Warriewood

Ecological Assessment Report

Prepared for
Jubilee Developments

December 2004

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Part 1

Ecological Impact Assessment

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Jubilee Developments

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1.0 BACKGROUND, CONSERVATION PLANNING CONTEXT & PURPOSE OF THIS REPORT

PLACE Environmental has been engaged to prepare an Ecological Assessment Report for a proposed residential development at Warriewood in the Pittwater Local Government Area. The site is located at the base of the Warriewood Escarpmet, a feature which connects several small conservation reserves to Ku-ring-gai Chase National Park. The site's sub-regional context is shown in **FIGURE 1**. The site is comprised of two properties (Lot 1 in DP5055 and Lot B in DP370222)[1]. **FIGURE 2** shows the site in greater detail and provides a reference for **PLATES 1 – 32.** The proposed development is shown as **FIGURE 3**.

Chapman & Murphy (1989) map much of the site as Watagan Soil Landscape. Small areas in the site's northeast are mapped as the Warriewood Soil Landscape. A map showing the extent of these landscapes and a description of their geology and soil characteristics are provided in **APPENDIX 1**. Based on site observation, it appears that the Warriewood landscape may infact extend further into Lot 1 than indicated by the maps (being also present under the glass houses). A waterway in the site's north will also contain alluvial deposits.

In a conservation planning context, the site and its immediate locality are well known and subject to strictly defined planning controls. Pittwater DCP 21 indicates that the site falls within; (i) Flora and Fauna Conservation Categories 1 & 2; and (ii) areas identified as Wildlife Corridor[2]. These designations are discussed further in **APPENDIX 2**. However, the Warriewood locality zone map indicates that the area generally proposed for development falls within the Warriewood Identified Urban Release Area. The general development area is also identified as suitable for medium density development under Development Control Plan No. 29 (Warriewood Valley Urban Land Release)[3]. The remainder of the site is mapped as unsuitable for development.

While the proposed development complies with Council's strategic intent for the property, further more detailed survey is required to confirm that the designation is appropriate, and that the development will not significantly affect the ecological value of surrounding areas. With these matters in mind, PLACE Environmental has been engaged to undertake a site assessment and prepare an Environmental Management Report which:

- Identifies features of ecological significance in the locality and on the site (particularly within the area proposed for development) which may affect the nature or extent of development proposed;
- Assess the suitability of the layout and associated development (infrastructure, bushfire buffers), and advise of changes required to protect significant features and habitats;
- Suggests means of mitigating development impacts, including rehabilitation of the waterway; and
- Prepare a report which outlines the methodology and results of our surveys, and discusses compliance with relevant environmental planning instruments.

[1] Herein referred to as Lot 1 and Lot B.
[2] The mapping makes no distinction between vegetated and cleared areas.
[3] Being identified in Sector 5.

FIGURE 1 LOCALITY

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warriewood locality

environment

figure 1
locality
date: 27 august 2004
project no: jub01_01/a
scale: as indicated
source: Dept of Lands 2002

FIGURE 2 SUBJECT SITE

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warriewood subject site

environment

figure 2
subject site
date: 27 august 2004
project no: jub01_02/a
scale: as indicated
source: pittwater council March 2002

FIGURE 3 PROPOSED DEVELOPMENT

warriewood environment

proposed development

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figure 3
proposed development
date: 27 august 2004
project no: jub01_03/a
scale: as indicated
source: pittwater council March 2002

2.0 ECOLOGICAL ASSESSMENT

2.1 METHODOLOGY

2.1.1 Review of Existing Data

Before the commencement of field surveys, relevant environmental planning documents and wildlife databases were reviewed to develop a working list of target species and potential management issues. Reviewed items include:

- Pittwater Council zoning maps; Warriewood Urban Land Release DCP; other conservation planning documents and maps available on the Pittwater Council website;
- Smith & Smith (2000) "Management Plan for Threatened fauna and flora in Pittwater" Prepared for Pittwater Council;
- The NSW National Parks and Wildlife Service Wildlife Atlas (specifying a search of the Pittwater LGA). Database search results are provided in **APPENDIX 3**; and
- The Environmental Protection & Biodiversity Conservation Act Matters of National Environmental Significance Search tool (specifying a search area of 5km around the site). Database search results are provided in **APPENDIX 4**.

2.1.2 Field Surveys

Field surveys were conducted on 27 & 28 July 2004. Tasks completed included; vegetation survey, fauna habitat assessment and targeted fauna survey. Further details are provided in **APPENDIX 5**.

2.2 DESCRIPTION OF THE SITE'S PLANT COMMUNITIES

2.2.1 Historical Patterns of Vegetation

Sydney area vegetation mapping (Benson & Howell 1994) shows that the adjacent Warriewood Escarpment supports Map Unit 10ag (Sydney Sandstone Gully Forest)[4]. The vegetation appears to be largely intact and is likely to be remnant. Historically, Lot B is likely to have supported similar forest to that which occurs upslope (ie Map Unit 10ag). It appears likely that the low-lying flats in Lot 1 may have supported Coastal Swamp Forest Complex containing *Eucalyptus botryoides*, *Eucalyptus robusta* and *Livistona australis* (Map Unit 27a)[5]. The waterway on the northern boundary of Lot 1 would have supported a mix of Coastal Swamp Forest Complex and Sydney Sandstone Gully Forest vegetation[6].

[4] Analogous to Open Forest / Woodland dominated by Eucalyptus piperita, Angophora costata, and Eucalyptus gummifera. Surveys indicate that this is an accurate description of this vegetation.

[5] This community has been largely cleared from the landscape and is now listed as an Endangered Ecological Community under the Threatened Species Conservation Act.

[6] Benson & Howell (1994) indicate that sheltered gullies in this map unit support *Ceratopetalum apetalum* and *Tristaniopsis laurina*.

2.2.2 Occurrence of threatened plants and Endangered Ecological Communities in the Pittwater LGA

Smith & Smith (2000) discuss the occurrence of threatened plants and Endangered Ecological Communities in Pittwater LGA. An extract of this document is provided in **APPENDIX 6**. NSW NPWS Wildlife Atlas map extracts (**APPENDIX 7**) show that there are known records of *Tetratheca glandulosa* to the west of the site, and *Grevillea caleyi* to the south. There are no other NPWS database records of threatened plant in close proximity to the site.

The Pittwater 21 DCP website shows the occurrence of threatened and other significant plant communities in the Pittwater LGA. The mapping shows that the site neither contains nor adjoins:

- Pittwater Spotted gum forest;
- Sydney Estuarine Coastal Swamp Forest Complex;
- Duffy's forest vegetation;
- Sydney freshwater wetlands;
- Mangroves and their habitats;
- Salmarsh and /or foreshore vegetation other than mangroves;
- Pittwater waterway containing seagrass;
- Littoral rainforest;or
- Heathland.

However, it is identified as:

- Land adjoining bushland reserve; and
- Land containing wetland other than Sydney freshwater wetland.

2.2.3 Remnant Vegetation – Composition, Condition and Status

It is quite apparent that much of the area proposed for development have been cleared and planted to pasture. The waterway has been heavily disturbed and now supports areas of reasonably young regrowth and dense weeds. There is a disturbed edge to the remnant Eucalypt forest, athough the vegetation remains reasonably intact beyond[7]. The site's three broad plant communities are shown in **FIGURE 4** and described below. A plant species list noting presence and abundance of species in each of the communities, and identifying weed status is provided in **APPENDIX 8**.

Community 1 – Mixed Riparian Vegetation

This community is located on the unnamed waterway which forms the site's northern boundary. The community falls wholly within the proposed waterway conservation zone and will be rehabilitated in accordance with the Landscape Plan being prepared by PLACE Design Group.

[7] Noting that slight changes in fire frequency, human intrusion and the presence of weeds are likely.

At its eastern (downstream) extent, Lantana and Bamboo form an impenetrable canopy over the waterway (**PLATES 1 - 3**). A wide variety of common urban weeds are also present, including Pampas grass, Dwarf umbrella tree, Swainsonia, Crofton weed, Winter senna, Canna lily, Blue cyanea, Banana, Agave, Small-leaved privet, Tobacco bush, Castor oil plant, Maidera vine and Stinking roger.

Areas further to the west support regenerating riparian rainforest (**PLATES 5 – 9**). The canopy of the community in this area is dominated by Coachwood, with secondary occurrence of Cabbage Palm, Australian Christmas Tree, Cheese Tree, Forest Oak, Hard Corkwood and Turpentine. In densely vegetated areas the understorey is relatively sparse (**PLATE 6**). It is more diverse in open disturbed areas (**PLATE 10**). Common species include; Lollybush, Native Peach, Smooth-mock Olive, Native Frangipani, Callicoma, Castor Oil Plant, White Beech, Common Wilkiea, Settlers Flax, Straw Treefern, Maidera Vine, Water Vine, Scrambling Lily and Snake Vine.

With reference to the criteria established in **APPENDIX 5**, none of the species recorded in this community (nor the community itself) are considered threatened. With reference to the Pittwater 21 DCP maps, the site is neither within, nor adjoins any Endangered Ecological Communities. Given its position on a waterway, this vegetation is of value in providing bank stability.

Community 2 – Tall Closed Grassland and Pasture Weeds (Mixed Species)

This variable community dominates both Lot 1 and Lot B and will accommodate much of the development.

PLATES 11 – 14 show the extent and broad structure of the community on Lot 1. **PLATES 15 – 17** show composition (noting a generally unkept state). Common species include; Kikuyu, Blady Grass, Couch Grass, Buffalo Grass, *Entolaisia* sp., *Eragrostis curvula*, Setaria, Bracken Fern, Stinking Roger, Fleabane, Black-eyed Susan, Paddy's Lucerne, Purple Top, Clover, Swainsonia, Blackberry Nightshade, Castor Oil Plant and *Brassica fruticulosa*. **PLATES 18 & 19** show the toe of the adjacent slope which is dominated by Bracken Fern and Blady Grass. There is secondary occurrence of weed species common to adjacent grassland. **PLATES 20 – 24** show that Lot B is maintained as a well manicured garden with common pasture grasses and landscape species.

With reference to the criteria established in **APPENDIX 5** none of the species recorded in this community (nor the community itself) are considered threatened. With reference to the Pittwater 21 DCP maps, the site is neither within, nor adjoins any Endangered Ecological Communities. Given that the original vegetation has been completely cleared, and the area now dominated by exotic species, its conservation values are considered low.

Community 3 Open Forest – Woodland (Mixed Sclerophyllous Species)

This community occupies the remainder of Lot 1, and falls largely outside of the area proposed for development. As discussed above, Benson & Howell's Sydney area vegetation mapping shows that this area supports Map Unit 10ag (Sydney Sandstone Gully Forest). Surveys indicate that the description is generally accurate, although the following additional observations were made.

The canopy of areas between the waterway and sandstone outcrop are dominated by Coast Banksia and Cheese Tree (**PLATE 25**). Secondary canopy species include Hard Corkwood and Forest Oak. The midstorey includes juvenile canopy species, Lollybush, Native Peach, Scentless Rosewood, Coffee Bush, Hopbush, Small-leaved Privet and Winter Senna. Groundcovers include; Harsh Ground Fern, Matrush, Bracken Fern, Kangaroo Grass and Settlers Flax. Climbers include; Snake Vine, Scrambling Lily, Wombat Berry and Water Vine. This area appears to form a transitional zone between the mesic waterway vegetation and the drier sandstone slopes.

Further to the south a small sandstone outcrop extends towards the development area. The canopy of the vegetation contains Red Bloodwood, *Angophora floribunda*, Turpentine and Sydney Peppermint. The midstorey includes; juvenile canopy species, Forest Oak, Black Sheoak, Blueberry Ash, Native Frangipani, *Astrotricha floccosa*, Winter Senna, Cheese Tree and Lollybush. The groundcovers include; Matrush, Grass Tree, Bracken Fern, Blady Grass and Settler's Flax. Climbers and scrambling plants include; Black-eyed Susan, Pearl Vine, Snake Vine and Five-leaf Water Vine.

In areas around the house, the midstorey has been removed, and the understorey maintained as mown grass (**PLATES 29 & 30**). The ridge to the south of the development area on Lot 1 supports similar vegetation to that which occurs to the west. **PLATE 31** shows vegetation within the bushfire clearing buffer. The vegetation is dominated by Black Sheoak, Forest Oak, Cheese Tree and *Acacia Longissima*. The midstorey includes juvenile canopy species, and the understorey Bracken Fern, Matrush and *Astrotricha Florccosa*.

With reference to the criteria established in **APPENDIX 5**, none of the species recorded in this community (nor the community itself) are considered threatened. With reference to the Pittwater 21 DCP maps, the site is neither within, nor adjoins any Endangered Ecological Communities. While the edge of the community is disturbed, and contains a range of weeds, its values beyond this disturbed edge are relatively high.

FIGURE 4 VEGETATION PLAN

warriewood environment

vegetation plan

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figure 4
vegetation plan
date: 1 september 2004
project no: jub01_04/a
scale: as indicated
source: pittwater council march 2002

Busfire Prone Land

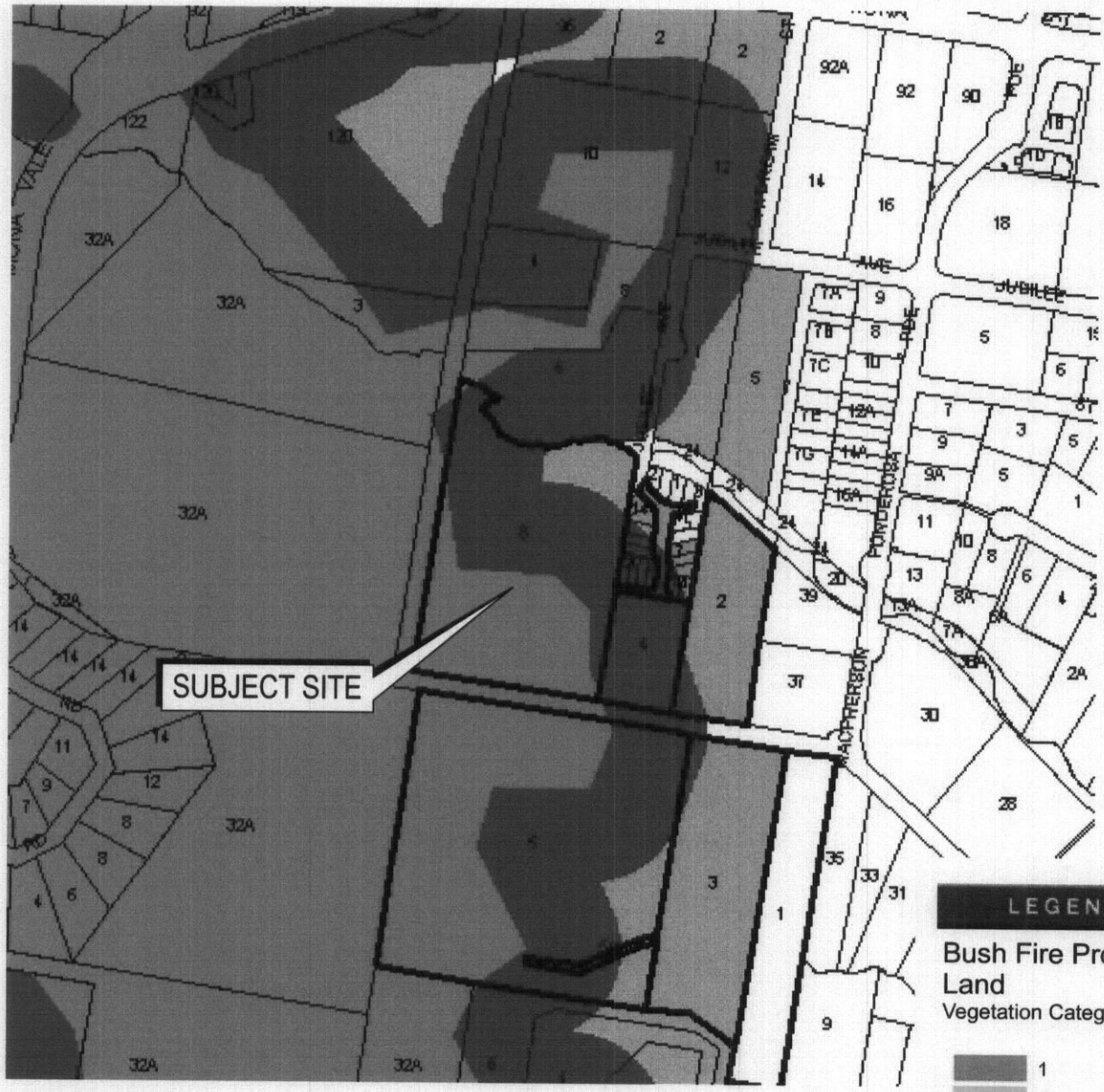

FIGURE 4 BUSHFIRE CATEGORIES

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warriewood
bushfire categories

figure 5
bushfire categories
date: 3 september 2004
project no: jub01_05/a
scale : as indicated
source: pittwater city council, bushfire prone land

2.3 THE SITE'S FAUNA HABITATS & CORRIDORS

2.3.1 Background

Before settlement, this area would have supported a mosaic of continuous forest, which allowed relatively uninhibited interaction between species' populations. However, much of the original forest has been lost. The ability of animals to persist in such fragmented landscapes shows a great deal of interspecific variation and is dependent on their biological attributes. While the abundance of some species may not change (and the abundance of others actually increase), the majority of species either decline in abundance, forming fragmented (often unviable) distributions throughout their former range. The more sensitive species may become locally extinct.

In such fragmented landscapes, corridors become critical to the long–term survival of populations within otherwise isolated remnants[8]. Corridors can take the form of a well-vegetated continuous area (eg a riparian zone) or small (sufficiently proximate) patches of habitat which act as stepping stones. Rather than acting as a conduit for the physical transfer of individuals, effective corridors facilitate genetic exchange by providing a continuum of breeding ranges.

The following section discusses the habitat value of the site, and its role in the wider landscape (threatened species being a specific focus). Smith and Smith (2000) has been a key source of baseliune information. Fauna recorded during the survey are listed in **APPENDIX 9**.

2.3.2 Amphibians

The Atlas of NSW Wildlife contains records of 16 species of Amphibian for the Pittwater LGA (**APPENDIX 3**). Amphibian surveys were conducted during dry conditions over one day in winter 2004. The duration and season of survey were not sufficient for the assessment to be considered comprehensive, and as such this report relies on a detailed review of local records and habitat assessment to determine habitat suitability.

The site's cleared portions (the areas proposed for development) are of limited value for amphibians due to a lack of potential shelter sites, and absence of permanent/semi-permanent waterbodies and other potential breeding sites. However, these areas are likely to support a suite of common and adaptable urban inhabitants including; the Eastern Dwarf Tree Frog, Common Eastern Froglet and Striped Marsh Frog.

Before disturbance, the site's waterway is likely to have supported many of the stream-dependent species known from this locality. Loss of riparian vegetation has affected these habitat values, although the catchment remains in reasonably good condition. Despite lack of survey results, it is likely that stream/wetland obligate species such as Tyler's Tree Frog and Peron's Tree Frog persist in the waterway.

The Atlas of NSW Wildlife contains records of two Threatened species, the Giant Burrowing Frog and Red-crowned Toadlet (both species are listed as Vulnerable in the

[8] For example, they allow recolonisation of the remnant following catastrophic events such as bushfire.

TSC Act 1995) in the Pittwater LGA. The EPBC Act interactive Protected Matters search tool indicates that the Heath Frog, Green and Golden Bell Frog, Giant Barred Frog and Stuttering Frog may also occur[9].

The Giant Burrowing Frog has been recorded in the upper reaches of Narrabeen Creek and Fern Creek, Ingleside (Ecotone Ecological Consultants1993, White 1994), and on the track at the entrance to Ingleside Reserve (observed by M. Turton in 1996). The Giant Burrowing Frog is associated with hanging sandstone shelves in the upper areas of small permanent creeklines (Thumm, 1996). Typical vegetation types range from dry and wet sclerophyll forests to heathland habitats (Thumm, 1996). The frog occurs within an altitude range of 10-1000 metres ASL, on varied soil types from clay to Quaternary sands (Thumm, 1996). Typical edge characteristics of these creeks include a combination of banks, rocky banks, and shorelines, and overhanging vegetation on the stream situation (Thumm, 1996). The site's waterway is not suitable for the Giant Burrowing Frog, and it is considered an unlikely occuurence in this feature. Potentially suitable habitat is located on the escarpment upslope of the proposed development area. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Red-crowned Toadlet has been recorded on a ridgetop near Woorarra Lookout in Deep Creek Reserve (Paul Burcher, December 1995), in an ephemeral drainage line near Ingleside Road (Recsei 1997), in the upper reaches of Narrabeen and Fern Creeks, Ingleside (Ecotone Ecological Consultants 1993), and in a seepage area at the base of a cliff at Minkara Road, Bayview (Skelton 1999).

The Red-crowned Toadlet exploits a range of habitats. Breeding areas are located along ephemeral water courses above the first order creeks which come off the sandstone ridges. Water flows through these drainage lines only after heavy rain, and when rain stops, these 'creeks' are reduced to a few small puddles. Ponds are usually short-lived and the breeding sites are generally in very steep sandstone escarpment areas, which are well-drained (Thumm, 1996).

When not breeding, Red-crowned Toadlets are thought to disperse over wider areas of its sandstone habitat, (i.e. into non-breeding areas) and many individuals have been observed sheltering undercover that would be unsuitable for egg-laying. However, it is likely that such 'dispersion' is only in the order of a few tens of metres from suitable breeding areas. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat, so recruitment and re-colonisation of areas of vacant habitat is likely to be low. The site does not contain suitable habitat for this species, although suitable habitat is present upstream (and upslope) from the proposed development area. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Heath Frog occurs on sandstone, shales and conglomerates with sandy soils, often with rich humus layers (Thumm 1996). It appears to be restricted to undisturbed woodland and heath communities at mid to high altitude (100-950 m asl), which are prone to infrequent natural fires (Thumm 1996, NPWS 2000). The species may be found sheltering and feeding along permanent mountain streams with low water velocity. Such streams typically have dense fringing vegetation of *Lomandra*, tea-trees and ferns (Thumm 1996).

[9] It should be noted that the EPBC Database will list a species on the basis of an actual record or potentially suitable habitat (there may not be an actual recent record).

Specimens have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). It forages both in the tree canopy and on the ground and it has been observed sheltering under rocks on high, exposed ridges during summer. The Heath Frog is not known from low altitude coastal habitats (NPWS 2000) and is unlikely to occur on the site.

The Green and Golden Bell Frog occur in large, permanent, open-water swamps or ponds that have a variable water level and dense vegetation. This frog inhabits various coastal forest associations including paperbark swamps, coastal heath, dry sclerophyll forest and open farmland. Water body types include natural sites and man-made sites, but only still-water or very slow flowing sites are used. This species is most often found in sites after recent disturbance and the water edge is typically clear of vegetation or contains fringing bulrushes (*Typha sp*) (White 1997). The open waterbodies preferred by the Green and Golden Bell Frog are absent from the site, and this species is unlikely to occur.

The Stuttering Frog inhabits riparian vegetation in subtropical, warm and cool temperate rainforest and wet sclerophyll forest. It prefers permanent first order streams in these habitats and is not found in ponds or ephemeral pools (Mahony *et al* 1997). Although the site's waterway is broadly suitable for this species, it does not support the permanent flows required by the species and is therefore unsuitable. In addition, there have been no recent records of the Stuttering Frog between Sydney and the Central Coast and there are no historical records from Pittwater LGA. These factors combined suggest that the Stuttering Frog would not occur on or near the site.

The Giant Barred Frog occurs in Rainforest and Wet Sclerophyll Forest habitats, but is only known from locations where the water if flowing and typically of high quality. It exploits 1st order to 4th order streams but is not found in ponds or ephemeral pools. There have been no recent records of the Giant Barred Frog between Sydney and the Central Coast and there are no historical records from Pittwater LGA. These factors combined suggest that the Giant Barred Frog would not occur on or near the site.

2.3.3 Reptiles

The Atlas of NSW Wildlife contains records of 41 Reptile species for the Pittwater LGA (**APPENDIX 3**). Reptile surveys were conducted during dry conditions over one day in winter 2004. The duration and season of survey were not sufficient for the assessment to be considered comprehensive, and as such this report relies on a detailed review of local records and habitat assessment to determine habitat suitability.

The site's cleared portions (conmprising much of the development area) provide habitat for a range of common agricultural/rural fringe species such as the Diamond Python, Eastern Brown Snake, Cream-striped Shining Skink, Garden Sunskinks and Bluetongue Lizard.

The dense weedy regrowth and riparian vegetation associated with the waterway provide a more diverse range of habitats and cover for this group, and are likely to support the Green Tree Snake, Red-bellied Black Snake, Eastern Water Skink and Weasel Shadeskink.

Dry Eucalypt woodland surrounding the site is likely to support many of the common and forest-dependent species known from the locality, including the Lace Monitor, Bar-sided Forest Skink, Robust Ctenotus, Burton's Snake Lizard, Leasueur's Velvet Gecko, Bearded Dragon and Tiger Snake.

The Atlas of NSW Wildlife contains records of two Threatened terrestrial[10] species, the Endangered Broad-headed Snake and the Vulnerable Rosenberg's Goanna in the Pittwater LGA. The EPBC Act interactive Protected Matters search tool indicates that no additional threatened terrestrial species are known or likely to occur.

The distribution of the Broad-headed Snake is centred on the Triassic sandstone of the Sydney Basin. The species typically exploits exposed sandstone outcrops and benching and in these locations the vegetation is mainly woodland, open woodland and/or heath. The Broad-headed Snake seasonally occupies distinctive microhabitats within these broader habitat types. It utilises rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (Webb & Shine 1998b). This species has been historically recorded within 2km of the site[11], and despite the lack of recent publicised records, may occur on the escarpment upslope of the development area. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10.**

Rosenberg's Goanna inhabits eucalypt woodland and heathland on sandy soils. It is more typical of ridgetop and plateau vegetation than the Lace Monitor (*Varanus varius*), which often occurs in gully forests (Smith and Smith 1990). It is also more of a ground dweller than the Lace Monitor, although it will climb trees when threatened. Rosenberg's Goanna shelter in burrows, hollow logs, rock crevices or under dense bushes (Green and King 1993). They usually dig the burrows themselves, but will use rabbit burrows if available. The presence of terrestrial termite mounds is an important habitat feature as these are used by the goannas as egg-laying sites.

Smith and Smith (2000) note that Rosenberg's Goanna was observed at Walter Road, Ingleside, in 1993 in an area of woodland near the Council nursery and Ku-ring-gai Chase National Park (ICF and Australian Museum 1994) and there is an additional record of a road casualty found at Ingleside in 1999. Rosenberg's Goanna has been recorded within 1.5km of the site and must be considered a possible occurrence in intact habitats which fringe the development area. It is possible that this species would occasionally range onto the development area; although no terrestrial termite mounds were observed, suggesting that breeding is unlikely in this area. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

2.3.4 Birds

The Atlas of NSW Wildlife contains records for one-hundred and sixty-eight (168) species of bird for the Pittwater LGA (**APPENDIX 3**). Bird surveys were conducted during dry conditions over one day in winter 2004. The duration and season of survey were not sufficient for the assessment to be considered comprehensive, and as such this report relies on a detailed review of local records and habitat assessment to determine habitat suitability.

The development area, which is comprised predominantly of grassland, supports a characteristic group of open country birds, including the House Sparrow, Magpie, Red-

[10] A suite of marine reptiles are known from local waters including the Green turtle and Leathery Turtle. These species are unlikely to have any reliance on the Subject Site and have not been addressed further in this report.
[11] Noting that the record is somewhat dated.

browed Finch, Common Myna, Common Starling, Spangled Drongo, Laughing Kookaburra and Red-whiskered Bulbul. A Brown Goshawk was recorded preying upon Red-browed Finches during the survey period.

The waterway vegetation supports species typical of closed forest including the Striated Thornbill, White-browed Scrubwren, Fan-tailed Cuckoo, Eastern Whipbird, Australian Brush Turkey, Lewin's Honeyeater and Golden Whistler.

Fringing Eucalypt forests and woodlands support a range of nectarivores not sustained by the open/cleared areas or the riparian forest areas, including the Brush Wattlebird, Noisy Friarbird, White-cheeked Honeyeater, New Holland Honeyeater and Noisy Miner. These woodlands, with a shrubby or heathy understorey also support a range of small insectivores which use open areas opportunistically including the Superb Fairy Wren, White-browed Scrubwren, Grey Fantail and Eastern Yellow Robin. Many of the Eucalypt forest dependent species known from the locality could use these habitats.

The Atlas of NSW Wildlife contains records of several threatened species from the Pittwater LGA, including; the Osprey, Bush Stone-Curlew, Glossy Black Cockatoo, Superb Fruit Dove, Black-browed Albatross, Sooty Tern, Regent Honeyeater, Southern Giant-Petrel, Swift Parrot, Turquoise Parrot, Barking Owl and Powerful Owl. In addition, there are records of the Masked Owl, Australasian Bittern and Black Bittern in the locality (Smith and Smith 2000) and these species will be considered. The EPBC Act interactive Protected Matters search tool indicates that no additional threatened terrestrial species are known or likely to occur. Oceanic/Estuarine species are considered unlikely to have any significant reliance on the site and are not considered further.

The Black Bittern is usually found along timbered watercourses, in wetlands where there are fringing trees and, particularly in northern Australia, in mangroves (Marchant and Higgins 1990). It occurs in both freshwater habitats and estuarine or brackish habitats and is generally associated with permanent rather than temporary waters. Repeated records over the last decade (e.g. Burton and Morris 1993, Morris and Burton 1993, 1996, Morris 2000) suggest that the Black Bittern, a sedentary species, is resident along the lower section of Deep Creek. It has also been observed in Warriewood Wetlands. The Black Bittern is unlikely to use the site's waterway due to its ephemeral nature.

The Australasian Bittern favours freshwater wetlands with tall, dense vegetation (*Phragmites*, *Typha*, *Juncus*, *Eleocharis*, *Baumea*, *Gahnia*, *Bolboschoenus*, etc.), but also occurs in estuarine and brackish wetlands, and sometimes in flooded, rank pastures (Marchant and Higgins 1990). There are local records of this species, although it is unlikely to occur on the site as preferred wetland habitats are absent.

The Osprey is predominantly coastal in Australia, feeding along the coast, in bays and estuaries and up coastal rivers and creeks (Marchant and Higgins 1993). It is not usually observed far from shore at sea, but ranges further offshore in bays and inlets. Sheltered waters are favoured because they provide protection from high waves and winds that interfere with fishing (Poole 1989). In the Pittwater area, Narrabeen Lagoon appears to be the most favoured feeding habitat. The site does not support potential foraging or nesting habitat for this species.

Typical habitat for the Bush Stone-curlew is considered to be eucalypt woodland with a dry, grassy understorey (Marchant and Higgins 1993). It is absent from both treeless areas and

dense forests. Although not usually a bird of wetlands, many of the birds reported in New South Wales coastal districts over the last 20 years have been associated with mangroves and saltmarshes in estuaries, often in island situations where they are afforded protection from foxes, dogs and cats (Smith 1991). In Pittwater, there is a resident breeding pair on the fringes of Careel Bay (Smith and Smith 1997). The birds have been present at Careel Bay since at least 1952 (Hindwood 1971). The nearest known population to Careel Bay is on Rileys Island in Brisbane Water (Roberts 1993). Woodlands with a dry, grassy understorey are absent from the site, and proximity to urban development suggests that birds present would be highly vulnerable to predation. These factors suggest that the species is unlikely to be resident in habitats adjacent to the site.

Smith and Smith (2000) note that Glossy Black-Cockatoos have been widely reported in the Pittwater Council area, including Barrenjoey Peninsula and the southern and western areas of Pittwater. Recorded locations have included Palm Beach, Newport, Deep Creek, Bayview, Church Point, Browns Bay, Ingleside, Mackerel Beach, Lovett Bay and Scotland Island. The species has also been recorded from Ku-ring-gai Chase and Garigal National Parks. The Glossy Black Cockatoo is unlikely to use the open grassland community, which lacks foraging and breeding resources, but may exploit adjacent Eucalypt woodlands sporadically. Foraging resources are present at the development/bushland interface (**PLATE 32**), comprised of Black Sheoak, a preferred food tree. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Swift Parrot inhabits eucalypt forest and woodland, particularly where there are flowering eucalypts. In its winter range on the mainland it congregates in areas where eucalypts are flowering profusely, and is thus dependent on species that flower in autumn and winter (Garnett 1993). It occurs during winter not only in extensively forested areas, but also in remnant patches of mature eucalypts within heavily cleared agricultural and urban areas. Smith and Smith (2000) note that in Pittwater, the Swift Parrot is most likely to be attracted by stands of flowering Swamp Mahogany. Large flocks of Swift Parrots occurred historically Pittwater Council area[12], although there have been few records of Swift Parrots in recent times. Small flocks were reported at Ingleside in July and August 1986 (Cooper 1990) and 4- 5 birds were sighted just outside the Pittwater area on the southern side of Deep Creek in May 1998. It has also been reported that Swift Parrots have occurred sporadically over the last 20 years in flowering Swamp Mahoganies in the Warriewood/Irrawong wetlands (Smith and Smith 2000). The site supports no areas of Swamp Mahogany, which certainly appears to be the focus of activity for Swift Parrots in the locality. This species is unlikely to utilise the development area, although Coast Banksia, a prolific winter flowering species, occurs adjacent to the development area (**PLATE 25**) and may be utilised. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Regent Honeyeater is chiefly a species of eucalypt woodland and open-forest, including forest edges, wooded farmland and urban areas with patches of mature eucalypts (Garnett 1993). Coastal heathland and scrub with flowering banksias are also utilised at times by the birds (Hindwood 1944). Optimum habitat supports large, mature eucalypts, rather than younger trees, so that high nectar flows occur when the trees flower (Franklin et al. 1989, Webster and Menkhorst 1992). As for the Swift Parrot, Regent Honeyeaters have rarely been recorded in or near Pittwater in recent history. Smith and Smith (2000) note that there are historical records from Garigal National Park in 1987, from Terrey Hills in

[12] In April and May 1938, hundreds of Swift Parrots were present at Mona Vale, where they were feeding on nectar from the blossoms of the Swamp Mahogany (*Eucalyptus robusta*) (Hindwood 1939).

1988 and 1991 and Irrawong Reserve in 1998. This species also appears to be strongly associated with Swamp Mahogany which is absent from the proposed development area. Coast Banksia, a prolific winter flowering species, occurs adjacent to the development area (**PLATE 25**) and may be utilised. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

Smith and Smith (2000) discuss many records of Powerful Owls in the Pittwater Council area. Most of the Pittwater records have come from the western parts of the LGA (Ingleside, Warriewood, Church Point, Bayview and western Mona Vale). Young birds have been reported at Narrabeen Creek, Warriewood, in 1994 (M. Cutting pers. comm.), McCarrs Creek, Church Point, in 1995 (Pittwater Council 1997a) and Bayview Woods in 1996 (Antcliff 1996), indicating that the species breeds in Pittwater. The Powerful Owl is likely to forage on the site's well vegetated upper slopes. It may nest in this area if suitable large hollow-bearing trees are available. Powerful Owls may roost in dense rainforest vegetation along the waterway. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Masked Owl was recorded at Avalon in 1935 (roosting under the canopy of a Cabbage-tree Palm) and Newport in 1965 (Debus and Rose 1994). In 1974 a pair was present at Warriewood throughout the year and attempted nesting, evidently without success (Rogers 1975). There have been no records of the Masked Owl in Pittwater since. However, it is a cryptic species and may still be present in the area. It has been recorded elsewhere in northern Sydney in recent years. The site supports the woodland/cleared land interface, which is known to be exploited by the Masked Owl elsewhere in its range, and it must be considered a potential occurrence at the site. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Barking Owl inhabits eucalypt forest and woodland, usually on fairly fertile soils. It seems to prefer open woodland vegetation and forest margins, rather than forest interiors. Timbered rivers and creeklines are a favoured habitat, especially inland, but also in coastal regions (Kavanagh *et al.* 1995, Debus 1997). This species was recorded at Avalon and Deep Creek in September-October 1978 (Debus 1997). A single individual was seen in Eucalypt woodland near the Pittwater Council nursery at Ingleside in December 1993 (ICF and Australian Museum 1994). There were further sightings of solitary individuals on Scotland Island (north of the site, on the Pittwater) in January-March 1998 (Atlas of NSW Wildlife), and again in late winter 1999. This species was also recorded at Palm Beach in April 1999. This species is strongly associated with fertile Eucalypt woodlands (eg Forest Red Gum on alluvium) and is not likely to regularly utilise riparian rainforest or sandstone Eucalypt woodlands. It is therefore unlikely to make regular use of the site.

2.3.5 Mammals

The Atlas of NSW Wildlife contains records of forty-five mammal species from the Pittwater LGA. Mammal surveys were conducted during dry conditions over one day in winter 2004. The duration and season of survey were not sufficient for the assessment to be considered comprehensive, and as such this report relies on a detailed review of local records and habitat assessment to determine habitat suitability.

Small terrestrial mammals generally occur in greatest diversity and abundance in areas with a complex vegetation structure[13]. Historically, the open Eucalypt forests of this locality would have supported a diverse range of species, including; the Bush Rat, Yellow-footed Antechinus, Brown Antechinus, Common Dunnart, Common Planigale, Spotted-tail Quoll and Brown Bandicoot. Although detailed trapping surveys were not conducted, results from surveys of similar disturbed habitat indicate that the exotic House Mouse and Black Rat are likely to dominate the small mammal fauna. The ubiquitous Brown Bandicoot also tends to persist. Waterway vegetation may support the Swamp Rat, and surrounding Eucalypt forest most of the other small terrestrial species known from the locality. Macropods such as the Swamp Wallaby may shelter in forest surrounding the site and forage in the site's open grasslands.

Arboreal mammals such as the Squirrel Glider, Koala and Eastern Pygmy Possum are likely to persist in the site's Eucalypt forest but will have little reliance on the open grassland or waterway. It is possible that there are occasional forays through these habitats, although these movements are unlikely to be critical to the persistence of the populations.

All of the Microchiropteran bats known from the locality could forage over the grassland community, although it provides poor quality habitat. All species could forage in the adjacent waterway vegetation and Eucalypt forest. The dense waterway vegetation provides roost opportunities for foliage roosting species[14], and the eucalypt forest provides tree hollows suitable for tree-hole roosting species. Clefts and cracks suitable for cave-roosting species are also common across the sandstone escarpment.

The open grasslands provide neither forage nor roost habitat for Megachiropteran bats. The waterway vegetation provides potential forage habitat and marginal roost habitat. Surrounding Eucalypt forest provides high quality forage habitat.

The Atlas of NSW Wildlife contains records of two Endangered Populations (Koala and Squirrel Glider) and several threatened species in the Pittwater LGA. The threatened species include; the Endangered Southern Brown Bandicoot, and the Vulnerable Spotted-tailed Quoll, Eastern Pygmy Possum, Grey-headed Flying Fox, Eastern Bent-wing Bat and Greater Broad-nosed Bat. The EPBC Act interactive Protected Matters search tool indicates that the Large-eared Pied Bat and Long-nosed Potoroo[15] are known or likely to occur.

Squirrel gliders inhabitat a range of habitats in coastal NSW from low, scrubby Eucalypt woodlands and Banksia thickets (Quin 1995, Sharpe and Goldingay 1998) to tall, wet Bucalypt forests boardering on rainforest (Suckling 1995). The availability of a year-round supply of carbohydrates (nectar, sap, gum and honeydew) appears to be a critical habitat requirement. In coastal New South Wales they typically inhabit areas with a diversity of tree and shrub species, including high nectar-producing species and one or more winter-flowering species (Quin 1995, Smith 1996, Sharpe and Goldingay 1998).

Smith and Smith (2000) note that records of the Squirrel Glider in Pittwater are confirmed by several specimens lodged at the Australian Museum and two sightings. All records to

[13] Particularly in areas with a dense understorey layer that provides shelter from predators and which offers nesting opportunities.
[14] Inspection of the old wooden bridge over the waterway (**PLATE 1**) failed to locate bat roosts.
[15] This species is not known from Pittwater LGA, and is unlikely to occur on the Subject Site

date have been from the Careel Bay/Avalon/Newport area of Barrenjoey Peninsula. The Squirrel Glider has not been recorded from Ku-ring-gai Chase or Garigal National Parks, although it must be considered a likely occurrence given habitat available. Although not recently recorded from this area or detected during surveys, it is possible that Squirrel Gliders persist in the site's Eucalypt woodlands. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

A household questionnaire survey targeting Koalas, Bandicoots and Gliders and covering the whole of the Pittwater Council area was undertaken in early 1993 by Higgs and Campbell (1993), who estimated that there were only four to six Koalas remaining on the Peninsula. Smith and Smith (2000) note that Koalas have been reported on the Peninsula during the 1990's from McKay Reserve, Palm Beach, south to Gladstone Street, Newport, but predominantly between the southern side of Careel Bay and Algona Reserve, Bilgola Plateau, and Attunga Reserve, Newport.

Smith and Smith (2000) discuss occasional records of Koalas elsewhere in the Pittwater Council area during the 1990's. In 1992, Koalas were seen at Ingleside near Ku-ring-gai Chase National Park, and at Irrawong Reserve, North Narrabeen. In 1997, scratchmarks thought to have been made by Koalas were observed at Bayview Woods, and probable Koala droppings were found at Monash Golf Course. These were the first records of Koalas from these parts of Pittwater since the 1960's (Smith and Smith 1990b). The sites are linked to Ku-ring-gai Chase National Park by bushland corridors and it is likely that the Koalas came from there rather than from the isolated Barrenjoey Peninsula population. In Ku-ring-gai Chase National Park itself there have been only two records of Koalas during the 1990's. One of these was on a ridge above Elvina Bay after the January 1994 bushfires. More recently, in November 1999, there has been another report of a Koala at Elvina Bay, suggesting that there are resident animals in this part of Pittwater, as well as on Barrenjoey Peninsula. Koala faecal pellets were recorded beneath a Southern Mahogany near the existing residence (**PLATE 30**). A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

Southern Brown Bandicoots are solitary animals that occupy overlapping home ranges whose size has been estimated at 0.8 to 3.2 ha in Victoria (Lobert 1990) and 2.3 to 6.6 ha in Tasmania (Heinsohn 1966). They are usually nocturnal, but can be diurnal in some situations (Heinsohn 1966, Lobert 1990). During the day they rest in nests on the ground, usually in dense vegetation, constructed from grass and other plant material, sometimes mixed with earth. They inhabit heath, scrub and heathy forest and woodland, usually on well drained soils (Opie *et al.* 1990, Menkhorst 1995). They are not found in wet forests. Stoddart and Braithwaite (1979) have suggested that heathland regenerating after fire is a favoured habitat that they are able to utilise because of their high reproductive rate and their use of less favourable adjacent habitats from which burnt heathland can be reinvaded (Smith and Smith 2000).

Smith and Smith (2000) note that the presence of the Southern Brown Bandicoot in the Pittwater Council area is yet to be confirmed. However, the adjacent Ku-ring-gai Chase National Park is the stronghold of the species in the Sydney area, with many records over the years (Atlas of NSW Wildlife). They have also been recorded just west of the Pittwater Council area at Kimbriki Tip in 1990 (ICF and Australian Museum 1994). In a recent study of bandicoots in northern Sydney, Southern Brown Bandicoots were recorded in Ku-ring-gai Chase National Park and both sections of Garigal National Park, but not in any of the smaller patches of bushland surveyed. It is unclear whether the Bandicoot would persist in

the bushland adjacent to the site but it must be considered a possibility. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Spotted-tailed Quoll has been recorded from both Ku-ring-gai Chase and Garigal National Parks. There have also been several records in the Pittwater Council area. Smith and Smith (2000) note that an individual was observed raiding a guinea-pig pen at Elvina Bay in the early 1990s (Pittwater Council 1997b). An adult male was trapped at a chicken coop in Marinna Road, Elanora Heights, on 9 May 1993, after a couple of reports in the area on 6 May. It was tagged and released in the Deep Creek area, but turned up and was re-trapped months later at Granville, again at a chicken coop. Another individual was reported at Avalon on 18 May 1993, possibly the same animal. More recently, there have been reports from western Mona Vale in July 1998 and summer 1999. The Spotted-tailed Quoll is likely to use the site's Eucalypt forest habitats. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps (Eby, 1995). Urban gardens and cultivated fruit crops also provide habitat for this species. Grey-headed Flying-foxes forage on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia* (Eby, 2000a), and the fruit of rainforest trees and vines. The area proposed for development does not provide habitat for this species. However, it is likely to utilise adjacent waterway vegetation and eucalypt forest. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Eastern Pygmy-possum is generally found in heathlands, shrublands and dry forests with a heathy understorey. The understorey characteristically includes a range of myrtaceous and proteaceous shrubs (such as banksias, grevilleas, callistemons, hakeas and melaleucas). The Eastern Pygmy Possum is an agile climber that feeds mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit. There are several records of this species from the Pittwater LGA and this species is considered a possible occurrence in the site's Eucalypt forests. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Large-eared Pied Bat has been recorded from a range of habitats in New South Wales, including dry and wet eucalypt forest, *Callitris* forest, Eucalypt forest with a rainforest understorey, sub-alpine woodland and sandstone outcrop country (Duncan *et al.* 1999). Daytime roost sites are caves and disused mine shafts, and even the abandoned, bottle-shaped mud nests of Fairy Martins. In caves, individuals huddle in groups of 3 to 37, often close to the cave entrance, in contrast to other cave-dwelling bats, which usually seek the deeper, darker parts of cave systems (Hoye and Dwyer 1995, Churchill 1998). The Large-eared Pied Bat has been recorded at the entrance of St Michaels Cave, North Avalon. The bat (or bats) had apparently been roosting in the cave with several hundred Common Bentwing-bats. The area proposed for development does not support the breeding/roosting habitat of this species, although it may forage in well vegetated areas on and around the site. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Eastern Bentwing-bat has been recorded in a wide range of habitats from grasslands through to subtropical rainforests, but it is typically found in well-timbered valleys (Dwyer 1995). Its primary habitat requirement is suitable roosting and breeding sites. These are

found in caves, mines, stormwater pipes and similar sites, even sometimes in buildings. There have been a number of recent records of the Eastern Bent-wing bat in Pittwater. Bats are known by local residents to occur regularly in St Michaels Cave, North Avalon. It is an important roosting site for the species in the Sydney region, but the bats are unlikely to breed in this cave. There are no known nursery caves in the vicinity of Sydney, the nearest being at Bungonia (Dwyer 1969). Unidentified bats that may be this species have been reported roosting elsewhere in Pittwater at Careel Cave and in a culvert at the Bilgola Bends. The site does not support the breeding/roosting habitat of this species, although it may forage in well vegetated areas on and around the site. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

The Greater Broad-nosed Bat occurs in a variety of habitats, including dry and wet eucalypt forest and woodland, and rainforest, but it apparently prefers moist gully forests (Churchill 1998). It usually roosts in tree hollows (chiefly eucalypts), but has also been recorded in the roof spaces of old buildings (Hoye and Richards 1995). It is believed to be dependent on mature forest on soils of high fertility (Braithwaite *et al.* 1993). Smith and Smith (2000) note that the Greater Broad-nosed Bat was recorded at Bilgola in July 1982 (Long 1983) and at Deep Creek Reserve in February/March 1996 (Turton 1996). The moist forests associated with the sites waterway appear ideal for this species, which is a likely occurrence. A section 5A Assessment has been prepared for this species and is included in **APPENDIX 10**.

2.3.6 Corridors

FIGURE 1 shows that the site is located at the base of the Warriewood Escarpment. **APPENDIX 2** (part 3) indicates that the escarpment is recognised by Pittwatwer Council as a wildlife corridor. The escarpment provides a vegetated dispersal pathway between Ingleside Park Recreation Reserve and Katandra Bushland Sanctuary. From this point there is a tenuous connection into Ku-ring-gai Chase National Park. There is also a very tenuous connection between the Warriewood Escarpment and Garrigal National Park. Areas between the base of the escarpment and the coast are completely developed, and it is clear that there will be no easterly dispersal of forest-dependent fauna from the edge of the escarpment vegetation.

3.0 BUSHFIRE HAZARD ASSESSMENT

3.1 LEGISLATIVE BACKGROUND

On 1 August 2002, the Rural Fires and *Environmental Legislation Amendment Act 2002* (Amendment Act 2002) came into force. It changed the Environmental Planning and Assessment Act 1979 (EP&A Act) and Rural Fires Act 1997 (RF Act) to improve the protection of life, property and the environment from bushfire. The Amendment Act 2002 increases the powers of the NSW Rural Fire Service (RFS) in development decisions affecting bushfire prone land and gives legal effect to the Planning for Bushfire Protection guideline (NSW Rural Fire Service and Department of Infrastructure Planning and Natural Resources 2001).

A key component of the new requirements is the Planning for Bushfire Protection guideline (NSW Rural Fire Service and Department of Infrastructure Planning and Natural Resources 2001). This document links with Australian Standard AS 3959 - Construction of Buildings in Bushfire-prone areas.

3.2 ASSESSMENT REQUIREMENTS

If a new development is to occur on bushfire-prone land, one of two new development assessment processes applies depending on the type of development proposed. The two types are:

- 'High risk' development - development that is more vulnerable to bushfire risk and requires a Bush Fire Safety Authority from the RFS. This development becomes 'integrated development' under s91(1) of the EP&A Act.
- Other development - development that does not require a BFSA (notably class 1, 2 and 3 buildings).

In accordance with *Planning for Bushfire Protection,* this document defines bushfire-prone areas as those areas:

- within (or within 100m) of high or medium bushfire hazards; or
- within (or within 30m) of low bushfire hazards;

In a practical sense, areas identified as being predominantly grasslands can be readily managed and as such are also not to be considered to be bushfire-prone.

3.3 ASSESSMENT METHODOLOGY

All areas in NSW which have been mapped as being of potential bushfire hazard (PBH) need to be assessed to determine appropriate setbacks from areas of fire hazard. Pittwater Council Mapping shows the site as Bushfire Prone Land (**FIGURE 5**) and there is therefore a requirement to assess the proposal against NSW Planning's Planning for Bushfire Protection (2001) and the Rural Fires Act (1997).

In accordance with *Planning for Bushfire Protection* (2001), the following procedure was adopted to assess the development level in order to determine whether the development is bushfire-prone and if so, what setbacks are required:

(a) Determination of vegetation type and class, as follows:

  (i) Identify all vegetation in each direction from the site for a distance of 140m.
  (ii) Consult *Planning for Bushfire Protection* and determine the appropriate setback for the assessed land use, vegetation group and slope range.
  (iii) Select the predominant vegetation group (1 to 3) as described in *Planning for Bushfire Protection.*

(b) Determine the average slope of the land between the Predominant Vegetation Class and the site.

(c) Consult Tables A2.2–2.4 in *Planning for Bushfire Protection* and determine the appropriate setback for the assessed land use, vegetation group and slope range.

3.4 ASSESSMENT RESULTS

3.4.1 Vegetation Groups

Much of the proposed development area is dominated by low grassland (pasture grasses). In accordance with *Planning for Bushfire Protection*, areas identified as being predominantly grasslands can be readily managed and as such are also not to be considered to be bushfire-prone. The site contains and is surrounded by a substantial area of Dry Sclerophyll Forest. This vegetation is considered to be Group 1 Vegetation.

3.4.2 Slope Analysis

The Bushfire Risk on the site is located upslope from the proposed development on slopes greater than 5^{0}. In accordance with *Planning for Bushfire Protection* and from a bushfire management point of view the risk category is uniform across the development area.

3.4.3 Asset Protection Zones

3.4.3.1 Background

Asset Protection Zones are required for any development adjoining a bushfire hazard area, whether it is a single building, a group of isolated buildings or an urban subdivision. The Asset Protection Zone acts as a buffer zone between the development and the hazard. The primary purpose of an Asset Protection Zone is to ensure that a progressive reduction of bushfire fuels occurs between the bushfire hazard and any habitable structures within the development.

3.4.3.2 Lots Containing or Adjacent to Group 1 Vegetation

The minimum specification for an Asset Protection Zones (APZ) for residential purposes in a bushfire-prone areas Impacted by Vegetation Group 1 (upslope, $>5^0$) is minimum separation distance of 20m, regardless of construction level.

A minimum cleared buffer of 20m in width between any proposed dwelling and retained vegetation would be sufficient to mitigate bushfire risk and would comply with the prescriptions in *Planning for Bushfire Protection* in these areas.

4.0 THE PROPOSED DEVELOPMENT - ENVIRONMENTAL MANAGEMENT & COMPLIANCE

4.1 DESCRIPTION OF THE DEVELOPMENT

An aerial photograph with development overlay is provided as **FIGURE 6**. The plan shows that development will be largely confined to the open grassland, with very minor encroachment of development and bushfire buffers into the disturbed edge of Community 3.

4.2 ECOLOGY

4.2.1 Plants and Plant Communities

As discussed in Section 2, the grassland community is a very poor representation of the original lowland forest, does not contain any threatened plants and provides poor habitat for the regeneration of such plants.

Small sections of the development extend into Community 3, and establishment of bushfire buffers will also require minor clearing and underscrubbing in this community. **FIGURE 6** shows that 4065m^2 falls within the development area., and that a further 2772m^2 will be cleared for bushfire management purposes. Surveys indicate that the area tobe affected is the disturded edge, which is dominated by regrowth species such as Black Sheoak and Cheese Tree. No threatened plants or Endangered Ecological Communities will be affected.

The waterway and associated riparian vegetation will be retained in the waterway buffer zone. Weeds will be removed and infill plantings provided to improve bank stability and the ecological values of this area. Further details are provided in the Landscape Plan being prepared by PLACE Planning & Design. It should be noted that species typical of Coastal Swamp Forest Complex and Sydney Sandstone Gully Forest vegetation will be used in the rehabilitation area.

Given the lack of identifiable impact on threatened plants or plant communties, no Section 5A assessments have been prepared. With reference to the administrative guidelines on significance, there is also unlikely to be a significant impact on nationally threatened plants or plant communities (Matters of National Environmental Significance) and no need to seek a determination from Department of Environment & Heritage on Controlled Action Status.

4.2.2 Fauna

As discussed in Section 2, the open grassland (focue for the development) provides habitat for a range of common agricultural and urban fringe fauna. Establishment of the development will result in a loss of habitat for this group. It is unlikely that threatened species will be affected.

Minor clearing of a regrowth edge on the Eucalypt forest will be required to accommodate components of the development and bushfire buffers (**FIGURE 6**). The clearing will remove very small areas of potential habitat for several threatened species known from this locality. Section 5A assessments have been prepared for affected species (**APPENDIX 10** In addition to the direct impact of habitat loss, the encroachment will allow edge effects to extend further into the retained vegetation. The extent to which the edge effects affect the area as a whole can be managed by providing a dense vegetative screen at the edge of clearing. The habitat loss will also be offset by regeneration works proposed for the waterway corridor.

Surveys indicate that the site does support potential Koala habitat, but that there is no requirement for a Koala Plan of Management to accompany the application. Further details are provided in **APPENDIX 11**

Given it present low-key landuse, the site is unlikely to generate significant light, noise and activity; factors which can affect utilisation of bushland by fauna. The proposed development will intensify the site's usage and may have an indirect impact on the fauna habitat values of adjacent areas. It should be noted that impacts are considered unlikely to be significant. However, Section 5A assessments for affected species are provided in **APPENDIX 10**

With reference to the administrative guidelines on significance, there is unlikely to be a significant impact on nationally threatened fauna (Matters of National Environmental Significance) and no need to seek a determination from Department of Environment & Heritage on Controlled Action Status.

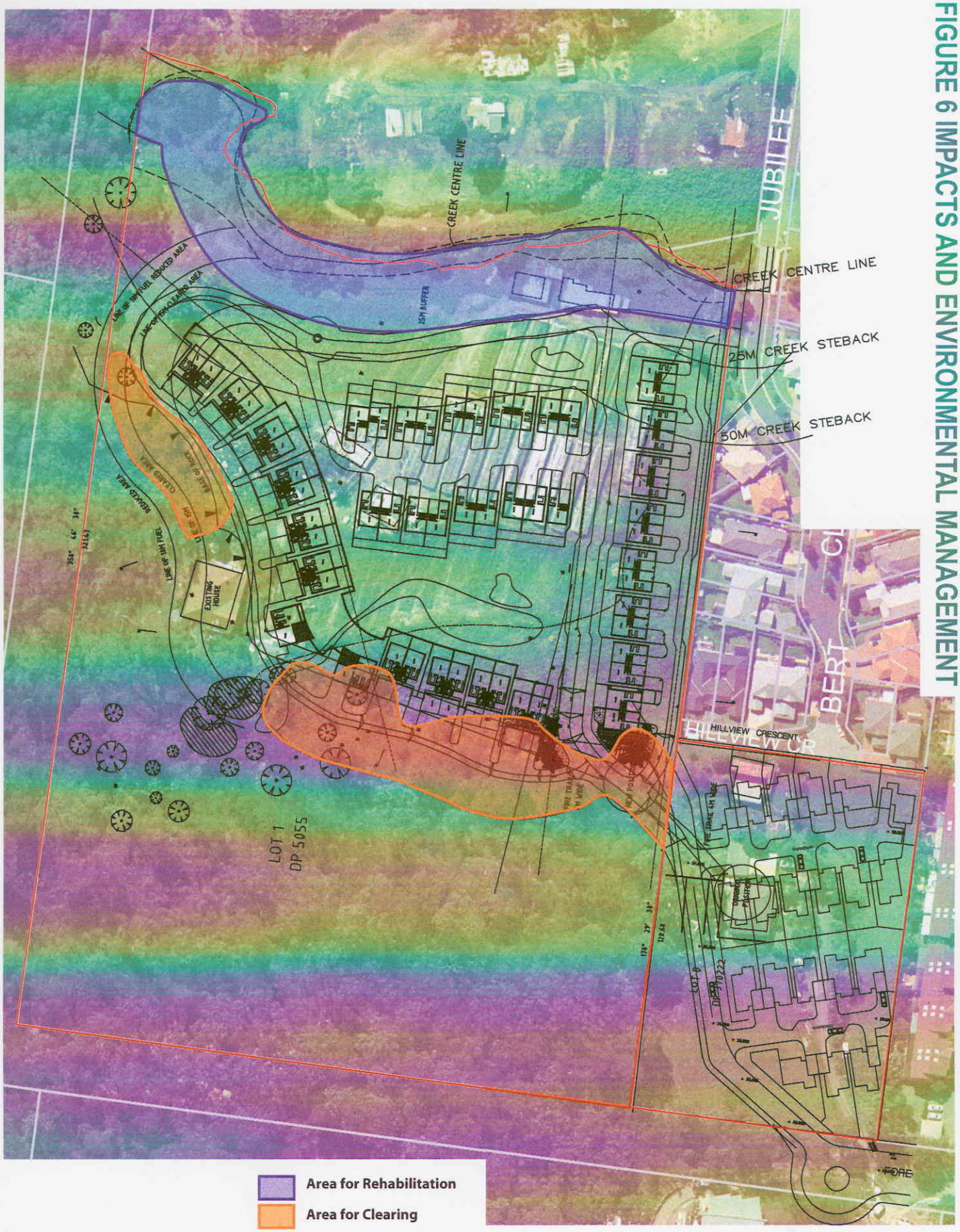
4.3 BUSHFIRE

With reference to Table A2.2 of the Planning for Bushfire Protection document, and assuming that all vegetation should be placed in Vegetation Category 1, the following Asset Protection Zones are recommended:

- 20m inner protection zone and 0m outer protection zone for areas upslope of the development envelope (**FIGURE 6**).

The proposed perimeter road provides adequate fire fighting access between the predominant threat and Units C28 – C35. It is suggested that a 4m wide crush gravel (road base) track be established along the rear of Units D38 – D45 (**FIGURE 6**). The development will be serviced by mains water, and there is no requirement for supplementary water supply.

FIGURE 6 IMPACTS AND ENVIRONMENTAL MANAGEMENT



warriewood environment

impacts and environmental management

PLACE ENVIRONMENTAL

figure 6
impacts and env management
date: 27 august 2004
project no. jub01_02/a
scale: as indicated
source: pittwater council March 2002

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PLATES

PLATE 3 –Dense Lantana along the waterway

PLATE 4 –View along the waterway to Warriewood Escarpment

PLATE 1 –Old timber bridge over waterway

PLATE 2 –Dense Lantana and Bamboo over waterway

PLATE 7 –Waterway pools

PLATE 8 –View along the Waterway

PLATE 5 –Areas of more riparian vegetation occur in the west

PLATE 6 –Understorey in areas of more intact riparian vegetation

PLATE 11 –View from glass houses west towards Warriewood Escarpment

PLATE 12 –View from glass houses west towards Warriewood Escarpment

PLATE 9 –Potential pedestrian bridge crossing point

PLATE 10 –View towards intact forest to the site's west

PLATE 13 –View from glass houses south towards Warriewood Escarpment spur

PLATE 14 –Northwest view across the site to the Warriewood Escarpment

PLATE 15 –Grassland community structure

PLATE 16 –Grassland community structure

PLATE 17 –Grassland community structure

PLATE 18 –Bracken fern and Blady grass at the grassland remnant forest interfact

PLATE 19 –Bracken fern and Blady grass at the grassland remnant forest interface

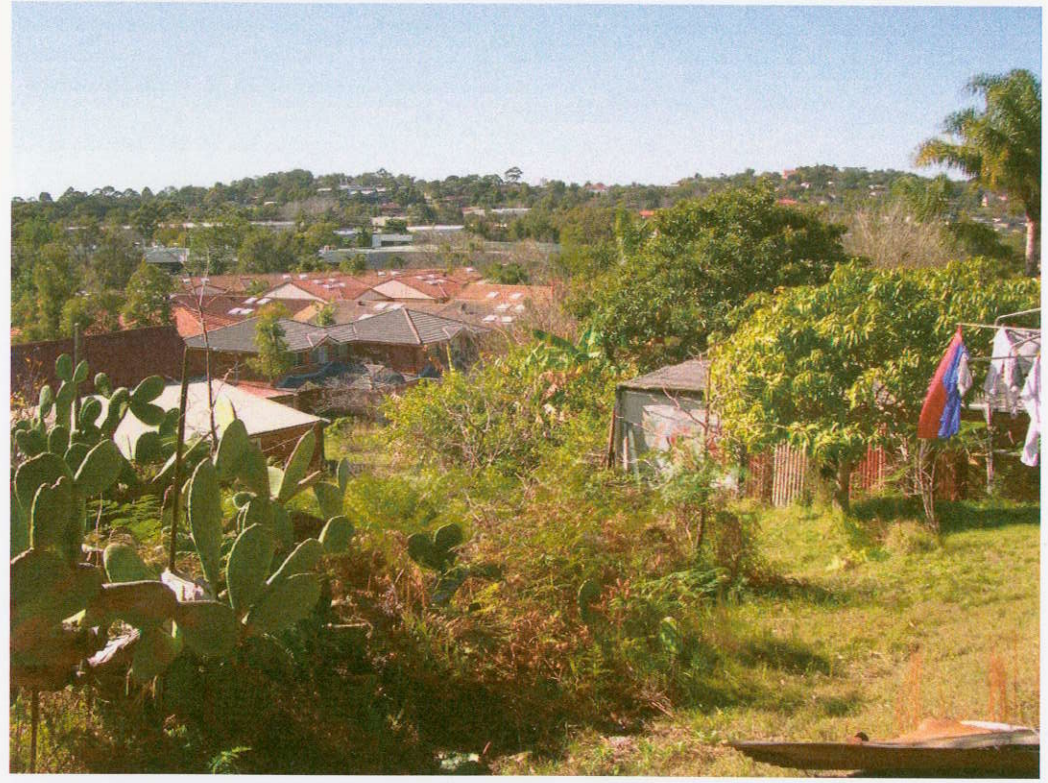


PLATE 20 –Gardens and Grassland in southern property

PLATE 23 –Gardens and Grassland in southern property

PLATE 24 –Gardens and Grassland in southern property

PLATE 21 –Gardens and Grassland in southern property

PLATE 22 –Gardens and Grassland in southern property

PLATE 25 –Coast Banksia woodland to west of development envelope

PLATE 26 –Eucalypt woodland to the west of the development envelope

PLATE 27 –Understorey of Eucalypt woodland (native dominants)

PLATE 28 –Understorey of Eucalypt woodland (exotic species common at boundary)

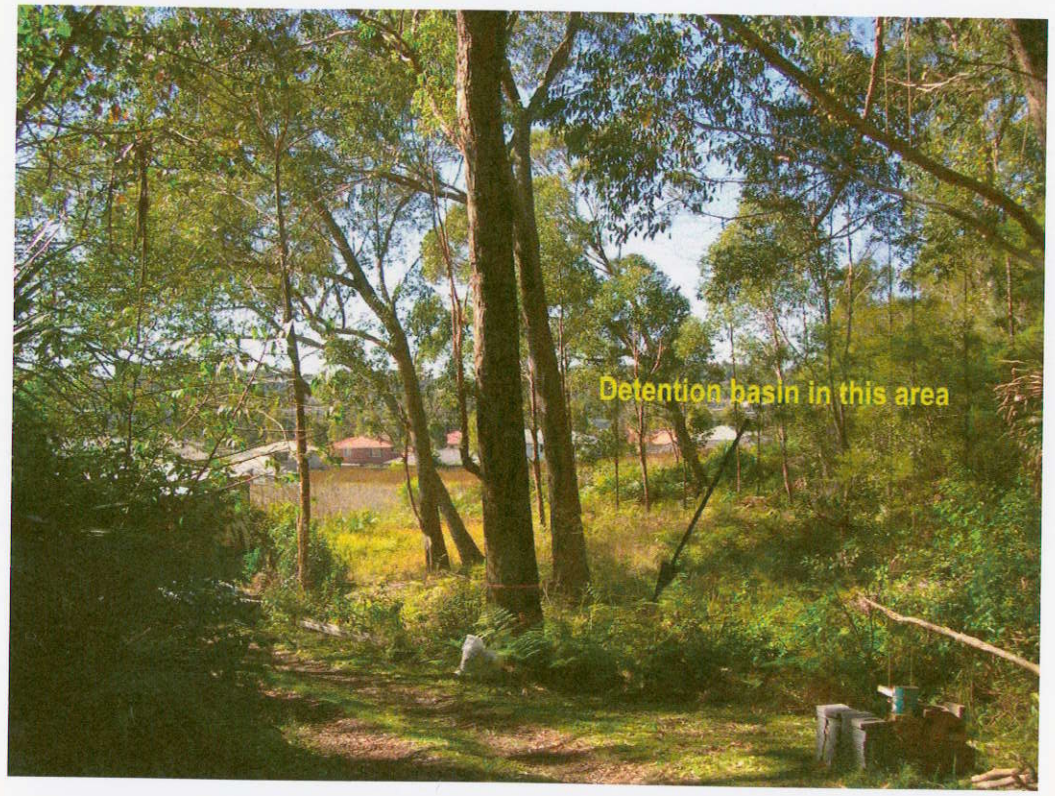


PLATE 31–Underscrubbing near existing house

PLATE 32 –Acacia and Black Sheoak regrowth along vegetation boundary

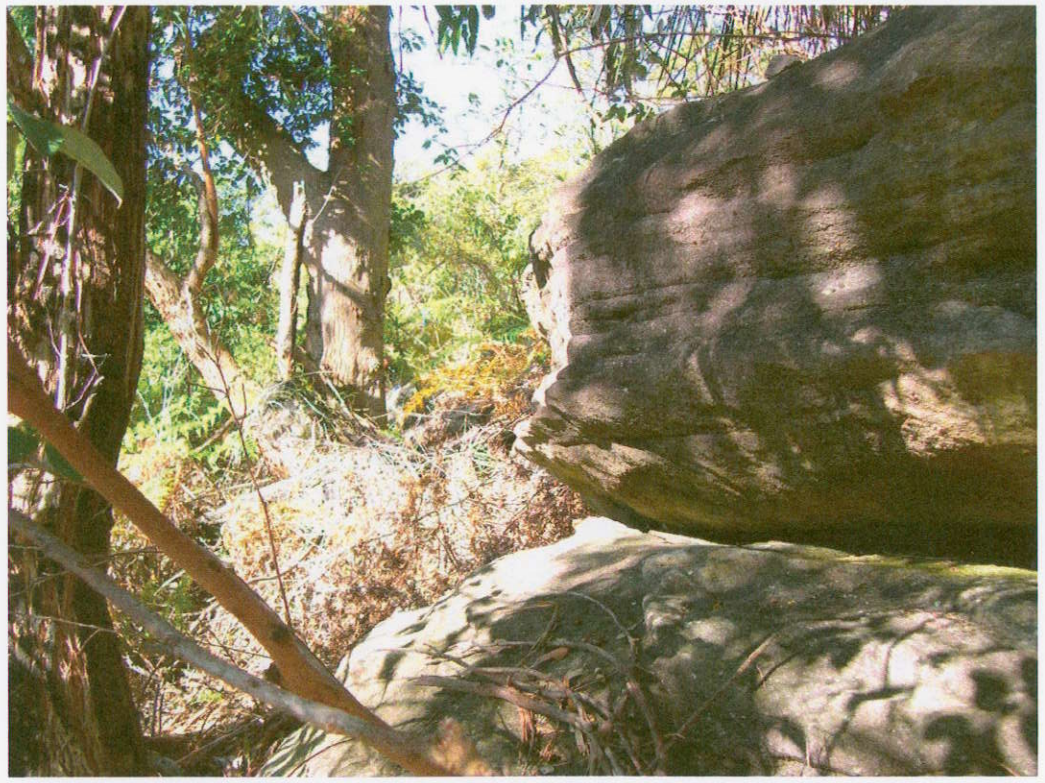


PLATE 29 –Rock outcrop

PLATE 30 –Underscrubbing near existing house

APPENDIX 1
SOIL LANDSCAPES INFORMATION

WATAGAN

Landscape_rolling to very steep hills on fine-grained Narrabeen Group sediments. Local relief 60-120 m, slopes >25%. Narrow, convex crests and ridges, steep colluvial sideslopes, occasional sandstone boulders and benches. Tall eucalypt open-forestwith closed-forest (rainforest) in sheltered positions.

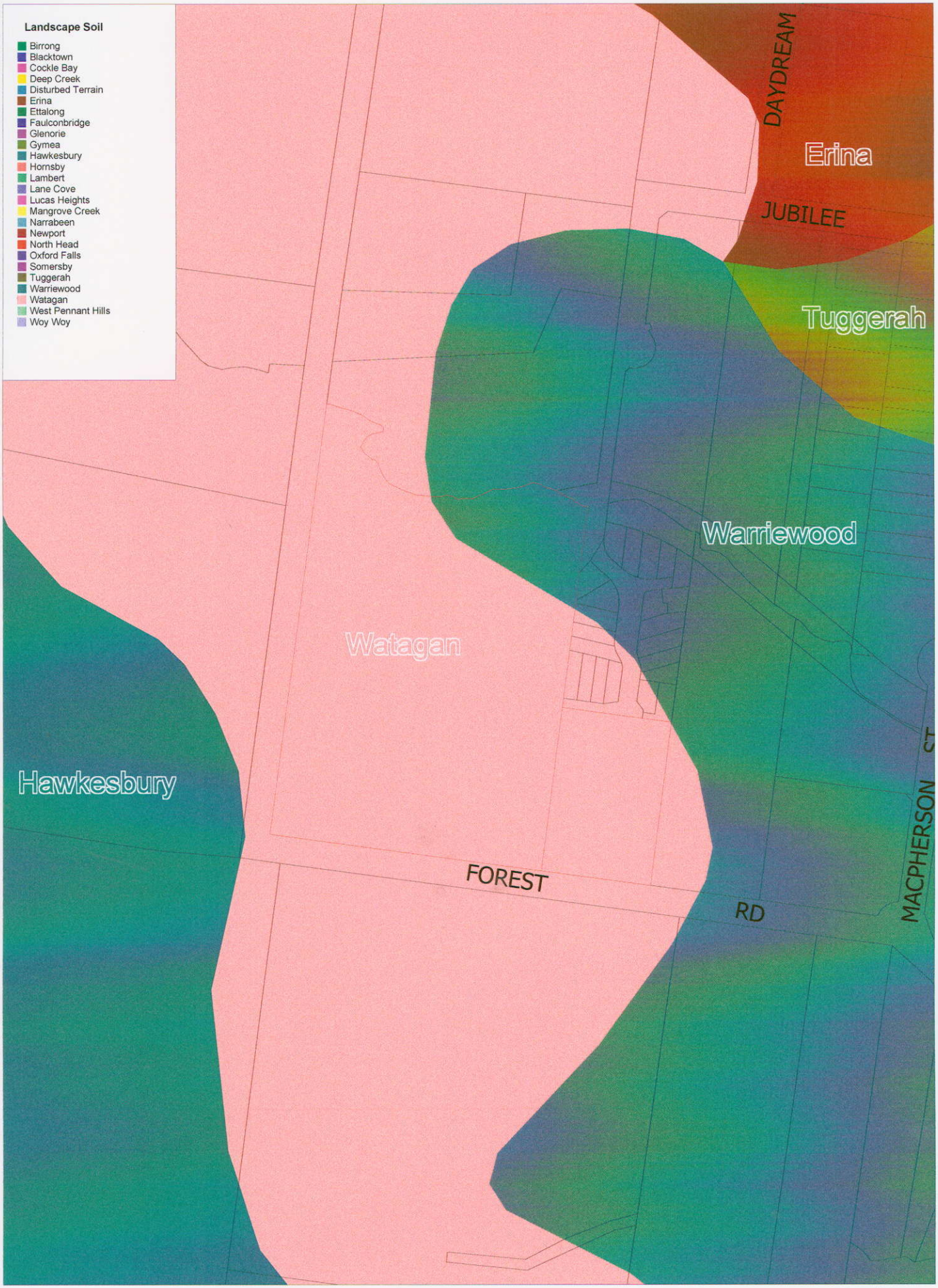
Soils_shallow to deep (30-200 cm) *Lithosols/Siliceous Sands (Uc1.24)* and *Yellow Podzolic Soils (Dy3.21, Dy3.41, Dy4.11)* on sandstones; moderately deep (100-200 cm) *Brown Podzolic Soils (Db1.11), Red {Podzolic Soils (Dr2.21)* and *Gleyed Podzolic Soils (Dg2.21)* on shales.
Limitations

WARRIEWOOD

Landscape_level to gently undulating swales, depressions and infilled lagoons on Quaternary sands. Local relief <10 m, slopes <3%. Watertable at <2 m. Mostly cleared of native vegetation.

Soils_deep (>150 cm), well sorted, sandy *Humus Podzols (Uc2.32)* and dark, mottled *Siliceous Sands (Uc1.21)*, overlying buried *Acid Peats (O)* in depressions; deep (>200 cm) *Podzols (Uc2.12, Uc2.32)* and pale *Siliceous Sands (Uc1.2)* on sandy rises.

Limitations_localised flooding and run-on, high watertables, highly permeable soil.



Soil Landscape Data - DIPNR 2004
This plan is not survey accurate.

Sydney Soil Landscpape
4,8 Forest Rad, Warriewood

NORTH
Scale 1:2500

APPENDIX 2
CONSERVATION CATEGORIES

B4 CONTROLS RELATING TO THE NATURAL ENVIRONMENT

B4.1 Flora and Fauna Conservation Category 1 Land

Outcome
The long-term viability of locally native flora and fauna and their habitats in the Pittwater LGA. (En)

Land to which this control applies
Areas of core habitat mapped as Flora and Fauna Conservation Areas, Category 1 (MDCP020)

Development to which this control applies

- *Specified Residential Development*
  Dwelling house (new)
  Dwelling house (alterations & additions)
  Attached dual occupancy
  Detached dual occupancy
  Multi-unit housing
  Shop-top housing (residential portion only)
- *Unspecified Residential Development*
  Includes all other residential development not individually specified above
- *Business Development*
- *Light Industrial Development*
- *Land Subdivision*
- *Other Development*
  Includes development not included in residential development, business development, light industrial development, or land subdivision.

Controls
Development shall not directly impact on vulnerable species, endangered populations or endangered ecological communities.

Development shall not significantly reduce or degrade habitat for locally native species, vulnerable species, endangered populations or endangered ecological communities.

Development shall not result in a significant loss of canopy cover or a net loss in native canopy trees.

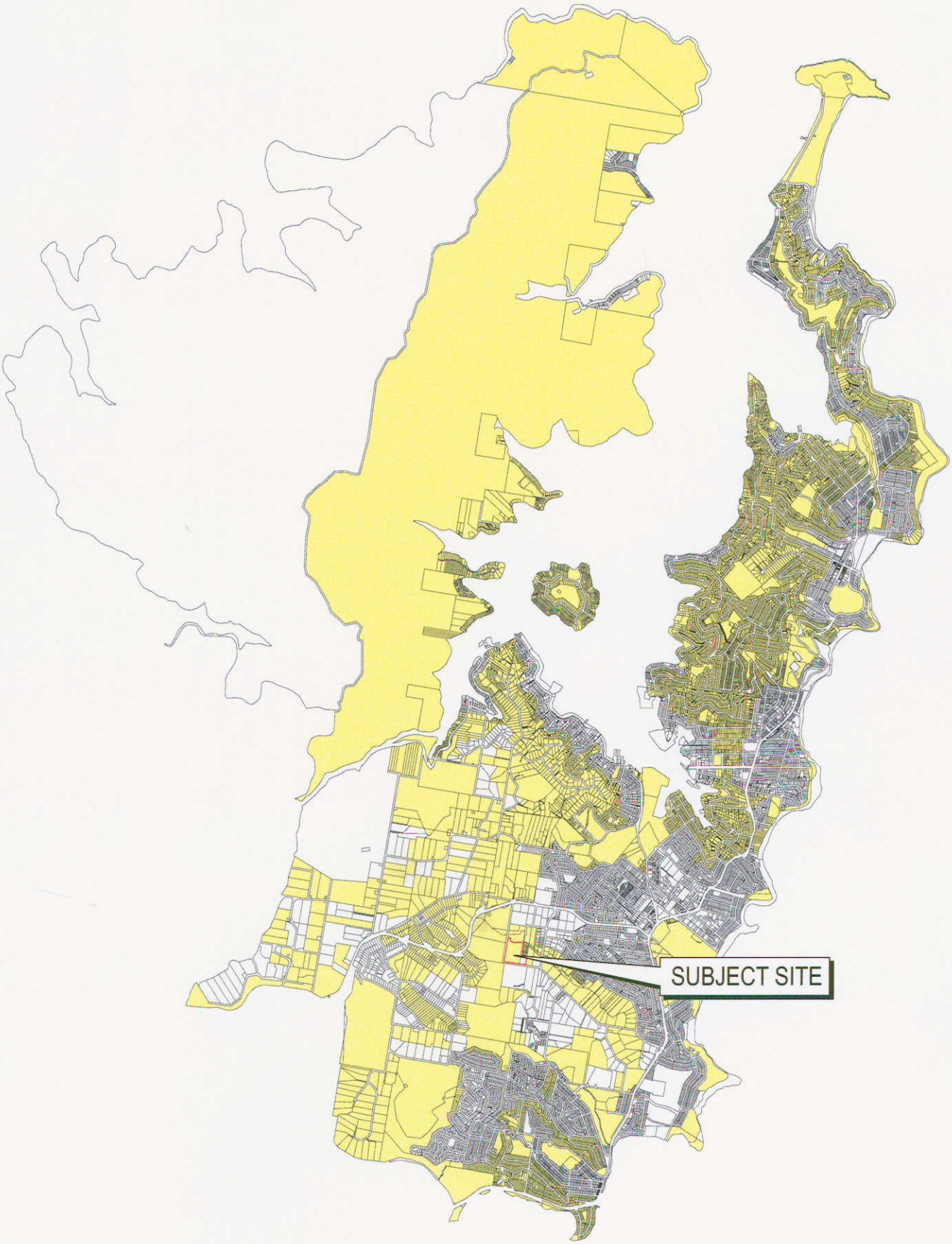
Development shall ensure any landscaping works are made up of 80% locally native plant species (ie species included in the endangered ecological community).

Variations
Council may consider variation to this control:

◊ for those activities listed in adopted Plans of Management.

◊ where development is proposed on parts of the site identified as not containing core bushland providing the development does not impact on core bushland on the site or adjoining properties.

◊ where a development is proposed in the area of least impact on core bushland and where there will be no net loss of core bushland.



Pittwater 21 Development Control Plan Map

MDCP023

All Land Mapped as Wildlife Corridor

B4.2 Flora and Fauna Habitat Enhancement Category 2 Land

Outcomes
Conservation, enhancement and/or creation of habitats for locally native flora and fauna to ensure the long-term viability of locally native flora and fauna and their habitats. (En)

Land to which this control applies
Areas of habitat mapped as Flora and Fauna Conservation Areas–Category 2 (MDCP021)

Development to which this control applies

- *Specified Residential Development*
  Dwelling house (new)
  Dwelling house (alterations & additions)
  Attached dual occupancy
  Detached dual occupancy
  Multi-unit housing
  Shop-top housing (residential portion only)
- *Unspecified Residential Development*
  Includes all other residential development not individually specified above
- *Business Development*
- *Light Industrial Development*
- *Land Subdivision*
- *Other Development*
  Includes development not included in residential development, business development, light industrial development, or land subdivision.

Controls
Development shall not directly impact on vulnerable species, endangered populations or endangered ecological communities.

Development shall not significantly reduce or degrade habitat for vulnerable species, endangered populations or endangered ecological communities.

Development shall not significantly reduce or degrade habitat for locally native species.

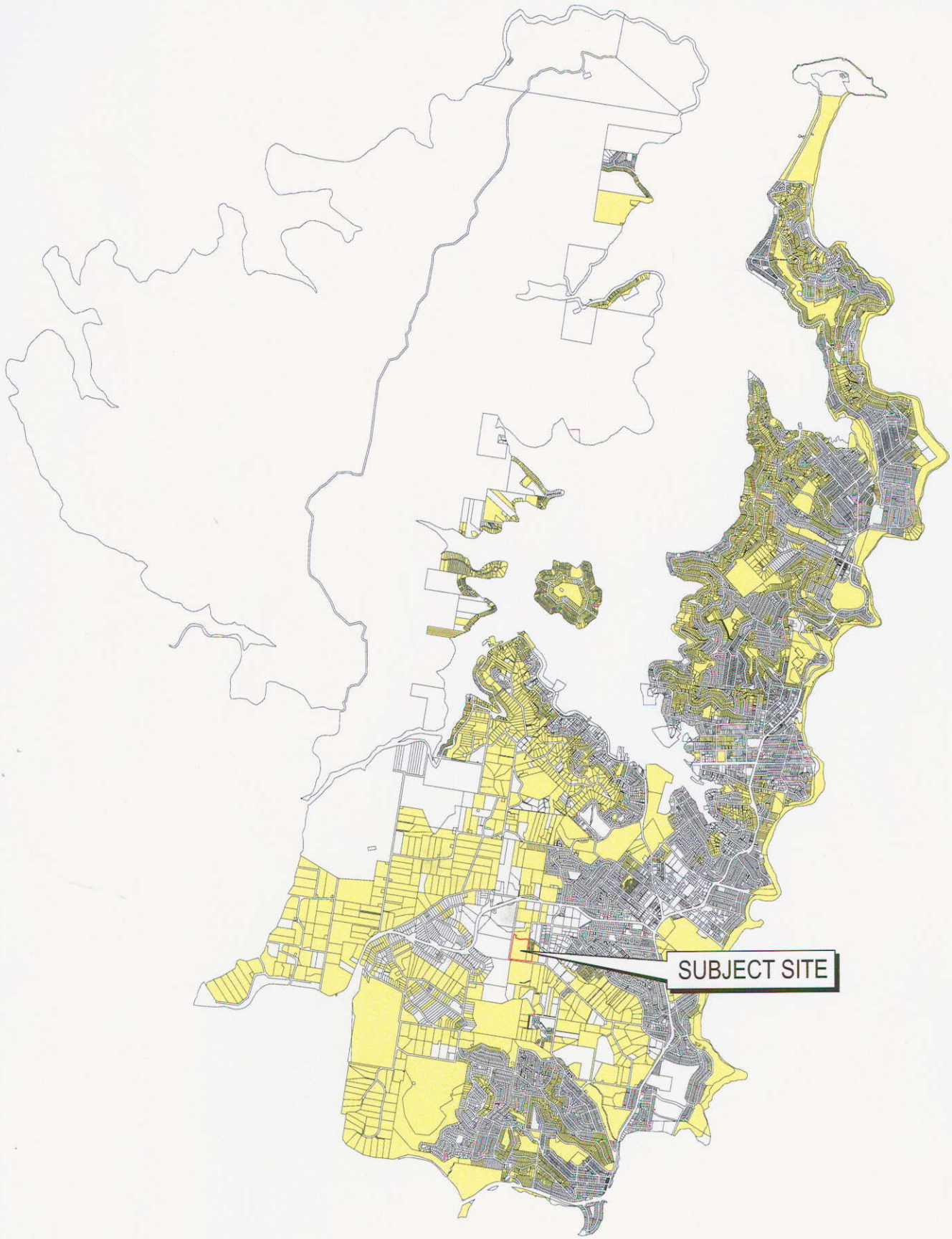
Development shall provide flora and fauna habitat by active restoration, regeneration, and / or creation.

Development shall not result in a significant loss of canopy cover or a net loss in native canopy trees.

Development shall ensure any landscaping works are made up of 80% locally native plant species (ie species included in the endangered ecological community).

Variations
Council may consider variation to this control:

◊ for those activities listed in adopted Plans of Management.
◊ where development is proposed on parts of the site identified as not containing native vegetation providing the development does not impact on bushland on the site or adjoining properties.
◊ where a development is proposed in the area of least impact on native vegetation and where there will be no net loss of native vegetation.



Pittwater 21 Development Control Plan Map

MDCP021

Area of Core Habitat Mapped as Flora and Fauna Conservation Areas, Category 2

B4.4 Wildlife Corridors

Outcomes
Retention and enhancement of wildlife corridors ensuring/providing the connection of flora and fauna habitats. (En)

Land to which this control applies
Land mapped as "Wildlife Corridor" (MDCP023)

Development to which this control applies:

- *Specified Residential Development*
  Dwelling house (new)
  Dwelling house (alterations & additions)
  Attached dual occupancy
  Detached dual occupancy
  Multi-unit housing
  Shop-top housing (residential portion only)
- *Unspecified Residential Development*
  Includes all other residential development not individually specified above
- *Business Development*
- *Light Industrial Development*
- *Land Subdivision*
- *Other Development*
  Includes development not included in residential development, business development, light industrial development, or land subdivision.

Controls:
Development shall not directly impact on / or significantly reduce / degrade habitat for locally native species, vulnerable species, endangered populations or endangered ecological communities.

Development shall retain wildlife corridors.

Development shall provide wildlife corridors via creation, restoration, and / or regeneration of habitat.

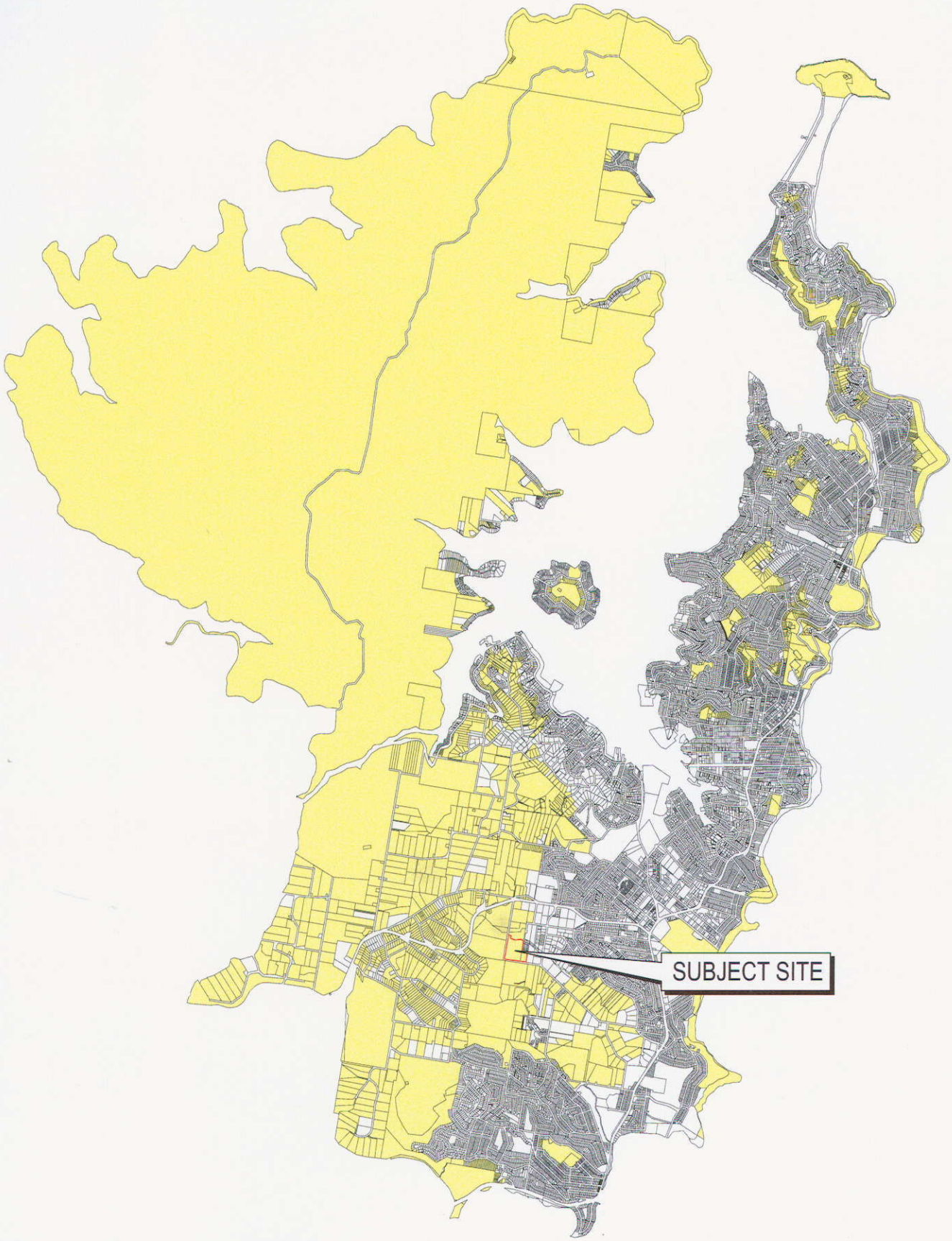
Development shall not result in a significant loss of canopy cover or a net loss in native canopy trees.

Development shall provide an adequate buffer to wildlife corridors.

Development shall ensure any landscaping works are made up of 80% locally native plant species (ie species included in the endangered ecological community).

Variations
Council may consider variation to this control:

◊ for those activities listed in adopted Plans of Management.
◊ where development is proposed on parts of the site identified as not containing a wildlife corridor providing the development does not impact on bushland on the site or adjoining properties.
◊ where a development is proposed in the area of least impact on a wildlife corridor and where there will be no significant net loss of native vegetation.



Pittwater 21 Development Control Plan Map

MDCP020

Area of Core Habitat Mapped as Flora and Fauna Conservation Areas, Category 1

APPENDIX 3
NSW NPWS WILDLIFE ATLAS SEARCH RESULTS

NSW National Parks & Wildlife Service
atlas of nsw wildlife

Search Results

Your selection: Flora, threatened species, LGA - PITTWATER
Report generated on 02/09/2004 - 16:33 (Data valid to 05/08/2004)

[redacted] [redacted] [redacted]

Choose up to 3 species to map.

Map	Scientific Name	Common Name	Legal Status	Count	Info
	Euphorbiaceae				
☐	Chamaesyce psammogeton		E1	1	
	Myrtaceae				
☐	Eucalyptus camfieldii	Heart-leaved Stringybark	V	4	
☐	Kunzea rupestris		V	2	
☐	Syzygium paniculatum		V	1	
	Orchidaceae				
☐	Cryptostylis hunteriana	Leafless Tongue Orchid	V	1	
☐	Genoplesium baueri		V	1	
	Proteaceae				
☐	Grevillea caleyi		E1	4	[redacted]
	Tremandraceae				
☐	Tetratheca glandulosa		V	2	

Choose up to 3 species to map.

DISCLAIMER: The Atlas of New South Wales Wildlife contains data from a number of sources including government agencies, non-government organisations and private individuals. These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Find out more about the Atlas.

NSW National Parks & Wildlife Service

atlas of nsw wildlife

Search Results

Your selection: Fauna, threatened species, LGA - PITTWATER
Report generated on 02/09/2004 - 16:31 (Data valid to 05/08/2004)

[redacted] [redacted] [redacted] [redacted]

Choose up to 3 species to map.

Aves	Map Scientific Name	Common Name	Legal Status	Count	[redacted]
Accipitridae					
	☐ Pandion haliaetus	Osprey	V	4	
Burhinidae					
	☐ Burhinus grallarius	Bush Stone-curlew	E1	11	
Cacatuidae					
	☐ Calyptorhynchus lathami	Glossy Black-Cockatoo	V	16	
Columbidae					
	☐ Ptilinopus superbus	Superb Fruit-Dove	V	1	
Diomedeidae					
	☐ Diomedea exulans	Wandering Albatross	E1	1	
	☐ Thalassarche melanophris	Black-browed Albatross	V	1	
Laridae					
	☐ Sterna fuscata	Sooty Tern	V	1	
Meliphagidae					
	☐ Xanthomyza phrygia	Regent Honeyeater	E1	4	
Procellariidae					
	☐ Macronectes giganteus	Southern Giant-Petrel	E1	1	
Psittacidae					
	☐ Lathamus discolor	Swift Parrot	E1	4	
	☐ Neophema pulchella	Turquoise Parrot	V	1	
Strigidae					
	☐ Ninox connivens	Barking Owl	V	6	
	☐ Ninox strenua	Powerful Owl	V	14	

Amphibia	Map Scientific Name	Common Name	Legal Status	Count	Info
Myobatrachidae					
	☐ Heleioporus australiacus	Giant Burrowing Frog	V	12	
	☐ Pseudophryne australis	Red-crowned Toadlet	V	7	

Mammalia	Map Scientific Name	Common Name	Legal Status	Count	Info

Balaenidae					
	☐ Eubalaena australis	Southern Right Whale	V	5	
Balaenopteridae					
	☐ Megaptera novaeangliae	Humpback Whale	V	2	
Burramyidae					
	☐ Cercartetus nanus	Eastern Pygmy-possum	V	7	■
Dasyuridae					
	☐ Dasyurus maculatus	Spotted-tailed Quoll	V	7	■
Otariidae					
	☐ Arctocephalus pusillus doriferus	Australian Fur-seal	V	1	
Peramelidae					
	☐ Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E1	21	
Petauridae					
	☐ Petaurus norfolcensis	Squirrel Glider	V	1	■
Phascolarctidae					
	☐ Phascolarctos cinereus	Koala	V	86	■
Pteropodidae					
	☐ Pteropus poliocephalus	Grey-headed Flying-fox	V	14	■
Vespertilionidae					
	☐ Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	9	
	☐ Scoteanax rueppellii	Greater Broad-nosed Bat	V	1	■

Reptilia	Map Scientific Name	Common Name	Legal Status	Count	Info
Cheloniidae					
	☐ Chelonia mydas	Green Turtle	V	4	
Dermochelyidae					
	☐ Dermochelys coriacea	Leathery Turtle	V	1	
Elapidae					
	☐ Hoplocephalus bungaroides	Broad-headed Snake	E1	1	■
Varanidae					
	☐ Varanus rosenbergi	Rosenberg's Goanna	V	1	

Choose up to 3 species to map.

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APPENDIX 4
EPBC ACT MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE DATABASE SEARCH RESULTS

Australian Government
Department of the Environment and Heritage

Protected Matters Search Tool

You are here: DEH Home > EPBC Act > Search

EPBC Act Protected Matters Report 18 August 2004 17:29

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.deh.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Point

Buffer: 5 km

Coordinates: -33.68114,151.284944

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.deh.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	47
Migratory Species:	32

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the

heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.deh.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.deh.gov.au/epbc/permits/index.html.

Commonwealth Lands:	4
Commonwealth Heritage Places:	None
Places on the RNE:	3
Listed Marine Species:	49
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	3
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information]
(Ramsar Sites)

TOWRA POINT NATURE RESERVE	Within same catchment as Ramsar site

Commonwealth Marine Areas [Dataset Information]

Approval may be required for a proposed activity that is likely to have a significant impact on the environment in a Commonwealth Marine Area, when the action is outside the Commonwealth Marine Area, or the environment anywhere when the action is taken within the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Within 3 Nautical Mile Limit

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Diomedea amsterdamensis Amsterdam Albatross	Endangered	Species or species habitat may occur within area
Diomedea antipodensis	Vulnerable	Species or species habitat may

Antipodean Albatross		occur within area
Diomedea dabbenena Tristan Albatross	Endangered	Foraging may occur within area
Diomedea exulans Wandering Albatross	Vulnerable	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western)	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross	Vulnerable	Species or species habitat may occur within area
Xanthomyza phrygia Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Fishes		
Macquaria australasica * Macquarie Perch	Endangered	Species or species habitat may occur within area
Prototroctes maraena * Australian Grayling	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Heleioporus australiacus * Giant Burrowing Frog	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea * Green and Golden Bell Frog	Vulnerable	Species or species habitat likely to occur within area
Litoria littlejohni * Littlejohn's Tree Frog, Heath Frog	Vulnerable	Species or species habitat likely to occur within area
Mixophyes balbus * Stuttering Frog, Southern Barred Frog (in Victoria)	Vulnerable	Species or species habitat likely to occur within area
Mammals		

Balaenoptera musculus * Blue Whale	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat likely to occur within area
Eubalaena australis * Southern Right Whale	Endangered	Species or species habitat may occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Chelonia mydas * Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Vulnerable	Species or species habitat may occur within area
Hoplocephalus bungaroides * Broad-headed Snake	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population)	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias Great White Shark	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark	Vulnerable	Species or species habitat likely to occur within area
Grevillea caleyi Caley's Grevillea	Endangered	Species or species habitat likely to occur within area
Haloragodendron lucasii Hal	Endangered	Species or species habitat likely to occur within area
Kunzea rupestris	Vulnerable	Species or species habitat likely to occur within area
Melaleuca deanei Deane's Melaleuca	Vulnerable	Species or species habitat likely to occur within area

Microtis angusii	Endangered	Species or species habitat likely to occur within area
Pimelea curviflora var. curviflora	Vulnerable	Species or species habitat likely to occur within area
Tetratheca glandulosa	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Xanthomyza phrygia Regent Honeyeater	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Diomedea amsterdamensis Amsterdam Albatross	Migratory	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross	Migratory	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross	Migratory	Foraging may occur within area
Diomedea exulans Wandering Albatross	Migratory	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross	Migratory	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Migratory	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel	Migratory	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross	Migratory	Species or species habitat may occur within area

Thalassarche cauta Shy Albatross	Migratory	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross	Migratory	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross	Migratory	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross	Migratory	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross	Migratory	Species or species habitat may occur within area
Migratory Marine Species		
Mammals		
Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus * Blue Whale	Migratory	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale	Migratory	Species or species habitat may occur within area
Eubalaena australis * Southern Right Whale	Migratory	Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Reptiles		
Chelonia mydas * Green Turtle	Migratory	Species or species habitat may occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Migratory	Species or species habitat may occur within area
Sharks		
Carcharodon carcharias Great White Shark	Migratory	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area
Other Matters Protected by the EPBC Act		
Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Catharacta skua Great Skua	Listed	Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross	Listed	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross	Listed	Species or species habitat may occur within area

Diomedea dabbenena Tristan Albatross	Listed	Foraging may occur within area
Diomedea exulans Wandering Albatross	Listed	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross	Listed	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross	Listed	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross	Listed	Species or species habitat may occur within area
Thalassarche chlororhynchos Yellow-nosed Albatross, Atlantic Yellow-nosed Albatross	Listed	Species or species habitat may occur within area

Thalassarche impavida Campbell Albatross	Listed	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross	Listed	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross	Listed	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross	Listed	Species or species habitat may occur within area
Fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus abdominalis Eastern Potbelly Seahorse, New Zealand Potbelly, Seahorse, Bigbelly Seahorse	Listed	Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse	Listed	Species or species habitat may occur within area
Histiogamphelus briggsii Briggs' Crested Pipefish, Briggs' Pipefish	Listed	Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish	Listed	Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish	Listed	Species or species habitat may occur within area
Notiocampus ruber Red Pipefish	Listed	Species or species habitat may occur within area
Phyllopteryx taeniolatus Weedy Seadragon, Common Seadragon	Listed	Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
Solenostomus paradoxus Harlequin Ghost Pipefish, Ornate Ghost Pipefish	Listed	Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish	Listed	Species or species habitat may occur within area
Stigmatopora nigra Wide-bodied Pipefish, Black Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus	Listed	Species or species habitat may occur

Double-ended Pipehorse, Alligator Pipefish	within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed — Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish	Listed — Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish	Listed — Species or species habitat may occur within area
Reptiles	
Chelonia mydas * Green Turtle	Listed — Species or species habitat may occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Listed — Species or species habitat may occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed — Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status — Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean — Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean — Species or species habitat may occur within area
Balaenoptera musculus * Blue Whale	Cetacean — Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale	Cetacean — Species or species habitat may occur within area
Delphinus delphis Common Dolphin	Cetacean — Species or species habitat may occur within area
Eubalaena australis * Southern Right Whale	Cetacean — Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean — Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin	Cetacean — Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Cetacean — Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Cetacean — Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean — Species or species habitat may occur within area
Tursiops aduncus Spotted Bottlenose Dolphin	Cetacean — Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean — Species or species habitat may occur within area
Commonwealth Lands [Dataset Information]	
Communications, Information Technology and the Arts - Australian Postal Corporation	
Communications, Information Technology and the Arts - Telstra Corporation Limited	

Defence - Defence Housing Authority

Unknown

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

Narrabeen Rock Pool NSW

Natural

Ku-ring-gai Chase National Park (1980 boundary) NSW

Long Reef Barrenjoey Coastal Rocks NSW

Extra Information

State and Territory Reserves [Dataset Information]

Garigal National Park, NSW

Ku-ring-gai Chase National Park, NSW

Narrabeen Aquatic Reserve, NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. Environment Australia acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCLIM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated:

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GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

APPENDIX 5
SITE ASSESSMENT METHODOLOGY

Vegetation Survey

The following tasks were completed during the specific vegetation survey:

- Designating plant communities based on the methodology set out by Walker & Hopkins (1990);
- Conducting searches for significant plants and plant communities (as listed by the EPBC Act and TSC Act);
- Compiling a plant species list; and
- Assessing the condition of the vegetation relative to its likely original floristic structure and composition.

Fauna Survey

A fauna habitat assessment[1] was conducted to determine the site's habitat values. Specific searches were conducted for the following features:

- Areas with a dense understorey which are favoured by small terrestrial mammals;
- Wetlands, streams and other features of importance for aquatic and semi-aquatic fauna, including ephemeral soaks and ponds;
- Caves, culverts, trees containing large and small hollows and other similar structures. Such features are used as roost or nest sites by a range of species;
- Key sites for herpetofauna, in particular rocky outcrops with sheets of exfoliating rock, surrounded by intact vegetation;
- Typically prominent nests of Raptors;
- Artificial structures and debris which provide shelter sites for herpetofauna and small terrestrial mammals;
- Specific feed tree species (ie Forest red gum for Koalas) and signs of activity (scats, chewed seed cones etc);
- Insect and blossom producing habitats; and
- Rainforest habitats.

In addition, targeted field survey was completed on the Subject Site, including the following methods:

- Active searches for reptiles were completed on rocky outcrops at the development/bushland interface;
- Diurnal bird survey was completed during a walk through of all site habitats, and from a high vantage point overlooking the site;
- Active searches of waterway habitats for amphibians and amphibian larvae;
- Random faecal pellet searches under mature Eucalypts; and
- General scat, track and scratch searches whilst traversing the site.

[1] Habitats occupied by the various threatened species are outlined in the National Parks & Wildlife Service Threatened Species Profiles and in habitat summaries on the Wildlife Atlas. Reference was also made to a wide range of standard texts.

APPENDIX 6
DESCRIPTION OF THREATENED PLANTS IN PITTWATER LGA
(EXTRACT FROM SMITH & SMITH 2000)

Management Issues:

- Beach dune management.
- Control of Bitou Bush control.
- Translocation (as an alternative to conservation *in situ*).
- Community education.
- Lack of knowledge of the species (in particular, the specific locations where it occurs in Pittwater).
- Recovery plan (no plan has yet been prepared for this species).

2.3.2 *Grevillea caleyi* (Caley's Grevillea)

Family: Proteaceae

Conservation Status: Endangered species in NSW (TSC Act). Also listed as an endangered species at national level in the Endangered Species Protection Act.

Distribution: *Grevillea caleyi* occurs in northern Sydney over an area of approximately 6 x 6 km which is centred on Terrey Hills and also includes parts of Duffys Forest, Belrose and Ingleside. Within this distribution some 20 stands of *Grevillea caleyi*, remnants of former populations, persist (Scott *et al.* 1995, as updated 2000). Only five of these stands occur within, or partly within, National Parks and Wildlife Service lands: three in Ku-ring-gai Chase National Park and two in the eastern section of Garigal National Park.

Pittwater Population: *Grevillea caleyi* occurs at Ingleside in the vicinity of the Baha'i Temple. The population here extends into both the Pittwater and Warringah Local Government Areas, with plants growing on privately owned land, land owned by the Roads and Traffic Authority and the Department of Land and Water Conservation, as well as in Garigal National Park. The population at this site is disturbed and fragmented by land clearing for the Baha'i Temple, a carpark, residential properties and Mona Vale Road, which bisects the habitat. Six months after the January 1994 fires, the section of the population within the Pittwater Council area numbered some 281 live adults, 544 dead adults and 428 seedlings on the north-western side of Mona Vale Road, and several plants in the vicinity of Powder Works Road (Scott *et al.* 1995). The section of the population in Garigal National Park numbered an estimated 1400 seedlings in Garigal National Park on the south-eastern side of Mona Vale Road. The latter have now grown to maturity and formed a good-sized stand of adult plants.

Specimens at the National Herbarium of New South Wales, Royal Botanic Gardens Sydney, show that *Grevillea caleyi* has been present around the Baha'i Temple since at least 1963. Other specimens at the herbarium suggest that the species was once more widespread in Pittwater. However, the localities given for these specimens are imprecise and it is unclear whether they were collected in Pittwater or Warringah: specimens from 'Pittwater Road' collected in 1914 and 1917, and a specimen from 'Elanora Heights-Collaroy' collected in 1950.

Habitat: Typically, *Grevillea caleyi* grows on iron-rich lateritic soils on ridgetops (170-240 m above sea level). It is usually found in open-forest vegetation, generally dominated by Silvertop Ash *Eucalyptus sieberi* and Red Bloodwood *Corymbia gummifera* (Scott *et al.* 1995). This community, known as the Duffys Forest Vegetation Community, is listed as an endangered ecological community and is discussed below in section 2.6.1. *Grevillea caleyi* is

also occasionally found in more typical Hawkesbury Sandstone ridgetop vegetation, low woodland of Red Bloodwood and Broad-leaved Scribbly Gum *Eucalyptus haemastoma.* One stand is located in Hawkesbury Sandstone gully forest, dominated by Sydney Red Gum *Angophora costata* and Sydney Peppermint *Eucalyptus piperita*, but the species appears to have been introduced to this site, rather than a natural occurrence.

Ecology: *Grevillea caleyi* is an open, spreading shrub that may grow to about 4 m high and 4 m across. It does not usually flower and produce seeds before 2.5-5 years of age (Scott *et al.* 1995). Flowers are produced sporadically throughout the year with a peak flowering period in late winter and spring. The large 'toothbrush' flowers appear to be bird pollinated and may be self compatible. Fruit maturation takes 2-3 months. Usually one large seed is produced per fruit. Fecundity is low with only about 3% of flowers resulting in seed. As individual plants age they produce more flowers and fruit. Seed dispersal is minimal. Upon maturity the fruits dehisce, dropping the seed to the ground beneath the parent plant. The viability of seeds is high and most are released in a dormant state. Through time there is a slow loss of dormancy resulting in a fluctuating trickle of germination, though most seedlings do not survive in the undisturbed environment. Seeds are predated at the fruit stage by weevils and then on the ground after seeds are shed by Bush Rats and Swamp Wallabies. Adult plants senesce from 12-15 years onwards.

Grevillea caleyi is fire-sensitive and relies on germination from a soil seedbank to recover after fire. Seedlings are common after fire, or in open disturbed places. The seed dormancy mechanism is not fully understood and it is unclear how fire promotes germination. During the 1994 fires, some 60% of the total habitat of *Grevillea caleyi* was burnt and many population fragments now consist solely of plants that have germinated since the fires. The number of plants in a population may thus fluctuate widely over short periods of time in response to fire or adult senescence. It takes some 8-12 years for the soil seedbank to reach a sufficient level to replace a population and so it is critical that the interval between successive fires is not less than 8-12 years at a site. Repeated fires at intervals of less than eight years may lead to the local extinction of *Grevillea caleyi* from a site. In sites unburnt for more than 15 years adult senescence may result in marked declines of the soil seedbank unless high levels of fecundity are maintained (Scott *et al.* 1995).

Management Issues:

- Recovery plan - a plan has been prepared (Scott *et al.* 1995) and a recovery team established, on which Pittwater Council is represented, to implement the plan. A new recovery plan is in preparation to comply with the requirements of the Threatened Species Conservation Act.
- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management (as discussed above, fire is a major factor in the *Grevillea caleyi* life cycle).
- Preservation of remnant individuals in urban areas.
- Loss of genetic integrity through hybridisation with planted *Grevillea* species.
- Translocation (as an alternative to conservation *in situ*).
- Unauthorised collection of plant material.
- Community education.
- Lack of knowledge of the species (the species is relatively well known compared with other threatened plants in the area, but there are still gaps in our knowledge).

2.3.3 *Microtis angusii* (Angus's Onion Orchid)

Family: Orchidaceae

Conservation Status: Endangered species in NSW (TSC Act). Also listed as an endangered species at national level in the Endangered Species Protection Act.

Distribution: *Microtis angusii*, which was first discovered in 1987, and formally described and named in 1996 (Jones 1996), is known from just two widely disjunct sites, one at Ingleside and the other at Sunny Corner State Forest, 100 km west of Sydney (National Parks and Wildlife Service 1999b).

Pittwater Population: The Ingleside population is located within the Mona Vale Road road reserve at the junction of the Pittwater and Warringah Local Government Areas. In September 1998 a total of 336 plants were counted at this site (National Parks and Wildlife Service 1999b).

Habitat: The natural habitat of this orchid is unknown as both confirmed locations are highly disturbed. The Ingleside population occurs in a ridgetop site that has been cleared of its original vegetation, used as a soil depot and vehicle parking site, and the dominant species at the site are now introduced weeds (*Acacia saligna* and *Hyparrhenia hirta*). It is possible that *Microtis angusii* may have been transported to the site as seeds within dumped soil (National Parks and Wildlife Service 1999b). The most likely natural habitat of *Microtis angusii* in the Pittwater-Warringah area is the Duffys Forest Vegetation Community, which has been listed as an endangered ecological community and is discussed below in section 2.6.1.

Ecology: *Microtis angusii* is a terrestrial orchid. For most of the year it is present only as underground tubers. It produces leaves and then flowering stems usually in late winter and spring (National Parks and Wildlife Service 1999b). Flowers have been recorded from May to October (Jones 1996). Other *Microtis* species flower prolifically after fires, and the same is probably true of *M. angusii*. *Microtis* flowers mature from the bottom of the inflorescence to the top, and the capsules at the bottom of the inflorescence may have released their seed before the flowers at the top have opened. By summer the above ground parts have withered and there is no visible evidence of the species.

Most *Microtis* species reproduce vegetatively by the formation of 'daughter' tubers from the main tuber, and can produce huge clonal colonies this way (Bates 1986). It is likely that *M. angusii* reproduces vegetatively in the same manner. Other *Microtis* species have been reported to use a 'three chance' system for reproduction from seed. That is, they produce seeds through the use of insects as pollination vectors, self fertilisation (autogamy) or production of seed without pollination (apomixis). However, not all species are capable of autogamy or apomixis.

M. angusii produces large quantities of minute seeds (Jones 1996), but little is known about seed production, dispersal, germination and recruitment in the species. It may be that the species reproduces primarily by vegetative means and that seed production is relatively unimportant (National Parks and Wildlife Service 1999b). It is unclear at this stage what factors trigger germination in *Microtis angusii*, or what level of seedling recruitment occurs. The time from germination to flowering is usually less than twelve months in *Microtis* species (National Parks and Wildlife Service 1999b).

Management Issues:

- Recovery plan - a draft plan has been prepared (National Parks and Wildlife Service 1999b).
- Lack of knowledge of the biology and ecology of the species.
- Fire management (fire is likely to be an important factor in the life cycle, but the most appropriate fire regime for the species is unknown).
- Habitat degradation (the only known site in Pittwater has been severely and repeatedly disturbed, and some level of disturbance, natural or otherwise, may be beneficial in promoting reproduction in the species, but other forms of disturbance are likely to be detrimental, such as soil compaction, rubbish dumping and overgrowth by weeds).
- Translocation (as an alternative to conservation *in situ*).
- Unauthorised collection of plant material (as a rare orchid, *Microtis angusii* is a possible target for unscrupulous orchid collectors).
- Community education.

2.3.4 *Persoonia hirsuta* (Hairy Geebung)

Family: Proteaceae

Conservation Status: Endangered species in NSW (TSC Act). Also listed as an endangered species at national level in the Endangered Species Protection Act.

Distribution: *Persoonia hirsuta* comprises two subspecies: *hirsuta* (narrower leaves with revolute margins) and *evoluta* (wider leaves with recurved margins). Both are considered to be endangered. Subspecies *hirsuta* grows along the coast from Gosford to Royal National Park, while subspecies *evoluta* extends from the Putty district west to Glen Davis and south to Hilltop. The subspecies intergrade extensively from the lower Blue Mountains to within 15 km of the coast (Harden 1991). The species has a very patchy distribution within its overall range, occurring as tiny populations in widely scattered locations.

Pittwater Population: The only record for the Pittwater Council area is from the vicinity of the Baha'i Temple at Ingleside (Scott 1995). A single plant was found here during a survey for *Grevillea caleyi* in 1994 (T. Auld pers. comm.). Another single plant was found during the 1994 *Grevillea caleyi* surveys about 2.5 km west of the Baha'i Temple at Tumbledown Dick Hill in Warringah. The latter plant has since been destroyed by human disturbance. The species has also been recorded in Ku-ring-gai Chase National Park, but not in Garigal National Park (NSW Scientific Committee 1998d).

Habitat: Typically grows in woodland or scrub/heath on sandstone, often where there is a clay influence at a shale/sandstone ecotone (James 1997). At both the Baha'i Temple and Tumbledown Dick Hill, the species was growing in the Duffys Forest Vegetation Community on lateritic soils associated with shale lenses within Hawkesbury Sandstone. This community has been listed as an endangered ecological community and is discussed below in section 2.6.1.

Ecology: *Persoonia hirsuta* is a spreading shrub that grows to about 1 m high, but may spread out over 2-3 m. At most of its known locations the population consists of only one to three plants (plus seeds in the soil seedbank), with the exception of two locations in the Baulkham Hills Local Government Area, where there are 10-20 plants (NSW Scientific Committee 1998d). There is evidence of a continued decline in the number of locations and the number

of individuals, and the species is particularly prone to local population extinctions because of the small number of plants found at all locations. The general ecology of the species and the requirements for successful reproduction are poorly known. Flowers are produced in November-January (Robinson 1994). The small population sizes suggest that the seeds germinate and successfully grow to maturity only under certain conditions, such as after a fire or other disturbance.

Management Issues:

- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Lack of knowledge of the biology and ecology of the species.
- Fire management (fire is likely to be an important factor in the life cycle, but the most appropriate fire regime for the species is unknown).
- Bushrock removal - identified as adversely affecting this species by NSW Scientific Committee (1999a).
- Preservation of remnant individuals in urban areas.
- Translocation (as an alternative to conservation *in situ*).
- Unauthorised collection of plant material.
- Community education.
- Recovery plan (no plan has yet been prepared for this species).

2.4 Vulnerable Fauna Species

2.4.1 Giant Burrowing Frog (*Heleioporus australiacus*)

Another common name for the species is Eastern Owl Frog.

Family: Myobatrachidae

Conservation Status: Vulnerable species in NSW (TSC Act). Also listed as a vulnerable species at national level in the Endangered Species Protection Act.

Distribution: The Giant Burrowing Frog occurs on the coast and ranges from central New South Wales to eastern Victoria (Cogger 1992). It is more patchily distributed to the south of Jervis Bay than to the north (Ehmann 1997).

Pittwater Population: The Giant Burrowing Frog has been recorded recently in the upper reaches of Narrabeen Creek and Fern Creek, Ingleside (Ecotone Ecological Consultants1993, White 1994), and on the track at the entrance to Ingleside Reserve (observed by M. Turton in 1996).

Habitat: In the Sydney region, the Giant Burrowing Frog occurs in eucalypt forest, woodland and heathland, usually on Hawkesbury Sandstone (Ehmann 1997). It breeds in burrows in the banks of small, densely vegetated creeks and drainage lines. Out of the breeding season, the frogs may disperse hundreds of metres away onto the nearby ridges. They usually spend the day in burrows, but also shelter under fallen logs and in dense undergrowth (Cogger 1992, White 1994). Like most frogs, they are most active during or directly after rain. In Pittwater, Giant Burrowing Frogs are most likely to be found in bushland on sandstone plateaus, ridges

Pittwater Population: The Greater Broad-nosed Bat was recorded at Bilgola in July 1982 (Long 1983) and at Deep Creek Reserve in February/March 1996 (Turton 1996).

Habitat: The species occurs in a variety of habitats, including dry and wet eucalypt forest and woodland, and rainforest, but apparently prefers moist gully forests (Churchill 1998). It usually roosts in tree hollows (chiefly eucalypts), but has also been recorded in the roof spaces of old buildings (Hoye and Richards 1995). It is believed to be dependent on mature forest on soils of high fertility (Braithwaite *et al.* 1993)

Feeding: The species has a varied insectivorous and carnivorous diet. Its flight is slow and direct, with poor manoeuvrability. It feeds on slow-flying prey such as large moths and a variety of beetles (Churchill 1998). It regularly consumes other bat species, at least in bat traps (Gilmore and Parnaby 1994). In dense vegetation it forages along natural and man-made flyways such as roads. Creeks and small rivers are favoured corridors where the species hawks backwards and forwards for prey, sometimes within 1 m of water. It also hunts at forest edges (Hoye and Richards 1995).

Breeding: Prior to birth, females congregate at maternity sites, located in suitable tree hollows, where males appear to be excluded during the birth and raising of the young. The single young is born in January (Hoye and Richards 1995).

Management Issues:

- Conservation of remnant bushland.
- Tree preservation in urban areas.
- Wildlife corridors.
- Habitat degradation in remnant bushland.
- Fire management.
- Rehabilitation of sick, injured or orphaned animals.
- Community education.
- Lack of knowledge of the species.
- Recovery plan (no plan has yet been prepared for this species).

2.5 Vulnerable Flora Species

2.5.1 *Eucalyptus camfieldii* (Heart-leaved Stringybark)

Family: Myrtaceae

Conservation Status: Vulnerable species in NSW (TSC Act). Also listed as a vulnerable species at national level in the Endangered Species Protection Act

Distribution: Rare and localised, usually in coastal scrub or heath, from Norah Head south to Bulli Pass and west to Peats Ridge and Hornsby. It has been recorded in Brisbane Water, Ku-ring-gai Chase, Royal and Sydney Harbour National Parks (Briggs and Leigh 1996).

Pittwater Population: As yet, not recorded in the Pittwater Council area. However, it occurs just outside the area in Ku-ring-gai Chase National Park, west of Elvina Bay (Lembit 1997,

Atlas of NSW Wildlife). It is a potential inhabitant of ridges and plateaus on Hawkesbury Sandstone geology in the western and southern parts of Pittwater.

Habitat: *Eucalyptus camfieldii* is found on sandstone ridgetops with shallow, low-nutrient soils, often where drainage is restricted. Soils are sandy or loamy, often lateritic. Typically these ridgetops support heath which includes species such as *Allocasuarina distyla*, *Angophora costata*, *A. hispida*, *Banksia oblongifolia*, *Corymbia gummifera*, *Eucalyptus haemastoma*, *E. oblonga*, *E. sieberi* and *Leptospermum trinervium* (Pryor 1981, Benson and McDougall 1998).

Ecology: *Eucalyptus camfieldii* is a mallee or small tree that is usually only 3-5 m high, although the bigger specimens may reach about 10 m (Pryor 1981, Benson and McDougall 1998). The plants live for more than 100 years and develop extensive lignotubers which may be up to 25 m across. What appears to be a large number of plants may be only one or a few individuals, and consequently population sizes are difficult to measure. The flowering period is variable and extends between April and December. The woody seed capsules are retained for up to one year before the seed is shed. Seed is dispersed locally by wind or gravity and there is no dormancy mechanism. Seeds are able to germinate without treatment, but seedlings are rarely reported. Following fire the species resprouts from the lignotuber and epicormic buds. Plants at North Head during the 1980's appeared to be dying in the absence of fire (30 years unburnt) due to competition from taller vegetation (Benson and McDougall 1998).

Management Issues:

- Lack of knowledge of the species in Pittwater (likely to occur in the area, but no known sites).
- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management.
- Bushrock removal - identified as adversely affecting this species by NSW Scientific Committee (1999a).
- Preservation of remnant individuals in urban areas.
- Translocation (as an alternative to conservation *in situ*).
- Unauthorised collection of plant material.
- Community education.
- Recovery plan (no plan has yet been prepared for this species).

2.5.2 *Pimelea curviflora* variety *curviflora* (Curved Rice-flower)

Family: Thymelaeaceae

Conservation Status: Vulnerable species (variety *curviflora* only) in NSW (TSC Act). Variety *curviflora* is also listed as vulnerable at national level in the Endangered Species Protection Act.

Distribution: *Pimelea curviflora* is a widespread species in which seven varieties have been distinguished (Threlfall 1983). The species is endemic to Australia and is found in all states. Six of the seven varieties occur in New South Wales (Harden 1990). Some of the varieties are common, but variety *curviflora* is restricted to the northern suburbs of Sydney and is rare

even within its restricted distribution. It is currently known from about 20 locations between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville (NSW Scientific Committee 1998e). Its former range extended south to the Parramatta River and Port Jackson, including Five Dock, Bellevue Hill and Manly.

Pittwater Population: As yet, *Pimelea curviflora* var. *curviflora* has not been recorded in the Pittwater Council area. However, it occurs just south of the area on the southern side of Narrabeen Lagoon (Smith and Smith 1995). In view of this, it is a species that should be targeted in future threatened flora surveys in Pittwater.

Habitat: In Warringah, *Pimelea curviflora* var. *curviflora* is mainly found in the Duffys Forest Vegetation Community (Smith and Smith 1997b, 2000). This community is associated with shale lenses on ridges in Hawkesbury Sandstone geology. It has been listed as an endangered ecological community and is discussed below in section 2.6.1. The population on the southern side of Narrabeen Lagoon is an exception, being found in Angophora Woodland, a Hawkesbury Sandstone community dominated by *Angophora costata* and found on ridges and slopes in the vicinity of coastal lagoons and estuaries (Smith and Smith 1995, 1997b). This community, like the Duffys Forest Vegetation Community, is a taller vegetation type than is typical of Hawkesbury Sandstone ridges, and appears to associated with more fertile conditions.

Ecology: *Pimelea curviflora* var. *curviflora* is a spindly, inconspicuous subshrub or shrub, mostly under 50 cm high. It may not always be visible at a site as it appears to survive for some time without any foliage after fire or grazing, relying on energy reserves in its tuberous roots (NSW Scientific Committee 1998e). Little is known of its ecological requirements.

Management Issues:

- Lack of knowledge of the species in Pittwater (likely to occur in the area, but no known sites).
- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management.
- Bushrock removal - identified as adversely affecting this species by NSW Scientific Committee (1999a).
- Translocation (as an alternative to conservation *in situ*).
- Community education.
- Recovery plan (no plan has yet been prepared for this species).

2.5.3 *Syzygium paniculatum* (Magenta Lillypilly)

Family: Myrtaceae

Conservation Status: Vulnerable species in NSW (TSC Act). Also listed as a vulnerable species at national level in the Endangered Species Protection Act.

Distribution: Grows naturally at widely separated localities in coastal areas between Bulahdelah and Jervis Bay (Harden 1991). It has been recorded in Booti Booti National Park, Myall Lakes National Park, Wamberal Lagoon Nature Reserve, Wyrrabalong National Park, Captain Cooks Landing Place Historic Site and Jervis Bay National Park (Briggs and Leigh

1996). Although rare in the wild, it is a popular ornamental species and is widely cultivated in the Sydney region (Benson and McDougall 1998). There may be some confusion over the name *Syzygium paniculatum* because in the past it was also applied to another, more common species now known as *Syzygium australe* (Brush Cherry), e.g. Floyd (1979).

Pittwater Population: In Pittwater, reported from Browns Bay (Cunningham 1994a), Scotland Island (Cunningham 1994a), Irrawong Reserve (Cunningham 1994b), and Hillside Road, Newport (Burcher 1999).

Habitat: *Syzygium paniculatum* typically grows in littoral (beach) rainforest on coastal sand dunes or in gallery (watercourse) rainforest on alluvial soils (Benson and McDougall 1998). However, it also grows in other rainforest types and in wetter eucalypt forest types. At Irrawong Reserve, it grows in alluvial Swamp Mahogany *Eucalyptus robusta* forest along Mullet Creek (Cunningham 1994b). Elsewhere in Pittwater it has been recorded growing on moist slopes on Narrabeen Group geology.

Ecology: *Syzygium paniculatum* varies in size from a shrub to a medium-sized tree. The trees live for 75-200 years. They produce flowers in December-January and are able to self-pollinate. Fruits are purple fleshy berries. Trees fruit irregularly, perhaps every second year. Fruits are dispersed locally by gravity and possibly more widely by birds and mammals, such as the Pied Currawong and Grey-headed Flying Fox, both of which are known to eat the fruit. Each fruit can produce multiple seedlings. Seeds are viable for less than three months and germinate readily without treatment. Seedlings found under adult plants are possibly short-lived. *Syzygium paniculatum* tolerates shade but needs light for regeneration. Trees may be killed by wildfire or may resprout from the base or epicormic shoots (Benson and McDougall 1998).

Management Issues:

- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management.
- Preservation of remnant individuals in urban areas.
- Translocation (as an alternative to conservation *in situ*).
- Loss of genetic integrity of the Pittwater population through interbreeding with planted specimens from other regions.
- Unauthorised collection of plant material.
- Community education.
- Lack of knowledge of the species.
- Recovery plan (no plan has yet been prepared for this species).

2.5.4 *Tetratheca glandulosa* (Glandular Pink-bell)

Family: Tremandaceae

Conservation Status: Vulnerable species in NSW (TSC Act). Also listed as a vulnerable species at national level in the Endangered Species Protection Act.

Distribution: *Tetratheca glandulosa* is endemic to the Sydney region, where it is restricted to the area between Mangrove Mountain and Port Jackson (Harden 1992).

Pittwater Population: *Tetratheca glandulosa* has been recorded from six locations in the Pittwater Council area during the last few years, all at Ingleside (appendix, Map 4). It has also been recorded in both Ku-ring-gai Chase National Park (Thomas and Benson 1985) and Garigal National Park (Sheringham and Sanders 1993).

Habitat: *Tetratheca glandulosa* usually grows on Hawkesbury Sandstone ridges and plateaus in eucalypt woodland, scrub and heath on sandy or rocky soils. James (1997) found that in western Sydney it was often associated with the sandstone/shale interface where soils have a stronger clay influence. In the Warringah-Pittwater area, it is sometimes found in the endangered Duffys Forest Vegetation Community, which is associated with shale lenses in Hawkesbury Sandstone, but occurs more often in other Hawkesbury Sandstone ridgetop woodland and heath communities (Smith and Smith 1997b, 2000).

Ecology: *Tetratheca glandulosa* is a spindly, inconspicuous subshrub 20-50 cm high. It flowers mainly between July and November (Harden 1992). The species is fire sensitive, that is adult plants are killed by fire and regenerate after fire only from seed (Sheringham and Sanders 1993). Species from the same genus, *T. ericifolia* and *T. shiressii*, took three to four years to flower following a fire in Brisbane Water National Park (Benson 1985).

Management Issues:

- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management (too frequent fires may exhaust the soil seedbank before it can be replenished, and thus eliminate the species from a site).
- Bushrock removal - identified as adversely affecting this species by NSW Scientific Committee (1999a).
- Translocation (as an alternative to conservation *in situ*).
- Unauthorised collection of plant material.
- Community education.
- Lack of knowledge of the species.
- Recovery plan (no plan has yet been prepared for this species).

2.6 Endangered Ecological Communities

2.6.1 Duffys Forest Vegetation Community

Conservation Status: Endangered ecological community in NSW (TSC Act). The final determination (NSW Scientific Committee 1998f) identifies the community as occurring in the Pittwater, Warringah and Ku-ring-gai Local Government Areas.

Description: The community is an open-forest or woodland varying in height from about 11 m to 22 m (Smith and Smith 2000). The main tree species are *Corymbia gummifera* (Red Bloodwood), *Eucalyptus sieberi* (Silvertop Ash), *Angophora costata* (Sydney Red Gum) and *Eucalyptus capitellata* (Brown Stringybark). However, not all of these occur in every stand, and other tree species may also be present. Common species in the shrub layer include *Acacia myrtifolia, Banksia spinulosa, Bossiaea obcordata, Pultenaea elliptica, Ceratopetalum gummiferum, Dillwynia retorta, Platysace linearifolia, Epacris pulchella, Boronia pinnata, Pimelea linifolia, Grevillea linearifolia, Hakea sericea, Pultenaea daphnoides, Pultenaea*

polifolia and *Lasiopetalum ferrugineum*. Common species in the ground layer include *Entolasia stricta, Micrantheum ericoides, Cyathochaeta diandra, Pteridium esculentum, Stipa pubescens, Tetrarrhena juncea, Lomandra obliqua, Themeda australis, Patersonia glabrata* and *Imperata cylindrica*. Not all of the above are present at every site.

A taller form of the community (18-26 m) occurs in the best sites and is characterised by the presence of *Eucalyptus pilularis* (Blackbutt) and/or *Syncarpia glomulifera* (Turpentine). However, this form of the community does not appear to be represented in Pittwater.

Distribution: The Duffys Forest Vegetation Community has a discontinuous distribution from Duffys Forest south to Seaforth, with a few outlying patches west to Pennant Hills Park and east to Bilgola Plateau. The total remaining area of the community is 236.5 ha, consisting of 94.3 ha in Ku-ring-gai Chase National Park, 19.3 ha in Garigal National Park, 3.2 ha in Lane Cove National Park, 103.5 ha in Warringah, 12.2 ha in Ku-ring-gai, 0.3 ha in Manly and 3.7 ha in Pittwater (Smith and Smith 2000). The original extent of the community has been estimated at about 1450 ha. Thus, only some 16% now remains.

Only two small stands of the Duffys Forest Vegetation Community are known in the Pittwater Council area (Map 5). One is a fragmented area of about 1.8 ha around the Baha'i Temple at Ingleside (a further 1.5 ha occurs here on the other side of Mona Vale Road in Garigal National Park). The other is an area of about 1.8 ha in Plateau Park, Bilgola.

Habitat: The Duffys Forest Vegetation Community is found on Hawkesbury Sandstone ridges, generally occurring where there are shale lenses and lateritic soils (NSW Scientific Committee 1998f, Smith and Smith 2000). Lateritic soils are characterised by a layer of ironstone gravel overlying a pallid, clayey zone of iron depletion. Sandstone outcrops are usually absent from stands of the community, although they may be present on the fringes. The greater height and grassiness of the Duffys Forest Vegetation Community indicates that the soils on which it develops are more fertile than those associated with typical Hawkesbury Sandstone ridge vegetation. Stands of the community generally occur on the tops of the ridges, upslope of other Hawkesbury Sandstone communities. However, Duffys Forest vegetation may also occur in a band downslope of other sandstone vegetation (although still in a ridge rather than a gully situation). This presumably reflects the presence of a shale lens, with sandstone layers both above and below.

Ecology: As is typical of most vegetation communities, the species composition of the Duffys Forest Vegetation Community varies from site to site, depending on local environmental factors and the past history of the site. At a given site the species composition is likely to vary over time in response to fire and other disturbances. Woody species found within the community include ones that regenerate vegetatively after fire (resprouters) and ones that are killed by fire and regenerate from the soil seedbank (obligate seeders). A number of the species killed by fire require fires for seed germination and establishment - there is generally no recruitment of new plants except after fire. These species will be eliminated from a site if fires are too frequent, preventing them from setting new seed and replenishing the soil seedbank, but will also be eliminated if fires are absent for too long, so that the plants senesce and die without being replaced, and survival of the population is dependent on the longevity of seed in the soil. One such species is *Grevillea caleyi*, an endangered species that is closely associated with the Duffys Forest Vegetation Community. *G. caleyi* requires fires preferably at intervals greater than eight years but less than 15 years (Scott *et al.* 1995). This fire regime is probably the most appropriate for the community as a whole.

Management Issues:

- Conservation of remnant bushland.
- Habitat degradation in remnant bushland.
- Fire management.
- Translocation (as an alternative to conservation *in situ*).
- Community education
- Lack of knowledge of the community.
- Recovery plan (no plan has yet been prepared for this community).

2.6.2 Pittwater Spotted Gum Forest

Conservation Status: Endangered ecological community in NSW (TSC Act). The final determination (NSW Scientific Committee 1998g) identifies the community as being restricted to the Pittwater Local Government Area.

Description: Pittwater Spotted Gum Forest is an open-forest (dieback has thinned some stands to woodland density), about 20-28 m high, dominated by *Corymbia maculata* (Spotted Gum). Other tree species include *Angophora costata, Angophora floribunda, Corymbia gummifera, Eucalyptus botryoides, E. paniculata, E. punctata, E. umbra* and *Syncarpia glomulifera*. Common low trees and shrubs include *Allocasuarina littoralis, A. torulosa, Dodonaea triquetra, Elaeocarpus reticulatus, Glochidion ferdinandi, Livistona australis, Macrozamia communis, Notelaea longifolia, Pittosporum undulatum, Platylobium formosum* and *Polyscias sambucifolia*. Ferns are prominent in the ground layer, especially in more sheltered sites, and include *Adiantum aethiopicum, Calochlaena dubia* and *Pteridium esculentum*. Other common species in the ground layer include *Desmodium rhytidophyllum, Dianella caerulea, Entolasia marginata, E. stricta, Lepidosperma laterale, Lomandra longifolia, Oplismenus aemulus* and *Themeda australis*. Climbers are common, including *Cissus hypoglauca, Geitonoplesium cymosum, Morinda jasminoides, Pandorea pandorana* and *Smilax glyciphylla* (Smith and Smith 1992a, 1992b).

Distribution: Forests dominated by Spotted Gum occur in various locations along the New South Wales coast. However, it is only the form found in the Pittwater Local Government Area that has been listed as an endangered ecological community (NSW Scientific Committee 1998g). This community is restricted to Barrenjoey Peninsula, Scotland Island and the western Pittwater foreshores, from Bayview to Towlers Bay (Map 5).

The major remnants on Barrenjoey Peninsula are within the Pittwater Council reserves, McKay Reserve, Angophora Reserve and Stapleton Park. Smaller remnants are located in some 17 smaller Council reserves and on private lands (Pittwater Council 1997b, Holden 1999). Away from Barrenjoey Peninsula, the largest remnants are on Council and private lands on Scotland Island and in the Elvina Bay/Lovett Bay/Towlers Bay area. Holden (1999) estimated that only about 51 ha of Pittwater Spotted Gum Forest remains in the Pittwater Council area. Thomas and Benson's (1985) vegetation map of Ku-ring-gai Chase National Park shows that the area of the community within the park is tiny, only a couple of hectares. The community does not occur in Garigal National Park (Sheringham and Sanders 1993), nor in the Warringah Council area (Smith and Smith 1997b).

Habitat: Pittwater Spotted Gum Forest is found on the interbedded shale, laminite and sandstone of the Newport Formation of the Triassic Narrabeen Group. The soils formed on the Newport Formation are generally deeper, more clayey and more fertile than those formed

on Hawkesbury Sandstone. Typically, Pittwater Spotted Gum Forest is found on hillslopes, but it may extend into gullies and up onto ridgetops (Holden 1999).

Ecology: As is typical of most vegetation communities, the species composition of Pittwater Spotted Gum Forest varies from site to site depending on local environmental factors and the past history of the site. At a given site the species composition is likely to vary over time in response to fire and other disturbances. The species composition of the understorey also varies within stands according to the aspect and topography. On drier, exposed sites the understorey contains more scleromorphic species, while on wetter, more sheltered sites it tends to be characterised more by ferns and rainforest species.

Some native rainforest species in the understorey of the Pittwater Spotted Gum Forest are actively spreading and becoming much denser within the community, particularly *Glochidion ferdinandi* and *Pittosporum undulatum*, but also *Livistona australis* and *Elaeocarpus reticulatus* (Holden 1999, Smith and Smith 1992a, 1992b). This trend has been linked to increasing nutrient and soil moisture levels from urban runoff, and prolonged absence of major bushfires. Stands of Pittwater Spotted Gum Forest often occur downslope of urban development and are thus particularly prone to impacts from urban runoff. Severe degradation of the community through eucalypt dieback and weed invasion is evident in sites subject to urban runoff (Smith and Smith 1992a, 1992b, Woodlots and Wetlands Pty Ltd 1997).

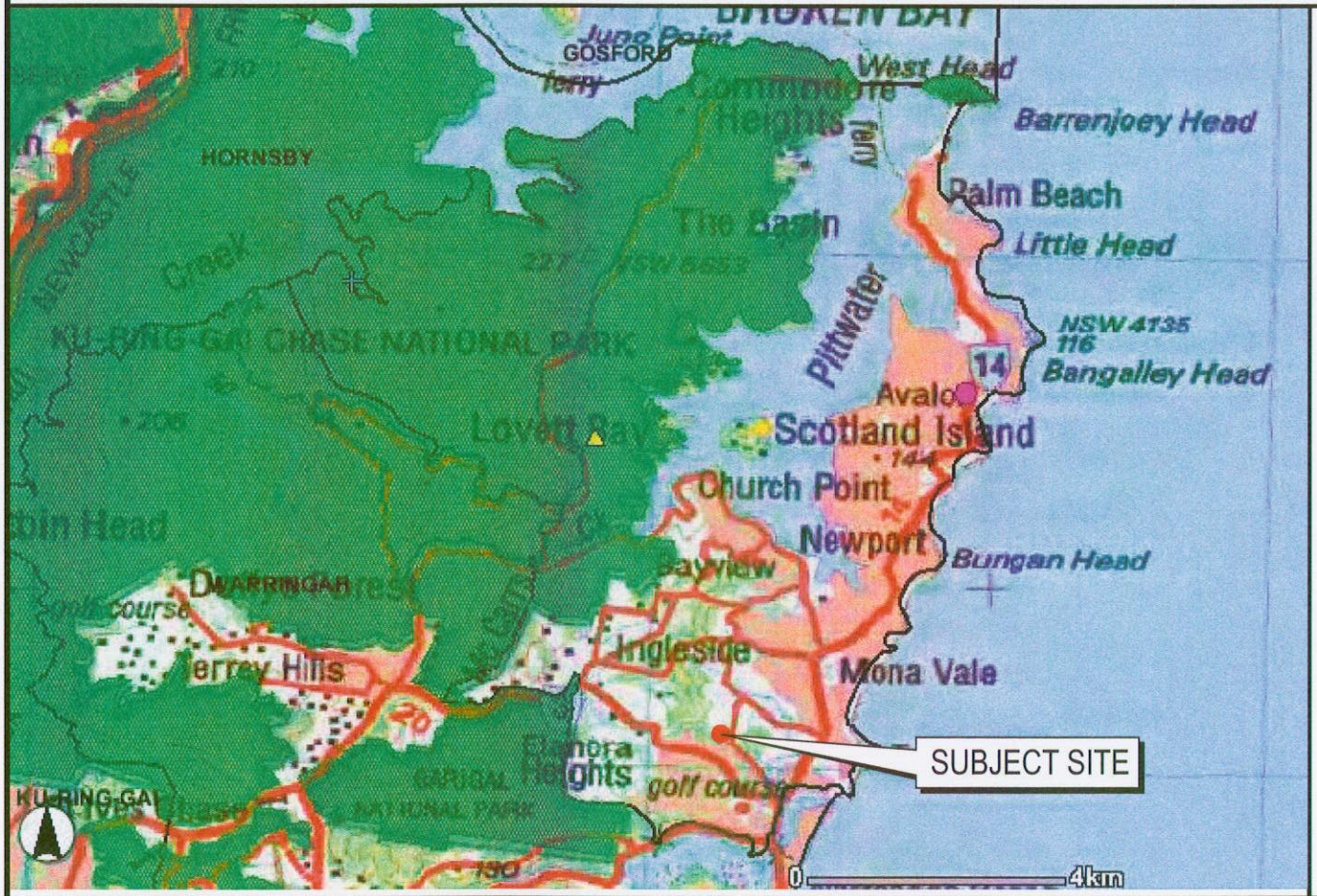
Most areas of Pittwater Spotted Gum Forest, now isolated within urban areas, have not been burnt in a high intensity fire since at least the 1960's (Holden 1999). The long-term absence of fire has been implicated in increases in certain native understorey species. In addition to the rainforest species discussed above, there is also concern over the increasing density of *Allocasuarina* species, especially *A. littoralis*, which are shading out other understorey species and inhibiting regeneration of tree species (Smith and Smith 1992a, 1992b). Species that are short-lived and dependent on fires for successful germination and recruitment from seed, such as many members of the Fabaceae family (peas and wattles), are likely to be eliminated from stands of Pittwater Spotted Gum Forest in the prolonged absence of fire. It is noteworthy that a high intensity pile burn in Spotted Gum Forest in Palmgrove Park resulted in the germination of a number of species of the family Fabaceae from the soil seedbank, species that were previously unknown in the park (Holden 1999).

Management Issues:

- Preservation of remnant bushland.
- Habitat degradation in remnant bushland (Pittwater Spotted Gum Forest shows more evidence of degradation, e.g. eucalypt dieback, weed invasion and increasing dominance of particular native species, than the Duffys Forest Vegetation Community)
- Fire management.
- Translocation (as an alternative to conservation *in situ*).
- Community education
- Lack of knowledge of the community.
- Recovery plan (no plan has yet been prepared for this community).

APPENDIX 7
NPWS MAPS OF THREATENED PLANT LOCATIONS

NPWS - Wildlife Atlas



Legend

- *Chamaesyce psammogeton*
- Heart-leaved Stringybark *Eucalyptus camfieldii*
- *Kunzea rupestris*
- Aboriginal Area
- Historic Site
- National Park
- Nature Reserve
- Regional Park
- State Conservation Area
- Local Government Area
- New South Wales

Map created by WM on August 31, 2004

Search Extent: LGA - PITTWATER

Map Extent: 151.16130, -33.72000, 151.38870, -33.57000

APPENDIX 8
PLANT SPECIES LIST

Warriewood Plant Species List

Family		Botanical Name	Common Name	C1	C2	C3
Agavaceae	*	*Agave vivipara*	Agave		*	
Anacardiaceae	*	*Mangifera indica*	Mango		*	
Apiaceae	*	*Centella asiatica*	Pennywort		*	
Apiaceae	*	*Platysace*		**		
Araceae		*Gymnostachys anceps*	Settler's flax	**		*
Araceae	*	*Monstera deliciosa*	Monsterio		**	
Araceae		*Pothos longipes*	Five-leaf water vine	**		*
Araliaceae		*Astrotricha*			*	*
Araliaceae	*	*Schefflera actinophylla*	Umbrella tree	*	*	*
Araucariaceae	*	*Araucaria heterophylla*	Norfolk Island pine		*	
Arecaceae		*Livistona australis*	Cabbage tree palm	**		
Arecaceae	*	*Syagrus sp.*	Cocos palm		**	
Asparagaceae	*	*Asparagus africanus*	Asparagus fern	*		
Aspleniaceae		*Asplenium australasicum*	Bird nest fern	*		
Asteraceae	*	*Ageratina adenophora*	Crofton weed	**	*	
Asteraceae	*	*Bidens pilosa*	Farmers friends	*	***	
Asteraceae	*	*Conzya albida*	Fleabane	**	***	
Asteraceae	*	*Erechtites valerianifolia*	Brazilian fireweed	*	**	
Asteraceae		*Hypochaeris radicata*	Catsear	*	**	
Asteraceae	*	*Silybum marianum*	Milk thistle	*	*	
Asteraceae	*	*Tagetes minuta*	Stinking Roger	**	***	
Asteraceae	*	*Taraxacum officinale*	Dandelion	*	**	
Basellaceae	*	*Anredera cordifolia*	Madeira vine	*		
Bignoniaceae	*	*Jacaranda mimosifolia*	Jacaranda		*	
Brassicaceae		*Brassica*			**	
Brassicaceae		*Brassica sp.*			**	
Brassicaceae		*Capsella burapastoralis*	Shepherd's purse		**	
Cactaceae	*	*Opuntia sp.*	Prickly pear		*	
Caesalpiniaceae	*	*Senna pendula* var. *glabrata*	Winter senna	**	*	
Cannaceae	*	*Canna indica*	Canna lily	*		
Casuarinaceae		*Allocasuarina littoralis*	Black she-oak	*		***
Casuarinaceae		*Allocasuarina torulosa*	Forest oak	*		**
Commelinaceae	*	*Commelina cyanea*	Scurvy weed	*	*	

Crassulaceae	*	*Bryophyllum delagoense*	Mother-of-millions	*	*	**
Cunoniaceae		*Callicoma serratifolia*	Black wattle	**		
Cunoniaceae		*Ceratopetalum apetalum*	Coachwood	***		
Cunoniaceae		*Ceratopetalum gummiferum*	Christmas bush	***		
Cyatheaceae		*Cyathea cooperi*	Straw treefern	*		
Dasypogonaceae		*Lomandra longifolia*	Spiny-headed mat rush	*		*
Davalliaceae	*	*Nephrolepis cordifolia*	Fishbone fern	*		
Dennstaedtiaceae		*Hypolepis muelleri*	Harsh ground fern	*		
Dennstaedtiaceae		*Pteridium esculentum*	Bracken fern	*	***	***
Dicksoniaceae		*Calochlaena dubia*	Soft bracken			*
Dracaenaceae		*Cordyline rubra*		*		
Dracaenaceae	*	*Sansevieria trifasciata*	Mother-in-law's tongue	*	*	
Elaeocarpaceae		*Elaeocarpus reticulatus*	Blueberry ash			**
Epacridaceae		*Monotoca sp.*				*
Euphorbiaceae		*Breynia*	Coffee bush	*		*
Euphorbiaceae	*	*Euphorbia sp.*	Poinsettia		*	
Euphorbiaceae		*Glochidion ferdinandii*	Cheese tree	**		*
Euphorbiaceae	*	*Ricinus communis*	Castor oil bush	***	*	
Fabaceae		*Acacia longissima*	Narrow leaf wattle			*
Fabaceae	*	*Bauhinia sp.*	-		*	
Fabaceae	*	*Desmodium rhytidophyllum*	-			*
Fabaceae		*Hardenbergia violacea*	Native sarsaparilla			*
Fabaceae		*Kennedia rubicunda*	Red kennedy pea	*		*
Facabeae		*Swainsona sp.*	Swainsona	*	*	
Fumariaceae		*Fumaria sp.*			*	
Lamiaceae		*Clerodendrum floribundum*	Lolly bush	*		*
Lauraceae	*	*Cinnamomum camphora*	Camphor laurel	*		
Lauraceae		*Endiandra sieberi*	Hard corkwood	**		*
Malvaceae	*	*Sida rhombifolia*	Paddy's lucerne		**	
Melastomaceas	*	*Tibouchina sp.*	Tibouchina		*	
Meliaceae		*Synoum muelleri*	Scentless rosewood	**		
Menispermaceae		*Sarcopetalum harveyanum*	Pearl vine	*		*
Menispermaceae		*Stephania japonica* var. *discolor*	Tape vine	**		*

Monimiaceae		*Wilkiea macrophylla*	Large-leaved wilkiea	*			
Moraceae		*Ficus obliqua*	Small-leaved fig	*			
Musaceae	*	*Musa sp.*	Banana	*			
Myrsinaceae		*Rapanea variabilis*	Muttonwood	*			
Myrtaceae		*Acmena hemilampra*	Broad-leaved Lilly pilly	*			
Myrtaceae		*Angophora floribunda*					***
Myrtaceae	*	*Callistemon spp.*	Bottlebrush species			*	
Myrtaceae		*Corymbia gummifera*	Red bloodwood				***
Myrtaceae		*Corymbia intermedia*	Pink bloodwood				***
Myrtaceae		*Eucalyptus botryoides*	Southern mahogany				***
Myrtaceae		*Eucalyptus piperata*	Sydney peppermint				***
Myrtaceae		*Syncarpia glomulifera*	Turpentine	**			***
Oleaceae	*	*Ligustrum sinense*	Small-leaved privet	*			
Oleaceae		*Notelaea venosa*	Smooth mock-olive	*			
Passifloraceae	*	*Passiflora edulis*	Passionfruit vine	*			*
Philesiaceae		*Eustrephus*	Wombat Berry	*		*	*
Philesiaceae		*Geitonoplesium cymosum*	Scrambling Lily	*		*	*
Phormiaceae		*Dianella caerulea*	Blue flax lilly	*			*
Phytolaccaceae	*	*Phytolacca*	Inkweed	*			
Pittosporaceae		*Billardiera*		*			
Pittosporaceae		*Pittosporum revolutum*	Hairy pittosporum	*			
Pittosporaceae		*Pittosporum undulatum*	Sweet pittosporum	*			*
Poaceae	*	*Andropogon virginicus*	Whisky grass			**	
Poaceae	*	*Cortaderia*	Pampas grass			*	
Poaceae		*Cynodon dactylon*	Couch			**	
Poaceae	*	*Bambusa sp.*	Bamboo	***			
Poaceae		*Entolasia sp.*				*	
Poaceae		*Eragrostis curvula*				*	
Poaceae		*Imperata cylindrica*	Blady grass			***	*
Poaceae		*Oplismenus imbecillus*	Basket grass			*	*
Poaceae	*	*Paspalum*	Paspalum			***	
Poaceae	*	*Pennisetum clandestinum*	Kikuyu grass			***	
Poaceae		*Setaria gracilis*				***	
Poaceae		*Stenotaphrum secundatum*	Buffalo grass			***	

Poaceae	*Themeda triandra*	Kangaroo grass		**	*
Polygonaceae	*Persicaria strigosa*		*		
Proteaceae	*Banksia integrifolia*	Coast banksia	*		**
Proteaceae	*Dodonaea triqueta*	Hopbush	*		***
Proteaceae	*Grevillea sp.*	Grevillea species		*	
Proteaceae	* *Macadamia sp.*	Macadamia cultivar		*	
Rosaceae	* *Malus sp.*	Apple		*	
Rubiaceae	*Pomax umbellata*				*
Rutaceae	* *Citrus sp.*	Bush lemon		*	
Rutaceae	*Zieria smithii*	Sandfly zieria		*	
Smilacaceae	*Smilax australis*	Austral sarsaparilla	*		*
Smilacaceae	*Smilax glycophylla*	Sweet sarsaparilla	*		*
Solanaceae	* *Cestrum*			*	
Solanaceae	* *Cestrum parqui*			*	
Solanaceae	* *Solanum americanum*	Blackberry nightshade		**	
Solanaceae	* *Solanum mauritianum*	Wild tobacco	*	*	
Solanaceae	* *Solanum nigrum*	Black	*	**	
Sterculiaceae	*Lasiopetalum ferrugineum*		*		
Tremandaceae	*Tetratheca thymifolia*	Black-eyed Susan	**	**	**
Ulmaceae	*Trema aspera*	Native peach	*	*	
Verbenaceae	*Gmelina*	White beech	*		
Verbenaceae	* *Lantana camara*	Lantana	***	*	*
Verbenaceae	* *Verbena bonariensis*	Purple top	*	***	
Vitaceae	*Cissus hypoglauca*	Water vine	*		
Xanthorrhoeaceae	*Xanthorrhoea sp.*	Grass tree			**

APPENDIX 9
FAUNA LIST

	Scientific Name	Common Name	Habitat		
			Cleared/developed	Riparian	Eucalypt Woodland
Amphibia					
Myobatrachidae	*Crinia signifera*	clicking froglet		*	
Reptilia					
Scincidae	*Cryptoblepharus virgatus*	Wall skink	*		
Scincidae	*Tiliqua scincoides*	eastern blue-tongued lizard	*		
Aves					
Acanthizidae	*Acanthiza lineata*	Striated thornbill		**	
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren		**	
Accipitridae	*Accipiter fasciatus*	brown goshawk	*		
Anatidae	*Chenonetta jubata*	Australian wood duck	*		
Artamidae	*Cracticus nigrogularis*	pied butcherbird	**		
Artamidae	*Gymnorhina tibicen*	Australian magpie	**		
Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo	**	*	
Cacatuidae	*Cacatua sanguinea*	Little Corella			*
Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike	**	**	*
Columbidae	*Geopelia humeralis*	bar-shouldered dove	*		
Columbidae	*Geopelia striata*	peaceful dove	**		
Corvidae	*Corvus coronoides*	Australian Raven	**	**	**
Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		*	

	Scientific Name	Common Name	Habitat		
			Cleared/developed	Riparian	Eucalypt Woodland
Dicruridae	*Dicrurus bracteatus*	spangled drongo		*	
Dicruridae	*Grallina cyanoleuca*	magpie-lark	*	*	*
Dicruridae	*Myiagra rubecula*	Leaden Flycatcher		*	
Dicruridae	*Rhipidura fuliginosa*	grey fantail		**	*
Dicruridae	*Rhipidura leucophrys*	willie wagtail	*		*
Eupetidae	*Psophodes olivaceus*	Eastern whipbird		**	
Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra	*		**
Halcyonidae	*Todiramphus sanctus*	sacred kingfisher			*
Hirundinidae	*Hirundo neoxena*	welcome swallow	**		
Hirundinidae	*Hirundo nigricans*	tree martin	*		
Maluridae	*Malurus cyaneus*	superb fairy-wren	*		*
Megapodiidae	*Alectura lathami*	Australian Brush Turkey		*	
Meliphagidae	*Acanthorhynchus tenuirostris*	eastern spinebill			*
Meliphagidae	*Anthochaera chrysoptera*	little wattlebird			**
Meliphagidae	*Lichenostomus chrysops*	yellow-faced honeyeater			**
Meliphagidae	*Lichmera indistincta*	brown honeyeater		*	**
Meliphagidae	*Manorina melanocephala*	noisy miner	*		*
Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		**	*
Meliphagidae	*Philemon corniculatus*	noisy friarbird			**
Meliphagidae	*Phylidonyris nigra*	white-cheeked honeyeater			**
Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush			*

	Scientific Name	Common Name	Habitat		
			Cleared/developed	Riparian	Eucalypt Woodland
Pachycephalidae	*Pachycephala pectoralis*	golden whistler		**	
Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		*	*
Pardalotidae	*Pardalotus punctatus*	spotted pardalote			*
Pardalotidae	*Pardalotus striatus*	striated pardalote			**
Passeridae	*Neochmia temporalis*	red-browed finch	***		
Petroicidae	*Eopsaltria australis*	eastern yellow robin		**	
Psittacidae	*Trichoglossus haematodus*	rainbow lorikeet			***
Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	***		
Sturnidae	*Acridotheres tristis*	common myna	***		
Threskiornithidae	*Threskiornis molucca*	Australian white ibis	*		
Zosteropidae	*Zosterops lateralis*	silvereye			*
Mammalia					
Macropodidae	*Wallabia bicolor*	swamp wallaby	*	*	*
Peramelidae	*Perameles nasuta*	Long-nosed bandicoot	*	*	
Phalangeridae	*Trichosurus vulpecula*	Common brushtail possum		*	*
Phascolarctidae	*Phascolarctos cinereus*	Koala			*
Pseudocheiridae	*Pseudocheirus peregrinus*	common ringtail possum	*	*	*

APPENDIX 11
SECTION 5A ASSESSMENTS

THREATENED SPECIES INFORMATION

Red-crowned Toadlet

Pseudophryne australis (Gray 1835)

Other common name(s): None

Conservation Status

The Red-crowned Toadlet is listed as a Vulnerable Species on Schedule 2 of the NSW Threatened Species Conservation Act 1995 (TSC Act). It is not currently listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Description

Red-crowned Toadlets are small frogs of the Family Myobatrachidae. As the common name suggests, they possess a bright reddish-orange 'T'-shaped or triangular pattern on the top of the head which extends between the eyes to the tip of the snout.

The dorsal body colour can be varying shades of brown with a reddish wash and often with a scattering of reddish orange spots on the back. They also have a short reddish stripe or spot in the centre of the back above the hindlimbs (known as a urostylar or coccygeal stripe) see fig. 1.

The sides and limbs are generally dark grey and patterned with a fine peppering of white flecks. There are prominent white flashes on the thighs and upper forelimbs. The undersurface is spectacularly marbled black and white.

The fingers and toes are without webbing, and the limbs are short. Red-crowned Toadlets crawl or walk slowly when moving, rather than employ the typical well-developed hopping gait of most other frogs.

Mature specimens are usually around 20-25 mm in length. When mature, females are slightly larger than males.

Some morphological and genetic variation exists over the species' range, suggesting that there are a number of isolates that warrant investigation (R. Wells; A. Stauber pers. comm.)

Red-crowned Toadlet tadpoles are very dark, almost black dorsally, with a continuous covering of melanophores. The ventral area is also heavily pigmented. The distinctive red head colour only appears at about the time of metamorphosis.

Figure 1

Distribution

The Red-crowned Toadlet has a restricted distribution, known from a relatively small area of mid-eastern New South Wales. It is known from isolated portions of the Sydney Basin, from Pokolbin State Forest in the north to the Nowra district in the South, and Mt Victoria in the west.

The species has undergone declines and has disappeared from significant areas of its former distribution in northern and southern Sydney as well as parts of the Watagan Range.

Recorded occurrences in conservation reserves

Populations of this species are currently reserved in Blue Mountains, Bouddi, Brisbane Water, Dharug, Garigal, Heathcote, Ku-ring-gai Chase, Lane Cove, Marramarra, Morton, Popran, Royal, Sydney Harbour, Wollemi & Yengo NPs; Barren Grounds, Muogamarra, & Nattai NRs; Bargo, Dharawal & Parr SRAs.

Although not primarily set aside for conservation purposes other significant lands providing conservation security for the species include several State Forests, Water Catchment areas and Commonwealth Dept. of Defence land at Holsworthy.

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Habitat

Known only from Triassic sandstones of the Sydney Basin Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched outcroppings. Within these geological formations, this species mainly occupies the upper parts of ridges, usually being restricted to within about 100 metres of the ridgetop. Red-crowned Toadlets may also occur on plateaus or more level rock platforms along the ridgetop. This area is usually less preferred than the first talus slope areas below the upper escarpment or just below benched rock platforms.

The species has been recorded from near sea-level to about 1000 metres elevation, but most sites are on fairly low coastal ranges under 200 m in elevation.

Favoured microhabitats for shelter sites are under flat sandstone rocks ('bush-rock') either resting on bare rock or damp loamy soils. They have also been found under logs on soil, beneath thick ground litter, particularly near large trees and in horizontal rock crevices near the ground.

Red-crowned Toadlets do not usually live along permanent flowing water courses occurring in gullies, instead preferring permanently moist soaks or areas of dense ground vegetation or litter along or near head-water stream beds. These are the non-perennial first or second order drainage systems that are adjacent to ridges, are ephemeral in nature, and commonly called 'feeder-creeks'. They channel water from the ridges, benches, cliffs and talus slopes to the perennial streams in the gullies below. Such watercourses are dry or reduced to scattered shallow pools or ponds for much of the year, and have sustained flow for only a few weeks following thunderstorms. Under natural conditions these feeder creeks have high water quality and low nutrient loads.

The principal vegetation communities that are found in association with this species are the open woodland and heath communities that are typical for Hawkesbury and Narabeen geology. Tree cover, when present, is usually open and low (10-20m) and with a xeromorphic understorey.

The climate of its habitat is extreme with parts of its distribution experiencing highly variable temperature and rainfall patterns. The rainfall pattern across this species' habitat precludes regular seasonal flooding events and this is believed to explain the unusual opportunistic breeding biology of the species.

Ecology

The Red-crowned Toadlet is a relatively long-lived species (8-10 years, Thumm unpublished), able to withstand prolonged periods of drought through its nocturnal, semi-fossorial lifestyle and use of moist microhabitat refugia. It is the only species of frog in the Sydney Basin that has adapted specifically to the sandstone ridgetop environment.

The Red-crowned Toadlet has a unique terrestrial reproductive strategy: small nests are formed within decomposing accumulated leaf matter; clutch sizes are small, consisting of around 20-24 large eggs (Thumm unpublished); nests retain the eggs through the early stages of tadpole development, which occurs within a water-filled membranous capsule; and then rainfall events flush the embryos from the nest, and tadpoles complete development within transient pools.

The timing of follow up rain events and duration of temporary pools is critical to reproductive success. Many clutches are lost to desiccation through evaporation of the shallow pools and therefore recruitment is usually in low numbers. Recent studies suggest a 0.1% reproductive success rate where tadpoles actually successfully complete metamorphosis and recruit in the wild (Thumm in press; M. Mahony pers. comm.). To offset this loss, females can lay multiple clutches and breed opportunistically when appropriate conditions prevail.

The species can also be found breeding along eroded gutters or the verges of unsealed fire trails. In these locations accumulations of leaf-litter in association with temporary pools mimics natural feeder creek breeding habitat.

The call of the male of this species has been variously described as a nasal 'ank-ank' or a short metallic 'erk' sound. It has also been likened to a grating 'cr-ee-k' repeated two or three times, as a 'squelch' sound, or an 'eeeek eek' repeated several times.

Frogs have been recorded calling in all months of the year, including winter, and eggs have been found in all months. Mid-winter breeding is infrequent and likely to occur during milder weather conditions that may prevail in the coastal part of its range in some years. Winter breeding in the elevated western populations has never been recorded and is unlikely due to the lower temperature ranges experienced there.

Red-crowned Toadlets have not been recorded breeding in permanently flowing

streams or waters that are even mildly polluted.

When not breeding, Red-crowned Toadlets are thought to disperse over wider areas of its sandstone habitat, (i.e. into non-breeding areas) and many individuals have been observed sheltering under cover that would be unsuitable for egg-laying. However, it is likely that such 'dispersion' is only in the order of a few tens of metres from suitable breeding areas. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat, so recruitment and re-colonisation of areas of vacant habitat is likely to be low.

Known prey for Red-crowned Toadlets are ants, termites, mites, pseudo-scorpions, collembolans and small cockroaches (Rose 1974; Webb 1983), although they are likely to eat most small invertebrates encountered.

Information on their natural predators is scant. Snakes are known to eat the species, but the consequences are uncertain. An immature Tiger Snake found road-killed had ingested an adult Red-crowned Toadlet (Rose, 1974) and a juvenile Red-bellied Black Snake that ate one in captivity died within minutes of consuming it (R. Wells unpublished).

The bold red markings of the species have been taken to represent some form of warning pattern against potential predators, but it is difficult to imagine how such a strategy would help a mainly fossorial and nocturnal species. The skin is known to exude a chemical secretion that has an unknown function. It may act as an anti-predator defence strategy, or perhaps an anti-bacterial or anti-fungal agent.

Threats

The original reasons for listing the Red-crowned Toadlet by the NSW Scientific Committee were:

Populations reduced; distribution suspected to be reduced; threatening processes severe; ecological specialist (Lunney et al. 2000).

Several land-use practices and activities are believed to be operating individually and/or in concert with other known and perhaps unknown factors to threaten the survival of this species.

Such threats include:

- *High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition* (KTP);
- *Bush Rock Removal* (KTP);
- expanding urbanisation (particularly along ridge tops) and which results in - *Loss of Biodiversity as a result of loss and/or degradation of habitat following clearing and fragmentation of native vegetation (currently a preliminary determination)*;
- disease – particularly Chytrid fungus;
- water pollution and
- changed hydrological regimes.

*(KTP – a Key Threatening Process listed under Schedule 3 of the TSC Act)

Management

- Prevention of habitat loss;
- Development and implementation of fire management plans with an appropriate fire regime for known areas of habitat. This should include appropriate buffers and a 'mosaic-burn' strategy where necessary;
- Active prevention of bushrock removal, and education concerning the collection and use of bushrock;
- Strategies to reduce stormwater runoff from ridgetop development and existing urban areas which alter the natural hydrology;
- Development of erosion and sediment control measures, particularly at the urban bushland interface to minimise nutrient loads.
- Those investigating Red-crowned Toadlets or their habitat should implement the NPWS frog disease hygiene protocol.

Recovery Plans

NSW NPWS Threatened Species Unit, Central Directorate has not yet commenced preparation of a recovery plan for this species.

For Further Information contact

Threatened Species Unit, Central Directorate, NSW NPWS PO Box 1967, Hurstville NSW 2220 Phone 02 9585 6678 www.npws.nsw.gov.au

May 2001

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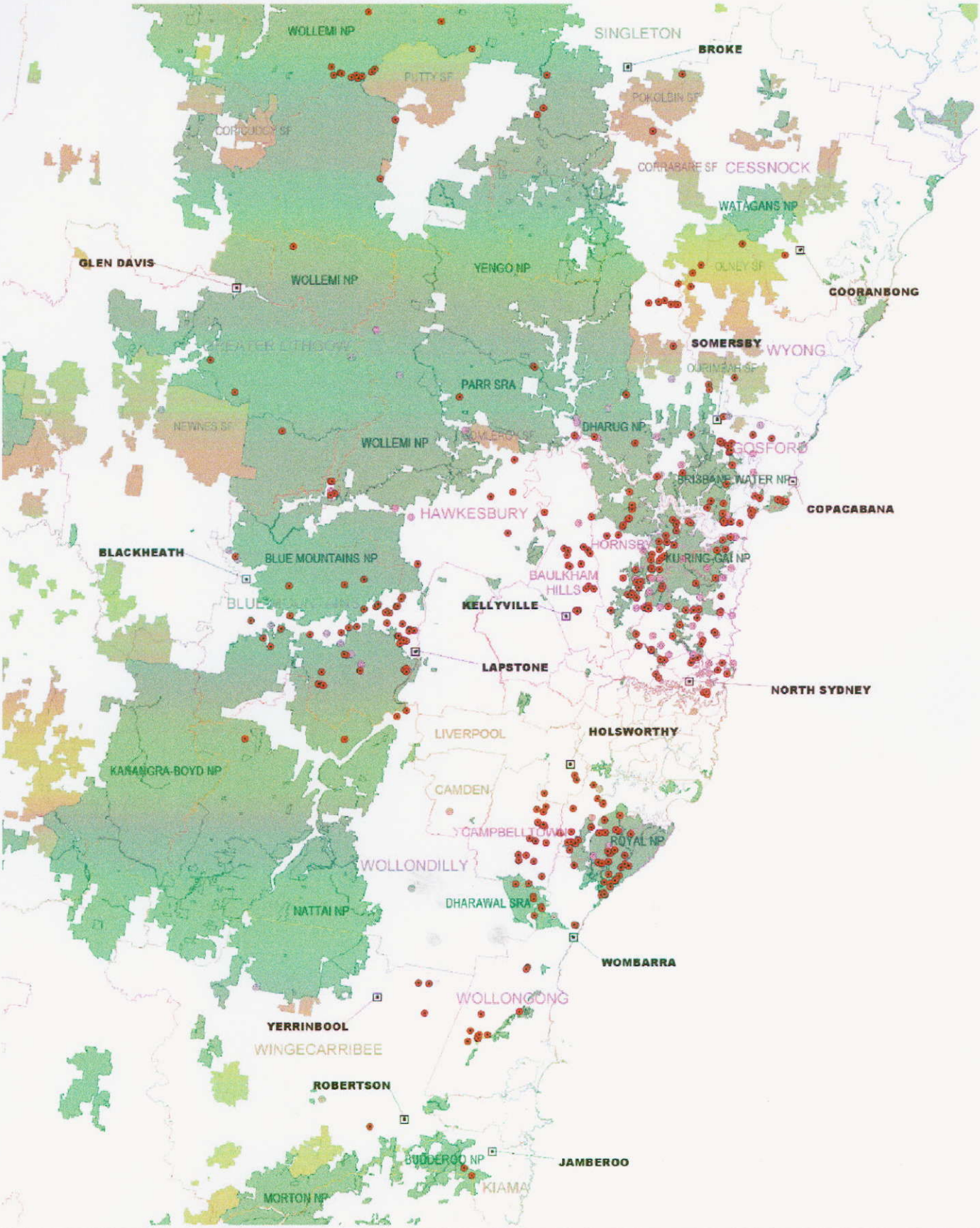

Coastline

Recent - Post 1990 records
Old - Pre 1990 records

Towns

Local Government Areas

NPWS Reserve

State Forest

Distribution of the Red-crowned Toadlet

Pseudophryne australis

N
W E
S

10 0 10 20 Kilometres

PROJECTION : Zone 56

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Central Directorate
May 2001

Red Crowned Toadlet

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Red-crowned Toadlet is not known to occur on the Subject Site, but is a potential occurrence outside the proposed development area. This species is rarely found far from breeding sites, which are absent from the development area, but are present in the upper reaches of gullies and waterways which occur on the Warriewood escarpment.

Vegetation clearing will not impact on the preferred, moist habitats of this species or sever habitat connections. There will be no adverse water quality related impacts at breeding sites, as the proposed development is located entirely downstream of preferred habitats. Therefore there will be no direct impact on any stage of its lifecycle. Local extinction will not be promoted by the proposal.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Red-crowned Toadlet in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Red-Crowned Toadlet is unlikely to make use of the forest edge/development interface. No suitable habitat for this species will be lost under the proposal.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposal will remove vegetation from the edge of a relatively large area of habitat, but will not create a new edge or barrier to fauna movement. Known habitat will not be isolated from currently proximate habitat as a result of this proposal.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Red-crowned Toadlet is comparatively well conserved (throughout a limited distribution) in New South Wales.

(g) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Red-crowned Toadlet has a very restricted distribution, and the Subject Site is located within the core of the geographic range of the species.

THREATENED SPECIES INFORMATION

Giant Burrowing Frog

Heleioporus australiacus (Shaw & Nodder 1795)

Other common name(s): Owl Frog, Southern Owl Frog, Eastern Owl Frog, Spotted Owl Frog, Burrowing Owl Frog

Conservation status

The Giant Burrowing Frog is listed as a **Vulnerable Species** on Schedule 2 of the NSW *Threatened Species Conservation Act, 1995* (TSC Act). It is not currently listed under the schedules of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Description

The Giant Burrowing Frog is a large rotund member of the Ground Frog Family Myobatrachidae reaching up to 100mm total length. It is a powerfully built species with muscular hind limbs and enlarged tubercles on the feet well suited to burrowing. Males in particular have extremely muscular forearms larger in girth than the hind limbs and with the fingers and thumb possessing enlarged nuptial spurs (Figure 1c). Females have much thinner forearms than males. Colouration tends to vary from a steely blue grey to black on the limbs and upper body but paler on the sides (northern populations) to a darker and more brownish colouration (southern populations). The ventral surface is white sometimes with a varying wash of bluish grey (north) or brown (south) and this darkening may also be present on the throat. The body surface is granular to the touch being adorned with numerous warts. The warts are particularly prominent on the back and sides and are capped by small black spines. Along the flanks some of the enlarged warts are creamish white to lemon yellow (north), but tending to be a more colourful canary yellow in southern individuals. A yellowish glandular bar follows the posterior portion of the upper jaw and extends below the prominent tympanum (eardrum). A yellowish splash is also present in the armpits and southern individuals usually have additional rich yellow markings along the posterior edge of the thighs and encircling the cloaca. There appear to be other consistent differences between northern and southern individuals in the shape of the skin flaps in the anterior corner of the eyes. These structures are likely to function to exclude dirt from the eye when burrowing. The eyes are prominent and large with a vertically elliptical pupil, the iris colour is silverish. Males call from within or adjacent to breeding chambers with a low pitched and plaintiff owl like oop oop oop oop in rapid succession.

Tadpoles are large and very dark brown to black attaining 75 mm total length prior to metamorphosis (Gillespie 1990). The tadpoles are also relatively short tailed and have an oral disc labial tooth formulae of 515 over 121 (south) (Watson & Martin 1973) and is apparently the same in the north (M. Anstis pers. comm.). The blue/grey ventral surface of Giant Burrowing Frog tadpoles allows them to be readily distinguished from tadpoles of other species where they occur.

Distribution

The Giant Burrowing Frog is distributed in south eastern NSW and Victoria, and appears to exist as two distinct populations: a northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Jervis Bay (Daly 1996); and a southern population occurring as disjunct 'pockets' from about Narooma south into eastern Victoria.

Recent NPWS surveys have extended the known distribution of the species to the north west near Mt Coricudgy and Kings Cross in Wollemi National Park. Their previously known northern extent was from near Kulnura and nearby Olney State Forest (Mahony 1993; Wellington & Wells 1995; Recsei 1996). They have been recorded at elevations up to 1000m (Mt Victoria).

There are fewer records from the southern population and frogs have only been found in a patchy distribution from the vicinity of the forested country west of Narooma (Wellington and Wells 1994; Lemckert *et al.* 1998; Lemckert 1998) south where they occur in the vicinity of Bega, Eden and Bombala in NSW (Webb 1981; 1987; Lunney & Barker

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1986; Gillespie 1990; Lemckert *et al.* 1998), and extending into Victoria, as far as Walhalla historically (1903) (Littlejohn & Martin 1967). In Victoria there is some concern over a lack of recent observations. There is still some doubt over whether the two populations are continuous or disjunct. Cogger (1996) has indicated a continuous population and others have also suggested this as likely (Wellington & Wells 1994; Daly 1996; Lemckert *et al.*. 1998) but needing further survey effort in the apparent 'gap' regions. More recent closer observation has revealed morphological differences between northern and southern populations where they persist at their southern and northern distributional extent respectively near Jervis Bay and Narooma. Work is in progress to determine the taxonomic status of the populations (M. Mahony pers. comm.).

Recorded occurrences in conservation reserves

Barren Grounds, Muogamarra, Nadgee, Nattai & Red Rocks Nature Reserves; Ben Boyd, Biamanga, Blue Mountains, Brisbane Water, Booderee (EA), Budderoo, Dharug, Garigal, Heathcote, Jervis Bay, Ku-ring-gai, Marramarra, Morton, Mount Imlay, Nattai, Popran, Royal, South East Forest, Wollemi & Yengo National Parks; Bargo, Dharawal & Parr SRAs (NPWS 1999).

Habitat

There appears to be a distributional shift from north to south in habitat preference. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations the frog is associated with small headwater creek lines and along slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from the collected water. They have also been observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised over time and are still surrounded by other undisturbed habitat (Wellington & Wells 1995; Recsei 1996).

In the southern population, records from Narooma, Bega, Bombala and eastern Victoria appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. However, the ridgetop, headwater and slow flowing stream association still appears to exist (Littlejohn & Martin 1967; Gillespie 1990, 1996).

Giant Burrowing Frogs do not appear to inhabit areas that have been cleared for agriculture (Mazzer, 1994) or for urban development.

Ecology

The Giant Burrowing Frog is a burrowing species and often spends significant periods of time underground during unfavourable conditions and to avoid detection during the day. Lee (1967) provides an overview of the ecology and taxonomy of the Genus *Heleioporus*, but with a particular emphasis on the Western Australian elements of the group.

Limited observations on this species suggest an ability to range widely, frequently being observed on roads at considerable distance from suitable riparian breeding, or other moist habitat (Hoser 1989; Gillespie 1990). Hoser (1989) suggests that they remain active throughout the year. Recent work by NSW State Forests has revealed that individuals possibly move 200-300m in a night, and at times take advantage of soft soil from the diggings of other animals (F. Lemckert, C. Slade, M. Stanton pers. comm.).

Giant Burrowing Frogs have been documented as being associated with yabbie burrows (Gillespie 1990; Daly 1996; Recsei 1996) however individuals are also capable of excavating their own burrow structures.

There appears to be three types of burrows: (i) Temporary burrows – which are created when the frogs are active to escape detection by day. These are generally shallow and excavated with the rear legs reversing in a revolving manner until they are beneath the surface. Often these chambers have only a few centimetres of soil covering them. At these times the frogs are likely to be vulnerable to surface disturbances, fire and possibly predation (Daly, 1996; Lemckert et al. 1998; R. Wells pers. comm.).

(ii) Aestivation burrows – these longer term "over-wintering chambers are generally much deeper and are sometimes unoccupied yabbie burrows (Hoser 1989; Daly 1996; Recsei 1996). They can be located in stream banks or in pond locations where they may angle down beneath the base of the pond which would be the last locations to dry out during drought (Wellington & Wells 1995).

(iii) Breeding burrows – which may have one (Martin 1967) or two (R. Wellington) openings, and are located in the banks of creek lines and ponded areas. Males call from within or adjacent to these burrows or even amongst accumulated vegetation debris (Moore 1961; Littlejohn & Martin 1967; Gillespie 1990; Daly 1996; pers obs.).

Amplexus is reported to occur within the breeding chamber (Lee 1967; Hoser 1989) and is apparently inguinal (lumbar) with the males utilising the enlarged nuptial spines to securely grasp the female (A. White pers. comm.). Eggs are laid, hatch and begin development within breeding burrows or amongst vegetation debris and are later flushed during subsequent rain events (Lee 1967; Martin 1967). Egg masses are foamy and may contain from around 400 (Hoser 1989) to 700-1200 eggs (Watson & Martin 1973). Eggs have been reported as unpigmented in the southern population (Martin 1967) but this has been contradicted by recent work (M. Mahony pers. comm.). However they are definitely pigmented in the north (Daly 1996; M. Anstis pers. comm.). The tadpole's development to metamorphosis is completed in ponds or pooled areas of the creekline. Breeding occurs mainly between mid summer to autumn (Cogger 1996) although calling has also been recorded between August and March (Moore 1961; Lee 1967). Tadpole development ranges from around 12 weeks duration up to possibly 6 months with late developing tadpoles over-wintering and completing development when warmer temperatures return (Gillespie 1990).

The Giant Burrowing Frog has a generalist diet and studies to date indicate that they mainly eat invertebrates; including: ants, beetles and cockroaches, and other venomous prey such as spiders, centipedes and scorpions (Littlejon & Martin 1967; Rose 1974; Webb 1983 &1987; Gillespie 1990).

Giant Burrowing Frogs have several apparent defence strategies. They tend to inflate themselves to appear larger to predators, exude a creamish, potentially toxic, secretion (Daly 1996), and emit a mournful cry (Daly 1996;). The nuptial spines are also used for defence as males will powerfully thrust their forearms together and 'spike' whatever is between them such as careless fingers, male opponents and perhaps potential predators (A. White pers. comm.).

Threats

Identified threats to the Giant Burrowing Frog include:

- Habitat loss through urban development of ridge top habitat sites (particularly northern populations);
- Clearing of vegetation for agricultural purposes (particularly the southern populations);
- Erosion and sedimentation of headwater creeklines, particularly where runoff rates and flows are exaggerated through upper catchment development or activity;
- Forestry activities where logging directly disturbs forest habitat or where roading and other activities impact indirectly on breeding sites, however in the south many records are from logged forest;
- Fire is known to have direct effects on the frog (R. Wells pers. comm) and likely indirect impacts via effects on invertebrate prey items;
- Road mortality may be significant where roads traverse and dissect major areas of habitat and particularly where populations are small;
- Giant Burrowing Frogs are also occasionally misidentified and killed as Cane Toads.

Other potential threats include: predation by feral and domestic animals, high nutrient flows, associated weed infestations and pH changes due to urban runoff (Recsei 1996; Green 1997).

Management

- Development of fire management plans with an appropriate fire regime for known areas of habitat and which include appropriate buffers and mosaic burn strategies where necessary. Hazard reduction and prescribed burn operations need to be mindful of the potential impacts on this species.
- Carrying out forestry habitat assessment and implementing protocols developed as part of the Eden and Southern Integrated Forestry Operations Approvals (IFOA) which give specific consideration to this species. In the lower North East IFOA development of such a protocol that adequately buffers impacts on habitat components. Mazzer (1994) outlines some suggested forestry management practices for the species to be implemented in Victoria. State Forests of NSW are currently undertaking radio-telemetry studies on the species (F. Lemckert, C. Slade, M. Stanton pers. comm.). NPWS

and SFNSW (with other agencies) have sponsored further investigations of both northern and southern populations that should provide useful information for this process.

- Development of best practice guidelines for land managers and utility organisations, which give guidance regarding track maintenance procedures and strategies to reduce or ameliorate impacts of essential road and other activity. Such strategies might include appropriate timing of works, drain design and maintenance, use of local country rock as road base, breeding site construction and microhabitat manipulation to encourage breeding activities.
- Development of erosion, sediment and flow control measures along major roads and at the urban-bushland interface, as well as educative strategies for the public living in these localities.
- Retention and supplementation of habitat on development sites and maintaining connectivity between populations particularly in potentially fragmented habitats.

Recovery Plans

NSW NPWS Threatened Species Unit Central Directorate has not yet commenced preparation of a recovery plan for this species.

For Further Information contact

Threatened Species Unit, Central Directorate, NSW NPWS PO Box 1967, Hurstville NSW 2220 Phone 02 9585 6678 www.npws.nsw.gov.au.

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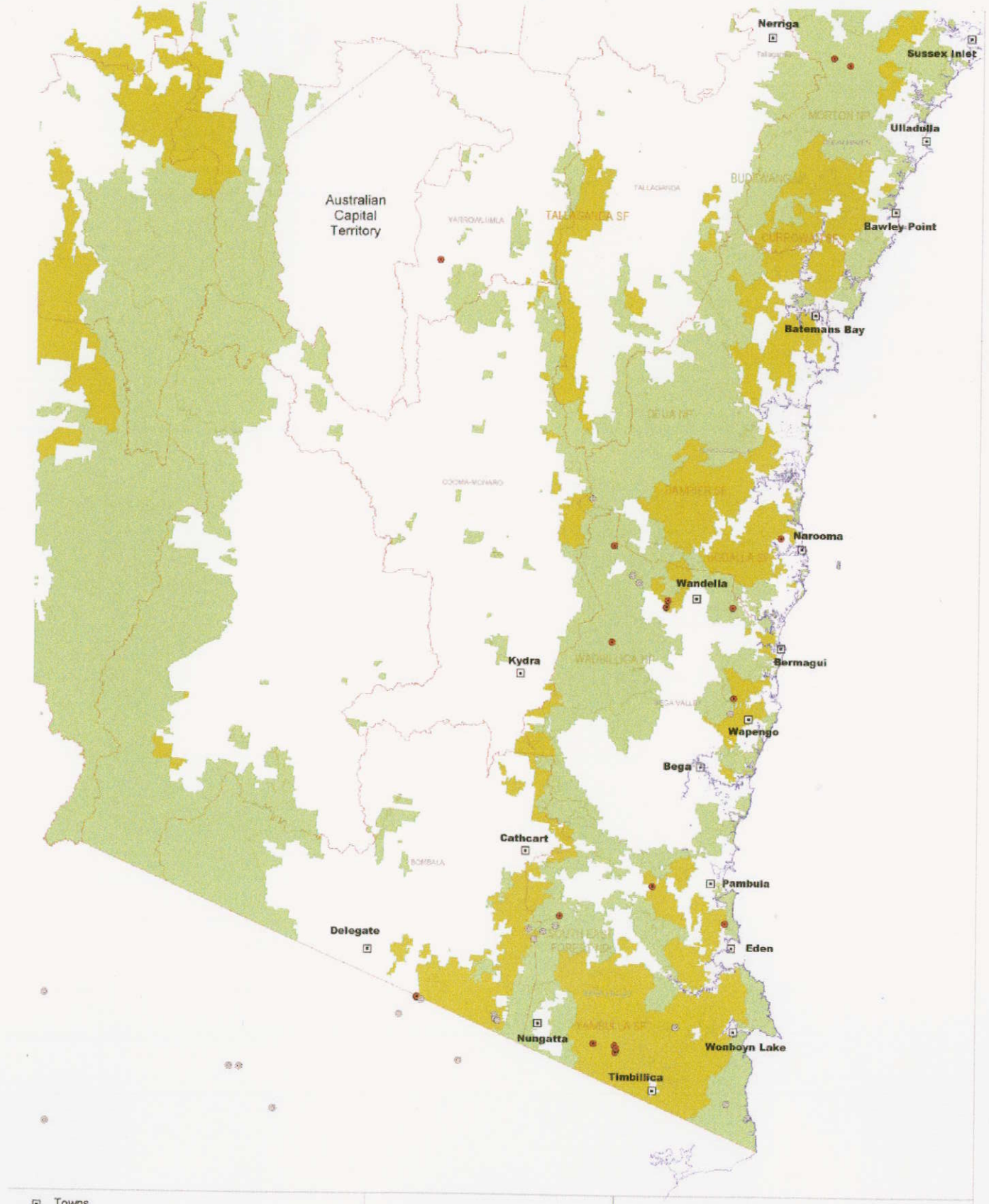
(a) Giant Burrowing Frog – Merimbula (southern population)

(b) Giant Burrowing Frog – Brisbane Water NP (northern population)

(c) Male hand with nuptial spurs

(d) Inflated defensive pose note skin secretion

Figure 1 a,b,c & d



Towns
Coastline
Giant Burrowing Frog Distribution
Post 1990 Records
Pre 1990 Records
Local Government Area
NPWS Reserves
State Forests

Distribution of the Giant Burrowing Frog

Heleioporus australiacus

Southern Distribution

10 0 10 20 Kilometres

PROJECTION : Zone 56

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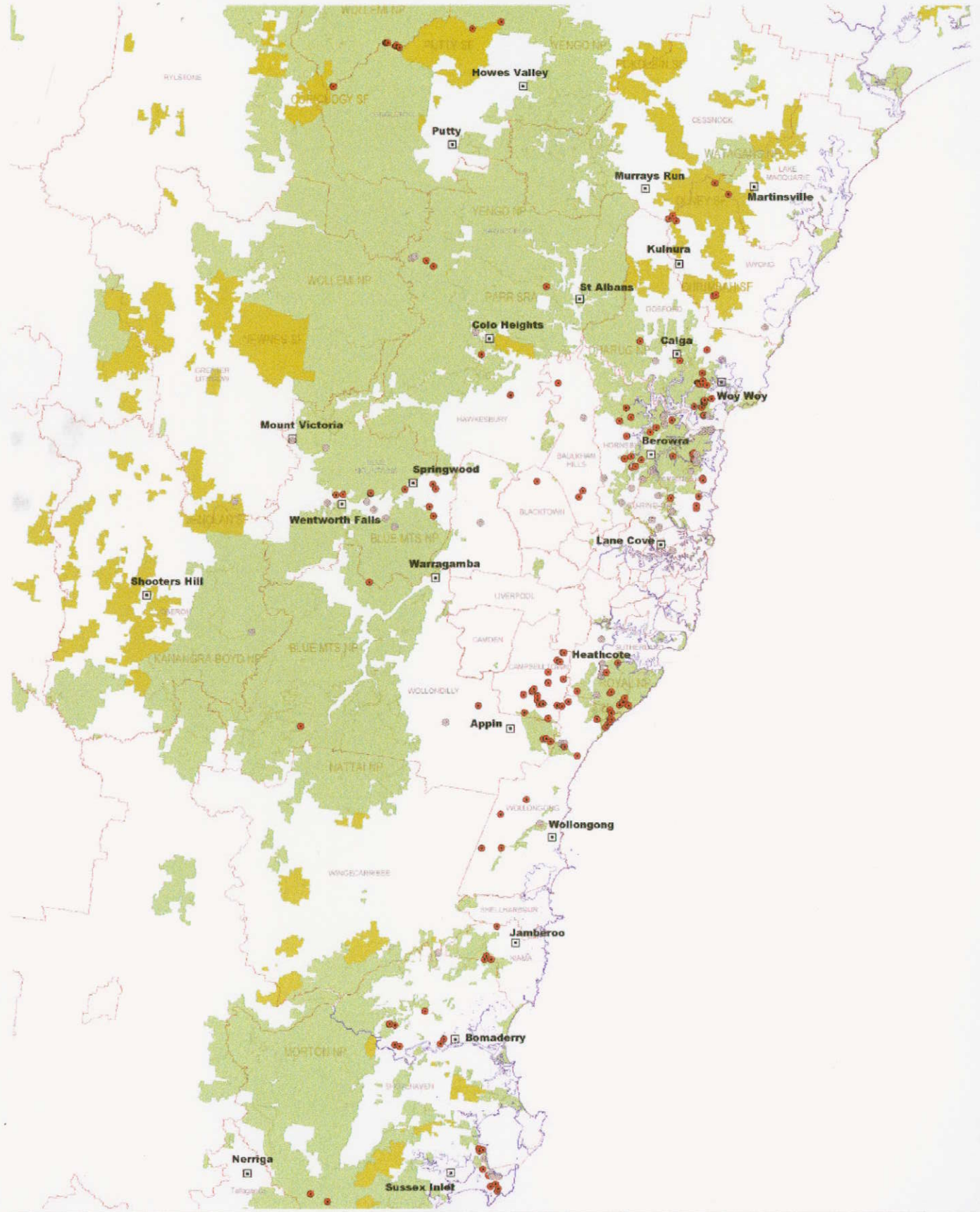

Towns
Coastline
Giant Burrowing Frog Distribution
Post 1990 Records
Pre 1990 Records
Local Government Area
NPWS Reserves
State Forests

Distribution of the Giant Burrowing Frog

Heleioporus australiacus

Northern Distribution

10 0 10 20 Kilometres

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Giant Burrowing Frog

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Giant Burrowing Frog is not known to occur on the Subject Site, but is a potential occurrence outside the proposed development area (all intact vegetation is located upslope).

The loss of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat type (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. There is no potential for adverse water quality impacts, as all suitable breeding sites are located upstream from the proposed development.

In light of the minimal loss of marginal habitat and limited potential for indirect impact, it is unlikely that a viable population of the Giant Burrowing Frog will be put at risk of extinction by the proposal.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Giant Burrowing Frog in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will result in the loss of two small patches of Eucalypt woodland on predominantly dry and exposed edges of vegetation. These areas are not likely to be exploited by the Giant Burrowing Frog, and do not provide connectivity between patches of suitable habitat. A significant area of Giant Burrowing Frog habitat will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposal will remove vegetation from the edge of a relatively large area of habitat, but will not create a new edge or barrier to fauna movement. Known habitat will not be isolated from currently proximate habitat as a result of this proposal.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Giant Burrowing Frog is comparatively well conserved throughout its limited distribution.

(g) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Subject Site is located within the core of the geographic range of the Giant Burrowing Frog.

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Rosenberg's goanna - vulnerable species listing

The Rosenberg's goanna (*Varanus rosenbergi*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its distribution has been reduced
- Its population is suspected to have been reduced
- It faces moderate threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W., Law, B. and Fisher, D. (2000) The

Related information

- Reptiles found in western Sydney
- NPWS calls on public to report Queanbeyan's wandering reptiles

threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Rosenberg's Goanna

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

Rosenberg's Goanna is not known to occur on the Subject Site, but is a potential occurrence. Preferred habitats are generally outside the proposed development area. It is however possible that this species would range into the development area from time to time, although activity is likely to be concentrated in intact habitats.

The loss of small areas of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat type (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge. There will be no loss of potential nesting sites of the species (termitaria), which are absent from the development area.

The loss of a small area of vegetation at an existing edge is not likely to reduce the area of foraging habitat for this species in the locality such that a viable population is put at risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of Rosenberg's Goanna in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The loss of less than 0.5ha of habitat from the edge of a forest patch is considered unlikely to compromise the viability of this species. In relation to the regional distribution of the habitat of this species, a significant area of habitat for Rosenberg's Goanna will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

Rosenberg's Goanna is poorly conserved in New South Wales.

(h) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

Rosenberg's Goanna is in the core of its limited geographic range (in NSW) in this area.

THREATENED SPECIES INFORMATION

Broad-headed Snake

***Hoplocephalus bungaroides* (Schlegel, 1837)**

Other common names Broad-head, Yellow-spotted Snake & Night Snake

Conservation status

The Broad-headed Snake is listed as an **Endangered Species** on Schedule 1 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act). This species is also listed as a**Vulnerable Species** on Schedule 1 of the Commonwealth *Endangered Species Protection Act, 1992.*

Description

The Broad-headed Snake is a medium sized, front-fanged, venomous snake (Serpentes: Elapidae). Its body colouration is generally black with lemon to golden yellow scales forming irregular cross bands, usually a single scale wide and interspaced by 3-4 black scales. Along the sides there tend to be yellow scales which interconnect the cross bands to produce a wavy or straight horizontal yellow striping. On the belly the colouration tends to be steely bluish grey but can be splotched with yellow. The broad ventral scales are keeled at their margin, an adaptation for climbing. The head is clearly distinct being much wider than the neck and is very obvious when aroused. The head is ornamented with irregularly placed yellow scales and the upper lip (labial) scales are also barred yellow.

They range in size from 22-28cm total length as neonates and up to around 90cm as adults, though rarely, larger sizes have been reported. Average size is about 60cm with females tending to reach the larger sizes.

Distribution

The Broad-headed Snake is restricted to the Sydney Basin and within a radius of about 200km of Sydney. Its distribution extends from Wollemi National Park in the north; the edge of the Clyde River catchment in the ranges southwest of Nowra in the south; and west to the upper Blue Mountains at Blackheath and Newnes. Its eastern most distribution is within Royal National Park and the escarpment areas above the northern end of the Illawarra. Old records exist for parts of Sydney Harbour foreshore and the eastern suburbs pre 1920, where the species formerly occurred along rocky sections of the Sydney coastline. The historical records from the entrance of Port Jackson south to Botany Bay, and around Middle Harbour, and "the inlets of Lane Cove and Parramatta"(Krefft 1869), are very old and these populations are thought extinct. Similarly there are also older records from outlying sandstone extensions at the NW edge of the Sydney Basin between Bathurst and Mudgee. In total there are approximately 170 available specimen records of the Broad-headed Snake, but only about 50 of these could be regarded as current or recent.

Their distribution today would appear to be centred in four key areas; Blue Mountains, southern Sydney, an area north west of the Cumberland Plain and the Nowra hinterland.

Broad-headed Snake

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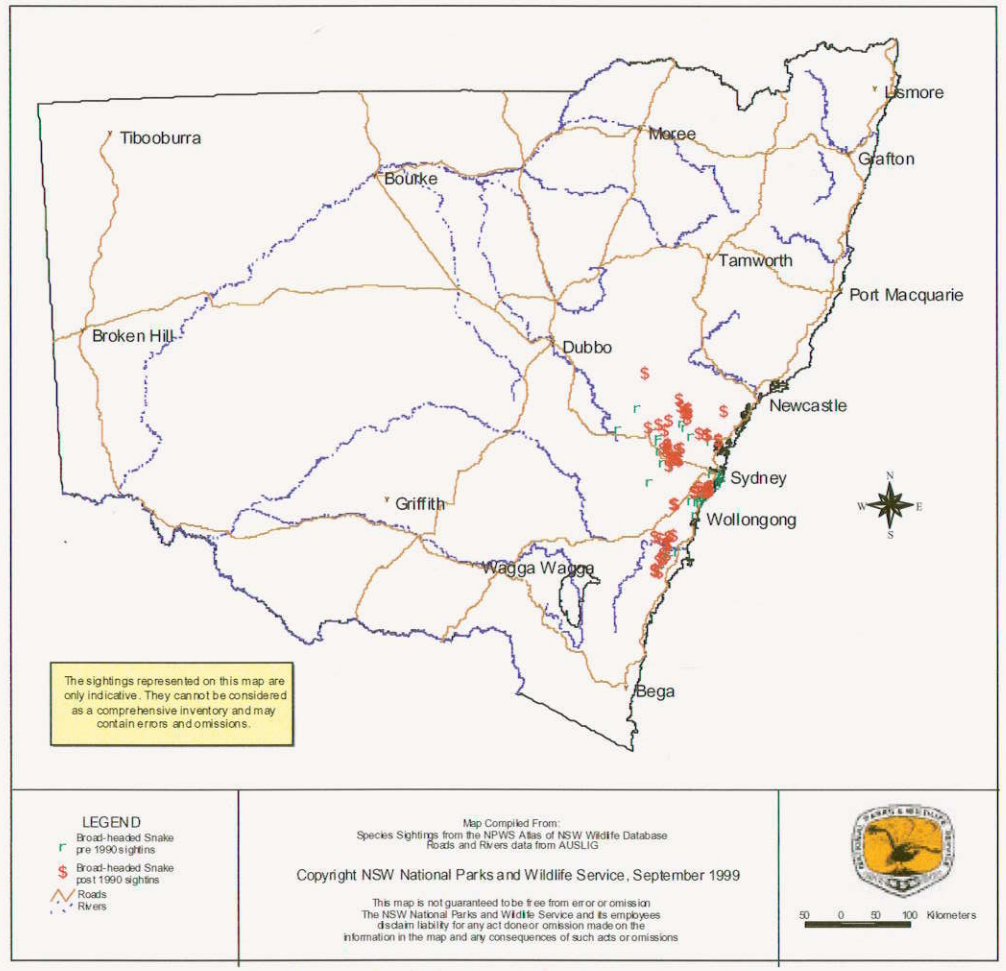

NPWS records of the Broad Headed Snake in NSW

Recorded occurrences in conservation reserves

The species is currently known from Blue Mountains, Heathcote, Morton, Royal, Wollemi and Yengo National Parks and Parr State Recreation Area. It is thought to be present in Dharug and Popran National Parks and was historically known from areas now within Garigal, Ku-ring-gai, Lane Cove and Marramarra National Parks (NPWS 1999).

Other important areas of distribution in which the species is believed to be afforded some level of security include: Avon, Cataract, Cordeaux, Nepean and Woronora Catchment areas and the Holsworthy Military Lands on the southern outskirts of Sydney.

Habitat

The Broad-headed Snake has a preferred habitat centred on the communities occurring on the Triassic sandstone of the Sydney Basin. The sites where they occur are typified by exposed sandstone outcrops and benching and in these locations the vegetation is mainly woodland, open woodland and/or heath. The Broad-headed Snake seasonally occupies distinctive microhabitats within these broader habitat types. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (Webb & Shine 1998b). Some of the canopy tree species found to regularly co-occur at known sites include *Corymbia eximia, C. gummifera, Eucalyptus sieberi, E. punctata* and *E. piperita* (NPWS unpublished).

Ecology

The Broad-headed Snake is nocturnal to crepuscular (active at dusk) and is an 'ambush predator', preying predominantly on lizards, particularly Lesueurs Velvet Geckos (Wells 1981; Webb & Shine 1994), at least during the cooler months. During this time the species can be found frequenting exposed sandstone ridgetops where it refuges under exfoliating sheets of sandstone resting on naked rock or within crevices. These refuges often have a predominantly west to north westerly aspect. This aspect effect is thought to provide thermoregulatory advantage and maximises temperature levels for the peak feeding periods of early evening (Webb & Shine 1998a).

During the warmer months of the year they become arboreal frequenting tree hollows (Webb 1996) and undergo a presumed dietary shift to small mammals (Shine 1983; 1990; Webb & Shine 1998b), although crepuscular arboreal skinks (*Eulamprus tenuis*) have also been reported in the diet of summer captured individuals (G. Turner 1998 unpublished). They give birth to live young (ovoviviparous) and tend to produce relatively low numbers of fairly advanced offspring by comparison to other snakes (Shine & Fitzgerald 1989). Clutch sizes are recorded as 4-12. Neonates are relatively large at birth but take 4-6 years to reach maturity. The snakes have an opportunistic ambush feeding strategy which results in low food intake. This has several likely consequences including low rates of growth, slow maturation and a breeding cycle that is less frequent than every year. These factors in concert may predispose the species to become threatened (Webb 1996; Webb & Shine 1998b).

Threats

- Bushrock Removal is occurring to supply natural rock for gardens and other landscaping (Krefft 1869; Hersey 1980; Shine & Fitzgerald 1989). It results in the loss of shelter used by the snakes their prey - geckos and the geckos prey - spiders and insects. Juvenile snakes are almost totally dependent on small geckos for food and so rock removal is likely to reduce recruitment (Webb & Shine 1998b). Losses due to intentional killing by bush rock collectors is also occurring (Cogger *et al.* 1993).
- Loss of habitat due to urbanisation of ridgetops is a serious threat (Krefft 1869; Webb & Shine 1994). It results in increased fragmentation and reduces the species' range (Cogger *et al.* 1993). Individual snakes return to specific locations and dont seem to move large distances (Webb & Shine 1998b). This limits likely recolonisation of areas.
- Bushfire is thought to impact on the snakes during summer when they occupy tree hollows. Altered regimes have reduced tree hollows and also impacts on prey.
- Illegal collection of snakes by unscrupulous herpetologists is suggested as impacting on this species (Burbidge & Jenkins 1984; Cogger *et al.* 1993). Recent changes to reptile keeping laws may result in a resurgence in interest in keeping this species in captivity and so increase pressure on wild populations.

- Forestry activities may disturb ridge tops, creates access trails and removes habitat trees. Trail creation increases the likelihood of habitat disturbance by opening up otherwise remote and inaccessible areas.
- Disturbance - the species is thought to be sensitive to incidental and/or intentional disturbance to the surface rock they utilise. Disturbance risk is a function of the proximity of habitat to roads and tracks (Goldingay 1998; Newell 1998).
- Impacts of feral animals has been suggested through predation by cats or foxes and microhabitat alteration by goats (Shine *et al.* 1998; Murphy 1996).

Management

- Regulation of removal of surface bushrock from areas of known habitat (Mahony 1997) as well as the sale of bush rock should be investigated. Improved vigilance and prosecution for illegal bush rock theft and snake collection.

Bush rock removal has received a preliminary listing by the Scientific Committee as a Key Threatening Process and, if finally determined, will require the preparation of a Threat Abatement Plan.

- Development proposals which open up areas of habitat should consider the indirect impact of disturbance to the species habitat which almost inevitably follows. Even in reserves, where development borders NPWS estate or where tracks merely traverse habitat, bush rock theft or disturbance is prevalent.
- Roads and tracks traversing areas of preferred habitat should be considered for closure or gating to reduce bush rock disturbance or theft.
- Prescriptions for forestry operations in areas of habitat. These should consider seasonality, reduced ridge top disturbance and tree hollow retention.
- A captive management strategy ensuring genetic diversity of captive stock is maintained. Explore the possibility of reintroductions, habitat rehabilitation and artificial habitat creation in select areas.
- Educational strategies to highlight the value of bushrock in natural systems. These should consider substitute rock and approaches to reduce demand for natural bush rock.

Recovery plans

A Recovery Plan is currently being prepared for the Broad-headed Snake. This plan will be exhibited and finalised during 2000.

Broad-headed Snake eating a Velvet Gecko

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For further information contact

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General enquiries: 43 Bridge St Hurstville NSW 2220 Phone 1300 36 1967 or 02 9585 6333.

Web site www.npws.nsw.gov.au

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Broad-headed Snake

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Broad-headed Snake is not known to occur on the Subject Site. Potential habitats occur within and adjacent to the site, but outside the proposed development area. Exposed sandstone outcrops occur at the development interface, but these were not found to support the primary prey of the Broad-headed Snake (Velvet Gecko), and lack the exfoliating sheets of stone which characterise preferred sites. These factors suggest that these specific outcrops are unlikely to be utilised.

More suitable sites occur upslope of the proposed development area, and despite an absence of recent records from the locality, the occurrence of this snake can not be discounted. These sites will not be impacted by the proposal.

The proposal will not remove the preferred habitat of this species or its prey. The development does not seek to intensify uses in adjacent bushland, and anthropogenic disturbance to this species (a major threatening process) will not be promoted. It is therefore considered unlikely that the proposed development will place a viable population at risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Broad-headed Snake in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The loss of less than 1ha of habitat from the edge of a forest patch may be significant to this species as the property level, however, larger and more intact areas of habitat occur locally which are considered capable of sustaining the species. In any case, sufficient vegetation will be retained on the site itself to cater for this species, should it actually occur.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Broad-headed Snake is comparatively well conserved in New South Wales. However, many populations have declined within conservation reserves.

(i) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Broad-headed Snake has a restricted distribution, and the Subject Site is located within the core of the former geographic range of the species. Its current status in the Pittwater LGA is not known.

THREATENED SPECIES INFORMATION

Regent Honeyeater

Xanthomyza phrygia **(Shaw, 1794)**

Other common names None

Conservation status

The Regent Honeyeater is listed as an **Endangered Species** on Schedule 1 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act). This species is also listed as an **Endangered Species** on Schedule 1 of the Commonwealth *Endangered Species Protection Act, 1992*.

Description (summarised from Menkhorst 1993)

Length
200-220mm
Wingspan
mm
Tail
mm
Bill
mm
Tarsus
mm
Weight
41-46g

The Regent Honeyeater is a medium-sized honeyeater with black, white and bright yellow plumage. Black plumage is dominate on the head, neck, breast and back are predominately black. The black plumage on the wings is edged with white and the outer feathers are bright yellow.
A distinguishing, large patch of bare, cream-coloured warty skin surrounds each eye.

Distribution

Historically this species was distributed from Kangaroo Island in South Australia along the eastern coastline of Victoria and NSW, to Dalby in Queensland and from the coast to the western slopes of the Great Dividing Range as far inland as Narrabri, Parkes and Warrumbungle National Park (Peters 1979). However, the species has declined greatly in numbers and disappeared from some parts of its former range as a result of clearing of large areas for agriculture (Blakers *et al.* 1984).

Though the species is widely dispersed, the range of this once abundant honeyeater has contracted dramatically (UBBS 1996). The species distribution is now extremely patchy, with the population having declined to less than 1500 individuals (NPWS 1997). There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungles NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley, and Capertee Valley (UBBS 1996; Ayers *et al.* 1996; NPWS 1997).

Regent Honeyeater

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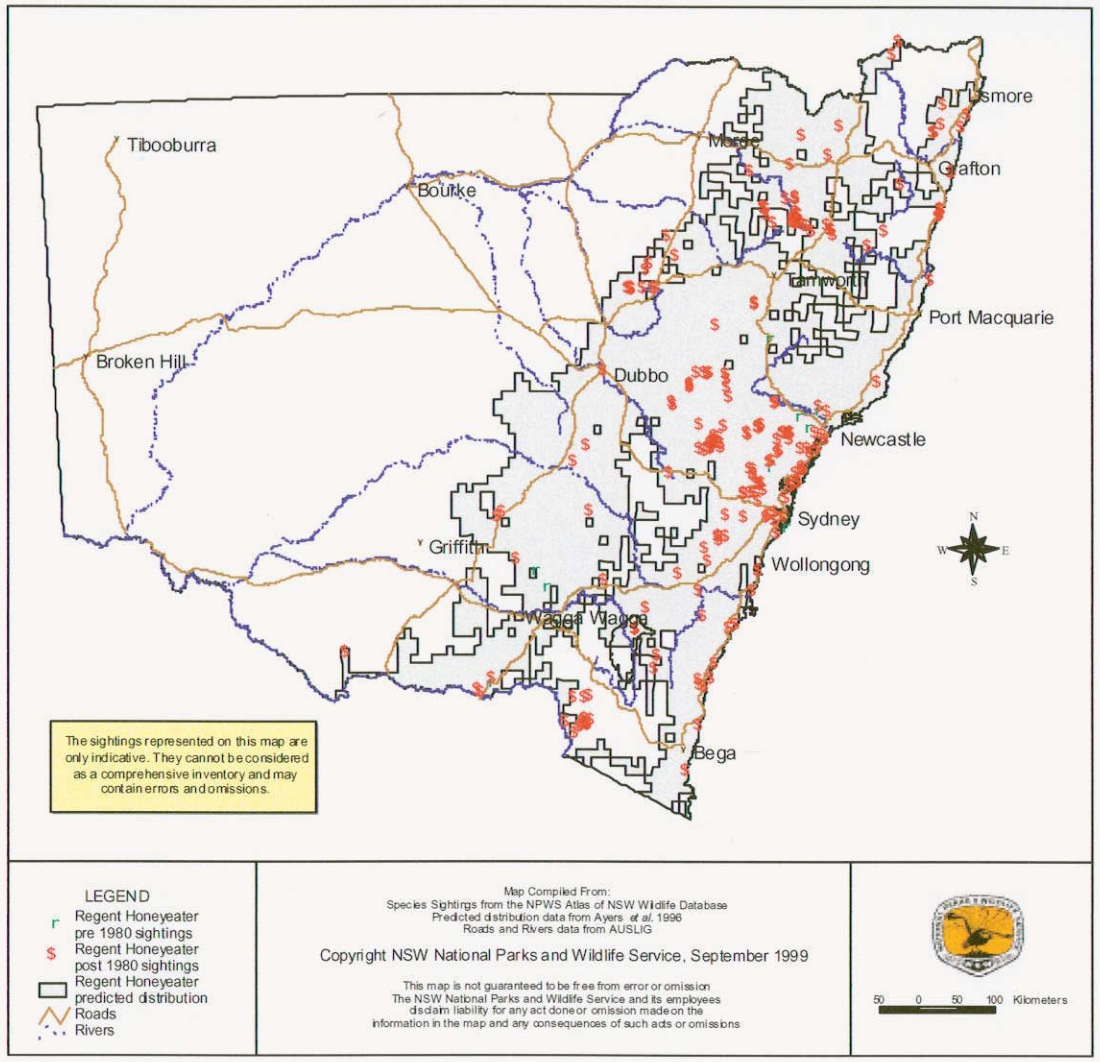

NPWS records of the Regent Honeyeater in NSW

In 1994, the largest aggregate of birds since the 1900s (approximately 152), was located in the Capertee valley during the 1995 breeding season (Ayers *et al.* 1996).

Recorded occurrences in conservation reserves

Munghorn Gap NR, Pilliga NR, Cocklebay NR, The Charcoal Tank NR, Yengo NP, Warrumbungle NP, Wollemi NP, Scheyville NP, Goulbourn River NP, Broadwater NP, Bundjalung NP, Yuraygir NP, Nattai NP, Brisbane Waters NP, Ingalba NP, Hat Head NP, Royal NP, Seven Mile Beach NP (NPWS 1999).

Habitat

The Regent Honeyeater is a semi-nomadic species which occurs in temperate eucalypt woodlands and open forest in south-eastern Australia (Pizzey 1980). Most records of the species are from box-ironbark eucalypt associations, and wet lowland coastal forests dominated by Swamp Mahogony, Spotted Gum and Riverine Casuarina woodlands (NPWS 1997). Remnant stands of timber, roadside reserves, travelling stock routes and street trees also provide important habitat at certain times (Ayers *et al.* 1996).

Ecology

The Regent Honeyeaters diet comprises of nectar and arthropods. Studies undertaken by Webster &Menkhorst (1992) indicate the main dietary item is nectar taken from 16 species of eucalypt and 2 species of mistletoe. However, the most frequent nectar sources are 3 species of eucalypt; Red Ironbark, White Box and Yellow box (Webster & Menkhorst 1992).

Nests are frequently located in Red Ironbark and Red River Gum but may also be in other eucalypts, mistletoe clumps and casuarinas. During the breeding season which occurs between July and November, 1-3 eggs are laid and incubated for a period of 12-15 days. Fledgling success may be dependent on the abundance of nectar from eucalypt flowers, predation and nests being damaged or blown down (Webster & Menkhorst 1992)

Threats

- Loss of habitat and fragmentation of habitat through clearing for agriculture, fenceposts and firewood, particularly in box-ironbark woodlands
- Slow incremental reduction in tree age classes
- Reduction in large flowering eucalypts in woodlands
- Grazing by domestic stock and rabbits prevents habitat regeneration
- Competition with other honeyeater species
- Tree decline and dieback on rural properties

Management

- Protection and maintenance of known or potential habitat, including the implementation of protection zones around recent records
- Control of feral animals around potential habitat areas, specifically targeting foxes

Recovery plans

A recovery plan has not been prepared for the species.

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Web site www.npws.nsw.gov.au

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Regent Honeyeater

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.

The Regent Honeyeater is not known to occur on the Subject Site, but is a potential occurrence, predominantly outside the proposed development area.

The loss of a narrow strip of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. The Regent Honeyeater is known to preferentially exploit Swamp Mahogany in Pittwater, and there will be no loss of individuals or stands of this species. The Regent Honeyeater opportunistically exploits irregular foraging resources, and thus is accustomed to a level of patchiness in its habitat. Minor losses such as the removal of individual trees (of non-preferred species) are unlikely to impact significantly on the species.

The Regent Honeyeater, which visits this locality sporadically is not likely to be threatened with extinction by the loss of a small number of trees and shrubs at the development interface on the Subject Site.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

There are no endangered populations of the Regent Honeyeater in this locality.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

Les than 1ha of vegetation will be disturbed on the Subject Site, and this patch does not contain high densities of the preferred food trees of this species. A significant area of Regent Honeyeater habitat will not be affected by the proposed development.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and migratory nature of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The preferred sub-coastal woodland habitat for the Regent Honeyeater is poorly represented in conservation reserves in New South Wales.

(j) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Regent Honeyeater is not approaching the limit of its distribution in this area.

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Swift parrot - endangered species listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Swift Parrot Lathamus discolor (Shaw) as an ENDANGERED SPECIES on Part 1 of Schedule 1 of the Act, and to omit reference to this species as a VULNERABLE SPECIES on Schedule 2 of the Act. Listing of Endangered Species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Swift Parrot Lathamus discolor (Shaw) is currently listed as a Vulnerable Species on Schedule 2 of the New South Wales Threatened Species Conservation Act. The Swift Parrot is also listed as an Endangered Species on the Schedules of the Commonwealth Endangered Species Protection Act, 1992.

2. The Swift Parrot occurs in woodlands and forests of New South Wales from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981).

3. The Swift Parrot breeds in Tasmania, where the breeding population has declined from in excess of 10,000 pairs to less than 1,000 pairs (Forshaw 1993, Garnett 1993, Brereton 1998). Numbers in New South Wales are considerably less than this.

4. The Swift Parrot is dependent on flowering

Related information

- Help eastern rosellas feel more at home in your neighbourhood
- Parrots
- The dangers of feeding lorikeets
- Double-eyed fig parrot - recovery plan (PDF - 554KB)
- Double-eyed fig parrot - species profile (PDF - 299KB)
- Regent parrot - species profile (PDF - 485KB)
- Turquoise parrot - species profile (PDF - 543KB)
- Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations - key threatening process declaration
- Double-eyed fig parrot - endangered species listing
- Eastern ground parrot - vulnerable species listing
- Night parrot - presumed extinct species listing
- Orange-bellied Parrot - endangered species listing
- Paradise parrot - presumed extinct species listing
- Purple-crowned lorikeet - vulnerable species listing
- Red-crowned parakeet (Lord Howe Is. subsp.) - presumed extinct species listing
- Regent parrot - endangered species listing
- Scarlet-chested parrot - vulnerable species listing
- Superb parrot - vulnerable species listing
- Turquoise parrot - vulnerable species listing
- Grain spill campaign to help save threatened superb parrot
- Help save swift parrot, an endangered winter visitor
- Help sought from the public

resources across a wide range of habitat in its wintering grounds in New South Wales (Shields and Crome 1992). Continued loss of this resource through conversion of native woodlands and forests to other land uses associated with human development threatens the continued existence of this species in nature in New South Wales in the short term (2 – 5 years).

5. In view of 2, 3 and 4 above, the Scientific Committee is of the opinion that the numbers of the Swift Parrot Lathamus discolor (Shaw) have been reduced to such a critical level and its habitats have been so drastically reduced that it is in immediate danger of extinction in New South Wales and therefore eligible for listing as an Endangered Species.

Proposed Gazettal date: 24/3/00
Exhibition period: 24/3/00 – 28/4/00

References:

Brereton, R. (1998). A review of the conservation status of the Swift Parrot Lathamus discolor. Submission to the Endangered Species Scientific Subcommittee, Environment Australia.

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About the NSW Scientific Committee

to track superb parrot
- More information about parrots
- North Coast community asked to help save endangered swift parrot
- Rainbow lorikeet and red-capped parrot added to licence exemption list
- Volunteers needed across the state for endangered bird survey
- Volunteers needed across the state to help save swift parrot and regent honeyeater
- Volunteers needed to help save swift parrot and regent honeyeater

Swift Parrot

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Swift Parrot is not known to occur on the Subject Site, but is a potential occurrence, predominantly outside the proposed development area. The loss of a narrow strip of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat type (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. Losses can be offset to a certain extent by the utilisation of preferred food trees of this species in waterway rehabilitation works.

The Swift Parrot which visit this locality sporadically are not likely to be threatened with extinction by the loss of a small number of trees and shrubs at the development interface. The species does not breed in Pittwater and will not suffer a loss of nesting resources as a result of the proposal.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Swift Parrot in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

Les than 1ha of vegetation will be disturbed on the Subject Site, and this patch does not contain high densities of the preferred food trees of this species. A significant area of habitat for the Swift Parrot will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and migratory nature of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

Habitat for the Swift Parrot is, on the whole, poorly represented in conservation reserves in New South Wales. Coastal habitats, which are utilised less consistently than sub-coastal woodlands are probably well represented.

(k) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Swift Parrot is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Glossy Black-cockatoo

***Calyptorhynchus lathami* (Temminck, 1807)**

Other common names Glossy Cockatoo, Casuarina Cockatoo, Leach's Black Cockatoo, Leach's Red-tailed Cockatoo, Latham's Cockatoo

Conservation status

The Glossy Black-cockatoo is listed as a **Vulnerable Species** on Schedule 2 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act).

Description (summarised from Crome & Shields 1992)

Length
480mm
Wing
350mm
Tail
215mm
Bill
46mm
Tarsus
25mm
Weight
425g

The adult male Glossy Black-cockatoo has mainly dull black plumage that may be tinged brownish. Two bright red panels are visible on the tail. The bill, eye ring and legs are dark grey. Flight is buoyant with shallow, effortless wing-beats. Individuals often fly at considerable height when travelling between feeding areas.

The female is similar in appearance to the male except for irregular yellow patches around the neck, head and orange-red tail panels. Immature birds are similar to the female with more yellow below and on wings and a paler bill.

Individuals differ from the Red-tailed Black-cockatoo due to their inconspicuous crest and distinctive calls that are soft, wavering and plaintive, disyllabic *kaa-er* and a harsh alarm screech.

Glossy Black-cockatoo - male and female

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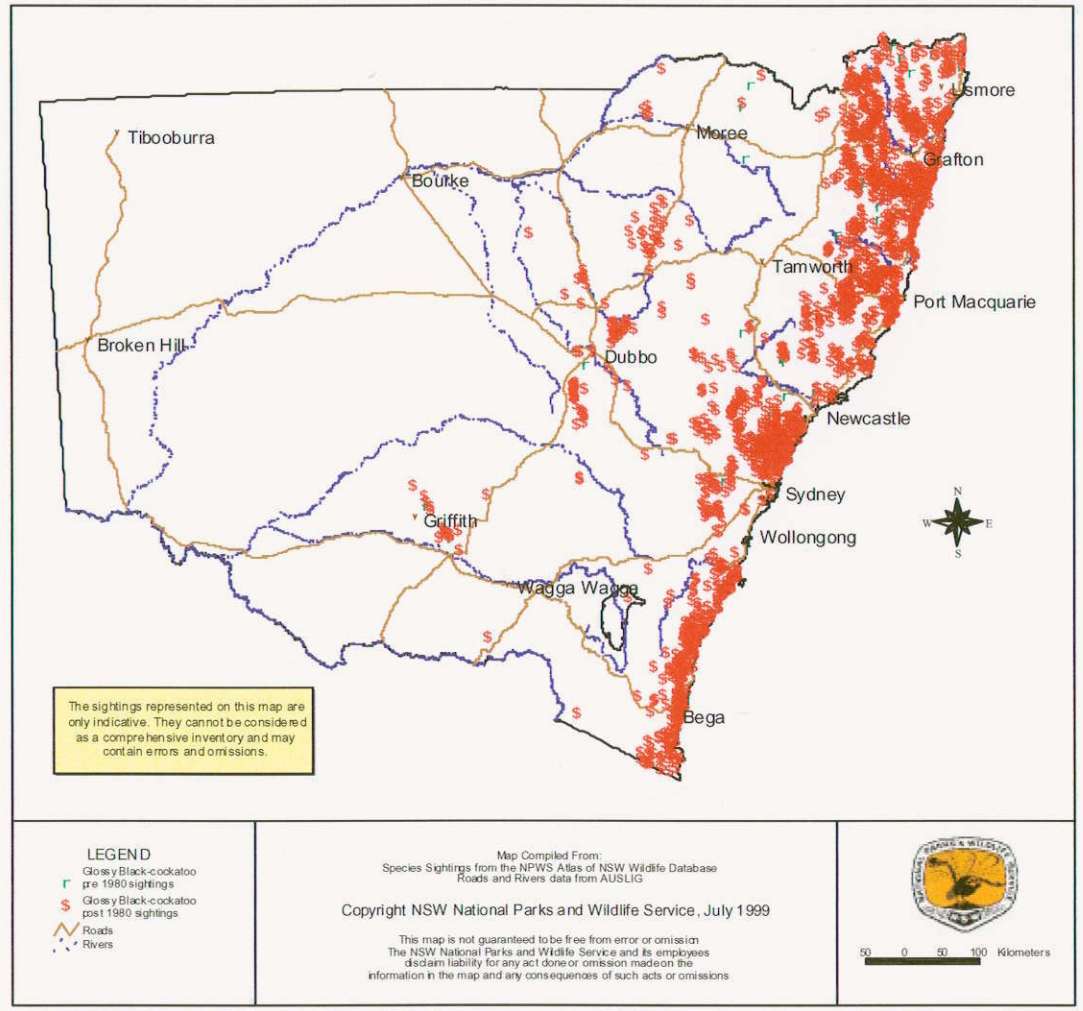

NPWS records of the Glossy Black-cockatoo in NSW

Distribution

The Glossy Black-cockatoo is sparsely distributed along the east coast and immediate inland districts from western Victoria to Rockhampton in Queensland (Crome & Sheilds 1992). In NSW, the species is found as far west as Cobar and Griffith in isolated mountain ranges (Pizzey 1991). Isolated populations of the species inhabit King Island in Bass Strait and Kangaroo Island off the coast of South Australia (Schodde *et al.* 1993).

The inland distribution of the species is restricted by the occurrence of the various casuarina species (Ayers *et al.* 1996).

Recorded occurrences in conservation reserves

Various conservation reserves throughout eastern and central NSW (NPWS 1999).

Habitat

The Glossy Black-cockatoo characteristically inhabits forests on sites with low soil-nutrient status, reflecting the distribution of key *Allocasuarina* spp. (Tanton 1994). The drier forest types with intact and less rugged landscapes are preferred by the species (NPWS 1994).

Ecology

The Glossy Black-cockatoo is probably the most specialised member of its family feeding exclusively on seeds extracted from the wooden cones of casuarinas (she-oaks). The bill is used to remove the tough outer hull while the cone is rotated in the left foot. The exposed seeds are then stripped away and eaten. The art of opening a casuarina cone is apparently learned behaviour, as immature birds frequently seem to have trouble manipulating the cones into the correct position (Crome & Shields 1992).

Adults only breed during the autumn and winter. During the 29 days of incubation the female is dependent on the male for food as she usually remains on the nest in a large tree hollow, lined with chips and dust (Crome & Shields 1992). Only one young bird is raised per season and a juvenile may associate with its parents for an indefinite period after fledging at approximately 60 days.

The species is gregarious, usually recorded in family parties of seldom more than 10. Locally nomadic, small flocks roam in search of feeding areas and roost communally.

Threats (summarised from Crome & Shields 1992; NPWS in prep.)

- Natural and other hazards may fragment habitat
- Loss of habitat through clearing and associated activities, including intensive logging, burning and grazing
- Logging of nest trees within the proximity of food resources
- Inappropriate fire regimes reducing its range by removing nesting and feeding resources

Management (summarised from Crome & Shields 1992; NPWS in prep.)

- Protection and maintenance of known or potential habitat
- Replanting areas with casuarina trees and promotion of their growth and development in areas from which they have been eliminated
- Alteration of prescribed burning and grazing regimes to ensure the enhancement and maintenance of the vegetation within known or potential habitat

Recovery plans

A recovery plan has not been prepared for this species.

References

Ayers D., Nash S. and Baggett K. 1996. Threatened Species of Western NSW. NPWS, Hurstville.

Crome F. and Shields J. 1992. Parrots and Pigeons of Australia. Angus and Robertson, Sydney.

NPWS 1994. Fauna of north-east NSW forests. North East Forests Biodiversity Study Report No. 3. NPWS, Hurstville.

NPWS (in prep.). Threatened Species Management Manual Forest Conservation Unit. NPWS, Hurstville.

NPWS 1999. Atlas of NSW Wildlife. NPWS, Hurstville.

Pizzey G. 1991. A Field Guide to the Birds of Australia. Revised Edition. Angus and Robertson, Sydney.

Schodde R., Mason I. and Wood J. 1993. Geographic differentiation in the Glossy Black-Cockatoo and its history. *Emu* 93: 156-66

Tanton M.T. 1994. Fauna impact statement. Proposed forestry operations in the Eden Management Area. Environmental Impact Statement. Volume B, Appendix 1. State Forest of NSW, Sydney.

For further information contact

Threatened Species Unit, Policy and Science Directorate Phone 02 9585 6540.
General enquiries: 43 Bridge St Hurstville NSW 2220 Phone 1300 36 1967 or 02 9585 6333.
Web site www.npws.nsw.gov.au

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Glossy-black Cockatoo

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Glossy-black Cockatoo is not known to occur on the Subject Site, but is a potential occurrence in habitats within and adjacent to the site, predominantly outside the proposed development area.

There will be no loss of trees which contain the large, deep hollows used by this species for nesting. There will be a minor loss of Black She-oak from the understorey of vegetation which occurs within Asset Protection Zones and this may result in a minor reduction in available habitat for this species. Those specimens to be lost were not observed to be fruiting prolifically and there was no evidence of recent usage by the Glossy Black Cockatoo. Black she-oak and Forest Oak can be planted in the riparian revegetation zone to offset this impact.

A minor loss of foraging resources is unlikely to threaten the local population of this species with risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Glossy-black Cockatoo in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Cockatoo is more likely to make regular use of habitats within the forest core and only occasional use of those at the forest edge/development interface. As such, vegetation loss in this area is unlikely to significantly impact on the species. A regionally significant area of Glossy-black Cockatoo habitat will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In

addition, the mobility and nomadic nature of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Glossy-black Cockatoo is comparatively well conserved in New South Wales.

(I) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Glossy-black Cockatoo is not approaching the limit of its distribution in this area.

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Powerful owl - vulnerable species listing

The powerful owl (*Ninox strenua*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its distribution has been reduced
- Its population is suspected to be reduced
- It faces moderate threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)
- It has poor recovery potential

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W.,

Related information

- Barking owl - draft recovery plan (PDF - 746KB)
- Barking Owl - vulnerable species listing
- Grass owl - vulnerable species listing
- Masked owl - vulnerable species listing
- Sooty owl - vulnerable species listing
- Southern boobook (Lord Howe Is. subsp.) - presumed extinct species listing
- Birds found in western Sydney
- Pilliga forests a major stronghold for barking owls

Law, B. and Fisher, D. (2000) The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Powerful Owl

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Powerful Owl is not known to occur on the Subject Site, but is a potential occurrence outside the proposed development area. This species occupies a large home range, concentrated on those patches which provide preferred prey or roosting sites. The site waterway represents a suitable roosting site, and will be rehabilitated, possibly to the advantage of the Powerful Owl.

The area of Eucalypt woodland to be lost as a result of this proposal is not likely to support a high abundance of preferred prey, and supports no suitable nest sites for the Powerful owl. Given that critical resources will not be affected by the proposed development, local extinction of the Powerful Owl is considered unlikely as a result of this proposal.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Powerful Owl in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. Owl is more likely to make regular use of habitats within the forest core and only occasional use of those at the forest edge/development interface. As such, vegetation loss in this area is unlikely to significantly impact on the species. A regionally significant area of Powerful Owl habitat will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and ranging behaviour of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Powerful Owl is comparatively well conserved in New South Wales.

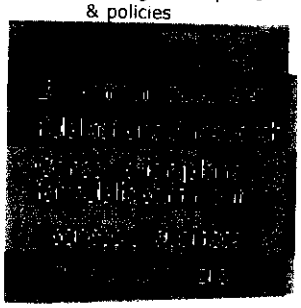
(m) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Powerful Owl is not approaching the limit of its distribution in this area.



Masked owl - vulnerable species listing

The masked owl (*Tyto novaehollandiae*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its distribution has been reduced
- Its population is suspected to be reduced
- It faces moderate threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)
- It has poor recovery potential

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W.,

Related information

- Barking owl - draft recovery plan (PDF - 746KB)
- Barking Owl - vulnerable species listing
- Grass owl - vulnerable species listing
- Powerful owl - vulnerable species listing
- Sooty owl - vulnerable species listing
- Southern boobook (Lord Howe Is. subsp.) - presumed extinct species listing
- Birds found in western Sydney
- Pilliga forests a major stronghold for barking owls

Law, B. and Fisher, D. (2000) The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Masked Owl

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Masked Owl is not known to occur on the Subject Site, but is a potential occurrence. This owl can range over an area of at least 200-300 hectares (and may range up to 3kms from any detection point). Studies by Kavanagh and Murray (1996) suggest that the Masked Owl may forage over a much larger area (over 1000ha) that may contain a mosaic of relatively undisturbed and disturbed environments.

The Subject Site may be utilised as a component of the home range of these owls, but provides no unique or restricted attributes that indicate that it is of greater significance than other disturbed sites in the locality. As such, a shifting of the forest edge (which is the only impact incurred by this species) due to proposed clearing is unlikely to threaten the viability of this species in the locality.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Masked Owl in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Masked Owl is likely to make occasional use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and ranging behaviour of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Red-crowned Toadlet is comparatively well conserved in New South Wales.

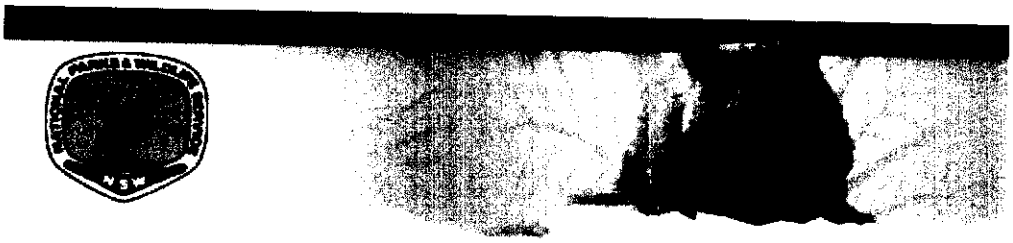
(n) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

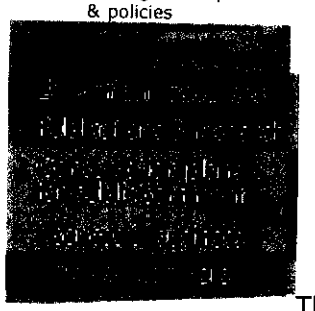
The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Masked Owl is not approaching the limit of its distribution in this area.





Superb fruit-dove - vulnerable species listing

The superb fruit-dove (*Ptilinopus superbus*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its population and distribution have been severely reduced
- It is an ecological specialist (it depends on particular types of diet or habitat)
- It has poor recovery potential

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W., Law, B. and Fisher, D. (2000) The threatened and non-threatened native

Related information

- Flock bronzewing - species profile (PDF - 342KB)
- Squatter pigeon - species profile (PDF - 544KB)
- Flock bronzewing - endangered species listing
- Rose-crowned fruit-dove - vulnerable species listing
- Squatter pigeon - endangered species listing
- White-throated pigeon (Lord Howe Is. subsp.) - presumed extinct species listing
- Wompoo fruit-dove - vulnerable species listing

vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Supurb Fruit Dove

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Supurb Fruit Dove is not known to occur on the Subject Site, but is a potential occurrence in the riparian habitats which support some fruiting rainforest species. This species will not incur habitat loss as a result of the proposal but will reap the benefits of waterway rehabilitation (there will be a net gain in habitat for this species). Local extinction of this species will not be promoted by this proposal.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Supurb Fruit Dove in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

Supurb Fruit Dove habitat will not be affected by the proposed development.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

All Supurb Fruit Dove habitat occurs outside of the development area. The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and ranging behaviour of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Supurb Fruit Dove is comparatively well conserved in New South Wales.

(o) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Supurb Fruit Dove is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Koala

***Phascolarctos cinereus* (Goldfuss, 1817)**

Other common names None

Conservation status

The Koala is listed as a **Vulnerable Species** on Schedule 2 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act). The conservation status of this species varies across Australia, from secure in some areas to vulnerable or extinct in others (ANZECC 1998).

Koala

Description (summarised from Martin & Handasyde 1995)

Head and body length (range of averages)
705-782mm (males)
687-716mm (females)
Weight (max range)
6.5-12kg (males)
5.1-8.5kg (females)

The Koala is an arboreal marsupial with fur ranging in colour from pale grey in the northern parts of its range to grey-brown in the south. Koalas have large furry ears and no tail. In the south of their range they are significantly larger than in the north (Lee & Martin 1988).

Distribution

The Koala has a fragmented distribution throughout eastern Australia, from north-east Queensland to the Eyre Peninsula in South Australia (Martin & Handasyde 1995). The distribution of the species also extends west of the Great Dividing Range, where it mostly occurs along inland rivers (Martin & Handasyde 1995).

In NSW, the Koala mainly occurs on the central and north coasts (Reed & Lunney 1990), although some populations occur in the western region (such as in the Pilliga region, to the west of Gunnedah), and an individual was recorded north of Wilcannia in 1994 (Ellis *et al.* 1997).

The species was historically abundant on the south coast of NSW (Lunney & Leary 1988), but now occurs in sparse and possibly disjunct populations (Reed *et al.* 1990) primarily in the Eden-Narooma area. Koalas are also known from a number of sites on the Southern Tablelands.

Recorded occurrences in conservation reserves

In NSW, Koalas have been recorded in numerous conservation reserves along the east coast and the slopes and tablelands of the Great Dividing Range (NPWS 1999).

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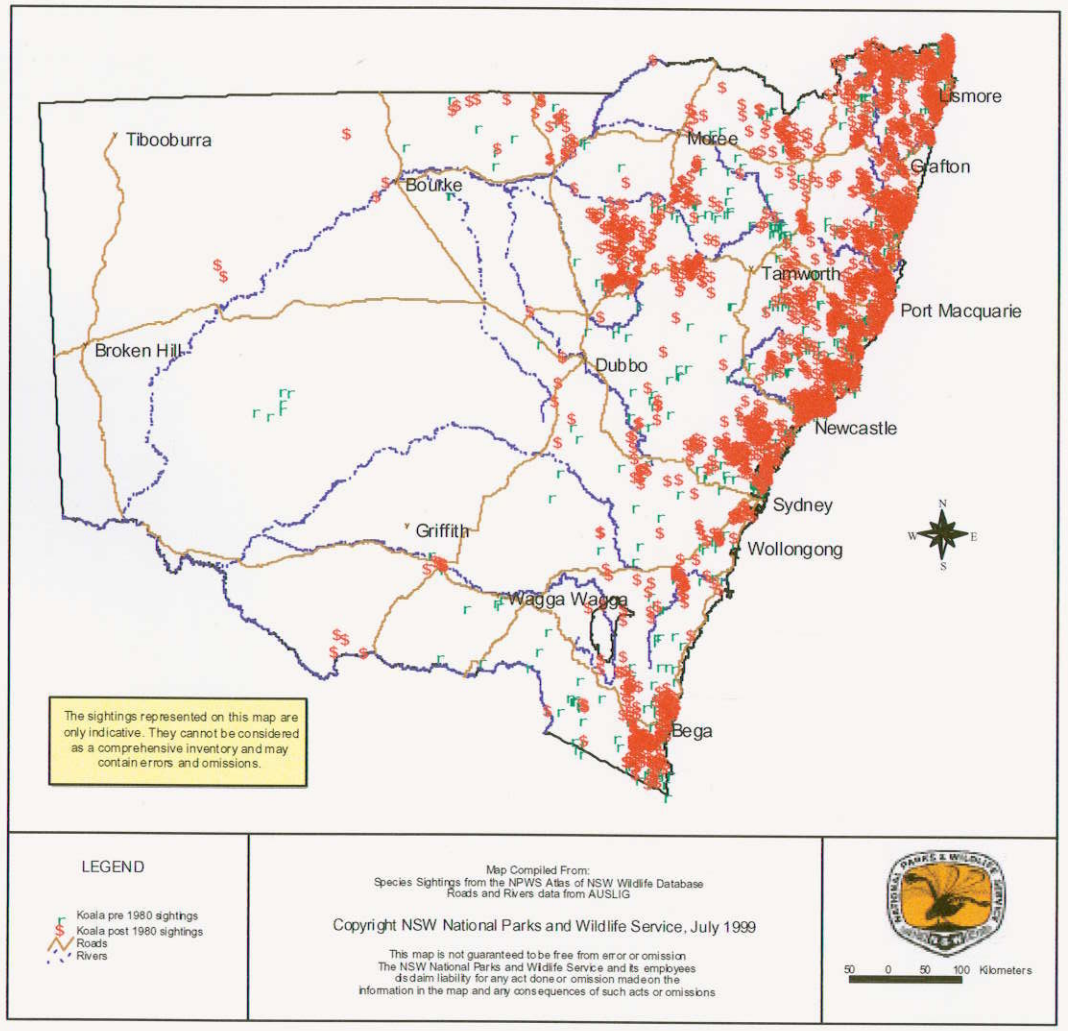

NPWS records of the Koala in NSW

Habitat

The Koala inhabits eucalypt forest and woodland. The suitability of forest and woodland communities as habitat for Koalas is influenced by the size and species of trees present, soil nutrients, climate, rainfall and the size and disturbance history of the habitat patches (Reed *et al.* 1990).

Ecology

Koalas spend the majority of their time resting in the forks of trees and are generally most active in the first few hours following sunset (Mitchell 1990).

Throughout NSW, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species (Phillips 1990). However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis (Hindell & Lee 1990).

Some preferred species in NSW include Forest Red Gum *Eucalyptus tereticornis*, Grey Gum *E. punctata*, Monkey Gum *E. cypellocarpa* and Ribbon Gum *E. viminalis*. In coastal areas, Tallowwood *E. microcorys* and Swamp Mahogany *E. robusta* are important food species, while in inland areas White Box *E. albens*, Bimble Box *E. populnea* and River Red Gum *E. camaldulensis* are favoured (Smith 1992).

The Koala's diet of eucalypt leaves is low in nutrients and difficult to digest. Koalas are able to deal with this diet because they have a

lower metabolic rate than most other mammals, low nutrient requirements and a complicated digestive tract that selectively keeps the nutritional parts of the diet and excretes the indigestible parts (Cork & Sanson 1990). Koalas also save energy by remaining relatively inactive.

Although Koalas are often regarded as solitary, they actually live in complex groups and individual animals have overlapping home range areas (Martin & Handasyde 1995). Young males reach sexual maturity at approximately two years, although they are generally excluded from mating by the dominant male (Martin & Handasyde 1990; Martin & Handasyde 1995).

Females reach sexual maturity at approximately two years and can produce one offspring each year, generally in summer (Martin & Handasyde 1990). Following birth, the young lives in the pouch for 6 months and on leaving the pouch it remains dependent on its mother, riding on her back. Young reach independence at about 12 months, although they can remain in the mother's home range for a further 2-3 years. After this period, young animals disperse to establish their own home range. Dispersal distances generally range from 1-11 km (Gall 1980; Mitchell & Martin 1990), although movements in excess of 50 km have been recorded (Steve Phillips unpublished data).

Threats

- Destruction of habitat by clearing for urban development, agriculture and mining, particularly on high nutrient content soils
- Fragmentation of habitat by roads, urban development and agriculture, which creates barriers to movement, isolates individuals and populations, alters population dynamics and prevents gene flow and the ability to maintain recruitment levels
- Mortality from attacks by dogs, road fatalities, fires, drought or other natural disasters, particularly in fragmented landscapes without suitable refuge areas
- Degradation of habitat by fire, weed invasion, removal of important habitat trees and climate change
- In stressed populations, infection by *Chlamydia*, causing cystitis, keratoconjunctivitis, infertility and other symptoms

Management

- Survey and research to assess and map Koala populations and habitat
- Identification, protection and management of habitat, incorporating buffer or protection zones around prime habitat and the use of habitat links
- Habitat restoration and re-establishment of Koala feed trees in protection zones and in areas where clearing threatens the long-term persistence of local populations
- Research to determine the impact of fire, weed invasion and logging regimes
- Control of predators, in particular wild and domestic dogs
- Design of roads to incorporate movement structures and exclusion fencing and the setting of appropriate speed zones to allow for Koala movements and to reduce Koala deaths on roads
- Implementation of appropriate burning, logging, water-flow (particularly in arid areas) and grazing regimes to ensure the maintenance of known or potential habitat
- Education of residents, landholders, community groups and relevant authorities about threats to and management of Koalas
- Continuing involvement of the community in the survey, care and management of Koalas

Recovery plans

A recovery plan for the Koala is in preparation.

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Koala

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the population is likely to be placed at risk of extinction.

The Koala was recorded from the Subject Site close to the existing residence which supported *Eucalyptus botryoides* and *Eucalyptus piperata*. These species are known to be preferred browse species in the locality. Smith and Smith (2000) found that *Eucalyptus punctata* is by far the most important food tree for Koalas in Pittwater and is a critical habitat component. Other favoured food trees are *E. haemastoma*, *E. robusta* and *E. racemosa*. The available information suggests that the next most important food trees are *Angophora costata*, *Corymbia gummifera*, *C. maculata*, *Eucalyptus botryoides*, *E. globoidea*, *E. paniculata*, *E. piperita* and *E. umbra*.

Intensification of uses adjacent to an area of known habitat of this species has the potential to introduce a range of detrimental processes, including vehicular strike, increased predation (by dogs) and stress to individual animals (promoting Chlamydial infection). A range of initiatives could be implemented to mitigate these impacts.

There will be no loss of trees from the area in which the Koala was recorded, and it is assumed that this area is of particular significance to at least one animal. There will be a loss of trees from the edge of the Eucalypt woodland for fire management purposes.

Habitat loss under this proposal can be mitigated by the establishment of preferred browse species in the site waterway corridor, which will be subject to rehabilitation/restorative works. This will enhance off-site connectivity for the Koala, which is likely to be important in terms of long term genetic integrity within the population.

In the listing of the local population as an Endangered Population, the NSW Scientific Committee noted that the remaining bushland reserves (in Pittwater LGA) are thought to have an insufficient representation of food trees and be inadequate for the continuing viability and rehabilitation of the present population. This proposal seeks to embellish the supply of preferred feed trees on the Subject Site, and thus has the potential to improve conditions for the population.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

The Koala Population in the Pittwater LGA is an Endangered Population. The NSW Scientific Committee Determination (NSW NPWS 1999) regarding this population noted the following:

The population of P. cinereus in the Pittwater LGA occurs between Ingleside and Elanora Heights in the south and Palm Beach in the north on the Barrenjoey

Peninsula. As one of the few Koala populations in the Sydney area this population is of particular conservation significance.

Between the 1940s and 1970s the population was the largest koala population in the Sydney area, estimated at 123 individuals in the 1970s. This population declined significantly to an estimated size of six individuals in 1993. The 1998 population is estimated to be less than this number.

Habitat loss and fragmentation due to increasing urbanisation has been the most significant cause of koala population decline in the Pittwater LGA. The remaining bushland reserves are thought to have an insufficient representation of food trees and be inadequate for the continuing viability and rehabilitation of the present population. Individual koalas have been forced to utilise trees in residential areas to obtain food, increasing the occurrence of road deaths and predation by dogs. The disease Chlamydia presents an additional threat to this population.

This proposal will not result in the loss of intact Koala habitat or the loss of individuals from the population. It will not disrupt the population such that viability is compromised.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Koala is likely to make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The development area is predominantly cleared of vegetation and provides no off-site connectivity for the Koala. The riparian corridor represents a potential dispersal pathway and will be rehabilitated as an integral component of this development. In the long term, the proposal stands to improve connectivity between patches of Koala habitat.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that Koalas are well conserved in New South Wales. At the regional level (Sydney and surrounds), the species is very poorly conserved.

(g) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Koala is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Spotted-tailed Quoll

***Dasyurus maculatus* (Kerr 1792)**

Other common names Tiger Cat, Tiger Quoll, Spotted-tiled Native Cat, Spotted-tail Dasyure.

Conservation Status

The Spotted-tailed Quoll is listed as a **Vulnerable Species** on Schedule 2 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act).

Description (summarised from Edgar & Belcher 1995)

Head and Body Length
380-759 mm (males)
350-450 mm (females)
Tail Length
370-550 mm (males)
340-420 mm (females)
Weight
up to 7 kg (males)
up to 4 kg (females)

The robust Spotted-tailed Quoll has rich rufous brown to dark brown fur above covered by white spots of varying size. The fur underneath is a pale brown to cream. This species is considerably larger than other quolls and has characteristic spots on its tail.

Distribution

There are two subspecies of the Spotted-tailed Quoll: *Dasyurus maculatus gracilis* occurs in a small isolated population in north Queensland, while *D. m. maculatus* occurs along the remainder of the east coast (NPWS in prep.) from south-east Queensland to Tasmania. This subspecies previously ranged over both sides of the Great Dividing Range from Queensland to South Australia and Tasmania (Edgar & Belcher 1995). However, following a dramatic decline in range and numbers, it is now distributed over a restricted range in isolated areas that may be too small to support long-term viable populations (Edgar & Belcher 1995). The species is probably extinct in South Australia and uncommon to rare in Queensland, NSW and Victoria, but numbers appear to have increased in Tasmania (Edgar & Belcher 1995).

In NSW, the Spotted-tailed Quoll occurs on both sides of the Great Dividing Range. The north-east of the state represents a stronghold for the species, as numbers in the south-east of the state have dramatically declined (NPWS in prep.). The western division of NSW has a number of scattered but unconfirmed records (Ayers *et al.* 1996).

Spotted-tailed Quoll

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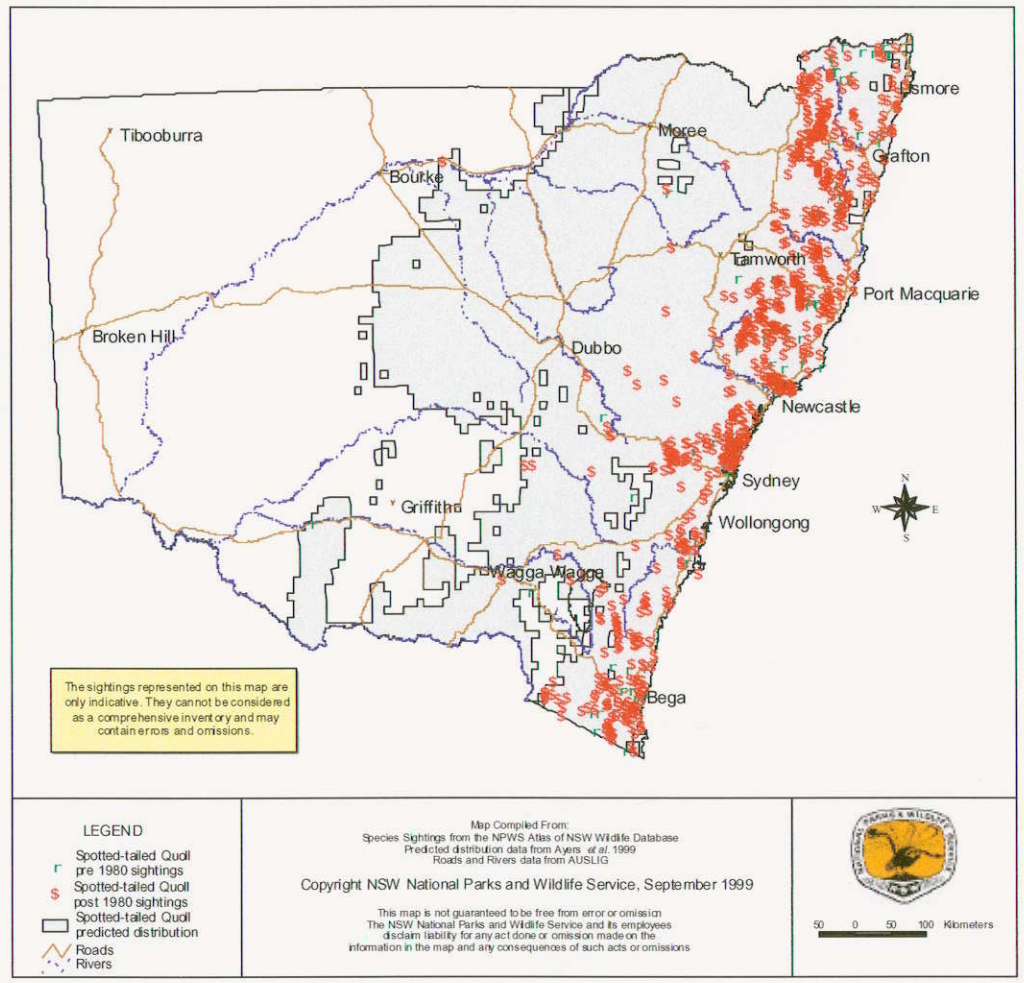

NPWS records of the Spotted-tailed Quoll in NSW

Recorded occurrences in conservation reserves

Numerous conservation reserves throughout eastern NSW (NPWS 1999).

Habitat

The Spotted-tailed Quoll utilises a variety of habitats including sclerophyll forest and woodlands, coastal heathlands and rainforests (Dickman & Read 1992; Edgar & Belcher 1995; NPWS in prep.). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas.

This species' habitat requirements include suitable den sites (such as hollow logs, tree hollows, rock outcrops or caves) and an abundance of food (such as birds and small mammals). Individuals also require large areas of relatively intact vegetation through which to forage.

Ecology

The Spotted-tailed Quoll is primarily solitary and nocturnal, although some diurnal activity does occur (Dickman & Read 1992). This species is primarily terrestrial, although it is an agile climber, using trees as vantage points from which to hunt (Dickman & Read 1992). It is an opportunistic carnivore which preys on birds, reptiles, small mammals (including gliders, possums, rats and small macropods) and invertebrates (Ayers *et al.* 1996). This species also scavenges carrion

and steals domestic poultry, and as a result is often persecuted (Edgar & Belcher 1995).

The Spotted-tailed Quoll nests in rock shelters, small caves, hollow logs or tree hollows (Ayers *et al.* 1996) and utilises numerous dens within its home range (NPWS in prep.). The home-range of this species is unknown, but estimates are between 800ha and 20km^2 (NPWS in prep.). It is a highly mobile species and there are numerous records of overnight movements of several kilometres (Edgar & Belcher 1995). Within its home range, this species has 'latrines' where it defecates, which are likely to define territories (Edgar & Belcher 1995).

The breeding period of the Spotted-tailed Quoll is from April to July with an average litter size of five (Edgar & Belcher 1995). The gestation period is 3 weeks and juveniles remain in the pouch for approximately 7 weeks (Dickman & Read 1992; Edgar & Belcher 1995). After leaving the pouch, social play is well developed by 13 weeks, and juveniles become independent at 18 weeks (Dickman & Read 1992). Maturity is attained at the age of one year (Edgar & Belcher 1995).

Threats

- Loss, fragmentation and degradation of habitat through clearing of native vegetation and subsequent development, logging and frequent fire (Edgar & Belcher 1995; Dickman & Read 1992; NPWS in prep.)
- Loss of large hollow logs and other potential den sites (Scotts 1992)
- Competition for food and predation by foxes and cats (Edgar & Belcher 1995; Dickman & Read 1992)
- Spread of epidemics, such as a parasitic protozoan, by cats to the Quolls (Edgar & Belcher 1995; Dickman & Read 1992)
- Historically (and currently) this species was extensively persecuted by humans following perceived predation on stock and poultry (Edgar & Belcher 1995; Dickman & Read 1992)
- Baiting of dingoes results in direct poisoning of Spotted-tailed Quolls and changes the composition of predators: reduced dingo numbers favours foxes which compete with quolls (Edgar & Belcher 1995; Dickman & Read 1992)

Management

- Protection and maintenance of known or potential habitat, including the implementation of protection zones around known den and latrine sites
- Retention of old growth elements, in particular tree hollow and fallen hollow logs
- Appropriate pest control programs which are targeted towards reducing fox and feral cat numbers without adversely affecting native species
- Education of landholders to prevent persecution of the Spotted-tailed Quoll
- Alteration of prescribed fires and grazing regimes to ensure the enhancement and maintenance of known or potential habitats and the reduction of habitat fragmentation

Recovery plans

A recovery plan has not been prepared for this species.

Spotted-tailed Quoll

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Spotted-tailed Quoll

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.

The Spotted-tailed Quoll is not known to occur on the Subject Site, but is a potential occurrence outside the proposed development area. The Quoll typically requires large areas of habitat, but may make seasonal use of more linear and smaller patches during dispersal movements. The intact habitats on the Subject Site may be used for this purpose.

There will be a loss of vegetation associated with this proposal. However, the disturbance will be limited to an existing edge and will not fragment a consolidated patch of habitat. Such a minor loss of habitat is unlikely to threaten the viability of a local population of this species.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

There are no endangered populations of the Spotted-tailed Quoll in this locality.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Spotted-tailed Quoll may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility and ranging behaviour of this species suggest that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Spotted-tailed Quoll is comparatively well conserved in New South Wales.

(p) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Spotted-tailed Quoll is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Southern Brown Bandicoot *Isoodon obesulus*

Shaw 1797

Other common names: Short-nosed Bandicoot, Southern Short-nosed Bandicoot, Brown Bandicoot

Conservation Status

Isoodon obesulus is listed as Endangered (Schedule 1) on the New South Wales *Threatened Species Conservation Act* 1995 and Endangered on the *Commonwealth Environmental Protection and Biodiversity Conservation Act* 1999.

Description

Isoodon obesulus is a medium-sized (400-1600g) terrestrial marsupial. Like other members of the bandicoot family (Peramelidae) the species has a long tapered snout with a naked nose, a compact body and short, pointed tail. The ears are small and rounded and the eyes are small. The dorsal surface of the body is coarsely furred, usually dark grey with golden-brown flecks. The softer fur of the underbelly is creamy-white. The fore-legs are short with curved claws on the digits, whilst the hindlimbs are longer, resembling those of macropods. The hind feet are characterised by syndactylus second and third digits, which are used for grooming.

In New South Wales *I. obesulus* is most easily confused with the Long-nosed Bandicoot (*Perameles nasuta*) and Long-nosed Potoroo (*Potorous tridactylus*), both of which may occur in the same or similar habitats. However, *I. obesulus* is generally smaller than the other two species and has relatively small ears, particularly compared to the Long-nosed Bandicoot. The closely related Northern Brown Bandicoot (*Isoodon macrourus*) is similar in appearance to the Southern Brown Bandicoot, but the distribution of the two species is not thought to overlap. *I. obesulus is* illustrated in Figure 1.

Figure 1. The Southern Brown Bandicoot (*Isoodon obesulus*). Photo: Bert Lobert.

Distribution

Isoodon obesulus is found in the south-east and south-west of mainland Australia, Tasmania, Cape York Peninsula, and a few islands off the coast of South Australia. Within New South Wales the species is rare and almost exclusively restricted to the coastal fringe of the State, from the southern side of the Hawkesbury River in the north, to the Victorian border in the south. More specifically, the species is considered to occur primarily in two areas: (i) Kuring-gai Chase and Garigal National Parks just north of Sydney (Figure 2), and (ii) Ben Boyd National Park and Nadgee Nature Reserve in the far south-east corner of the State (Ashby *et al.* 1990). In between these two areas the species has been found in a small number of National Parks (see below for full list) as well as several State Forests (East Boyd, Mumbulla, Maroota, Nullica, Nadgee, Nalbaugh, Timbillica and Yambulla), although the number of records in any one location are scant (Figure 3). The species has also been reported from private land in the Northern Sydney Metropolitan Area (Atkins 1999).

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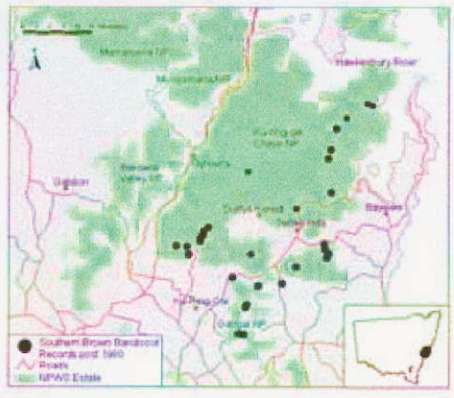

Figure 2. Locality records for the Southern Brown Bandicoot (*Isoodon obesulus*) in the Northern Sydney Metropolitan Area. Source: NPWS Wildlife Atlas and Atkins (1999).

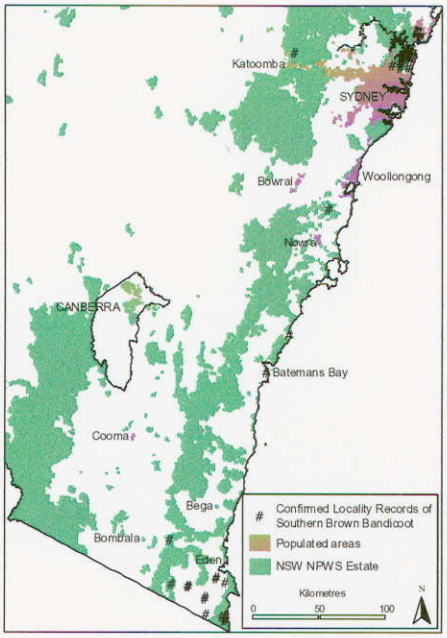

Figure 3. Confirmed locality records for the Southern Brown Bandicoot (*Isoodon obesulus*) in New South Wales. Source: NPWS Wildlife Atlas and Atkins (1999).

Recorded Occurrences in Conservation Reserves

Isoodon obesulus has been recorded from the following conservation reserves in New South Wales: Ben Boyd National Park, Blue Mountains National Park, Budderoo National Park, Garigal National Park, Ku-ring-gai Chase National Park, Nadgee Nature Reserve and South East Forests National Park (Genoa and Walimma Sections).

Habitat

Isoodon obesulus occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland (Hocking 1990; Kemper 1990; Menkhorst and Seebeck 1990; Rounsevell *et al*. 1991). In Tasmania the species has also been recorded in temperate rainforest (Green 1979).

Many of the habitats occupied by the species are prone to fire (Braithwaite 1983; Lobert 1990) and some authors have suggested that the species prefers to occupy early seral stages following disturbance (ie. Menkhorst and Seebeck 1990). In heathland at Cranbourne, Victoria, a series of researchers (Braithwaite and Gullan 1978; Stoddart and Braithwaite 1979; Opie 1980) found that animals favoured regenerating habitat of between 4-8 years of age following bulldozing activity, relative to other available habitats of between 10-12 and >25 years of age. This was particularly the case for large, lactating female animals with the greatest energetic requirements. This difference in preference was thought to reflect changes in habitat complexity, with many bandicoots occupying younger structurally simple heath rather than older structurally complex heath (Braithwaite and Gullan 1978). In a study undertaken at the same site some 15 years later, Lobert and Lee (1990) found no such pattern, with animals predominantly occupying older (14-18 years) rather than younger (3-4 years) heath. Furthermore, this preference was consistent across the population regardless of sex or age class.

Despite these contrary findings, Menkhorst and Seebeck (1990) considered that *I. obesulus* displayed a true preference for newly regenerating heathland habitat, making the species amenable to active ecological management. They suggested the use of controlled fires to produce a spatial mosaic of different ages, such that favoured

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seral habitat was constantly being created. This mosaic not only would enable mature animals to utilise high quality habitat as it becomes available, but also allow newly emerged pouch young the chance to successfully disperse into new habitat, leading to population stability (Stoddart and Braithwaite 1979).

The characteristics of early seral habitats that might favour the species are poorly understood. They may be related to the high productivity of this type of habitat (Stoddart and Braithwaite 1979). During early plant succession, plant diversity and nutrient availability can be relatively high and the vegetation is capable of sustaining an abundant and diverse invertebrate fauna (Braithwaite 1983). Recently burned sites have also been found to support large populations of beetle larvae, a preferred food item for the species (Opie 1980).

In Tasmania it seems that habitat structure is more important in influencing habitat use by the species than habitat type or seral stage (Heinsohn 1966). Moloney (1982) believed that the close proximity of dense vegetative cover was essential before animals moved into open areas. Quin (1985) observed the species in a variety of habitats but all were generally in the vicinity of dense vegetation. These observations are particularly interesting given the absence of foxes in Tasmania. More research is needed on the habitat preferences of *I. obesulus* in relation to fire and time since disturbance (Claridge *et al.* 1991).

Reproduction

Isoodon obesulus is thought to have a gestation period of less than 15 days, a remarkably short time (Lobert and Lee 1990). Neonates have a pouch life of approximately two months (Stoddart and Braithwaite 1979), and it is during the latter stages of pouch life that juvenile mortality is greatest. If the pouch young survives the weaning period, the new emergent gains independence almost immediately. Female bandicoots are capable of resuming oestrus and becoming pregnant before the completion of suckling of the previous litter. This allows one litter to immediately follow another in the pouch, affording a potentially high reproductive capacity.

Although adult females are capable of producing up to 6 young per litter (Braithwaite 1983), the mean litter size is typically between 2-4 young (Heinsohn 1966; Stoddart and Braithwaite 1979; Lobert and Lee 1990). Because the pouch has 8 teats the unused teats allow one litter to immediately succeed another without waiting for used and enlarged teats to revert to normal size. Thus, bandicoots have the potential to produce multiple litters during the year. The number of such litters depends primarily on the duration of the breeding season. In Tasmania, *I. obesulus* breeds for approximately eight months of the year with females capable of producing up to four litters per annum (Heinsohn 1966). The breeding season corresponds to the time of maximum food abundance, usually following heavy rainfall. In Victoria the breeding season of *I. obesulus* is two to three months shorter than in Tasmania. The onset of breeding has been found to be highly predictable (Stoddart and Braithwaite 1979; Lobert and Lee 1990) with females entering oestrus synchronously. This synchronicity has been linked to predictable environmental factors such as photoperiod, rather than ephemeral factors such as rainfall and prey abundance (Stoddart and Braithwaite 1979).

In Tasmania, *I. obesulus* reaches reproductive maturity at a minimum of four and six months of age for females and males, respectively (Heinsohn 1966). This compares to a minimum of seven months in some Victorian populations (Lobert and Lee 1990). Tasmanian animals grow faster and weigh more as adults (Heinsohn 1966) than Victorian animals (Lobert and Lee 1990). In

south-eastern New South Wales, it seems that forest-dwelling animals grows larger than Victorian heathland animals, although data are limited (Claridge *et al.* 1991).

Population Ecology

The paucity of long-term population studies of *I. obesulus* makes it difficult to estimate survivorship of individuals over time. In Victoria, recruitment rates of locally born young into populations of *I. obesulus* also appear to be low. Stoddart and Braithwaite (1979) found that between 12-18% of young remained on their heathland study site. Thus, about 80% of new animals entering the trappable population came from elsewhere. On the same site, only several years later, Lobert and Lee (1990) found slightly higher local recruitment rates (36%).

Heinsohn (1966) observed that newly independent animals rapidly established themselves in territories removed from their place of birth. This pattern of juvenile dispersal is critical to the species being able to exploit spatially and temporally ephemeral habitats, such as those subject to episodic fire. If local extinction of bandicoot populations is inevitable as habitat matures then the survival of the species is enhanced by the dispersal of offspring into adjacent, better quality habitat. High dispersal rates have associated low survival rates, so the reproductive season is necessarily prolonged in order to maximize the likelihood of population survival.

Information regarding the longevity of individuals in the wild is scant. Using mark-recapture data, Heinsohn (1966) estimated that most bandicoots live for at least two years provided they reach sexual maturity. Individuals up to 3.5 years of age have been reported (Lobert and Lee 1990).

Home Range and Nesting

Home range studies of *I. obesulus* are limited and comparisons can be tenuous due to methodological biases (see Lobert 1990). Ecological factors such as site productivity and habitat structure may also influence home range size. Despite these limitations, the majority of home range studies of the species have reported similar estimates, ranging from 0.5 to 6.0ha. There is some evidence of differences in home range size according to gender and habitat use but the results are inconclusive (e.g. Heinsohn 1966; Lobert 1990).

Bandicoots usually nest in a shallow depression in the ground covered by leaf litter, grass or other plant material. The upper surface of this covering may be mixed with earth to waterproof the inside of the nest. Internally, the nest comprises a hollow chamber, often lined with grass and leaves with no distinct entrance or exit.

There have been few studies of the nesting habits of wild animals. In the most extensive study to date, Lobert (1990) found that heathland-dwelling animals utilised a small number of shelter sites, all under dense vegetation. Nests usually comprised oval-shaped mounds of leaf litter and soil. At each end were openings which led into a central chamber lined with twigs and leaves. In south-eastern New South Wales, McNee *et al.* (1989) observed a radio-tracked animal consistently sheltering in a dense thicket of *Acacia floribunda*, surrounded by open vegetation. In contrast to other bandicoot studies, McNee *et al.* (1989) found that the animal did not form nests, instead resting under dense clumps of vegetation or, in one case, within a hollow log. In South Australia, Paull (1992) found that the majority of nests of *I. obesulus* were located under mature *Xanthorrhoea australis*. The structure of these nests was similar to that reported by other studies. In the absence of *Xanthorrhoea*, other structures such as blackberry (*Rubus* spp.) thickets

and rabbit burrows offered alternative shelter (Paull 1992).

Activity and Behaviour

Most studies of the activity cycle of the species have revealed a nocturnal habit. For example, Heinsohn (1966) observed that wild animals usually emerged from their nest after sunset and suspected that animals returned to their nest at or before sunrise. In contrast, Lobert (1990) found that heathland-dwelling animals were primarily diurnal during the autumn and winter. It was hypothesized that this behaviour was due to the almost impenetrable vegetation where the bandicoots occurred, which afforded protection from mammalian and avian predators (Lobert 1990).

Male bandicoots are highly pugnacious and mainly solitary from a young age. Aggressive behaviour is normally expressed as visible threats, chases, or avoidance of one sort or another. Scarring is also typical. Individuals apparently nest alone supporting suggestions of social intolerance (Stoddart and Braithwaite 1979). Extensive home range overlap and a lack of aggression between individual males have been observed, but this was attributed to high population densities. In contrast to male-male interactions, female-female and male-female interactions are rarely antagonistic. Interactions between male and female animals appears to be restricted to that necessary for reproduction.

Diet

Isoodon obesulus is omnivorous, opportunistically exploiting a wide variety of food resources such as invertebrates, plant material and fungi (Stoddart and Braithwaite 1979). Bandicoots obtain food by either searching or probing the litter and ground vegetation, or by digging in the soil. In such latter cases, the foraging activity of *I. obesulus* is indicated by the presence of characteristic scratch marks in the soil, often conical in shape and several centimetres deep. These forage-diggings cannot be distinguished from those made by other bandicoot species such as the Long-nosed Bandicoot. The holes are dug with the forefeet, and are usually large enough to accommodate the animal's snout when it is searching for food. A single animal may dig multiple holes in a small area if food is locally concentrated resulting in the soil-litter cover being severely pockmarked.

The subterranean food extracted by the species sometimes varies seasonally. In Tasmania, Heinsohn (1966). Lobert and Lee (1990) reported *that I. obesulus* in Southern Victoria mainly fed on a range of invertebrates during summer and autumn while during winter and spring the fruit-bodies of hypogeous fungi were favoured. In other studies, invertebrates have formed the most significant component of the diet year-round, with some plant material also consumed (e.g. Quin 1985). In south-eastern New South Wales, Claridge *et al.* (1991) found that sympatric populations of *I. obesulus* and *P. nasuta* had very similar diets, feeding mainly on ants, beetle larvae and plant material. Seeds and the fruit-bodies of hypogeous fungi were also consumed on a seasonal basis. There was some partitioning of the fungal species eaten.

Threats

Key factors thought responsible for the decline of *I. obesulus* across parts of its historical range include predation by feral carnivores, habitat loss and inappropriate fire regimes leading to degradation of habitat. Road-kill from vehicular traffic may also be impacting upon some populations of the species. Each of these potential threats is described in more detail below.

Natural, indigenous predators of *I. obesulus* include quolls, snakes and a variety of diurnal and nocturnal

raptors (Heinsohn 1966; Lobert and Lee 1990). The species is also preyed upon by feral foxes and dogs, and presumably by cats (Claridge *et al.* 1991; Paull 1999). The absence of the fox in Tasmania is thought to be a factor contributing to the widespread distribution and abundance of the species. In contrast, the presence of these feral predators in South Australia coincided with the disappearance of populations of bandicoots from several areas. Furthermore, there is some evidence to suggest that foxes may affect the sex ratio of populations of *I. obesulus*, with female animals being more susceptible to predation than male animals.

The clearance of native habitat for agricultural and pastoral use has been implicated in the local extinction of populations of *I. obesulus* across several States. For example, in southern New South Wales, clearing of the Bega Valley in the early part of this century led to massive decline in the number of bandicoots, although there is some uncertainty over whether these were *I. obesulus* or the related *P. nasuta* (Lunney and Leary 1988).

The effects of wildfire on *I. obesulus* are poorly known, although anecdotal information suggests that the species may respond positively to such disturbance in some instances. In Tasmania, populations of the species recovered well after wildfire. Similarly, at Nadgee Nature Reserve in southern New South Wales, bandicoots (*I. obesulus* and/or *P. nasuta*) were seen to increase in numbers four to five years after a severe wildfire and then decrease (Catling and Newsome 1981). However, in the same general area, following a repeat fire of similar intensity, bandicoots did not reach peak abundance until 14-15 years post-disturbance (Peter Catling, CSIRO Wildlife and Ecology, pers. comm.). To some extent, the rapidity with which bandicoots recover post-fire may depend on how quickly ground vegetation re-establishes. In some cases ground cover does not develop quickly enough, leading to the demise of populations. For example in the Mount Lofty Ranges in South Australia, wildfire caused an overall long-term reduction in the area of dense ground cover and localised extinction of the species occurred.

Braithwaite (1983) has hypothesized that the decrease in frequency of low-intensity fire following European occupation of south-eastern Australia has led to an overall decline in the distribution and abundance of *I. obesulus*. This hypothesis stems largely from observations made by Stoddart and Braithwaite (1979) at a single Victorian site, where animals were found to preferentially occupy young regenerating heathland. Research on the distribution and habitat preferences of the Southern Brown Bandicoot in South Australia (Paull 1995; 1999), supports the observations of Stoddart and Braithwaite (1979), in so far as animals were more likely to be found in areas with recent (5-7 year) evidence of fire. However, this seral stage of habitat was by far the most commonly represented across study sites, and bandicoots were also present in very recently burnt (1-2 year) and long unburnt (> 20 year) habitats. Although it appears that the species may be favoured by the careful and strategic use of prescribed fire, more information is required on the scale, intensity and timing of burning that might best suit animals.

There are several road-kill records of *I. obesulus* within Ku-ring-gai Chase National Park, immediately north of Sydney, and a smaller number from elsewhere in the southern part of the State. This indicates that where roading intersects suitable habitat, animals are susceptible to death or injury. This risk may be increased when individuals are dispersing to other areas.

Management

Management strategies for *I. obesulus* should focus on pro-

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moting and/or retaining areas of habitat with dense understorey vegetation. Where possible, a range of habitats of differing regeneration age post-disturbance (ie. through prescribed fire) should be created. Where fire is applied, the intervals between successive fires should be sufficiently long to enable regeneration of the understorey vegetation. Control of feral dogs, foxes and cats should be undertaken where the species is thought to be under threat from predation. This may particularly be the case where disturbance to understorey vegetation is planned to occur. Also, in areas of habitat adjacent to private land, responsible ownership of domestic pet should be promoted. For example, dogs should be kept on leashes when being walked and cats should be kept indoors after dark. When considering development proposals a series of environmental assessment principles should be implemented (see attached guidelines).

Recovery Plans

A draft recovery plan has been prepared for *I. obesulus* (NPWS 2001).

For further information, please contact the Southern Brown Bandicoot (*Isoodon obesulus*) Recovery Planning Officer at either:

Threatened Species Unit, Central Directorate, NSW NPWS, PO Box 1967, Hurstville NSW 2220. Phone (02) 9585 6678, or;

Threatened Species Unit, Southern Directorate, NSW NPWS, PO Box 2115, Queanbeyan NSW 2620. Phone (02) 6298 9727, or;

Website: www.npws.nsw.gov.au.

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Southern Brown Bandicoot

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Southern Brown Bandicoot is not known to occur on the Subject Site, but is a potential occurrence outside the proposed development area. There will be a loss of scattered trees and shrubs on the periphery of the proposed development, associated with Asset Protection Zones (for Bushfire Management purposes). The majority of these areas support a sparse ground cover, which provides little shelter for this species, suggesting that the habitat to be lost is unlikely to be preferred by the species.

Lack of disturbance to the preferred densely vegetated habitats of this species indicates that the proposal is not likely to disrupt the lifecycle of a population to the extent that it is placed at risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Southern Brown Bandicoot in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Southern Brown Bandicoot may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Southern Brown Bandicoot is comparatively well conserved in New South Wales throughout a limited distribution.

(q) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Southern Brown Bandicoot is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Squirrel Glider

***Petaurus norfolcensis* (Kerr, 1792)**

Other common names Flying Squirrel, Sugar Squirrel, Squirrel Flying Opossum, Squirrel Flying Phalanger

Squirrel Glider

Conservation status

The Squirrel Glider is listed as an **Vulnerable Species** on Schedule 2 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act).

Description (summarised from Suckling 1995)

Head and Body Length
180-230 (210)mm
Tail Length
220-300 (270)mm
Weight
190-300 (230)g

The Squirrel Glider is very similar in appearance to the smaller Sugar Glider, *Petaurus breviceps*. However, the Squirrel Glider has a longer, more pointed face, longer and narrower ears and a bushier tail. The fur is blue-grey to brown-grey above and white or cream below. A distinctive dark mid-dorsal stripe extends from between the eyes to mid-back. The tail is bushy and is covered with grey to black fur.

Vocalisation is a deep and throaty gurgling chatter.

Distribution

The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. The species is found inland as far as the Grampians in Victoria and the Pilliga and the Coonabarabran areas of NSW (Quin 1995; NPWS 1999). Suitable habitat also exists in the River Red Gum Forests and Yellow Box woodlands of the Murray Darling Basin (Quin 1995).

Recorded occurrences in conservation reserves

Blue Mountains NP, Brisbane Water NP, Tooloom NP, Border Ranges NP, Mount Warning NP, Warrumbungle NP and Binnaway NR (NPWS 1999).

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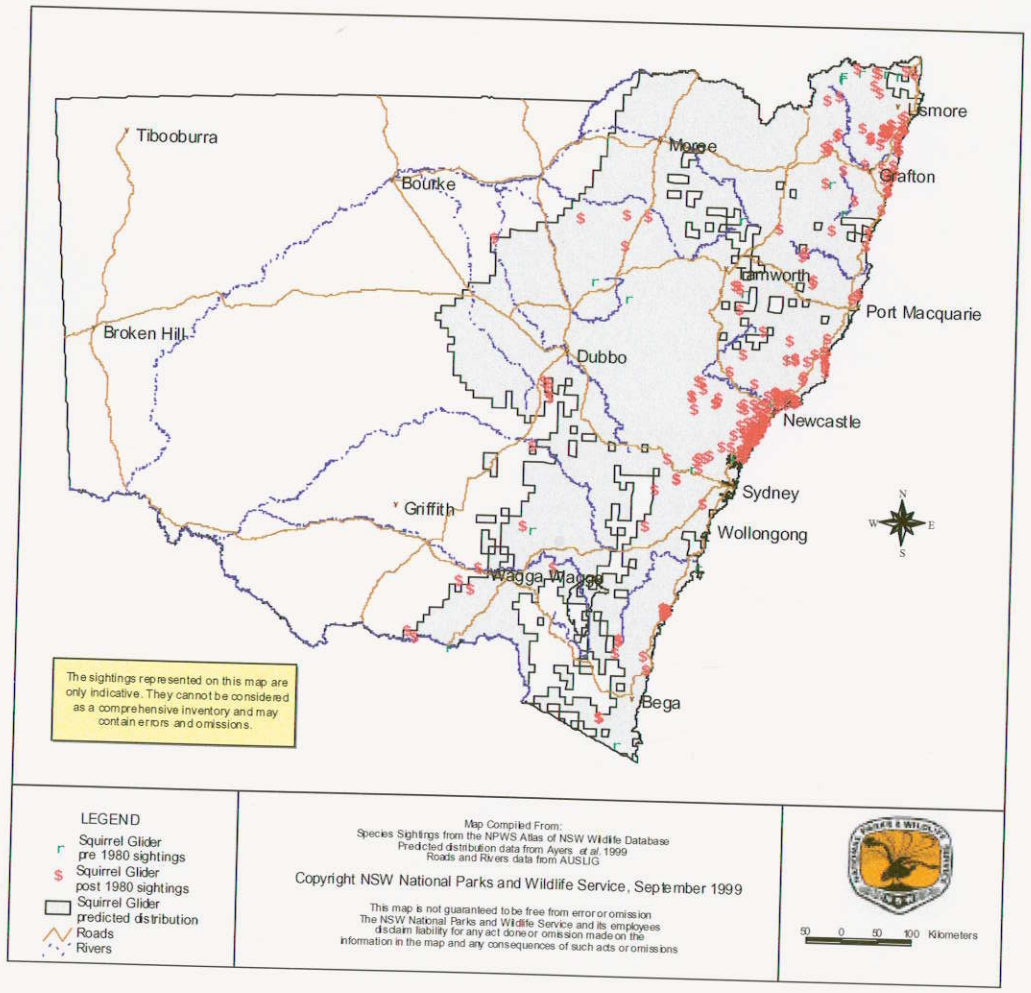

NPWS records of the Squirrel Glider in NSW

Habitat

The Squirrel Glider inhabits dry sclerophyll forest and woodland and is generally absent from rainforest and closed forest (Menkhorst *et al.* 1988).

In NSW, potential habitat includes Box-Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the north-east. Individuals have also been recorded in a diverse range of vegetation communities, including Blackbutt, Forest Red Gum and Red Bloodwood forests, Coastal Banksia heathland and Grey Gum/Spotted Gum/Grey Ironbark dry hardwood forests of the Central NSW Coast (Quin 1995).

The Squirrel Glider requires abundant hollow-bearing trees and a mix of eucalypts, acacias and banksias. Within a suitable vegetation community at least one flora species should flower heavily in winter and one or more of the eucalypts should be smooth-barked (Menkhorst *et al.* 1988; Quin 1995).

Ecology

The Squirrel Glider is nocturnal and shelters in tree hollows (Suckling 1995). This species lives in family groups of between 2 and 10, generally comprising of one male, at least 2 females and juveniles (Quin 1995; Suckling 1995). Births occur throughout the year and are likely to reflect the

availability of food, particularly pollen and nectar . Females are capable of raising two litters in a year and young are thought to leave the nest at around 6 months. Juveniles remain in their natal range for approximately 1 year after emerging from the nest, with juvenile males experiencing aggression from the dominant male. Juvenile mortality following dispersal is high, but established individuals are thought to survive for up to 6 years (Quin 1995).

Squirrel Gliders are agile climbers and can glide for more than 50m in one movement. Nightly movements are estimated as between 300 and 500m. Home-ranges have been estimated as between 0.65 and 8.55ha and movements tend to be greater for males than females . The home-range of a family group is likely to vary according to habitat quality and availability of resources (Quin 1995).

As an ecological specialist, the species feeds on nectar, pollen, flowers, acacia gum and insects, particularly caterpillars (Menkhorst & Collier 1987). Sap from the Yellow-bellied Glider's feeding scars may also be eaten. Squirrel Glider's forage in the upper and lower forest canopies and in the shrub understorey. During winter when other food resources are scarce the Squirrel Glider may obtain its energy from the winter flowers of the Coastal Banksia, Red Ironbark, River Red Gum, Grey Ironbark, Spotted Gum, Forest Red Gum and, in some areas, Blackbutt (Quin 1995). Xanthorrhoea and mature acacias may also provide a valuable food source. Smooth-barked eucalypts are preferred as these eucalypts form hollows more readily than rough-barked and support a greater diversity of invertebrates (Quin 1995).

Threats (Gilmore & Parnaby 1994; Menkhorst *et al.* 1988)

- Loss and fragmentation of habitat through clearing and associated activities
- Logging of old growth elements removes hollow bearing trees
- Inappropriate fire regimes may deplete food resources and isolate populations making them susceptible to regional catastrophic events
- Predation by foxes and cats

Management

- Protection and maintenance of known or potential habitat, including the implementation of protection zones around recent records
- Introduced animal control programs, specifically targeting recently disturbed areas with known or potential habitat for the species
- Alteration of prescribed burning and grazing regimes to ensure the enhancement and maintenance of floristic and structural diversity of the vegetation within known or potential habitat

Recovery plans

A recovery plan is being prepared for this species.

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For further information contact

Threatened Species Unit, Policy and Science Directorate Phone 02 9585 6540.
General enquiries: 43 Bridge St Hurstville NSW 2220 Phone 1300 36 1967 or 02 9585 6333.
Web site www.npws.nsw.gov.au

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Squirrel Glider

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Squirrel Glider may occur in remnant Eucalypt woodland on and adjacent to the Subject Site. This species may utilise habitats which will be cleared under the current proposal, although it's status on and near the site is not certain. Vegetation loss associated with the proposal will however, be limited to that required for Bushfire Management purposes (less than 0.5ha in extent) and a substantial area of vegetation will be conserved.

It is likely that if the Squirrel glider currently occurs on the Subject Site it will persist in the area of vegetation to be retained. Should the species occur, its lifecycle is not likely to be so significantly disrupted by a minor reduction in habitat that it will be placed at risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

The Pittwater population of the Squirrel Glider on the Barrenjoey Peninsula, north of Bushrangers Hill is listed as an Endangered Population on Part 2 of Schedule 1 of the Threatened Species Conservation Act. Should the Squirrel Glider occur on or adjacent to the Subject Site, it would not be a part of the Endangered Population. The life cycle of this species is not likely to be disrupted such that the viability of the population is likely to be significantly compromised

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Squirrel Glider may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Squirrel Glider is comparatively well conserved in New South Wales.

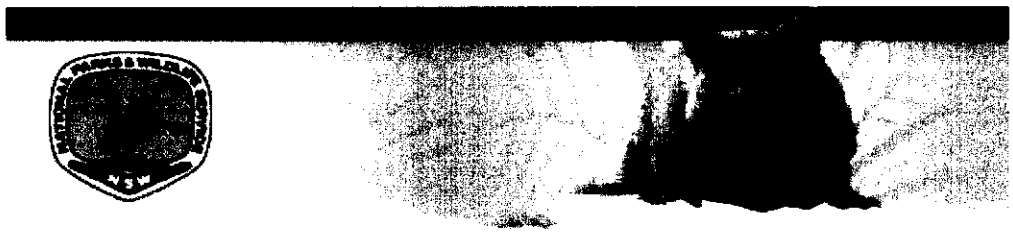
(r) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Squirrel Glider is not approaching the limit of its distribution in this area.



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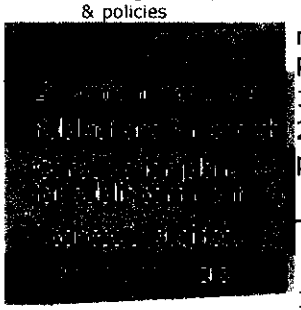

Eastern pygmy-possum - vulnerable species listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Eastern Pygmy-possum *Cercartetus nanus* (Desmarest, 1818) as a VULNERABLE SPECIES on Schedule 2 of that Act. Listing of vulnerable species is provided for by Part 2 of the Act.

The Scientific Committee found that:

1. The Eastern Pygmy-possum *Cercartetus nanus* (Desmarest, 1818) is a small arboreal marsupial that is distributed in the south-eastern corner of mainland Australia and in Tasmania. In New South Wales the species is found in coastal areas and at higher elevation in the south, but north of Newcastle at higher elevation only. Pygmy-Possums are agile climbers that feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit.

2. Although the Eastern Pygmy-possum is broadly distributed, recent studies have shown that within this range the species appears to be patchily distributed and its overall abundance is low.

3. Despite a large number of intensive trapping programs undertaken in the eastern forests and woodlands of New South Wales in recent years, only a small number of captures (154) have resulted from a total trapping effort of 315,000 Elliott trap-nights and 57,000 pitfall

Related information

- Mountain pygmy-possum - draft recovery plan (PDF - 2MB)
- Western pygmy possum - recovery plan (PDF - 400KB)
- Western pygmy possum - species profile (PDF - 189KB)
- Mountain pygmy-possum - endangered species listing
- Western pygmy possum - endangered species listing
- Exciting animal finds in Western NSW
- Pigmy possum survey in Snowy Mountains
- Plans to save mountain pygmy possum up for discussion
- Protecting threatened species in the ski resorts
- Royal's hidden population of pygmy possums astounds researchers
- SnowyHydro comes to the rescue to help endangered species

trap-nights (Bowen and Goldingay 2000).

4. Other detection techniques such as spotlighting, predator scat analysis, hair tubes and trapping in trees have produced similar low rates of detection. Capture rates are highest for installed nest-boxes and traps set in flowering banksias. This may reflect a habitat preference or a more successful trapping method.

5. From these and more recent studies (A. Tulloch, pers. comm.) there were only six, localities where more than 10 observations of Pygmy-Possums have been made. These were the Pilliga area, New England Tablelands, Barren Grounds Nature Reserve-Budderoo National Park, Royal and Heathcote National Parks, Kioloa State Forest and the Eden area.

6. The factors threatening the survival of the Eastern Pygmy-possum include isolated sub-populations with little opportunity for dispersal which increases the risk of local extinction, clearing that results in habitat loss and fragmentation, inappropriate fire regimes that remove nectar-producing understorey plants, the loss of nest sites due to past intensive forestry and firewood collection, and predation by foxes and cats.

7. In view of 2, 3, 4, 5 and 6 above, the Scientific Committee is of the opinion that the Eastern Pygmy-possum *Cercartetus nanus* is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate, and is therefore eligible for listing as a vulnerable species.

Proposed Gazettal date: 08/06/01
Exhibition period: 08/06/01 - 13/07/01

References

Bowen, M. and Goldingay, R. (1999) Distribution and status of the Eastern Pygmy Possum (Cercartetus nanus) in New South Wales. Aust Mammal. In press.

Turner, V. and Ward, S. (1995) Eastern Pygmy Possum Cercartetus nanus. In The Mammals of Australia, Ed. R. Strahan, pp 217-218. Reed Books: Sydney.

About the NSW Scientific Committee

Eastern Pygmy Possum

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Eastern Pygmy Possum may occur in remnant Eucalypt woodland on and adjacent to the Subject Site. This species may utilise habitats which will be cleared under the current proposal, although it's status on and near the site is not certain. Vegetation loss associated with the proposal will however, be limited to that required for Bushfire Management purposes (less than 0.5ha in extent) and a substantial area of vegetation will be conserved.

It is likely that if the Eastern Pygmy Possum currently occurs on the Subject Site it will persist in the area of vegetation to be retained. Should the species occur, its lifecycle is not likely to be so significantly disrupted by a minor reduction in habitat that it will be placed at risk of extinction.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Eastern Pygmy Possum in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Eastern Pygmy Possum may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Eastern Pygmy Possum is comparatively well conserved in New South Wales.

(s) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Eastern Pygmy Possum is not approaching the limit of its distribution in this area.

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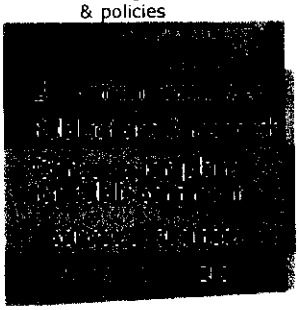

Large-eared pied bat - vulnerable species listing

The large-eared pied bat (*Chalinolobus dwyeri*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its population and distribution are suspected to be reduced
- It faces severe threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)
- It concentrates (individuals within populations of the species congregate or aggregate at specific locations)

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

Related information

- Bat calls of NSW - region-based guide to the echolocation calls of Microchiropteran bats
- Eastern bentwing-bat - vulnerable species listing
- Eastern cave bat - vulnerable species listing
- Eastern false pipistrelle - vulnerable species listing
- Eastern long-eared bat - vulnerable species listing
- Eastern long-eared bat - vulnerable species listing
- Golden-tipped bat - vulnerable species listing
- Greater broad-nosed bat - vulnerable species listing
- Hoary wattled bat - vulnerable species listing
- Inland forest bat - vulnerable species listing
- Large-footed myotis - vulnerable species listing
- Little bentwing-bat - vulnerable species listing
- Little pied bat - vulnerable species listing
- Lord Howe Island bat - presumed extinct species listing
- New guidebook tunes in to bat frequencies

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W., Law, B. and Fisher, D. (2000) The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Large-eared Pied-bat

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.

The Large-eared Pied-bat is not known to occur on the Subject Site, but is a potential occurrence. The loss of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. Such a minor loss of habitat is unlikely to threaten the viability of a local population of this species.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

There are no endangered populations of the Large-eared Pied-bat in this locality.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Large-eared Pied Bat may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility of this species suggests that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Large-eared Pied-bat is comparatively well conserved in New South Wales.

(t) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Large-eared Pied-bat is not approaching the limit of its distribution in this area.

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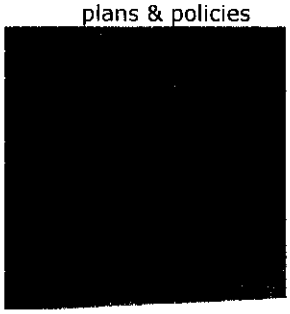

Eastern bentwing-bat - vulnerable species listing

The eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its population has been reduced to a critical level, but is suspected to be stable
- It faces severe threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)
- It concentrates (individuals within populations of the species congregate or aggregate at specific locations)

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened

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Related information

- Bat calls of NSW - region-based guide to the echolocation calls of Microchiropteran bats
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- Lord Howe Island bat - presumed extinct species listing
- New guidebook tunes in to bat frequencies

Species Conservation Act.

- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W., Law, B. and Fisher, D. (2000) The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney. Buy this publication from the NSW Government Online Bookshop.

Eastern Bent-wing Bat

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Eastern Bent-wing Bat is not known to occur on the Subject Site, but is a potential occurrence in habitats within and adjacent to the site, predominantly outside the proposed development area. The loss of a narrow strip of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. Such a minor loss of habitat is unlikely to threaten the viability of a local population of this species.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Eastern Bent-wing Bat in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Eastern Bent-wing bat may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility of this species suggests that minor habitat losses will not compromise movement at the landscape scale.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.

The NPWS information sheet indicates that the Eastern Bent-wing Bat is comparatively well conserved in New South Wales.

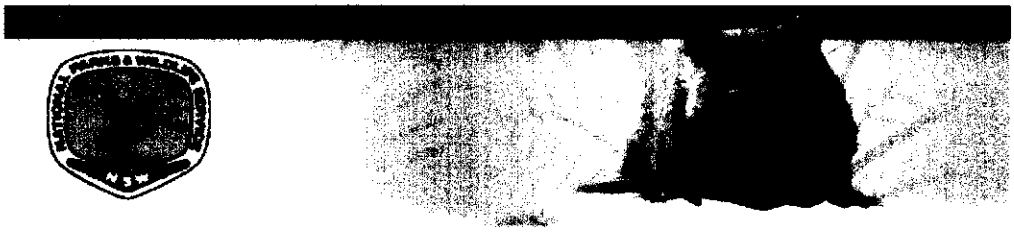
(u) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Eastern Bent-wing Bat is not approaching the limit of its distribution in this area.



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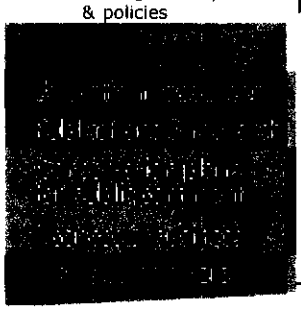

Greater broad-nosed bat - vulnerable species listing

The greater broad-nosed bat (*Scoteanax rueppellii*) is listed as VULNERABLE on the schedules of the NSW Threatened Species Conservation Act. The species was listed because:

- Its population has been reduced
- It faces severe threatening processes
- It is an ecological specialist (it depends on particular types of diet or habitat)

The above reasons are a summary of why the species was listed as vulnerable. The reasons are based on:

- Criteria set down in the Endangered Fauna (Interim Protection) Act, which has now been replaced by the Threatened Species Conservation Act.
- Data obtained from a questionnaire sent out to experts on this species. The questionnaire was used to evaluate the status of all threatened and non-threatened native vertebrates in NSW. The results were published in an NPWS monograph which you can buy online - see below for more details.

More information

- Lunney, D., Curtin, A.L., Ayers, D., Cogger, H.G., Dickman, C.R., Maitz, W., Law, B. and Fisher, D. (2000) The threatened and non-threatened native

Related information

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- Little hentwing-bat - vulnerable species listing
- Little pied bat - vulnerable species listing
- Lord Howe Island bat - presumed extinct species listing
- New guidebook tunes in to bat frequencies

Greater Broad-nosed Bat

(a) **In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.**

The Greater Broad-nosed Bat is not known to occur on the Subject Site, but is a potential occurrence in habitats within and adjacent to the site, predominantly outside the proposed development area. The loss of a narrow strip of Eucalypt woodland as a result of fire management practices will reduce the overall availability of this habitat (which is broadly suitable for this species) in the locality. The disturbance will however, be limited to an existing edge and will not fragment a consolidated patch of habitat. Such a minor loss of habitat is unlikely to threaten the viability of a local population of this species.

(b) **In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.**

There are no endangered populations of the Greater Broad-nosed Bat in this locality.

(c) **In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.**

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Greater Broad-nosed Bat may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) **Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.**

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility of this species suggests that minor habitat losses will not compromise movement at the landscape scale.

(e) **Whether critical habitat will be affected**

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Greater Broad-nosed Bat is comparatively well conserved in New South Wales.

(v) **Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.**

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Greater Broad-nosed Bat is not approaching the limit of its distribution in this area.

THREATENED SPECIES INFORMATION

Grey-headed Flying-fox

Pteropus poliocephalus Temminck, 1825

Conservation Status

The Grey-headed Flying-fox is listed as a **Vulnerable Species** on Schedule 2 of the NSW *Threatened Species Conservation Act, 1995* (TSC Act), and as a **Vulnerable Species** under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Population estimates indicate that this species has declined by approximately 30% over the last 10 years (Tidemann *et al*., 1999).

Description (from Tidemann, 1995 and Eby, 1995)

Head and body length
230 - 289 mm
Forearm length
138 – 180 mm
Weight
600 - 1000 g

Grey-headed Flying-fox

The Grey-headed Flying-fox has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. This species can be distinguished from other flying-fox species by leg fur which extends to the ankle. Wing membranes are black and the wingspan can be up to one metre.

Distribution

The Grey-headed Flying-fox is endemic to Australia. It occurs along the east coast from Bundaberg in Queensland to Melbourne, Victoria (Eby, 2000a). The distribution of this species has contracted south, formerly ranging north to Rockhampton (Eby, 2000a). This species may range to the western slopes of the Great Dividing Range in northern NSW (Eby, 1991). At any one time, the majority of animals only occupy a small proportion of this entire range.

Recorded Occurrence in Conservation Reserves

In NSW, Grey-headed Flying-foxes have been recorded in numerous conservation reserves along the east coast, and the tablelands and eastern slopes of the Great Dividing Range.

Habitat

The Grey-headed Flying-fox occurs in "subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps" (Eby, 1995). Urban gardens and cultivated fruit crops also provide habitat for this species. The Grey-headed Flying-fox is ineligible for critical habitat declaration given its status as a Vulnerable Species.

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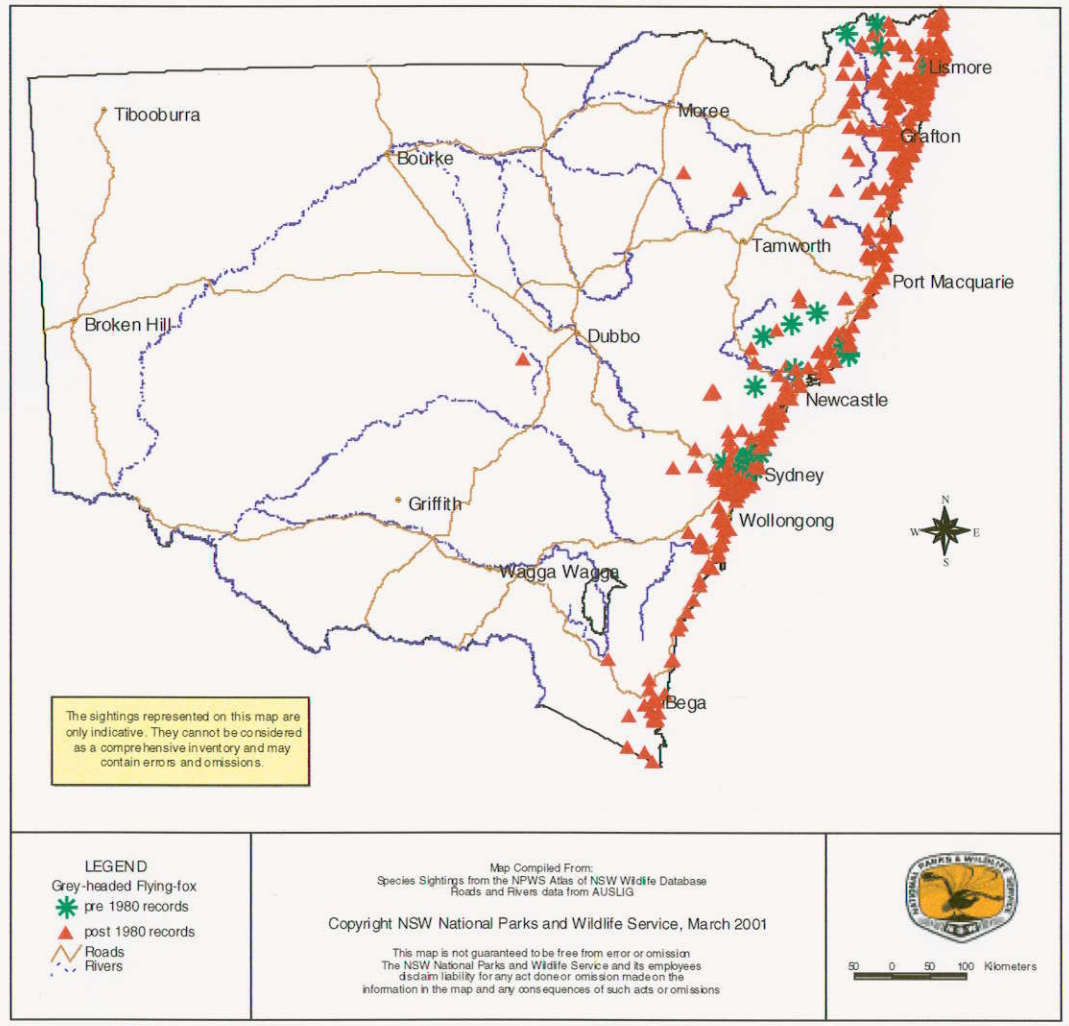

NPWS records of the Grey-headed Flying-fox in NSW

Ecology

Grey-headed Flying-foxes forage on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia* (Eby, 2000a), and fruits of rainforest trees and vines. This species is an important pollinator and seed-disperser of native trees.

The availability of native fruits, nectar and pollen varies over time and throughout the range of the species. Grey-headed Flying-foxes accommodate this by migrating in response to food availability, sometimes travelling hundreds of kilometres. In addition, during periods when native food is limited, Grey-headed Flying-foxes disperse from colonial roosts, often foraging in cultivated gardens and fruit crops. This species occasionally inflicts severe crop damage during periods of native food shortage.

A number of studies have noted the annual southerly movement of animals in spring and summer and their return to the coastal forests of north-east NSW and south-east Queensland in winter (Ratcliffe, 1932; Eby, 1991; Parry-Jones & Augee, 1992). This results in large fluctuations of the numbers of this species in NSW from as few as 20% of the total population in winter up to around 75% of the total population in summer (Eby, 2000a).

This species roosts in large aggregations or 'camps' of up to tens of thousands of animals, depending upon the abundance of

locally available food sources. Camps are generally located in close proximity (20 km or less) to a regular food source, often in stands of riparian rainforest, Paperbark or Casuarina forest (Eby, 1995). Site fidelity is high and some camps in NSW have been used for over a century (Eby, 2000b).

Grey-headed Flying-foxes breed annually with mating commencing in January. Males use strongly-scented secretions to mark mating territories and loud calls are made while defending territories and during mating. This species has a sophisticated array of vocalisations (Tidemann, 1995) and noise at camps can be substantial.

The majority of reproductively mature females give birth to a single young each October/November after a 6-month gestation. Females carry their dependent young during foraging flights for 3 weeks following birth. For the next 2 months, flightless young remain at the camp while adults forage. At around 3 months, young are able to fly and forage outside the camp, and at 6 months they are weaned.

Threats

- Destruction of habitat by clearing for urban development and agriculture, particularly critical winter foraging habitat in the coastal forests of north-east NSW (Eby, 2000a). Loss of foraging habitat increases the severity of food shortages leading to starvation of animals, spontaneous abortion and high infant mortality;
- Disturbance at roosting sites, particularly during the last few weeks of pregnancy when females can spontaneously abort;
- Unregulated shooting;
- Electrocution on power lines;
- Competition and hybridisation with the Black Flying-fox *Pteropus alecto*.

Management

- Research into the biology and ecology of the species, in particular recruitment rates and longevity;
- Continuing synchronous annual counts to track population trends and monitor success of management actions;
- Conducting education programs to increase awareness about Grey-headed Flying-foxes;
- Encouraging and supporting industry groups in conducting research to identify alternative non-lethal crop protection mechanisms and encouraging horticulturalists to employ those mechanisms;
- Implementing strict enforcement of licence conditions and taking appropriate action against unlicensed shooting;
- Consultation and negotiation with Local Government and residents to resolve existing conflict with roost sites;
- Identification and protection of key foraging areas to ensure foraging resources are available throughout the year;
- Protection of roost sites through conservation mechanisms such as Local Government zonings or Voluntary Conservation Agreements;
- Provision of appropriate buffer zones around roost sites in Local Environment Plans to restrict development which may result in conflict between residents and flying-foxes.

Recovery Plans

Under the *Threatened Species Conservation Act* 1995, a Recovery Plan for the Grey-headed Flying-fox is required to be prepared by 2006.

References and Further Reading

Eby, P. 1991. Seasonal movements of Grey-headed Flying-foxes, *Pteropus poliocephalus* (Chiroptera: Pteropodidae), from two maternity camps in northern New South Wales. *Wildlife Research* 18: 547-559.

Eby, P. 1995. The biology and management of flying-foxes in NSW: Species management report number 18. Llewellyn, L. (ed). NPWS, Hurstville.

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NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

Grey-headed Flying Fox

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population is likely to be placed at risk of extinction.

The Grey-headed Flying Fox is not known to occur on the Subject Site, but is a likely occurrence. This species is likely to utilise the site when dominant Eucalypts are in blossom. A small number of Eucalypts will be lost under this proposal, but this ill be mitigated by revegetation works in the waterway corridor. There should be no net loss of habitat from the Subject Site for this species under this proposal.

Given that there will be no long-term reduction in foraging resources for this species, and no disturbance to potential roost areas, the current proposal is unlikely to compromise the long term viability of a local population of this species.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

There are no endangered populations of the Grey-headed Flying Fox in this locality.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The proposal will require the removal of a narrow band of vegetation at the existing edge of a relatively large patch of habitat. The Grey-headed Flying Fox may make use of the forest edge/development interface. However, the loss incurred (<0.5ha) could not be considered significant at a regional scale.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The proposed development is primarily located within an existing cleared area, and although contributing to edge effects, will not actually fragment an intact area of bushland or sever a movement corridor which might be utilised by this species. In addition, the mobility of this species suggests that minor habitat losses will not compromise movement at the landscape scale.

(e) Whether critical habitat will be affected

The proposed development will not affect critical habitat.

(f) **Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (other similar protected areas) in the region.**

The NPWS information sheet indicates that the Grey-headed Flying Fox is comparatively well conserved in New South Wales.

(w) Whether the development or activity proposed is of class of development or activity that is recognised as a threatening process.

The proposed development will involve the clearing of native vegetation, which is recognised as a Key Threatening Process (KTP) under the TSC Act. The Scientific Committee Determination regarding this KTP found that clearing of any area of native vegetation, including areas less than 2 hectares in extent, may have significant impacts on biological diversity.

This development will result in the removal of 0.6ha of vegetation, contributing to this Key Threatening Process, however, the disturbance area is on the edge of a larger remnant and contains many regrowth elements. In addition, an area of approximately 0.5ha will be revegetated along the site waterway, improving off-site connectivity and offsetting the habitat loss.

(h) **Whether any threatened species, population or ecological community is at the limit of its known distribution.**

The Grey-headed Flying Fox is not approaching the limit of its distribution in this area.

APPENDIX 11
SEPP 44 ASSESSMENT

1.0 Is the land within a local government area identified in Schedule 1 of the policy?

Yes. The site is situated within the Pittwater LGA.

2.0 Does the land contain potential Koala habitat?

Yes, surveys indicate that the area is currently used by Koalas.

3.0 Do Schedule 2 species comprise greater than 15% of species in the upper and lower strata of the tree component?

No schedule 2 species were recorded at the site.

4.0 Is the land core Koala Habitat?

NA

5.0 Is a Plan of Management required?

There is no requirement to prepare a Koala plan of management.

Warriewood

Ecological Assessment Report

Part 2

Ecological Sustainability Plan

Prepared for
Jubilee Developments

December 2004

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place
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place

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TABLE OF CONTENT

1.0 INTRODUCTION

1.1 BACKGROUND

PLACE Environmental has been engaged to prepare an Ecological Sustainability Plan for a proposed development at 4 & 8 Forest Road Warriewood. The Ecological Sustainability Plan is a map based report written for the property owner and those living on the site to aid them in maximising the long-term sustainability of the sites (and Pittwater's) ecological processes (natural areas). The Plan applies to the site for the life of the development.

1.2 CONTENT OF THE ECOLOGICAL SUSTAINABILITY PLAN

The following table lists issues that are to be addressed in the ESP. All issues will not apply to all sites. Tick which issues are covered and insert n/a if the issue does not apply to the site. Note all sites are to retain areas of native vegetation and key habitat features for the life of the development.

TABLE 1
Requirements of Ecological Sustainability Plan–Site Plan

Annotated plan showing the following	*√ or n/a*
All areas of native vegetation	√
Native trees include species, size, condition (e.g. SULE rating) Accurate survey and describe native trees within 5m of proposed works	N/A
Trees to be retained and those to be modified/removed	√
Areas with medium to high regeneration potential	√
Areas of native vegetation to be retained	√
Areas of vegetation proposed to be removed	√
Areas of Noxious and Environmental Weeds	√
Areas of habitat features, bushrock (over 2m), caves, termite mounds etc	√
Footprint of house and associated works (fuel reduced zones, waste-water etc)	√
Areas for exclusion fencing–during development/establishment phase	√
Areas appropriate for storage of materials during construction	√
Recommended access ways during construction	√
Areas for bush-regeneration	√
Areas for planting trees (if appropriate)	√
Areas for planting low and or mid strata	√
Areas for landscaping	√
Fuel reduced zone	√
Fuel free zone	√
Waste-water disposal zone	N/A
Recommended Environmental Protection Zone (EPZ) *if appropriate*	√
Areas for managing domestic animals (see requirements of Pittwater Council Control Documents *Pittwater 21*)	√
Wildlife Corridors and Core/Fragmented Bushland (as per Pittwater Council Maps)	√

1.3 REQUIREMENTS OF ECOLOGICAL SUSTAINABILITY PLAN–REPORT

TABLE 2
Requirements of Ecological Sustainability Plan–Report

Report covering	√ *or n/a*
Site Preparation Description of: ▪ Tree, vegetation and habitat protection, ▪ Sediment and erosion control for natural features, ▪ Weed control, ▪ Top soil/ litter layer treatment, ▪ Surface treatment and stabilisation (mulch etc), ▪ Site drainage with respect to natural features,	√
Weed Removal and Regeneration ▪ List of Noxious and Environmental Weeds	√
▪ Timeline for removing Noxious Weeds and controlling/removing Environmental Weeds (*for updated weeds list see Dept of Agriculture web page*). Timeline to include the area / number of weed species acceptable as a background level. Cross reference location with Map.	√
Description of Planting (if planting) ▪ Planting aims, e.g. supplementary planting in a regeneration area, or a native vegetation area or planting in a landscape area.	√
▪ Species list recommended for planting–as appropriate (if the ESP is replacing a Landscaping Plan give details of species to be planted and size range / Pittwater Spotted Gum Forest Endangered Ecological Community.). Identify source of local native, plant stock.	See detail by others
▪ Description of areas for bush regeneration, trees to be retained, trees to be planted (and what size), etc	See detail by others
▪ A schedule of materials–including elements such as weed matting, mulch, edging, walling, paving and fencing.	See detail by others
▪ Description of works meeting minimum requirements of Landscaping Policy (i.e. 50% of development screened in 3 yrs).	See detail by others
Long-term Management ▪ Management of habitat features, including protection during construction and for the life of development. Also include the provision of nesting boxes etc as appropriate. Maintenance period for 12 to 24 months after Issue of Occupation Certificate. NB maintenance can be by land occupier.	√
▪ Indicate areas that are to be maintained as 'bushland' for the life of the development	√
▪ Description of exclusion areas for domestic animals *as relevant*	√
▪ Reference to other documents if relevant (e.g. frequency and type of fuel reduction, care for on-site water disposal system)	√
Check-sheets listing activities to be completed on an on-going basis.	
▪ List of Noxious Weeds to be managed/removed (at all times).	√
▪ List of Environmental Weeds to be managed/removed (all times).	√
▪ Area of native vegetation and trees to be maintained/retained.	√
▪ Area from which domestic animals are not permitted.	√

2.0 SITE PREPARATION

2.1 TREE, VEGETATION AND HABITAT PROTECTION

The proposed development will result in some habitat loss, although the majority of existing vegetation will be conserved. Development will be largely confined to an area of open grassland, with very minor encroachment of development and bushfire buffers into the disturbed edge of existing vegetation (see site plan **FIGURE 1**).

2.2 SEDIMENT AND EROSION CONTROL FOR NATURAL FEATURES

A range of measures would be adopted during the construction and occupation phase of the development to control sedimentation and erosion. In particular, the site will drain to detention basins close to the eastern waterway, but located outside of proposed revegetation areas (see site plan). Construction management should be addressed in a detailed sediment and erosion plan.

2.3 WEED CONTROL

There are a number of different methods for controlling environmental weeds. Control methods can be manual, mechanical, chemical, biological, or environmental. The choice of method/s varies according to the weed species, its density, and available resources (time, labour, equipment, finances) (Ousterhout 2003). The following table lists the various methods and techniques associated with the different types of control.

TABLE 1
Methods and Techniques of Weed Control

Control Type	Methods and Techniques
Manual	• Hand pulling • Digging out crown • Chipping/Grubbing
Mechanical	• Slashing • Pushing by tractor or dozer • Harvesting • Brush cutting • Chainsawing
Environmental	• Using fire to alter the weed's preferred environment. • Using moisture to alter the weed's preferred environment • Use of native vegetation to alter the weed's preferred environment
Biological	• Use of predatory insects • Use of biological diseases (fungi, bacteria)
Chemical	• Foliar spraying • Basal Bark Spraying • Stem injection • Cut stump

After Ousterhout (2003)

A suitably qualified and experienced weed control contractor will be employed to carry out weed control works. Weed eradication will be undertaken on a progressive basis through localised treatment of invasive species with non-residual herbicides or other appropriate methods (see above). Follow up treatments will be undertaken as determined by the contractor to treat germinating seeds and re-shooting individuals.

FIGURE 1 SITE PLAN

DETAIL 1 TREE RETENTION

SCHEDULE 1 GENERAL EXCLUSION ZONE RESTRICTIONS

- Parking or movement of construction machinery and vehicles;
- Placement of site offices, storage sheds, portaloos, and other permanent or temporary structures;
- Storage of building materials, fuels and other chemicals;
- Dumping of excess materials and / or wastes; and
- Washing off vehicles and construction machinery, rinsing out fuel containers, and disposal of cleaning products.

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warriewood environment
site plan

figure 1
site plan
date: 8 december 2004
project no: jub01_01/a
scale: as indicated
source: pittwater council March 2002

2.4 TOP SOIL/ LITTER LAYER TREATMENT/ SURFACE TREATMENT AND STABILISATION

Areas to be retained as natural bushland will not be modified by any treatment. The Waterway revegetation area will be mulched using a suitable weed free product to exclude weeds and reduce topsoil loss.

2.5 SITE DRAINAGE WITH RESPECT TO NATURAL FEATURES

There will be no engineering works within the site waterway. An overland flow path in the western portions of the site will be incorporated as a landscaped swale, to the specifications of the hydraulic engineer.

3.0 WEED REMOVAL AND REGENERATION

3.1 LIST OF NOXIOUS AND ENVIRONMENTAL WEEDS

TABLE 2
List of Noxious and Environmental Weeds

Family		Botanical Name	Common Name
Agavaceae	*	*Agave vivipara*	Agave
Anacardiaceae	*	*Mangifera indica*	Mango
Apiaceae	*	*Centella asiatica*	Pennywort
Apiaceae	*	*Platysace lanceolata*	
Araceae	*	*Monstera deliciosa*	Monsterio
Araliaceae	*	*Schefflera actinophylla*	Umbrella tree
Araucariaceae	*	*Araucaria heterophylla*	Norfolk Island pine
Arecaceae	*	*Syagrus sp.*	Cocos palm
Asparagaceae	*	*Asparagus africanus*	Asparagus fern
Asteraceae	*	*Ageratina adenophora*	Crofton weed
Asteraceae	*	*Bidens pilosa*	Farmers friends
Asteraceae	*	*Conzya albida*	Fleabane
Asteraceae	*	*Erechtites valerianifolia*	Brazilian fireweed
Asteraceae	*	*Silybum marianum*	Milk thistle
Asteraceae	*	*Tagetes minuta*	Stinking Roger
Asteraceae	*	*Taraxacum officinale*	Dandelion
Basellaceae	*	*Anredera cordifolia*	Madeira vine
Bignoniaceae	*	*Jacaranda mimosifolia*	Jacaranda
Cactaceae	*	*Opuntia sp.*	Prickly pear
Caesalpiniaceae	*	*Senna pendula* var. *glabrata*	Winter senna
Cannaceae	*	*Canna indica*	Canna lily
Commelinaceae	*	*Commelina cyanea*	Scurvy weed
Crassulaceae	*	*Bryophyllum delagoense*	Mother-of-millions
Davalliaceae	*	*Nephrolepis cordifolia*	Fishbone fern
Dracaenaceae	*	*Sansevieria trifasciata*	Mother-in-law's tongue
Euphorbiaceae	*	*Euphorbia sp.*	Poinsettia
Euphorbiaceae	*	*Ricinus communis*	Castor oil bush
Fabaceae	*	*Bauhinia sp.*	-
Fabaceae	*	*Desmodium rhytidophyllum*	-

Family		Botanical Name	Common Name
Lauraceae	*	*Cinnamomum camphora*	Camphor laurel
Malvaceae	*	*Sida rhombifolia*	Paddy's lucerne
Melastomacease	*	*Tibouchina sp.*	Tibouchina
Musaceae	*	*Musa sp.*	Banana
Myrtaceae	*	*Callistemon spp.*	Bottlebrush species
Oleaceae	*	*Ligustrum sinense*	Small-leaved privet
Passifloraceae	*	*Passiflora edulis*	Passionfruit vine
Phytolaccaceae	*	*Phytolacca octandra*	Inkweed
Poaceae	*	*Andropogon virginicus*	Whisky grass
Poaceae	*	*Cortaderia selloana*	Pampas grass
Poaceae	*	*Bambusa sp.*	Bamboo
Poaceae	*	*Paspalum dilatatum*	Paspalum
Poaceae	*	*Pennisetum clandestinum*	Kikuyu grass
Proteaceae	*	*Macadamia sp.*	Macadamia cultivar
Rosaceae	*	*Malus sp.*	Apple
Rutaceae	*	*Citrus sp.*	Bush lemon
Solanaceae	*	*Cestrum nocturnum*	
Solanaceae	*	*Cestrum parqui*	
Solanaceae	*	*Solanum americanum*	Blackberry nightshade
Solanaceae	*	*Solanum mauritianum*	Wild tobacco
Solanaceae	*	*Solanum nigrum*	Black nightshade
Verbenaceae	*	*Lantana camara*	Lantana
Verbenaceae	*	*Verbena bonariensis*	Purple top

3.2 TIMELINE FOR REMOVING NOXIOUS WEEDS AND CONTROLLING/REMOVING ENVIRONMENTAL WEEDS

Initially, all woody weeds should be removed using appropriate control methods from the Ecological Protection Zone and Waterway Rehabilitation Zone. Follow up weed removal and management should be implemented as required at 1 month, 3 months, 6 months, 12 months, 18 months, 24 and 36 months.

4.0 DESCRIPTION OF PLANTING

4.1 PLANTING AIMS

The site Waterway will be rehabilitated using an appropriate mix of native flora with a view to restoring historical patterns of vegetation. It is considered likely that the waterway on the northern boundary would have supported a mix of Coastal Swamp Forest Complex and Sydney Sandstone Gully Forest vegetation.

4.2 SPECIES LIST RECOMMENDED FOR PLANTING

A Landscaping Plan has been prepared which provides further detail regarding species to be utilised, proposed spacing and size classes.

4.3 DESCRIPTION OF AREAS FOR BUSH REGENERATION

The proposed Waterway Rehabilitation Zone is shown on the site plan and incorporates the entire length of the waterway on the Subject Site. A Landscaping Plan has been prepared which provides further detail regarding species to be utilised, proposed spacing and size classes.

5.0 LONG-TERM MANAGEMENT

5.1 MANAGEMENT OF HABITAT FEATURES

There are no areas in which establishment of roads and services affect the Waterway Rehabilitation Zone or Environmental Protection Zone, and designating these areas as exclusion zones during the construction phase should control indirect impacts. These areas are to remain as exclusion zones during construction of dwellings. Exclusion zone restrictions include:

- Parking or movement of construction machinery and vehicles except those involved in the rehabilitation works[1];
- Placement of site offices, storage sheds, portaloos, portable concrete mixers and other permanent or temporary structures;
- Storage of building materials, fuels and other chemicals;
- Dumping of excess building materials, disposal of landscape wastes; and
- Washing off vehicles and construction machinery, rinsing out paint tins, and disposal of cleaning products.

5.2 ENVIRONMENTAL PROTECTION ZONES

A large proportion of the Subject Site will be included within an Environmental Protection Zone (EPZ). There will be no access to this zone for residents, and it is intended that domestic pets be completely excluded.

The Waterway Rehabilitation Zone will become an EPZ once it is considered to be off maintenance. The rehabilitation of this zone should be in accordance with a detailed Vegetation Management Plan which specifies minimum performance requirements and timeframes. There will be no public access save for a single bridge to the north, and a proposed pedestrian/cycle path.

[1] The Landscape/Rehabilitation Contractor is to develop a series of logical pathways to minimise disturbance to planting areas.