

WARRINGAH NATURAL AREA SURVEY

Vegetation History and Wildlife Corridors
August 2005

WARRINGAH COUNCIL



Warringah Council

Jamieson Park, Narrabeen Lagoon
photo by Peter Smith

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Summary

Warringah Council's Natural Area Survey has surveyed and mapped the native vegetation of the Warringah Local Government Area outside Ku-ring-gai Chase and Garigal National Parks. NSW Department of Environment and Conservation has mapped the vegetation within the national parks. The present report draws on this mapping to estimate the distribution of native vegetation types in the Warringah Local Government Area prior to European settlement, for comparison with their present distribution; and to identify existing and potential wildlife corridors linking the remnant bushland in Warringah.

Three maps have been produced and incorporated in Council's geographic information system: maps of the distribution of 11 native vegetation types in the Warringah Local Government Area in 1750 and 2000, and a map of existing and potential wildlife corridors in Warringah. A table has been compiled subdividing the 11 vegetation types into 37 vegetation communities and estimating the area of each community in 1750 and in 2000, with a further breakdown showing the reservation status of the remaining vegetation. Also present in Warringah are two derived communities (not present in 1750) and a submerged aquatic community (not mapped).

Forty-one percent of the native vegetation of the Warringah Local Government Area has been lost since 1750, but the impact of clearing has been very uneven. Fifteen of the 37 vegetation communities have been cleared to less than 30% of their original area. The majority of these are communities that are more or less restricted to the vicinity (within 4 km) of the coast, where very little native vegetation now remains. Away from the coast, the most reduced communities are those associated with shale lenses on ridges and plateaus in Hawkesbury Sandstone. The flat topography, absence of rock outcrops, and the more fertile soils, meant that these sites were selectively cleared for agricultural and later urban development in Warringah, in preference to the rocky, rugged, infertile sandstone areas.

Twenty-two of the 37 vegetation communities are poorly represented in reserves, with less than 15% of their estimated area in 1750 reserved in national parks or other reserves, or else with a reserved area of less than 5 ha. The 22 communities are:

- Bangalay Slopes Forest – 10% remains, 5% reserved (8 ha reserved)
- Silvertop Ash-Brown Stringybark Forest – 21% remains, 14% reserved (120 ha)
- Blackbutt-Turpentine Forest – 10% remains, 1% reserved (2 ha)
- Angophora-White Mahogany Forest – 100% remains (3 ha), none reserved
- Coastal Banksia-Eucalypt Scrub – 7% remains, 6% reserved (10 ha)
- Forest Oak Forest – 69% remains, almost all reserved, but only 2.5 ha
- Tall Open-forest/Closed-forest – 69% remains, all reserved, but only 4.5 ha
- Coastal Banksia-Teatree Scrub – 13% remains, almost all reserved (1.5 ha)
- Narrabeen Escarpment Scrub – 34% remains, 12% reserved (1.5 ha)
- Themeda Grassland – 13% remains, all reserved (0.7 ha)
- Lomandra Sedgeland – 23% remains, all reserved, but only 0.2 ha
- Sandstone Headland Heath – 13% remains, almost all reserved (7.5 ha)
- Heart-leaved Stringybark Mallee – 68 % remains, 7% reserved (0.3 ha)
- Estuarine Reedland – 16% remains, 10% reserved (5 ha)
- Estuarine Paperbark Scrub – 50% remains, all reserved, but only 2.5 ha
- Swamp Mahogany Forest – 16% remains, 12% reserved (4.5 ha)
- Bangalay Alluvial Forest – 16% remains, 13% reserved (41 ha)
- Palm Woodland – 16% remains, 9% reserved (8.5 ha)
- Water Fern Swamp – 16% remains, 13% reserved (5 ha)
- Paperbark Swamp – 16% remains, all reserved, but only 4 ha
- Coastal Freshwater Lagoon – 100 % remains, all reserved, but only 2 ha
- Coastal Dune Swamp – 1.5% remains, 1% reserved (0.5 ha)

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1. Introduction

The Warringah Natural Area Survey involved identifying, describing and mapping the native vegetation communities of the Warringah Local Government Area outside Ku-ring-gai Chase and Garigal National Parks. Thirty-seven vegetation communities were identified in the study area. These can be grouped into 11 broader vegetation types, corresponding to the vegetation map units of Benson and Howell (1994), plus a twelfth type for derived communities (i.e. communities that were not part of the original vegetation of Warringah but have developed as a result of human activities). The 37 vegetation communities, and their component plant species, are described and discussed in a separate report (Smith and Smith 2005). The vegetation maps resulting from the survey, showing the distribution and condition of the 37 vegetation communities throughout the Warringah area, have been incorporated in Warringah Council's geographic information system.

The present report addresses two additional aspects of the Warringah Natural Area Survey:

- an assessment of the distribution of native vegetation types in the Warringah Local Government Area prior to European settlement, for comparison with their present distribution; and
- identification of existing and potential wildlife corridors linking the remnant bushland in Warringah and providing opportunities for movement and genetic exchange of fauna and flora between remnants.

2. Vegetation History

2.1 Methods

The distribution of vegetation communities in Warringah is related to geology, soils and topography (Smith and Smith 2005, Thomas and Benson 1985, Sheringham and Sanders 1993, Lembit 2000). Each community has a specific habitat that makes it possible to estimate their former distribution in the cleared or highly disturbed areas of Warringah by extrapolation from the remnant vegetation using geological, soils and topographic maps.

The vegetation types used for the historical mapping were the vegetation map units of

Benson and Howell (1994). Base maps at a scale of 1:20 000 were obtained from Warringah Council's geographic information system showing the present distribution of the vegetation types, based on the Warringah Natural Area Survey (Smith and Smith 2005). The maps also included NSW Department of Environment and Conservation vegetation mapping for Ku-ring-gai Chase and Garigal National Parks, based on the surveys by Thomas and Benson (1985), Sheringham and Sanders (1993) and Lembit (2000), each of which uses a different vegetation classification system. The various DEC vegetation map units were converted to the corresponding Benson and Howell (1994) types as described in Table 2 of Smith and Smith (2005). The distribution of the Duffys Forest vegetation community in the national parks has been mapped more accurately by Smith and Smith (2000), and this mapping was incorporated in the base maps in place of the DEC mapping.

The original vegetation in the now cleared and highly disturbed parts of the Warringah Local Government Area was estimated using the following:

- vegetation and topographic maps at a scale of 1:8500 from the Warringah Natural Area Survey (Smith and Smith 2005),
- maps of the current (scale 1:16 000) and estimated past (scale 1:100 000) distribution of the Duffys Forest vegetation community (Smith and Smith 2000),
- a 1:12 500 map of the extent of wetland vegetation along Dee Why Creek in 1946, based on aerial photographs (Winning 1994),
- Sydney 1:100 000 geological map (Geological Survey of NSW 1983),
- Sydney 1:100 000 soil landscapes map (Soil Conservation Service of NSW 1989), and
- topographic and orthophoto maps at a scale of 1:25 000 (Central Mapping Authority of NSW 1987, Land Information Centre 2000, Land and Property Information NSW 2001, 2002).

The estimated former vegetation boundaries were marked on the base maps and scanned into Warringah Council's geographic information system. Two maps were then produced: one showing the estimated distribution of the Benson and Howell (1994) vegetation types in the Warringah LGA in the year 1750, prior to European settlement; and one showing the distribution in the year 2000. These two maps are reproduced in this report at a scale of 1:60 000.

During the study it was found that there is an area of mangrove vegetation in Bantry Bay that has not been included in either the Department of Environment and Conservation mapping or the Warringah Natural Area Survey. The approximate boundary of this area was determined from the Parramatta River 1:25 000 orthophoto map (Land and Property Information NSW 2002) and incorporated in the present mapping.

The areas of the vegetation units in 1750 and 2000 were obtained from Council's geographic information system. Areas were determined or estimated not just for the Benson and Howell (1994) vegetation types used in the maps, but also for the component vegetation communities recognised in the Warringah Natural Area Survey. The DEC vegetation map units were converted to Warringah NAS communities using the correlations described in Table 2 of Smith and Smith (2005). Data on the areas of the communities in 2000, and a breakdown into the areas in DEC reserves (Ku-ring-gai Chase and Garigal National Parks), in other reserves, and outside reserves, were obtained from Warringah Council's Bushland Reserve Strategic Planning Project (Wright 2003).

Some of the DEC units represent a combination of two Warringah NAS communities. These were treated as follows:

- Community 20 in Ku-ring-gai Chase National Park (Thomas and Benson 1985) was

- divided half and half between Swamp Oak Forest and Saltmarsh,
- areas in Ku-ring-gai Chase National Park mapped as Community 15/17 (Thomas and Benson 1985) were divided half and half between Bloodwood-Scribbly Gum Woodland and Sandstone Heath,
- Woodland and Low Woodland in Garigal National Park east (Sheringham and Sanders 1993) were divided between Bloodwood-Scribbly Gum Woodland and Narrow-leaved Scribbly Gum Woodland in proportion to the relative areas of these two communities in the remainder of the Warringah LGA,
- Estuarine Forest in Garigal National Park west (Lembit 2000) was divided half and half between Mangrove Swamp and Swamp Oak Forest,
- Sydney Sandstone Gully Forest in Garigal National Park west (Lembit 2000) was divided between Peppermint-Angophora Forest and Coachwood Rainforest in proportion to the relative areas of these two communities in the remainder of the Warringah LGA,
- Wet Heath in Garigal National Park west (Lembit 2000) was divided between Sandstone Heath and Sandstone Swamp in proportion to the relative areas of these two communities in the remainder of the Warringah LGA, and
- areas in Ku-ring-gai Chase National Park and Garigal National Park east mapped as Duffys Forest vegetation by Thomas and Benson (1985) and Sheringham and Sanders (1993), but outside the areas mapped by Smith and Smith (2000), were divided between Bloodwood-Scribbly Gum Woodland and Narrow-leaved Scribbly Gum Woodland in proportion to the relative areas of these two communities in the remainder of the Warringah LGA.

Three of the DEC map units represent communities that do not currently occur in the Warringah LGA outside the national parks. These have been treated as additional communities to the ones described in the Warringah NAS: Blackbutt Open-forest (Thomas and Benson 1985, Community 8), Tall Open-forest/Closed-forest and Paperbark Swamp (Sheringham and Sanders 1993). Thus, a total of 40 vegetation communities have been distinguished in the Warringah LGA, which may be grouped into 11 Benson and Howell (1994) vegetation types, plus a twelfth type for derived communities that were not part of the original vegetation of Warringah. One of the original communities, Seagrass Meadow, is a submerged aquatic community that was discussed in the Warringah NAS, but not mapped. This community has not been included in the present study.

When estimating the original areas of the vegetation communities in 1750, the following assumptions were made:

- Mangrove Swamp only occurred in Middle Harbour, not in the coastal lagoons, and its original extent was estimated at roughly 16 ha,
- the only area of Rough-barked Apple-Forest Oak Forest that has been cleared was at Cottage Point (i.e. this community was not represented in the Narrabeen Slopes Forest around Collaroy Plateau),
- Narrabeen Escarpment Scrub was restricted to the seaward side of Collaroy Plateau, and its original extent was estimated at roughly 12 ha,
- Angophora-White Mahogany Forest was restricted to its current location, and none has been cleared,
- the original ratio of Silvertop Ash-Brown Stringybark Forest to Blackbutt-Turpentine Forest in the cleared/highly disturbed areas of Warringah was the same as the current ratio in the remnant vegetation outside the national parks,
- Blackbutt Open-forest was restricted to its current location, and none has been cleared,
- Lomandra Sedgeland was restricted to sea cliffs on Narrabeen Group geology, and its original extent was estimated at roughly 1 ha,
- the ratio of Coastal Wattle Heath to Spinifex Grassland in 1750 was estimated at 3:1, not the current ratio of 1.4:1,

- Sandstone Headland Heath only occurred along the coast on Hawkesbury Sandstone geology, and its original extent was estimated at roughly 60 ha,
- Estuarine Paperbark Scrub was restricted to the coastal lagoons, and its original extent was estimated at roughly 5 ha,
- Coastal Freshwater Lagoon was restricted to its current location, and none has been cleared,
- apart from the above, the relative proportions of the vegetation communities within each Benson and Howell (1994) vegetation type was the same in 1750 as in 2000.

2.2 Comparison of Warringah Vegetation in 1750 and 2000

Forty-one percent of the native vegetation of the Warringah Local Government Area has been lost since 1750, but the impact of clearing has been very uneven, with some vegetation communities far more affected than others. Three communities typical of Hawkesbury Sandstone make up the majority of the native vegetation in Warringah: Bloodwood-Scribbly Gum Woodland, Peppermint-Angophora Forest and Sandstone Heath. Although these three communities have been reduced in area, they have been relatively less reduced than many other communities, with the result that, as a proportion of the Warringah vegetation, they have increased from an estimated 70% in 1750 to 79% in 2000 (Appendix 1).

The National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia 2001) and the Natural Heritage Trust Bilateral Agreement (Commonwealth of Australia 2003) require the NSW Government to prevent further clearing of ecological communities that are already over 70% cleared. In the Warringah Local Government Area, 15 of the 37 original vegetation communities considered (i.e. excluding Seagrass Meadow, which was not mapped) are over 70% cleared (Appendix 1). Eleven of these are forms of endangered ecological communities listed in the NSW *Threatened Species Conservation Act 1995* (at 20/8/05). The four communities that aren't listed are Bangalay Slopes Forest, Coastal Banksia-Teatree Scrub, Lomandra Sedgeland and Sandstone Headland Heath.

The majority of the over-cleared communities are ones that are more or less restricted to the vicinity (within 4 km) of the coast, where very little native vegetation now remains. The only coastal communities that have not been so drastically reduced are: Estuarine Paperbark Scrub, which has been preserved around the edge of Dee Why Lagoon; Coastal Freshwater Lagoon, which was apparently restricted to a single locality at Deep Creek, where it remains intact; and Coastal Wattle Heath and Spinifex Grassland, which have been widely restored in beach dune revegetation programs.

Away from the coast, the only communities that have been reduced to less than 30% of their original extent are the two main Duffys Forest communities, Silvertop Ash-Brown Stringybark Forest and Blackbutt-Turpentine Forest. Duffys Forest vegetation is associated with shale lenses in Hawkesbury Sandstone, especially where these outcrop on ridgetops and plateaus. The flat topography, absence of rock outcrops, and the more fertile soils, meant that these sites were selectively cleared for agricultural and later urban development in Warringah, in preference to the rocky, rugged, infertile sandstone areas.

A figure of 15% of the pre-1750 area of a vegetation community has been adopted by the Commonwealth and NSW Governments as a benchmark for the minimum proportion of the community that should be set aside in reserves (although a higher proportion should be reserved for communities of restricted extent). If applied to the Warringah Local Government Area, the data in Appendix 1 indicate that 22 of the 37 original vegetation communities considered are poorly represented in reserves, that is, less than 15% of their estimated area in 1750 has been conserved in Department of Environment and Conservation, Warringah

Council and other bushland reserves, or else the area reserved is very small – less than 5 ha.

The 22 communities are:

Narrabeen Slopes Forest

Bangalay Slopes Forest – 10% remains, 5% reserved (8 ha reserved)

Duffys Forest

Silvertop Ash-Brown Stringybark Forest – 21% remains, 14% reserved (120 ha)

Blackbutt-Turpentine Forest – 10% remains, 1% reserved (2 ha)

Angophora-White Mahogany Forest – 100% remains (3 ha), none reserved

Coastal Dune Forest

Coastal Banksia-Eucalypt Scrub – 7% remains, 6% reserved (10 ha)

Sydney Sandstone Gully Forest

Forest Oak Forest – 69% remains, almost all reserved, but only 2.5 ha

Tall Open-forest/Closed-forest – 69% remains, all reserved, but only 4.5 ha

Coastal Clay Heath

Coastal Banksia-Teatree Scrub – 13% remains, almost all reserved (1.5 ha)

Narrabeen Escarpment Scrub – 34% remains, 12% reserved (1.5 ha)

Themeda Grassland – 13% remains, all reserved (0.7 ha)

Lomandra Sedgeland – 23% remains, all reserved, but only 0.2 ha

Coastal Sandstone Heath

Sandstone Headland Heath – 13% remains, almost all reserved (7.5 ha)

Heart-leaved Stringybark Mallee – 68 % remains, 7% reserved (0.3 ha)

Coastal Swamp Forest Complex

Estuarine Reedland – 16% remains, 10% reserved (5 ha)

Estuarine Paperbark Scrub – 50% remains, all reserved, but only 2.5 ha

Swamp Mahogany Forest – 16% remains, 12% reserved (4.5 ha)

Bangalay Alluvial Forest – 16% remains, 13% reserved (41 ha)

Palm Woodland – 16% remains, 9% reserved (8.5 ha)

Water Fern Swamp – 16% remains, 13% reserved (5 ha)

Paperbark Swamp – 16% remains, all reserved, but only 4 ha

Coastal Freshwater Swamp

Coastal Freshwater Lagoon – 100 % remains, all reserved, but only 2 ha

Coastal Dune Swamp – 1.5% remains, 1% reserved (0.5 ha)

3. Wildlife Corridors in Warringah

3.1 Importance of Wildlife Corridors

As the native vegetation of Warringah becomes more and more fragmented, it is increasingly important to maintain and to re-establish vegetation links between the larger areas of remnant bushland. Such links are crucial in order to facilitate fauna movements between remnants. Termed ‘wildlife corridors’, their significance is now widely recognised and they have become an important consideration in land-use planning (Saunders and Hobbs 1991).

Wildlife corridors are habitat areas themselves, and so increase the area of habitat available to native fauna and flora. However, by providing a linkage between larger habitat remnants, their value is much greater than just the additional habitat that they represent. They allow animals to move from one large remnant to another and thus enable outbreeding and genetic exchange between what would otherwise be small, isolated populations of doubtful long-term viability. Fauna populations may be able to persist in isolated areas of remnant bushland in the short term, but some movement of individuals between remnants is needed if the isolated

populations are to survive over the longer term.

Wildlife corridors provide a means by which fauna species may recolonise areas of habitat where they have become locally extinct. Extinctions may occur as a result of specific events such as fires or disease outbreaks, or simply by chance (e.g. unusually poor breeding success or high mortality, or a combination of both). Small, isolated populations such as those in bushland remnants are particularly prone to local extinction and there is little likelihood of recolonisation in the absence of wildlife corridors.

Wildlife corridors provide a route for the dispersal of young animals, and for the movements of migratory or nomadic species. Birds and bats, because they can fly, are less dependent on wildlife corridors, especially those species that regularly travel long distances. Nevertheless, maintaining an obvious vegetation corridor across an area of alien habitat can be valuable as a guiding pathway, even for long-distance travellers.

By facilitating animal movements, wildlife corridors also have strong indirect effects on plant populations because they facilitate movement of animal-borne pollen and seeds between remnants. Just as they do for animal populations, wildlife corridors enable outbreeding of plant populations in isolated remnants, and recolonisation of areas of former habitat where plant populations have died out.

The original arguments for the benefits of wildlife corridors were largely intuitive and theoretical. However, recent empirical studies have demonstrated that corridors do increase movement rates and interbreeding between larger areas of habitat for a variety of animal species, including small mammals (Aars and Ims 1999, Coffman *et al.* 2001, Haddad *et al.* 2003), birds (Haas 1995) and insects (Haddad 1999, Tewksbury *et al.* 2002, Haddad *et al.* 2003). The effect of wildlife corridors in increasing the movement of plant pollen and seed has also been demonstrated (Tewksbury *et al.* 2002, Haddad *et al.* 2003).

Wildlife corridors can occur in a number of ways: natural corridors (e.g. bands of riparian vegetation along watercourses); remnant corridors (vegetation remaining after clearing of the surrounding area); regenerated corridors (natural regrowth of vegetation that had been cleared or degraded); and planted corridors (deliberately created either as wildlife corridors or for other purposes such as roadside plantings to provide a vegetation screen).

The quality of the corridor as fauna habitat will be a critical factor in its effectiveness. A wide, uninterrupted corridor of bushland in good condition, with a full complement of plant species and vegetation layers, is obviously the best option, and it is important to retain and protect such links where they still exist. However, even corridors consisting only of bushy gardens and street plantings can play a role in maintaining connections between fauna populations. The frequency of use of the corridor may be very low, but the movement of just one or two animals between populations can be critical.

3.2 Wildlife Corridors in Warringah

Existing and potential wildlife corridors in Warringah are shown on the accompanying map, where they are described as vegetation corridors. Four categories are recognised:

Priority 1 wildlife corridors link two or more of the four largest bushland areas in Warringah:

- Ku-ring-gai Chase National Park,
- western section of Garigal National Park,
- eastern section of Garigal National Park plus the extensive, continuous bushland to the south of the park, and

- Manly Dam Reserve.

All the priority 1 corridors are areas of patchy and disturbed vegetation interrupted by major roads and development. None is a continuous corridor. However, they are important linkages that require recognition, protection and enhancement through bushland rehabilitation or revegetation, supplemented by garden, park and street plantings. Possible means of facilitating fauna movements under or over busy roads should also be investigated. In some cases the marked corridors incorporate possible alternative routes between the same two core bushland areas, shown either as separate corridors or as a broad or branching corridor. It may be necessary to concentrate on just one of these routes as the main priority to achieve the desired linkage, although the more routes there are for fauna movements, the better the linkage.

Priority 2 wildlife corridors link the following isolated, medium-sized areas of bushland with larger areas of bushland or with each other:

- Jamieson Park and adjacent bushland,
- Dee Why Lagoon Reserve,
- Allenby Park, and
- NSW Gun Club bushland at Duffys Forest.

Some of these are tenuous links with little opportunity for revegetation beyond promoting the use of native plants in local gardens. In each case, two or more alternative corridor routes are indicated for linkages with larger areas of bushland.

Priority 3 wildlife corridors include the following:

- a general vegetation linkage along the coast and around the edges of the coastal lagoons,
- a corridor across Duffys Forest linking two parts of Ku-ring-gai Chase National Park, and
- dead-end corridors linking a number of small bushland areas within the corridor with a larger area of bushland.

Fauna movement hazards identify major roads that represent a barrier and hazard to fauna movement between the bushland areas on either side. They include sections of Mona Vale Road, Wakehurst Parkway, Warringah Road and Morgan Road. These areas are equivalent in importance to priority 1 wildlife corridors, but the management issues here are not so much revegetation to improve the corridor, as facilitating fauna movements and making them less hazardous (e.g. by enhancing existing culverts as a route for fauna movements).

Acknowledgements

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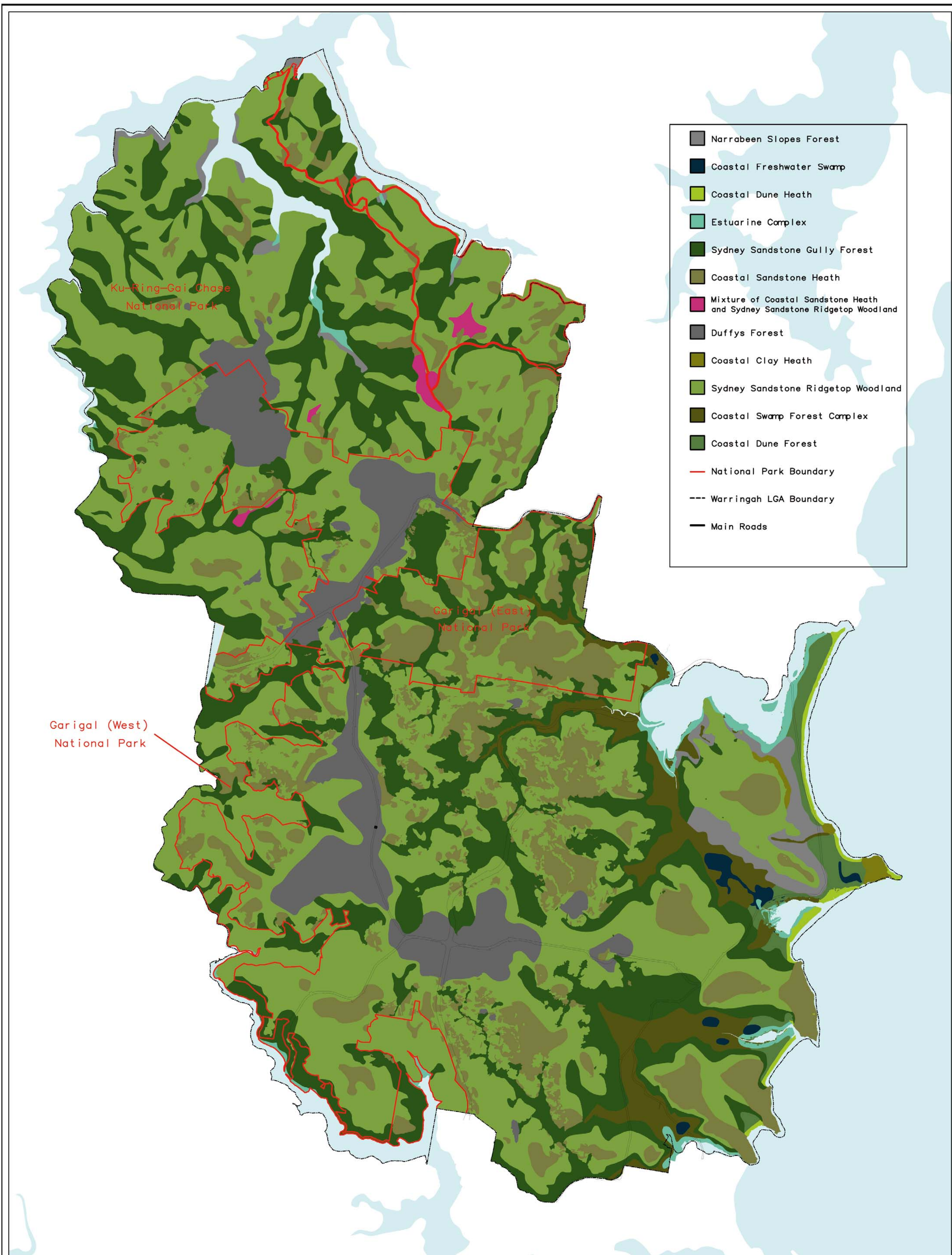
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Appendix 1. Vegetation change in the Warringah Local Government Area between 1750 and 2000, and reservation status of the remaining native vegetation

Sydney vegetation map unit (Benson and Howell 1994)	Warringah vegetation community (Warringah Natural Area Survey)	1750 area (ha)	2000 area		DEC reserves		Other reserves		Outside reserves	
			ha	1750 %	ha	1750 %	ha	1750 %	ha	1750 %
4a. Estuarine Complex	Seagrass Meadow (not mapped)									
	Mangrove Swamp	16.00	12.63	78.94	7.46	46.63	0.07	0.44	5.10	31.88
	Saltmarsh	38.37	13.04	33.98	5.08	13.24	7.79	20.30	0.17	0.44
	Swamp Oak Forest	89.26	30.33	33.98	5.80	6.50	15.73	17.62	8.80	9.86
	Total for 4a	143.63	55.98	38.98	18.33	12.76	23.59	16.42	14.07	9.80
9h. Narrabeen Slopes Forest	Bangalay Slopes Forest	170.38	17.08	10.02	0	0	8.15	4.78	8.93	5.24
	Rough-barked Apple-Forest Oak Forest	57.60	57.23	99.36	57.16	99.24	0	0	0.07	0.12
	Total for 9h	227.98	74.31	32.59	57.16	25.07	8.15	3.57	9.00	3.95
9sf. Duffys Forest	Silvertop Ash-Brown Stringybark Forest	877.37	184.07	20.98	105.00	11.97	15.40	1.76	63.67	7.26
	Blackbutt-Turpentine Forest	213.93	20.38	9.53	1.10	0.51	0.76	0.36	18.52	8.66
	Angophora-White Mahogany Forest	2.92	2.92	100	0	0	0	0	2.92	100
	Total for 9sf	1094.22	207.37	18.95	106.10	9.70	16.16	1.48	85.11	7.78
9t. Coastal Dune Forest	Coastal Banksia-Eucalypt Scrub	164.46	10.87	6.61	0	0	10.06	6.12	0.81	0.49
10ag. Sydney Sandstone Gully Forest	Peppermint-Angophora Forest	3465.66	2380.16	68.68	1835.65	52.97	199.71	5.76	344.80	9.95
	Coachwood Rainforest	40.45	27.78	68.68	20.08	49.64	6.61	16.34	1.09	2.69
	Forest Oak Forest	3.63	2.49	68.68	0	0	2.49	68.60	0.003	0.08
	Blackbutt Open-forest	63.39	63.39	100	63.39	100	0	0	0	0
	Tall Open-forest/Closed-forest	6.58	4.52	68.68	4.52	68.69	0	0	0	0
	Total for 10ag	3579.71	2478.34	69.23	1923.64	53.74	208.81	5.83	345.89	9.66
10ar. Sydney Sandstone Ridgetop Woodland	Bloodwood-Scribbly Gum Woodland	5100.96	3270.78	64.12	2132.25	41.80	292.20	5.73	846.33	16.59
	Narrow-leaved Scribbly Gum Woodland	125.62	80.55	64.12	74.62	59.40	1.64	1.31	4.29	3.42
	Angophora Woodland	1459.20	935.65	64.12	874.61	59.94	40.76	2.79	20.28	1.39
	Total for 10ar	6685.77	4286.97	64.12	3081.48	46.09	334.60	5.00	870.89	13.03
21a. Coastal Clay Heath	Coastal Banksia-Teatree Scrub	12.46	1.58	12.68	0	0	1.57	12.60	0.01	0.08
	Narrabeen Escarpment Scrub	12.00	4.10	34.17	0	0	1.49	12.42	2.61	21.75
	Themeda Grassland	5.60	0.71	12.68	0	0	0.71	12.68	0	0
	Lomandra Sedgeland	1.00	0.23	23.00	0	0	0.23	23.00	0	0
	Total for 21a	31.06	6.62	21.31	0	0	4.00	12.88	2.62	8.44
21b. Coastal Dune Heath	Spinifex Grassland	13.84	10.97	79.26	0	0	10.29	74.35	0.68	4.91
	Coastal Wattle Heath	41.51	15.67	37.75	0	0	9.50	22.89	6.17	14.86
	Total for 21b	55.35	26.64	48.13	0	0	19.79	35.75	6.85	12.38

Sydney vegetation map unit (Benson and Howell 1994)	Warringah vegetation community (Warringah Natural Area Survey)	1750 area (ha)	2000 area		DEC reserves		Other reserves		Outside reserves	
21g. Coastal Sandstone Heath	Sandstone Heath	1650.98	1122.47	67.99	633.3	38.36	141.25	8.56	347.92	21.07
	Sandstone Swamp	81.21	55.21	67.99	28.54	35.14	4.82	5.94	21.85	26.91
	Sandstone Headland Heath	60.00	8.07	13.45	0	0	7.68	12.8	0.39	0.65
	Yellow-top Ash Mallee	304.44	206.98	67.99	108.84	35.75	10.03	3.29	88.11	28.94
	Heart-leaved Stringybark Mallee	3.93	2.66	67.68	0	0	0.27	6.87	2.39	60.81
	Total for 21 g	2100.55	1395.40	66.43	770.68	36.69	164.05	7.81	460.66	21.93
27a. Coastal Swamp Forest Complex	Estuarine Reedland	47.21	7.70	16.31	1.31	2.77	3.61	7.65	2.78	5.89
	Estuarine Paperbark Scrub	5.00	2.51	50.2	0	0	2.51	50.2	0	0
	Swamp Mahogany Forest	36.67	5.98	16.31	0	0	4.45	12.14	1.53	4.17
	Bangalay Alluvial Forest	322.22	52.55	16.31	17.69	5.49	23.43	7.27	11.43	3.55
	Palm Woodland	9.38	1.53	16.31	0	0	0.81	8.64	0.72	7.68
	Water Fern Swamp	37.53	6.12	16.31	2.43	6.47	2.50	6.66	1.19	3.17
	Paperbark Swamp	24.65	4.02	16.31	4.02	16.31	0	0	0	0
	Total for 27 a	482.66	80.41	16.95	25.45	5.27	37.31	8.02	17.66	3.66
28c. Coastal Freshwater Swamp	Coastal Freshwater Lagoon	1.79	1.79	100	0	0	1.79	100	0	0
	Coastal Dune Swamp	48.99	0.71	1.45	0	0	0.47	0.96	0.24	0.49
	Total for 28c	50.78	2.51	4.94	0	0	2.27	4.47	0.24	0.47
(Derived communities)	Yellow Bloodwood-Grey Gum Forest	0	5.40	-	0	-	0	-	5.40	-
	Artificial Wetland	0	1.69	-	0	-	1.48	-	0.21	-
	Total for derived communities	0	7.09	-	0	-	1.48	-	5.61	-
Total area of native vegetation		14616.20	8632.51	59.06	5982.84	40.93	830.27	5.68	1819.41	12.45

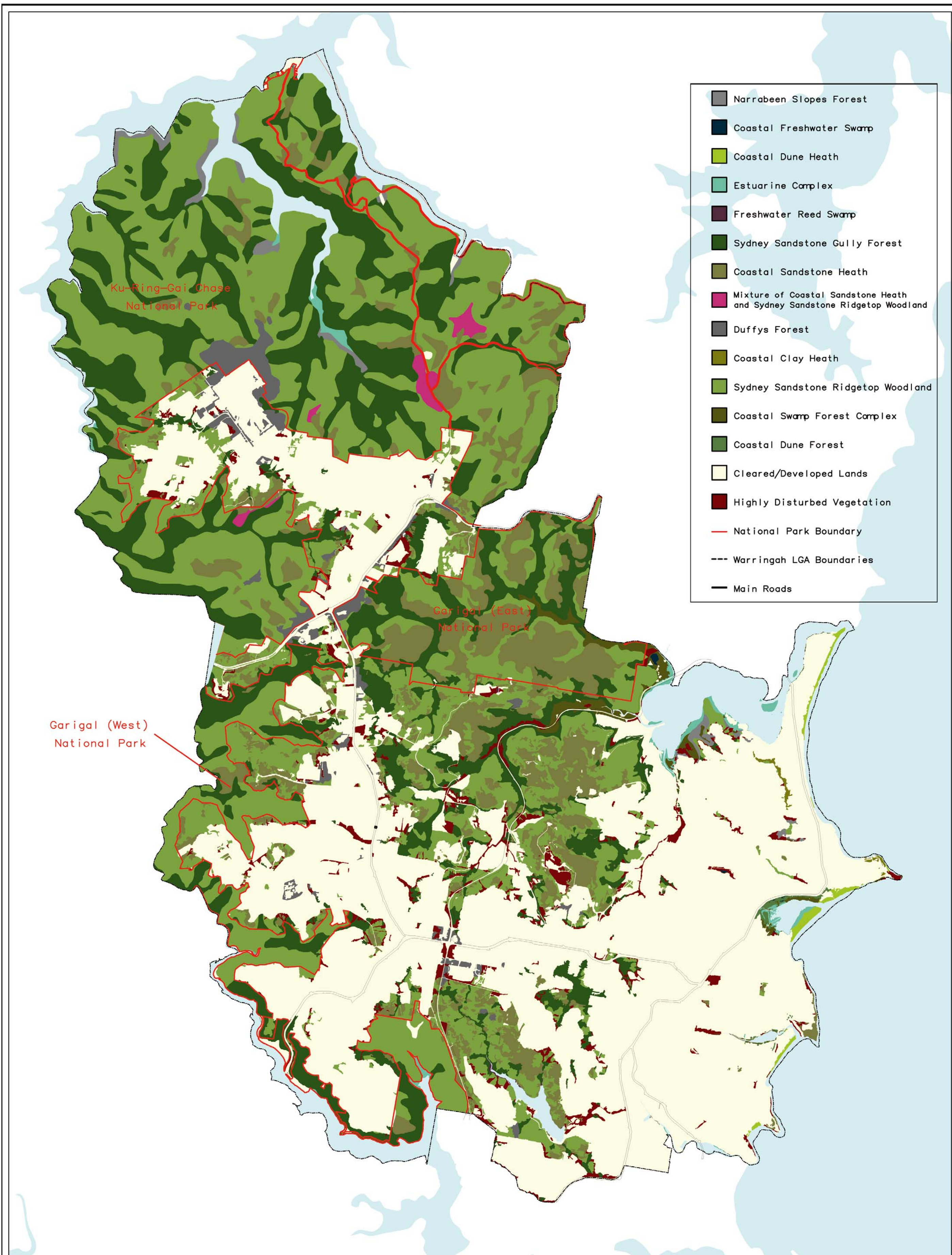


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Scale 1:60000

Estimated Native Vegetation Units of Warringah in the Year 1750

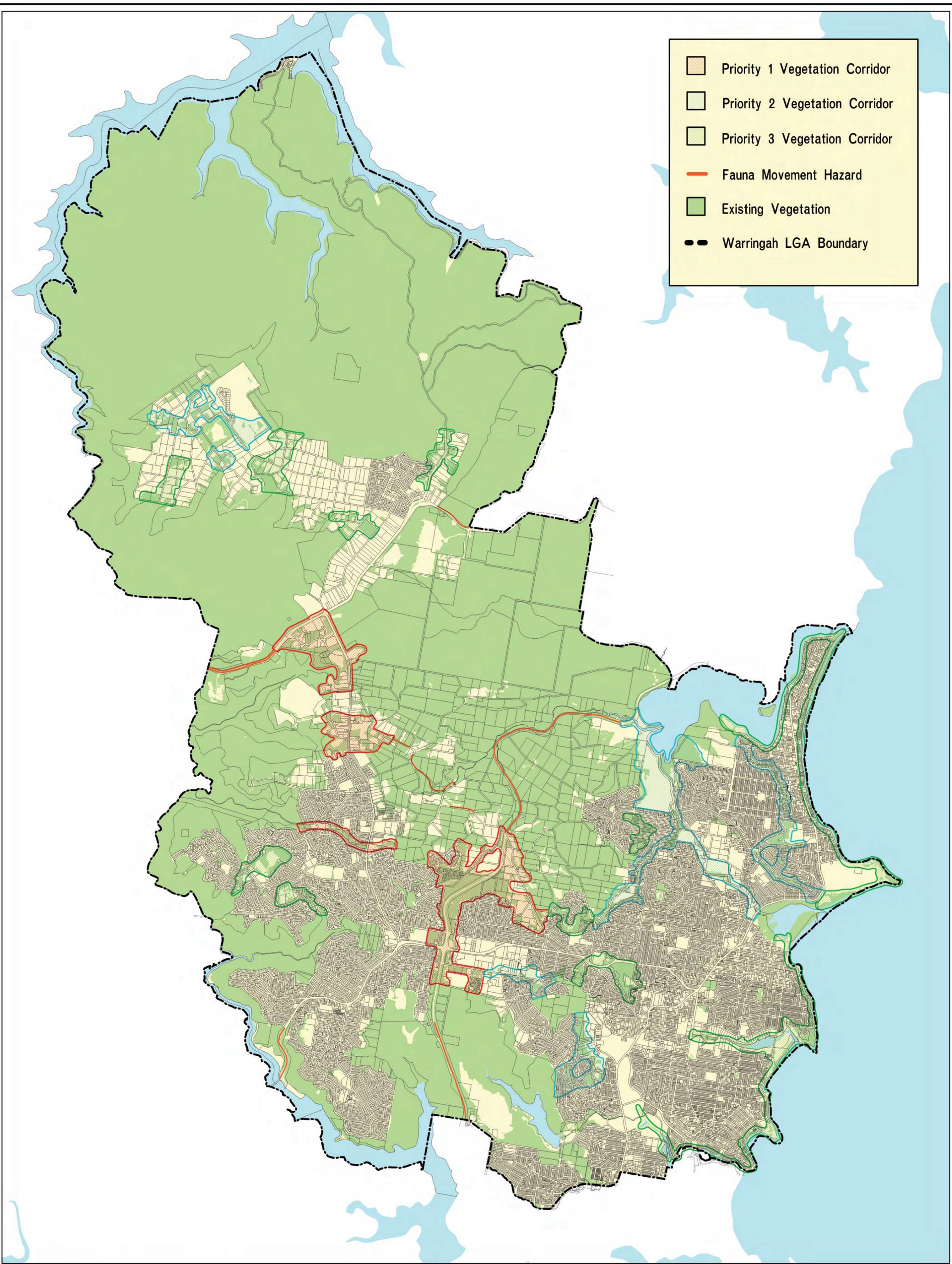


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Native Vegetation Units of Warringah in the Year 2000



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Existing and Potential Vegetation Corridors in Warringah