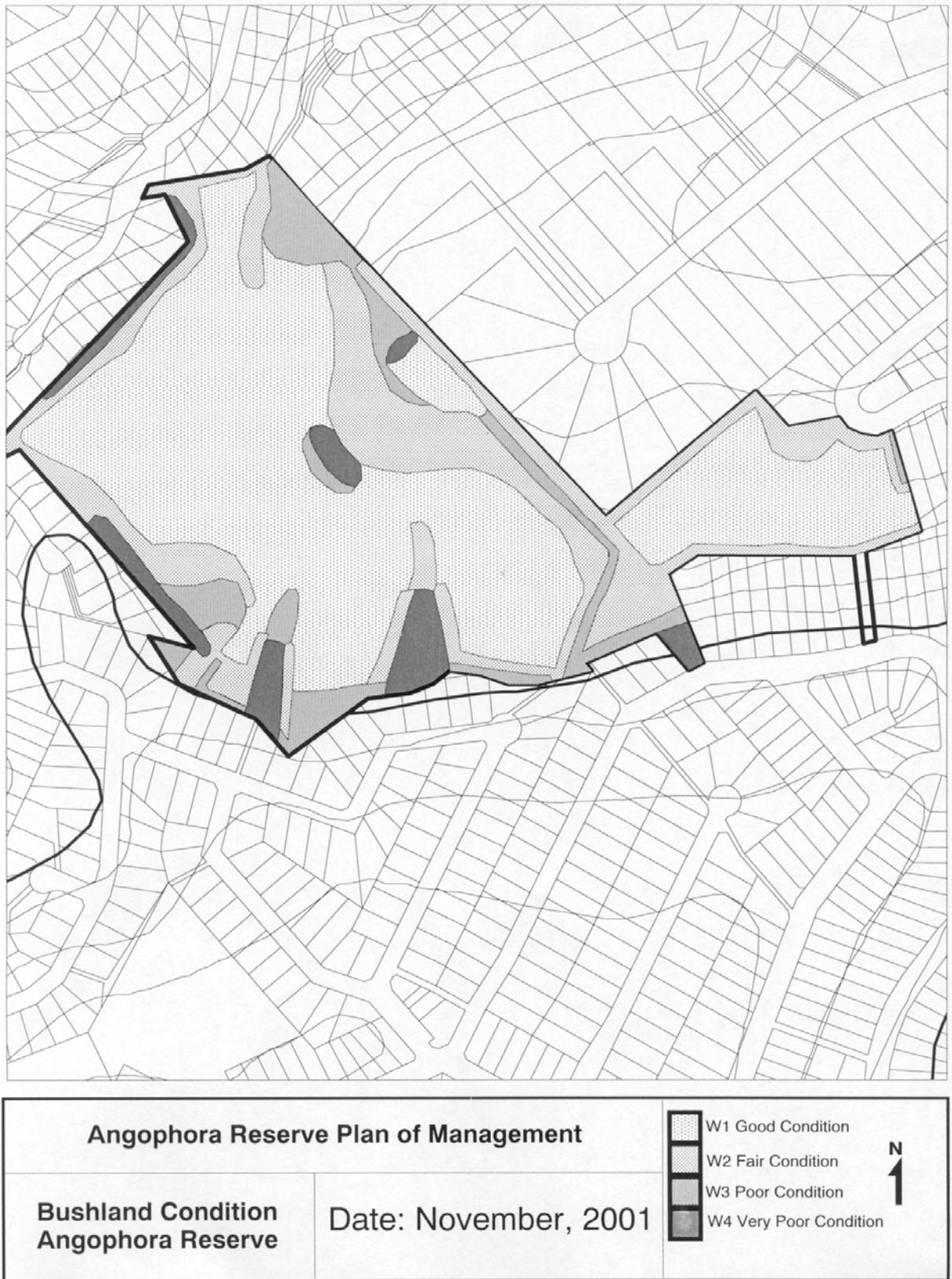
A special feature of the reserve is the giant specimen of Sydney Red Gum (also known as Smooth Barked Apple) *Angophora costata* (Location shown on Map 2). Preservation of this particular tree was the chief reason for the establishment of Angophora Reserve in 1937. This tree is identified in Council's Heritage Study of the Barrenjoey Peninsula and Pittwater area (McDonald McPhee 1989) as a landscape item of heritage significance. It is also listed in the Draft Local Environment Plan for Heritage Conservation. The tree is not especially tall (estimated 30 to 35 metres) but has a very thick trunk (10 metres circumference at the base). It was thought to be the largest and oldest of its species. The tree is still standing but now no longer living (believed to have died in 1993 after a long drought) but remains on site and contains significant hollows, thus continuing to provide habitat for a number of species of fauna.

Vegetation map. Figure 8



Angophora Reserve Plan of Management		 Hawkesbury Sandstone woodland
Map: Vegetation Map	Date: March, 2001	 Newport Formation open-forest
		 Cabbage-tree Palm stands
		 Sedge swamp
		 Fern swamp

Figure 9: Bushland Condition Map





Angophora Reserve Plan of Management		
Map: Weed Distribution Contours: 10 m Scale: 1:7500	Date: Feb, 2001	

3.6. Fauna

Two frog species, four lizards, thirty four birds and eight mammals have been recorded in or near the reserve (Appendix 2). These totals include three introduced birds and one introduced mammal. Other species are likely to be found with further survey, but the fauna is generally depauperate, as with most small urban reserves. However, it is surprisingly rich in two groups - parrots and mammals.

The parrots of which there are seven species, are very prominent. Especially common are rainbow lorikeets and sulphur-crested cockatoos. These are beautiful birds and their noisy activity is an enjoyable feature of the reserve. Other birds include several species which, although common in bushland around Sydney, tend to disappear from built-up areas. These are the Golden Whistler, Eastern Whipbird, Variegated Fairy-wren, White-browed Scrubwren and Brown Thornbill.

The mammal species include the koala, which is listed as a Vulnerable Species in NSW under Schedule 2 of the Threatened Species Conservation Act (1995). The Pittwater Koala Population has also been listed as an endangered Population under Schedule 1 of the TSC Act.

Other notable mammals are the echidna, long-nosed bandicoot and squirrel glider. The echidna is reasonably common around Sydney but is usually found in larger areas of bushland. The long-nosed bandicoot is also reasonably common in the bushier parts of Sydney, including Pittwater (Ray Williams, pers. comm.), but is a species of some concern because it appears to be declining. Once described as 'extremely abundant' in suburban Sydney (Marlow 1962), it has disappeared from a number of suburbs over the last 20 years.

The squirrel glider is listed as 'Vulnerable,' on Schedule 2 of the TSC Act. The Barrenjoey population of Squirrel Glider is also listed as an endangered population under Schedule 1 of the TSC Act. As indicated by specimens at the Australian Museum, there are only two localities near Sydney where the species has been recorded over the last 20 years: the Avalon area and Grose Vale-Kurmond (Linda Gibson, per. comm.).

The Koala Colony

Several koala colonies occur around the outskirts of Sydney, but the koala colony at Avalon is the only example of one persisting within the suburbs (although there is a possibility that koalas may still occur in Garigal National Park). The colony is now confined to the area between Newport Heights and Careel Head, and has become isolated from the nearest other colony, which is in Ku-ring-gai Chase National Park (Smith & Smith 1990). The Avalon colony is well known and not only locally. It has been the subject of a children's book (Wince 1977) and is mentioned in several other books and articles on koalas, both scientific and popular (e.g. Lee & Martin 1988; Williamson 1975).

The Avalon colony has declined from an estimated 123+ koalas in 1970 to an estimate of only some eight koalas in 1989 (Smith & Smith 1990) and between four and six in 1993. The colony is in imminent danger of local extinction. The decline has followed extensive residential development on Barrenjoey Peninsula since the 1950's. The area of forested land on the Peninsula has been reduced from 705 hectares (47% of the Peninsula north of Bungan Beach) in 1946 to 125 hectares (8%) in 1989. Several Council bushland reserves appear to be used by the remaining koalas as refuges (Smith & Smith 1990). Angophora Reserve is the most important of these. The others are Stapleton Park, Careel Headland Reserve and Crown of Newport Reserve, with Algona Reserve also used. The most recent sighting in Avalon in February 2000 was with a juvenile showing that the small remnant population is still breeding.

The recent adoption of the Management Plan for Threatened Fauna and Flora in Pittwater also provides for the protection of threatened species in Pittwater.

3.7. Cultural heritage

Aboriginal Heritage

The reserve contains one of the most archaeologically significant Aboriginal shelter sites in the Sydney region (McDonald 1988, 1992). This is a large overhang in a sandstone cliff-line, containing faded red and black drawings (ochre and charcoal), a large shell midden, stone artifacts and a burial site. This site has been known locally for some time and recorded on the National Parks and Wildlife Service's Aboriginal Sites Register.

Human bones were found at the site in March 1988. Because of the possibility of a recent murder, the site was extensively excavated, using conventional archaeological techniques. In all, the remains of five, and possibly six, individuals were recovered. It became clear that these represented Aboriginal burials and the Metropolitan Local Aboriginal Land Council requested that the remains be reburied at the site.

In addition to the human bones, a large amount of archaeological material was collected. This comprises large quantities of shells (both coastal and estuarine), large mammal, bird, reptile and fish bones, plant material, and stone, bone and shell artifacts. Analysis of this wealth of material has now been undertaken. It appears that intensive use of the shelter commenced about 2000 years ago and ended about 1150 years ago, with the site probably being a home base camp during the latter part of its occupation (McDonald 1988, 1992).

Two layers are apparent in the deposit, corresponding to two different periods of usage. The lower layer contains low densities of material and very few shells. This suggests that it corresponds to the period before the sea rose to its present level about 6000 years ago (Hughes & Lampert 1982). During this period the sea was 100 to 150 metres lower and some 20 kilometres further east. The upper layer of the deposit is much richer in archaeological material, including large amounts of shell. The shelter was used intensively at this time, as both a living site and a burial site. It is not yet known when or for how long this intensive usage occurred, but it does appear to be prior to 1788. No evidence has been found of occupation after European contact.

One and possibly three other Aboriginal sites have been found in the reserve (Tessa Corkill, pers. comms.). The definite site is a small rock overhang with two Aboriginal drawings, and is listed in the National Parks and Wildlife Service's Register. The other two sites are also small rock shelters. There appears to be evidence of Aboriginal occupation at these two shelters but this is still to be confirmed. An archaeological survey has been made along the first sewer-line to be constructed in the reserve but no sites were detected (McDonald 1984). No survey has been made of the reserve as a whole.

European Heritage

There appears to be no significant European heritage on the reserve although a complete survey of the site has not been completed.

3.8. Recreation

The primary recreation use of the reserve is for walking by Pittwater residents. Two main walking tracks extend through the reserve, firstly one from the Palmgrove Road to Wandeen Road entrances and the second from Hilltop Road to Chisholm Avenue. Walking provides a healthy activity and interaction for members of the community and is done in a thoughtful and sustainable manner fitting in with the objectives of the reserve.

Figure 10 shows the location of the formal and informal walking tracks in the reserves and 9 access points into the reserve. Other informal tracks should be regenerated if they are considered damaging to the reserve.

Figure 10. Walking Tracks



Angophora Reserve Plan of Management		  Formal Tracks  Minor Tracks  Access points
Map: Tracks Map	Date: March, 2001	

4. Significance

The survival of remnant native vegetation in urban areas is a rare phenomenon and Sydney has been especially lucky in this regard. This has been due not so much to far-sighted planning as to a combination of infertile soils, difficult terrain and a relatively short period of European settlement. Nevertheless, the great value of these areas of remnant bushland is now being recognised and documented (e.g. Department of Environment and Planning 1986; National Trust 1987a).

All remnant bushland areas are significant for the following reasons:

- ❖ They provide 'green space' in the urban environment. Even when highly degraded in relation to their original condition, this may still be prized by local residents as a bushy area. This role of enriching the urban experience applies not only to people who visit the reserves but also those who drive past and even those who simply know that bushland is there. The scarcer the areas of remnant bushland, the greater their value as 'green space'.
- ❖ They provide a habitat for many species of native flora and fauna that would otherwise disappear from urban areas. The extent to which a reserve can maintain populations of these species depends on how large it is (or how large the relatively undisturbed parts are), how far from other areas of bushland (which determines how readily the reserve can be recolonised), and how sympathetically it is managed.
- ❖ Urban bushland is also important as a wildlife corridor, allowing migratory or nomadic species to filter through large cities. This role is often evident only from occasional sightings of unusual birds or butterflies in these reserves.
- ❖ They are an important scientific resource, especially as a record of a district's original landscape and vegetation. Even weed invasion and other adverse influences on small, isolated reserves provide opportunities for important research, not just from a management viewpoint but also in terms of improving our general understanding of how ecosystems function.
- ❖ They are an important educational resource. Their value here lies chiefly in their accessibility. It provides nearby schools and other educational institutions with natural areas that can be visited without the need for a major excursion, where it is feasible to carry out studies involving repeated visits.
- ❖ They provide recreational opportunities. Bushwalking is a popular pastime around Sydney, whether undertaken for exercise or as a quiet stroll to 'see the wildflowers and birds'. Angophora Reserve, with its steep scenic topography and rich flora and birdlife, are well suited for both purposes.

In addition to these general features, Angophora Reserve is significant for several specific features:

- ❖ It samples a range of different plant communities, including two that are characteristic of Barrenjoey Peninsula and are poorly represented in National Parks and Nature Reserves, namely, the Spotted Gum *C. maculata* open-forest and the Cabbage-tree Palm *Livistona australis* stands.
- ❖ It supports a rich array of plant species, including the only known extant population around Sydney of the Elbow Orchid *Arthrochilus prolixus*, which is at the southern limit of its distribution.
- ❖ Angophora Reserve contains a giant specimen (now dead) of Sydney Red Gum *Angophora costata*, believed to be the largest of its species.
- ❖ It is important habitat for the Avalon koala colony, the only example in the Sydney region of a koala colony persisting within the suburbs. The koala in Pittwater is protected under Schedule 1 Part 2 and Schedule 2 of the Threatened Species Conservation Act 1995.

- ❖ The fauna of the reserve, although poor in total number of species, is notably rich in parrots and mammals. Apart from the koala, the most significant species are the long-nosed bandicoot (which has disappeared from a number of Sydney suburbs over the last 20 years) and the squirrel glider (which is also listed on the endangered fauna schedule, and is now only known around Sydney from one other locality).
- ❖ It contains one of the most archaeologically significant Aboriginal shelter sites in the Sydney region, which has a very high scientific potential for revealing intensive and complex use of the shelter. The presence of previously undisturbed human skeletal remains within a substantial midden deposit makes this site quite unique in the Sydney area. Also due to the presence of human remains, the site is has a high level of significance to the Aboriginal community.

The significance of these features is such that the reserve has been included on the Australian Heritage Commission's Register of the National Estate.

5. Management

5.1. General objectives

Angophora Reserve is classified as community land under the Local Government Act 1993 and then is further categorized as Natural area.

Under the category of natural area Angophora Reserve is further categorized as:

- (a) bushland
- (c) escarpment
- (d) watercourse

Under Section 36 E of the Act, the reserve must be managed in accordance with the following Core Objectives for **Natural areas**:

- (a) to conserve biodiversity and maintain ecosystem function in respect of land, or the feature or habitat in respect of which the land is categorized as a natural area, and
- (b) to maintain the land, or that feature or habitat, in its natural state and setting, and
- (c) to provide for the restoration and regeneration of the land, and
- (d) to provide for community use of and access to the land in such a manner as will minimise and mitigate and disturbance caused by human intrusion, and
- (e) to assist in and facilitate the implementation of any provision restricting the use and management of the land that are set out in a recovery plan or threat abatement plan prepared under the Threatened Species Conservation Act 1995 or the Fisheries Management Act 1994.

for **Bushland**

- (a) to ensure the ongoing ecological viability of the land by protecting the ecological biodiversity and habitat values of the land, the flora and fauna (including invertebrates, fungi and micro-organisms) of the land and other ecological values of the land, and
- (b) to protect the aesthetic, heritage, recreational, educational and scientific values of the land, and
- (c) to promote the management of the land in a manner that protects and enhances the values and quality of the land and facilitates public enjoyment of the land, and to implement measures directed to minimising or mitigating and disturbance caused by human intrusion, and
- (d) to restore degraded bushland, and
- (e) to protect existing landforms such as natural drainage lines, watercourses and foreshores, and
- (f) to retain bushland in parcels of a size and configuration that will enable the existing plant and animal communities to survive in the long term, and
- (g) to protect bushland as a natural stabiliser of the soil surface.

for **Escarpment**

- (a) to protect any important geological, geomorphological or scenic features of the escarpment, and
- (b) to facilitate safe community use and enjoyment of the escarpment.

for **Watercourse**

- (a) to manage watercourses so as to protect the biodiversity and ecological values of the instream environment, particularly in relation to water quality and water flows, and
- (b) to manage watercourses so as to protect the riparian environment, particularly in relation to riparian vegetation and habitats and bank stability, and
- (c) to restore degraded watercourses, and
- (d) to promote community education, and community access to and use of the watercourse, without compromising the other core objectives.

5.2. Issues and Principal Management Activities

5.2.1. Vegetation management

The majority of the bushland is considered to be of good condition for an urban reserve, with the problem areas being mainly confined to the boundaries and drainage lines. Most areas of weed infestation have been subject to bush regeneration or weed control activities primarily through Council employing the National Trust to undertake bush regeneration works. A comparison of reports by the National Trust indicated that the bush regeneration program in the reserve has been quite successful due to the ongoing effort from 1986 to 2000. Although only a few areas are considered to be of poor condition at this stage, ongoing regeneration works are required to prevent previously weeded sites returning to poor condition.

On the upper slopes, on Hawkesbury Sandstone, there were extensive areas where the trees are dead or dying and the vegetation dominated by weeds, especially Lantana *Lantana camara* and Crofton Weed *Ageratina adenophora*. Tree die back and weed invasion are associated with pollution from the stormwater outlets particularly off The Circle and Bilwara Avenue. These areas have been the focus of much planting and regeneration work to repair this problem. On the lower slopes, on the Newport Formation shales, dense Lantana thickets remain beneath the Cabbage-tree Palm stands on the main drainage lines, and in one large section of the Spotted Gum Forest. The tree canopy in the weedy areas on the Newport Formation is still relatively healthy, in contrast to the weedy areas on Hawkesbury Sandstone. Angophora Reserve contains two creeks and five water outlets.

The National Trust's bush regeneration team has in the past concentrated on less badly affected parts of the reserve, where their approach, based on the Bradley Method of Bush Regeneration (Bradley 1988), has proved very effective in controlling the spread of weeds. The most heavily weed-infested areas are not suited to the Bradley Method and had often been left for treatment using other techniques (such as those described by Temple and Bungey 1980). In recent years, however, the Trust has adopted and refined a wider range of techniques and become more involved in the treatment of the worst affected areas (National Trust 1987a). In the early 1990's Council sought to consolidate and work previously worked sites around upper parts of the reserve. In the late 1990's Council adopted a program of combining weed control with hazard reduction burning, which enables advances to be made on larger degraded areas that were then included within the bush regeneration contract. A general description of bush regeneration techniques has been provided by Buchanan (1989).

The heavy weed infestations below the stormwater outlets have been a major issue for the reserve and should be a priority for ongoing treatment. However, weed control efforts will only be effective in the long term if there is effective control of the pollution problems. Otherwise, there will be repeated re-infestation by weeds and substantial regeneration of native species may prove impossible, unless by planting species more suited to wetter more nutrient-rich conditions (in other words, species not native to the particular site but, preferably, ones native to the district). Council has undertaken treatment of all the stormwater outlets (see Drainage Management).

The Cabbage-tree Palm stands are also badly degraded by lantana and should be a priority for treatment. These stands have considerable conservation, scenic and historical value. These areas have been the focus of some regeneration works and should continue. Their continued rehabilitation should result not only in a more natural understorey but also, eventually, a denser palm canopy.

Other areas that require special attention are the boundaries of the reserve, the access points and the main tracks. Not only are these the sites where weed invasion typically begins, they are also important for the enjoyment of the reserve by residents and visitors - they are the most visible parts of the reserve.

Of particular note is the southern boundary where the private land extends well below the cliff line. This has become a constant source of weed encroachment and rubbish dumping over the cliff. Efforts should be made to educate the land owners of this issue and encourage environmentally aware management of these areas.

Elbow-Orchids

Preservation of the population of Elbow Orchids *Arthrochilus prolixus* in the reserve is a specific management objective. However, very little is known of the species' ecological requirements and its response to disturbance. It has a patchy distribution in the reserve, typically occurring in colonies in situations such as the edges of tracks, where there is an opening in the usually dense layer of ferns and other low vegetation. The species occurs in Angophora Reserve in both Hawkesbury Sandstone woodland and Newport Shale Formation forest.

As a general principle, undue disturbance of the colonies of Elbow Orchids should be avoided. However, partial clearing of the ground vegetation in and around individual colonies may be warranted should these become overgrown.

Giant Angophora

Fakes (1989) assessed the health of the giant Angophora and concluded that general changes in the reserve may have had a detrimental effect on the overall condition of the tree. Its condition in 1989 was a reflection of its great age and advanced state of senescence. By 1990 the health of the tree had deteriorated further and Council became concerned about the number of large dead limbs located above the tree viewing area and the main walking track through the reserve. The hazardous limbs were removed under the supervision of a tree care consultant who ensured that no undue damage was caused to the tree and the natural symmetry of the tree crown was not soiled. The tree's decline cannot be attributed to any one cause and was likely to be the result of decreasing resistance with age and long-term changes in the catchment from urbanisation. At that stage the giant Angophora had little life left but functioned as an important shelter and nesting habitat for birds, arboreal mammals and insects.

In 1992 Fakes again reported on the tree's condition. She reported that about 60% of the trunk and 95% of the canopy were now dead and that the tree was approaching the end of its life. No treatment was recommended for the termites and borers in evidence, neither were fertilizers as this may have hastened the tree's death. In 1993 the tree died following a long drought. The habitat values of the tree were emphasized and if limbs are removed for safety reasons, that they are inspected for wildlife and alternatives such as nesting boxes are installed if appropriate.

Fakes' view (1992) was that nothing could have been done realistically to prolong the life of the tree and that sympathetic management of the surrounding bush was probably the best treatment. The tree should remain as a point of interest and a feature of important habitat value until the stability of the trunk is compromised and the tree poses significant risk to Reserve uses.

Angophora Reserve has been subject to a range of vegetation management activities in the past which have concentrated on the management of weeds, the conservation of the giant Angophora (now dead) and the management of the Elbow Orchid *Arthrochilus prolixus*. Future activities will be focused on the control of weeds, regeneration of bushland, appropriate fire regime and the conservation of plant communities.

Objectives:

- To contain and where possible eradicate plants not consistent with vegetation communities in the Reserve (weeds).
- To identify sources or causes of weed infestation treated where possible.
- To conserve and enhance the vegetation communities and populations particularly Spotted Gum Forest, Cabbage-tree Palms *Livistona australis* and Elbow Orchid *Arthrochilus prolixus*.
- To promote public awareness of and involvement in vegetation management issues in Angophora Reserve.
- To conserve vegetation communities and populations that provide specific habitat and resource value for threatened and significant fauna species.
- To retain the Giant Angophora as it stands as an important habitat for wildlife and as a natural heritage feature.

Performance targets:

- The decrease in weed abundance, diversity and distribution in Angophora Reserve.
- The increase in community involvement and understanding of vegetation management in the reserve.
- The maintenance or increase in habitat values for threatened or significant fauna.
- A reduction in die back of mature trees in the reserve.

Actions:

- Implement bush regeneration, noxious and environmental weed removal and revegetation programs.
- To identify and remove sources of and causes of weed infestations through bush regeneration and drainage works.
- Undertake community education programs in the form of information/field days and printed materials and promote involvement through Bushcare groups and other community groups.
- Implement regeneration and revegetation programs with focus on fauna habitat and resource trees and plants.
- Monitor the stability of The Giant Angophora trunk and take further actions where necessary to minimise risks.
- To produce/maintain appropriate interpretive signage to highlight significance of The Giant Angophora.

Performance assessments:

- Assess weed abundance, diversity and distribution through periodic assessment of the reserve and review contractor reports on work undertaken.
- Compare community involvement in Bushcare and other community groups.
- Attitudes of neighbors will be monitored through response to information days, written complaints and compliments.
- Formal surveys of attitudes and understanding will be considered every 5 years.
- Monitoring of The Giant Angophora trunk stability.

5.2.2. Water management and other Pollution

Pollution problems arise in Angophora Reserve because of the urban development in the upper part of the catchments on Bilgola Plateau. Runoff and seepage from the urban areas enters the reserve along its southern and western boundaries, although the number of houses within the catchment is much less on the western boundary (Hilltop Road).

The urban areas in the upper catchment were unsewered until 1984, when the eastern section (The Circle, Bilwara Avenue) was connected. The western section (Wandeen Road, Hilltop Road) was connected to the sewerage system in July 1991. Alleviation of the problems (including tree die back) associated with unsewered areas was a major step in reducing pollution. Nonetheless, urban stormwater runoff still remains a major problem. Runoff from urban areas is much greater in volume than from vegetated areas (up to ten times the volume) and it carries high sediment loads. It also transports weed propagules and various pollutants (Bliss *et al.* 1979). High phosphorus levels are a particular concern. Tests of stormwater in the reserve have recorded phosphorous levels 50 to 100 times greater than in natural runoff (Wright 1988). They have been linked with increasing soil phosphorus levels in urban bushland. This increase has resulted in the expansion of weeds and some rainforest species such as Sweet Pittosporum *Pittosporum undulatum* and Cheese Tree *Glochidion ferdinandi* becoming more abundant (Clements 1983; Leishman 1986; Lambert & Turner 1987).

Comparisons of soil phosphorus levels in Angophora Reserve, and in other urban and non-urban bushland areas around Sydney, indicated levels in Angophora Reserve were far above what would be expected under natural conditions. The measurements from the Hawkesbury Sandstone soils are unusually high, even when compared with other urban bushland sites. This probably reflected the proximity of the sampled soils to previously unsewered housing. Since these measurements works have been undertaken to connect all houses to town sewer and control stormwater outlets entering the reserve. Monitoring of phosphorus levels at a number of sites in the reserve near the stormwater outlets has since been undertaken.

In a study of urban bushland in sewered areas, Leishman (1986) concluded that stormwater outlets were the major source of excess nutrients. She recorded excessive soil phosphorus levels below stormwater outlets and consistently heavy weed infestation at these sites. The latter is a common observation around Sydney and is also the case in Angophora Reserve. There are five stormwater outlets at the top of the reserve off The Circle and Bilwara Avenue. The most badly degraded parts of the reserve are clearly associated with these stormwater outlets. Large areas down slope of the outlets were dominated by weeds, especially Lantana *Lantana camara* and Crofton weed *Ageratina adenophora* beneath a canopy of dead and dying trees. Bush regeneration work carried out by the National Trust in recent years has for the meantime removed much of the serious infestations below the outlets located in The Circle and Bilwarra Avenue.

Although dead and dying trees are particularly noticeable in the degraded areas below the stormwater outlets, they occur throughout the reserve, especially in the vicinity of drainage lines. The Smiths survey (1993) found that 20% of all taller trees were dead and 19% unhealthy (from a sample of 373 trees from six parts of the reserve, trees were classed as unhealthy if a third or more of the canopy was dead. The healthiest of the sample sites was the gentler slopes in the Wandeen Road corner of the reserve, where only 2% of trees were dead. The healthiest of the main tree species was Spotted Gum *Corymbia maculata*. The poor tree health is of special concern in this reserve because of the Pittwater Koala population.

It is clear that the stormwater outlets are causing serious degradation of the vegetation. Causes include changes in moisture regimes, increased wetness and nutrients. The installation of sediment and nutrient traps at the existing outlets has been undertaken.

Other problems which warrant attention are the dumping of rubbish and garden clippings in the reserve, and illegal discharge of polluted water into the reserve especially from swimming pools. Discharge of swimming pool water can cause significant degradation of native vegetation and should be prevented.

Stormwater Management Strategy

In 1994 The Stormwater Management Strategy for Angophora Reserve was produced and proposed the construction of management structures and revegetation programs at the 5 outlets. With the aid of grant funding the majority of this work, in a slightly modified form, has been completed and monitoring of their effects is in place. Phosphorus levels of water and soil in and below these structures has been measured and can be compared to future tests which will provide the basis for ongoing monitoring in the reserve. It cannot be compared to past tests due to incompatible test designs.

Angophora Reserve has been subject to a range of drainage works aimed at reducing impacts of stormwater and sewage flowing into the reserve. These include the connection of all houses to the central sewerage systems and construction of a number of sediment basins. Future works will be aimed at maintaining these structures and monitoring their performance in relation to trapping of sediments and nutrients.

Objectives:

- To prevent damage associated with stormwater entering the reserve.
- To reduce adverse impacts of stormwater management on tree health and vegetation condition.

Performance targets:

- The reduction of velocity of flows, volume, nutrient and sediment levels of water entering and within the reserve.
- Reduction in adverse impacts of stormwater management on tree health and vegetation condition.

Actions:

- The design, construction and maintenance of structures that mitigate these effects.
- Regeneration and vegetation of areas effected by erosion and nutrient loading.
- Continue the monitoring of the effects of drainage works on phosphorus levels.

Performance assessments:

- The monitoring of stormwater in relation to velocity and water quality.
- Monitor tree condition and weed plumes below stormwater outlets.

5.2.3. Fauna management

The 'Management Plan for Threatened Fauna and Flora in Pittwater' (Smith and Smith, 2000) provides and detailed history of the threatened species and populations and prescribes actions for their conservation.

Koalas

General recommendations for preservation of the koala colony on Barrenjoey Peninsula have been made by Smith & Smith (1990). Council in 1990 adopted a short-term management strategy based on these recommendations for the koala population.

The following discussion in relation to Angophora Reserve is based on these recommendations. As it is well known that koalas feed on eucalypt foliage, and that of the related genus *Angophora* and other native species. Koala habitat in the reserve is being degraded through the extensive eucalypt dieback associated with urban runoff and inappropriate fire regimes resulting in eucalypts being replaced by weeds and rainforest vegetation.

Another important consideration is tree species composition. Although a large number of trees are known to be browsed occasionally by koalas, the bulk of their diet in any area usually comes from only one or two species (Lee & Martin 1988). On Barrenjoey Peninsula the principal food tree is the Grey Gum *Eucalyptus punctata*, with Scribbly Gum *E. haemastoma* and Swamp Mahogany *E. robusta* as important secondary food trees (Smith & Smith 1990). The numbers of food trees in the reserve are shown in the table below (table 1). This indicates that the reserve although an important refuge for Koalas, represents a poor food source. There are only some 64 mature food trees in the reserve, representing only 11% of the total number of mature trees. The three main tree species in the reserve - Sydney Red Gum *Angophora costata*, Red Bloodwood, *C. gummifera* and Spotted Gum *C. maculata* are occasionally browsed by koalas, but tend to be avoided.

The reserve should be improved as koala habitat by planting more food trees. The planting program should concentrate on Grey Gums. As well as being the most favored food tree on the Peninsula, Grey Gum is known to satisfy the nutritional requirements of koalas throughout the year (Cork *et al.*, 1983; Cork 1986).

Table 1, Number of Koala Food Trees in the Reserve

There are an estimated 600 live, mature trees in the reserve. The following is based on a sample of 300. Trees were classed unhealthy if at least a third of the canopy was dead. The Importance rankings are based on Smith and Smith (1990)

Species and Importance to Koalas	Numbers of Live Trees	Percentage Unhealthy
Principal Koala Food Tree		
E. Punctata	38	26
Secondary Koala Food Trees		
E. haemastoma	2	0
E. robusta	2	0
Sometimes Browsed But Not Usually Favoured		
Angophora costata	182	25
A. florabunda	2	0
E. botryiodes	6	67
C. gummifera	124	31
C. maculata	146	10
E. paniculata	12	17
E. piperita	48	25
E. umbra	48	25
Not Known To Be Browsed		
Syncarpia glomulifera	10	0

The strip of remnant bushland adjacent to the north-eastern corner of Hudson Park (larger of the two lots that make up Angophora Reserve) between Chisholm Avenue and Ruskin Rowe should be preserved. The smaller patch of remnant bushland between Angophora Reserve and the major cliff line to the south also warrants preservation. These two adjoining areas of bushland significantly increase the effective size and value of the reserve as a refuge for Koalas. These areas are identified as important wildlife corridors in the Bilgola Plateau Locality Plan No. 9 Section 3.3.1, Habitat and Wildlife Corridors Strategy (1995) and referred to in the DCP 25 Biodiversity. Land such as this will be provided for in the Pittwater 21 document to be finalised in 2002.

A major problem for the koala population on Barrenjoey Peninsula is attack by dogs, particularly large dogs and dogs working in packs. Dogs appear to be the chief cause of death in this koala colony (Smith & Smith 1990). Dogs should not be allowed to roam free, particularly at night, or where koalas are likely to be on the ground such as where there is a discontinuous tree canopy. More rigorous enforcement of the Companion Animals Act is needed, and frequent evening patrol of the area. However, this should be accompanied by a public education program. It is essential that residents be made aware of the threat posed to koalas by dogs. Cats are less of a threat to koalas being a major predator of smaller animals, such as long-nosed bandicoots and squirrel gliders.

Gliders and Bandicoots

Development of appropriate management strategies for preservation of squirrel gliders and other arboreal mammals in the reserve is hampered by a lack of knowledge. Relatively little is known of the ecology of many of these species.

The squirrel glider is a medium-sized, nocturnal, arboreal, gliding possum that moves from tree to tree, shelters during the day (and breeds) in tree hollows, and feeds on insects, nectar, pollen and plant exudates (Suckling 1983; Menkhorst *et al.* 1988; Menkhorst & Collier 1988). Sugar gliders are also uncommon on the peninsula and share common habitat requirements. Potential problems for these species in the reserve are the declining tree health (see Section 4.2) and predation by cats and dogs. The survival of the local populations is also threatened by clearing of remnant bushland and eucalypts outside the reserve. Policies outlined in Sections 4.2 and 4.6 in regard to the tree health and preservation of neighbouring bushland should also benefit the glider populations. It is widely accepted that the area required for a sustainable population of squirrel gliders is greater than the area available in Angophora reserve. This population is therefore reliant on the connecting habitat (including private property) between large reserves for its survival.

The long-nosed bandicoot is a medium-sized terrestrial mammal which shelters during the day in a nest on the ground, and feeds at night on insects and plant material, usually obtained by digging (Stodart 1977, 1983; Brown *et al.* in press). The species has disappeared from some Sydney suburbs where it was abundant in the 1950's and 1960's. Possible reasons include clearing of its bushland habitat, predation by cats, dogs and foxes, and disease, particularly toxoplasmosis, which has caused concern in studies of the closely related Eastern Barred Bandicoot *Perameles gunnii* (Obendorf & Munday, 1991).

In a comprehensive study of eastern barred bandicoots in an urban situation at Hamilton, Victoria, Brown (1987) identified feral and domestic (pet) cats as major predators, especially of juvenile Bandicoots. Cat control was a central issue in the management plan subsequently developed for the bandicoot population at Hamilton.

The Squirrel Glider colony on Barrenjoey Peninsula, and the Long-nosed Bandicoot population throughout the northern suburbs of Sydney both warrant further study to determine what management actions are necessary for their preservation. Previous fauna management activities have been limited due to the lack of knowledge about local populations. Future activities are aimed towards the long term conservation of native fauna species and populations on the Barrenjoey Peninsula through the provision of habitat and food resources.

Fox baiting programs have been undertaken in Pittwater in 2000, 2001 and 2002 as part of the Regional Fox Control Program with the aim of protecting native fauna from predation by foxes. The 2002 program includes plans to bait using 1080 in Angophora Reserve between May and June.

The introduction of Peafowl to the reserve by residents of Ruskin Rowe was a contentious issue in the reserve. The proposed removal of the Peafowl from Ruskin Rowe was met with strong public opposition. A public meeting was held to discuss the issue, with many residents attending to listen to the speakers and voice their opinion. The recommendations from the meeting were the removal of Peafowl from Angophora Reserve, that council had no jurisdiction to manage Peafowl on private property and that land owners are open to obtaining their own advice on management of Peafowl on their property.

Objectives:

- To monitor and improve the habitat and resource values of the site for native fauna species particularly for those species that are threatened or significant.
- To promote awareness of native fauna and activities that threaten these species.
- To conserve populations of native fauna in particular Koalas, Squirrel/Sugar Gliders and Long-nose Bandicoots through monitoring and management.
- To control or eradicate introduced fauna in the reserve.

Performance targets:

- The increase in abundance, diversity and distribution of habitat and resource values for native fauna species. e.g., food trees, hollows.
- The increased awareness of Koalas, Squirrel/Sugar Gliders and Long-nosed Bandicoots populations and the reduction of threatening processes such as dogs and cats in the reserve.
- Better understanding of Koalas, Squirrel/Sugar Gliders and Long-nosed Bandicoots populations in the reserve.
- Achieve sustainable populations of Koalas, Squirrel/Sugar Gliders and Long-nosed Bandicoots.
- The reduction in numbers of foxes, dogs, cats, peafowl and other introduced species in the reserve.

Actions:

- Implement regeneration and reinstatement programs with focus on fauna habitat and resource trees and plants.
- Monitor number and quality of resource trees for Koalas and Squirrel/Sugar Gliders.
- Undertake on going monitoring of fauna in the reserve to gain greater understanding of threatened populations.
- Conduct education program educating the community about native fauna species and the threat their cats and dogs pose to these species.
- Undertake feral species control and eradication programs.

Performance assessments:

- Monitor populations of threatened fauna to gauge success of programs.
- Monitoring of health of habitat trees in the reserve for Koalas and Gliders.
- Monitor distribution and abundance of feral species.
- Attitudes of neighbours will be monitored through response to education program, written complaints and compliments.
- Formal survey of attitudes and understanding will be considered every 5 years.

5.2.4. Fire management

Fire management is one of the most complex and controversial issues in the management of bushland reserves. Fire is a natural disturbance in Sydney bushland, but its effects depend on the fire regime - the combination of fire frequency, fire intensity and season of fire occurrence. Changes to the fire regime can seriously degrade the conservation values of the reserve. In addition, fires escaping from bushland reserves can pose a threat to human life and property. The problem for the managing authorities is to determine and maintain a fire regime that will maximise conservation values while minimising the bushfire threat.

Historical Changes to the Fire Regime

The fire regime in Angophora Reserve has changed with its isolation by urban development. In the 1920's and 1930's when there were few residents at Avalon, the area was subject to numerous wildfires (letter from Lois Koonce, a former resident). Their occurrence, especially the more severe fires, has declined with extensive urban development since the 1950's.

As the adjacent bushland has been cleared, Angophora Reserve is now subject only to internal fires, not ones sweeping in from other areas. Fires starting within the reserve are unlikely to develop into major fire events because of the small area to which they are confined. The reserve was last burnt by severe wildfire in the early 1940's (Garvin Kable, pers. comm.), although there have been several minor wildfires since then.

The reserve is also now subject to prescribed burning. This is the practice of lightly burning an area at intervals of no more than 10 years in autumn and winter to decrease fuel loads and reduce the incidence of any damaging spring or summer wildfires which are difficult to control.

Recording of fire events in the past has been rough records and anecdotal evidence. To effectively prescribe and manage fire it is necessary that the fires in the reserve be recorded and mapped.

Ecological Effects of the Changes

In the prolonged absence of fire, rainforest plants tend to invade eucalypt forests and may form a dense understorey and midstorey. The eucalypt forest species may eventually be excluded from such sites because they are unable to regenerate under the dense canopy (Ashton 1981; Smith & Guyer 1983).

In Angophora Reserve there is evidence of increasing populations of fire-sensitive rainforest species in the Spotted Gum *C. maculata* open-forest of the lower slopes. Particular species involved are Cheese Tree *Glochidion ferdinandi*, Sweet Pittosporum *Pittosporum undulatum* and Cabbage-Tree Palm *Livistona australis*. If this trend continues the Spotted Gum Forest may eventually be degraded by inappropriate species. Because of the moist conditions on the lower slopes, these sites are burnt only by the hottest fires. They have probably not burnt since the big fire of the early 1940's, if then.

Expansion of rainforest plants is a general phenomenon in bushland reserves around Sydney and is also linked to increasing soil nutrient levels due to urban runoff.

She-oaks *Allocasuarina* spp. also appear to be increasing in the reserve in the absence of major fires. In particular, large areas of the Hawkesbury Sandstone woodland now have a dense understorey of black she-oak *A. littoralis*, whereas air photos from the 1940's and 1950's indicate a much more open understorey in these areas. At Ocean Grove, Victoria, Withers & Ashton (1977) and Withers (1978 a,b, 1979) have described how a eucalypt woodland which had remained unburnt for over 90 years was in the process of being replaced by a dense scrub of Black She-oak. A similar transition seems to be occurring at Avalon. Although Black She-oaks are killed by major fires, few are killed in less intense fires, such as prescribed burns.

General reviews of fire ecology in Australia are provided by Gill *et al.* (1981) and Ealey (1984). Hawkesbury Sandstone vegetation has been comparatively well studied, both at a community level (Siddiqi *et al.* 1976, Benson 1985; Nieuwenhuis 1987; Clark 1988) and by detailed studies of individual species (Bradstock & Myerscough 1981; Bradstock & O'Connell 1988, Auld 1986a,b, 1987, Zammit & Westoby 1987a,b, 1988 Zammit 1988). These studies indicate that the optimal fire regime to maintain plant species diversity in Hawkesbury Sandstone woodland involves moderate to high intensity fires in summer or autumn at intervals of 10 to 30 years.

Comparable information is lacking for the Spotted Gum Forest on the Newport Shales Formation. However, the moister conditions indicate a rather longer period between fires, since only the hottest fires are likely to penetrate. The cabbage-tree palm stands, like other rainforest types, occur in infrequently burnt sites.

From the point of view of fauna conservation, individual fires occurring in the reserve should be limited in extent. Even low intensity fires may render the burnt area temporarily uninhabitable for species dependent on a dense scrub layer, such as Brown Thornbills, White-browed Scrubwrens and Variegated Fairy-wrens (Smith 1989). These species require an unburnt refuge area if their populations are to survive.

Fire Hazard in the Reserve

The long-term fire hazard in the reserve was assessed using the methods of the Department of Environment and Planning's Circular No. 74 (1984) which has now been superseded by Circular C10 - Planning in Fire Prone Areas. The hazard is low on the downslope side of the moist Newport shale Formation vegetation. However, because of the steep topography, even allowing for the small size of the reserve, the fire hazard is high upslope on the Hawkesbury Sandstone vegetation.

To reduce the hazard around the upper rim of the reserve it is desirable to have a fire protection zone at 40 metres wide where fuel loads are maintained at low levels - preferably below 5 tonnes per hectares (Luke 1982). This would probably require prescribed burns at intervals of about five years, depending on the rate of fuel accumulation. An alternative but more costly and difficult method is clearing with hand tools.

Ecological Effects of Hazard Reduction

Repeated burns at intervals of about five years will eliminate some native species from the burnt areas. While adult plants of some species are able to survive fire and resprout, other species are readily killed by fire, even at low intensities, and must rely on regeneration from seed. Between fire intervals shorter than the time required for these obligate-seeders to set seed can eliminate or severely reduce their populations, allowing the expansion of resprouting species and leading to a reduction in biodiversity. The various studies quoted above indicate that a fire-free interval of at least ten years is required to prevent loss of plant species from Hawkesbury Sandstone woodland.

Weeds may increase in numbers after an area is burnt, especially on the edges of a reserve, where there is likely to be a large supply of weed seeds in the soil (Bradley 1988). As discussed in Section 4.2, increasing soil nutrient levels due to urban runoff are a major factor promoting weed invasion in the reserve.

Little information is available on the ecological effects of hazard reduction by hand clearing. Like prescribed burning it is a form of disturbance likely to favour some plant species, including some weed species, at the expense of others. Hand clearing if carried out carefully, may have less impact than burning, but whether the extra time and money involved would be better spent elsewhere is debatable.

Fire management has previously concentrated on the protection of land and property in the surrounding residences, and in the future will aim to conserve biodiversity through fire and protect land and property in the surrounding residences from the dangers of wildfire.

Objectives:

- To minimise the fire hazard of the reserve to the surrounding residences.
- To promote awareness of fire risk and prevention to the community.
- To implement or simulate a near natural fire regime for hazard reduction and the maintenance of biodiversity.
- To exclude fire from those areas considered fire sensitive.
- To map fire events in terms of intensity, distribution and season.

Performance targets:

- The reduction of fire risk to surrounding residences.
- The increase of awareness in the community about fire risk and ecological importance of fire.
- The maintenance of biodiversity through a near natural fire regime.

Actions:

- Investigate fire history in the reserve and plan for ecological, hazard reductions or simulations of fire for the conservation of biodiversity.
- Educate the community through printed materials and information days about risks of fire and prevention.
- To undertake fire hazard reduction in a 40metre fire protection zone through fuel clearing and hazard reduction burns on reserve boundaries.
- To undertaken the development of a fire action plan/strategy in consultation with the Rural Fire Service, to be approved by the bushland management committee.

Performance assessment:

- Assess fuel loads in area giving high risk to boundaries to determine need for hazard reduction activities.
- Assess vegetation structure and floristics in the reserve to determine need for ecological burns.
- Attitudes of neighbors will be monitored through response to education program, written complaints and compliments.

5.2.5. Recreation and access management

Walking tracks

There are two main walking tracks through the reserve - from the Palmgrove Road entrance to the Wandeen Road entrance, and from this track to the Hilltop Road and Chisholm Avenue entrances (Map 5). Some upgrading and marking of these tracks has occurred in the late 1990's mainly to define them more clearly and to prevent erosion. At present the proliferation of sidetracks makes it difficult for casual visitors to find their way. The junction of the two tracks is a particular problem and is poorly sign posted. In general, however, it is desirable to keep the tracks as unobtrusive as possible.

Informal tracks should either be left or regenerated depending on their use level and impact on the reserve. The maintenance of tracks however will be contained to the formal main tracks that cross the reserve.

Access

The reserve is located in the back streets of Avalon, with the only signposts to it being at the corner of Palmgrove Road, Elouera Road and at the Wandeen Road entrance. The reserve has a narrow frontage on Palmgrove Road but access elsewhere is by eight narrow passages between houses. There is public access from all surrounding roads except Ruskin Rowe. The main entrances are from Palmgrove Road and Wandeen Road. The nine access points to the reserve are:

- (1) Palmgrove Road. One of the two main entrances. Signposted but with a variety of different signs, which should be simplified.
- (2) Chisholm Avenue. A sealed driveway used by neighbouring residents. No indication to casual visitors that it is an access route to the reserve, which should be sign posted.
- (3) Hilltop Road. A wooden staircase up a steep hillside covered with a mixture of garden plants, weeds and natives. No signpost and to the casual visitor it appears to be private property. Across the road is a public pathway leading to Clareville Beach.
- (4) Wandeen Road. The other main entrance to the reserve. Well sign posted, requires mowing of the road verge to give a "cared for appearance".
- (5) Bilwara Avenue, west. Narrow passage between houses. Low eucalypts and she-oaks with an understorey of mixed native, weeds and garden plants. Stormwater outlet and cliff nearby. No public access provided.
- (6) Bilwara Avenue, east. Narrow passage between houses. Mown grass. Stormwater outlet and cliff nearby. No public access provided.
- (7) The Circle, west. Similar to (6)
- (8) The Circle, centre. Widest of the access points from The Circle and Bilwara Avenue. Weedy bush and cliff nearby. No public access provided.
- (9) The Circle, east. Narrow, poorly defined passage between houses. Garden plants. Stormwater outlet and cliff nearby. No public access provided.

There is good, signposted access to the reserve from the east (Palmgrove Road) and the west (Wandeen Road). There is also good access from the north, from Hilltop Road and Chisholm Avenue, although its use, especially by casual visitors, is inhibited by the lack of signs, which should be provided.

Although there are several access points from the south, along Bilwara Avenue and The Circle, these are all poorly defined and none leads to a major track. Due to the risk associated with the cliff line, access should be limited to management only.

The recreation management of this reserve has concentrated on the provision of walking tracks. Walking tracks and signage will remain the only recreation provision of the reserve. Management will maintain the recreation values of the reserve in a safe, sustainable, low impact way minimising the effects of the ecosystems of the reserve.

Objectives:

- To provide for sustainable low impact recreation opportunities in the reserve.
- To provide for appropriate management access via right of ways.
- To maintain and upgrade where necessary the walking track in the reserve.
- To confine recreation to hardened and maintained tracks to reduce impacts on the reserve.
- To provide interpretive signage in the reserve (directive, environmental and prohibitive).

Performance targets:

- Minimise the degradation of walking tracks.
- Discourage informal walking tracks through their closure and regeneration.
- The provision of appropriate signage.
- Unwanted or illegal access is eliminated.

Actions:

- Ongoing maintenance program and when required upgrades of the two main walking tracks in the reserve.
- The closure, regeneration and revegetation of inappropriate walking tracks in the reserve.
- The review and development of signage in the reserve.

Performance assessment:

- Periodic walk through assessments of the tracks to assess condition and prescribe work needed.
- Provision and maintenance of appropriate signs.
- Attitudes of neighbors will be monitored through response to education program, written complaints and compliments.
- Formal survey of attitudes and understanding will be considered every 5 years.

5.2.6. Cultural heritage management

The chief concern in management of the Aboriginal sites is to prevent damage by vandalism. The two known sites are not readily accessible at present and this situation should be maintained. This site was subject to a significant excavation and the buried human remains of a number of the area's previous inhabitants remain in the reserve. The location of the sites should not be publicised.

No archaeological survey has been made of the reserve as a whole. In view of the significance of the main shelter site, such a survey is well warranted.

The heritage management in this reserve will continue to be focused on gaining knowledge and the protection of cultural sites. The management of the known site primarily involves the minimising of degradation and the detailed recording of artifacts.

Objectives:

- To preserve Aboriginal and European cultural heritage values of the site.
- Where possible undertake studies of heritage sites in the reserve to gain information on past use of the area.
- Manage heritage sites in order to minimise their degradation.
- To establish and maintain consultation with appropriate stakeholders.

Performance targets:

- The systematic recording of heritage sites.
- The protection of heritage sites from disturbance.

Actions:

- Encourage research by the Metropolitan Local Aboriginal Land Council to undertake an archaeological survey of the reserve in consultation with research institutions and the National Parks and Wildlife Service.
- Do not publicise presence or location of the shelter cave in the reserve for its protection.
- To encourage the Metropolitan Local Aboriginal Land Council to investigate the outcome of the coroner to rebury the Aboriginal remains in the reserve in conjunction with the National Parks and Wildlife Service.

Performance assessment:

- Degradation of the heritage sites will be periodically assessed and appropriate management prescribed.
- Inventory of heritage data for the site be undertaken so a complete picture can be achieved.

APPENDIX 1. FLORA LIST

Vascular plant species recorded in January and February 1989, plus additional species recorded by the National Trust (1983, 1986, 1987b, 1988) marked NT and by Reg Angus (pers. comm.) marked RA.

O occasional F frequent A abundant * Introduced species

Species	Sandstone Woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
FERNS						
Family Adiantaceae						
<i>Adiantum aethiopicum</i>		O	O			
<i>Cheilanthes austrotenuifolia</i>	O					
Family Aspleniaceae						
<i>Asplenium</i> sp. (NT)						
Family Blechnaceae						
<i>Blechnum cartilagineum</i>		O	O			O
<i>Doodia aspera</i>			O			
Family Cyatheaceae						
<i>Calochlaena dubia</i>	A	A	F	O		F
<i>Cyathea australis</i>		O				F
<i>C. cooperi</i> (NT)						
Family Davalliaceae						
* <i>Nephrolepis cordifolia</i>	O					O
Family Dennstaedtiaceae						
<i>Histiopteris incisa</i>		O				
<i>Hypolepis muelleri</i>			O			
<i>Pteridium esculentum</i>	A	F	O	O		F
Family Gleicheniaceae						
<i>Gleichenia dicarpa</i>	O			A		
<i>G. rupestris</i>	O					
<i>Sticherus</i> sp. (NT)						
Family Lindsaeaceae						
<i>Lindsaea linearis</i>	O	O				
Family Osmundaceae						
<i>Todea barbara</i>	O					
Family Psilotaceae						
<i>Psilotum nudum</i> (NT)						
Family Selaginellaceae						
<i>Selaginella uliginosa</i>	O					

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Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
CYCADS						
Family Zamiaceae						
<i>Macrozamia communis</i>	O	F	O			
FLOWERING PLANTS - DICOTYLEDONS						
Family Acanthaceae						
<i>Pseuderanthemum variabile</i>	O	F	O			
Family Anacardiaceae						
* <i>Rhus succedanea</i>						O
Family Apiaceae						
<i>Actinotus helianthi</i>	F					
* <i>Apium leptophyllum</i>						O
<i>Hydrocotyle acutiloba</i>	O	F	F		O	
* <i>H. bonariensis</i>	O					O
<i>Platysace lanceolata</i>	O					
<i>P. linearifolia</i>	O					
<i>Trachymene incisa</i>		O				
<i>Xanthosia tridentata</i>	O					
Family Apocynaceae						
<i>Parsonia straminea</i>	O	O				
Family Araliaceae						
<i>Astrotricha floccosa</i> (NT)						
<i>Polyscias sambucifolia</i>	F	F		O		
Family Asclepiadaceae						
<i>Marsdenia rostrata</i>		O				
Family Asteraceae						
* <i>Ageratina adenophora</i>			O		O	A
* <i>Ageratum houstonianum</i>			O			
* <i>Bidens pilosa</i>	O	O			O	F
<i>Brachycome angustifolia</i>	O					
<i>Cassinia uncata</i>	O	O				
* <i>Chrysanthemoides monilifera</i>	O					O
* <i>Conyza albida</i>	O	O			O	F
* <i>Coreopsis lanceolata</i>	O				O	O
* <i>Erechtites valerianifolia</i>		O	O			O
* <i>Gnaphalium</i> sp. (purpureum group)	O				O	
<i>Helichrysum diosmifolium</i>		O				
* <i>Hypochoeris radicata</i>	O	O		O	O	O
<i>Langenifera stipitata</i>	O	O				
<i>Senecio lautus</i>	O					
* <i>Sonchus oleraceus</i>	O					O
<i>Vernonia cinerea</i>		O				

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Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
Family Balsaminaceae <i>*Impatiens</i> sp.						O
Family Bignoniaceae <i>Pandorea pandorana</i>	O	F	O			
Family Caesalpiniaceae <i>*Cassia coluteoides</i>	O				O	F
Family Campanulaceae <i>Wahlenbergia gracilis</i>	O	O			O	
Family Caprifoliaceae <i>*Lonicera japonica</i> (NT)						
Family Caryophyllaceae <i>*Stellaria media</i>	O					
Family Casuarinaceae <i>Allocasuarina littoralis</i> <i>A. torulosa</i>	A O	F A	F	F	O	F
Family Convolvulaceae <i>Dichondra repens</i> <i>*Ipomoea indica</i>		O				O
Family Crassulaceae <i>Crassula sieberana</i> <i>* Kalanchoe tubiflora</i>	O					O
Family Dilleniaceae <i>Hibbertia dentata</i> <i>H. diffusa</i> <i>H. empetrifolia</i> <i>H. obtusifolia</i>	O O O	O O O				
Family Droseraceae <i>Drosera binata</i> <i>D. spathulata</i>	O O			O		
Family Elaeocarpaceae <i>Elaeocarpus reticulatus</i>	O	F	O	O		
Family Epacridaceae <i>Astroloma</i> sp. (NT) <i>Epacris microphylla</i> <i>E. pulchella</i> <i>Melichrus procumbens</i> <i>Monotoca scoparia</i>	O F O O			O	A O	
Family Euphorbiaceae <i>Amperea xiphoclada</i> <i>Breynia oblongifolia</i>	O O	O				

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Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
<i>Glochidion ferdinandi</i>	O	A	O			O
<i>Omalthus populifolius</i>	O	O	O			
<i>Phyllanthus thymoides</i>	O	O				
<i>Ricinocarpos pinifolius</i>	O					
Family Eupomatiaceae						
<i>Eupomatia laurina</i>		O	O			
Family Fabaceae						
<i>Aotus ericoides</i>	O					
<i>Bossiaea ensata</i> (NT)						
<i>Desmodium rhytidophyllum</i>		F				
<i>Dillwynia retorta</i>	O					
* <i>Genista monspessulana</i>						O
<i>Glycine clandestina</i>	F	F			O	
<i>G. tabacina</i>	O					
<i>Gompholobium latifolium</i>	O	O				
<i>Hardenbergia violacea</i>	O	O				
<i>Hovea linearis</i>		O				
<i>Kennedia rubicunda</i>		O				
<i>Oxylobium ilicifolium</i>		O				
<i>Platylobium formosum</i>	F	F				O
<i>Pultenaea daphnoides</i>		O				
<i>P. elliptica</i>	F	O		O	O	
* <i>Trifolium repens</i>						O
Family Gentianaceae						
* <i>Centaurium erythraea</i>					O	
Family Goodeniaceae						
<i>Dampiera stricta</i>	O					
<i>Goodenia heterophylla</i>		O				
<i>G. ovata</i>						O
<i>Scaevola ramosissima</i>	O	O				
Family Haloragaceae						
<i>Gonocarpus micranthus</i>	O				F	
Family Lamiaceae						
<i>Plectranthus parviflorus</i>	O					
Family Lauraceae						
<i>Cassytha glabella</i>					F	
<i>C. pubescens</i>	O	O				O
Family Lobeliaceae						
<i>Lobelia alata</i>	O					
<i>Pratia purpurascens</i>	O	F				
Family Loganiaceae						
<i>Mitrasacme polymorpha</i>	O					

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Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
Family Malvaceae						
* <i>Pavonia hastata</i>						O
* <i>Sida rhombifolia</i>	O	O				F
Family Meliaceae						
<i>Synoum glandulosum</i>		O				
Family Menispermaceae						
<i>Sarcopetalum harveyanum</i> (NT)			O			
<i>Stephania japonica</i>		O	O			
Family Mimosaceae						
* <i>Acacia baileyana</i>						O
<i>A. floribunda</i>		O				
<i>A. longifolia</i>	O					
<i>A. myrtilifolia</i> (NT)						
<i>A. parramattensis</i>		O	O			
* <i>A. podalyriifolia</i>						O
<i>A. suaveolens</i>	O	O		O		
<i>A. ulicifolia</i>	F	O				
Family Monimiaceae						
<i>Wilkiea huegeliana</i>		O	O			O
Family Moraceae						
<i>Ficus rubiginosa</i>		O				O
Family Myrsinaceae						
<i>Rapanea variabilis</i>		O				
Family Myrtaceae						
<i>Acmena smithii</i>		O	O			
<i>Angophora costata</i>	A	F		O		F
<i>A. floribunda</i>		O				
<i>Baeckea linifolia</i>	O					
<i>Callistemon citrinus</i>	O			F	A	
<i>Darwinia fascicularis</i> (NT)						
<i>Eucalyptus botyroides</i>		O	O			
<i>Corymbia. gummifera</i>	A	F				F
<i>E. haemastoma</i>	O					
<i>C. maculata</i>	O	A	O			O
<i>E. paniculata</i>		O				O
<i>E. piperita</i>	O			O		
<i>E. punctata</i>	O	O				O
<i>E. robusta</i>						O
<i>E. umbra</i>	O	O	O			O
<i>Kunzea ambigua</i>	O			O	O	
<i>Leptospermum attenuatum</i>	O				O	
<i>L. flavescens</i>	O	O		O	F	O
<i>L. juniperinum</i>					O	
<i>Melaleuca armillaris</i>	O					
<i>Syncarpia glomulifera</i>	O	F				O

Angophora Reserve Plan of Management

Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
Family Ochnaceae						
* <i>Ochna serrulata</i>						O
Family Oleaceae						
* <i>Jasminum polyanthum</i> (NT)						O
* <i>Ligustrum lucidum</i>						O
<i>L. sinense</i>	O	O	F		O	O
<i>Notelaea longifolia</i>		O				
* <i>Olea africana</i> (NT)						
Family Oxalidaceae						
<i>Oxalis corniculata</i> s.1.		O				O
Family Passifloraceae						
* <i>Passiflora edulis</i>	O					O
Family Pittosporaceae						
<i>Billardiera scandens</i>	O	O				
<i>Pittosporum revolutum</i>		O				
<i>P. undulatum</i>	O	F	O			O
Family Plantaginaceae						
* <i>Plantago lanceolata</i>						O
Family Polygonaceae						
<i>Persicaria descipiens</i>						O
<i>P. hydropiper</i>			O			
* <i>Rumex sagittatus</i> (NT)						
Family Proteaceae						
<i>Banksia ericifolia</i>	O				O	
<i>B. integrifolia</i>	O	O				
<i>B. oblongifolia</i>	O				F	
<i>B. serrata</i>	F	O				O
<i>B. spinulosa</i>	F			O	F	
<i>Grevillea linearifolia</i>	O					
<i>G. sericea</i>	F	O		O	F	
<i>G. speciosa</i> (NT)						
<i>Hakea dactyloides</i>	O					
<i>H. gibbosa</i>	O					
<i>H. salicifolia</i>	O					
<i>H. sericea</i>	O					
<i>Isopogon anemonifolius</i>	O					
<i>Lambertia formosa</i>	O					
<i>Lomatia silaifolia</i>	O					
<i>Persoonia levis</i>	F	O				
<i>P. linearis</i>	O	O				
<i>Petrophile pulchella</i>	O				F	
<i>Xylomelum pyriforme</i>		O				
Family Ranunculaceae						
<i>Clematis aristata</i>		O				
<i>C. glycinoides</i> (NT)						

Angophora Reserve Plan of Management

Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
<i>Pomaderris lanigera</i>	O					
Family Rosaceae						
* <i>Cotoneaster glaucophyllus</i>						O
* <i>Raphiolepis indica</i>						O
<i>Rubus hillii</i>			O			
Family Rubiaceae						
<i>Morinda jasminoides</i>		O	O			
<i>Opercularia aspera</i>		O				
<i>Pomax umbellata</i>	F	O				
Family Rutaceae						
<i>Boronia ledifolia</i>	O	O				
<i>Zieria smithii</i>		O				
Family Santalaceae						
<i>Exocarpos cupressiformis</i>		O				
Family Sapindaceae						
<i>Dodonaea triquetra</i>	O	F				O
Family Scrophulariaceae						
<i>Veronica plebeia</i>	O					
Family Solanaceae						
* <i>Solanum americanum</i>						O
* <i>S. mauritianum</i>		O	O			O
<i>S. prinophyllum</i>		O				
Family Sterculiaceae						
* <i>Brachychiton acerifolius</i> (NT)						
<i>Lasiopetalum ferrugineum</i>	O	O		O		
Family Thunbergiaceae						
* <i>Thunbergia alata</i>						O
Family Thymelaeaceae						
<i>Pimelea linifolia</i>	O	O			O	
Family Tremandraceae						
<i>Tetratheca thymifolia</i>	O					
Family Ulmaceae						
<i>Trema aspera</i>		O				O
Family Verbenaceae						
<i>Clerodendrum tomentosum</i> (NT)						
* <i>Lantana camara</i>	O	F	A	O	O	A
* <i>Verbena bonariensis</i>						O

Angophora Reserve Plan of Management

Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
Family Violaceae						
<i>Viola hederacea</i>		O	O			
Family Vitaceae						
<i>Cayratia clematidea</i>		O				
<i>Cissus hypoglauca</i>	O	F	F			F
FLOWERING PLANTS - MONOCOTYLEDONS						
Family Alliaceae						
* <i>Agapanthus orientalis</i>						O
Family Araceae						
* <i>Alocasia</i> sp. (NT)						
Family Arecaceae						
<i>Livistona australis</i>	O	A	A			O
Family Cannaceae						
* <i>Canna indica</i>			O			O
Family Commelinaceae						
<i>Commelina cyanea</i>	O	O				O
* <i>Tradescantia albiflora</i>			O			F
Family Cyperaceae						
<i>Baumea rubiginosa</i>						O
* <i>Cyperus erogrostis</i>			O			
<i>C. involucratus</i>						O
<i>C. laevis</i>		O				
<i>C. polystachyos</i>	O	O				O
* <i>C. rotundus</i>						O
<i>Fimbristylis dichotoma</i>		O				
<i>Gahnia clarkei</i>	O	O	F	F		F
<i>Isolepis nodosa</i>						O
<i>Lepidosperma laterale</i>	O	O				
<i>Ptilanthelium deustum</i>					O	
<i>Schoenus apogon</i>	O					
<i>S. melanostachys</i>		O		O		O
Unidentified species (long, terete leaves)					F	
Family Haemadoraceae						
<i>Haemadorum planifolium</i>	O					
Family Iridaceae						
<i>Patersonia sericea</i>	O					
Family Juncaceae						
<i>Juncus continuous</i>	O	O			O	
* <i>J. imbricatus</i>					O	

Angophora Reserve Plan of Management

Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
<i>*Asparagus densiflorus</i>	O	O			O	F
<i>Burchardia umbellata</i>					O	
<i>Caesia vittata</i>	O	O				
<i>Dianella caerulea</i>	F	F			O	
<i>*Lilium formosanum</i>	O	O			O	F
<i>Schelhammera undulata</i>	O	O				
<i>Thysanotus juncifolius</i>	O	O			O	
Family Orchidaceae						
<i>Acianthus</i> sp. (NT)						
<i>Arthrochilus prolixus</i>	O	O				
<i>Caladenia carnea</i> (RA)						
<i>Caladenia catenata</i> (RA)						
<i>Calochilus campestris</i> (RA)						
<i>Chiloglottis reflexa</i> (RA)						
<i>Chiloglottis trapeziformis</i> (RA)						
<i>Crystostylis erecta</i>	O	O				
<i>Dipodium punctatum</i>	O					
<i>Diuris aurea</i>						
<i>Microtis parvifolia</i>						
<i>Genoplesium fimbriatum</i>						
<i>Pterostylis acuminata</i>						
<i>Pterostylis nutans</i>						
<i>Thelymitra ixioides</i>						
Family Philesiaceae						
<i>Eustrephus latifolius</i>	O	O				
<i>Geitonoplesium cymosum</i>	O	F	O			O
Family Poaceae						
<i>*Andropogon virginicus</i>					F	
<i>Anisopogon avenaceus</i>	O					
<i>Aristida vagans</i>	O	O				
<i>*Axonopus affinis</i>		O				
<i>*Bambuseae</i> sp. (NT)	O					
<i>*Briza maxima</i>						O
<i>*Bromus catharticus</i>	O					
<i>*Cortaderia selloana</i>						O
<i>Cymbopogon refractus</i>		O				
<i>Danthonia tenuior</i>	O				O	
<i>Dichelachne micrantha</i>		O				
<i>Digitaria parviflora</i>	O	O				
<i>Echinopogon caespitosus</i>	O	O				
<i>*Ehrharta erecta</i>	O	O				
<i>Entolasia marginata</i>	O	F				
<i>E. stricta</i>	F	F		O		O
<i>Eragrostis brownii</i>	O				O	
<i>Imperata cylindrica</i>	F	O				O
<i>Microlaena stipoides</i>	O	O				
<i>Oplismenus aemulus</i>		F				O
<i>O. imbecillis</i>			O			

Angophora Reserve Plan of Management

Species	Sandstone woodland areas	Shale forest	Palm stands	Fern swamp	Sedge swamp	Weed
Family Poaceae						
<i>Panicum effusum</i>	O					
<i>P. obseptum</i>			O			
<i>P. simile</i>	O	O			O	
<i>Paspalidium radiatum</i>	O	O				O
* <i>Paspalum dilatatum</i>						O
* <i>P. urvillei</i>	O	O				F
<i>Poa affinis</i>	O	O	O			
* <i>Setaria geniculata</i>	O	O	O		O	O
* <i>S. palmifolia</i> (NT)						
* <i>Sporobolus africanus</i>	O	O				O
<i>Stipa pubescens</i>	O	O		O		
<i>Themeda australis</i>	F	O		O		O
Family Restionaceae						
<i>Empodisma minus</i>	O					
<i>Lepyrodia scariosa</i>	F	O		O	A	
Family Smilacaceae						
<i>Smilax australis</i>		O				
<i>S. glycyphylla</i>	O	F	O	O		
Family Strelitziaceae						
* <i>Strelitzia</i> sp. (NT)						
Family Typhaceae						
<i>Typha</i> sp					O	
Family Xanthorrhoeaceae						
<i>Lomandra filiformis</i>	O	O				
<i>L. glauca</i>	F					
<i>L. longifolia</i>	F	O	O	O		O
<i>L. multiflora</i>		O				
<i>L. obliqua</i>	O	O				
<i>Xanthorrhoea arborea</i>		O				
<i>X. sp.</i>	O	O				

APPENDIX 2. FAUNA LIST

Vertebrate species recorded in summer (main survey, January-February) and winter (occasional visits, July-September) 1989, with additional mammal records from local residents and specimens at the Australian Museum.

* Introduced species

FROGS

Common Eastern Froglet *Crinia signifera*: Several heard calling along drainage lines in the reserve.

Striped Marsh Frog *Limnodynastes peroni*: One calling from a nearby garden.

REPTILES

Copper-tailed Skink *Ctenotus taeniolatus*: A couple seen in sandstone woodland.

Eastern Water Skink *Eulamprus quoyii*: A couple seen along a rocky drainage line and in the fern swamp.

Delicate Skink *Lampropholis delicata*: Very common in ground litter throughout the reserve.

Eastern Blue-tongued Lizard *Tiliqua scincoides*: One juvenile seen in sandstone woodland.

BIRDS

*Spotted Turtle-Dove *Streptopelia chinensis*: Moderately common throughout the reserve both summer and winter.

Galah *Cacatua roseicapilla*: Often flying over, both summer and winter. This inland species has colonised the Sydney region only in the last 50 years.

Sulphur-crested Cockatoo *Cacatua galerita*: Very common, with a flock of 50-60 regularly roosting in shale forest near the giant angophora. These birds range well outside the reserve.

Little Corella *Cacatua sanguinea*: Small numbers occasionally fly over, both summer and winter, sometimes joining larger flocks of Sulphur-crested Cockatoos. Like the Galah, this is an inland species which has colonised the Sydney region only in the last 50 years, possibly from aviary escapees.

Rainbow Lorikeet *Trichoglossus haematodus*: Very common throughout the reserve both summer and winter. Noisy, active and brilliantly coloured, they are a prominent and attractive feature.

Scaly-breasted Lorikeet *Trichoglossus chlorolepidotus*: Several seen, both summer and winter, but much less numerous than the Rainbow Lorikeet, with which they often associate.

Australian King-Parrot <i>Alisterus scapularis</i> :	One seen flying over Hudson Parade in summer. Likely to visit the reserve.
Eastern Rosella <i>Platycercus eximius</i> :	Seen on a couple of occasions within the reserve and probably resident in the vicinity, ranging in and outside the reserve to feed.
Crimson Rosella <i>Platycercus elegans</i> :	Group of five birds including juveniles, possibly present throughout year.
Common Koel <i>Eudynamis scolopacea</i> :	Moderately common in and around the reserve in summer. A breeding migrant to the Sydney region, only present in spring and summer.
Southern Boobook <i>Ninox novaeseelandiae</i> :	Heard calling from the reserve at night in late winter.
Laughing Kookaburra <i>Dacelo novaeguineae</i> :	Moderately common throughout the reserve both summer and winter.
Dollarbird <i>Eurystomus orientalis</i> :	Regularly seen flying about the reserve in summer, apparently a single pair with one dependent young, presumably having nested in or near the reserve. A breeding migrant to the Sydney region, only present in spring and summer.
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i> :	Seen or heard in the reserve a couple of times in winter. Recorded year round.
*Red-whiskered Bulbul <i>Pycnonotus jocosus</i> :	Occasional birds, both summer and winter, mostly around the Lantana thickets.
Golden Whistler <i>Pachycephala pectoralis</i> :	Seen or heard at several sites in the reserve, both summer and winter. All birds seen were immatures.
Grey Fantail <i>Rhipidura fuliginosa</i> :	Seen or heard a couple of times in winter. A number of pairs present and a partly deteriorated nest located in a <i>Casuarina</i> sp.
Eastern Whipbird <i>Psophodes olivaceus</i> :	Heard calling in summer in the shale forest with a dense understorey. Likely to be resident in the reserve.
Variegated Fairy-wren <i>Malurus lamberti</i> :	Moderately common throughout the reserve both summer and winter. Probably several resident family groups.
White-browed Scrubwren <i>Sericornis frontalis</i> :	Seen or heard at several sites in the reserve, both summer and winter. Probably several resident pairs or family groups.
Brown Thornbill <i>Acanthiza pusilla</i> :	Moderately common throughout the reserve both summer and winter. Probably several resident pairs.
Red Wattlebird <i>Anthochaera carunculata</i> :	Moderately common throughout the reserve both summer and winter.

Little Wattlebird <i>Anthochaera chrysoptera</i> : September.	Recorded only once in the reserve, in September.
Noisy Friarbird <i>Philemon corniculatus</i> :	A small flock seen in the reserve in winter. May occur only as a non-breeding autumn-winter migrant.
Noisy Miner <i>Manorina melanocephala</i> :	Moderately common in the reserve, both summer and winter, especially around the Palmgrove Road entrance, where there appears to be a resident colony.
Yellow-faced Honeyeater <i>Lichenostomus chrysops</i> :	Several seen in the reserve in winter. May occur only as a non-breeding autumn-winter migrant.
White-naped Honeyeater <i>Melithreptus lunatus</i> :	One seen in the reserve in winter. May occur only as a non-breeding autumn-winter migrant.
Mistletoebird <i>Dicaeum hirundinaceum</i> :	One flying over the reserve in summer. A nomadic species feeding chiefly on mistletoe fruits. No mistletoes were seen in the reserve.
Spotted Pardalote <i>Pardalotus punctatus</i> :	Heard calling in the reserve on several occasions in summer and winter.
Silvereye <i>Zosterops lateralis</i> :	Moderately common throughout the reserve both summer and winter. Winter population are probably non-breeding migrants from the south.
*Common Mynah <i>Acridotheres tristis</i> :	Recorded both summer and winter, mainly in nearby streets and gardens, sometimes visiting the reserve.
Grey Butcherbird <i>Cracticus torquatus</i> :	Moderately common in and around the reserve both summer and winter.
Australian Magpie <i>Gymnorhina tibicen</i> :	Recorded both summer and winter, mainly in nearby streets and gardens, sometimes visiting the reserve.
Pied Currawong <i>Strepera graculina</i> :	Moderately common throughout the reserve both summer and winter. Nesting recorded in September.
Australian Raven <i>Corvus coronoides</i> :	Often flying over, sometimes visiting the reserve, both summer and winter.

MAMMALS

- Short-beaked Echidna *Tachyglossus aculeatus*: Not encountered during our survey but seen in the reserve in recent years (Garvin Kable, pers. comm.)
- Long-nosed Bandicoot *Perameles nasuta*: A common species in the reserve, as indicated by reports from several adjacent residents, and the many fresh bandicoot diggings throughout. Up to four separate individuals were heard calling during spotlighting traverses, but efforts to trap the species were unsuccessful (20 trap-nights using large Elliott traps).
- Koala *Phascolarctos cinereus*: Not recorded during our visits to the reserve, but reported between January and September 1989 by local residents in neighbouring streets all around: Ruskin Rowe, Palmgrove Road, The Circle, Bilambee Avenue, Bilwara Avenue, Lower Plateau Road, Wandeen Road and Hilltop Road (Smith & Smith 1990).
- Common Ringtail Possum *Pseudocheirus peregrinus*: One seen when spotlighting in the reserve, and one skull found. Probable ringtail nests were found throughout the reserve.
- Squirrel Glider *Petaurus norfolcensis*: Not recorded during our survey but the Australian Museum has a number of specimens from the area: one from Palmgrove Road near the reserve in December 1988, a female with two pouch young from the Careel Bay area in October 1989, and a couple from the Avalon area in the 1950's (Linda Gibson, pers. comm.).
- Common Brushtail Possum *Trichosurus vulpecula*: Up to two were seen during spotlighting traverses of the reserve, and one female was trapped twice (in 20 trap-nights using large Elliott traps). Recorded in both sandstone woodland and shale forest.
- Grey-headed Flying-fox *Pteropus poliocephalus*: One found dead beside Lower Plateau Road near the reserve.
- *Black Rat *Rattus rattus*: One male and one female were trapped in shale forest (in 80 trap-nights using small Elliott traps, plus 20 trap-nights using large Elliott traps).

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