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Survey and Mapping of the Vegetation of Bongil Bongil National Park

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Credits

Mark Cameron: Spatial Analyst, responsible for provision of spatial analysis for GIS, Definiens and field data capture processes.

Paul Sheringham: Principal Botanist, responsible for the field survey and stratification of sites, data entry, numerical analysis and writing the sections of this report on the floristic survey.

R. John Hunter: Botanist, undertook (with Paul Sheringham) field surveys of littoral rainforest sites and identification of rainforest specimens.

Martin Smith: Ranger, provided his extensive knowledge of the park to assist in the location of rainforest and wet sclerophyll forest sites.

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Editing undertaken by Peter J. Higgins, Bronzewing Services.

Design and layout undertaken by Katrina Mckay, OEH.

List of abbreviations

ADS-40	Airborne Digital Sensor (Leica Geosystems)
AGS	Australian Group Selection
APM	Australian Paper Manufacturers Limited (to 13 December 1984), then APM Limited (to 2 May 1986); subsequently Amcor Limited
CCA	Comprehensive Coastal Assessment
CHCC	Coffs Harbour City Council
CRA	Comprehensive Regional Assessment
CRAFTI	Comprehensive Regional Assessment Aerial Photograph Interpretation
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DPI	NSW Department of Primary Industries
EPBC	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
GIS	Geographic Information System
LGA	Local Government Area
JANIS	Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee
LiDAR	Light Imaging Detecting and Ranging
LPI	NSW Land and Property Information (now LPMA)
LPMA	NSW Land and Property Management Authority
NEFBS	North East Forests Biodiversity Study
NP	National Park
NP Estate	Public land-holdings managed by the NSW NPWS, including national parks, nature reserves, state recreation areas and Aboriginal areas; also includes land purchased by NPWS but not yet gazetted
NPWS	NSW National Parks and Wildlife Service (which now falls within OEH)
NR	Nature Reserve
NRAC	Natural Resources Audit Council (in reference to natural resources audit of Upper North Coast NSW in 1995)
NSW	New South Wales
OEH	Office of Environment and Heritage, Department of Premier and Cabinet
PWG	Parks & Wildlife Group of OEH
RFA	Regional Forestry Agreement
ROTAP	Rare or Threatened Australian Plant
SF Estate	Public land-holdings managed by State Forests of NSW, including state forests and flora reserves
SF NSW	State Forests of NSW
subsp.	subspecies
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
UPGMA	Unweighted pair-group arithmetic averaging
var.	variety
WRA	Western Regional Assessment

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Summary

A vegetation survey of Bongil Bongil NP, situated approximately 20 kilometres south of Coffs Harbour on the Mid North Coast of New South Wales (NSW), was undertaken to fill gaps in the knowledge of vascular plant biodiversity in the area to assist with the management of the National Park and to provide data for a trial of Definiens software for vegetation mapping and modelling. A combination of geology, aspect, landform and vegetation height-class was used to randomly stratify sites.

Full floristic sampling was conducted at 111 sites and the data analysed using a hierarchical agglomerative clustering analysis. Overall, 453 plant taxa were recorded in the field site survey, and 33 vegetation communities were delineated following numerical analysis and expert review. The vegetation varied from sedgelands and wetlands to wet and dry open forest and rainforest. The 33 communities were organised into four classes: communities on alluvial deposits, on coastal barrier sands, on estuarine deposits, and on metasedimentary geology. The communities occurring on coastal barrier sands were further classified into three groups: (1) those on older Pleistocene backbarrier deposits; (2) those on recent Holocene dune deposits; and (3) Dune Soak Shrublands and Sedgelands and Pricky Couch Grassland communities occurring on Holocene sands with a subsaline soil influence. Using previous studies and the current survey a list of over 670 plant taxa was compiled for the National Park.

Bongil Bongil National Park has recently been expanded with two additions that were gazetted by legislation on the 25th February, 2011. Due to this recent gazettal, these additional areas have not been included in any statistics, maps or analysis in this report.

Vegetation communities of Bongil Bongil NP	
Class	**Common name of community (community number)**
Alluvial Communities	
	Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (12)
	Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest (13)
	Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (17)
	Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (26)
	Derived Freshwater Wetland (1)
	Blackbutt Creek-bank Forest (28)
	Derived Native Grassland (29)
Communities on Coastal Barrier Sands	
(1) Pleistocene backbarrier deposits	White's Tea-tree Shrubland (8)
	Tantoon Tea-tree Shrubland (9)
	Swamp Mahogany–*Melaleuca sieberi* Shrubland (33)
	Swamp Mahogany–Satinwood Sand Swamp Forest (10)
	Scribbly Gum Sand Forest (27)
	Baloskion pallens–Blechnum indicum Sedgeland (32)
(2) Holocene dunes	Strandline Grassland (2)
	Coast Wattle Shrubland (3)
	Coast Banksia Shrubland (4)
	Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest (24)
	Pink Bloodwood Sand Open Forest (23)
	Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (18)

(3) Subsaline influence	Dune Soak Shrubland (6)
	Dune Soak Sedgeland (7)
	Prickly Couch Grassland of Intermittent Coastal Lagoons (5)
Estuarine Communities	
	Grey Mangrove Shrubland/Woodland/Closed Forest (11)
	Sea Rush Saltmarsh (15)
	Saltwater Couch Saltmarsh (16)
	Schoenoplectus subulatus Saltmarsh (31)
	Swamp Oak Swamp Sclerophyll Forest (14)
Communities on Metasediments	
	Headland Brushbox Littoral Rainforest (19)
	Tallowwood–Blackbutt–Turpentine Dry Open Forest (20)
	Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest (21)
	Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (25)
	Pink Bloodwood–Turpentine Meander Plain Forest (22)
	Bangalow Palm–Coachwood–Maidens Blush Gully Rainforest (30)

The vegetation was found to be influenced by differences in geological formation, with differences in vegetation on metasediments, estuarine alluvial deposits and coastal barrier sands. The vegetation of the coastal barrier sands was linked to topographical position, depth of the watertable, fire-frequency and degree of exposure to coastal onshore winds. Vegetation of the bedrock areas was influenced by the division between Devonian and Permian metasediments, and also topographical position and aspect. Estuarine and alluvial vegetation was influenced by tidal influence, salinity, the size and location of the adjacent floodplain and underlying geographical features, such as levees, meander plains and creek banks.

Four threatened plants species (*Threatened Species Conservation Act 1995* [NSW]), and three rare or threatened Australian plant (ROTAP) species and a number of other rare species and those at the limit of their distribution were recorded from the National Park during the current surveys. Significant taxa recorded included:

Endangered: *Alexfloydia repens* (Floyd's Grass), *Lindsaea incisa* (Slender Screw Fern).

Vulnerable: *Niemeyera whitei* (Rusty Plum), *Peristeranthus hillii* (Brown Fairy-chain Orchid).

ROTAP: *Anetholea anisata* (Ringwood) (2RCa), *Eucalyptus fusiformis* (Nambucca Ironbark) (2RC–), *Marsdenia fraseri* (3RC–).

Other significant species: *Aneilema biflorum*, *Artanema fimbriatum, Baumea gunnii, Callistemon linearis* (Narrow-leaved Bottlebrush), *Callitris macleayana* (Stringybark Pine), *Chiloglottis sylvestris* (Bird Orchid), *Gonocarpus chinensis* subsp. *verrucosus, Isolepis fluitans* (Floating Club-rush), *Lepidozamia peroffskyana* (Burrawang), *Leptinella longipes*, *Ophioglossum pendulum* (Ribbon Fern), *Patersonia fragilis* (Narrow-leaved Purple Flag), *Persoonia conjuncta*, *Schoenoplectus mucronatus*, *Schoenus lepidosperma* subsp. *pachylepis*, *Sesuvium portulacastrum* (Ice Plant), and *Vigna marina* (Dune Bean).

1 Introduction

The classification and mapping of vegetation into communities is a means of representing and simplifying the description of biodiversity, which is composed of species, communities and populations. In conservation planning it is assumed that protection of a proportion of each vegetation community or ecosystem will also protect sufficient proportions of these elements of biodiversity and their interactions with the environment (NPWS 1994; JANIS 1997).

This survey was a collaborative project between the Biodiversity and Conservation Assessment Section (BACS) of the North-East Branch Environmental Protection and Regulation Group (EPRG) and the Coffs Coast Area of the New South Wales (NSW) National Parks and Wildlife Service (Parks and Wildlife Group (PWG)), all of which are within the Office of Environment and Heritage, Department of Premier and Cabinet (OEH). The survey was designed to improve knowledge of the distribution and abundance of individual plant species within Bongil Bongil National Park (NP), and to both inform and aid the management of biodiversity within the National Park. Stratification of the survey, data collection and mapping were done to sample adequately the diverse environmental influences on vegetation within Bongil Bongil NP.

Further impetus to the study was the presence of Floyd's Grass (*Alexfloydia repens*), an endangered species until recently considered to be restricted to the Coffs Harbour coast (Simon 1992; NSW Scientific Committee 2001), and the Black Grass-dart (*Ocybadistes knightorum*), an endangered butterfly, that is dependent on Floyd's Grass for food and habitat (Sands 1997; Braby 2000; NSW Scientific Committee 2002; Andren & Cameron In prep.).

Before the current survey there had been five systematic surveys of vegetation that included sites within the current boundaries of Bongil Bongil NP (see Section 1.2.8 Previous studies, below). An additional five studies that examined vegetation non-systematically and to varying levels of detail have been conducted in the reserve.

1.1 Objectives of the survey

The objectives of this project were:

- To improve the extent and accuracy of information available on the vegetation of Bongil Bongil NP, primarily to assist in management of the reserve, specifically fire, pests, endangered ecological communities and threatened plant species. This was done through collation of existing data, survey design employing stratified random sampling, full systematic floristic field surveys, and subsequent analysis of data.
- To test the efficacy of Definiens object-oriented image analysis software to provide a fine-scale map of vegetation of the reserve.
- To investigate the capabilities of forthcoming high spatial-resolution digital data to inform fine-scale vegetation survey and mapping.

1.2 Study area

The study area is on the Mid North Coast of NSW, with the northern end of the National Park abutting parts of Sawtell–Toormina and approximately 10 kilometres south of Coffs Harbour (Figure 1.1). The study area lies within the New South Wales North Coast Bioregion and the Coffs Coast and Escarpment Subregion (Thackway & Cresswell 1995). Two additions to the National Park were gazetted by legislation on the 25th February, 2011, these additions have not been included this report.

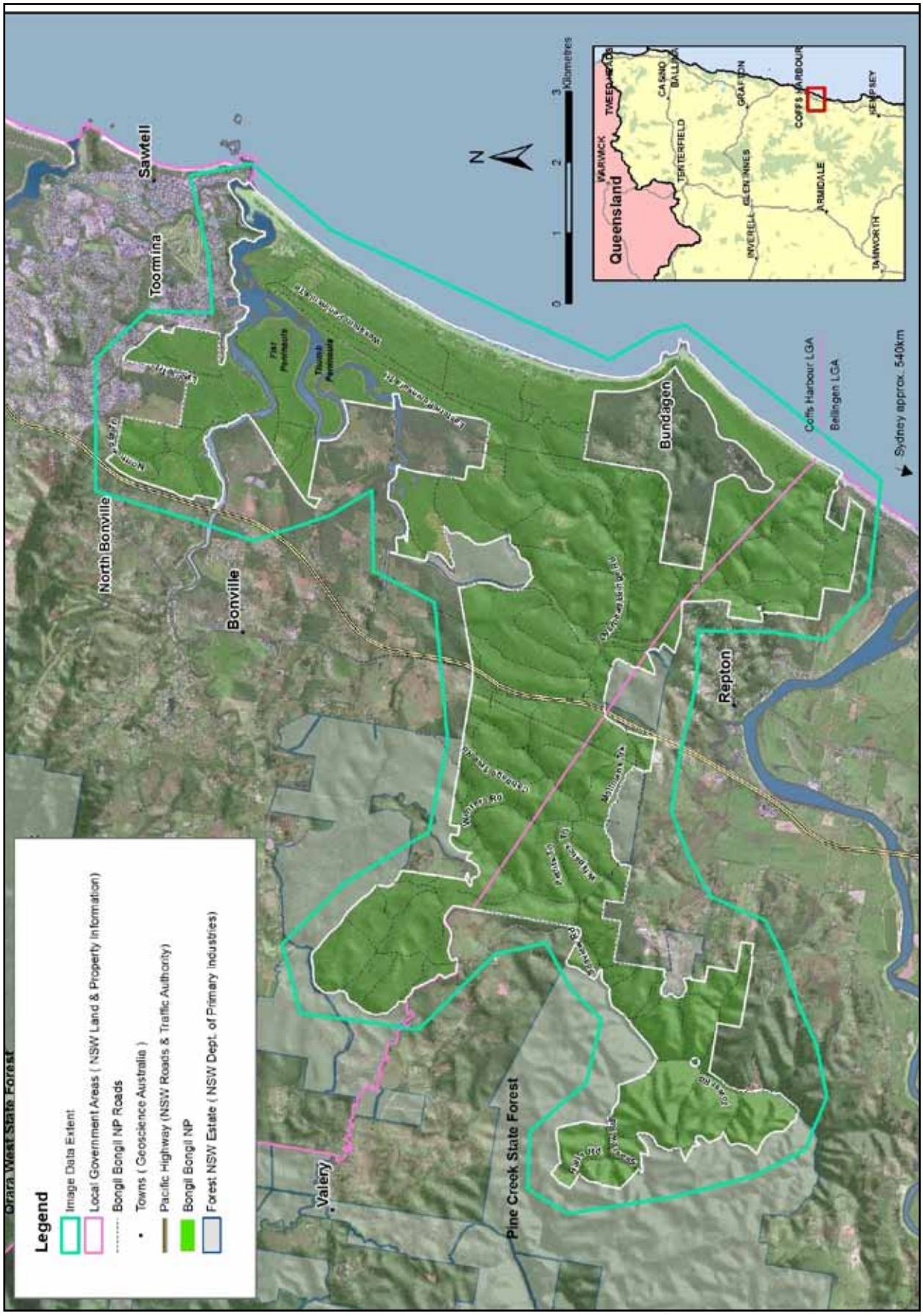


Figure1.1 The study area.

1.2.1 Geology

The major geological types within the National Park are Quaternary sands and alluvia and Devonian and Permian metasediments (Figure 1.2).

Quaternary sand and alluvium. The dominant features of the coast of Bongil Bongil NP are Holocene sandy beaches and dunes. Adjoining these sediments are older, undifferentiated Pleistocene sands forming strandplains and low-lying freshwater swamps. Both Scrub and Bundageree Creeks drain via estuarine channels of interbarrier creek deposits, which fill during periods of heavy rain and then drain across intermittent coastal lakes and lagoons on Bundageree Creek and Scrub Creek (see Figure 1.3).

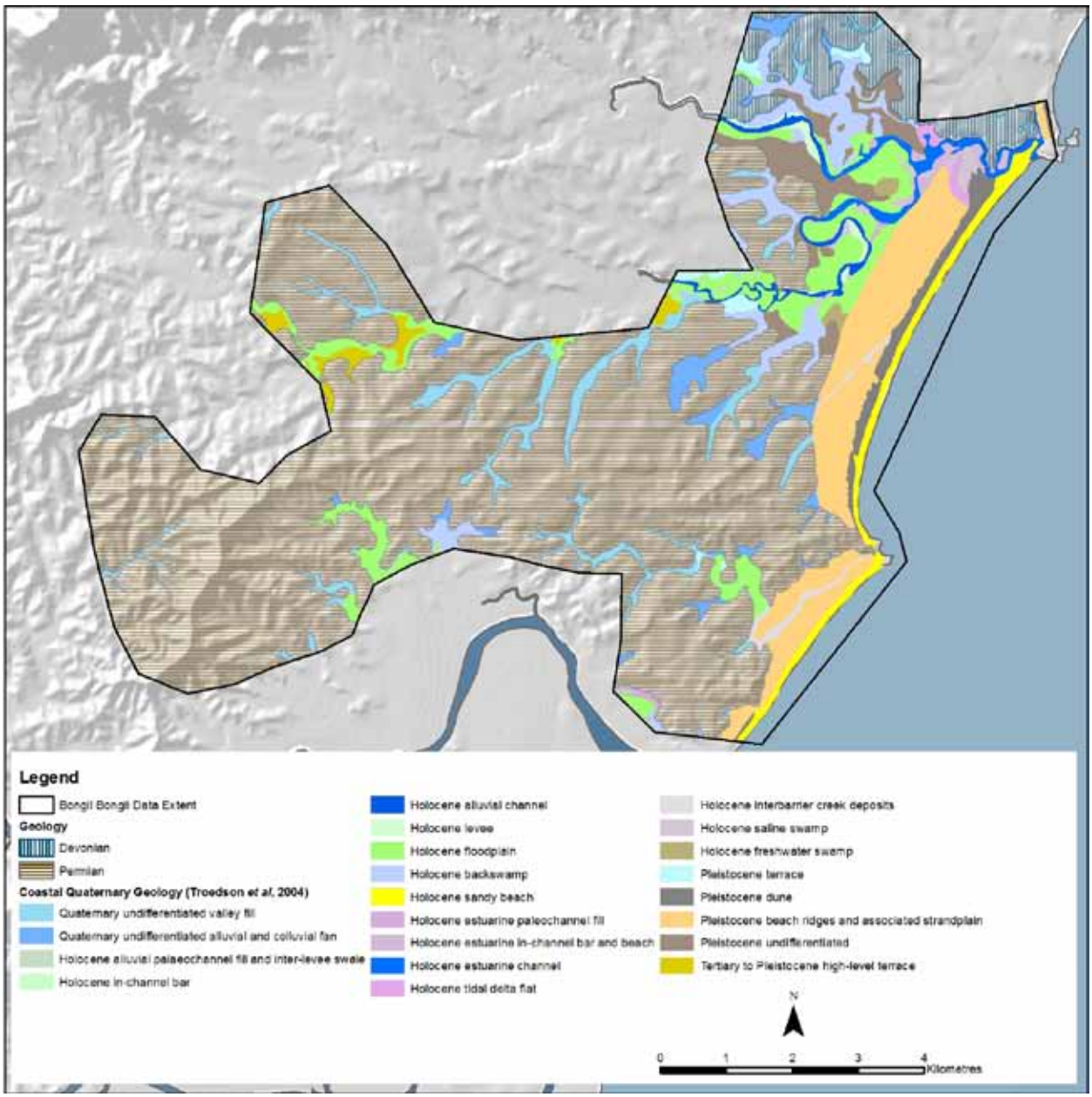


Figure 1.2 Geology of Bongil Bongil NP.

Figure 1.3 Rivers and creeks of Bongil Bongil NP.

The transition from the coastal barrier sands to the alluvial plain is abrupt, compared with other nearby coastal areas, such as near Coffs Harbour Regional Airport to the north. Along the lower reaches of Bonville and Pine Creeks, estuarine sediments have been deposited in swamps, tidal delta flats and basins and bays. The main creeks can be seen in Figure 1.3. Areas of Quaternary alluvium occur along the floodplains, terraces, backswamps and colluvial and alluvial fans of Pine and Bonville Creeks.

Sedimentary rocks. There are two types of meta–sedimentary rocks within Bongil Bongil NP. In the south of the park Permian sedimentary rocks of the Nambucca Beds (Bellingen Slates) form low, rolling coastal hills, whereas at North Bonville the underlying geology comprises younger Devonian sediments of the Brooklana Beds and Moombil siltstones.

1.2.2 Coastal Quaternary geology

A new classification of Quaternary deposits was undertaken for the coastal zone of NSW by Troedson *et al.* (2004). Quaternary deposits were divided into four depositional classes: alluvial, estuarine, coastal barrier sand and undifferentiated. The depositional classes were also differentiated into Holocene and Pleistocene deposits. Holocene sediments are deposits in the active depositional coastal zone and have accumulated over the last 10 000 years following post-glacial marine transgression (Troedson *et al*. 2004). Pleistocene barrier sands were deposited during times of high sea-level earlier than 10 000 years ago.

Alluvial plain depositional systems occur on the landward section of the coastal plain. They are most extensive in the estuarine deltaic plains of the main coastal rivers and extend into narrow non-tidal valleys of coastal catchments. Estuarine depositional environments occur in waterbodies of brackish to marine salinity and under some tidal influence. Coastal barrier systems are located on the seaward side of the coastal plain and comprise wind-blown and marine-deposition sands (Troedsen *et al*. 2004).

1.2.3 Soil landscapes

The soil landscapes of the study area can be divided into a number of groups: transferral (*Bonville* soil landscape), colluvial (*Diehappy*, *Never Never*), erosional (*Pine Creek*, *Ulong*), alluvial (*Bellinger*, *Coffs Creek*, *Dairyville*, *Glennifer*), deltaic/estuarine (*Toormina*), Aeolian and barrier sand (*Bundagen, Coffs Harbour*), and beach/barrier (*Goolawah*) (Department of Land and Water Conservation 1999).

There are six soil landscapes on metasediments in the National Park. The *Bonville* soil landscape occurs on footslopes and drainage plains associated with transferral soil materials derived from Bellingen Slate (Nambucca Beds). Within the National Park the *Diehappy* soil landscape is located west of the Pacific Highway on steep slopes near the Seaview Fire Tower. It is a colluvial landscape with metasediments of the Nambucca Beds as the underlying type of rock. The most extensive colluvial soil landscape on metasedimentary geology in the park is the *Never Never* soil landscape. This is a colluvial soil landscape that occurs in association with Bellingen Slate of the Nambucca beds on undulating coastal hills. The *Pine Creek* soil landscape is found on undulating to rolling hills and rises on Permian metasediments. The *Ulong* soil landscape is associated with undulating to low rolling hills on Carboniferous metasediments of the Brooklana beds and Moombill siltstones.

There are four alluvial landscapes in the park. The *Coffs Creek* soil landscape is found on the river flats and terraces of Pine and Bonville Creeks; the *Bellinger* soil landscape is characterised by level to

undulating alluvial terraces and floodplains in the Bellinger Valley, (within the park it is only found associated with the upper Pine Creek floodplain) and the *Dairyville* landscape is found in riparian areas on Bonville Creek (Milford 1999; Eddie 2000). The *Glennifer* soil landscape consists of isolated high remnant terraces of the Orara and Bucca valleys.

The *Toormina* soil landscape is mapped from the deltaic/estuarine areas of Pine and Bonville Creeks. Three soil landscapes occur on barrier sands: *Bundagen*, *Coffs Harbour* and *Goolawah*. The *Coffs Harbour* soil landscape represents low flat Pleistocene sandplains. These areas are mapped as undifferentiated Pleistocene sediments and freshwater swamps by Troedsen *et al.* (2004). They occur at North Bonville, at the end of Bonville Station Road and immediately east of the Western Peninsula Trail. The *Goolawah* soil landscape is located on the mainland and barrier beaches and foredunes along the coast. The *Bundagen* soil landscape occupies gently undulating Holocene barrier sands and low beach ridges between Sawtell and Bundagen Headland.

1.2.4 Climate

Climatic patterns are controlled by the progression of high- and low-pressure systems and associated troughs across the continent. Seasonal patterns of temperature and rainfall are driven by the north–south migration of high-pressure systems. The effects of tropical cyclonic activity and landforms also have an impact on the climate of the region. Longer term trends in rainfall and temperature are influenced by the El Niño–Southern Oscillation (ENSO), which determines the circulation and strength of trade winds directing moisture across eastern Australia (NRAC 1996b).

In the study area, summers are hot and winters warm. The annual mean summer maximum temperature is 27.0°C and the minimum is 19.1°C, in February. The annual mean minimum winter maximum and minimum temperatures are 18.8°C and 6.6°C, in July (Bureau of Meteorology, Coffs Harbour Meteorological Office, accessed 17 November 2010, <http://www.bom.gov.au/climate/averages/tables/cw_059040.shtml>).

Rainfall is highest in February and March and lowest in late winter to spring, with September being the driest month. The mean annual rainfall is 1678.5 mm (Bureau of Meteorology, Coffs Harbour Meteorological Office, accessed 17 November 2010, <http://www.bom.gov.au/climate/averages/tables/cw_059040.shtml>).

1.2.5 Aboriginal heritage

Aboriginal communities have an association with and connection to the land. The land and water within a landscape are central to Aboriginal spirituality and contribute to Aboriginal identity. Aboriginal communities associate natural resources with food and medicine, caring for the land, passing on cultural knowledge, kinship systems and strengthening social bonds. Aboriginal heritage and connection to nature are inseparable from each other and need to be managed in an integrated manner across the landscape (DECCW 2010).

The area protected in the reserve is considered to be of great spiritual significance to the Gumbaynggirr people. The surrounding area provided the Gumbaynggirr people with an abundant variety of foods, medicines, shelter and utensils. Large tool-making workplaces or 'factories', camping sites, ceremonial grounds, increase sites (sites of ceremonies to increase the availability of a food resource) and large middens are found within the reserve and its surrounds (DECCW 2010).

This evidence of indigenous people's connections to the reserve is important for Aboriginal people today as they provide evidence of the tradition of everyday uses.

1.2.6 Land-use and history

Bongil Bongil NP was established in March 1995 as part of the recently elected Carr Labor Government's pledge for 25 new National Parks in NSW, including a promise to create a National Park at Bonville. The first stage of the establishment of the park involved the acquisition of freehold lands at Bonville Beach, including large areas of ex-APM eucalypt plantation, and the addition of coastal Crown Land, including the Bundagen Flora Reserve. In 1999, a block of 120 hectares of largely unmanaged recreation reserve lands north of Bonville Creek was purchased from Coffs Harbour City Council, and added to the National Park. Further major additions to the National Park were made in 2003 as a result of negotiations during the Regional Forest Agreement (RFA) process, and the gazettal of freehold lands at North Bonville. The current area of the park is 4233 hectares.

The former Pine Creek State Forest comprises a large part of Bongil Bongil NP. Most of the forested area of the park has had a long history of logging, and substantial parts of the reserve display the impacts of frequent fire, clearing and the establishment of plantations of Flooded Gum (*Eucalyptus grandis*) and Blackbutt (*Eucalyptus pilularis*). The following is a chronology of forestry and gazettal events (summarised from Newman and Partners 1996 and State Forests of NSW 2000). Maps of the history of gazettals of Bongil Bongil NP, and the history of mining, logging and forestry treatments are presented in Appendix 1 (Maps A1.1–A1.4).

1870 Logging in the Pine Creek area began, with unregulated and selective logging of trees. The frequency and intensity of introduced forest fires increased as a result of European settlement.

1881 Pine Creek Forest was notified under the Crown Lands Act (8550 hectares) as Reserve No. 121.

1882 A further 5180 hectares were added to Pine Creek Forest bringing the total to 13 730 hectares.

1882–1919 Settlement pressures reduced Pine Creek Forest to 4120 hectares by 1919.

1890 Legislation was introduced to make timber cutting under license obligatory in an effort to quell exploitation of the large mature and over-mature trees (high-quality boles).

1916 The NSW Forestry Commission was formed and the subsequent *Forestry Act* of 1916 imposed conditions to try and bring order to a largely chaotic logging industry.

1919 Pine Creek State Forest No. 537 was dedicated, which saw the commencement of silvicultural improvement actions.

1920 Pine Creek State Forest was regarded as 'cut-out' by the standards of the day.

1920–38 Yields of sawlogs declined dramatically over this period owing to the previous overexploitation of high-quality boles.

1940 On 3 May Pine Creek State Forest was dedicated as 'National Forest' No. 17 (3260 hectares).

1942–50 The advent of World War II saw yields increase sharply but these fell again towards 1950.

1950 Australian Group Selection (AGS) logging and silvicultural treatments began. AGS involved the calculated creation of canopy gaps to promote regrowth of species and was most effective

with Blackbutt. The 'gully conversion' program also began, to establish Flooded Gum plantations through clearfelling, burning debris and then planting or direct seeding.

1950s – 1960s Compartment-based logging intervals of 20–25 year were introduced (though the actual frequency of logging increased over the next three decades). Most of the timber taken was regarded as high-quality logs (or quota logs, ≥40 cm in diameter) and harvest volumes were pre-allocated to mills.

1960s – mid-1980s Harvesting focussed on 'up-river' forests and clearfelling for establishment of plantations.

1970–73 An increase in establishment of local Flooded Gum and Blackbutt plantations adjacent to Pine Creek State Forest funded by Australian Paper Manufacturers Ltd (APM).

Mid-1980s Greater emphasis on quality stem-retention practices and general shift from minor harvesting programs (poles, sleepers and salvage operations) to integrated harvesting operations.

1984 Land owned by APM was acquired and added to Pine Creek State Forest. Parts of these ex-APM lands had been clear-felled of native vegetation to establish plantations, even in areas of heathlands and shrublands.

1985 Bundagen Flora Reserve (73 ha) was gazetted in 1985 to protect one of the best examples of least disturbed littoral rainforest remaining in NSW.

1990–95 Gradual restucturing of the timber industry, favouring fully integrated harvesting operations, took place at this time. In 1994 the 'Gaps and Clusters' regeneration technique was introduced but withdrawn on environmental grounds in 1995.

1995 Bongil Bongil NP was gazetted in March, and incorporated small parts of Pine Creek State Forest, such as the Bundagen Flora Reserve.

Concerns about the impacts of logging operations on populations of Koalas (*Phascolarctos cinereus*) are raised by residents and the Pine Creek Koala Support Group (PCKSG). Studies of the Koala in Pine Creek State Forest establish the population of approximately 400 individuals to be a regionally significant population (AUSTECO 1997). Subsequently, the National Parks & Wildlife Service (NPWS, now the Office of Environment and Heritage, Department of Premier and Cabinet (OEH)) withdrew its approval for harvesting in October 1995 where there was likely to be an impact on the Koala as per the *Threatened Species Conservation Act 1995* (NSW) (TSC Act). In December 1995, the Director-General NPWS confirmed that a management plan specifically for Koalas for Pine Creek State Forest was required before any further harvesting in Pine Creek State Forest was approved.

1995–2003 This period saw the development of a Koala Management Plan jointly managed by State Forests of NSW (SFNSW) and NPWS. To the best available knowledge no further timber harvesting occurred (outside of plantations) in Pine Creek State Forest until its de-gazettal in 2003.

2003 2786 hectares of Pine Creek State Forest de-gazetted and added to the adjacent Bongil Bongil NP. Also gazetted in 2003 were approximately 370 hectares of land north of Bonville Creek purchased from Coffs Harbour City Council in 1998. Some of this included ex-APM plantation.

2004 On 2 April, 1.25 hectares of freehold land at North Bonville gazetted and added to the National Park.

2006 On 1 July, a further 97 hectares of Pine Creek State Forest de-gazetted and added to Bongil Bongil NP as part of a delayed transfer arrangement.

2007 On 26 October, a small area (0.79 ha) of adjacent freehold land in North Bonville area added to Bongil Bongil NP.

2010 On 1 March, 32.8 hectares of freehold land purchased by the NSW Roads and Traffic Authority (RTA) as compensatory habitat to be transferred to OEH. At the time of writing it is awaiting gazettal. Some further RTA purchased additions are soon to follow.

Disturbances other than forestry practices are also worth noting. Floyd (1990) mentions a collection of fisherman's shacks along the eastern bank of Pine Creek on the Bongil Peninsula that were demolished in the 1970s, and a four-wheel drive track running north from Tuckers Rocks to Bundagen Head, through the Bundagen littoral rainforest. The four-wheel drive track was used by epiphyte thieves to fell trees and remove specimens. Significant thefts of rare native orchids and species of *Platycerium* (staghorn and elkhorn ferns) occurred routinely, particularly east of the end of Burma Road, on the south bank of Pine Creek. Both authorised and unauthorised collection of firewood and the theft of fencing and pole materials was also commonplace throughout the forest. Also, an individual by the name of 'Digger' Ross operated a sand extraction lease on the coast, north of Scrub Creek, until the mid-1970s (L. Foster, pers. comm., 2009).

Weeds such as Glory Lily (*Gloriosa superba*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Lantana (*Lantana camara*) and Broad-leaved Paspalum (*Paspalum mandiocanum)* have become well established throughout the National Park during this documented long history of disturbance.

1.2.7 Fire history

Aboriginal fire regimes and intensities before European settlement of NSW are very poorly known, or unknown, and sometimes the source of intense debate. European settlement caused the rapid displacement of the Aboriginal people of south-eastern Australia and the subsequent loss of knowledge relating to pre-European fire practices (Benson & Redpath 1997). Lack of knowledge regarding Aboriginal fire practices for Bongil Bongil NP is no exception.

There is also very little information on post-European fire regimes and intensities for the National Park before World War II. It has been suggested that fires were more frequent and more intense following European settlement (Newman and Partners 1996; State Forests of NSW 2000) and that the general practice of settlers – regular burning of forest adjacent to settlement to protect cleared land from wildfires, to improve access and to provide relief grazing for stock in dry periods – would have been followed in the areas in and around the current National Park (Newman and Partners 1996).

The fire history after World War II is much better known, with the recording of wildfires, hazard reduction burning and the use of fire in forestry management. Although there is no formally documented history of wildfire for the area of Pine Creek State Forest west of the Pacific Highway, former State Forest Foreman Jack Burke stated that no part of the forest west of the Highway had been burned by wildfire since at least 1946 (interview by Newman and Partners 1996).

In Pine Creek State Forest, fire was used for forest regeneration by burning the heads of felled trees

to generate seedbeds of preferred species such as Blackbutt. In Pine Creek State Forest, fire was used most consistently to promote growth of Flooded Gum via the 'Gully Conversion' program of the 1950s and 1960s. The procedure involved salvage logging, felling of non-commercial trees and understorey, and burning.

The fire history of land east of the Pacific Highway is more formally recorded in the fire database of the Parks and Wildlife Group (PWG) and contains all wildfire information in Newman and Partners (1996). A high-resolution map of the fire history of the National Park is found in Appendix 1 (Map A1.5).

1.2.8 Previous studies

Before the current survey, there had been five systematic surveys of vegetation – of various levels of detail – that included sites within the current boundaries of Bongil Bongil NP. In addition, there were five non-systematic studies that examined the vegetation in Bongil Bongil NP to some extent. The five main systematic surveys were:

- A presence–absence survey of overstorey species was undertaken by Austin and Heyligers (1989), to obtain a representative sample of the floristic variation in a forested area of approximately 20 000 km^2. Gradsects (transects incorporating significant environmental gradients) were sampled using climatic, topographical and lithological characteristics of the study area.
- Littoral rainforest at Bundagen Flora Reserve and at Scrub Creek to the north was described by Floyd (1990). The rainforest was identified as rainforest suballiance 16. Floyd compiled a list of 137 plant taxa for the Bundagen Flora Reserve, sampling the area using a random traverse method; the relative abundance of each taxon was also recorded. The most common canopy species at Bundagen Headland were Riberry (*Syzygium leuhmanii*), *Euroschinus falcata* and Lilly Pilly (*Acmena smithii*).
- The vegetation of the Coffs Harbour–Urunga State Forest management area was surveyed by Tweedie *et al.* (1995), including six sites in the former Pine Creek State Forest.
- As part of a survey and mapping of vegetation of the Coffs Harbour Local Government Area (LGA), Fisher *et al.* (1996) sampled one site that now lies within the Bongil Bongil NP.
- As part of broader forest ecosystem classification and mapping, 18 regional forest ecosystems were modelled as occurring in Bongil Bongil NP (NPWS 1999). Later, as part of a mapping project for the Northern Rivers Catchment Area an additional six vegetation mapping units were added to cover communities that had not been identified by the Forest Ecosystem Layer (Eco Logical Australia 2005). The most widely predicted forest ecosystems in the park were Wet Foothills Blackbutt–Turpentine Forest, Wet Flooded Gum–Tallowwood–Dry Grassy Forest, Tallowwood–Grey Gum Forest, and Wet Coastal Tallowwood–Brushbox Forest.

The non-systematic studies were:

- Clancy (1988) recorded 280 plant taxa in a study area encompassing Bonville Beach. He described the following vegetation types: (1) Saltmarsh; (2) Sedgeland; (3) Mangroves; (4) Swamp Oak Swamp Forest; (5) Paperbark Swamp Forest; (6) Flooded Gum (*Eucalyptus grandis*)–Blackbutt (*Eucalyptus pilularis*) Plantations; (7) Native Open Forest; (8) Forest Redgum (*Eucalyptus tereticornis*)–Tallowwood (*Eucalyptus microcorys*)–Grey Ironbark (*Eucalyptus siderophloia*) Open Forest; (9) Palm (*Archontophoenix cunninghamiana*) Forest; (10) Swamp

Mahogany (*Eucalyptus robusta*)–Broad-leaved Paperbark (*Melaleuca quinquenervia*) Swamp Forest; (11) Littoral Rainforest with Brush Box (*Lophostemon confertus*), Tuckeroo *(Cupaniopsis anarcardioides*), Yellow Pear-fruited Tamarind (*Mischocarpus pyriformis*) and Riberry (*Syzygium leuhmannii*); (12) Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*) Scrub; and (13) Foredune Vegetation.

- Large areas of the former Pine Creek State Forest were mapped using the 'Forest Types' system (Forestry Commission of NSW 1989a). This system involved mapping vegetation within the State Forest using aerial photography interpretation and subsequent ground-truthing. The Forest Type system is biased towards the mapping of commercial vegetation and many non-commercial vegetation types within the study area, such as paperbark forest, swamp and heathland, were mapped only broadly.
- The vegetation of Bundagen Flora Reserve was described in Research Note 47 (Forestry Commission of NSW 1989b). The major vegetation types were Tuckeroo Littoral Rainforest, an area of Subtropical Rainforest dominated by Red Bean (*Dysoxylum mollissimum* subsp. *molle*) and an area of depauperate Headland Brushbox. Vegetation communities dominated by Blackbutt (*Eucalyptus pilularis*), Coast Banksia (*Banksia integrifolia*) and Pink Bloodwood (*Corymbia intermedia*) were recorded on sand, with areas of Broad-leaved Paperbark and Swamp Oak communities occurring along the creek.
- The Botany Department of the University of New England undertook a survey of the vegetation of the Bonville Beach Sandmass to assess the impact of a proposed borefield, which was to identify supplies of fresh groundwater as a domestic water supply for the Coffs Harbour region in the event of inadequate water in the current supply system (Bale *et al.* 1992). A list of plant taxa was compiled and nineteen (19) vegetation communities were described. Communities recorded include: Littoral Rainforest, Low Closed Vine Thicket, Palm Forest, Pink Bloodwood (*Corymbia intermedia*) Wet Open Forest, Blackbutt (*Eucalyptus pilularis*) Wet Open Forest, Flooded Gum (*Eucalyptus grandis*) Wet Open Forest, Wet Open Forest (Flooded Gum–Tallowwood–Pink Bloodwood–Brushbox–Swamp Mahogany–Turpentine), Swamp Oak (*Casuarina glauca*) Forest, Broad-leaved Paperbark (*Melaleuca quinquenervia*) Swamp Open Forest, Swamp Mahogany (*Eucalyptus robusta*) Swamp Open Forest, Bloodwood/Banksia Low Open Forest, Grey Mangrove (*Avicennia marina*)–River Mangrove (*Aegiceras corniculata*) Closed Scrub, Milky Mangrove (*Excoecaria agallocha*) Closed Scrub, Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*) Open Scrub, Sea Rush (*Juncus kraussii* subsp. *australiensis*) Sedgelands, and Dune Complex (Coast Wattle).
- Greg Elks (unpublished data) conducted a site survey in 2006 for a fire-response study and review of environmental factors that included a vegetation assessment.

2 Methods

The methodology for the study comprises four main aspects:

- A stratified random survey of the vegetation structure and florisitics of Bongil Bongil NP using environmental and structural influences on the vegetation to locate sites.
- Numerical analysis of the full floristic vegetation data, and determination of the distribution and abundance of plant species and their relationship to environmental influences.
- Remote sensing interpretation and modelling (e.g. satellite imagery, aerial photography, abiotic surfaces) to delineate and interpolate the vegetation communities within the National Park.
- Finally, an assessment of the accuracy of the delineated vegetation communities as outlined in the *Interim Native Vegetation Type Standard* (Sivertsen 2010).

2.1 Existing data

2.1.1 Flora survey data

Only data that were collected during the current survey were analysed to minimise the influence of observer variability in the delineation of communities. It has been found that incorporating site data from a range of past surveys can lead to problems in the interpretation of the results of numerical analysis, where groupings of sites can be an artefact of observer variability (e.g. DEC 2004; Bell 2007). However, as a first step, we reviewed the existing floristic point datasets that contained data collected from within the study area to assess their use as supporting information for the current study and to help to identify gaps in existing sampling. A shape file was created in ArcView (Esri, Redlands, CA) by downloading all sites in the study area from the YETI Database ('Yet Another Vegetation Survey Database'; see section 2.5, Data management, below, for full explanation).

Overall, 28 survey sites have previously been sampled in the study area (Table 2.1). Only eight of these sites were full floristic samples with measures of cover abundance (Tweedie et al. 1995; Fisher et al. 1996). Full floristic surveys were conducted on six rainforest sites using an irregular meander or traverse of the site (Floyd 1990). Another 14 sites sampled overstorey taxa only, as part of a RAPID overstorey assessment for the Comprehensive Regional Assessment (CRA) or for research by the CSIRO (Austin & Heyligers 1989; NPWS 1999).

Table 2.1 Summary of previous systematic surveys with sites that fall within the current study area.

For a fuller explanation of these studies, see Introduction (section 1.1.8, Previous studies). Number of sites is the number of sites within the Bongil Bongil study area.

Survey	Plot-size	Type of data	No. of sites	Reference
Floyd rainforest sites	Irregular traverse	Full floristic survey, relative abundance	6	Floyd (1990)
Coffs Harbour–Urunga State Forest flora surveys	20 × 50 m, nested	Full floristic survey, cover abundance	7	Tweedie et al. (1995)
NPWS Rapid Overstorey Sites	Plotless	Canopy taxa only	4	NPWS (1999)
CSIRO gradsect	20 × 50 m	Canopy taxa only	10	Austin & Heyligers (1989)
Coffs Harbour City Council (CHCC) survey	20 × 50 m	Full floristic survey, cover abundance	1	Fisher et al. (1996)

2.1.2 Vegetation mapping data

In addition to the vegetation survey datasets, there are several mapped datasets that partly or fully cover the Bongil Bongil NP study area, though each vary by method, time of capture and mapping scale.

The requirements for vegetation mapping for NSW NPWS surveys have recently been set out by the NSW Department of Environment, Climate Change & Water in the *Native Vegetation Type Mapping Strategy 2009–2013* (DECCW 2009). The strategy lists five levels of mapping product classes (summarised in Table 2.2). The survey and vegetation mapping for Bongil Bongil NP of this survey falls under product Class 5.

Table 2.2 Mapping product-classes for native vegetation (adapted from DECCW 2009).

Map product class	Description
1	**Predictive vegetation layers** Vegetation distribution and type is interpolated from existing biotic or abiotic mapping (e.g. soil landscapes, land systems).
2	**Composite of existing vegetation coverage** Compiles various existing mapping coverages within a study area, into a single classification.
3	**Regional scale vegetation map – remote sensed** Image interpretation validated by field reconnaissance to map vegetation structure and dominant floristics. No plot sampling.
4	**Full floristic vegetation map** Image interpretation validated by stratified plot sampling to map vegetation structure and full compositional floristics. Based on quantitative data.
5	**Fine classification, high spatial resolution, full floristics vegetation map** As for class 4 with higher sampling, finer detail and higher accuracy.

Listed below are the known existing mapped datasets with a brief summary of their attributes and an estimation of product class.

- **Eastern Bushlands Database – Product Class 2**
  Structural and floristic vegetation mapping covering the eastern portion of NSW. Mapping based on visual interpretation of hardcopy Landsat TM satellite imagery. Data should not be used at scales finer than 1 : 250 000 (Roberts 1992).
- **State Forest RN 17 – Product Class 3**
  Focussed on commercial forest types and done only for NSW State Forest Estate. Based on a remotely sensed classification. Covers the area of Bongil Bongil NP that was gazetted from Pine Creek State Forest (Forestry Commission of NSW 1989).
- **CRAFTI – Product Class 3**
  The aim of the CRAFTI (Comprehensive Regional Assessment Aerial Photograph Interpretation) project was to assess and map readily observable patterns using aerial photo interpretation to determine broad floristic groups and forest structure information to guide modelling of forest ecosystems, old-growth forest and flora and fauna communities (NPWS 2001a, 2001b). CRAFTI was a gap-filling exercise and did not re-map existing data; CRAFTI thus does not cover those areas already mapped by Coffs Harbour City Council (see below) and State Forest RN17 mapping (preceding).
- **Forest Ecosystem – Product Class 1**
  Predictive mapping of derived ecosystems based on modelling of the relationship between

the mapped distribution of the ecosystem and abiotic variables. Modelled output is 100-metre pixels in raster format and covers all of Bongil Bongil NP (NPWS 1999).

- **Coffs Harbour City Council (CHCC) Mapping – Product Class 4**
  Fine-scale mapping of all of the Coffs Harbour LGA except National Park and State Forest Estate. A small area of Bongil Bongil NP covered by this mapping was previously freehold land that has been added to the National Park since 1996. Vegetation types were identified from API then classified by their component canopy species into associations then communities (Fisher et al. 1996). Although a requirement for mapping product class 4 is quantitative community classification, which is not part of this mapping, this mapping is of sufficient scale to warrant Class 4 ranking.

The aforementioned map datasets were not of use in deriving the mapping product in this project. The scale of classification and polygon delineation were insufficient to assist directly in the generation of a new mapped product.

2.2 Survey stratification and selection of sites

2.2.1 Survey stratification

The project used a random stratified sampling strategy. Strata sampled were a combination of deposition environment and geology, aspect, and three vegetation height-classes derived using a non-ground and ground-strike recording from small-footprint LiDAR data. Rainforest was also identified as a special vegetation formation.

Deposition environment and geology. The study area was partitioned into areas of either (1) unconsolidated sediments (alluvial, estuarine, coastal barrier and undifferentiated) or (2) bedrock geology, and different methods were employed to select sites in these two areas.

In areas of Quaternary sand and alluvium a combination of deposition class (estuarine, alluvial, coastal barrier sand and undifferentiated sediments) and landform unit (see Table 2.3), and vegetation height-classes (0–2 m, 2–8 m, 8–30 m; see below) was used.

In areas of bedrock geology, sites were stratified using the main geological strata (Devonian and Permian sediments), three aspect classes (sheltered, exposed and intermediate; see below) and vegetation height-classes (see below).

Table 2.3 Deposition environment used for areas of Quaternary sand and alluvium.

Deposition class	Landform units
Alluvial	Alluvial and colluvial fan, floodplain, valley fill, backswamp, terrace, alluvial channel, levee, high-level terrace
Estuarine	Saline swamp, interbarrier creek deposits, in-channel bar and beach, palaeochannel fill, channel, tidal delta flat
Coastal Barrier Sands	Holocene and Pleistocene ridge and strandplain, dune, sandy beach
Undifferentiated	Undifferentiated, freshwater swamp

Aspect class. This stratum was used only in areas of bedrock geology. Three aspect classes were derived based on exposure to solar radiation: exposed, sheltered and intermediate. Classes were assigned on the basis of ranges of compass directions:

- exposed, western and north-western aspects (225–360°)

- sheltered, north-eastern to southern aspects (90–180°)
- intermediate, between the preceding (0–90°, 180–225°).

Aspect was derived using a digital elevation model from ground-strike recording from a small-footprint LiDAR data (obtained from CHCC).

Vegetation height-class. Three height-classes of vegetation were defined, based on the structural vegetation categories of Specht (1970).

0–2 metres (saltmarsh, heathland)

2–8 metres (shrubland, mangroves)

8–30 metres (forests and woodlands)

The height-classes were derived using a non-ground and ground-strike recording from small-footprint LiDAR data (CHCC).

Rainforest. Areas of known rainforest were targeted based on existing mapping at a formation level (State Forest RN 17 mapping; Forestry Commission of NSW 1989), by visual observation of remotely sensed imagery, and through identification of rainforest stands by those with thorough local knowledge of the park (M. Smith, pers. obs.).

Rainforest was broken into two broad categories: (1) **coastal rainforest***:* littoral rainforest and headland Brushbox east of the Pacific Highway; and (2) **hinterland rainforest**: riparian gully rainforest on sediments and alluvium west of the Pacific Highway. The survey originally focused on the eastern section of the National Park where good remote-sensing imagery was available. It was decided later in the project to extend the coverage to the whole National Park. However, owing to rain and flooding it was not possible to sample some of the forests in the south-west of the reserve. This area is a priority for further survey.

A summary of the allocation of sites to different strata of the survey in unconsolidated sediments is shown in Table 2.4 and for bedrock sites in Table 2.5.

Table 2.4 Breakdown of sites to unconsolidated sediments.

Deposition class	Number of sites	Height-class (number of sites)	Landform unit (number of sites)
Alluvial	30	0–2 (1)	Backswamp (1)
		2–8 (5)	Backswamp (2), Floodplain (2), Levee (1)
		8–30 (24)	Floodplain (16), Alluvial Fan (4), Levee (1), Valley flat (3)
Estuarine	15	0–2 (6)	Saline swamp (6)
		2–8 (3)	Palaeochannel fill (3)
		8–30 (6)	Interbarrier creek deposits (3), Saline swamp (3)
Coastal Barrier Sand	28	0–2 (8)	Dune (8)
		2–8 (4)	Dune (4)
		8–30 (16)	Dune (14), Ridge and Strandplain (2)
Undifferentiated	7	0–2 (3)	Freshwater swamp (3)
		2–8 (2)	Undifferentiated (2)
		8–30 (2)	Undifferentiated (2)
Anthropogenic	2	0–2 (2)	Waterbody (2)
Total	**82**		

Table 2.5 Allocation of sites to metasedimentary geology.

Geology	Number of sites	Aspect/Topographic position
Devonian metasediments	2	Intermediate (2)
Permian metasediments	27	Exposed (6), Intermediate (6), Gully (5), Sheltered (10)
Total	**29**	

2.3 Field survey and survey methodology

The field survey used site-survey standards compatible with previous surveys by DECCW and NPWS (Comprehensive Regional Assessments [NPWS 1999]; North East Forests Biodiversity Study [NPWS 1994]). It also followed standards recommended in the *Guidelines for Mapping Native Vegetation* (DLWC 2000) and the more current *Native Vegetation Interim Type Standard* (Sivertsen 2010).

Site sampling was undertaken from October 2008 to December 2009. Sites were sampled by Paul Sheringham, with assistance from John Hunter in littoral rainforest. Floristic data were collected in quadrats of 50 × 20 m, 20 × 20 m or 40 × 10 m. All species of vascular plant occurring within each plot were identified and listed, and assigned a cover-abundance score using a six-point modified Braun-Blanquet scale (Poore 1955). As far as possible, sites were placed in visually homogeneous vegetation to avoid sampling ecotones.

Structural, physical and disturbance data were also collected for each quadrat. Structural data included growth form (tree, shrub, grass, sedge, herb), height-range and percentage crown cover of the dominant taxa within each vegetation layer present (emergent, tallest, middle and lower) (see Walker & Hopkins 1990). Physical site data included altitude, slope, aspect, soil-depth and soil-type, field geology and landform element in accordance with McDonald Isbell (1990), McDonald et al. (1990), and Speight (1990). An assessment of the condition of the sites in terms of fire, grazing, logging and weed disturbance (intensity of disturbance as severe, moderate, low; also time since disturbance for all but weeds).

Sites were numbered using an 8–10 digit code. All sites were denoted by: the geological strata; the vegetation height-class; a landform-unit class for unconsolidated sediments or aspect for bedrock sites; and then a three-digit site number. For example:

C	B	0	2	D	N	0	1	1	

Strata	CB	Coastal Barrier Sands
Vegetation height-class	02	0–2 metres
Landform unit-class/Aspect	DN	Dune
Site number	`011	Site 11

2.3.1 Rapid Data Points

Sampling of the Rapid Data Points used as reference sample sites (see section 2.8.1, Sampling design, below) was conducted over 11 days in September–November 2010.

2.4 Data management

Data were entered into the 'Bongil National Park vegetation survey database' held in a central YETI database ('Yet Another Vegetation Survey Database; Ellis et al. 2009). YETI is an Access (Microsoft

Corporation, Redmond, WA) database, developed by Michael Bedward and Murray Ellis for the entry of floristic, structural, physical and disturbance data collected at flora sites. Database entry fields relate to the field pro forma. Data can be readily exported from YETI into data analysis software.

2.5 Data analysis and classification of communities

Vegetation communities were classified using quantitative data analysis of field data from 111 sites. Full floristic data, including weeds, from the sites was analysed using PATN V3 (Belbin 1994). The number of groups was set at 30. Within the PATN program a Bray-Curtis coefficient was generated to identify dissimilarity between sites and then an unweighted pair-group arithmetic averaging (UPGMA) clustering strategy was applied to the matrix to derive a hierarchical classification using a default beta of –0.1.

A dendrogram and two-way table were then produced to display relationships between individual sites and groups of sites. Groups of sites and species in the two-way table were examined and related to other structural, physical and environmental variables. Each broad group was split or amalgamated to best represent patterns observed in the field. Some of the 'Broad-leaved Paperbark Swamp Sclerophyll' floristic groups were amalgamated. There was considerable variation in these sites in terms of occurrence of wetland understorey plants based on micro-scale variations in inundation and levels of salinity.

A FIDEL analysis (Keith & Bedward 1999) was done to indicate positive diagnostic taxa within each community. Positive diagnostic taxa are those that are more likely to be found in a community than in other communities. Diagnostic species are identified by calculating the group and non-group frequency of each taxa. Only positive indicator species are included in each profile.

2.6 Remote sensing interpretation and spatial interpolation

2.6.1 Definiens – A method of remote interpretation and spatial interpolation

Remote interpretation can be summarised as the visual interpretation of vegetation information from remotely sensed image-products by specialist interpreters. Interpretation results in mapped or delineated boundaries of vegetation types. Spatial interpolation is described by Sivertsen (2010) as mapping the distributions of vegetation types by interpreting their likely occurrence in unvisited parts of the landscape between locations where vegetation types have been observed on the ground. Interpolation of vegetation types usually employs some sort of statistical modelling that establishes relationships between site-data and relevant environmental influences. Interpretation and interpolation are not mutually exclusive but rather two different or complementary methods used to determine a mapped representation of vegetation types.

The interpretation and interpolation for the project was carried out predominantly in Definiens software (Definiens 2007a, 2007b), which is based upon object-based image analysis (OBIA). The two fundamental principles of OBIA are segmentation and classification. Firstly, spatial data are segmented into 'objects', or polygons, by a range of segmentation algorithms (Baatz & Schäpe 1999; Zhang & Maxwell 2006; Definiens 2007a, 2007b). Secondly, the image objects are then classified using a seemingly inexhaustible array of hierarchical, temporal, spectral and spatial context tools. Definiens also provides a simple, yet very effective, suite of editing tools for selecting, merging, splitting and

reclassifying objects/polygons.

The concepts and applications of Definiens are complex and vast and beyond the scope of the summary here; for further discussion of Definiens see Blaschke et al. (2008) and references therein.

This project used Definiens for all interpretation and modelling . All spatial data were configured or pre-processed ready for import into Definiens for analysis. Figure 2.1 summarises the flow of interpretation and interpolation within Definiens. A more detailed description of the process can be found in Appendix 4. A semi-automated approach within Definiens was used for the mapping. This involves a combination of modelling (interpolation) and manual, two-dimensional (2D) classification (interpretation). The approach is predominantly knowledge driven and reliant upon collaboration between botanical and Definiens expertise.

The process went from classifying those communities most easily identified to those more difficult to classify, that is from 'knowns' to 'least knowns'. The known communities were either very limited in distribution, small in patch-size, adhered to strict ecological envelopes and were thus fast and easy to classify accurately. The least knowns were areas of disturbance where factors other than natural ecological processes affected the distribution of the community and the species composition of the community. Manual classification combined with automated steps were used to map the knowns first, and then customised nearest-neighbour analysis (Definiens 2007a, 2007b) was used to 'model' the remaining least-known communities.

Both Definiens Developer 7 and Definiens Server 7 software were used in the mapping process. Developer 7 is a client version whereas Server 7 is an enterprise version designed to batch-process large datasets and large-volume projects. The effort required to overcome Developer 7 limitations eventually became unsustainable and a Definiens Server 7 license was obtained and the program used when Developer 7 had reached its limits in terms of processing. The Server version was installed on the same personal computer on which Developer 7 was installed but manages memory far more efficiently and thus overcame all of the problems associated with Developer 7. All rule-sets and work-flows are designed in the Developer 7 environment but are sent to the Server 7 environment for processing. Table 2.6 summarises the results of both Definiens processing environments and also includes estimates of operational resources and times.

Table 2.6 Definiens environment and processing times.

Computing environment
IBM Intellistation Z Pro (Windows XP 32 bit) Twin processors: 2 × Intel® Xeon™ processor 3.60 GHz 8 Gb RAM Storage 900 Gb (3 linked 300 Gb RAID disks)
Definiens Developer 7
Multi-resolution segmentation – Internal stitching and tiling rule-set – 48 hours – 751 182 objects **Note:** Too many objects and Developer 7 replaced by Server 7 segmentation
Definiens Server 7
Multi-resolution segmentation – 4 hours 26 minutes – 493 321 objects
Nearest neighbour processing – approximately 2.5 hours

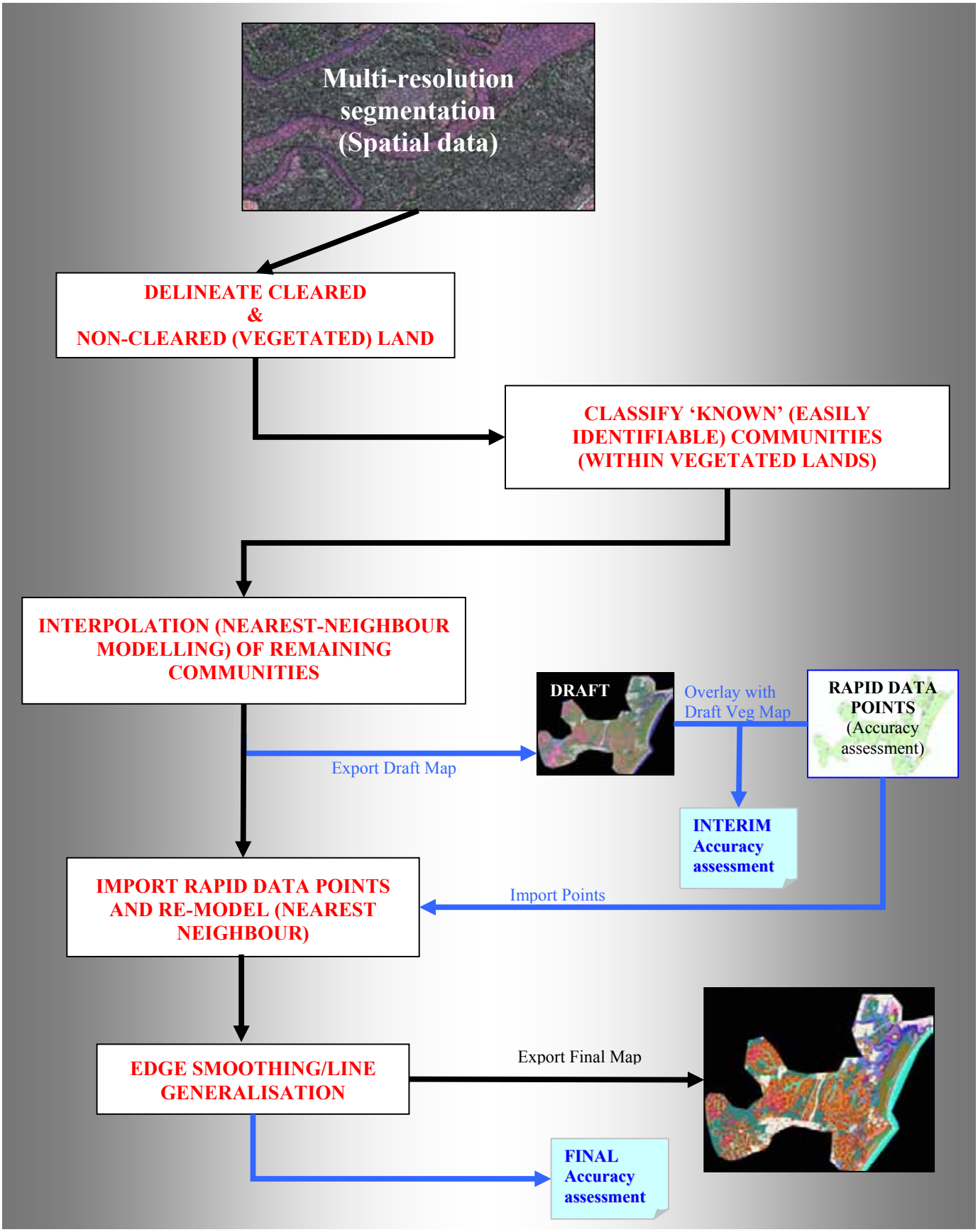


Figure 2.1 Flow-chart showing the Definiens interpolation–interpretation process.

2.6.2 Imagery

A range of remotely sensed products was used to generate the vegetation mapping for the project (Table 2.7). Some remotely sensed products were used directly in Definiens whereas others were used in context to assist in understanding the distribution of species or communities or both. The original intent was to use the Airborne Digital Sensor (ADS-40) flown by the NSW Department of Lands (Mills 2010). However, owing to a series of intense rainfall events, digital capture using ADS-40 was suspended beyond the timeframes of this project. We then purchased a Quickbird image, selection of which was based on its similarity to the ADS-40 data in terms of the same spectral range, and similar spectral and spatial resolution. In essence the most current and accurate datasets available at the time of the study were utilised.

Table 2.7 Imagery used, and the interpretation and application of the imagery for the spatial interpolation process.

Abbreviations: 2D, two dimensional; 3D, three dimensional ECW, compressed ER Mapper format; BIL, generic satellite image format; IMG, Erdas Imagine native format; ESRI Grid, ESRI raster format.

Imagery type [source of imagery]	Date of acquisition	Scale	Supply format	Format used	Application
Quickbird Satellite Image (4 MS bands + Pan) [DECCW]	5 Jun 2008	2.4 m multispectral and 60 cm panchromatic band	16-bit Tiff	Principal component pan-sharpened 8-bit – IMG format	Direct use–2D
Multispectral photography (3 MS bands) [CHCC]	12–21 Jan 2007	22 cm	8-bit ECW	8-bit ECW	Context use – 2D
LiDAR (thinned, ground) [CHCC]	12–21 Jan 2007	60 cm	xyz point (cloud-text format)	Interpolated into ESRI Grid then converted to 8-bit IMG format	Direct use – 2D
LiDAR (non-thinned, non-ground) [CHCC]	12–21 Jan 2007	60 cm	xyz point (cloud-text format)	Interpolated into ESRI Grid then converted to 8-bit IMG format	Direct use – 2D
Hardcopy aerial photographs [DECCW]	17 Mar 1994	1 : 25 000	Film	Hardcopy	Context use – 3D-stereo
Digital aerial photographs [DECCW]	21 Aug 2000	1 : 25 000	8-bit ECW	8-bit ECW	Context use – 2D
Spot 5 Image (Path – 391, Row – 411) [DECCW]	6 Feb 2005	2.5 m	8-bit BIL and ECW	8-bit ECW	Context use – 2D

2.6.3 Spatial accuracy

The spatial accuracy of the Quickbird image is determined from the accuracy of the CHCC multispectral photography and the CHCC LiDAR, which is expected to be ±1.5 metres. When obtained, the Quickbird image was rectified only and thus required orthorectification. Orthorectification was performed in ERDAS Imagine software using the CHCC photography as ground control and the LiDAR used for terrain rectification. Approximately 30 ground-control points were selected that were temporally unaffected and spatially identifiable between both images (i.e. roof corners, railway lines, rocks, and so on). Overall, a root mean square (RMS) error of <1 was obtained for each ground-control point.

A conservative estimate of the accuracy of the orthorectified Quickbird image would be ±3 metres.

This estimate allows for the variable nature of dynamic environments such as coastal estuaries, beach vegetation and sand-dunes.

2.6.4 Abiotic data

The abiotic datasets used within the interpretation and interpolation processes of Definiens reflected those used in survey stratification (see section 2.2, Survey stratification and selection of sites) and those identified by the principal botanist (P. Sheringham) to be critical in explaining the ecological distribution of species or communities or both.

Geology. The most important abiotic layer for describing the distributions of species and communities is the deposition environment and geology data (see section 1.2.1, Geology, and 2.2, Survey stratification and selection of sites), hereafter referred to as Geology Strata or GS. The GS layer was constructed predominantly from Troedson et al. (2004) with some minor input (i.e. Permian versus Devonian sediments) from Leitch et al. (1971). Attributes of the GS dataset are shown in Table 2.8. It should be noted that two scales of process are retained in GS – Deposition and Unit, resulting in 23 separate classes. The GS layer is shown in Figure 1.2.

Table 2.8 Geology Strata attributes.

Area is area of each within the Bongil Bongil NP study area.

Polygon ID	No. of polygons	Deposition class	Landform unit	Area (ha)
1	22	Alluvial Plain	Alluvial and colluvial fan	136.63
2	2	Alluvial Plain	Alluvial channel (subaqueous)	51.50
3	6	Alluvial Plain	Alluvial palaeochannel fill and inter-levee swale	7.59
4	13	Alluvial Plain	Backswamp	254.78
5	34	Alluvial Plain	Floodplain	432.11
6	9	Alluvial Plain	High-level terrace	61.00
7	1	Alluvial Plain	In-channel bar	0.47
8	6	Alluvial Plain	Levee	22.04
9	7	Alluvial Plain	Terrace	40.93
10	38	Alluvial Plain	Valley fill	322.29
11	6	Coastal Barrier	Beach ridge and associated strandplain	509.17
12	3	Coastal Barrier	Dune	87.99
13	1	Coastal Barrier	Sandy beach	113.99
14	9	Devonian		301.92
15	1	Estuarine Plain	Estuarine channel (subaqueous)	70.64
16	9	Estuarine Plain	Estuarine in-channel bar and beach	28.65
17	4	Estuarine Plain	Estuarine palaeochannel fill	16.13
18	2	Estuarine Plain	Interbarrier creek deposits	30.82
19	16	Estuarine Plain	Saline swamp	33.65
20	4	Estuarine Plain	Tidal-delta flat	16.99
21	13	Permian		4439.95
22	2	Undifferentiated	Freshwater swamp	17.23
23	13	Undifferentiated	Undifferentiated	197.12

Elevation. The elevation layer was constructed from thinned-ground LiDAR data and, where there were no LiDAR data, from the 25-metre pixel Digital Elevation Model (DEM) of the NSW Land and Property Management Authority (LPMA). LiDAR was only captured for the Coffs Harbour Local Government Area and south of this, in the Bellingen Local Government Area, the LMPA data were used. The boundary between the two local government areas can be seen in Figure 1.1.

The LiDAR component of the dataset has vertical accuracy of ±15 cm and a horizontal accuracy of ±1.5 metres.

Aspect. Aspect is applied only in areas of Permian and Devonian metasediments as it has little to no influence in areas of flatter deposition. Aspect was derived from the elevation data and reclassified into four classes:

- 1 – Alluvium (flat areas where the influence of aspect is negligible, extracted from GS layer)
- 2 – Exposed (225–360°)
- 3 – Intermediate (0–90°, 180–225°)
- 4 – Sheltered (90–180°).

The distribution of aspect classes is shown in Figure 2.2.

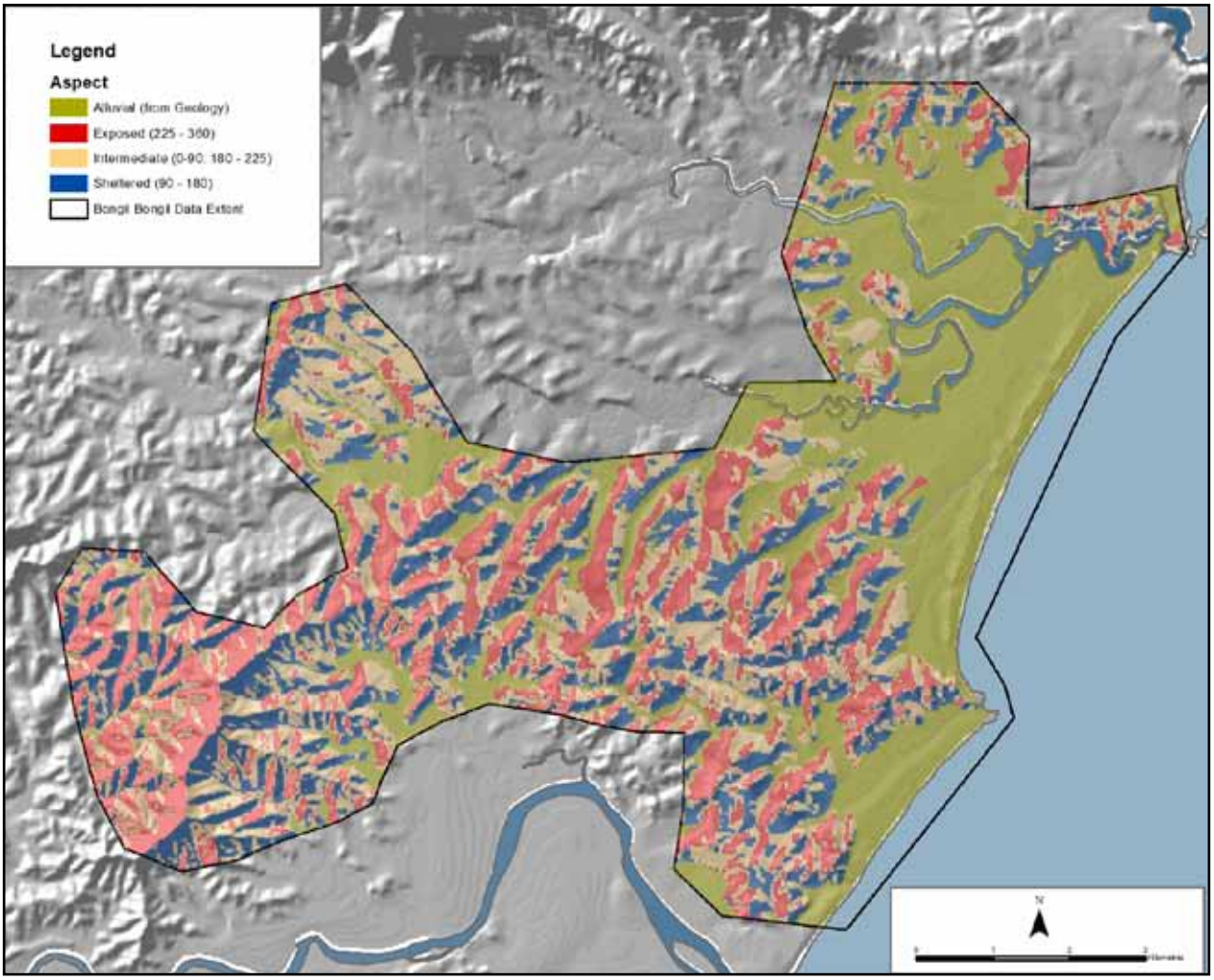


Figure 2.2 Aspect classes in Bongil Bongil NP study area.

Topographical position. Topographical position was defined using the method developed by Skidmore (1990). Topographical position, like aspect, is only applicable in areas of metasediment as it has no ecological influence in depositional areas. Topographical position is a surface that describes relative position in the landscape between, and including, ridge and gully. The output is a continuous range of values between 0 (gully) and 100 (ridge) but was reclassed into six categories:

- 1 – Flat (flat areas where influence of aspect is negligible; see Aspect above)
- 2 – Gully (0–20)
- 3 – Lower Slope (20–40)
- 4 – Mid-slope (40–60)
- 5 – Upper Slope (60–80)
- 6 – Ridge (80–100).

The distribution of topographical position is shown in Figure 2.3.

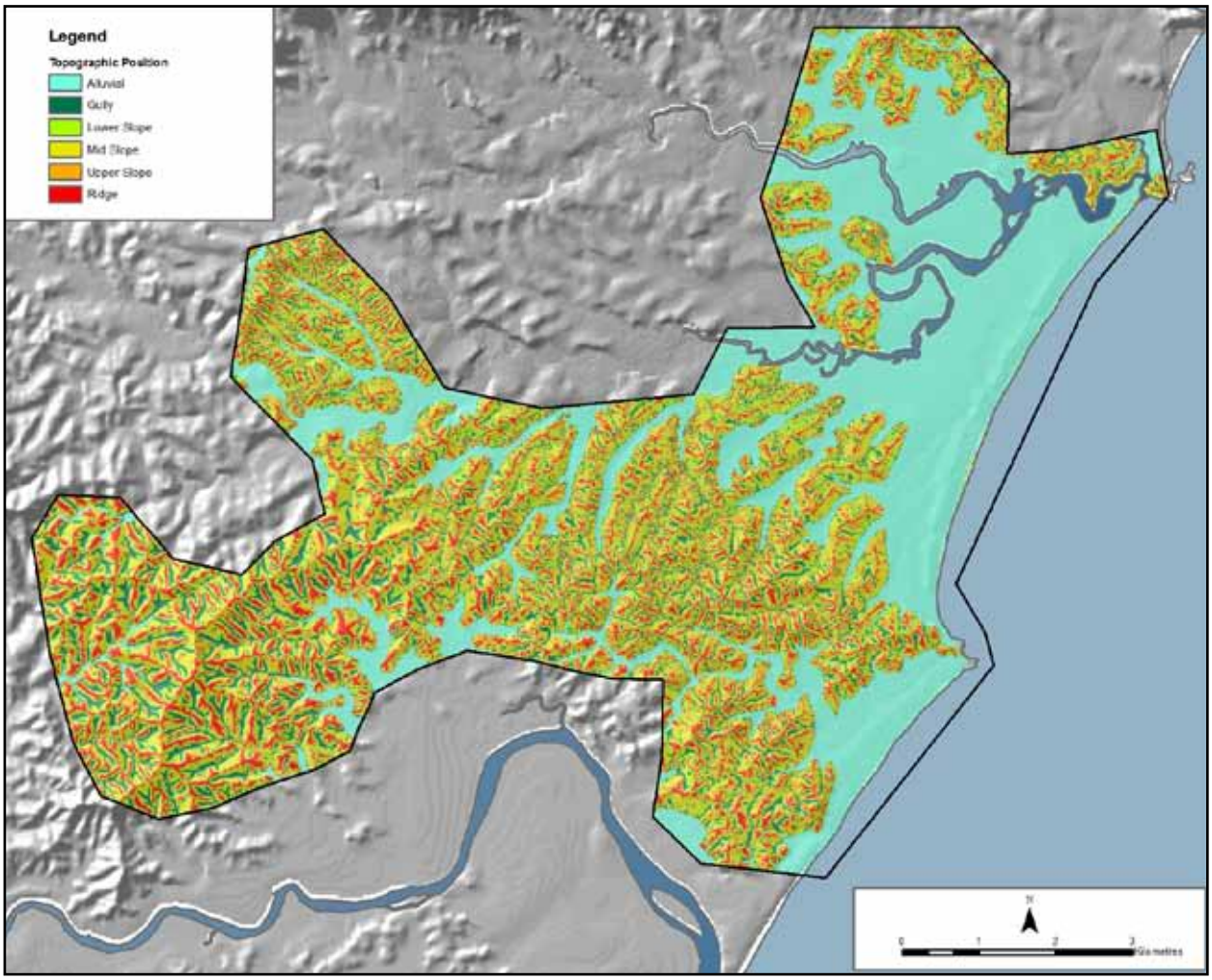


Figure 2.3 Topographical position (determined using methods of Skidmore 1990).

2.6.5 Floristic field survey data

All survey sites were captured as point localities using a hand-held Garmin 60Cx GPS with accuracy estimated to be ≤4 metres. All sites were converted to spatial point datasets then buffered by 10 metres to approximate the size of survey plots. The resulting 20-metre diameter polygon versions, complete with community classification attributes, were imported into Definiens.

2.6.6 Disturbance history

As stated previously, Bongil Bongil NP has an intense history of forestry. The history of Pine Creek SF has been captured in digital spatial format (ESRI File Geodatabase) as part of this project so the information can be applied directly or utilised as a potential vegetation 'condition' surrogate, or both. Forestry practices in Pine Creek SF from 1940 to 1995 were sourced mainly from *A Brief History of Forestry Management at Pine Creek* (Newman and Partners 1996).

Fifty forestry compartment maps were digitised on-screen via visual transfer into existing GIS compartment boundaries from hardcopy maps and text descriptions. All available imagery shown in Table 2.7 was used in delineating the internal compartment boundaries of disturbance patterns.

During the 1970s, APM established forestry plantations outside Pine Creek SF. These plantations have also been captured from the existing vegetation maps of CHCC (Fisher et al. 1996), CRAFTI (NPWS 2001a, 2001b) and State Forest Research Note 17 mapping (Forestry Commission of NSW 1989). Given the scale of linework capture of these datasets, the boundaries were reviewed and refined using on-screen aerial photography from 1997, 2000 and 2007 utilising available imagery.

Established plantations were mapped and imported.

Several other datasets were collated into GIS format as part of the product supply of this project but have not been applied directly into the analysis. These include: sand-mining (from Troedson et al. 2004), sand-extraction (L. Foster, pers. comm., 2009; J. Turbill, pers. comm., 2009) and fire history (DECCW Corporate GIS Wildfire database). These datasets are supplied and available for future reference.

2.7 Accuracy assessment

Accuracy of the delineated vegetation communities from the Definiens analysis was assessed based on the three components outlined in the Interim Native Vegetation Type Standard (Sivertsen 2010): sampling design, response design, and estimation and analysis protocol.

2.7.1 Sampling design

The reference sample-sites occur along linear transectss that were designed using random stratified sampling. These reference sample-sites are termed 'rapid data points' or RDPs. The transect paths were designed using botanical expertise and the stratified data layers that were used in designing the full floristic surveys (see section 2.2, Survey stratification and selection of sites). The design and placement of transects was influenced by the following factors (in no particular order):

- Environmental stratification
- Intensity of disturbance (i.e. accessibility)
- Proportional vegetation community sampling where practical

- Time and resources
- Targeted areas – remotely observed areas of anomalous texture, tone or pattern
- Location of existing full floristic survey sites.

In all, 12 transects were identified, with the aim of being able to complete one transect per day. However, owing to time constraints, two transects were omitted. The two omitted transects were chosen based on existing replication of substrate and time needed for completing them. The locations of the transects are shown in Figure 2.4.

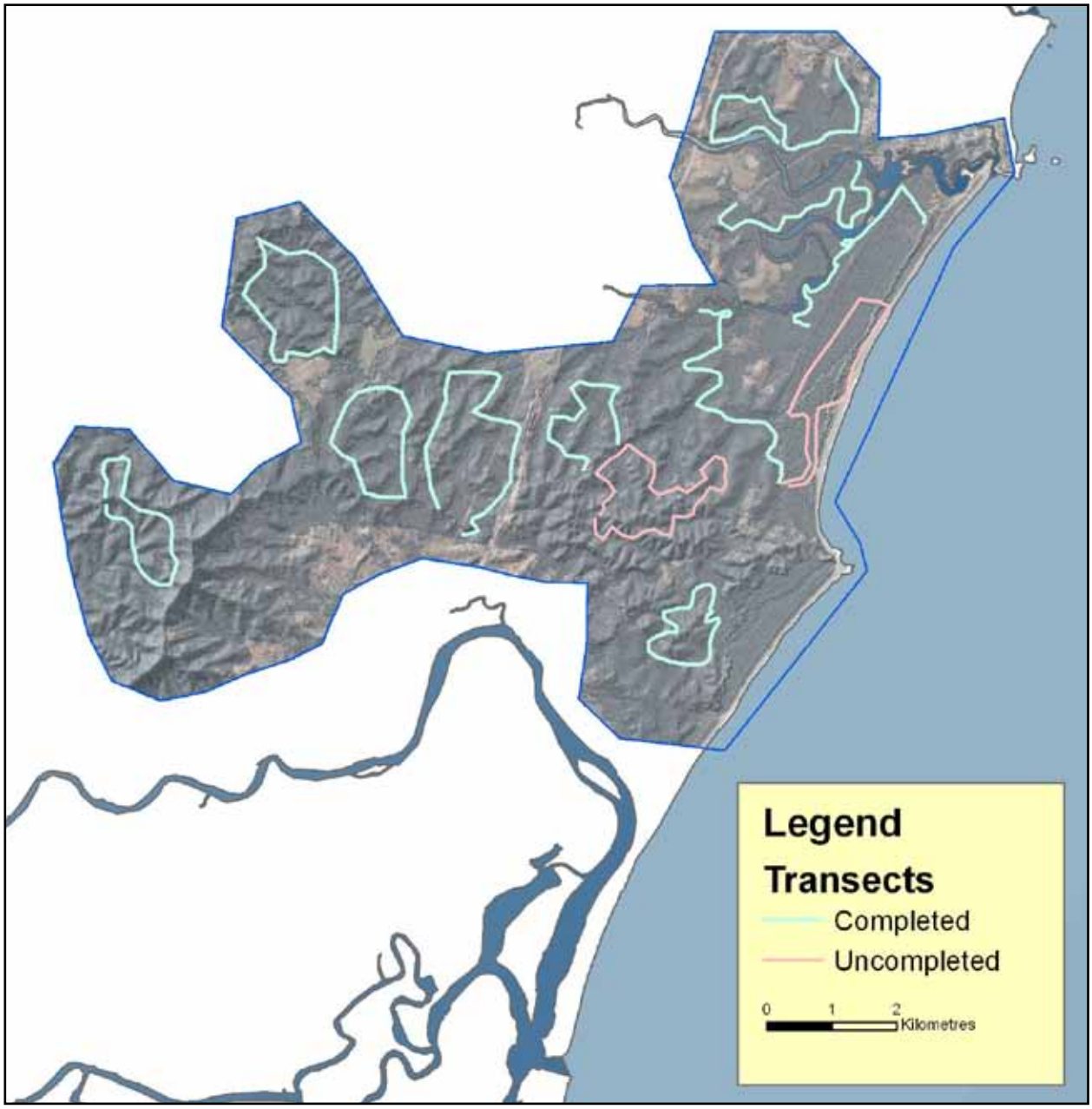


Figure 2.4 Location of randomly stratified transects.

Data capture involved two staff – one botanist and one data recorder – walking the transect and recording floristic, structural, landform and substrate information within a 10-metre radius of a selected site. Sites were recorded along the transect where there were distinct observable changes in vegetation structure and floristics. All efforts were made to avoid recording points in ecotonal areas.

Navigation in the field was facilitated by use of a hand-held Hewlett-Packard iPAQ H2400 PC with

attached SirfStar III GPS. The live GPS on-screen display of the transect in the hand-held PC allowed the *in situ* tracking of the transect. Customised data entry forms were prepared for recording information at each site.

2.7.2 Response design

The response design component of the accuracy assessment comprises an evaluation protocol and a labelling protocol (Sivertsen 2010). The evaluation protocol specifies the type of information collected at each site; the labelling protocol is the assignment of an existing vegetation community classification to that site.

Evaluation protocol. As mentioned previously, information at each site was captured via customised forms. The information captured at each site is shown in Table 2.9.

Table 2.9 Data collected at accuracy assessment reference sites.

BBNP, Bongil Bongil NP.

Field	Value list
SiteID	Predefined list of identifiers (rdp1–rdp300)
Date	dd/mm/yyyy
Deposition unit (for Quaternary sand and alluvium)	see 'Deposition class' field in Table 2.8
Landform process class	See 'Landform unit' field in Table 2.8
Topographic position (for metasediments)	Gully/LowerSlope/MidSlope/UpperSlope/Ridge/Flat
Aspect (for metasediments)	Exposed/Intermediate/Sheltered/Flat
Geology (for metasediments)	Permian or Devonian
Structural class	0–2 m/2–8 m/8–30 m
Emergent stratum	Up to 5 species from complete BBNP species list
% cover Emergent	0–100% (in 5% gradations)
Tallest stratum	Up to 5 species from complete BBNP species list
% cover Tallest	0–100% (in 5% gradations)
Mid-layer 1	Up to 5 species from complete BBNP species list
% cover Mid-layer 1	0–100% (in 5% gradations)
Mid-layer 2	Up to 5 species from complete BBNP species list
% cover Mid-layer 2	0–100% (in 5% gradations)
Lower layer 1	Up to 5 species from complete BBNP species list
% cover Lower layer 1	0–100% (in 5% gradations)
Lower layer 2	Up to 5 species from complete BBNP species list
% cover Lower layer 2	0–100% (in 5% gradations)
Floristic community	33 vegetation communities
Indicator species	1 species per site from complete BBNP species list
Evaluation	Absolutely Right/Reasonable or Acceptable/Understandable But Wrong/Absolutely Wrong
Notes	Free text entry

Labelling protocol. The assignment of a vegetation community to each RDP was done based upon botanical assessment via a degree of correctness (Table 2.10) or 'fuzzy set' as described by Gopal & Woodock (1994). The fuzzy set avoids binary assignment of 'yes' or 'no' and provides more flexibility for the botanical expert to acknowledge existing floristic and structural heterogeneity at a site or ambiguity regarding community classes (Gopal & Woodcock 1994).

Table 2.10 Degrees of correctness (after Gopal & Woodcock 1994).

Accuracy level	Degree of correctness	Description
1	Absolutely right	No doubt about the match. Perfect.
2	Reasonable or Acceptable	May not be the best possible but is acceptable; this does not pose a problem to the user if it is seen on the map. Right.
3	Understandable but wrong	Not good; there is something about the site that makes the answer understandable but there is clearly a better answer. This answer would pose a problem for users of the map. Not right.
4	Absolutely wrong	Absolutely unacceptable. Very wrong.

2.7.3 Estimation and analytical protocol

The assessment of accuracy adopted the 'confusion-matrix approach' discussed in Sivertsen (2010). The assessment process can be regarded as a blind-testing procedure whereby the botanical expert recording the RDP has no *in-situ* knowledge of the mapped communities and their boundaries at each site (Woodcock & Gopal 2000). Consistency was promoted in this process by having the same botanist that developed the vegetation classification perform the RDP site assessments.

The matrix is populated with RDPs as 'reference' points or 'points of truth' against the interpreted and interpolated map outputs.

It is important to note here that the information collected from RDPs are extremely valuable as validation data in addition to their role as accuracy indicators. For this reason, the project produced an interim matrix-based accuracy assessment of a draft vegetation map product. The RDPs were then re-introduced into the draft map for re-interpretation and re-modelling to produce an improved final map product along with an adjusted final accuracy assessment.

2.7.4 Linework smoothing and minimum polygon size

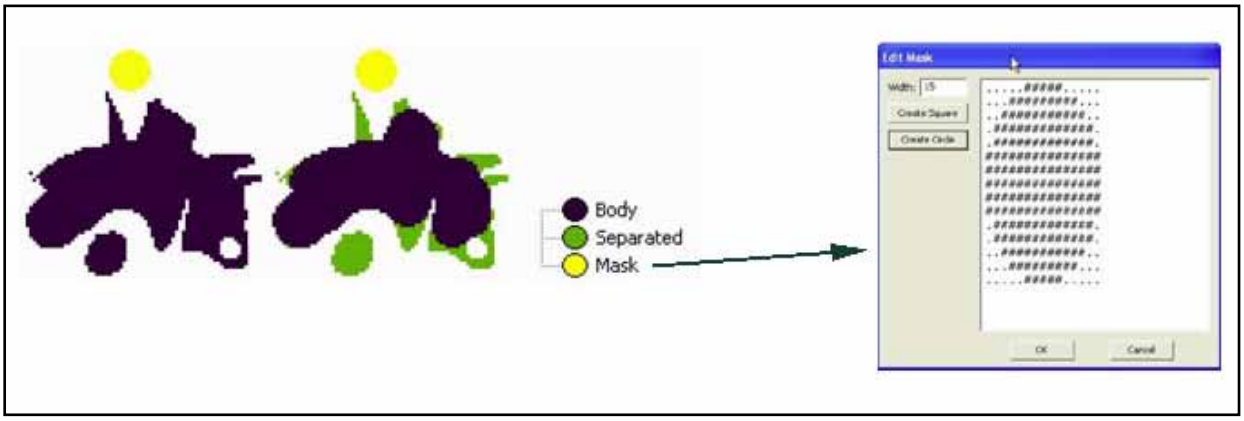
Linework smoothing is a last step to remove blocky or square edges and unnecessary vertices from the linework of the maps. This was conducted in two stages, firstly in Definiens then in ArcInfo (Esri) GIS.

Definiens smoothing. A pixel-based 'Morphology algorithm' in Definiens was applied to each vegetation community in order to remove unnecessary jagged edges. Morphology involves either adding pixels (coating/closing) to an object or removing pixels (sanding/opening) from an object to smooth its border. In each case, a user-defined virtual mask-shape is created to control the addition or subtraction of pixels. The Open (sanding) parameter for Morphology was utilised after testing both parameters. A demonstration of the Morphology algorithm is shown in Figure 2.5, where the dark 'body' represents the community object and the 'separated' area represents the removed pixels based on the yellow circular 'mask'.

For each vegetation community, a customised mask was created to smooth appropriately with regards to the size, distribution and shape of the communities objects. As a general rule, communities with large objects had larger masks, smaller and unique communities had smaller masks. The size of masks for each vegetation community is given in Table 3.5 (Results).

Because the Definiens Morphology algorithm is pixel-based its processing requirements can be prohibitive on large or numerous polygons. This was overcome by using Parent Process Object (PPO) processing, that is one polygon at a time per community as opposed to all polygons in a community at once.

Figure 2.5 Functioning of the Open (sanding) parameter in Morphology within Definiens.



The dark body represents the community object, and the 'separated' (green) area represents the removed pixels based on the yellow circular 'mask'. The area of the community object that cannot contain the mask completely is separated.

ArcInfo GIS. Lastly, the 'Generalise' command of ArcInfo was applied to simplify linework that followed image pixel edges that resulted from the underlying Quickbird image (i.e. 60 cm). The 'BendSimplify' (ArcInfo Help Documentation) option in the Generalise command was chosen, along with a Weed Tolerance of 5 metres.

The Morphology algorithm removes the issues of major structural edges whereas Generalise removes minor edges without altering the general shape of the polygons. Small polygons and slivers were removed after linework smoothing. Size of minimum polygons was interpreted from user needs and implemented for each community. Polygons that were deemed slivers or too small for a community were merged into the adjacent polygon that had the longest shared border.

2.7.5 Results of the linework smoothing

The two-stage approach to smoothing provided improved linework. An example of the results can be seen in Figure 2.6.

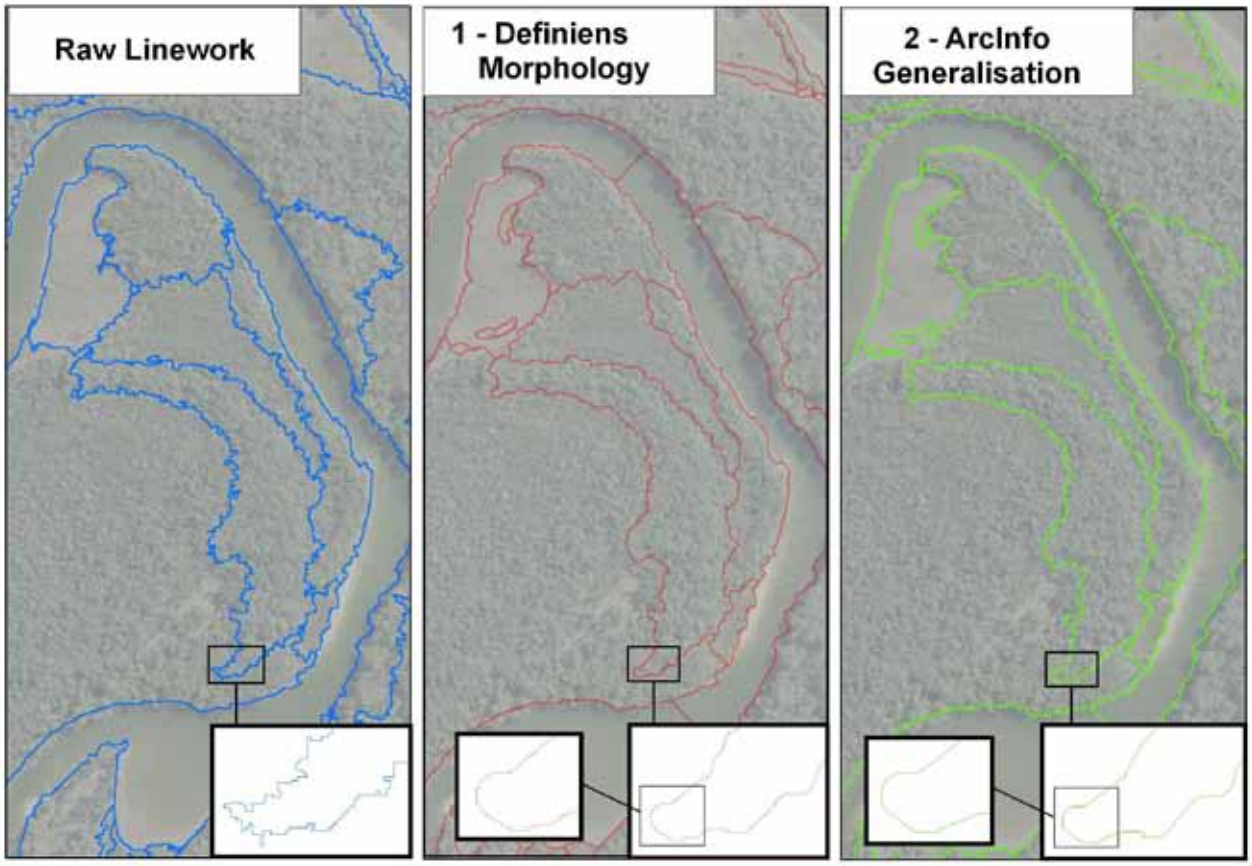


Figure 2.6 Example of linework smoothing.

Note that the extra linework shown in the Morphology and Generalisation frames are a result of classification updates, not line-smoothing.

The result of the line-smoothing was a large reduction in line vertices created as a result from pixelated edges. Before ArcInfo generalisation there were 891 524 vertices and 6279 arcs whereas after generalisation there were 284 785 vertices and 6279 arcs, a 68% reduction in line vertices after the line generalisation was applied.

The Morphology algorithm removed all large jagged edges but smaller polygons were maintained via smaller Morphology masks. The Morphology algorithm produces visually smooth lines that reflect an ecological appearance of tree-crown boundaries.

3 Results

The vegetation survey completed a total of 111 full floristic sites. The location of the survey sites, and the Rapid Data Points for assessment of the survey, are shown on Figure 3.1. The results below first summarise the floristic composition of native and exotic plant species recorded in the sample sites and opportunistically. The results of the quantitative analysis of the field survey data are then given and the vegetation communities delineated are displayed in a dendrogram and then grouped based on observed environmental relationships. A profile of all significant plant species recorded in the surveys is also presented.

We then present the results of the spatially delineated vegetation communities and the final map product. Each mapped community is then described in terms of proportion and areal distribution within Bongil Bongil NP.

Lastly, we examine the accuracy assessment process required under the *Interim Native Vegetation Type Standard* (Sivertsen 2010; see Methods). Results of the Rapid Data Point survey and subsequent accuracy assessment measures are then presented.

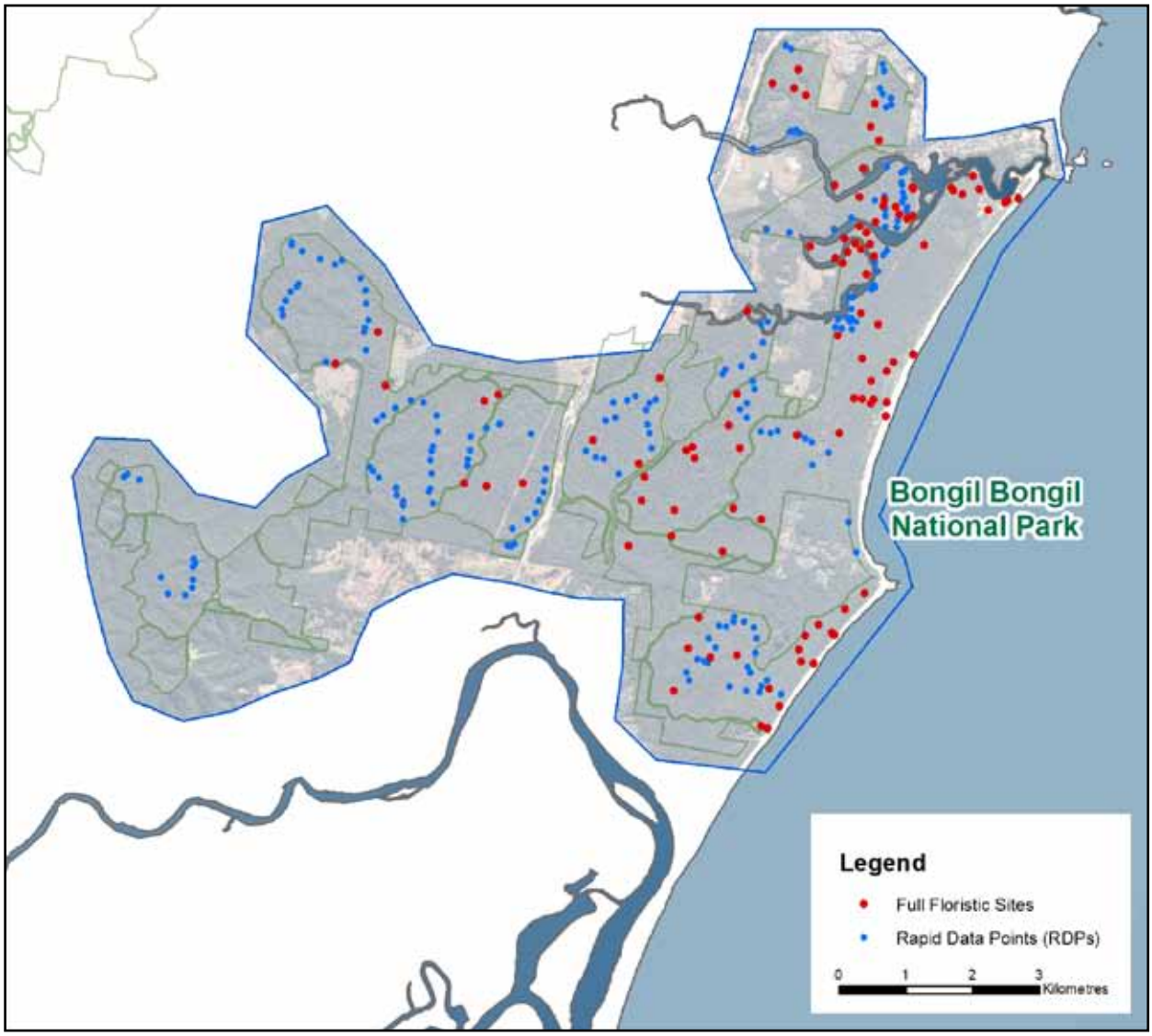


Figure 3.1 Location of survey sites and rapid data points.

3.1 The vegetation of Bongil Bongil National Park

3.1.1 Floristics

In total, 458 vascular plant taxa were recorded in the site surveys. Combining the results of the current survey with those of previous floristic studies in Bongil Bongil NP (see Methods), 674 plant taxa have been recorded, including: 1 club moss (1 family), 2 fern allies (2 families), 50 ferns (19 families), 1 cycad (1 family), 5 conifers (5 families), 423 dicotyledons (92 families), and 190 monocotyledons (33 families). Of the plants recorded in the present survey, 115 had not previously been reported from the National Park (assessed using records from the Atlas of NSW Wildlife, which includes all records from previous floristic surveys identified in Methods).

The most common plant families by number of taxa were Fabaceae (50), Mrytaceae (47), Poaceae (47), Cyperaceae (44), Orchidaceae (28), Asteraceae (27), Lauraceae (17), Euphorbiaceae (12), Proteaceae (11), Rutaceae (10), Sapindaceae (10), Apocynaceae (11), and Solanaceae (9); these common families combined total 323 taxa, just less than the half the total number of species. A full list of plants from Bongil Bongil NP is provided in Appendix 3.

The most commonly recorded native plant species from the current surveys were Lawyer Vine (*Smilax australis*), Narrow-leaved Palm Lily (*Cordyline stricta*) and Wombat Berry (*Eustrephus latifolius*). The trees Broad-leaved Paperbark (*Melaleuca quinquenervia*), Tuckeroo (*Cupaniopsis anarcardioides*) and *Guioa semiglauca* were very frequently recorded, as were the ground covers *Ottochloa gracillima,* Spiny-headed Mat Rush (*Lomandra longifolia*) and Blue Flax-lily (*Dianella caerulea* var. *producta*). The most frequently recorded taxa are summarised in Table 3.1.

Exotic plants were also commonly detected in the study area, with 33 taxa recorded in the present survey, which represents 7.2% of the total number of species recorded during this survey. The most frequently recorded introduced species are summarised in Table 3.2. Lantana (*Lantana camara*) was clearly the most commonly recorded. The next most common weeds were Broad-leaved Paspalum (*Paspalum mandiocanum*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Winter Senna (*Senna penna* var. *glabrata*) and Glory Lily (*Gloriosa superba*).

The most species-rich community in the National Park was Headland Brushbox Littoral Rainforest; the least species-rich communities were Sea Rush Saltmarsh and Grey Mangrove communities.

Table 3.1 Frequency of occurrence of native plant taxa in the Bongil Bongil NP study area. Frequency is the number of the 111 sites in which a taxon was recorded

Name	Family	Number of sites
Cordyline stricta	Asteliaceae	63
Oplismenus imbecillis	Poaceae	61
Synoum glandulosum subsp. *glandulosum*	Meliaceae	61
Lomandra longifolia	Lomandraceae	55
Archontophoenix cunninghamiana	Arecaceae	55
Smilax australis	Smilacaceae	53
Eucalyptus pilularis	Myrtaceae	50
Eustrephus latifolius	Luzuriagaceae	50
Eucalyptus grandis	Myrtaceae	49
Lantana camara	Verbenaceae	48
Dianella caerulea var. *producta*	Phormiaceae	47

Calochlaena dubia	Dicksoniaceae	46
Allocasuarina torulosa	Casuarinaceae	46
Imperata cylindrica var. *major*	Poaceae	46
Viola banksii	Violaceae	45
Morinda jasminoides	Rubiaceae	44
Corymbia intermedia	Myrtaceae	43
Gahnia sieberiana	Cyperaceae	52
Melaleuca quinquenervia	Myrtaceae	42
Syncarpia glomulifera	Myrtaceae	40
Blechnum cartilagineum	Blechnaceae	40
Eucalyptus microcorys	Myrtaceae	39
Pseuderanthemum variabile	Acanthaceae	39
Trochocarpa laurina	Ericaceae	38

Table 3.2 Frequency of occurrence of exotic plant taxa in the Bongil Bongil NP study area.

Name	Family	Number of sites
Lantana camara	Verbenaceae	48
Paspalum mandiocanum	Poaceae	14
Chrysanthemoides monilifera subsp. *rotundata*	Asteraceae	13
Senna pendulas	Fabaceae (Caesalpinioideae)	11
Cinnamomum camphora	Lauraceae	8
Gloriosa superba	Colchicaceae	7
Nymphaea caerulea subsp. *zanzibarensis*	Nymphaeaceae	6
Andropogon virginicus	Poaceae	5
Baccharis halimifolia	Asteraceae	4
Tradescantia fluminensis	Commelinaceae	4
Conyza parva	Asteraceae	3
Ficus spp.	Moraceae	3
Bidens pilosa	Asteraceae	2
Conyza bonariensis	Asteraceae	2
Oenothera affinis	Onagraceae	2
Solanum mauritianum	Solanaceae	2
Solanum capsicoides	Solanaceae	1
Taraxacum officinale	Asteraceae	1
Stenotaphrum secundatum	Poaceae	1
Sonchus oleraceus	Asteraceae	1
Cakile edentula	Brassicaceae	1
Solanum nigrum	Solanaceae	1
Panicum bisulcatum	Poaceae	1
Solanum chenopodioides	Solanaceae	1
Panicum schinzii	Poaceae	1
Sida rhombifolia	Malvaceae	1
Schefflera actinophylla	Araliaceae	1
Hypochaeris radicata	Asteraceae	1
Pinus elliottii	Pinaceae	1
Ligustrum sinense	Oleaceae	1
Ageratina adenophora	Asteraceae	1
Phytolacca octandra	Phytolaccaceae	1
Citrus x taitensis	Rutaceae	1

3.1.2 Numerical analysis

Vegetation communities were classified using quantitative data analysis of field data from the 111 full floristic survey sites. Using PATN V3 (see Methods), a dendrogram of the vegetation communities was produced. Based on the field surveys and preliminary examination of the data, the dendrogram was set at the 30-group level, and 28 floristic groups – the vegetation communities – were initially delineated following decisions to amalgamate several identified groups.

Of the 34 terminal groups of the dendrogram, four were amalgamated with one of the remaining 28 floristic groups. Groups were amalgamated for several reasons. Community 12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest is an amalgamation of three groups identified separately in the dendrogram. The main group consisted of seven sites. In the dendrogram, three sites (AL830FL019, EST830ICD007, AL830FL001) split into two separate groups sensitive to the presence of ecotonal species; it was decided to amalgamate these with the main group of sites. Community 14 Swamp Oak Swamp Sclerophyll Forest comprised four Swamp Oak sites with saltmarsh ground-cover species, identified in two separate groups. One group (of one site, EST830SS034) was separated based on a high cover abundance of Twig Rush (*Baumea juncea*). It was decided to amalgamate these two saltmarsh dominated groups into a single community. Community 30 Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest comprised four sites forming two closely related rainforest groups dominated by Bangalow Palm. The main group consisted of three sites (PM830GL109, PM830GL108, PMGL102). Another site (AL830VF101) was amalgamated with the main group of three; it was a Coachwood-dominated rainforest site misallocated within the classification to Community 26 Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest.

In addition, following the initial PATN analysis of the floristic survey, two vegetation communities were identified from the rapid data point (RDP) fieldwork conducted as part of the survey accuracy assessment. They were:

- *Baloskion pallens–Blechnum indicum* Sedgeland (Community 32)
- Swamp Mahogany–*Melaleuca sieberi* Shrubland (Community 33).

These two communities (32 and 33) were sampled directly during the RDP survey only once. The Swamp Mahogany–*Melaleuca sieberi* Shrubland (Community 33) was revisited and two full floristic fieldwork plots conducted and then re-analysed in PATN to confirm its separation from the White's Tea-tree Shrubland (Community 8). Sampling full floristic plots was not necessary for the *Baloskion pallens–Blechnum indicum* Sedgeland (Community 32) as it is an isolated and singular occurrence within the park.

A simplified dendrogram showing the relationships between the 29 floristic groups analysed through PATN is presented in Figure 3.2. The dendrogram includes Community 33, which was included after the initial analysis.

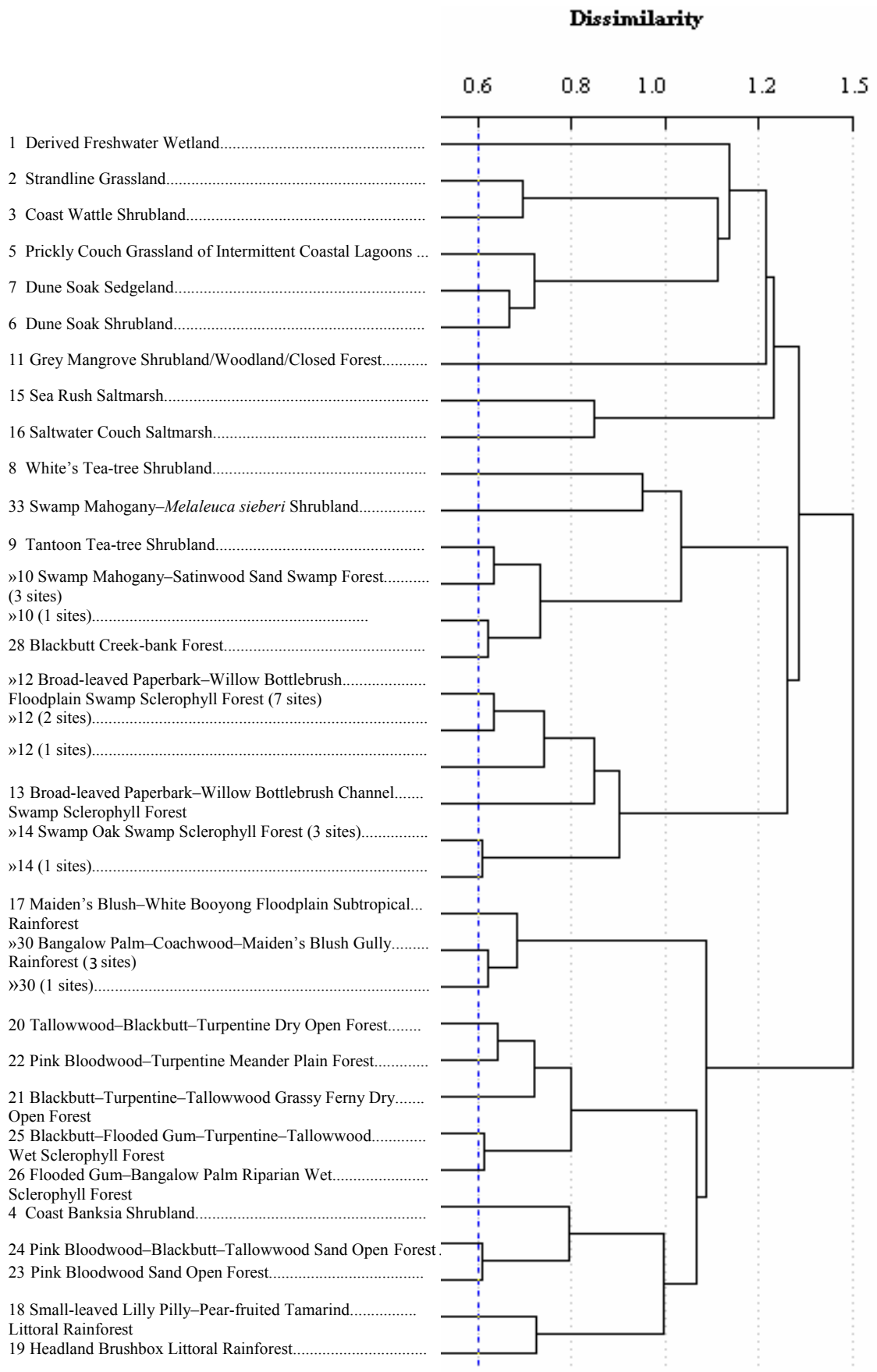


Figure 3.2 A simplified dendrogram showing the classification of the vegetation into floristic groups. Where terminal branches have been amalgamated into a single community they are identified with » and only one branch has the full name of the community. The number of sites amalgamated for each branch are also indicated.

A further three communities were delineated from interpretation of remote photo imagery (See Methods, and section 3.4.2. Rapid data points, below). These communities were:

- *Schoenoplectus subulatus* Saltmarsh (Community 31)
- Scribbly Gum Sand Forest (Community 27)
- Derived Native Grassland (Community 29).

The combined 33 vegetation communities (i.e. the 29 floristic groups of the dendrogram plus one community solely identified via the RDPs and three communities determined from remote imagery, as above) were split into four major vegetation classes, which correlate with geology, deposition environment, tidal influence and aspect, slope and topography. The four vegetation classes were:

- estuarine communities
- communities on coastal barrier sands
- alluvial communities
- communities on metasediments.

To illustrate floristic relationships with environmental influences the communities occurring on coastal barrier sands were further classified into three groups: (1) those on older Pleistocene backbarrier deposits; (2) those on recent Holocene dune deposits; and (3) Dune soak Shrublands and Sedgelands and Pricky Couch Grassland communities occurring on Holocene sands with a subsaline soil influence. A summary of group relationships, with the four vegetation classes and 33 vegetation communities is in Table 3.3.

Table 3.3 The four vegetation classes and 33 identified vegetation communites identified in Bongil Bongil NP.

is the identification number of the vegetation community. Communities marked with an asterisk (*) were areas identified as vegetation mapping units but not sampled (see section 3.1.2, above).

Vegetation class	Vegetation community	#
Alluvial Communities		
	Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	12
	Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest	13
	Maiden's Blush–White Booyong Floodplain Subtropical Rainforest	17
	Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest	26
	Derived Freshwater Wetland	1
	Blackbutt Creek-bank Forest	28
	Derived Native Grassland*	29
Communities on Coastal Barrier Sands		
Pleistocene Backbarrier	White's Tea-tree Shrubland	8
	Tantoon Tea-tree Shrubland	9
	Swamp Mahogany–*Melaleuca sieberi* Shrubland	33
	Swamp Mahogany–Satinwood Sand Swamp Forest	10
	Scribbly Gum Sand Forest	27
	Baloskion pallens–Blechnum indicum Sedgeland*	32

Holocene Dunes	Strandline Grassland	2
	Coast Wattle Shrubland	3
	Coast Banksia Shrubland	4
	Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest	24
	Pink Bloodwood Sand Open Forest	23
	Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest	18
Sub saline influence	Dune Soak Shrubland	6
	Dune Soak Sedgeland	7
	Prickly Couch Grassland of Intermittent Coastal Lagoons	5
Estuarine Communities		
	Grey Mangrove Shrubland/Woodland/Closed Forest	11
	Sea Rush Saltmarsh	15
	Saltwater Couch Saltmarsh	16
	Schoenoplectus subulatus Saltmarsh*	31
	Swamp Oak Swamp Sclerophyll Forest	14
Communities on Metasediments		
	Headland Brushbox Littoral Rainforest	19
	Tallowwood–Blackbutt–Turpentine Dry Open Forest	20
	Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	21
	Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	25
	Pink Bloodwood–Turpentine Meander Plain Forest	22
	Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest	30

3.1.3 Endangered Ecological Communities

A number of the vegetation communities delineated in Bongil Bongil NP represent listed Endangered Ecological Communities under the New South Wales Threatened Species Conservation Act (1995). These communities, the EEC of which they are part and the area of each within the National Park are listed in Table 3.4. A high-resolution map of the distribution of the EECs recorded within Bongil Bongil NP is in Appendix 1 (Map A1.6).

Table 3.4 Vegetation communities delineated in this survey and their relationship to listed Endangered Ecological Communities. Area is the area of the vegetation community within the park.

Bongil Bongil NP Vegetation Community	Endangered Ecological Community listing	Area (ha)
12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	(i) Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004a) (ii) Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004b)	265.77
13 Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest	Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004a)	37.25
14 Swamp Oak Swamp Sclerophyll Forest	Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004b)	14.82
17 Maiden's Blush–White Booyong Floodplain Subtropical Rainforest	Lowland rainforest on floodplain in the NSW North Coast Bioregion (NSW Scientific Committee 1999)	5.37
18 Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest	Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004c)	68.85

19 Headland Brushbox Littoral Rainforest	Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004c)	12.71
30 Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest	(i) Lowland rainforest in NSW North Coast and Sydney Basin Bioregion (NSW Scientific Committee 2006) and (ii) Lowland rainforest on floodplain in the NSW North Coast Bioregion (NSW Scientific Committee 1999)	119.16
15 Sea Rush Saltmarsh	Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004d)	18.9
31 *Schoenoplectus subulatus* Saltmarsh	Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004d)	0.05
16 Saltwater Couch Saltmarsh	Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004d)	1.03
7 Dune Soak Sedgeland	Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004d)	0.43
5 Prickly Couch Grassland of Intermittent Coastal Lagoons	Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004d)	0.21
6 Dune Soak Shrubland	Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (NSW Scientific Committee 2004b)	1.23
Total area		**545.82**

3.2 Plant taxa of conservation significance

Two endangered and two vulnerable species listed under the *Threatened Species Conservation Act 1995* (TSC Act) and three rare or threatened Australian plant (ROTAP) taxa (Briggs & Leigh 1996) were recorded during the present survey. An additional seven threatened or rare species have been previously reported from the park. No species considered threatened under Commonwealth legislation (*Environmental Protection and Biodiversity Conservation Act 1999* [EPBC Act]) were recorded. A summary of taxa of conservation significance is given in Table 3.5, and profiles for threatened plant taxa recorded during the present survey are provided below (section 3.2.1).

The rare plants most frequently recorded in the survey were *Eucalyptus fusiformis* (Nambucca Ironbark; recorded from seven sites), *Alexfloydia repens* (Floyd's Grass; five sites), *Peristeranthus hillii* (Brown Fairy-chain Orchid; two sites) and *Niemeyera whitei* (Rusty Plum; two sites). Several threatened species had also been recorded in the National Park previously but not during this survey. They were *Anetholea anisata* (Ringwood), *Acianthella amplexicaulis, Acronychia littoralis* (Scented Acronychia), *Chamaesyce psammogeton, Marsdenia longiloba, Oberonia titania, Senna acclinus* (Rainforest Cassia) and *Tinospora tinosporoides*.

A number of other regionally uncommon and locally rare species were recorded during the survey. Some records were at their northern limit of the taxon, others filled gaps in the known distribution of the taxon. *Aneilema biflorum*, *Artanema fimbriatum, Baumea gunnii, Callistemon linearis* (Narrow-leaved Bottlebrush), *Callitris macleayana* (Stringybark Pine), *Chiloglottis sylvestris* (Bird Orchid), *Gonocarpus chinensis* subsp. *verrucosus, Isolepis fluitans* (Floating Club-rush), *Lepidozamia peroffskyana* (Burrawang), *Leptinella longipes*, *Ophioglossum pendulum* (Ribbon Fern), *Patersonia fragilis* (Narrow-leaved Purple Flag), *Persoonia conjuncta*, *Schoenoplectus mucronatus*, *Schoenus lepidosperma* subsp. *pachylepis*, *Sesuvium portulacastrum* (Ice Plant) AND *Vigna marina* (Dune Bean).

Table 3.5 Plant taxa of conservation significance.

No. of floristic sites is the number of survey sites in which a taxon was recorded during this survey; P = species recorded previously but not during present survey. *TSC Act* = *Threatened Species Conservation Act 1995* (NSW); ROTAP = rare or threatened Australian plant (Briggs & Leigh 1996).

Taxon (Common name)	No. of floristic sites	*TSC Act*	ROTAP
Alexfloydia repens (Floyd's Grass)	5	Endangered	2K
Lindsaea incisa (Slender Screw Fern)	– (O/2)[A]	Endangered	
Niemeyera whitei (Rusty Plum)	2	Vulnerable	
Peristeranthus hillii (Brown Fairy-chain Orchid)	2	Vulnerable	
Anetholea anisata (Ringwood)	– (O/1)[A]		2RCa
Eucalyptus fusiformis (Nambucca Ironbark)	7		2RC–
Marsdenia fraseri	1		3RC–
Acronychia littoralis (Scented Acronychia)	P	Endangered	3ECi
Chamaesyce psammogeton	P	Endangered	
Marsdenia longiloba	P	Endangered	3RC–
Senna acclinis (Rainforest Cassia)	P	Endangered	3RC–
Oberonia titania	P	Vulnerable	
Tinospora tinosporoides (Arrowhead Vine)	P	Vulnerable	3RC–
Acianthella amplexicaulis	P		3RC–

[A] These species were only recorded opportunistically (numeral indicates the number of sites).

3.2.1 Profiles of threatened plant taxa

The following provides summaries of all threatened plant taxa, and the communities in which they occurred. Status is as given in Table 3.5. Information on the distribution of species beyond Bongil Bongil NP is drawn from the Atlas of NSW Wildlife (DECCW) and PlantNET (National Herbarium of New South Wales, Royal Botanic Gardens & Domain Trust, Sydney) unless otherwise referenced.

Alexfloydia repens **Endangered (TSC Act)**

Floyd's Grass


Alexfloydia repens

Recorded in five Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest sites (Community 12). The overstorey species recorded with *Alexfloydia repens* included Broad-leaved Paperbark (*Melaleuca quinquenervia*), Willow Bottlebrush (*Callistemon salignus*) and Swamp Oak (*Casuarina glauca*) and there was an open mid-layer of Prickly Paperbark (*Melaleuca styphelioides*), Broad-leaved Paperbark and Willow Bottlebrush. Saw Sedge (*Gahnia sieberiana*) and River Lily (*Crinum pedunculatum*) were sometimes present in the lower layer. The dense ground layer contained herbs and grasses in association with a high cover abundance of Floyd's Grass. Associate species included Native Violet (*Viola banksii*), *Ottochloa gracillima*, *Leptinella longipes*, *Oplismenus aemulus* and *Hypolepis muelleri*. Floyd's Grass is known from headlands at Boambee and Korora and forested floodplain wetlands bordering Pine and Boambee Creeks. A map of the distribution of Floyd's Grass within Bongil Bongil NP is in Appendix 1 (Map A1.7). Floyd's Grass has recently been discovered in several new locations on Warrell Creek, included the newly gazetted Gaagal Wanggaan NP.

Lindsaea incisa **Endangered (TSC Act)**

Slender Screw Fern


Lindsaea incisa

Recorded opportunistically at two localities in the north of the National Park, with both records on damp sandy soils. One site was in the understorey of Swamp Mahogany–*Melaleuca sieberi* Shrubland (Community 33) and the other in riparian Broad-leaved Paperbark mapped as Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12). *Lindsaea incisa* is endemic to the north coast where it occurs between Bongil Bongil NP and Bungawalbyn NP. The records within Bongil Bongil NP represent the known southern limit of the species.

Niemeyera whitei **Vulnerable (TSC Act)**

Rusty Plum

This species was located in two floristic sites in Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (Community 25), at four RDPs in Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest (Community 30) and Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (Community 26), and recorded opportunistically at several localities. Recorded from many sites in an area between Ngaamba NR north to Sherwood NR with disjunct northern occurrences at Broken Head, Nightcap NP and Numinbah NR.

Peristeranthus hillii **Vulnerable (TSC Act)**

Brown Fairy Chain Orchid


Peristeranthus hillii

Found in two systematic floristic sites, both Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (Community 18) at Bundagen. It was recorded growing as an epiphyte on the trunks of littoral rainforest trees. *P. hillii* is known to occur north from Port Macquarie. There are records of this species from Evans Head, Iluka, Brunswick Heads NR, Little Pimlico Island NR and Moobal NR.

Anetholea anisata **2RCa (ROTAP)**

Ringwood

This species has been recorded in floodplain rainforest on Pine Creek. It was observed opportunistically during the rapid site surveys in Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (Community 17). *Anetholea anisata* is endemic to the Bellinger and Nambucca Valleys, with one outlying record near Murwillumbah. It is found in Dorrigo NP, Bindarri NP, Juugawaari NR and Ganay NR.

Eucalyptus fusiformis **2RC– (ROTAP)**

Nambucca Ironbark


Eucalyptus fusiformis

Found in seven full floristic sites, and at five RDPs, all in Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (Community 25) in the wetter gullies and forest areas of the National Park. *E. fusiformis* has a scattered distribution on the north coast and tablelands and into Queensland. The material collected from these Ironbarks in Bongil Bongil NP have characteristics that overlap with the closely related *Eucalyptus ancophila*.

Marsdenia fraseri **3RC– (ROTAP)**

Found in one site in Blackbutt Creek-bank Forest (Community 28). *Marsdenia fraseri* occurs on the north coast of NSW and into Queensland.

3.2.2 Other species of special conservation significance

Aneilema biflorum

Recorded only once in this survey, in Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest (Community 30) near Mailmans Track. This species is more common in escarpment areas than on the coast. It looks superficially like Wandering Jew (*Tradescantia fluminensis*) but has thinner leaves and small white flowers.

Artanema fimbriatum

A regionally uncommon shrub, occurring at scattered localities on the north coast of NSW and into Queensland. Only recorded once in the park in a weedy plantation area mapped as 'Ecological restoration' near the railway line at North Bonville.


Artanema fimbriatum

Baumea gunnii

This uncommon sedge was recorded only once, opportunistically, in a sedgeland at North Bonville. In NSW it is known from scattered localities on the coast and tablelands. There is a record to the north of Bongil Bongil NP, near East Boambee. The nearest coastal records are from Landsdowne SF, near Taree, and it has also been recorded at Myall Lakes NP and at Mungo Brush.

Callistemon linearis
Narrow-leaved Bottlebrush

Recorded once opportunistically in the current survey in an area mapped as Swamp Mahogany–Satinwood Sand Swamp Forest (Community 10). This species is regionally uncommon and occurs more often on sandstone substrates, such as those in Sherwood NR.


Callistemon linearis

Callitris macleayana
Stringybark Pine

This species has a disjunct distribution at scattered localities on the north coast of NSW. It is common in Whian Whian State Conservation Area and Nightcap NP to the north. The nearest records are from Cascade and Bellinger River NPs to the west, and Myall Lakes NP is the nearest coastal record. In Bongil Bongil NP it is encountered sporadically on sandy soils on creek-banks and adjoining areas of wet heath and shrublands, in White's Tea-tree Shrubland (Community 8) and Tantoon Tea-tree Shrubland (Community 9). *Callitris macleayana* does not resprout and is sensitive to too-frequent fire.


Callitris macleayana

Chiloglottis sylvestris
Bird Orchid

Recorded from only one site in the current survey, in Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (Community 25). The species is distributed on the north and central coast and tablelands of NSW and into Queensland. This species has been recorded in escarpment areas such as Washpool and Gibraltar Range NPs. The nearest coastal record is from the Wallarah Peninsula on the central coast.


Chiloglottis sylvestris

Gonocarpus chinensis subsp. *verrucosus*

A taxon that was recorded only once in the present survey, in Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12). It was considered regionally uncommon by Sheringham & Westaway (1995), but has subsequently been recorded more commonly in recent surveys of the north coast.

Isolepis fluitans
Floating Club-rush

A regionally uncommon sedge on the north coast and tabelands of NSW that also occurs in Victoria and Queensland. In the study area it was recorded from a drainage channel dividing areas of Swamp Mahogany–*Melaleuca sieberi* Shrubland (Community 33) at North Bonville. This is the only known north coast record.


Lepidozamia peroffskyana

Lepidozamia peroffskyana
Burrawang

This species was seen in two locationS within the park during the survey. This species occurs on the north coast of NSW and into Queensland, where it is common in escarpment areas. It is apparently uncommon in coastal areas of northern NSW, including Bongil Bongil NP.

Leptinella longipes

A herb species that was recorded in three sites in Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12). This species is regionally uncommon on the north coast of NSW. Locally it has been recorded adjacent to the Coffs Harbour Regional Park, at Deep Creek, south of Valla and in the Warrell Creek catchment.


Leptinella longipes

Ophioglossum pendulum
Ribbon Fern

A distinctive epiphytic fern that was previously known from only three sites on the north coast of NSW; it also occurs in Queensland. It was recorded from four floristic sites in this survey, in Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (Community 18). It is often epiphytic on Staghorn FernS (*Platycerium* superbum) and Elkhorn Ferns (*Platycerium bifurcatum*).

Patersonia fragilis
Narrow-leaved Purple Flag

Recorded in Tantoon Tea-tree Shrubland (Community 9) near the Eastern Peninsula Trail and the Fist Peninsula. This species has a disjunct distribution on the coast and tablelands of NSW. The nearest coastal records are at Limeburners Creek NR to the south, and Bundjalung NP to the north. There are tableland records on the Gibraltar Range (Sheringham & Westaway 1995).

Persoonia conjuncta

This species was recorded in Tallowwood–Blackbutt–Turpentine Dry Open Forest (Community 20) and Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest (Community 21) within the park, where it is uncommon. *P. conjuncta* is endemic to the north coast, distributed between the Manning River and Coffs Harbour area (PlantNET).

Schoenoplectus mucronatus

This species was recorded only once in the survey where it forms a very restricted occurence in a saltmarsh community.

Schoenus lepidosperma subsp. *pachylepis*

An uncommonly collected sedge species that has only been located at Crowdy Head and Wallingat NPs to the south of Bongil Bongil NP, and at Wardell and Evans Head to the north. The records within Bongil Bongil NP fill a major gap in the known distribution of this taxon. In the park it was recorded in estuarine areas of Pine Creek and in one site in Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12).

Sesuvium portulacastrum
Ice Plant

A strandline succulent that is not common within Bongil Bongil NP. There are scattered records on coastal foreshores and offshore islands on the central and northern coasts and into Queensland.


Sesuvium portulacastrum

Vigna marina
Dune Bean

Recorded in one site in Strandline Grassland (Community 2) on Bundagen Beach. This species occurs sporadically in strandline vegetation of the north coast of NSW and Queensland. Recorded in Bundjalung, Yuraygir and Hat Head NPs and also on Split Solitary Island (Sheringham & Westaway 1995). The record from Bongil Bongil NP fills a gap in the known distribution of the species.


Vigna marina

3.3 Mapping and spatial interpolation

3.3.1 Map units (Interpretation & Interpolation)

The 33 vegetation communities were delineated spatially in Definiens and exported into digital ESRI format. The resultant map was then clipped to the spatial boundary of Bongil Bongil NP and an archived version of the full study area stored for future reference. The final map product is shown in Figure 3.3 along with a more detailed version in Appendix 1 (Map A1.8).

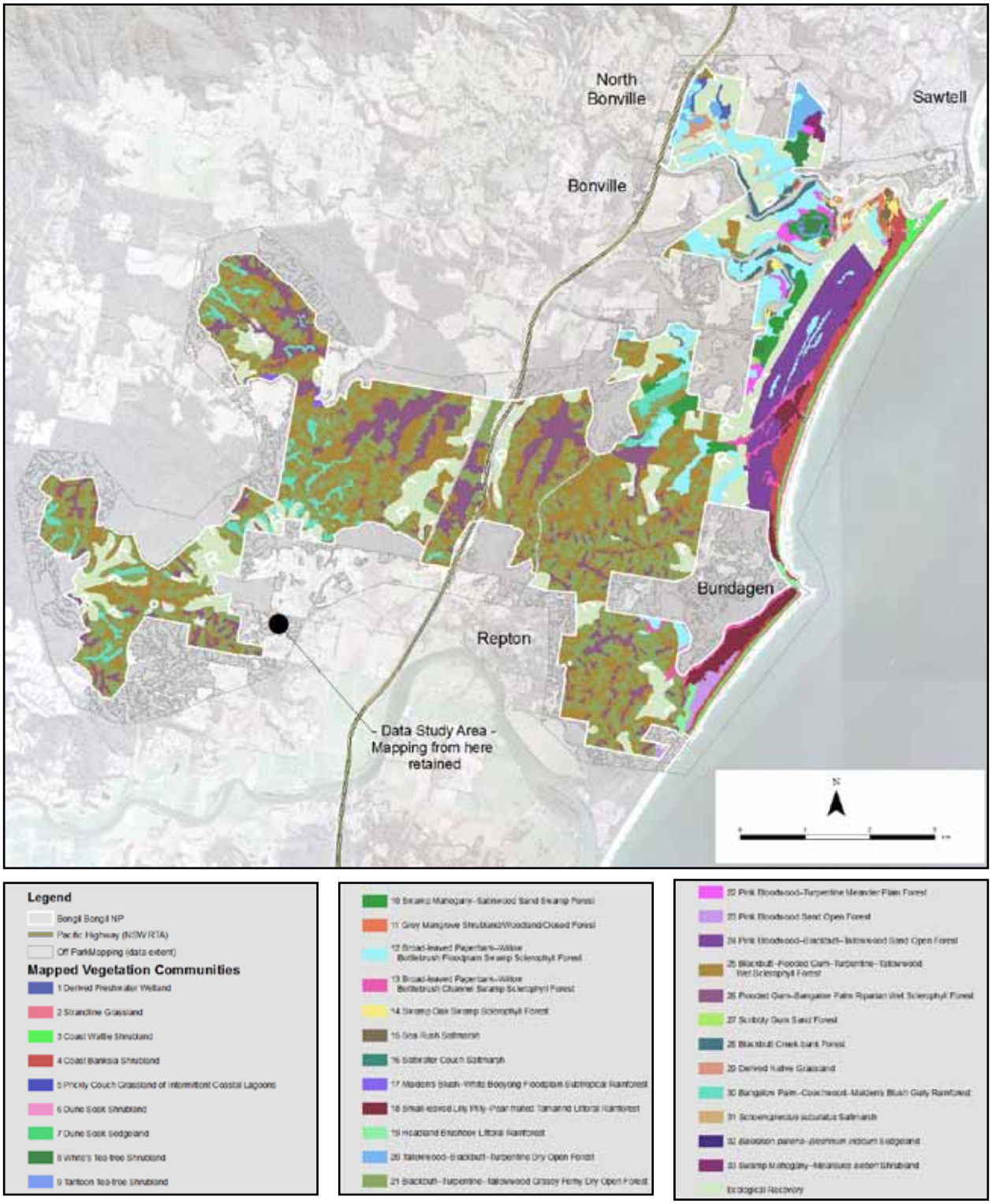


Figure 3.3 Map of the vegetation communities of Bongil Bongil National Park

Table 3.6 shows, for each community, areal extents within Bongil Bongil NP, and areal proportion within the park, minimum polygon size, morphology smoothing and the methods of derivation (RSI). It should be noted that the 'Cleared' category includes some non-park easements, such as the Pacific Highway, power line easements and the major north coast railway line. These were included simply for east–west spatial continuity of the overall park boundary.

Table 3.6 Statistics of the identified vegetation communities of Bongil Bongil NP

For details of morphology smoothing and methods of derivation, see Methods. % area is the percentage area of the National Park. Under Derivation, Manual = 2D mapping and interpretation; OBIA = Definiens classification (i.e. object-based image analysis); NN = Definiens Nearest-neighbour classification.

Map Unit #	Map unit	Area (ha)	% area	No. of polygons	Minimum polygon size (ha)	Morphology Edge Smoothing Mask	Derivation (RSI)
1	Derived Freshwater Wetland	7.90	0.18	2	0.01	Circle 15	Manual
2	Strandline Grassland	20.58	0.48	11	None	Circle 10	Manual + OBIA
3	Coast Wattle Shrubland	45.26	1.06	4	0.01	Circle 15	Manual + OBIA
4	Coast Banksia Shrubland	86.61	2.02	8	0.1	Circle 15	Manual
5	Prickly Couch Grassland of Intermittent Coastal Lagoons	0.22	<0.01	2	None	Circle 10	Manual
6	Dune Soak Shrubland	1.23	0.03	5	None	Circle 10	Manual
7	Dune Soak Sedgeland	0.44	0.01	7	None	Circle 10	Manual
8	White's Tea-tree Shrubland	23.09	0.54	3	0.1	Circle 15	Manual
9	Tantoon Tea-tree Shrubland	3.87	0.10	2	0.1	Circle 15	Manual + OBIA
10	Swamp Mahogany–Satinwood Sand Swamp Forest	59.02	1.36	7	0.1	Circle 15	Manual + OBIA
11	Grey Mangrove Shrubland/Woodland/ Closed Forest	14.55	0.34	28	0.01	Circle 15	Manual
12	Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	265.78	6.19	35	0.1	Circle 15	Manual + OBIA (NN)
13	Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest	37.25	0.87	8	0.01	Circle 15	Manual
14	Swamp Oak Swamp Sclerophyll Forest	14.83	0.34	24	0.01	Circle 15	Manual
15	Sea Rush Saltmarsh	18.90	0.44	29	0.01	Circle 10	Manual + OBIA
16	Saltwater Couch Saltmarsh	1.03	0.02	5	0.01	Circle 10	Manual
17	Maiden's Blush–White Booyong Floodplain Subtropical Rainforest	5.38	0.13	2	0.1	Circle 15	Manual
18	Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest	68.85	1.61	10	0.01	Circle 15	Manual
19	Headland Brushbox Littoral Rainforest	12.72	0.29	3	0.1	Circle 15	Manual

20	Tallowwood–Blackbutt–Turpentine Dry Open Forest	34.33	0.80	10	0.1	Circle 15	OBIA
21	Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	858.29	19.97	219	0.3	Circle 15	OBIA (NN)
22	Pink Bloodwood–Turpentine Meander Plain Forest	24.67	0.58	9	0.1	Circle 15	OBIA (NN)
23	Pink Bloodwood Sand Open Forest	22.84	0.53	4	0.1	Circle 15	Manual + OBIA (NN)
24	Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest	189.04	4.41	3	0.1	Circle 15	Manual
25	Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	971.07	22.55	338	0.3	Circle 15	OBIA (NN)
26	Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest	396.58	9.30	149	0.3	Circle 15	OBIA (NN)
27	Scribbly Gum Sand Forest	1.33	0.03	1	0.1	Circle 15	Manual
28	Blackbutt Creek-bank Forest	26.09	0.61	15	0.1	Circle 15	Manual + OBIA (NN)
29	Derived Native Grassland	10.04	0.23	3	0.1	Circle 15	Manual
30	Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest	119.16	2.78	49	0.1	Circle 15	Manual
31	*Schoenoplectus subulatus* Saltmarsh	0.05	<0.01	1	None	Circle 10	Manual
32	*Baloskion pallens–Blechnum indicum* Sedgeland	0.25	0.01	1	None	Not smoothed	Manual
33	Swamp Mahogany–*Melaleuca sieberi* Shrubland	8.20	0.19	1	0.1	Circle 15	Manual
100	Ecological recovery	696.34	16.27	43	0.3	Circle 15	Existing data + Manual
200	Sand	51.45	1.20	11	0.3	Circle 15	OBIA
300	Water	110.45	2.57	39	0.01	Circle 15	OBIA
400	Cleared	65.96	1.57	24	0.3	Circle 15	OBIA

3.4 Accuracy assessment

3.4.1 Accuracy measure

Accuracy assessment was conducted in a two-stage process. Firstly, an interim accuracy measure via a confusion matrix was calculated on a draft version of the map by overlaying rapid data points (RDPs). Following this, the RDPs were re-inserted into the interpretation–interpolation transects and the map refined using the RDP information. An overall accuracy measurement is then estimated from information in the interim confusion matrix and changes resulting from inserting the RDPs.

3.4.2 Rapid data points

As discussed in Methods, RDPs were surveyed on only 10 of 12 transects. Overall, a total of 184 RDPs were surveyed (see Figure 3.1). Table 3.7 displays the tabulated results of all the RDPs, with the 20 communities recorded and the 'degrees of correctness' assigned by botanical experts.

Table 3.7 Summary of the rapid data points

Records have been sorted in descending order via the 'Total sites per community' column.

Vegetation community	Absolutely right	Reasonable or acceptable	Understandable but wrong	Absolutely wrong	Total sites per community
25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	42	14	2		58
12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	22	1	1	1	25
26 Flooded Gum–Bangalow Palm–Riparian Wet Sclerophyll Forest	13	3	3		19
10 Swamp Mahogany–Satinwood Sand Swamp Forest	10	2	5		17
21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	10	6			16
30 Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest	13	1		1	15
22 Pink Bloodwood–Turpentine Meander Plain Forest	2	1	2	1	6
14 Swamp Oak Swamp Sclerophyll Forest	3	1	1		5
8 White's Tea-tree Shrubland	4				5
20 Tallowwood–Blackbutt–Turpentine Dry Open Forest	2	1			3
9 Tantoon Tea-tree Shrubland	2	1			3
11 Grey Mangrove Shrubland/Woodland/Closed Forest	2				2
13 Broad-leaved Paperbark – Willow Bottlebrush Channel Swamp Sclerophyll Forest	1		1		2
15 Sea Rush Saltmarsh	2				2
28 Blackbutt Creek-bank Forest	1	1			2
17 Maiden's Blush–White Booyong Floodplain Subtropical Rainforest	1				1
18 Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest	1				1
23 Pink Bloodwood Sand Open Forest	1				1
32 *Baloskion pallens–Blechnum indicum* Sedgeland	1				1
33 Swamp Mahogany–*Melaleuca sieberi* Shrubland	1				
Total sites	**134**	**32**	**15**	**3**	**184**

As described earlier, two vegetation communities (map units) were identified as a direct result of the RDP fieldwork: *Baloskion pallens–Blechnum indicum* Sedgeland (Community 32), and Swamp

Mahogany–*Melaleuca sieberi* Shrubland (Community 33). Both of these communities were sampled directly during RDPs only once and hence were labelled as 'Absolutely Wrong' against the nearest possible community. The draft map was updated to cater for both communities. For accuracy assessment analysis the 'degree of correctness' was adjusted to 'Absolutely Right' for both communities and this is reflected in Table 3.7. This has been done to reflect map 'accuracy' as opposed to classification completeness.

The remaining 13 identified vegetation communities that are absent from Table 3.7 are not present in the matrix for one or more of the following reasons:

- patches are small in size or easily interpreted with high confidence, or both
- limited spatial distribution
- field verified
- ecologically distinct
- absent from transect design owing to confidence of delineation.

These remaining communities are listed in Table 3.8 and include a brief description of the reasons for their ease of interpretation.

Table 3.8 Communities not captured by the rapid data points.

Vegetation community	Interpretation
1 Derived Freshwater Wetland	Accurately interpreted; spectrally distinct
2 Strandline Grassland	Definitive strip, i.e. first line of vegetation on beach
3 Coast Wattle Shrubland	Definitive beach coastal strip
4 Coast Banksia Shrubland	Definitive beach coastal strip
5 Prickly Couch Grassland of Intermittent Coastal Lagoons	Small definitive patches near beach; field verified
6 Dune Soak Shrubland	Small definitive patches in soaks near beach; spectrally distinct and field verified
7 Dune Soak Sedgeland	Small definitive patches in soaks near beach; spectrally distinct and field verified
16 Saltwater Couch Saltmarsh	Ecologically distinctive; accurately interpreted
19 Headland Brushbox Littoral Rainforest	Ecologically distinctive; accurately interpreted
24 Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest	Linked strongly to Barrier Sands substrate north of Bundagen
27 Scribbly Gum Sand Forest	One isolated patch
29 Derived Native Grassland	Disturbance related features; accurately interpreted
31 *Schoenoplectus subulatus* Saltmarsh	Only two locations; spectrally distinct from other saltmarsh communities

3.4.3 Interim accuracy assessment

The interim accuracy assessment utilised all 'Absolutely Right' and 'Reasonable or Acceptable' labelled RDPs (n = 166) and overlayed these onto the draft map to produce a confusion matrix. The 'Understandable but Wrong' and 'Absolutely Wrong' categories (n = 18) were discarded as they were reflective of disturbance and no community allocation could be applied.

For purposes of populating the confusion matrix, all 13 sites shown in Table 3.8 were assigned a single pseudo-RDP that was totally correct. Allocating more than one pseudo-site per community elevates overall accuracy estimates, so single sites were chosen to eliminate promotion of greater accuracies.

The interim accuracy assessment resulted in an interim overall accuracy of 62.57%, utilising 166 RDPs ('Absolutely Right' and 'Reasonable or Acceptable') and 13 pseudo-sites.

The full confusion matrix is presented in Appendix 5.

3.4.4 Final accuracy assessment

Based upon the interim accuracy assessment and information within the confusion matrix, final accuracy is estimated to be 90%.

Estimation is derived from all the misclassification errors in the interim confusion matrix (Appendix 5). Off-diagonal elements in the matrix are errors but there are also degrees to these errors, that is gross total misclassification *versus* ecologically similar or adjacent communities, or both. Table 3.9 shows the spread of misclassification errors in terms of the stratification parameters and their areal distribution within Bongil Bongil NP.

Table 3.9 Misclassification errors for each stratification parameter (sorted by 'Area of NP')

Stratification parameters	Area of NP (ha)	% area	Total RDPs	RDPs misclassified in map
Metasediments	2773.85	65	99	46
Alluvial	616.09	14	52	22
Holocene Dune	599.97	14	4	0
Estuarine	163.95	4	4	2
Pleistocene Backbarrier	123.46	3	5	1

Table 3.10 summarises the draft map misclassifications only. Gross errors were those where the draft community map had no ecological similarity to the community nominated from the overlayed field-based RDP. To analyse this approach, each of the field-verified RDP sites in Table 3.10 were reported against every spatially adjacent community in the final map as a surrogate for ecological similarity. If spatial adjacency between two communities was not found in the final map then the error was regarded as a gross error in the draft map and shaded orange. For example, the RDP Community 10, Swamp Mahogany–Satinwood Sand Swamp Forest has no spatial adjacency to Community 20, Tallowwood–Blackbutt–Turpentine Dry Open Forest in the final map and therefore tagged as a gross error in the draft map assessment.

Table 3.10 All misclassification errors (orange shading indicates gross errors).

Community at the RDPs (reference data)	Draft map/model misclassifications	No. of misclassifications
9 Tantoon Tea-tree Shrubland	10 Swamp Mahogany–Satinwood Sand Swamp Forest	3
10 Swamp Mahogany–Satinwood Sand Swamp Forest	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	2
	20 Tallowwood–Blackbutt–Turpentine Dry Open Forest	1
	22 Pink Bloodwood–Turpentine Meander Plain Forest	1
	28 Blackbutt Creek-bank Forest	1
12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	10 Swamp Mahogany–Satinwood Sand Swamp Forest	2
	13 Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest	2
28 Blackbutt Creek-bank Forest	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	1

14 Swamp Oak Swamp Sclerophyll Forest	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	2
	13 Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest	1
	28 Blackbutt Creek-bank Forest	1
15 Sea Rush Saltmarsh	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	1
21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	18 Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest	1
	25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	6
22 Pink Bloodwood–Turpentine Meander Plain Forest	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	2
25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest	1
	20 Tallowwood–Blackbutt–Turpentine Dry Open Forest	1
	21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	18
	26 Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest	5
26 Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest	21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	2
	25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	7
30 Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest	21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest	1
	25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest	3
	26 Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest	2

Overall there were only five gross error relationships in the interim assessment and they were all single occurrences. Most other misclassifications were from the heavily sampled metasediments where interpolation occurred. Errors resulted from small spatial errors between very similar communities and the complex mosaic of intense disturbance that has occurred from 1870 to 2002.

Interpreted communities. All misclassification of vegetation communities that were manually mapped or interpreted were predominantly small spatial boundary errors or where RDPs were located in a transition zone between two communities.

In summary, the final 90% accuracy estimate is a balance between very high accuracy for interpreted communities (closer to 100%) and below 90% for the interpolated communities.

4 Discussion

4.1 Distribution of vegetation communities

The distribution of the vegetation communities of Bongil Bongil NP is influenced strongly by geology, aspect and topographical position in metasedimentary areas, and by the level of inundation by floodwaters and tidal influences in creek and estuarine areas. The vegetation of Permian and Devonian metasediments and coastal barrier sands differs from that of alluvial and estuarine soils. Disturbance history also plays a significant role in determining the characteristics of vegetation communities, especially where intensive silvicultural treatments have been repeatedly applied, where fire has been repeatedly applied within ecological prescription timeframes, or where the extant vegetation is regrowth from prior forest clearing activities.

When considering the dendrogram of community relationships (see Results: Figure 3.2), the initial major division splits (1) moist sclerophyll forests and rainforest on metasediments, alluvium and sand from (2) forested wetlands, saline wetlands and grasslands and shrublands growing on coastal barrier sands, and estuarine and floodplain sediments. Based on expert knowledge, field observation and interpretation of the dendrogram the vegetation communities can be grouped based on species composition and environmental influences.

Derived freshwater wetlands (Community 1 and 29). Derived Freshwater Wetland (Community 1) is a distinct vegetation type growing in the dams at North Bonville, with Tall Spike Rush (Eleocharis sphacelata) and Narrow-leaved Cumbungi (Typha orientalis) and floating plants including Cape Water Lily (Nymphaea caerulea subsp. zanzibarensis) and Nardoo (Marsilea mutica). Derived Native Grassland (Community 29) is an open area of tall grassland to sedgeland that is an artefact of past clearing of swamp sclerophyll vegetation. There is a varied zonation of native and exotic grasses, sedges and rushes across the mapped area. Emergent Broad-leaved Paperbark and Swamp Oaks are present.

Saline wetlands (communities 11, 14, 15, 16 and 31). The most low-lying and most saline areas within Pine Creek support mangrove and saltmarsh vegetation communities. Sea Rush Saltmarsh (Community 15) is the most widespread saltmarsh type. Occupying the most saline saltmarsh, including salt scalds, is Saltwater Couch Saltmarsh (Community 16), and the lowest, most waterlogged areas within the saline swamps contain very small areas of *Schoenoplectus subulatus* Saltmarsh (Community 31). Swamp Oak Swamp Sclerophyll Forest (Community 14) has a distinct lower layer of saltmarsh and adjoins communities 15 and 16; it has a very simple floristic composition of saline grasses and rushes with a low abundance of herbs. Extensive areas of Grey Mangrove Shrubland/ Woodland/Closed Forest (Community 11) fringe the upper tidal estuary of Pine Creek.

Forested wetlands of the floodplain (communities 12 and 13). In less saline areas on the alluvial floodplains, levees, terraces and backswamps, the lower layer of saltmarsh is replaced by sedges (*Gahnia clarkei*, *Carex* spp) and herbs (*Leptinella longipes, Apium prostratum*), grasses (*Alexfloydia repens, Ottochloa gracillima, Oplismenus aemulus*) and an increased abundance of Broad-leaved Paperbark (*Melaleuca quinquenervia*), Willow Bottlebrush (*Callistemon salignus*) and, in the understorey, Prickly Paperbark (*Melaleuca styphelioides*); this characterises Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12). Swamp Oak (*Casuarina glauca*) dominate the canopy of some examples of community 12, but it is the floristics of the lower layers that differentiate Community 12 from Community 14 (Swamp Oak Swamp Sclerophyll Forest; see Saline wetlands above). Community 12 is widespread across the floodplain and there is a great deal of variation in the dominance of sedges, herbs and grasses occupying the lower layer. This community relates to both

the Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions Endangered Ecological Community (NSW Scientific Committee 2004a) and Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions Endangered Ecological Community (NSW Scientific Committee 2004b).

The other community in this category is Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest (Community 13), a distinct forested wetland community restricted to channels of interbarrier creek deposits along Scrub and Bundageree Creeks. It is delineated on this basis of low species richness, typified by sedges and lilies, and the restricted channel environment that it occupies. The lower layer is often wholly absent or extremely sparse, and at times of flood is completely inundated by floodwaters, and floating waterplants such as *Azolla filiculoides* can cover the water surface.

Vegetation of Holocene dunes (communities 2, 3, 4, 18, 23 and 24). The vegetation of the Holocene dunes follow a typical transition from exposed vegetation (Community 2 – Strandline Grassland) to the vegetation of the foredunes (Community 3 – Coast Wattle Shrubland) and then sheltered dune crests and ridges (Community 4 – Coast Banksia Shrubland). The most sheltered parts of the Holocene dunes and areas least affected by fire disturbance support Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (Community 18). South of Bundagen Headland the Coast Banksia Shrubland (Community 4) contains a range of littoral rainforest species. However, the northern examples of this community are more open, and weeds such as Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) and Glory Lily (*Gloriosa superba*) are abundant. Only scattered depauperate samples of Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest or Coast Banksia Shrubland are found north of Scrub Creek. Luxuriant stands of Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (Community 18) occur adjacent to Bundageree Creek, with very tall emergent Pink Bloodwood (*Corymbia intermedia*), Strangler Fig (*Ficus watkinsiana*) and tall Small-leaved Lilly Pilly (*Syzygium luehmaniana*) suggesting a possible input of floodplain sediments from the creek.

Pink Bloodwood Sand Open Forest (Community 23) occurs on less sheltered Holocene dune sands. a dry open forest dominated by Pink Bloodwood (*Corymbia intermedia*) with a mid-layer of Tuckeroo (*Cupaniopsis anacardioides*), a dense lower layer of Bracken Fern (*Pteridium esculentum*) and Grass tree (*Xanthorrhoea glauca* subsp. *glauca*), and a sparse ground layer of *Pomax umbellata* and Basket Grass (*Oplismenus aemulus*). The northern examples of this at the end of the eastern Peninsula Trail community have a high representation of rainforest trees and shrubs. Bloodwood–Blackbutt–Tallowwood Sand Open Forest (Community 24) occurs on the dune/swale system behind Bongil Beach. Willow Bottlebrush and Broad-leaved Paperbark are most common in the swales, associated with some sedges and rushes. Tallowwood (*Eucalyptus microcorys*), Blackbutt (*Eucalyptus pilularis*) (*Banksia integrifolia* subsp. *integrifolia*) and Pink Bloodwood (*Corymbia intermedia*) are common on the dune crests. An open to dense layer of Blady Grass (*Imperata cylindrica* var. *major*), Bracken Fern and Hopbush (*Dodonaea triquetra*) with dense tangles of Lawyer Vine (*Smilax australis*) is often present.

Holocene dune vegetation with a saline influence (communities 5, 6 and 7). Both Dune Soak Shrubland (Community 6) and Dune Soak Sedgeland (Community 7) are floristically and ecologically distinct communities, restricted to waterlogged swales on sand-dunes where saline water rises to the surface. The species composition is characteristic of saltmarsh and saline swamp sclerophyll forest. The sedges *Ficinia nodosa, Cyperus laevigatus* and *Cladium procerum* are indicator species for these communities. A similarly restricted community is Prickly Couch Grassland of Intermittent Coastal

Lagoons (Community 5), which was mapped only on sediments deposited around a small lagoon that overflows across the beach after flood events. This community also has affinities with saltmarsh.

Riparian and floodplain vegetation (communities 17, 26 and 30). Two rainforest communities (communities 17 and 30) and one wet sclerophyll forest type (Community 26) occur in river and gully environments within Bongil Bongil NP. Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (Community 17) is distributed on the floodplain of Pine Creek. This is an important rainforest remnant that has been heavily cleared across its former range. The 5 hectares of this lowland subtropical rainforest EEC (Lowland rainforest on floodplain in the NSW North Coast Bioregion) reserved in Bongil Bongil NP is highly significant. Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest (Community 30) is best developed in riparian strips in gully areas of the park on alluvial and colluvial soils. Downstream of these areas of rainforest, riparian wet sclerophyll forests have developed on broader alluvial valleys and fans. Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (Community 26) is the second-most extensive community mapped in the park.

Floodplain sclerophyll forest (communities 22 and 28). Two floodplain sclerophyll forest communities occur within Bongil Bongil NP. Pink Bloodwood–Turpentine Meander Plain Forest (Community 22) occurs on slightly raised meander plains and alluvial terraces where a moist forest community can develop on the sandy soils. In some locations along Pine Creek, clay soils outcrop on the higher creek-banks and these support Blackbutt Creek-bank Forest (Community 28). These sites were grouped together in the initial analysis of the floristic survey but were subsequently mapped separately following sampling of rapid data points in these habitats. There is an area of Turpentine (*Syncarpia glomulifera*) growing on sandy soils in the North Bonville area east of Lyons Trail that needs to be further investigated to determine if it should be treated as a distinct community. It possessed heathy understory species that were different to the mesic species composition of sites elsewhere.

Vegetation of Devonian and Permian metasediments (communities 19, 20, 21 and 25). There is a clear division between vegetation growing on Devonian metasediments and those growing on Permian metasediments. Tallowwood–Blackbutt–Turpentine Dry Open Forest (Community 20) is a dry open forest with a grassy lower layer that grows on Devonian metasediments with an undulating landform. Topography and aspect are less important influences on this vegetation community than underlying geology.

Aspect and topographic position, however, were found to be important influences on the vegetation growing on Permian metasediments. The species composition of these communities is more mesic than the communities growing on Devonian metasediments. Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest (Community 21) occurs on exposed to intermediate ridges and upper slopes. Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (Community 25) occurs on intermediate to sheltered aspects on mid- to lower slopes, and is the most widespread community within Bongil Bongil NP. It was noted during the sampling of rapid data points that in the western section of the park Flooded Gum is replaced by Sydney Blue Gum (*Eucalyptus saligna*) with increasing altitude. These western areas should be sampled to see if they represent a distinct ecological community. Community 25 grades into Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (Community 26; see above) which occurs in alluvial valleys and on alluvial fans but also in areas mapped as Permian metasediments.

Headland Brushbox Littoral Rainforest (Community 19) is primarily located on steep slopes and headlands on metasediments exposed to the ocean, though the community also occurs on sand on the footslopes below the steep bluff of Bundagen Headland. A structurally wind-pruned occurrence of

this community is found at Bundagen Headland. This community is subject to landslip in times of high rainfall as evidenced adjacent to the Bluff Trail, and at Tuckers Rocks where major rainfall events during February, March and April 2009 led to large land slumps.

Wet heath and shrublands and swamp sclerophyll forests on Pleistocene waterlogged sand (communities 8, 9, 10, 27, 32 and 33). A distinct group of communities (and map units) growing on waterlogged soils were identified in the analysis and confirmed by ground-truthing. *Baloskion pallens–Blechnum indicum* Sedgeland (Community 32), which grows with emergent Swamp Mahogany (*Eucalytpus robusta*) and Broad-leaved Paperbark, occurs at the lowest, most-waterlogged point of some freshwater wetlands. White's Tea-tree Shrubland (Community 8) was located in three disjunct areas in the park, and Tantoon Tea-tree Shrubland (Community 9) fringed the large wet heath and shrubland in the north of the park, east of Bonville Station. Extensive areas of Swamp Mahogany–Satinwood Sand Swamp Forest (Community 10) adjoined the wet heath and shrubland and occupied much of the floodplain located on sands. An area which had a distinctive overstorey of Scribbly Gum (*Eucalyptus signata*) was mapped as a separate map unit (Community 27). The one site sampled included an open forest cover of Scribbly Gum, with a middle stratum of shrubs including Tantoon Tea-tree (*Leptospermum polygalifolium* subsp. *cismontanum*), Slender Tea-tree (*Leptospermum trinervium*) and Satinwood (*Nematolepis squamea* subsp. *squamea*). The lower layer contained Tassel Rush (*Baloskion tetraphyllus* subsp. *meiostachyum*), Saw Sedge (*Gahnia sieberiana*) and Grass tree (*Xanthorrhoea fulva*). This community has similar floristic and environmental influences to Community 10. It was mapped due to the dominance of Scribbly Gum (*Eucalyptus signata*). Swamp Mahogany–*Melaleuca sieberi* Shrubland (Community 33) is floristically and ecologically distinct from other shrublands on waterlogged sandy soils. It has a species composition suggesting a clay influence from surrounding bedrock hillslopes.

4.2 Conservation significance of the vegetation

There are many restricted and threatened vegetation communities in Bongil Bongil NP. The most restricted of these communities, by area, are Dune Soak Sedgeland (Community 7) and Dune Soak Shrubland (Community 6), Pricky Couch Grassland of Intermittent Coastal Lagoons (Community 5), *Baloskion pallens–Blechnum indicum* Sedgeland (Community 32), *Schoenoplectus subulatus* Saltmarsh (Community 31) and Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (Community 17).

In total, 545.82 hectares of the park has been mapped as an amalgam of six Endangered Ecological Communities listed under the *Threatened Species Conservation Act 1995* (TSC Act). Endangered Ecological Communities occurring in the National Park are listed in Table 3.4 (Results).

4.3 Exotic species

Lantana (*Lantana camara*), Glory Lily (*Gloriosa superba*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) and Broad-leaved Paspalum (*Paspalum mandiocanum*) are the most abundant and potentially threatening weed species within Bongil Bongil NP.

Lantana was recorded in 48 sites in a large proportion of vegetation communities, and across a range of habitats from metasediments, alluvial and coastal barrier sands and riparian gullies subjected to areas of past disturbance from clearing and logging. It is very abundant in some of the former plantation areas of the park. Lantana poses a threat to the EECs and populations of threatened plant species.

Broad-leaved Paspalum was recorded in 14 sites. It colonises road verges and shoulders, old log-dumps and snigging trails, is common within the more sparsely vegetated and more open parts of the plantation blocks of the park and can be found on disturbed creek-banks. However, this invasive grass also spreads into undisturbed areas of swamp sclerophyll communities. It was frequently present in varying abundances within survey sites and has the potential to spread and threaten floodplain endangered ecological communities and populations of the threatened Floyd's Grass (*Alexfloydia repens*). In every site that Floyd's Grass was recorded in this survey, Broad-leaved Paspalum was also present. The transformation of the Sharks Head area by targeted weeding leading to the rejuvenation of the population of Floyd's Grass there has shown what is possible with concentrated bush regeneration aimed at reducing the impact of Broad-leaved Paspalum. The potential spread of Broad-leaved Paspalum into populations of Floyd's Grass should be closely monitored.

Glory Lily was recorded in seven sites and was most abundant during spring to early autumn in Coast Wattle Shrubland (Community 3) and Coast Banksia Shrubland (Community 4). It was also recorded in sites of Headland Brushbox Littoral Rainforest (Community 19) and, much less commonly, Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (Community 18). Glory Lily is restricted to sandy soil-types so its environmental impacts away from the coastline diminish rapidly as does the threat it poses to the wider reserve.

Cape Water Lily (*Nymphaea caerulea* subsp. *zanzibarensis*) is common in water storage areas at North Bonville and was frequent as an emergent floating waterplant along Scrub Creek. It does not seem to pose a threat to the vegetation communities it occupies.

Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) is very abundant in communities Coast Wattle Shrubland (Community 3) and Coast Banksia Shrubland (Community 4).

Groundsel Bush (*Baccharis halmifolia*) was recorded growing in swamp sclerophyll vegetation communities such as Swamp Oak Swamp Sclerophyll Forest (Community 14) and Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (Community 12). As a listed noxious weed this species has frequently been the target of control activity during the 15 years the area has been a declared conservation reserve, and its abundance has been significantly reduced over this time.

Senna pendula var. *glabrata* was found in 11 sites in the park. Although reasonably common throughout the Park this plant occurs at low densities and does not pose a significant environmental threat to the ecological functioning of the National Park.

4.4 Remote sensing, image interpretation and Definiens

4.4.1 Data quality

The quality of input data has a direct influence on the output quality of an interpolated map-product. For mapping at Product Class 5 (see Methods) the accuracy and scale of ecological predictors need to be commensurate with the scale of ecological processes determining the extents of the vegetation communities. For this project the following summations can be made.

Input imagery quality. The 22-cm multispectral photography of Coffs Harbour City Council (CHCC) was superior in spatial resolution to that of the Quickbird satellite image and thus contained more spatial information. The photography was not used directly for the project as it was spatially incomplete for the study area and lacked a NIR band, which provides needed additional information

for vegetation analysis.

The 60-cm pan-sharpened Quickbird satellite imagery was adequate for Definiens analysis. However, although the Quickbird imagery is regarded as having high spatial resolution, it possesses poor spectral range, with only four multispectral bands. The result is an increase in information in the spatial domain with no extra means to classify it in a spectral capacity. Ideally, high spatial resolution imagery that contains numerous vegetation-specific bands would improve classification in a digital analysis.

Geology Strata (GS). The GS layer was vital but not captured at the same fine scale as the distribution of the vegetation communities. In terms of the classification of deposition units it was detailed enough but spatial accuracy was not commensurate. For example, there were 3–4 definite alluvial fans where Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (Community 26) occurred but these were not evident in the geology layer and were thus modelled as a drier metasediment community. These errors were detected and rectified manually.

Overall, the GS layer was vital, and spatial deficiencies were overcome to a degree by being more inclusive with categories when modelling for individual communities.

LiDAR. LiDAR coverage for the study area was not complete and modelling in its absence has caused an estimated deterioration in modelling accuracy across the metasediment areas. Quantifying this is difficult given the vast array and complexity of disturbance evident in the first place. The obvious reason for the deterioration in modelling accuracy is the broader scale 25-metre pixel DEM that was used where there was no LiDAR coverage. Also, the lack of LiDAR's spatial coverage prevented the utilisation of powerful tree-structure indices that are a distinct advantage of non-ground strike LiDAR. To quantify improvement would require a repeat of the process with full LiDAR coverage.

It is also important to mention the difficulties smoothing out 'microvariation' or 'high-frequency noise' in LiDAR data. Deriving standard indices, such as slope and aspect, from raster LiDAR data is problematic. For example, a flat alluvial area will contain many aspect classes owing to surface roughness of ±15 cm resulting from LiDAR vertical accuracy.

The application of smoothing filters (multiple shapes and sizes) proved ineffective as the problem is multiscaled across a study area the size of Bongil Bongil NP. Resampling and interpolation of LiDAR to larger cell-sizes also proved ineffective as it lost required detail (i.e. fine scale drainage networks on the alluvial flats). A satisfactory solution was found by smoothing the resulting LiDAR-derived terrain indices afterwards as opposed to smoothing the LiDAR initially.

Where the luxury of LiDAR existed its efficacy was unquestioned. LiDAR's inherent accuracy, both horizontal and vertical, allows direct structural classification which in some cases can be used both directly or indirectly, or both, for vegetation community classification.

Disturbance – Logging history. The derivation of the logging history layer was a great achievement for the project and it presents a detailed history of vegetation 'condition' for Bongil Bongil NP. In deriving this layer, all available imagery was utilised to cover temporal variations in forestry activities of the time. Subsequently, spatial accuracy will vary in accordance with quality of imagery sources used.

From the final disturbance layer, the 'Plantation' category was extracted then inserted into the interpolation process. Spatially inaccurate boundaries resulting from the 'Plantations' were refined in a last review of linework against both the Quickbird image and CHCC's multispectral photography.

No attempt has been made to classify the 'condition' or floristic composition of these former

plantations and they have now been tagged as 'Ecological recovery' given their protection within a national park.

4.4.2 Definiens (Object-Based Image Analysis – OBIA)

It is suggested that the complexity, condition and variability of vegetation diversity on the north-eastern coast of New South Wales prevents any fully automated approach to Class 5 vegetation mapping. Use of Definiens would be no exception to this assertion.

For this study, Definiens was both efficient and accurate for delineating 'high-contrast' features, such as cleared *versus* woody vegetation *versus* sand *versus* water bodies. It was also very effective for delineating vegetation communities on alluvial substrates where LiDAR coverage existed. Combinations of both manual and automated approaches in Definiens in these areas proved successful. It is to be noted that the suite of manual classification and editing tools in Definiens are user friendly and very efficient.

As discussed previously, the modelling on metasediments proved less accurate than that of the alluvial areas. Again, how much of this is attributable to data quality and disturbance is not known. Aerial photograph interpretation (API) in such areas would have proved advantageous to obtain more accurate terrain interpretation resulting from stereo capability with fine-scale imagery. Unfortunately the Airborne Digital Sensor ADS-40 stereo imagery (Leica Geosystems) was not available at the time the project was undertaken.

The project was initially started with Definiens Developer 7, a client version of the software. Developer 7 has processing limits with regard to larger datasets, internal rasterisation of thematic data and segmentation. This project reached those limitations and thus a switch to Definiens Server 7 (Enterprise Version) was initiated midway through the process. The Definiens Server project specifications, segmentations, rulesets and community modelling parameters can be obtained by contacting author M. Cameron.

At the time of writing, the next version of Definiens software products is available (Ecognition 8) and these products have addressed many of the processing limitations present in Developer 7.

Overall, Definiens possesses a vast range of tools that could replicate the ecological influences causing the distribution of vegetation communities very well. However, understanding this suite of tools and combining them into strategies to replicate these influences remains challenging.

4.4.3 Accuracy assessment

Accuracy assessment for this project focussed mainly on the resulting thematic vegetation community map. The accuracy assessment described by Gopal & Woodcock (1994) and Woodcock & Gopal (2000), and recommended by Sivertsen (2009) have been adopted in principle for this project.

The design of the accuracy assessment was not as thorough as that outlined by Gopal & Woodcock (1994) and Woodcock & Gopal (2000), and lacked means to assess quantity and degree of errors (via the MAX, RIGHT and DIFFERENCE functions). Field survey would have facilitated use of these functions had it documented the probability of every community occurring at each site via 'degrees of correctness'. However, even without these extra functions, the accuracy assessment was thorough and provided a statistically viable way of assessing the mapped product for Bongil Bongil NP.

4.5 Fire interval guidelines

Based on the fire guidelines of the NPWS Fire Guidelines for Broad Vegetation Types (DECCW 2011a; see also NPWS 2002) and other sources (Chiswell & Redpath 2006; Eco Logical Australia 2007; see Table 4.1) fire **should be excluded** from 14 of the 33 communities (community number is in parentheses):

- Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (17)
- Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (18)
- Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest (30)
- Dune Soak Shrubland (6)
- Dune Soak Sedgeland (7)
- Prickly Couch Grassland of Intermittent Coastal Lagoons (5)
- Grey Mangrove Shrubland/Woodland/Closed Forest (11)
- Sea Rush Saltmarsh (15)
- Saltwater Couch Saltmarsh (16)
- *Schoenoplectus subulatus* Saltmarsh (31)
- Swamp Oak Swamp Sclerophyll Forest (14)
- Headland Brushbox Littoral Rainforest (19)
- Derived Freshwater Wetland (1)
- Derived Native Grassland (29).

Interim fire guidelines for the remaining 20 communities are discussed below. These guidelines are based on minimum fire requirements of component community species where known. These intervals are suggestions only and need to be adapted as fire research and information on the fire ecology of plant communities and species becomes available. Fire events in the park are ideal opportunities to collect data on fire responses.

The suggested fire intervals are based on some general observations, from which could be developed testable hypotheses:

- Many areas of Bongil Bongil NP have a long history of logging, clearing, establishment of plantations and fire disturbance. The park is starting a lengthy process of recovery from decades of disturbance. A 'long' fire-free interval is recommended for many communities, in particular moist forests, to allow sensitive areas to recover.
- Rainforest and mesic communities were once more extensive in the park, particularly in the western gully areas. There are extensive areas of riparian and wet sclerophyll forest dominated by Flooded Gum in the park as a result of forest management that encouraged establishment of preferred and commercially useful species. The former state forest and private lands were managed to actively remove some species in favour of more commercially useful species such as Flooded Gum and Blackbutt.
- The National Park contained a higher abundance of mesic species before its history of frequent and diverse disturbance. There is anecdotal evidence that in the past there was a far greater representation of Sassafras (*Doryphora sassafras*) and Coachwood (*Ceratopetalum apetalum*)

and fruit-bearing rainforest in coastal sand forests and which provided an abundant food resource for large flocks of pigeons (J. Burke, pers. comm.). This is in part supported by the high proportion of mesic plant species found in the best examples of Coast Banksia Shrubland (Community 4) and Pink Bloodwood Sand Open Forest (Community 23).

- Some areas of grassy forest on ridges and upper slopes on metasediments in the southern section of the park were encouraged by past logging and burning.
- Much of the reserve's forests are comprised of young trees. Pockets of mature to old-growth stages of wet sclerophyll and dry sclerophyll forest are not common in the reserve and it is suggested that protection and expansion of these areas will be enhanced by sensitive fire-management prescriptions, such as avoiding crown fires in mature and old-growth forests wherever possible.

A summary of the vegetation communities and their recommended fire intervals is given in Table 4.1.

Strandline Grassland (2). The NSW Fire Interval Guidelines (DECCW 2011a) recommend a fire interval of 2–10 years for grasslands. For Bongil Bongil NP it is recommended that there are no planned fires for this community, although fire is unlikely to be an important disturbance factor in this dunal vegetation community, which is subject to significant and frequent erosion.

Coast Banksia Shrubland (4). Parts of this community south of Bundagen Headland contain many littoral rainforest plant species. The primary juvenile period for Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*) is 10 years. Therefore an interim fire-free period of at least 12 years is recommended to enable the persistence of Coast Banksia and littoral rainforest species.

White's Tea-tree Shrubland (8). This community is dominated by White's Tea-tree (*Leptospermum whitei*) and Olive Tea-tree (*Leptospermum liversidgei*). Although there is no information on the fire response of White's Tea-tree, Olive Tea-tree is recorded as a resprouting species (DECCW 2011b). There is no information on the life-history characteristics of either of these community dominants. However, Fern-leaved Banksia (*Banksia oblongifolia*), which is a co-dominant lower-layer species in this community, has recorded primary and secondary juvenile periods of 12–15 years. At North Bonville this community has undergone past clearing up to 30 years ago, but has recovered to a natural species composition. A fire-free period of 15+ years is recommended.

Tantoon Tea-tree Shrubland (9). This community contains old-growth Tantoon Tea-tree *(Leptopsermum polygalifolium* subsp. *cismontanum*). The lifespan of this tea-tree has been recorded as 80 years (DECCW 2011b). There is no sign that the tall shrubs within this community are senescing. The NPWS Fire Guidelines (DECCW 2011a) and Chiswell & Redpath (2006) recommend a fire-interval for heathland vegetation communities generally of 7–20 years. However, for Bongil Bongil NP it is recommended that no fires be planned in this community until research into the impact and response of fire on old-growth tea-tree can be undertaken.

Swamp Mahogany–*Melaleuca sieberi* Shrubland (33). The fire-interval for this community is as for White's Tea-tree Shrubland (15+ years), where the minimum fire-interval is determined by the primary juvenile period of Fern-leaved Banksia, which is a common species in the lower layer of both communities.

Swamp Mahogany–Satinwood Sand Swamp Forest (10). Fire-intervals of 10–30 years are recommended, subject to further investigation of the fire requirements of this swamp sclerophyll community.

Scribbly Gum Sand Forest (Community 27). Fire-intervals of 10–30 years are recommended, subject to further investigation of the fire requirements of this swamp sclerophyll community.

***Baloskion pallens–Blechnum indicum* Sedgeland (Community 32).** A fire-interval of 6–35 years is recommended. The community has an overstorey of mature Swamp Mahogany similar to that of community 10, and a fire regime for swamp sclerophyll forest vegetation is suggested.

Coast Wattle Shrubland (3). Fire in this dunal community creates a potential erosion risk. However, the role of fire in controlling infestations of Bitou Bush in combination with herbicide treatment should be further investigated. Coast Wattle (*Acacia longifolia* subsp. *sophorae*) is also a fire-sensitive species and fire-regimes should be designed to enable its persistence. The primary juvenile period of Coast Wattle subsp. *sophorae* is recorded as 5 years (DECCW 2011b). A fire-free period of at least 10 years is recommended.

Tallowwood–Blackbutt–Turpentine Dry Open Forest (20). Chiswell & Redpath (2006) recommend a fire interval of 3–6 years to maintain a grassy forest. This community is likely to tolerate more-frequent ground fire than other mesic forest communities of the park, and many of the grass, fern and shrub species are able to mature and re-establish quickly after fire. However, the NPWS Fire Guidelines (DECCW 2011a) recommended a more conservative interval of 10–50 years for this community, a recommendation followed here. It is hypothesised that in some areas the grassy understorey of this community is an artefact of past land-management and disturbance.

Blackbutt–Turpentine–Tallowwood Grassy/Ferny Dry Open Forest (21), Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (25), Pink Bloodwood–Turpentine Meander Plain Forest (22). For these three wet sclerophyll communities a fire interval of 20–100+ years is recommended (Chiswell & Redpath 2006). It is recommended that crown fires should be avoided, to enable an expansion of mature and old-growth stands of these communities, which are currently rare in the park.

Blackbutt Creek-bank Forest (28). A fire interval of 10–50 years is recommended for this community.

Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (26). A fire-interval of 20–100+ years is suggested, which is a combination of recommended minimum (as per NPWS Fire Guidelines [DECCW 2011b]) and maximum (Chiswell & Redpath 2006) fire-free intervals. These riparian forests should be managed to encourage natural dynamics and to provide an environment for the natural expansion of riparian rainforest to replace areas were Flooded Gum has been established.

Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest (24). This community appears to have been severely disturbed, possibly through intense fire. Dense tangles of Lawyer Vine and Blady Grass are common, as are weeds such as Lantana and Bitou Bush. A fire-interval of 10–30 years is recommended because (1) the recommended minimum fire-interval for Coast Banksia (subsp. *integrifolia*), which is a component of this community, is 10 years; and (2) a 'long' fire-free interval would allow recovery of this community. The minimum fire-intervals in the NPWS Fire Guidelines (7–30 years; DECCW 2011a) and Chiswell & Redpath (2006) (3–25 years) appear to be too short.

Pink Bloodwood Sand Open Forest (23). The recommended fire-interval for this community, of 10–30 years, is as for Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest (Community 24). The better samples of Pink Bloodwood Sand Open Forest appear to contain more mesic species suggesting that they have been protected from more frequent disturbance from fire.

Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (12). A fire-interval of 15–30 years is suggested for this Swamp Sclerophyll Forest, based on the upper fire-free

interval in the NPWS Fire Guidelines (DECCW 2011a) and the minumum fire-interval recommended by Chiswell & Redpath (2006). Whereas Broad-leaved Paperbark and Willow Bottlebrush can recover from fire, and the community could tolerate fire in the right season, the benefits of fire on this community are uncertain, and therefore planned fire is not recommended.

Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest (13). This is a floodplain channel and riparian community that would not appear to require burning, and would be unlikely to carry fire even in the driest seasons. It is recommended that no fire be planned for this community.

The fire recommendations provided are interim in nature, and are based on limited data on the fire responses of key species that make up the communities, and also a sketchy knowledge of the past distribution of natural communities after clearing, logging and plantation disturbance, and patchy fire-history data. These recommendations should be used as a starting point only in formulating fire-management plans in the reserve. They should be used as a basis to guide future fire research and investigation. Assumptions made about the fire ecology of species and communities can be found to be very wrong for even apparently fire-adapted species and communities.

Table 4.1 Identified vegetation communities of Bongil Bongil NP and guidelines for fire-intervals.

Suggested intervals for Bongil Bongil NP are derived from a combination of the NPWS Fire Guidelines (DECCW 2011a; see also NPWS 2002); recommendations for fire regimes for the north coast (Chiswell & Redpath 2006); and recommendations for Yarriabini NP, near Scotts Head, to the south of Bongil Bongil NP (Ecological Australia 2007). Ranges of figures are minimum and maximum intervals.

Bongil Bongil vegetation community (#)	Vegetation type	Recommended fire interval (figures are years unless stated)			
		NPWS Fire Guidelines	North coast	Yarriabini NP	Bongil Bongil NP – suggested
Alluvial					
Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest (12)	Swamp sclerophyll forest	7–35	15–30		15–30
Broad-leaved Paperbark – Willow Bottlebrush Channel Swamp Sclerophyll Forest (13)	Swamp sclerophyll forest	7–35	15–30		No planned fire
Maiden's Blush–White Booyong Floodplain Subtropical Rainforest (17)	Rainforest	Avoid fire	Exclude fire	No planned fire	Exclude fire
Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest (26)	Wet sclerophyll forest	25–60	20–100+		20–100+; protect mature, old-growth stands from crown fire, allow natural reestablishment of rainforest
Derived Freshwater Wetland (1)	Freshwater wetland	Avoid fire	6–35		Exclude fire
Blackbutt Creek-bank Forest (28)	Semi-mesic grassy forest	10–50	3–25		10–50

Derived Native Grassland (29)	Grassland	–	–	–	A derived community – no recommendation
Coastal Barrier Sands					
Pleistocene Backbarrier					
White's Tea-tree Shrubland (8)	Heathland	7–30	7–20		15+
Tantoon Tea-tree Shrubland (9)	Heathland	7–30	7–20		No planned fire; investigate impact of fire on old-growth tea tree
Swamp Mahogany–*Melaleuca sieberi* Shrubland (33)	Heathland	7–35	7–20		15+
Swamp Mahogany–Satinwood Sand Swamp Forest (10)	Swamp sclerophyll forest	7–35	15–30		10–30
Scribbly Gum Sand Forest (27)	Swamp Sclerophyll Forest	7–35	15–30		10–30
Baloskion pallens–Blechnum indicum Sedgeland (32)	Heathland	7–30	6–35		7–35
Holocene Dunes					
Strandline Grassland (2)	Grassland	2–10	No recommendation		No planned fires
Coast Wattle Shrubland (3)	Heathland	7–30	7–20		10–30
Coast Banksia Shrubland (4)	Heathland	7–30	7–20	10–20 years; emphasis on intervals in the range of 10–12 years	12+; longer fire-free period recommended in areas with littoral rainforest trees
Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest (24)	Shrubby dry sclerophyll forest	7–30	3–25		10+
Pink Bloodwood Sand Open Forest (23)	Shrubby dry sclerophyll forest	7–30	3–25		10–30
Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest (18)	Rainforest	Avoid fire	Exclude fire		Exclude fire
Sub saline influence					
Dune Soak Shrubland (6)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Dune Soak Sedgeland (7)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Prickly Couch Grassland of Intermittent Coastal Lagoons (5)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Estuarine					
Grey Mangrove Shrubland/Woodland/Closed Forest (11)	Saline wetlands	Avoid fire	Exclude fire		Exclude fire
Sea Rush Saltmarsh (15)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Saltwater Couch Saltmarsh (16)	Saline wetland	Avoid fire	Exclude fire		Exclude fire

Schoenoplectus subulatus Saltmarsh (31)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Swamp Oak Swamp Sclerophyll Forest (14)	Saline wetland	Avoid fire	Exclude fire		Exclude fire
Metasediments					
Headland Brushbox Littoral Rainforest (19)	Rainforest	Avoid fire	Exclude fire		Exclude fire
Tallowwood–Blackbutt–Turpentine Dry Open Forest (20)	Semi-music grassy forest	10–50	3–6		10–50
Blackbutt–Turpentine–Tallowwood–Grassy Ferny Dry Open Forest (21)	Semi-mesic grassy forest	10–50	20–100+	20–100+	20–100+; protect mature, old-growth stands from crown fire
Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest (25)	Wet sclerophyll forest	25–60	20–100+		20–100+; protect mature, old-growth stands from crown fire
Pink Bloodwood–Turpentine Meander Plain Forest (22)	Wet sclerophyll forest	25–60	20–100+		20–100+; protect mature, old-growth stands from crown fire
Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest (30)	Rainforest	Avoid fire	Exclude fire		Exclude fire

4.6 Floyd's Grass and the Black Grass-dart

The presence of Floyd's Grass (*Alexfloydia repens*) in the National Park has led to a more detailed examination of the distribution of the species. Floyd's Grass is an endangered species (TSC Act) until recently considered to be restricted to the Coffs Harbour coast (Simon 1992; NSW Scientific Committee 2001). However, other patches of the grass have recently been discovered at Warrell Creek, approximately 50 kilometres south of Coffs Harbour. Further impetus to the survey of Floyd's Grass was the Black Grass-dart (*Ocybadistes knightorum*), an endangered butterfly that is dependent on Floyd's Grass for food and habitat (Lambkin & Donaldson 1994; Sands 1997; Braby 2000; NSW Scientific Committee 2002; Andren & Cameron In prep.).

As a result of the current survey, Bongil Bongil NP is now known to contain 73 individual patches of Floyd's Grass, with a combined total area of approximately 16.14 hectares. It was only possible to map each individual patch of Floyd's Grass by walking the perimeter of the patch with a hand-held global positioning system (GPS). No form of remote sensing, modelling or aerial photograph interpretation would be able to map the distribution given that the grass is a ground species that occurs mostly next to saline coastal estuaries and co-occurring with various overstorey species. The distribution of Floyd's Grass in Bongil Bongil NP is shown in Appendix 1 (Map A1.7).

4.7 Further work

4.7.1 Plant identification issues

The following species groups presented some difficulty in identification during the current survey. However, it is unlikely that problems of identification affected the results of the community analysis.

Ironbarks (*Eucalyptus* spp.). It was difficult to collect material from ironbarks in the wetter forests of the park. Where adequate material was collected it was determined as being intermediate between

Eucalyptus fusiformis and *Eucalyptus ancophila*. It has been suggested that *Eucalyptus paniculata* (Grey Ironbark) also occurs within the reserve (M. Smith, pers. obs.). The identification of *E. paniculata* requires observation of adult leaves (discolorous), fruits and buds to confirm identification. The bloodwoods on sand were determined as C. intermedia, but C. gumifera could also occur.

Saw Sedges (*Gahnia* spp.). *Gahnia sieberiana versus Gahnia clarkei.* All saw sedges from swamp sclerophyll on the floodplain and estuarine areas were identified as *Gahnia clarkei*. This species has generally thin, green leaves and flowers without glumes. Material from *Gahnia* on sandy backbarrier in heathlands and shrublands were identified as *Gahnia sieberiana*. *G. sieberiana* is a stouter plant with broader grey-green leaves and flowers with glumes. However, flowering material was not always available. It is felt that any confusion in the identification of these two species would not have affected the floristic classification.

Mat Rushes (*Lomandra* spp.). In sites where infertile material was present it is possible that identifications of *Lomandra spicata, Lomandra hystrix* and *Lomandra longifolia* could have been confused.

Ground ferns. Some fern material without spores or fertile fronds from ground fern genera such as *Lastreopsis, Hypolepis, Apslenium, Blechnum wattsii* were difficult to identify.

4.7.2 Further survey priorities

Areas in the south western section of the study area should be surveyed to sample the occurrence of vegetation dominated by Sydney Blue Gum that occupies higher elevation slopes on Permian metasediments. More field verification work of the vegetation community is warranted, particularly in the sclerophyll forest areas of the reserve. Targeted threatened plant surveys would also be useful, as site surveys can miss such species.

4.7.3 Further field validation and maintenance system

The issues around moving vegetation mapping and survey data to an 'Update & Maintenance' system are problematic. Such a system would require appropriate expertise and infrastructure to store, assess and revise vegetation data products in terms of currency and spatial accuracy. Such a system would then inform larger statewide vegetation information systems. Even though the data for this project are detailed, they still require entry into 'Update & Maintenance' mode so that temporal variation in biodiversity and corrections can be verified, implemented and recorded systematically by appropriate experts.

It is recommended that an 'Update & Maintenance' system be developed and that Bongil Bongil NP data be entered into such a system and that all individual vegetation survey and mapping projects would benefit from such a system.

4.7.4 Definiens and Aerial Photography Interpretation

Any future vegetation mapping work in a Definiens environment would benefit from the following:

- LiDAR pre-processing to overcome 'microvariation'
- LiDAR Tree Crown Delineation and Structure Indices
- Improved processing capabilities (i.e. Server versions)

- Further investigation of segmentation and classifications strategies
- Investigation of Definiens 3D (space) and 4D (time) analysis environments that are now available.

One important area of investigation remains the integration of stereo API and Definiens approaches. Definiens software caters for traditional pixel-based modelling techniques with the added suite of tools and techniques found in an object-based environment. This means that fuzzy logic, spatial context, hierarchical context, tone and texture can also be utilised as influences on vegetation community distribution Stereo API allows the operator to interpret spatial context, texture and tone from fine-scale imagery. Advances in hardware and software now mean that API can be conducted in a 3D GIS digital environment. Also, the interpreter possesses an *a priori* knowledge of local landscape and environmental factors that influence community distributions. Integrating the strengths of both approaches would surely benefit future vegetation survey and mapping work but how best to do this remains untested.

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Appendix 1 Maps of Bongil Bongil National Park

The following maps show various aspects of the history of Bongil Bongil NP (Maps A1.1–A1.5); the distribution of Endangered Ecological Communities listed under the *Threatened Species Conservation Act* and delineated in the park (Map A1.6); the distribution of the endangered Floyd's Grass in Bongil Bongil NP (Map A1.7); and the final mapped vegetation communities of Bongil Bongil NP (Map A1.8).

Map A1.1 Gazettals to Bongil Bongil National Park (see Introduction, section 1.2.6 Land-use and history).

Map A1.2 History of mining in Bongil Bongil National Park (see Introduction, section 1.2.6 Land-use and history).

Map A1.3 Forestry – history of logging in Bongil Bongil National Park (see Introduction, section 1.2.6 Land-use and history).

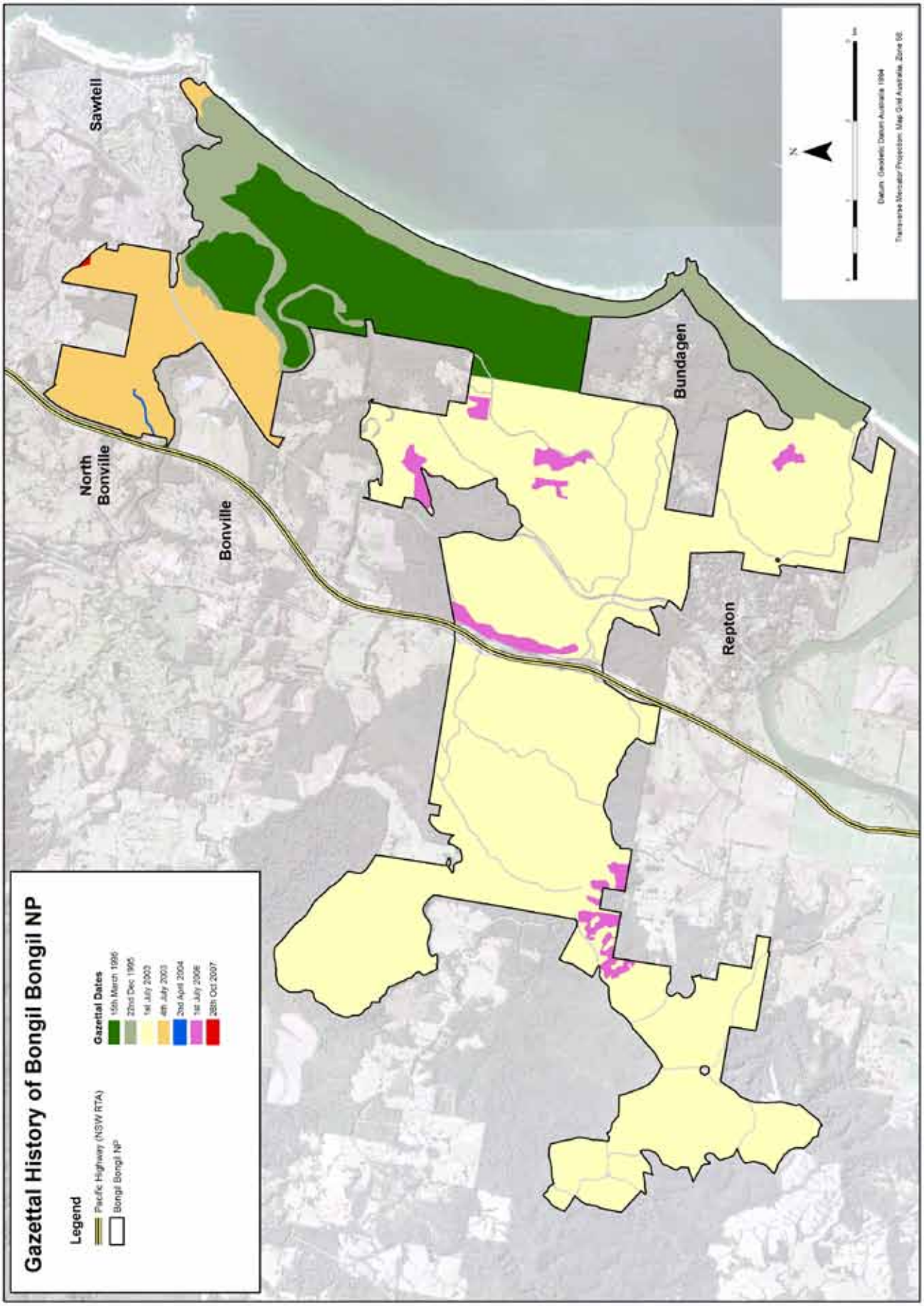
Map A1.4 Forestry treatments in Bongil Bongil National Park (see Introduction, section 1.2.6 Land-use and history).

Map A1.5 Fire history of Bongil Bongil National Park (see Introduction, section 1.2.7 Fire history).

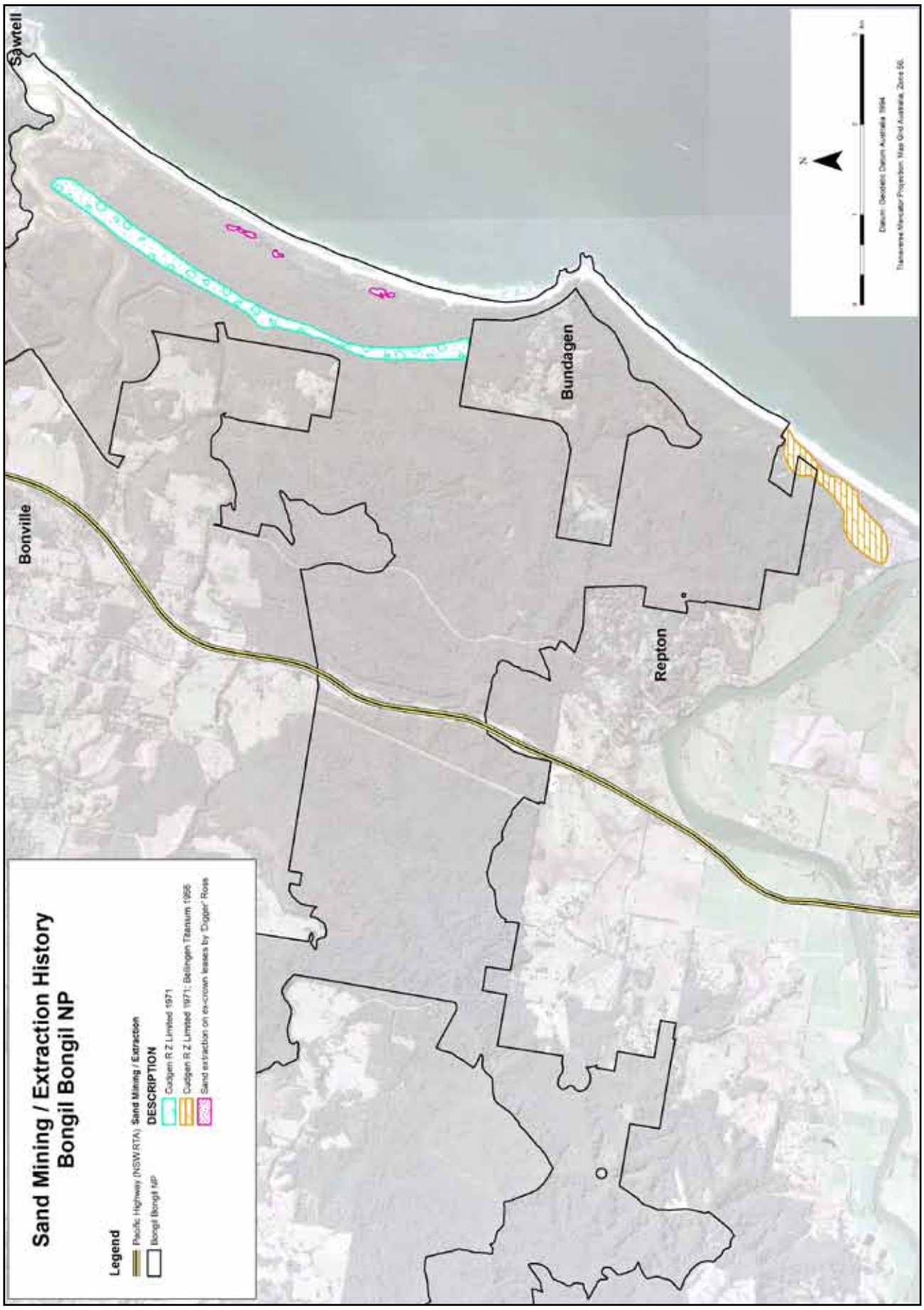
Map A1.6 Distribution of Endangered Ecological Communities (EECs) in Bongil Bongil National Park (see Results, section 3.1.3 Endangered Ecological Communities).

Map A1.7 Distribution of the endangered Floyd's Grass (*Alexfloydia repens*) in Bongil Bongil National Park.

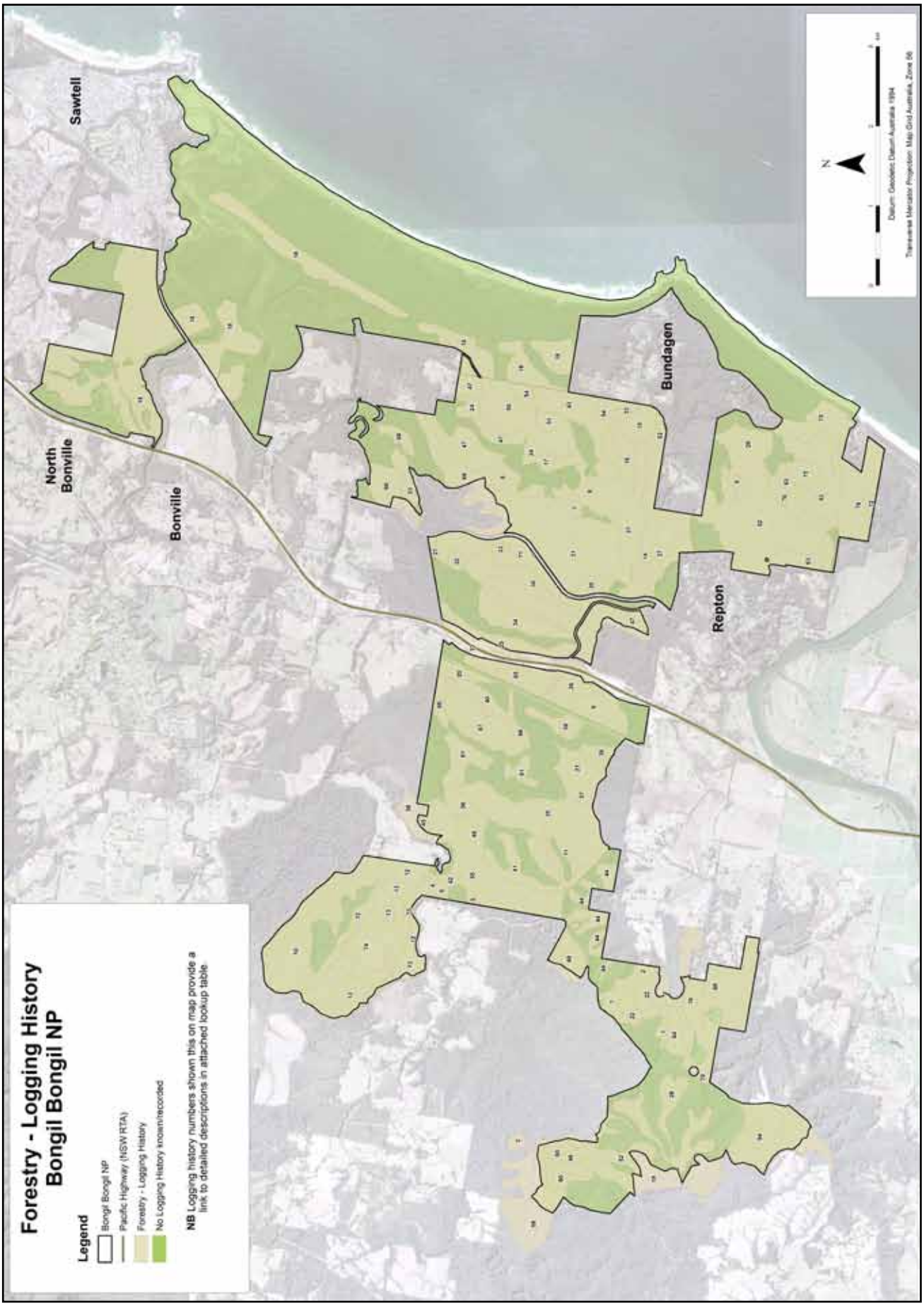
Map A1.8 Mapped vegetation communities of Bongil Bongil National Park (see Results, section 3.3 Mapping and spatial interpolation).



Map A1.1 Gazettals to Bongil Bongil National Park



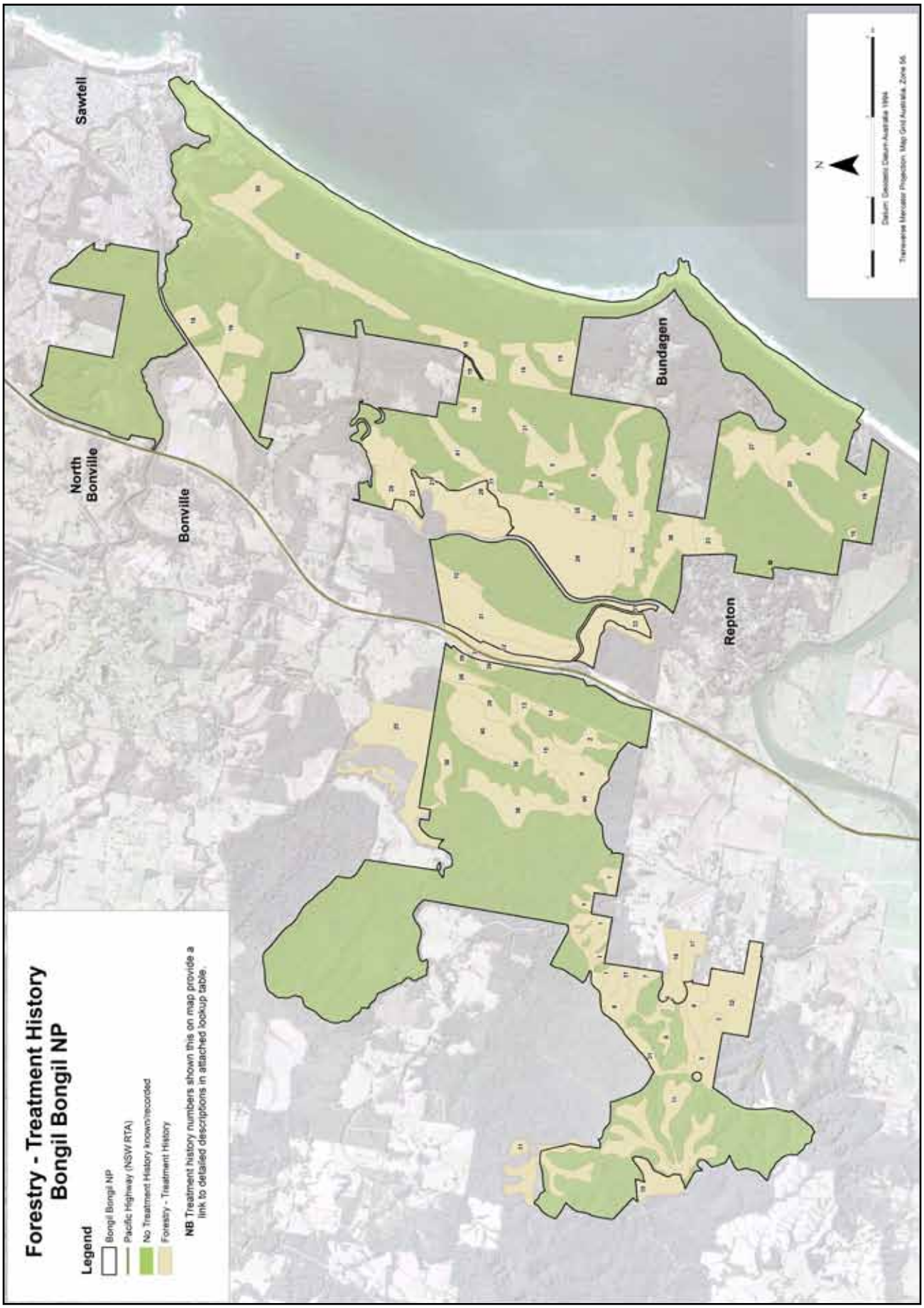
Map A1.2 History of mining in Bongil Bongil National Park



Map A1.3 Forestry – history of logging in Bongil Bongil National Park

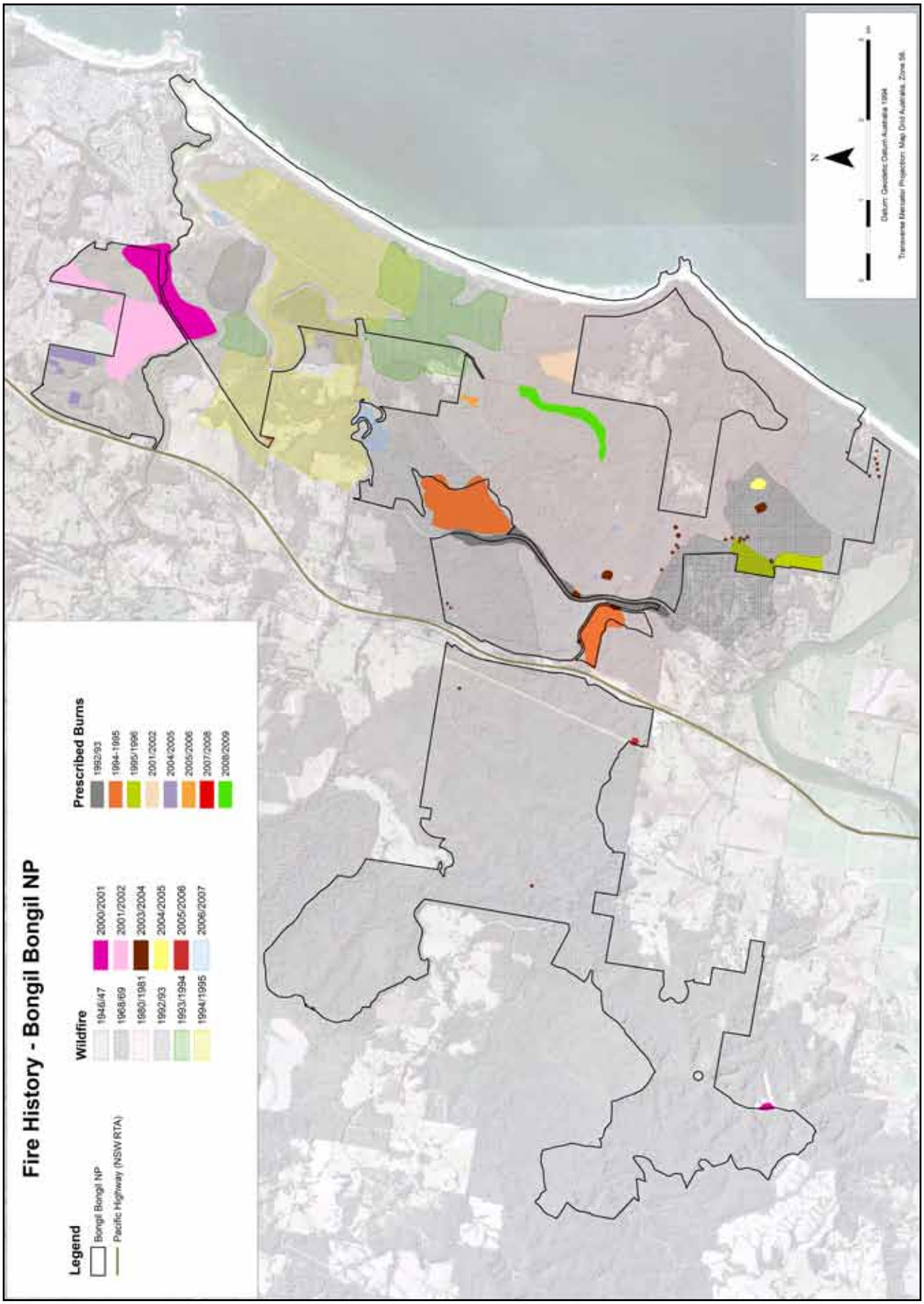
Map Label #	Description of Forestry Logging Activites
1	Clearfell operations (1950 - 1959)
2	Clearfell operations (1950 - 1959); Plantation thinning (1980 - 1984); Plantation thinning (1985 - 1994)
3	Clearfell operations (1960 - 1964)
4	Flooded Gum thinning (1980 - 1984)
5	Flooded Gum thinning (1980 - 1984); Quota logging operations (1985 - 1989); Quota logging operations (1990 - 1994)
6	Fire salvage (1980 - 1984)
7	Integrated (quota) operations (1980 - 1985)
8	Integrated (quota) operations (1980 - 1985); Integrated (quota) operations (1985 - 1990)
9	Integrated (quota) operations (1985 - 1989)
10	Integrated (quota) operations (1986 - 1990)
11	Integrated (quota) operations (1990 - 1994)
12	Integrated pole operations (1980 - 1984)
13	Integrated pole operations (1980 - 1984); Integrated (quota) operations (1985 - 1989); Integrated (quota) operations (1990 - 1994)
14	Logging (1955 - 1959)
15	Logging Flooded gum (1960 - 1961); Quota logging operations (1961 - 1962); Fire salvage of flooded gum (1980 - 1981)
16	Logging Flooded gum (1960 - 1964); Quota logging operations (1980 - 1984); Quota logging operations (1985 - 1989)
17	Part Clearing for Plantation 10 (1990 - 1994)
18	Plantation ex-APM thinned
19	Plantation thinning (1961 - 1962)
20	Plantation thinning (1975 - 1979)
21	Plantation thinning (1980 - 1984); Plantation thinning (1985 - 1989)
22	Plantation thinning (1980 - 1984); Plantation thinning (1985 - 1989); Plantation thinning (1990 - 1994)
23	Plantation thinning (2002 - 2002)
24	Plantation thinning (2003 - 2003)
25	Plantation thinning (2006 - 2006)
26	Quota logging (1960 - 1964); Quota logging (1965 - 1969)
27	Quota logging (1975 - 1979)
28	Quota logging (1984 - 1986)
29	Quota logging operations (1954 - 1959); Quota logging operations (1960 - 1964); Quota logging operations (1980 - 1994)
30	Quota logging operations (1955 - 1960)
31	Quota logging operations (1955 - 1960); Quota logging operations (1984 - 1985)
32	Quota logging operations (1960 -)
33	Quota logging operations (1960 - 1964)
34	Quota logging operations (1960 - 1964); Flooded Gum quota logging operations (1975 - 1979)
35	Quota logging operations (1960 - 1964); Quota logging operations (1965 - 1969); Integrated (quota) operations (1990 - 1994)
36	Quota logging operations (1960 - 1964); Quota logging operations (1975 - 1979); Logging Flooded Gum area (1990 - 1994)
37	Quota logging operations (1960 - 1964); Quota logging operations (1980 - 1984); Quota logging operations (1985 - 1989)
38	Quota logging operations (1960 - 1964); Ridge quota logging (1965 - 1969)
39	Quota logging operations (1960 - 1964); Ridge quota logging (1965 - 1969); Integrated operations (1990 - 1995)
40	Quota logging operations (1960 - 1965); Integrated operations (1990 - 1993)

Map Label #	Description of Forestry Logging Activites
41	Quota logging operations (1965 - 1969)
42	Quota logging operations (1965 - 1969); Flooded Gum thinning (1980 - 1984); Quota logging operations (1985 - 1994)
43	Quota logging operations (1965 - 1969); Quota logging operations (1985 - 1989)
44	Quota logging operations (1965 - 1969); Quota logging operations (1985 - 1990)
45	Quota logging operations (1965 - 1969); Quota logging operations (1985 - 1994); Quota logging operations (1990 - 1994)
46	Quota logging operations (1965 - 1969); Quota logging operations (1990 - 1994)
47	Quota logging operations (1970 - 1974)
48	Quota logging operations (1970 - 1974); Quota logging operations; ex-State Forest area (1985 - 1989)
49	Quota logging operations (1975 - 1979)
50	Quota logging operations (1975 - 1979); Quota logging operations (1980 - 1984)
51	Quota logging operations (1975 - 1979); Quota logging operations (1980 - 1984); Quota logging operations (1985 - 1989)
52	Quota logging operations (1980 - 1984); Quota logging operations (1985 - 1989)
53	Quota logging operations (1980 - 1984); Quota logging operations (1985 - 1989); Sleeper cutting (1989 - 1992)
54	Quota logging operations (1985 - 1989)
55	Quota logging operations (1985 - 1989); Quota logging operations (1990 - 1994)
56	Quota logging operations (1990 - 1994)
57	Quota logging operations including plant (1965 - 1969)
58	Quota logging operations; ex-APM (1965 - 1969); Quota logging operations; ex-APM (1970 - 1974); Quota logging operations; ex-APM (1985 - 1994)
59	Quota logging operations; ex-APM (1985 - 1989)
60	Quota logging operations; ex-State Forest area (1985 - 1989)
61	Quota operations (1955 - 1959)
62	Quota operations (1960 - 1964); Quota logging operations (1980 - 1989); Sleeper cutting (1989 - 1992)
63	Quota operations (1960 - 1964); Quota operations (1980 - 1985)
64	Quota operations (1965 - 1970)
65	Quota operations (1970 - 1975)
66	Quota ridge and Flooded Gum area (1960 - 1964)
67	Quota ridge and Flooded Gum area (1960 - 1964); Integrated (quota) operations (1985 - 1989); Integrated (quota) operations (1990 - 1994)
68	Quota sawlog operations (1970 - 1974)
69	Quota/clearing for planting (1965 - 1970)
70	Quota/clearing for planting (1965 - 1970); Plantation thinning (1982 - 1985)
71	Ridge quota logging (1960 - 1964)
72	Salvage and thinning (1960 - 1960); Salvage and thinning (1980 - 1984); Sleeper cutting (1990 - 1994)
73	Selection log Flooded Gum (1960 - 1964); Integrated pole operations (1980 - 1984)
74	Selection log Flooded Gum (1960 - 1964); Integrated pole operations (1980 - 1984); Integrated (quota) operations (1985 - 1994)
75	Sleeper cutting (1989 - 1992)
76	Sleeper cutting (1990 - 1994)

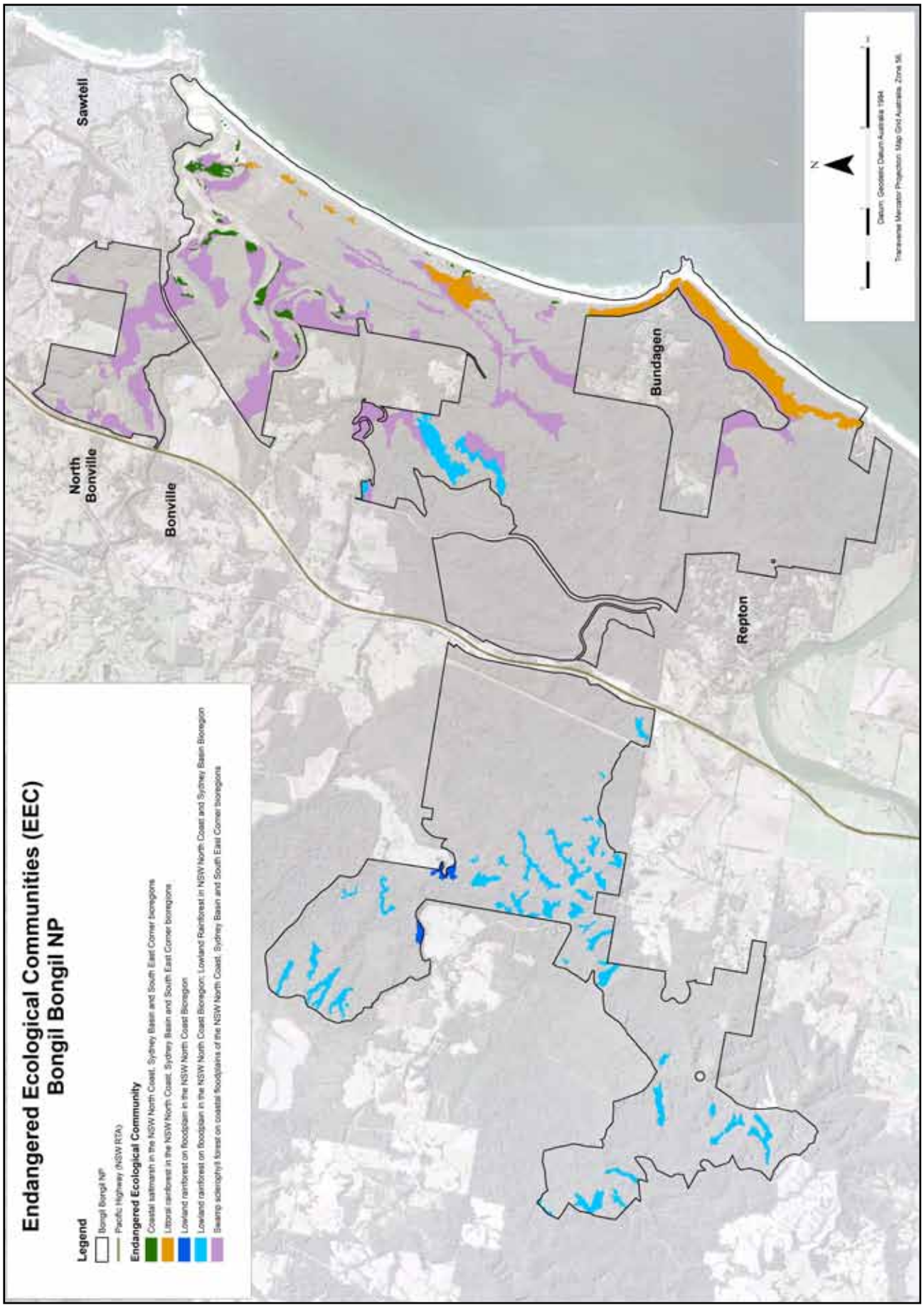


Map A1.4 Forestry treatments in Bongil Bongil National Park

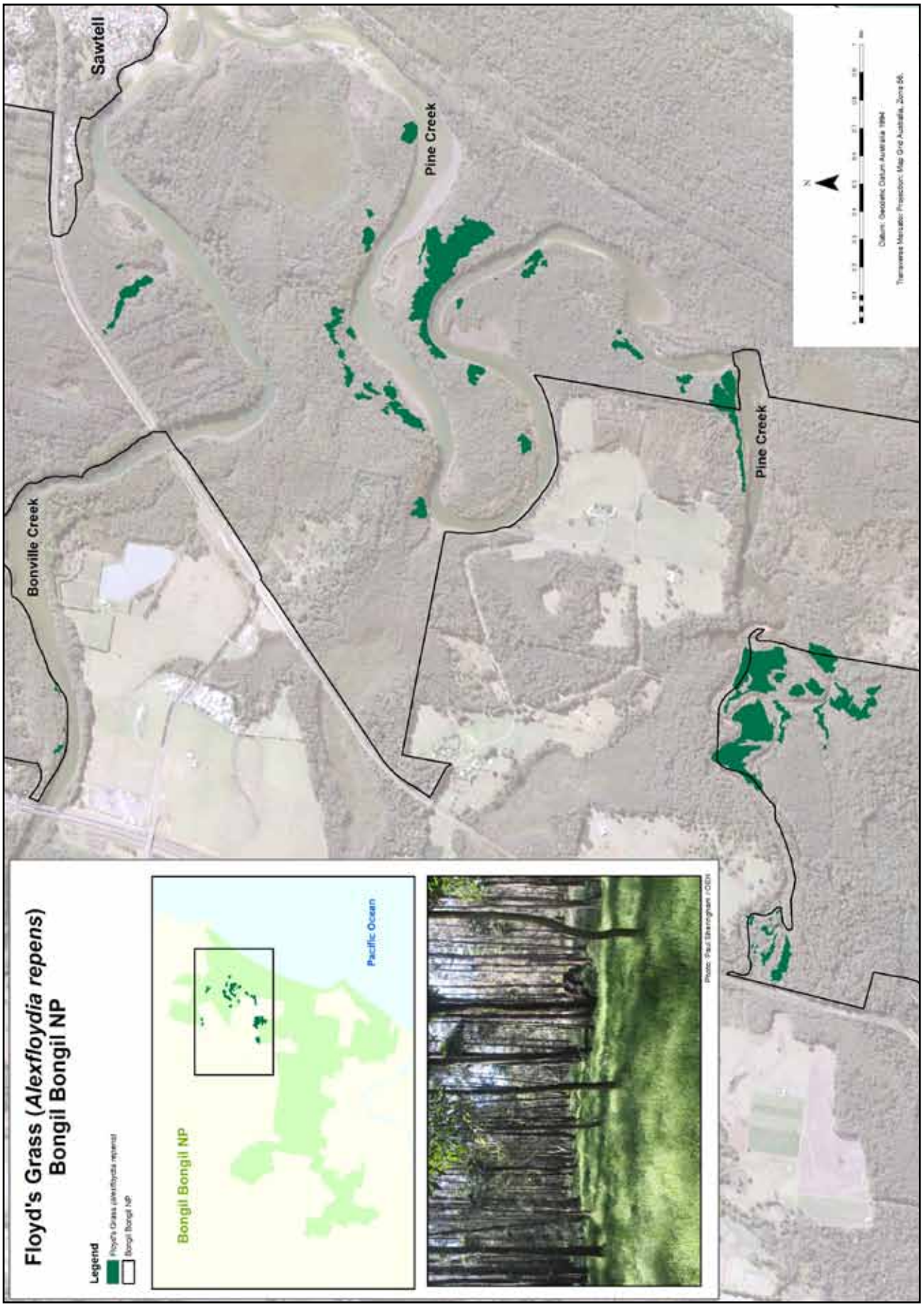
Map Label #	Description of Forestry Treatment Logging Activites
1	Flooded Gum plantation 38 NCT (1978 - 1978)
2	Flooded Gum plantation number 17 (1955 - 1959)
3	Plant banana block (1993 - 1993); Timber Stand Improvement (1960 - 1970)
4	Plantation (No. 28); Flooded Gum (1965 - 1969)
5	Plantation 12 established (1953 - 1954)
6	Plantation 13 (1953 - 1953); Plantation 16 (1953 - 1953); Plantation 18 (1953 - 1953)
7	Plantation 13 (1953 - 1953); Plantation 16 (1957 - 1957); Plantation 18 (1958 - 1958)
8	Plantation 14 established (1956 - 1956); Timber Stand Improvement (1960 - 1970)
9	Plantation 15 (1957 - 1957); Clear/burn/saw Flooded Gum (1962 - 1964)
10	Plantation 19 (1959 - 1959); Plantation 20 (1960 - 1960); Plantation 21 (1961 - 1961)
11	Plantation 19 (1959 - 1960); Plantation 20 (1959 - 1960); Plantation 21 (1959 - 1960)
12	Plantation 24 established (1960 - 1964)
13	Plantation 25 (1965 - 1965)
14	Plantation 25 (1965 - 1969); Plantation 26 (1965 - 1969)
15	Plantation 26 (1966 - 1966)
16	Plantation 33 (1970 - 1970)
17	Plantation 33 (1970 - 1970); Plantation 36 (1973 - 1973); Timber Stand Improvement (1960 - 1970)
18	Plantation 6 established (1945 - 1949)
19	Plantation clearing and planting
20	Plantation establishment
21	Plantation establishment (1940 - 1950); Plantation establishment (1975 - 1979)
22	Plantation establishment (1940 - 1953); Plantation establishment (1975 - 1979)
23	Plantation establishment (1975 - 1979)
24	Plantation establishment (1980 - 1985)
25	Plantation ex-APM
26	Plantations 7 and 8 (1945 - 1949)
27	Timber Stand Improvement (1954 - 1959); Timber Stand Improvement and burnt (1960 - 1964)
28	Timber Stand Improvement (1955 - 1959)
29	Timber Stand Improvement (1955 - 1959); Timber Stand Improvement /burnt/spot sown in gaps (1960 - 1964)
30	Timber Stand Improvement (1960 - 1961)
31	Timber Stand Improvement (1960 - 1964)
32	Timber Stand Improvement (1960 - 1970)
33	Timber Stand Improvement (1970 - 1974)
34	Timber Stand Improvement (1980 - 1985)
35	Timber Stand Improvement (1985 - 1990)
36	Timber Stand Improvement and burnt (1955 - 1959)
37	Timber Stand Improvement and burnt (1960 - 1964)
38	Timber Stand Improvement and burnt (1960 - 1964); Timber Stand Improvement and burnt (1965 - 1969)
39	Timber Stand Improvement and burnt (1960 - 1965)
40	Timber Stand Improvement and burnt (1963 - 1965)
41	Timber Stand Improvement enrichment planting (1962 - 1962); Timber Stand Improvement enrichment planting (1970 - 1974)



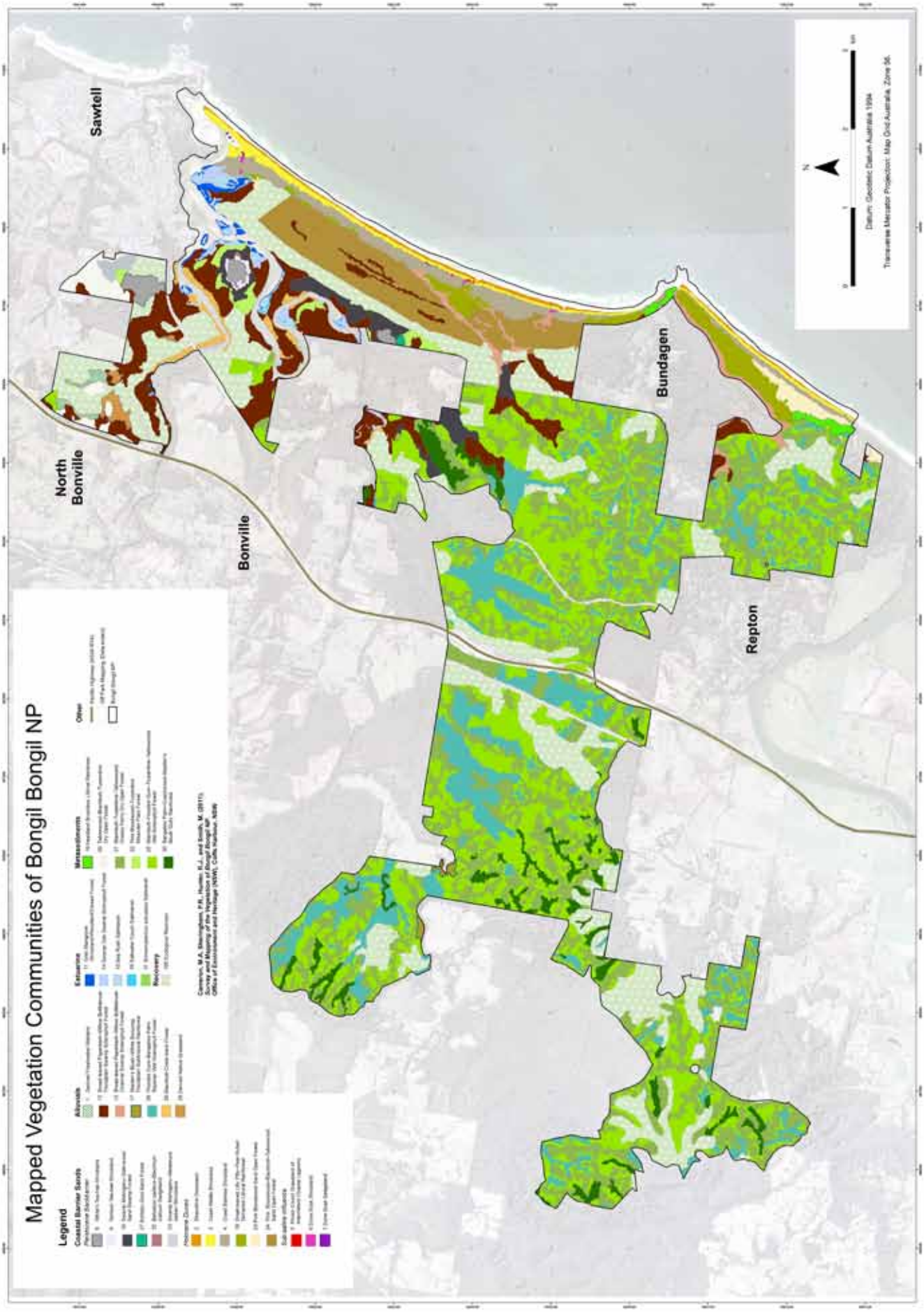
Map A1.5 Fire history of Bongil Bongil National Park



Map A1.6 Distribution of Endangered Ecological Communities



Map A1.7 Distribution of the endangered Floyd's Grass



Map A1.8 Mapped vegetation communities of Bongil Bongil National Park

Appendix 2 Vegetation Community Profiles

The following appendix provides a profile of each of the 33 vegetation communities delimited during the current survey of Bongil Bongil National Park.

Throughout this Appendix, the following abbreviations or conventions are used:

NP, National Park; NR, Nature Reserve; SCA, State Conservation Area; SF, State Forest; TSR, Travelling Stock Route; EEC, Endangered Ecological Community.

Under **Significant taxa**, species are listed with their status under the TSC (Vulnerable, Endangered), relevant ROTAP codes, or as significant in NSW (designated 'S').

Under **Floristics**, species are arranged by decreasing summed cover abundance. The dominant species of the structural layers that were recorded at the sites are noted: E, emergent; T, tallest layer; M, mid-layer; L, lower layer; *, exotic species. Where there are two layers within a stratum, the layers are recorded as M1 and M2 or L1 and L2.

Where there is no entry for groups of plants (e.g. Mistletoes, Ferns, etc.) there were no records in those groups in the sites of that community.

For **Number of taxa per plot**, figures in parentheses are means ± standard deviation.

The tables of **Indicator native taxa** provides the results of the fidelity analysis. Taxa with a positive diagnostic relationship to the community are listed; these species are those that are more likely to be recorded the target community than in other communities. Some uninformative species are also listed. For each taxon, the median cover score and frequency % within the community and in all other sites is recorded.

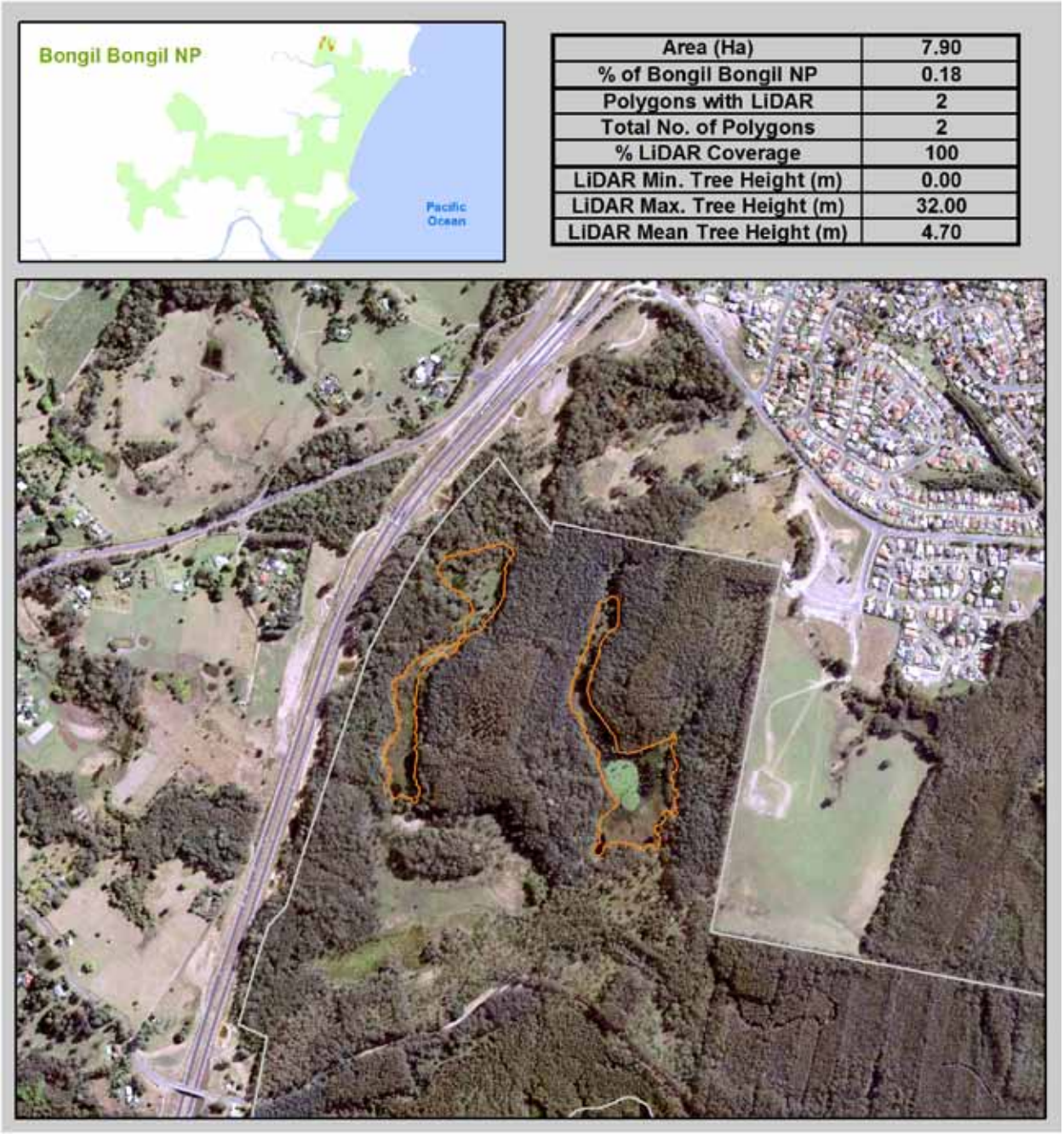
Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class

Appendix 2 The 33 vegetation communities of Bongil Bongil National Park identified in the current survey.

Community	Name
1	Derived Freshwater Wetland
2	Strandline Grassland
3	Coast Wattle Shrubland
4	Coast Banksia Shrubland
5	Prickly Couch Grassland of Intermittent Coastal Lagoons
6	Dune Soak Shrubland
7	Dune Soak Sedgeland
8	White's Tea-tree Shrubland
9	Tantoon Tea-tree Shrubland
10	Swamp Mahogany–Satinwood Sand Swamp Forest
11	Grey Mangrove Shrubland/Woodland/Closed Forest
12	Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest
13	Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest
14	Swamp Oak Swamp Sclerophyll Forest
15	Sea Rush Saltmarsh

Appendix 2 The 33 vegetation communities of Bongil Bongil National Park identified in the current survey.	
Community	**Name**
16	Saltwater Couch Saltmarsh
17	Maiden's Blush–White Booyong Floodplain Subtropical Rainforest
18	Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest
19	Headland Brushbox Littoral Rainforest
20	Tallowwood–Blackbutt–Turpentine Dry Open Forest
21	Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest
22	Pink Bloodwood–Turpentine Meander Plain Forest
23	Pink Bloodwood Sand Open Forest
24	Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest
25	Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest
26	Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest
27	Scribbly Gum Sand Forest
28	Blackbutt Creek-bank Forest
29	Derived Native Grassland
30	Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest
31	*Schoenoplectus subulatus* Saltmarsh
32	*Baloskion pallens–Blechnum indicum* Sedgeland
33	Swamp Mahogany–*Melaleuca sieberi* Shrubland

Community 1 Derived Freshwater Wetland



Area (Ha)	7.90
% of Bongil Bongil NP	0.18
Polygons with LiDAR	2
Total No. of Polygons	2
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	32.00
LiDAR Mean Tree Height (m)	4.70

Derived Cape Waterlily (***Nymphaea caerulea*** subsp. ***zanzibarensis***), ***Eleocharis acuta***, Tall Spike Rush (***Eleocharis sphacelata***), Narrow-leaved Cumbungi (***Typha orientalis***) Freshwater Wetlands

Sites (3): AL02BS091, AN02WB089, AN02WB090

Rapid Data Points: –

Equivalent communities

NPWS NSW Coastal Vegetation community 64101 *Eleocharis sphacelata* Sedgeland; 65041 *Typa orientalis* Rushland (Griffith & Wilson 2007); MU 203 *Elaeocharis sphacelata* Freshwater Wetland (Somerville 2008).

Description

Derived freshwater sedgeland and rushland communities growing in dams at North Bonville. There is a complex zonation of sedges, rushes and herbs based on water depth. Scattered Broad-leaved Paperbarks (*Melaleuca quinquenervia*) are present. Dominant emergent sedges and rushes recorded include Tall Spike Rush (*Eleocharis sphacelata*) and Narrow-leaved Cumbungi (*Typha orientalis*). Smaller common sedges and rushes include *Eleocharis acuta*, *Cyperus haspan* subp. *juncoides* and Water Ribbons (*Triglochin procerum*), which commonly occur in shallower parts of the dams. Floating water plants include the introduced Cape Waterlily (*Nymphaea caerulea* subsp. *zanzibarensis*) and Nardoo (*Marsilea mutica*). The Cape Waterlily is particularly abundant in deeper open water parts of the dam.

Distribution and Habitat

Habitat: Occurs in water storages of upper Bonville Creek. Areas mapped as anthropogenic water storages and alluvial backswamps.

Disturbance: This community is a derived freshwater wetland created by impounding riparian vegetation along Bonville Creek. The introduced Cape Waterlily is a common weed growing in these wetlands.

Distribution within the park: Recorded at survey sites at Western Dam Trail and Storylands Trail.

Area: 8 ha.

Conservation

Threats: None noted.

Conservation status: The conservation status of *Eleocharis sphacelata* Sedgelands is considered fair, and that of *Typha orientalis* Rushlands poor (Griffith 2005). Griffith & Wilson (2007) recorded a community of Cape Waterlily growing with *Ludwigia peploides* subsp. *montevidensis* and *Persicaria attenutata*, which they considered poorly reserved. Cape Waterlily is the only one of these species present in Bongil Bongil NP and it is spread throughout the community and is very abundant in open water areas of the dams. Artificial habitats such as these are not considered as part of the Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004e).

Significant taxa: The only record of Nardoo (*Marsilea mutica*) in this survey was in this community.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Emergent	0	4	*Eleocharis sphacelata*, *Typha orientalis*
Lower 1	0.2	1	*Eleocharis acuta*, *Eleocharis sphacelata*, *Persicaria strigosa*
Lower 2	0	0.2	*Nymphaea caerulea* subsp. *zanzibarensis*

Floristics

Emergent small trees and shrubs: *Melaleuca quinquenervia* (E), *Typha orientalis* (E).

Sedges and rushes: *Eleocharis acuta* (L1), *Eleocharis sphacelata* (L1), *Typha orientalis*, *Cyperus haspan* subsp *juncoides*, *Triglochin procerum*.

Herbs and shrubs: *Nymphaea caerulea* subsp. *zanzibarensis* (L2)*, *Marsilea mutica*, *Persicaria strigosa* (L1), *Philydrum lanuginosum*.

Number of native taxa: 10 **Number of taxa per plot**: 4–5 (4.7 ± 0.6)

Number of exotic species: 1

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Eleocharis acuta	3	1	0	0	positive
Eleocharis sphacelata	5	0.3333	0	0	positive
Marsilea mutica	1	0.3333	0	0	positive
Nymphaea caerulea subsp. *zanzibarensis*	4	1	0	0	positive
Philydrum lanuginosum	1	0.3333	0	0	positive
Triglochin procerum	1	0.3333	0	0	positive
Typha orientalis	3	0.3333	0	0	positive
Melaleuca quinquenervia	1	0.3333	3	0.1942	uninformative
Persicaria strigosa	1	0.3333	1	0.009709	uninformative

Community 2 Strandline Grassland

Area (Ha)	20.58
% of Bongil Bongil NP	0.48
Polygons with LiDAR	11
Total No. of Polygons	11
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	2.00
LiDAR Mean Tree Height (m)	0.32

Strandline *Spinifex sericeus* Grassland

Sites (3): CB02DN008, CB02DN025, CB02DN097

Rapid Data Points: –

Equivalent communities

Grasslands–Maritime Grasslands (Keith 2004); NPWS NSW Coastal Vegetation community 6202: *Spinifex sericeus* low to mid-high, sparse to closed tussock grassland (Griffith & Wilson 2007).

Description

A strandline grassland community in which *Spinifex sericeus* is abundant; other herbs and prostrate shrubs include Pig Face (*Carpobrotus glausecens*), *Ipomoea brasiliensis*, *Hydrocotyle bonariensis a*nd the introduced American Sea Rocket (*Cakile edentula*). There are also scattered shrubs of the introduced Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) and Coast Wattle (*Acacia longifolia* subsp. *sophorae*).

Distribution and Habitat

Habitat: Coastal foredunes.

Disturbance: This community is subject to continued disturbance from storm events. Recent storms (March–June 2009) have washed away much of this community immediately south of Sawtell to Scrub Creek. The beach and strandline vegetation were eroded back to the Bitou Bush–Coast Wattle foredune community. Bitou Bush is present in the community at low cover abundance, as is American Sea Rocket.

Distribution within the park: Recorded on the foredune from Tuckers Rocks to Sawtell.

Area: 21 ha.

Conservation

Threats: Threatened by rises in sea-level and increased storm intensity resulting from climate change.

Conservation status: Mapped from Broadwater NP, Bundjalung NP, Iluka NR and Yuraygir NP (Griffith & Wilson 2007).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0–0.3	35–40	*Spinifex sericeus*

Floristics

Trees and shrubs: *Acacia longifolia* subsp. *sophorae* (L1), *Chrysanthemoides monilifera* subsp. *rotundata* (L1)*.

Grasses: *Spinifex sericeus* (L1).

Herbs and shrubs: *Cakile edentula**, *Impomoea brasiliensis*, *Vigna marina*, *Carpobrotus glaucescens*, *Hydrocotyle pedicellosa*.

Number of native taxa: 9 **Number of taxa per plot:** 3–5 (4.3 ± 1.2)

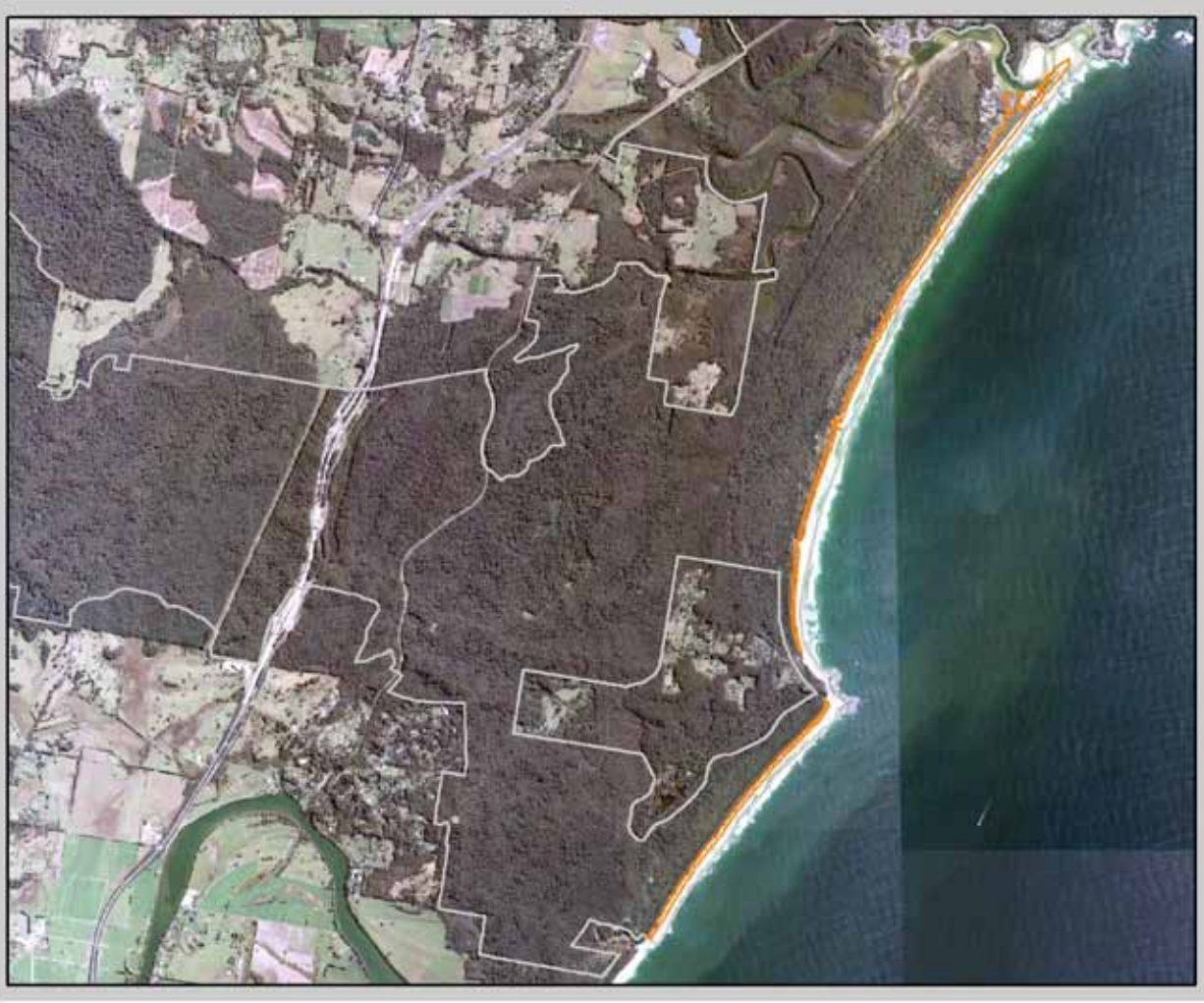
Number of exotic species: 2

Indicator taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia longifolia subsp. *sophorae*	2	0.6667	1	0.04854	positive
Cakile edentula	2	0.3333	0	0	positive
Carpobrotus glaucescens	1	0.3333	0	0	positive
Senecio pinnatifolius var. *maritimus*	1	0.3333	0	0	positive
Spinifex sericeus	4	1	4	0.01942	positive
Vigna marina	2	0.3333	0	0	positive

Community 3 Coast Wattle Shrubland

Area (Ha)	45.26
% of Bongil Bongil NP	1.06
Polygons with LiDAR	4
Total No. of Polygons	4
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	6.25
LiDAR Mean Tree Height (m)	0.51



Coast Wattle (*Acacia longifolia* subsp. *sophorae*)–Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) Coastal Heathland/ Shrubland

Sites (2): CB02DN070, CB02DN071

Rapid Data Points: –

Equivalent communities

Grasslands–Maritime Grasslands (Keith 2004); NPWS NSW Coastal Vegetation community 5408: *Acacia sophorae* low to tall, sparse to closed shrubland (Griffith & Wilson 2007).

Description

A dunal heathland community in which Coast Wattle (*Acacia longifolia* subsp. *sophorae*) is most abundant in the upper layer, with the exotic Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*). Bitou Bush is abundant from Bundagen Headland north to the mouth of Pine Creek immediately south of Sawtell. Grasses such as *Zoysia macrantha* and *Spinifex sericeus* form a dense cover in the ground layer.

Distribution and Habitat

Habitat: Holocene dune sands exposed to the sea.

Disturbance: There has been much past disturbance from sand mining, and extensive areas of this community are dominated by Bitou Bush.

Distribution within the park: Coastal foredunes throughout the park.

Area: 45 ha.

Conservation

Threats: Extreme storm events, and further infestation by Bitou Bush.

Conservation status: Well conserved in many coastal reserves.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0.3–1.5	70	*Acacia longifolia* subsp. *sophorae*, *Chrysanthemoides monilifera* subsp. *rotundata*
Lower 2	0–0.4	60	*Zoysia macrantha*, *Spinifex sericeus*

Floristics

Small trees and shrubs: *Acacia longifolia* subsp. *sophorae* (L1), *Chrysanthemoides monilifera* subsp. *rotundata**, *Banksia integrifolia* subsp. *integrifolia*.

Grasses: *Zoysia macrantha* (L2), *Spinifex sericeus*, *Imperata cylindrica* var. *major*.

Herbs and shrubs: *Crinum pedunculatum*.

Number of native taxa: 7 **Number of taxa per plot**: 5 (5 ± 0)

Number of exotic species: 1

Indicator taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia longifolia subsp. *sophorae*	5	1	1	0.04808	positive
Chrysanthemoides monilifera subsp. *rotundata*	2	1	1	0.09615	positive
Spinifex sericeus	4	1	4	0.02885	positive
Zoysia macrantha	5	1	3	0.03846	positive

Community 4 Coast Banksia Shrubland

Area (Ha)	86.61
% of Bongil Bongil NP	2.02
Polygons with LiDAR	6
Total No. of Polygons	8
% LiDAR Coverage	75
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	12.29
LiDAR Mean Tree Height (m)	3.51

Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*)–Tuckeroo (*Cupaniopsis anacardioides*) Shrubland on Coastal Dunes

Sites (3): CB28DN067, CB28DN068, CB28DN069

Rapid Data Points: –

Equivalent communities

Heathlands–Coastal Headland Heath (Keith 2004); NPWS NSW Coastal Vegetation community 0502: *Cupaniopsis anacardioides* simple, notophyll-microphyll, low to tall closed forest; NPWS NSW Coastal Vegetation community 3523: *Banksia integrifolia* ssp. *integrifolia* low to mid-high, open to closed forest (Griffith & Wilson 2007).

Description

An open shrubland of Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*) with littoral rainforest species, including Tuckeroo (*Cupaniopsis anacardioides*), Beach Acronychia (*Acronychia imperforata*), Beach Alectryon (*Alectryon coriaceus*) and Brush Cherry (*Syzygium australe*). There is an open lower layer of grasses, including Blady Grass (*Imperata cylindrical* var. *minor*), Prickly Couch (*Zoysia macrantha*) and Basket Grass (*Oplismenus imbecillis*), and herbs, including Flax-lily (*Dianella congesta*), *Hydrocotyle peduncularis* and *Viola banksii*.

Distribution and Habitat

Habitat: Holocene dunes.

Disturbance: Past mining, and infestation with Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) and Glory Lily (*Gloriosa superba*).

Distribution within the park: Most common in the dunes from Tuckers Rocks to Bundagen Headland, often adjacent to areas of littoral rainforest.

Area: 87 ha.

Conservation

Threats: Areas of this community have been extensively disturbed north of Bundagen Headland and are further threatened by the spread of weeds. The best examples are located between Tuckers Rocks and Bundagen Headland.

Conservation status: Probably well reserved. **Significant taxa**: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	2–7	35–60	*Banksia integrifolia* subsp. *integrifolia*, *Cupaniopsis anacardioides*, *Alectryon coriaceus*, *Acronychia imperforata*, *Syzygium australe*
Lower 1	0.2–2	25	*Imperata cylindrica* var. *major*, *Dianella congesta*
Lower 2	0–0.3	30–40	*Zoysia macrantha*, *Commelina cyanea*, *Gloriosa superba*

Floristics

Emergent small trees and shrubs: *Banksia integrifolia* subsp. *integrifolia* (T), *Cupaniopsis anacardioides* (T), *Alectryon coriaceus* (T), *Acronychia imperforata* (T), *Syzygium australe* (L1).

Grasses: *Imperata cylindrica* var. *major* (L1), *Zoysia macrantha* (L2), *Oplismenus imbecillis* (L2), *Andropogon virginicus*, *Digitaria parviflora*, *Eragrostis leptostachya*, *Microlaena stipoides* var. *stipoides*, *Paspalum mandiocanum**.

Ferns: *Pteridium esculentum*.

Sedges and rushes: *Cyperus gracilis*, *Ficinia nodosa*, *Lomandra longifolia*, *Lomandra filiformis* subsp. *filiformis*.

Mistletoes: *Muellerina celastroides*.

Epiphytes: *Platycerium bifurcatum*, *Platycerium superbum*.


Brush Cherry (*Syzygium australe*)

Herbs and shrubs: *Dianella congesta* (L1), *Commelina cyanea* (L2), *Gloriosa superba** (L2), *Hydrocotyle peduncularis*, *Viola banksii*, *Acacia longifolia* subsp. *sophorae*, *Conyza parva**, *Conyza bonariensis**, *Breynia oblongifolia*, *Chrysanthemoides monilifera* subsp. *rotundata**, *Maclura cochinchinensis*, *Oenothera affinis**, *Pratia purpurascens*, *Bidens pilosa**, *Crinum pedunculatum*, *Einadia hastata*, *Lantana camara**, *Leucopogon lanceolatus*, *Monotoca elliptica*, *Persoonia stradbrokensis*, *Pomax umbellata*, *Senna septemtrionalis** (L1), *Solanum chenopodioides**, *Sonchus oleraceus**.

Climbers: *Smilax australis*, *Cayratia clematidea*, *Cissus antarctica*, *Hibbertia scandens*, *Rubus parvifolius*, *Sarcopetalum harveyanum*.

Number of native taxa: 46 **Number of taxa per plot**: 29–32 (30 ± 1.5)

Number of exotic species: 11

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Banksia integrifolia	4	1	1	0.04854	positive
Cayratia clematidea	3	0.6667	1	0.1068	positive
Commelina cyanea	2	1	1	0.1165	positive
Cupaniopsis anacardioides	3	1	1	0.1942	positive
Cyperus gracilis	2	0.3333	0	0	positive
Dianella congesta	3	1	0	0	positive
Digitaria parvflora	1	0.3333	0	0	positive
Einadia hastata	1	0.3333	0	0	positive
Hydrocotyle peduncularis	2	1	1	0.1262	positive
Imperata cylindrica var. *major*	3	1	2	0.2718	positive
Muellerina celastroides	1	0.3333	0	0	positive
Oplismenus imbecillis	3	0.6667	2	0.3689	positive
Smilax australis	2	1	1	0.466	positive
Viola banksii	2	1	1	0.3592	positive
Zoysia macrantha	3	1	5	0.02913	positive

Community 5 Prickly Couch Grassland of Intermittent Coastal Lagoons

Area (Ha)	0.22
% of Bongil Bongil NP	0.00
Polygons with LiDAR	2
Total No. of Polygons	2
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	1.50
LiDAR Mean Tree Height (m)	0.29

Prickly Couch (*Zoysia macrantha*), Blue Couch (*Cynodon dactylon*), Sea Rush (*Juncus kraussii* subsp. *australiensis*) Intermittent Coastal Lagoon (ICOLL) Riparian Grassland

Sites (1): CB02DN024

Rapid Data Points: –

Equivalent communities

Saline Wetlands–Saltmarsh (Keith 2004); Coastal saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004d; DEC 2005).

Description

A grassland–rushland community dominated by Prickly Couch (*Zoysia macrantha*), Blue Couch (*Cynodon dactylon*) and Sea Rush (*Juncus kraussii* subsp. *australiensis*).

Distribution and Habitat

Habitat: This community grows on sediments deposited on flood channels of small coastal creeks and which form a small impounded lagoon that empties out across Bundagen Beach at times of high rainfall.

Disturbance: Weeds are present. Rubbish has been washed along the creek.

Distribution within the park: Occurs along Bundagen Beach near Scrub Creek at two locations where small creeks empty out onto the beach.

Area: 0.21 ha.

Conservation

Threats: Invasion by weeds, and rises in sea-level.

Conservation status: Poorly known. This community has species in common with the Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0.4–4	85	*Juncus kraussii* subsp. *australiensis*, *Cladium procerum*
Lower 2	0–0.4	25	*Zoysia macrantha*, *Cynodon dactylon*

Floristics

Emergent small trees and shrubs: *Casuarina glauca*.

Grasses: *Zoysia macrantha* (L2), *Cynodon dactylon* (L2), *Panicum bisulcatum*, *Stenotaphrum secundatum*.

Sedges and rushes: *Juncus kraussii* subsp. *australiensis* (L1), *Cyperus* spp., *Cladium procerum* (L1), *Carex pumila*, *Ficinia nodosa*, *Schoenoplectus validus*.

Herbs and shrubs: *Hydrocotyle pedicellosa*, *Crinum pedunculatum*, *Bacopa monnieri*.

Number of native taxa: 13 **Number of taxa per plot**: 13 (n = 1)

Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Bacopa monnieri	2	1	0	0	positive
Carex pumila	2	1	3	0.01905	positive
Casuarina glauca	1	1	3	0.1619	uninformative
Cladium procerum	2	1	1	0.04762	positive
Crinum pedunculatum	2	1	1	0.1238	positive
Cynodon dactylon	4	1	0	0	positive
Ficinia nodosa	2	1	3	0.05714	positive
Hydrocotyle pedicellosa	2	1	1	0.04762	positive
Juncus kraussii subsp. *australiensis*	3	1	2	0.1238	positive
Panicum bisulcatum	2	1	2	0.009524	positive
Schoenioplectus validus	1	1	0	0	positive
Zoysia macantha	5	1	3	0.04762	positive

Community 6 Dune Soak Shrubland

Area (Ha)	1.23
% of Bongil Bongil NP	0.03
Polygons with LiDAR	5
Total No. of Polygons	5
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	11.40
LiDAR Mean Tree Height (m)	4.58

Dune Soak Swamp Oak (*Casuarina glauca*) Shrubland

Sites (1): CB28DN094

Rapid Data Points: –

Equivalent communities

NPWS NSW Coastal Vegetation community 6602: *Carex pumila* – **Phyla nodiflora* low to mid-high closed forbland (Griffith & Wilson 2007); Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004b).

Description

A closed Swamp Oak (*Casuarina glauca*) shrubland with a lower layer of Tall Spike Rush (*Ficinia nodosa*), *Schoenus nitens* and *Cladium procerum*. Also present are sedges and herbs, including *Carex pumila*, *Triglochin striatum* and *Cyperus laevigatus*.

Distribution and Habitat

Habitat: Occurs in depressions, seepage lines and swales of dunes where the water table rises to the surface with a subsaline influence.

Disturbance: Fire, and encroachment of weeds, including Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*).

Distribution within the park: Scattered among dunes swales and depressions north from near Scrub Creek to near Bonville Creek.

Area: 1.24 ha.

Conservation

Threats: Weeds, climate change and changes in the watertable.

Conservation status: Poorly known. This is an unusual and restricted community growing among sand dunes. Griffith & Wilson (2007) map only 13.5 ha of dune soak vegetation in Yuraygir and Bundjalung NPs. This community is representative of the Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	2–7	45	*Casuarina glauca*
Lower 1	0–2	40	*Ficinia nodosa, Cladium procerum*

Floristics

Small trees and shrubs: *Casuarina glauca* (T), *Melaleuca quinquenervia*.

Sedges and rushes: *Ficinia nodosa* (L1), *Cladium procerum* (L1).

Herbs and shrubs: *Hydrocotyle pedicellosa*.

Number of native taxa: 5 **Number of taxa per plot**: 5

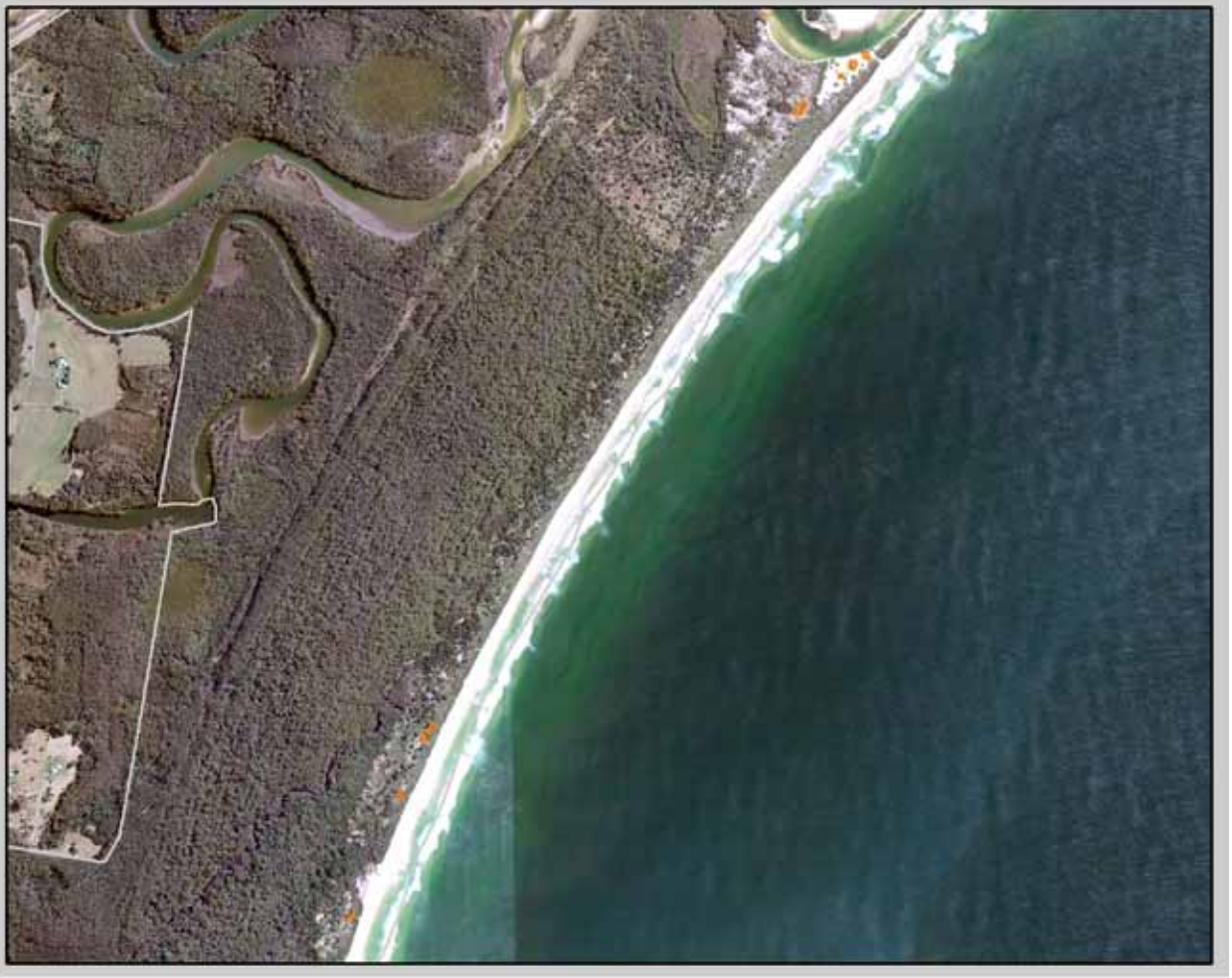
Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Casuarina glauca	4	1	3	0.1619	positive
Cladium procerum	3	1	1	0.04762	positive
Ficinia nodosa	4	1	2	0.05714	positive
Melaleuca quinquenervia	2	1	3	0.1905	positive

Community 7 Dune Soak Sedgeland

Area (Ha)	0.44
% of Bongil Bongil NP	0.01
Polygons with LiDAR	7
Total No. of Polygons	7
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	2.57
LiDAR Mean Tree Height (m)	0.57



Tall Spike Rush (*Ficinia nodosa*), *Schoenus nitens* Dune Soak Sedgeland

Sites (2): CB02DN095, CB02DN096

Rapid Data Points: –

Equivalent communities

NPWS NSW Coastal Vegetation community 6602: *Carex pumila* – **Phyla nodiflora* low to mid-high closed forbland (Griffith & Wilson 2007); Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004d).

Description

A sedgeland community in which Tall Spike Rush (*Ficinia nodosa*) and *Schoenus nitens* are most abundant in terms of cover. Also present are the sedges and herbs *Carex pumila*, *Triglochin striatum* and *Cyperus laevigatus*.

Distribution and Habitat

Habitat: Occurs in dune depressions, seepage lines and swales where the watertable rises to the surface with a subsaline influence.

Disturbance: Some examples of Dune Soak Sedgeland are affected by Blady Grass (*Imperata cylindrica* var. *minor*) and invasion by other weeds, such as Bitou Bush (*Chrysanthemoides monolifera* subsp. *rotundata*), Kurnell Curse (*Hydrocotyle bonariensis*) and Whisky Grass (*Andropogon virginicus*). The surrounding dunes appear to have been disturbed in the past.

Distribution within the park: Scattered among the dune swales and depressions north from near Scrub Creek to near Bonville Creek.

Conservation

Threats: Weeds, sea-level rise associated with climate change, changes in the watertable.

Conservation status: Poorly known. As with Dune Soak Shrublands (Community 6), this is an unusual and restricted community growing among sand dunes. Griffith & Wilson (2007) map only 13.5 ha of dune soak vegetation in Yuraygir and Bundjalung NPs. This community is representative of Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0.5	4	*Ficinia nodosa*
Lower 2	0.4	1	*Schoenus nitens*, *Hydrocotyle bonariensis*, *Carex pumila*

Floristics

Emergent small trees and shrubs: *Casuarina glauca.*

Grasses: *Andropogon virginicus**.

Sedges and rushes: *Schoenus nitens* (L2), *Ficinia nodosa* (L1), *Carex pumila* (L2), *Cladium procerum*, *Cyperus laevigatus*, *Juncus kraussii* subsp. *australiensis*.

Herbs and shrubs: *Hydrocotyle bonariensis** (L2), *Triglochin striatum*, *Lobelia anceps.*

Climbers: *Ipomoea brasiliensis.*

Number of native taxa: 12 **Number of taxa per plot**: 9 (9 ± 0)

Number of exotic species: 1

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Carex pumila	3	1	2	0.009615	positive
Cyperus laevigatus	2	0.5	0	0	positive
Ficinia nodosa	4	1	1	0.04808	positive
Ipomoea brasiliensis	2	0.5	2	0.009615	positive
Schoenus nitens	5	1	0	0	positive
Triglochin striatum	2	1	3	0.03846	positive

Community 8 White's Tea-tree Shrubland

Area (Ha)	23.09
% of Bongil Bongil NP	0.54
Polygons with LiDAR	3
Total No. of Polygons	3
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	16.67
LiDAR Mean Tree Height (m)	2.78

White's Tea-tree (*Leptospermum whitei*)–*Leptospermum liversidgei* Wet Heathland/Shrubland

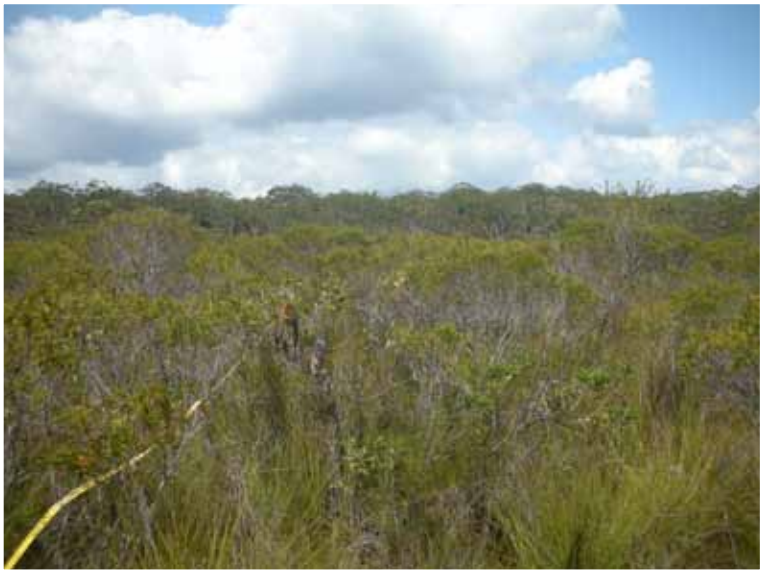
Sites (5): AL28BS026, AL28BS028, UN02FS02, UN02FS05, UN02FS09

Rapid Data Points (5): rdp-133, rdp-157, rdp-164, rdp-165, rdp-176

Equivalent communities

Freshwater Wetlands–Coastal Heath Swamps (Keith 2004); NPWS NSW Coastal Vegetation community 60021 *Banksia oblongifolia–Leptospermum liversidgei–Lepyrodia interrupta–Sprengelia sprengelioides–Xanthorrhoea fulva* API group (Griffith & Wilson 2007); Community No. 26: *Banksia oblongifolia–Xanthorrhoea fulva* wet heathland (Griffith *et al*. 2003).

Description



A heath or shrubland dominated by an open cover of White's Tea-tree (*Leptospermum whitei*), *Leptospermum liversidgei*, Grass tree (*Xanthorrhoea fulva*) and Fern-leaved Banksia (*Banksia oblongifolia*). A dense cover of the sedge *Sporodanthus interruptus* is present in the lower layer, along with Saw Sedge (*Gahnia sieberiana*). A diversity of sclerophyllous shrubs are present in the lower layer including *Epacris obtusifolia*, *Aotus ericoides*, *Bauera capitata* and *Boronia falcifolia*. Devil's Twine (*Cassytha filiformis*) is frequently encountered as tangles among the branches of shrubs. Sundews (*Drosera spatulata*) and *Sellaginella uliginosa* grow in the moist sandy soil. Other species indicative of this community include *Goodenia paniculata*, Milkmaids (*Burchardia umbellata*), Milkwort (*Comesperma defoliatum*), *Baumea gunnii* and *Stackhousia nuda*.

Distribution and Habitat

Habitat: Poorly drained sandy soils on undifferentiated Pleistocene unconsolidated sediments.

Disturbance: No weeds were recorded in the community. An old road cuts through the occurrence of the community on the Western Peninsula Trail and at North Bonville this community was cleared and windrowed in an attempt to establish *Eucalyptus* plantations, which has failed except for the occurrence of occasional Flooded Gum saplings and rusted cages surrounding dead seedlings.

Distribution within the park: Recorded at survey sites at North Bonville, Western Peninsula Trail and the Fist Peninsula.

Area: 23 ha.

Conservation

Threats: Under minimal threat.

Conservation status: Wet heathland and shrubland communities in which *Leptospermum liversidgei, Banksia oblongifolia* and *Xanthorrhoea fulva* (Community 26 of Griffith *et al.* 2003) occur are represented in Bundjalung and Yuraygir NPs and Moonee Beach NR. *Leptospermum whitei* is recorded in this community and does co-occur with *Leptospermum liversidgei* but not as a cover-abundant species. In the similar communities 24 and 25 of Griffith *et al.* (2003) *Banskia ericifolia* is recorded as a constant species, but this taxon is not recorded in the community at Bongil Bongil NP. Therefore communities in which *Leptospermum liversidgei* and *Leptospermum whitei* are co-dominant are not well documented in the literature and may be uncommon. It is thus possible the association of *Leptospermum whitei* and *Leptospermum liversidgei* is reserved only within Bongil Bongil NP, where *Leptospermum whitei* reaches its southern limit, and then as an only a small area of the association.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	1–5	35–45	*Leptospermum whitei*, *Leptospermum liversidgei*, *Baeckea frutescens*
Lower 1	0.2–1.5	15–55	*Xanthorrhoea fulva*, *Leptospermum liversidgei*, *Sporadanthus interruptus*, *Banksia oblongifolia*
Lower 2	0–0.5	15–65	*Gahnia sieberiania*, *Baumea muelleri*

Floristics

Emergent small trees and shrubs: *Leptospermum whitei* (M1), *Xanthorrhoea fulva* (L1), *Leptospermum liversidgei* (M1, L1), *Banksia oblongifolia* (L1), *Baeckea frutescens* (M1), *Banksia aemula* (M1), *Leptospermum polygalifolium* subsp. *cismontanum*.

Ferns: *Nephrolepis cordifolia**, *Schizaea dichotoma*.

Sedges and rushes: *Sporadanthus interruptus* (L1, L2), *Gahnia sieberiana* (L2), *Baumea muelleri* (L2), *Baloskion tetraphyllum* subsp. *meiostachyum*.

Herbs and shrubs: *Epacris obtusifolia*, *Aotus ericoides*, *Bauera capitata* (L2), *Selaginella uliginosa*, *Burchardia umbellata*, *Goodenia paniculata*, *Adrastaea salicifolia*, *Boronia falcifolia*, *Micrantheum ericoides*, *Comesperma defoliatum*, *Drosera spatulata*, *Leucopogon juniperinus*, *Mitrasacme polymorpha*, *Pimelea linifolia*, *Stackhousia nuda*, *Utricularia uniflora*, *Sprengelia sprengelioides*, *Monotoca elliptica*, *Leucopogon margarodes*, *Melaleuca sieberi*, *Ricinocarpos pinifolius*, *Xyris gracilis*, *Cryptostlyis erecta*.


Leptospermum whitei

Climbers: *Cassytha filiformis*, *Cassytha glabella*, *Smilax glyciphylla*.

Number of native taxa: 36 **Number of taxa per plot**: 20–31 (23 ± 5)

Number of exotic species: 1

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Adrastaea salicifolia	1	0.6	0	0	positive
Aotus ericoides	2	1	1	0.009901	positive
Baeckea frutescens	3	0.6	1	0.0297	positive
Banksia oblongifolia	3	1	1	0.009901	positive
Bauera capitata	3	0.8	0	0	positive
Boronia falcifolia	1	0.8	0	0	positive
Burchardia umbellata	2	0.6	0	0	positive
Cassytha glabella	1	0.2	0	0	positive
Comesperma defoliatum	2	0.4	0	0	positive
Cryptostlyis erecta	1	0.2	0	0	positive
Drosera spatulata	2	0.4	0	0	positive
Epacris obtusifolia	2	1	0	0	positive
Gahnia sieberiana	2	0.8	2	0.3366	positive
Leptospermum liversidgei	3	1	0	0	positive
Leptospermum whitei	4	1	2	0.0396	positive
Leucopogon juniperinus	2	0.4	0	0	positive
Micrantheum ericoides	1	0.4	0	0	positive
Mitrasacme polymorpha	2	0.4	0	0	positive
Ricinocarpos pinifolius	1	0.2	0	0	positive
Schizaea dichotoma	1	0.2	0	0	positive
Selaginella uliginosa	2	0.8	1	0.009901	positive
Sporadanthus interruptus	4	1	1	0.009901	positive
Sprengelia sprengelioides	1	0.4	0	0	positive
Stackhousia nuda	2	0.4	0	0	positive
Utricularia uniflora	1	0.6	0	0	positive
Xanthorrhoea fulva	4	1	3	0.0396	positive
Xyris gracilis	1	0.2	0	0	positive

Community 9 Tantoon Tea-tree Shrubland

Area (Ha)	3.87
% of Bongil Bongil NP	0.10
Polygons with LiDAR	2
Total No. of Polygons	2
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	15.00
LiDAR Mean Tree Height (m)	4.73

Tantoon Tea-tree (*Leptospermum polygalifolium* subsp. *cismontanum*), White's Tea-tree (*Leptospermum whitei*), Satinwood (*Nematolepis squamea* subsp. *squamea*) and Swamp Mahogany (*Eucalyptus robusta*) with Tassel Rush (*Baloskion tetraphyllum* subsp. *meiostachyum*), Grass tree (*Xanthorrhoea fulva*) and Saw Sedge (*Gahnia sieberiana*) Tall Shrubland/Open Forest

Sites (3): AL28FL010, AL830FL006, UN830UN105

Rapid Data Points (3): rdp-156, rdp-159, rdp-163

Equivalent communities

Freshwater Wetlands–Coastal Heath Swamps (Keith 2004); NPWS NSW Coastal Vegetation community No. 34: *Banksia ericifolia* subsp. *macrantha* +/– *Leptospermum whitei* – *L. polygalifolium* subsp. *cismontanum* swamp sclerophyll shrubland, and community No. 41: *Eucalyptus robusta*/*E. signata* – *Baloskion tetraphyllum* subsp. *meiostachyum* swamp sclerophyll mallee shrubland, mallee forest and mallee woodland (Griffith et al. 2003).

Description

A very tall shrubland to open forest dominated by Tantoon Tea-tree (*Leptospermum polygalifolium* subsp. *cismontanum*), White's Tea-tree (*Leptospemum whitei*), Satinwood (*Nematolepis squamea* subsp. *squamea*) and Swamp Mahogany (*Eucalyptus robusta*). A mid-layer is often present, including Satinwood and Slender Tea-tree (*Leptospermum trinervium*). A lower layer of shrubs also occurs, with *Leucopogon margarodes* and *Leucopogon lanceolatus* present. A second lower layer is characterised by Saw Sedge (*Gahnia sieberiana*), Tassell Rush (*Baloskion tetraphyllus* subsp. *meiostachys*), Grass tree (*Xanthorrhoea fulva*) and Curly Sedge (*Caustis recurvata*).

Distribution and Habitat

Habitat: Occurs on the outer edge of a sandy freshwater swamp on waterlogged soils. This swamp is located on a slightly raised sandy plateau. The vegetation communities grade from Swamp Mahogany–Satinwood Open Forest on Sand (community 10) to Tantoon Tea-tree (this community), to White's Tea-tree Shrubland (community 8) in the most poorly drained areas at the centre of the swamp.

Disturbance: In very good condition and includes very tall, old Tantoon Tea-trees.

Distribution within the park: Western Peninsula Trail and the Fist Peninsula.

Area: 4 ha.

Conservation

Threats: None identified.

Conservation status: This community has not been previously described from surveys and is possibly unique. This community is most closely related to communities 34 and 41 of Griffith *et al.* (2003; see Equivalent communities, above), which are conserved in Broadwater NP, Bundjalung NP, Yuraygir NP, Hat Head NP, Limeburners Creek NR, Lake Innes NR, Crowdy Bay NP and Booti Booti NP. Whereas the Bongil Bongil community shares Tantoon Tea-tree, Swamp Mahogany and Tassell Rush and Grass tree (*Xanthorrhoea fulva*) with these two communities, it also contains abundant Satinwood and White's Tea-tree, which are not present in Community 34 or 41 of Griffith *et al*. (2003).

Significant taxa: None recorded. The only records of *Patersonia fragilis* in the survey were in this community. This species is apparently locally uncommon, and the nearest coastal records are at Bundjalung NP to the north and Kattang NR to the south.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	8–22	20–25	*Leptospermum polygalifolium* subsp. *cismontanum*, *Nematolepis squamea* subsp. *squamea*
Middle 1	2–8	15–55	*Leptospermum polygalifolium* subsp. *cismontanum*, *Nematolepis squamea* subsp. *squamea*, *Leptospermum trinervium*, *Leptospermum whitei*
Lower 1	0.1–2	10–60	*Gahnia sieberiana*, *Leucopogon lanceolatus*, *Leucopogon margarodes*
Lower 2	0–0.1	5–30	*Gahnia sieberiana*, *Baloskion tetraphyllum* subsp. *meiostachyum*, *Caustis recurvata*, *Xanthorrhoea fulva*

Floristics

Emergent small trees and shrubs: *Leptospermum polygalifolium* subsp. *cismontanum* (M1, L1), *Nematolepis squamea* subsp. *squamea* (M1, L1), *Eucalyptus robusta* (T), *Elaeocarpus reticulatus*, *Eucalyptus signata* (T), *Leptospermum trinervium* (M1), *Acmena smithii*, *Baeckea frutescens*, *Banksia aemula*, *Callicoma serratifolia*, *Endiandra sieberi*, *Eucalyptus pilularis*, *Livistona australis*, *Syncarpia glomulifera*.

Ferns: *Pteridium esculentum*, *Blechnum indicum*.

Sedges and rushes: *Gahnia sieberiana* (L1, L2), *Baloskion tetraphyllum* subsp. *meiostachyum* (L2), *Caustis recurvata* (L2), *Hypolaena fastigiata*, *Sporadanthus interruptus*.

Herbs and shrubs: *Xanthorrhoea fulva* (L2), *Leptospermum whitei* (M1), *Leucopogon lanceolatus* (L1), *Leucopogon margarodes* (L1), *Oxylobium robustum*, *Acacia ulicifolia*, *Goodenia paniculata*, *Mitrasacme paludosa*, *Pimelea linifolia*, *Banksia oblongifolia*, *Patersonia fragilis*, *Selaginella uliginosa*.

Climbers: *Smilax glyciphylla*, *Cassytha filiformis*.

Number of native taxa: 36 **Number of taxa per plot**: 19–20 (19.6 ± 0.6)

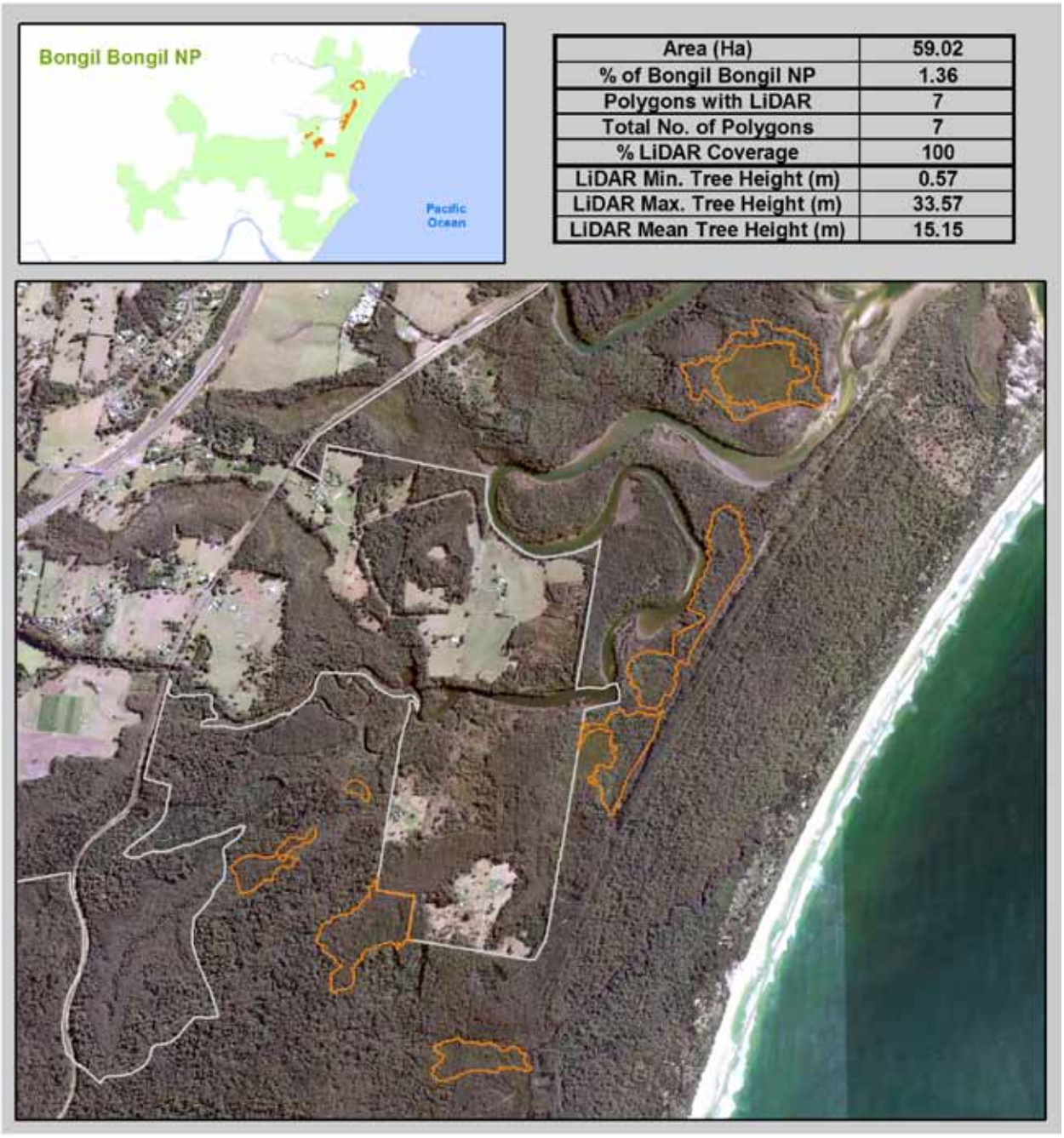
Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Amperera xiphoclada	1	0.25	0	0	positive
Baloskion tetraphyllum subsp. *meiostachyum*	3	1	1	0.05882	positive
Elaeocarpus reticulatus	2	0.5	1	0.1863	positive
Eucalyptus robusta	3	1	2	0.07843	positive
Eucalyptus signata	3	0.25	0	0	positive
Gahnia sieberiana	3	1	1	0.3333	positive
Hypolaena fastigiata	2	0.25	0	0	positive
Leptospermum polygalifolium subsp. *cismontanum*	3	1	2	0.05882	positive
Leptospermum trinervium	3	0.25	0	0	positive

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Leptospermum whitei	4	0.5	4	0.06863	positive
Leucopogon lanceolatus	3	1	1	0.08824	positive
Leucopogon margarodes	3	0.75	1	0.04902	positive
Mitrasacme paludosa	2	0.25	0	0	positive
Nematoleopis squamea	3	1	2	0.03922	positive
Oxylobium robustum	2	0.75	1	0.02941	positive
Patersonia fragilis	1	0.25	0	0	positive
Smilax glyciphylla	2	0.5	1	0.2647	positive
Xanthorrhoea fulva	2	0.75	4	0.05882	positive

Community 10 Swamp Mahogany–Satinwood Sand Swamp Forest



Area (Ha)	59.02
% of Bongil Bongil NP	1.36
Polygons with LiDAR	7
Total No. of Polygons	7
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.57
LiDAR Max. Tree Height (m)	33.57
LiDAR Mean Tree Height (m)	15.15

Swamp Mahogany (*Eucalyptus robusta*), Broad-leaved Paperbark (*Melaleuca quinquenervia*), Satinwood (*Nematolepis squamea* subsp. *squamea*) and Tassell Rush (*Baloskion tetraphyllus* subsp. *meiostachyum*) Wallum Swamp Sclerophyll Shrubland to Open Forest

Sites (4): AL830CF038, AL830FL036, AL830FL012, AL830FL106

Rapid data points (10): rdp-70, rdp-71, rdp-132, rdp-134, rdp-137, rdp-140, rdp-145, rdp-146, rdp-155, rdp-166

Equivalent communities

Forested Wetlands–Coastal Swamp Forests (Keith 2004); NPWS NSW Coastal Vegetation community 4002: *Eucalyptus robusta* mid-high to very tall, open woodland to closed forest (Griffith & Wilson 2007).

Description

The upper layer comprises Swamp Mahogany (*Eucalyptus robusta*), rarely in association with Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Pink Bloodwood (*Corymbia intermedia*). There is a mid-layer of Tantoon Tea-tree (*Leptospermum polygalifolium* subsp. *cismontanum*) and Satinwood (*Nematolepis squamea* subsp. *squamea*). The lower layer is typified by an open to dense cover of Tassel Rush (*Baloskion tetraphyllum* subsp. *meiostachyum*), Blueberry Ash (*Elaeocarpus reticulatus*) and Saw Sedge (*Gahnia clarkei*). The climber Native Sarsparilla (*Smilax gyciphylla*) was common in these sites. The community contains wet heath species shared with the White's Tea-tree Shrubland and Tantoon Tea-tree Shrubland communities (8 and 9 respectively).

Distribution and Habitat

Habitat: Occurs on sandy undifferentiated soils in areas of impeded drainage fringing Tantoon Tea-tree Shrubland and White's Tea-tree Shrubland communities.

Disturbance: Some evidence of logging in one site.

Distribution within park: Western Peninsula Trail at the end of Overhead Bridge Road.

Area: 59 ha.

Conservation

Threats: None identified.

Conservation status: Recorded in Broadwater NP, Bundjalung NP, Yuraygir NP, Crowdy Bay NP, Hat Head NP, Arakoon SRA, Lake Innes NR, and Limeburners Creek NR.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	6–20	20–35	*Eucalyptus robusta, Melaleuca quinquenervia, Corymbia intermedia*, *Lophostemon suaveolens*, *Eucalyptus resinifera* subsp. *hemilampra*
Middle 1	2–6	5–35	*Leptospermum polygalifolium* subsp. *cismontanum*, *Nematolepis squamea* subsp. *squamea*
Lower 1	0.1–2	5–60	*Baloskion tetraphyllum* subsp. *meiostachyum*, *Elaeocarpus reticulatus, Gahnia sieberiana*
Lower 2	0–0.1	5–10	*Pomax umbellata*

Floristics

Trees: *Eucalyptus robusta* (T), *Melaleuca quinquenervia* (T), *Corymbia intermedia* (T), *Lophostemon suaveolens* (T), *Eucalyptus resinifera* subsp. *hemilampra.*

Sub-canopy trees and shrubs: *Leptospermum polygalifolium* subsp. *cismontanum* (M1), *Nematolepis squamea* subsp. *squamea* (M1), *Acacia melanoxylon* (M1), *Banksia integrifolia* subsp. *integrifolia*, *Banksia spinulosa* var. *collina*, *Livistona australis*, *Synoum glandulosum* subsp. *glandulosum.*

Grasses: *Entolasia marginata.*

Ferns: *Pteridium esculentum*, *Platycerium bifurcatum*, *Psilotum nudum*.

Sedges and rushes: *Baloskion tetraphyllum* subsp. *meiostachyum* (L1), *Gahnia clarkei* (L1), *Lomandra longifolia*, *Caustis recurvata*, *Lepidosperma laterale*, *Schoenus brevifolius.*

Epiphytes: *Cymbidium madidum*, *Platycerium bifurcatum.*

Shrubs: *Elaeocarpus reticulatus* (L1), *Dodonaea triquetra*, *Leptospermum whitei* (M1), *Melaleuca sieberi*, *Xanthorrhoea fulva* (L1), *Leucopogon lanceolatus* (L1), *Acacia ulicifolia*, *Endiandra sieberi*, *Breynia oblongifolia*, *Lantana camara**, *Leucopogon margarodes*, *Myrsine variabilis*, *Notelaea longifolia*, *Oxylobium robustum*, *Aotus ericoides*.

Herbs: *Pomax umbellata* (L2), *Dianella caerulea* var. *producta*, *Amperea xiphoclada* var. *xiphoclada*.

Blueberry Ash (Elaeocarpus reticulatus)

Climbers: *Hibbertia scandens*, *Smilax glyciphylla*, *Smilax australis*, *Billardiera scandens*, *Cassytha filiformis*, *Eustrephus latifolius*, *Kennedia rubicunda*, *Parsonsia straminea*, *Hibbertia dentata*.

Number of native taxa: 52

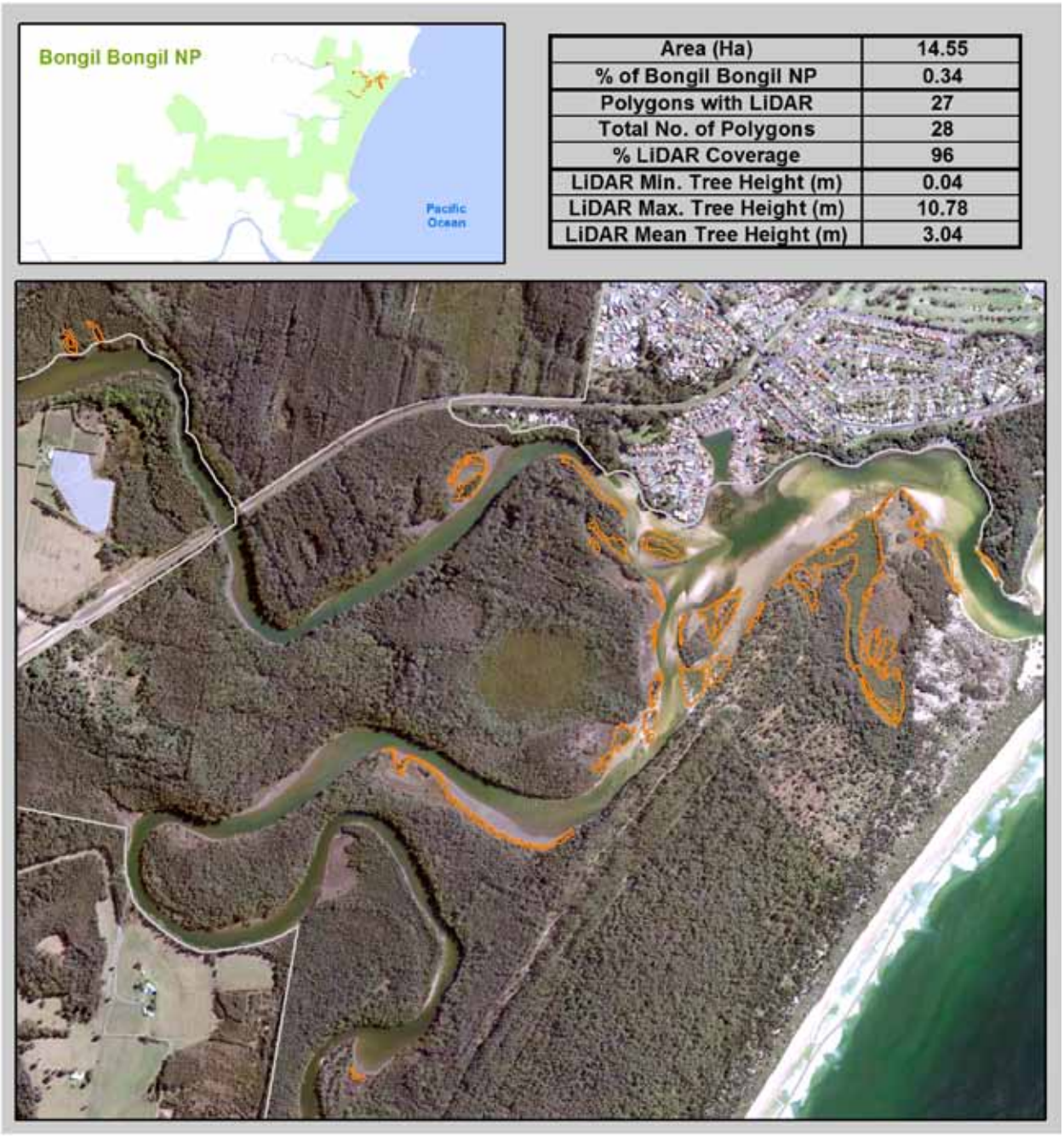
Number of taxa per plot: 21–29 (24 ± 4)

Number of exotic species: 1

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia melanoxylon	2	0.5	1	0.03846	positive
Angophora costata	1	0.5	0	0	positive
Baloskion tetraphyllum subsp. *meiostachyum*	5	1	1	0.07692	positive
Banksia spinulosa var. *collina*	1	0.5	0	0	positive
Eucalyptus robusta	4	1	2	0.09615	positive
Gahnia clarkei	3	1	2	0.3462	positive
Leptospermum polygalifolium subsp. *cismontanum*	3	1	3	0.07692	positive
Leptospermum whitei	2	1	4	0.06731	positive
Lomandra longifolia	2	1	1	0.3846	positive
Lophostemon suaveolens	2	0.5	1	0.04808	positive
Melaleuca quinquenervia	2	1	3	0.1827	positive
Melaleuca sieberi	3	0.5	1	0.01923	positive
Nematolepis squamea subsp. *squamea*	2	1	2	0.05769	positive
Pomax umbellata	2	0.5	1	0.07692	positive
Schoenus brevifolius	1	0.5	0	0	positive
Xanthorrhoea fulva	3	0.5	4	0.07692	positive

Community 11 Grey Mangrove Shrubland/ Woodland/Closed Forest



Area (Ha)	14.55
% of Bongil Bongil NP	0.34
Polygons with LiDAR	27
Total No. of Polygons	28
% LiDAR Coverage	96
LiDAR Min. Tree Height (m)	0.04
LiDAR Max. Tree Height (m)	10.78
LiDAR Mean Tree Height (m)	3.04

Grey Mangrove (*Avicennia marina* subsp. *australasica*) Shrubland/ Woodland/Closed Forest

Sites (3): EST28PC092, EST28PC093, EST28PC098

Rapid Data Points (2): rdp-180, rdp-181


River Mangrove (*Aegiceras corniculata*)

Equivalent communities

Saline Wetlands–Mangroves (Keith 2004).

Description

A mangrove closed shrubland dominated by Grey Mangrove (*Avicennia marina* subsp. *australasica*); River Mangrove (*Aegiceras corniculata*) was occasionally recorded.

Distribution and Habitat

Habitat: Estuarine tidal channels.

Disturbance: There was no evidence of any disturbance.

Distribution within the park: Pine Creek Estuary.

Area: 14 ha.

Conservation

Threats: None apparent.

Conservation status: Well represented in reserves.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Emergent	5-8	50-65	*Avicennia marina* subsp. *australasica*, *Aegiceras corniculata*

Floristics

Emergent small trees and shrubs: *Avicennia marina* subsp. *australasica*, *Aegiceras corniculata*.

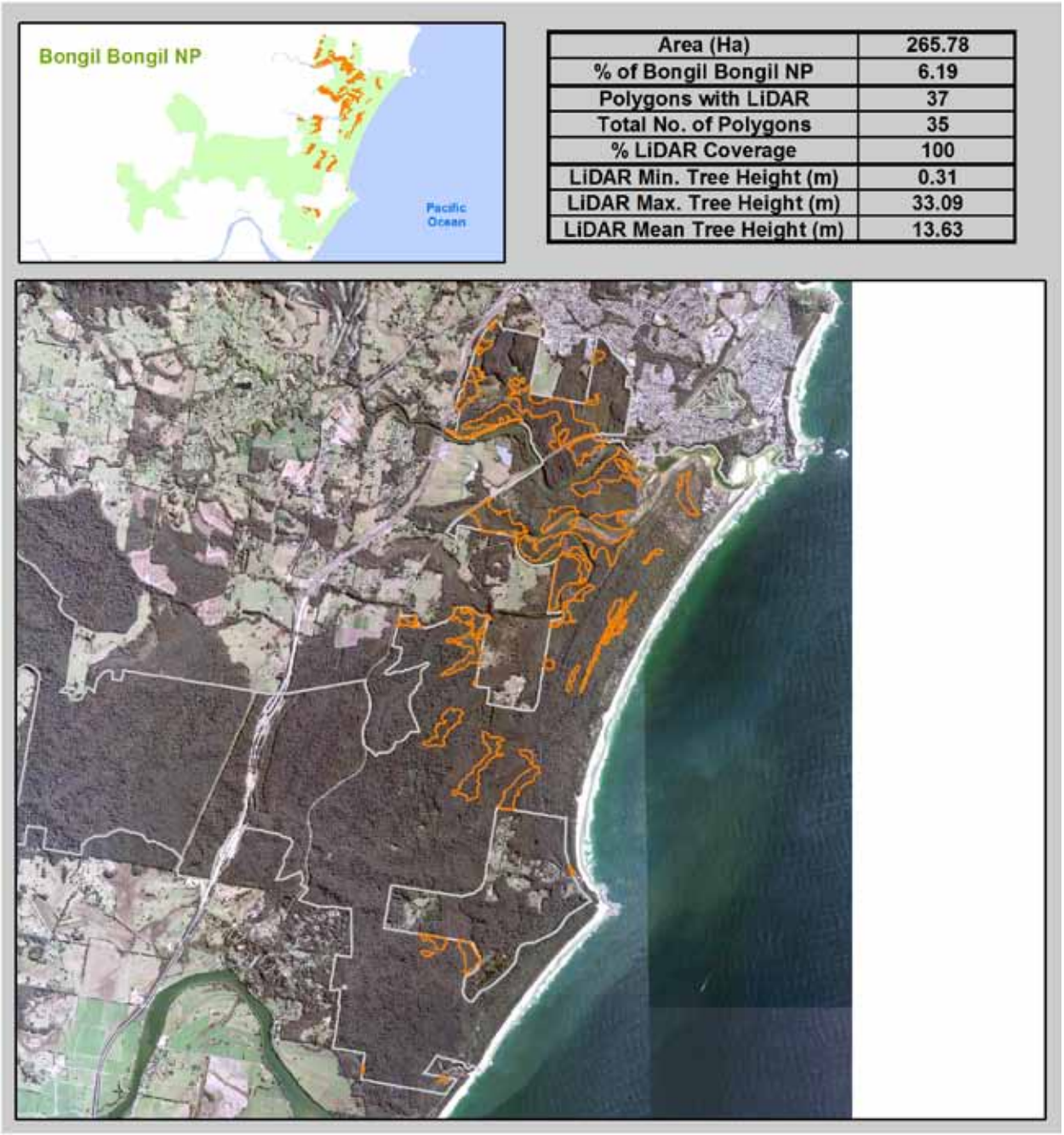
Number of native taxa: 2 **Number of taxa per plot**: 1–2 (mean 1.66 ± 0.6)

Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Aegiceras corniculata	1	0.6667	0	0	positive
Avicennia marina subsp. *australasica*	5	1	0	0	positive

Community 12 Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest



Area (Ha)	265.78
% of Bongil Bongil NP	6.19
Polygons with LiDAR	37
Total No. of Polygons	35
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.31
LiDAR Max. Tree Height (m)	33.09
LiDAR Mean Tree Height (m)	13.63

Broad-leaved Paperbark (*Melaleuca quinquenervia*), Willow Bottlebrush (*Callistemon salignus*), Swamp Oak (*Casuarina glauca*) Floodplain Swamp Sclerophyll Forest

Sites (10): AL28FL047, AL830FL001, AL830FL003, AL830FL004, AL830FL016, AL830FL017, AL830FL019, AL830FL029, EST830PCF015, EST830ICD007,]

Rapid Data Points (22): rdp-72, rdp-82, rdp-83, rdp-84, rdp-94, rdp-95, rdp-96, rdp-97, rdp-100, rdp-136, rdp-138, rdp-143, rdp-144, rdp-149, rdp-153, rdp-161, rdp-162, rdp-168, rdp-169, rdp-170, rdp-179, rdp-184

Equivalent communities

Forested Wetlands–Coastal Floodplain Wetlands (Keith 2004); NPWS NSW Coastal Vegetation community 4003: *Melaleuca quinquenervia* mid-high to very tall, open woodland to closed forest; and 4099 *Melaleuca quinquenervia–Casuarina glauca* mixed stands (Griffith & Wilson 2007); Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004a) and Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004b).

Description

A swamp sclerophyll forest of Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Willow Bottlebrush (*Callistemon salignus*), with Swamp Oak (*Casuarina glauca*) and, occasionally, Swamp Mahogany (*Eucalyptus robusta*) and Swamp Turpentine (*Lophostemon suaveolens*). There is an open mid-layer consisting of Prickly Paperbark (*Melaleuca styphelioides*), Broad-leaved Paperbark and Willow Bottlebrush. The lower layer varies considerably from dense swards of Saw Sedge (*Gahnia clarkei*), areas of Floyd's Grass (*Alexfloydia repens*), Native Violet (*Viola banksii*), *Ottochloa gracillima* and River Lily (*Crinum pedunculatum*) to open areas with standing water and floating waterplants such as *Azolla filiculoides*. The climber Hairy Silkpod (*Parsonsia straminea*) is abundant in many sites. In more saline sites Twig Rush (*Baumea juncea*) and Sea Rush (*Juncus kraussii* subsp. *australiensis*) are sometimes present in the ground layer. The species composition is highly dynamic and changes in response to flood events and tidal changes.

Distribution and Habitat

Habitat: Occurs on alluvial backswamps, fans and floodplains and occasionally on estuarine channels on the floodplain of Pine and Boambee Creeks. It occupies slightly higher areas of the floodplain with less tidal influence than the more saline Swamp Oak Swamp Sclerophyll Forest community (community 14).

Disturbance: Weeds are present, including Broad-leaved Paspalum (*Paspalum mandiocanum*) and Lantana (*Lantana camara*).

Locations: Widespread on the floodplain of Pine Creek and also occurs on Bundageree Creek–Freshwater Creek in the southern section of the park.

Area: 265 ha.

Conservation

Threats: Invasion of weeds, in particular the further encroachment of Broad-leaved Paspalum.

Conservation status: This community includes examples of Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004a) and Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004b).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	1–30	25–55	*Melaleuca quinquenervia*, *Callistemon salignus*, *Casuarina glauca*, *Eucalyptus robusta*, *Lophostemon suaveolens*
Middle 1	1–12	5–50	*Melaleuca styphelioides*, *Melaleuca quinquenervia*, *Callistemon salignus*
Lower 1	0.1–2	10–40	*Gahnia clarkei, Crinum pedunculatum*, *Hypolepis muelleri*
Lower 2	0–0.5	30–65	*Alexfloydia repens*, *Viola banksii*, *Ottochloa gracillima*, *Oplismenus aemulus*, *Azolla filiculoides*

Floristics

Trees: *Melaleuca quinquenervia* (T) (M1), *Callistemon salignus* (T) (M1), *Casuarina glauca* (T), *Eucalyptus robusta* (T), *Lophostemon suaveolens* (M1), *Corymbia intermedia*, *Eucalyptus grandis*.


Broad-leaved Paperbark (Melaleuca quinquenervia)

Sub-canopy trees and shrubs: *Melaleuca styphelioides* (M1), *Acacia maidenii*, *Alphitonia excelsa*, *Acmena smithii*, *Cinnamomum camphora**, *Endiandra sieberi*, *Ficus coronata*, *Livistona australis*, *Nematolepis squamea* subsp. *squamea*.

Grasses: *Alexfloydia repens* (L2), *Ottochloa gracillima* (L2), *Imperata cylindrica* var. *major*, *Oplismenus aemulus* (L2), *Paspalum mandiocanum**, *Oplismenus imbecillis*, *Microlaena stipoides* var. *stipoides*, *Sporobolus virginicus* var. *minor*, *Andropogon virginicus**, *Panicum bisulcatum*.

Ferns: *Pteridium esculentum*, *Hypolepis muelleri* (L1), *Azolla filiculoides* (L2), *Blechnum indicum*, *Calochlaena dubia*, *Platycerium superbum*, *Asplenium australasicum*, *Nephrolepis cordifolia*, *Platycerium bifurcatum*, *Pyrrosia confluens* var. *confluens*.

Sedges and rushes: *Gahnia clarkei* (L1), *Baumea juncea* (L1), *Lomandra longifolia* (L1),

Juncus kraussii subsp. *australiensis* (L1), *Gahnia aspera*, *Baumea articulata*, *Isolepis inundata*.

Epiphytes: *Platycerium superbum*, *Asplenium australasicum*, *Platycerium bifurcatum*, *Plectorrhiza tridentata*, *Pyrrosia confluens* var. *confluens*.

Shrubs: *Crinum pedunculatum* (L1), *Lantana camara**, *Cordyline stricta*, *Alocasia brisbanensis*, *Myrsine variabilis*, *Senna septemtrionalis**, *Tabernaemontana pandacaqui*, *Clerodendrum floribundum* var. *floribundum*, *Desmodium nemorosum*, *Duboisia myoporoides*, *Hibbertia aspera*, *Leptospermum polygalifolium* subsp. *cismontanum*, *Notelaea longifolia*, *Oxylobium robustum*.

Herbs: *Viola banksii* (L2), *Dianella caerulea* var. *producta*, *Commelina cyanea*, *Polymeria calycina*, *Brunoniella australis*, *Centella asiatica*, *Dipodium variegatum*, *Hydrocotyle peduncularis*, *Lobelia anceps*, *Oxalis exilis*, *Pratia purpurascens*, *Pseuderanthemum variabile*, *Tabernaemontana pandacaqui* (M1), *Alternanthera denticulata*, *Gonocarpus chinensis* subsp. *verrucosus*, *Maclura cochinchinensis*, *Persicaria strigosa* (L2), *Pomax umbellata*, *Rubus moluccanus* var. *trilobus*, *Solanum capsicoides**, *Tradescantia fluminensis**, *Vernonia cinerea*.

Climbers: *Parsonsia straminea*, *Marsdenia rostrata*, *Morinda jasminoides*, *Hibbertia scandens*, *Eustrephus latifolius*, *Stephania japonica* var. *discolor*, *Sarcopetalum harveyanum*, *Smilax australis*, *Smilax glyciphylla*, *Cassytha filiformis*, *Geitonoplesium cymosum*, *Histiopteris incisa*.

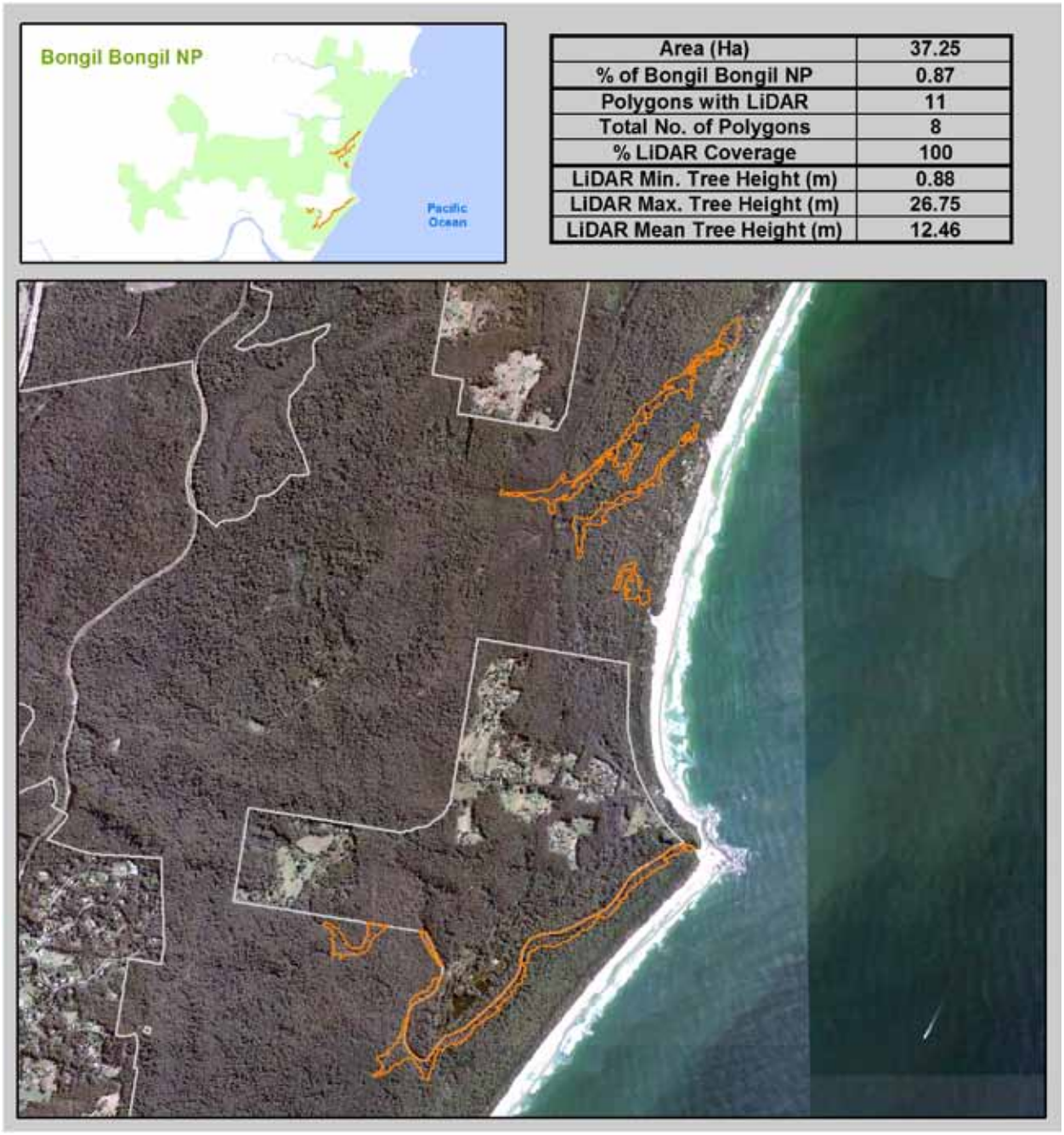
Number of native taxa: 85 **Number of taxa per plot**: 23–36 (31 ± 6)

Number of exotic species: 7

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Azolla filiculoides	4	0.125	0	0	positive
Baumea juncea	2	0.5	4	0.02041	positive
Callistemon salignus	3	1	2	0.1327	positive
Casuarina glauca	2	1	4	0.102	positive
Crinun pedunculatum	2	0.5	1	0.102	positive
Gahnia sieberiana	4	1	1	0.3061	positive
Gonocarpus chinensis subsp. *verrucosus*	1	0.125	0	0	positive
Isolepis inundata	1	0.125	0	0	positive
Marsdenia rostrata	2	1	1	0.102	positive
Melaleuca quinquenervia	4	0.875	2	0.1429	positive
Ottochloa gracillima	2	0.5	2	0.1735	positive
Parsonsia straminea	3	0.875	1	0.2755	positive
Polymeria calycina	1	0.375	0	0	positive
Viola banksii	2	1	1	0.3265	positive

Community 13 Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest



Area (Ha)	37.25
% of Bongil Bongil NP	0.87
Polygons with LiDAR	11
Total No. of Polygons	8
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.88
LiDAR Max. Tree Height (m)	26.75
LiDAR Mean Tree Height (m)	12.46

Broad-leaved Paperbark (*Melaleuca quinquenervia*)–Willow Bottlebrush (*Callistemon salignus*) Channel Swamp Sclerophyll Forest

Sites (3): EST830P022, EST830P023, CB830RD085

Rapid Data Points (2): rdp-68, rdp-77

Equivalent communities

Forested Wetlands–Coastal Floodplain Wetlands (Keith 2004); NPWS NSW Coastal Vegetation community 4003: *Melaleuca quinquenervia* mid-high to very tall, open woodland to closed forest (Griffith & Wilson 2007); Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004a).

Description

An open swamp sclerophyll forest of Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Willow Bottlebrush (*Callistemon salignus*). The epiphytic orchid *Cymbidium madidum* is commonly found growing on Broad-leaved Paperbarks. Owing to regular inundation, the understorey is very sparse and often wholly absent, with fallen leaves and other debris often the only ground covering. Where present, understorey species include River Lily (*Crinum pedunculatum*), Jointed Twig Rush (*Baumea articulata*), *Carex apressa* and River Lily (*Cladium procerum*).

Distribution and Habitat

Habitat: A billabong community found on creek channels with an impeded opening to the ocean, where the floodplain expands greatly during times of heavy rain, and extensive areas are covered with floodwater. Occurs in areas mapped as Quaternary sediment unit interbarrier creek deposits (Troedsen *et al.* 2004).

Disturbance: None recorded.

Distribution within the park: The channel and floodplain of Scrub Creek and Bundagaree Creek.

Area: 36 ha.

Conservation

Threats: The encroachment of weeds, including Broad-leaved Paspalum (*Paspalum mandiocanum*) and Cape Waterlily (*Nymphaea caerulea* var. *zanzibarensis*), is a possible threat.

Conservation status: This community is an example of Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004a).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	8–25	35–40	*Melaleuca quinquenervia, Callistemon salignus*
Lower 1	0–1.5	5–50	*Crinum pedunculatum*, *Baumea articulata*, *Carex apressa*, *Cladium procerum*

Floristics

Trees: *Melaleuca quinquenervia* (T), *Callistemon salignus* (T), *Eucalyptus robusta*, *Ficus watkinsiana*, *Archontophoenix cunninghamiana*, *Eucalyptus grandis*, *Livistona australis*.

Sub-canopy trees and shrubs: *Guioa semiglauca*.

Grasses: *Imperata cylindrica* var. *major*.

Ferns: *Cyclosorus interruptus*, *Pyrrosia confluens* var. *confluens*.

Sedges and rushes: *Baumea articulata*, *Carex appressa* (L1), *Cladium procerum* (L1), *Lomandra hystrix*, *Lomandra longifolia*, *Juncus usitatus* (L1).

Epiphytes: *Cymbidium madidum*.

Shrubs: *Chrysanthemoides monilifera* subsp. *rotundata**, *Crinum pedunculatum* (L1), *Clerodendrum floribundum* var. *floribundum*, *Hibiscus diversifolius*

Climbers: *Parsonsia straminea*, *Eustrephus latifolius*, *Smilax australis*.


Cymbidium madidum

Number of native taxa: 25 **Number of taxa per plot**: 10–17 (13 ± 4)

Number of exotic species: 2 (*Nymphaea caerulea* var. *zanzibarensis* recorded opportunistically)

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Callistemon salignus	3	0.6667	2	0.1845	positive
Carex appressa	2	0.3333	0	0	positive
Crinum pedunculatum	2	0.6667	1	0.1165	positive
Cyclosorus interruptus	1	0.3333	0	0	positive
Cymbidium madidum	2	1	1	0.1553	positive
Juncus usitatus	1	0.3333	0	0	positive

Community 14 Swamp Oak Swamp Sclerophyll Forest

Area (Ha)	14.83
% of Bongil Bongil NP	0.34
Polygons with LiDAR	23
Total No. of Polygons	24
% LiDAR Coverage	96
LiDAR Min. Tree Height (m)	0.70
LiDAR Max. Tree Height (m)	15.65
LiDAR Mean Tree Height (m)	7.31

Swamp Oak (*Casuarina glauca*) Swamp Sclerophyll Forest

Sites (4): AL830LV045, AL28LV046, EST830SS018, EST830SS034

Rapid Data Points (4): rdp-85, rdp-141, rdp-160, rdp-101

Equivalent communities

Forested Wetlands–Coastal Swamp Forests (Keith 2004); NPWS NSW Coastal Vegetation community 4005: *Casuarina glauca* Swamp Sclerophyll Forest and Woodland (Griffith & Wilson 2007); Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004b).

Description

This community is a swamp sclerophyll forest and shrubland dominated by Swamp Oak (*Casuarina glauca*). The understorey consists of the saltmarsh species Salwater Couch (*Sporobolus virginicus*), *Hemarthria uncinata*, Twig Rush (*Baumea juncea*), Sea Rush (*Juncus kraussii* subsp. *australiensis*) and Creeping Brookweed (*Samolus repens*).

Distribution and Habitat

Habitat: This community occurs on highly saline swamps and tidally influenced levees.

Disturbance: There was evidence of a fire at AL28LV046. Adult trees had been killed and a dense low regrowth of Swamp Oak has established with a very low species diversity.

Distribution within the park: Tidal estuary of Pine Creek.

Area: 15 ha.

Conservation

Threats: Climate change and rises in sea-level.

Conservation status: This community is an example of Swamp Oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	2–10	25–55	*Casuarina glauca*
Middle 1	1–3	5	*Melaleuca styphelioides*, *Melaleuca styphelioides*
Lower 1	0–1.5	30–85	*Hemarthria uncinata*, *Phragmites australis*, *Baumea juncea*, *Juncus kraussii* subsp. *australiensis*
Lower 2	0–0.5	25–85	*Hemarthria uncinata*, *Leptinella longipes*, *Triglochin striatum*

Floristics

Trees: *Casuarina glauca* (T), *Callistemon salignus*, *Melaleuca quinquenervia* (M1), *Cinnamomum camphora**.

Sub canopy trees and shrubs: *Melaleuca styphelioides* (M1), *Cupaniopsis anacardioides*, *Guioa semiglauca*.

Grasses: *Hemarthria uncinata* (L1) (L2), *Phragmites australis* (L1), *Ottochloa gracillima*, *Paspalum mandiocanum* *.

Ferns: *Platycerium bifurcatum*.


Creeping Brookweed (Samolus repens)

Sedges and rushes: *Baumea juncea* (L1), *Juncus kraussii* subsp. *australiensis* (L1), *Gahnia clarkei*, *Schoenoplectus subulatus*.

Epiphytes: *Platycerium bifurcatum*.

Shrubs: *Baccharis halimifolia**, *Chrysanthemoides monilifera* subsp. *rotundata**, *Crinum pedunculatum*.

Herbs: *Samolus repens* (L1), *Leptinella longipes* (L2), *Lobelia anceps*, *Triglochin striatum* (L2), *Viola banksii*, *Alternanthera denticulata*, *Apium prostratum*, *Senna septemtrionalis**, *Solanum nigrum**, *Taraxacum officinale**.

Climbers: *Parsonsia straminea*, *Marsdenia rostrata*, *Morinda jasminoides*.
Number of native taxa: 27 **Number of taxa per plot**: 11–19 (15 ± 4)
Number of exotic species: 7

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Baumea juncea	4	0.5	2	0.03922	positive
Callistemon salignus	2	0.5	3	0.1863	positive
Casuarina glauca	4	1	3	0.1373	positive
Hemarthria uncinata	4	0.75	0	0	positive
Juncus kraussii subsp. *australiensis*	2	1	2	0.09804	positive
Melaleuca quinquenervia	2	0.5	3	0.1863	positive
Melaleuca styphelioides	2	0.5	2	0.02941	positive
Phragmites australis	3	0.25	0	0	positive
Samolus repens	3	0.5	1	0.01961	positive
Schoenoplectus subulatus	1	0.5	0	0	positive

Community 15 Sea Rush Saltmarsh

Area (Ha)	18.90
% of Bongil Bongil NP	0.44
Polygons with LiDAR	27
Total No. of Polygons	29
% LiDAR Coverage	93
LiDAR Min. Tree Height (m)	0.03
LiDAR Max. Tree Height (m)	14.28
LiDAR Mean Tree Height (m)	2.47

Sea Rush (*Juncus kraussii* subsp. *australiensis*) Saltmarsh

Sites (2): EST02SS011, EST02SS048

Rapid Data Points (2): rdp-141, rdp-152

Equivalent communities

Saline Wetlands–Saltmarsh (Keith 2004); NPWS NSW Coastal Vegetation community 6502: *Juncus kraussii* ssp. *australiensis* tall to very tall closed rushland (Griffith & Wilson 2007); Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004d).

Description

A dense rushland community in which Sea Rush (*Juncus kraussii* subsp. *australiensis*) is the single dominant species. The only other plant species recorded in this community was Creeping Brookweed (*Samolus repens*).

Distribution and Habitat

Habitat: Saline swamps.

Disturbance: None observed.

Distribution within the park: Located in the Pine Creek estuary.

Area: 19 ha.

Conservation

Threats: Rises in sea level caused by climate change.

Conservation status: This community is an example of the Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above). Sea Rush Saltmarsh is reserved in Broadwater NP, Bundjalung NP, Yuraygir NP, Moonee Beach NR, Hat Head NP, Limeburners Creek NR, Crowdy Bay NP, Lake Innes NR and Booti Booti NP (Griffith & Wilson 2007). A saltmarsh community dominated by Sea Rush and Mat Grass (*Hemarthria uncinata*) was recorded in Ukerebagh NR (Sheringham *et al.* 2009).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0–1	85–90	*Juncus kraussii* subsp. *australiensis*

Floristics

Sedges and rushes: *Juncus kraussii* subsp. *australiensis* (L1).

Herbs: *Samolus repens*.

Number of native taxa: 2 **Number of taxa per plot**:2 (2 ± 0)

Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Juncus kraussii subsp. *australiensis*	6	1	2	0.1154	positive
Samolus repens	1	1	3	0.01923	uninformative

Community 16 Saltwater Couch Saltmarsh

Area (Ha)	1.03
% of Bongil Bongil NP	0.02
Polygons with LiDAR	5
Total No. of Polygons	5
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	9.80
LiDAR Mean Tree Height (m)	1.47

Saltwater Couch (*Sporobolus virginicus* var. *minor*), Water Ribbons (*Triglochin striatum*) and *Sarcocornia quinqueflora* subsp. *quinqueflora* Saltmarsh

Sites (4): EST02SS014, EST02SS020, EST02SS035, EST02SS021

Rapid Data Points: –

Equivalent communities

Saline Wetlands–Saltmarsh (Keith 2004); NPWS NSW Coastal Vegetation community 6102: *Sarcocornia quinqueflora* ssp. *quinqueflora* – *Sporobolus virginicus* dwarf to low closed chenopod shrubland/tussock grassland (Griffith & Wilson 2007); Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004d).

Description

A saltmarsh community in which Saltwater Couch (*Sporobolus virginicus* var. *minor*) is clearly dominant, and Water Ribbons (*Triglochin striatum*) and *Sarcornia quinqueflora* subsp. *quniqueflora* commonly occur. Clumps of Sea Rush (*Juncus kraussii* subsp. *australiensis*) occur occasionally.

Saltwater Couch
Sporobolus virginicus

Distribution and Habitat

Habitat: Tidally influenced saline swamps.

Disturbance: None observed.

Distribution within the park: Areas too small to map occur as a mosaic with other saltmarsh types, particularly in the large estuarine complex at the end of the Eastern Peninsula Trail.

Area: 1 ha.

Conservation

Threats: Mangroves are recruiting in saltmarsh communities in the National Park, which presents some threat. Sea-level rise is also a threat.

Conservation status: This community is an example of Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0–0.5	65–85	*Sporobolus virginicus* var. *minor*, *Juncus kraussii* subsp. *australiensis*, *Triglochin striatum*, *Sarcocornia quinqueflora* subsp. *quinqueflora*

Floristics

Grasses: *Sporobolus virginicus* var. *minor* (L1).

Sedges and rushes: *Juncus kraussii* subsp. *australiensis* (L1).

Herbs: *Triglochin striatum* (L1), *Sarcocornia quinqueflora* subsp. *quinqueflora* (L1).

Number of native taxa: 4 **Number of taxa per plot**: 2–4 (3 ± 1)

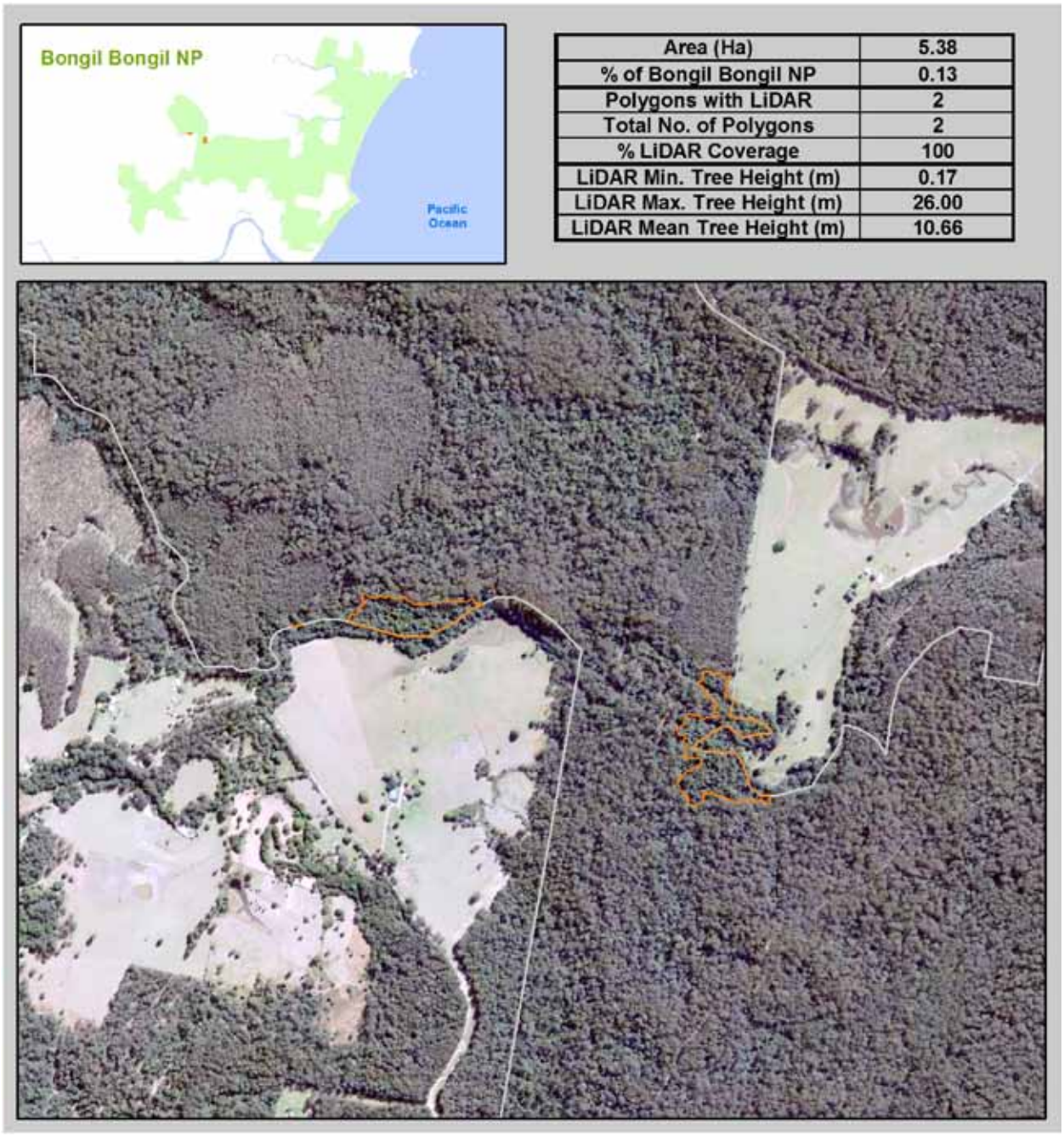
Number of exotic species: 0


Sarcocornia quinqueflora

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Juncus kraussii subsp. *australiensis*	2	0.75	2	0.1078	positive
Sarcocornia quinqueflora subsp. *quinqueflora*	4	0.5	0	0	positive
Sporobolus virginicus var. *minor*	6	1	2	0.03922	positive
Triglochin striatum	3	0.75	2	0.02941	positive

Community 17 Maiden's Blush–White Booyong Floodplain Subtropical Rainforest



Area (Ha)	5.38
% of Bongil Bongil NP	0.13
Polygons with LiDAR	2
Total No. of Polygons	2
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.17
LiDAR Max. Tree Height (m)	26.00
LiDAR Mean Tree Height (m)	10.66

Maiden's Blush (*Sloanea australis*), Hairy-leaved Bolly Gum (*Neolitsea dealbata*), White Booyong (*Heritiera trifoliolata*) Floodplain Subtropical Rainforest

Sites (2): AL830FL099, AL830FL0100

Rapid Data Points (1): rdp-61

Equivalent communities

Rainforest–Subtropical Rainforests (Keith 2004); Suballiance 1: *Agyrodendron trifoliatum* (Floyd 1990); Lowland rainforest on floodplain in the NSW North Coast Bioregion EEC (NSW Scientific Committee 1999).

Description

A subtropical rainforest community with Maiden's Blush (*Sloanea australis*), Hairy-leaved Bolly Gum (*Neolitsea dealbata*), White Booyong (*Heritiera trifoliolata*), Sassafras (*Doryphora sassafras*) and Bangalow Palm (*Archontophoenix cunninghamiana*) being the most common trees. Many large buttressed trees are present. *Pothos longipes,* Climbing Fern (*Lygodium microphyllum*) and Giant Pepper Vine (*Piper novae*, *hollandiae*) are abundant, using adventitious roots to climb the smooth-barked trunks of the rainforest trees. Lawyer Vine (*Calamus muelleri*) is also abundant at many levels of the lower to mid-layer. The lower layer is often very sparse and consists of the fern *Lastreopsis acuminata* and *Lomandra hystrix*.

Distribution and Habitat

Habitat: This community is found on the alluvial floodplain of Pine Creek.

Disturbance: Some large buttressed trees and figs are present, with a profusion of climbers and ferns, and for an example of a lowland rainforest it is in good condition. However, there is some evidence of past disturbance and breakages of the canopy, and Wandering Jew (*Tradescantia fluminensis*) was recorded at both sites. There was also evidence of sediment deposited from recent floods.

Distribution within park: Located on Pine Ceek near the Flying Fox Trail.

Area: 5 ha.

Conservation:

Threats: Invasion by weeds.

Conservation status: Lowland subtropical rainforests on alluvium have been heavily cleared throughout their range and are poorly reserved. This community is an example of Lowland rainforest on floodplain in the NSW North Coast Bioregion EEC (NSW Scientific Committee 1999). The suballiance recognised by Floyd is known to be reserved only at Coramba NR and within Dorrigo NP (Floyd 1990). This is probably a highly significant occurrence of lowland subtropical rainforest at the eastern limits of its range.

Significant taxa: Prickly Ash (*Orites excelsus*) and *Rhodamnia argentea*, which are more typical of mountainous or escarpment rainforest areas, such as the Dorrigo area, were recorded in this community. Ringwood (*Anetholea anisata*) (ROTAP: 2RCa) is known from this community. The climbers Giant Pepper Vine (*Piper novae-hollandiae*) and *Pothos longipes* were common in this community.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	4–28	70	*Sloanea australis*, *Neolitsea dealbata*, *Heritiera trifoliolata*, *Doryphora sassafras*, *Archontophoenix cunninghamiana*
Middle 1	1–5	15–25	*Neolitsea dealbata*, *Doryphora sassafras*
Lower 1 and 2	0–1.5	15	*Lomandra hystrix*, *Lastreopsis acuminata*, *Ripogonum discolor*

Floristics

Trees: *Sloanea australis* (T), *Neolitsea dealbata* (T, M1, L1), *Heritiera trifoliolata* (T, L1), *Doryphora sassafras* (M1), *Archontophoenix cunninghamiana* (T), *Sloanea woollsii* (T), *Ficus watkinsiana*.


Pothos longipes

Sub-canopy trees and shrubs: *Jagera pseudorhus* var. *pseudorhus* (L1), *Mischocarpus pyriformis* subsp. *pyriformis*, *Sarcopteryx stipata*, *Orites excelsus*, *Acmena smithii*, *Beilschmiedia elliptica*, *Croton verreauxii*, *Cryptocarya microneura*, *Drypetes deplanchei*, *Doryphora sassafras*, *Ficus coronata*, *Litsea reticulata*, *Pittosporum multiflorum*, *Pittosporum revolutum*, *Psychotria loniceroides*, *Rhodamnia argentea*, *Schizomeria ovata*, *Triunia youngiana*.

Grasses: *Oplismenus imbecillis*.

Ferns: *Lygodium microphyllum*, *Lastreopsis acuminata* (L2), *Asplenium australasicum*, *Blechnum patersonii* subsp. *patersonii*, *Doodia caudata*.

Sedges and rushes: *Lomandra hystrix* (L1, L2).

Epiphytes: *Asplenium australasicum*.

Shrubs: *Tabernaemontana pandacaqui*, *Cordyline stricta*, *Linospadix monostachya*, *Tasmannia stipitata*, *Citrus x taitensis**, *Gymnostachys anceps*.

Herbs: *Tradescantia fluminensis**.

Climbers: *Calamus muelleri* (M1, L1), *Pothos longipes* (M1), *Cephalaralia cephalobotrys*, *Embelia australiana*, *Piper novae*, *hollandiae*, *Ripogonum discolor* (L1), *Trophis scandens* subsp. *scandens*, *Cissus antarctica*, *Cissus sterculiifolia*, *Flagellaria indica*, *Morinda jasminoides*, *Ripogonum fawcettianum*.

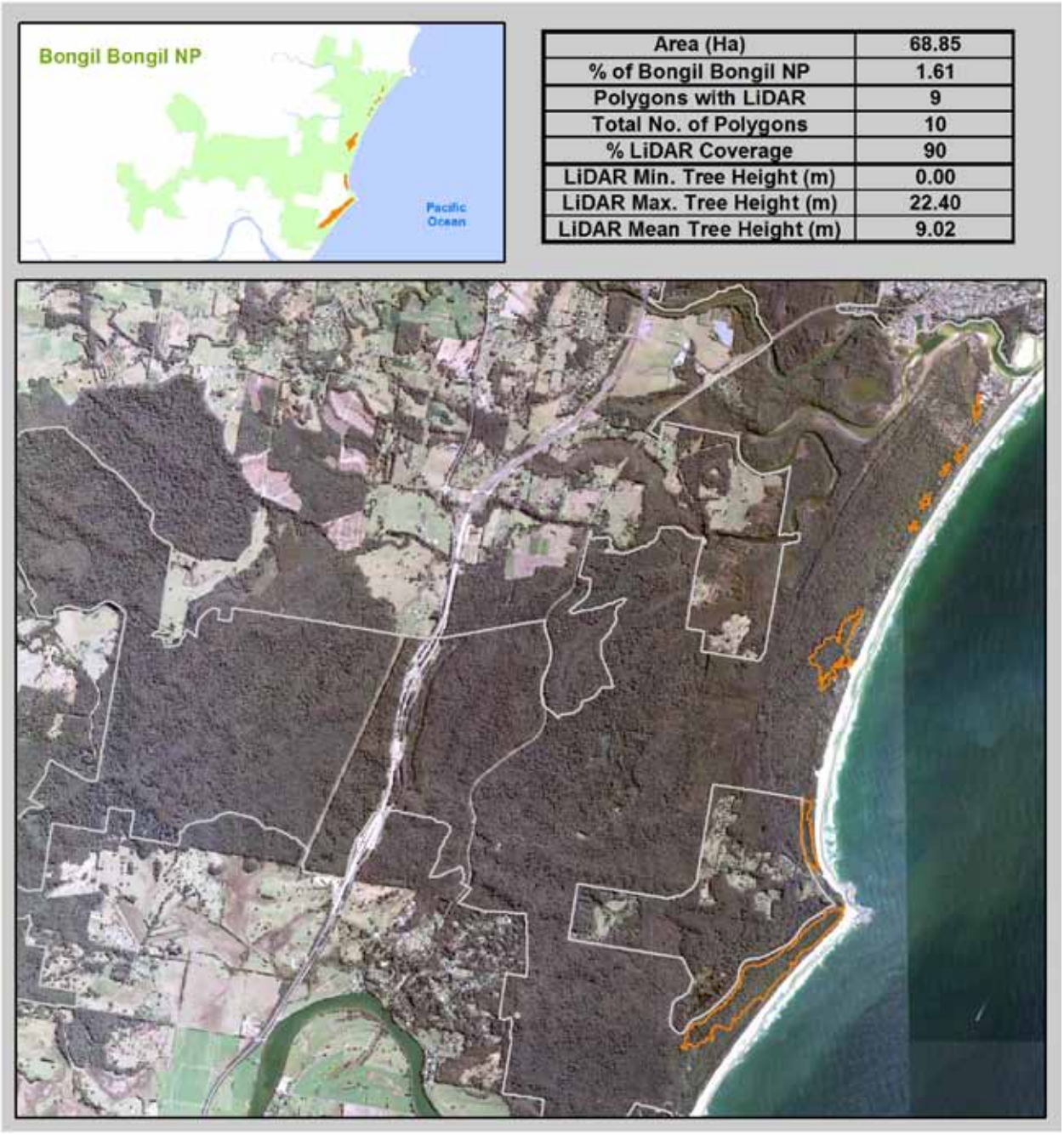
Number of native taxa: 51 **Number of taxa per plot**: 31–38 (35 ± 5)

Number of exotic species: 2

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Archontophoenix cunninghamiana	3	0.5	1	0.3173	Positive
Beilschmiedia elliptica	1	0.5	0	0	Positive
Calamus muelleri	4	1	2	0.1731	positive
Cephalaralia cephalobotrys	2	1	1	0.09615	positive
Doryphora sassafras	3	0.5	0	0	positive
Embelia australiana	2	1	1	0.06731	positive
Ficus watkinsiana	2	0.5	1	0.1058	positive
Heritiera trifoliolata	3	1	0	0	positive
Jagera pseudorhus var. *pseudorhus*	3	1	1	0.125	positive
Lastreopsis acuminata	3	0.5	0	0	positive
Linospadix monostachya	2	0.5	1	0.1346	positive
Lomandra hystrix	3	1	2	0.01923	positive
Lygodium microphyllum	2	1	0	0	positive
Mischocarpus pyriformis subsp. *pyriformis*	2	1	3	0.1154	positive
Neolitsea dealbata	4	1	1	0.04808	positive
Orites excelsa	2	0.5	0	0	positive
Piper novae-hollandiae	2	1	0	0	positive
Pothos longipes	4	1	2	0.009615	positive
Rhodamnia argentea	1	0.5	0	0	positive
Ripogonum discolor	3	0.5	1	0.04808	positive
Sarcopteryx stipata	2	1	1	0.04808	positive
Sarcopteryx stipata	4	1	2	0.04808	positive
Sloanea woollsii	2	0.5	3	0.009615	positive
Tasmannia stipitata	2	0.5	1	0.06731	positive
Triunia youngiana	1	0.5	0	0	positive
Trophis scandens subsp. *scandens*	3	0.5	2	0.05769	positive

Community 18 Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest



Area (Ha)	68.85
% of Bongil Bongil NP	1.61
Polygons with LiDAR	9
Total No. of Polygons	10
% LiDAR Coverage	90
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	22.40
LiDAR Mean Tree Height (m)	9.02

Small-leaved Lilly Pilly (*Syzygium luehmannii*), Pear-fruited Tamarind (*Mischocarpus pyriformis* subsp. *pyriformis*), Myrtle Ebony (*Diospyros pentamera*) and Brown Bolly Gum (*Litsea australis*) Littoral Rainforest

Sites (9): CB830DN063, CB830DN064, CB830DN065, CB830DN066, CB830DN076, CB830DN077, CB830DN078, CB830DN081, CB830DN082

Rapid Data Points (1): rpd-6

Equivalent communities

Rainforests–Littoral Rainforests (Keith 2004); NPWS NSW Coastal Vegetation community 0504: *Syzygium luehmannii – Acmena hemilampra* subsp. *hemilampra* simple, notophyll-microphyll, tall to very tall closed forest (Griffith & Wilson 2007); Suballiance 16: *Syzygium leuhmannii–Acmena hemilampra* (Floyd 1990); Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004c).

Description

This community has emergent Pink Bloodwood (*Corymbia intermedia*), Brushbox (*Lophostemon confertus*) and, occasionally, Flooded Gum (*Eucalyptus grandis*). In some sites Strangler Figs (*Ficus watkinsiana*) were common growing on large Brushbox trees. There is a dense subcanopy of rainforest trees, with Pear-fruited Tamarind (*Mischocarpus pyriformis* subsp. *pyriformis*), Myrtle Ebony (*Diospyros pentamera*), Small-leaved Lilly Pilly (*Syzygium luehmannii*) and Brown Bolly Gum (*Litsea australis*) being most common. Numerous other rainforest trees and shrubs are present, including Water Gum (*Tristaniopsis laurina*), Blue Lilly Pilly (*Syzygium oleosum*), Yellow Tulipwood (*Drypetes deplanchei*), *Guioa semiglauca*, Lilly Pilly (*Acmena smithii*), Tuckeroo (*Cupaniopsis anacardioides*), Flintwood (*Scolopia braunii*) and Bolly Gum (*Litsea reticulata*). Epiphytic ferns are prolific in some of the sites, including Elkhorn (*Platycerium bifurcatum*), Stag Horn (*Platycerium superbum*), Felt Fern (*Pyrrosia confluens* var. *confluens*), Ribbon Fern (*Ophioglossum pendulum*), Bird's Nest Fern (*Asplenium australasicum*) and Hare's Foot Fern (*Davallia solida* var. *pyxidata*). The most abundant climber is Long-leaved Water Vine (*Cissus sterculiifolia*). An open ground layer is present and the more abundant species recorded were Narrow-leaved Palm Lily (*Cordyline stricta*) and *Lomandra spicata*.

Distribution and Habitat

Habitat: Located in sheltered aspects on Holocene dunes. Taller rainforests occur on deep sandy soils that receive alluvial input from Bundageree Creek and Scrub Creek. In areas more exposed to the sea the rainforest becomes lower and more stunted.

Disturbance: Weeds, tracks and evidence of fire.

Distribution within the park: Bundagen and Scrub Creek areas.

Area: 69 ha.

Conservation

Threats: None.

Conservation status: This community is an example of Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: *Peristeranthus hillii* (TSC: Vulnerable).

Structure

Layer	Height (m)	Cover (%)	Dominant species
Emergent	20–35	35	*Corymbia intermedia*, *Lophostemon confertus*
Tallest	8–35	20–75	*Mischocarpus pyriformis* subsp. *pyriformis*, *Diospyros pentamera*,*Syzygium luehmannii*, *Litsea australis*, *Tristaniopsis laurina*, *Syzygium oleosum*, *Drypetes deplanchei*, *Guioa semiglauca*, *Acmena smithii*, *Cupaniopsis anacardioides*, *Scolopia braunii*, *Litsea reticulata*
Midde 1	2–10	35–75	*Mischocarpus pyriformis* subsp. *pyriformis*, *Diospyros pentamera*, *Syzygium luehmannii*
Lower 1	0.3–3	15–25	*Cissus sterculiifolia*, *Lomandra spicata*, *Ripogonum album*, *Smilax australis*
Lower 2	0–0.3	5–20	*Tripladenia cunninghamii*, *Oplismenus imbecillis*, *Tmesipteris truncata*

Floristics

Trees and shrubs: *Mischocarpus pyriformis* subsp. *pyriformis* (T, M1), *Diospyros pentamera* (T, M1), *Syzygium luehmannii* (M1, T), *Litsea australis* (T), *Corymbia intermedia* (E, T), *Tristaniopsis laurina* (T), *Syzygium oleosum*, *Drypetes deplanchei*, *Guioa semiglauca*, *Notelaea longifolia*, *Acmena smithii*, *Cupaniopsis anacardioides*, *Eucalyptus grandis* (E, T), *Ficus watkinsiana*, *Elaeodendron australe*, *Litsea reticulata*, *Lophostemon confertus* (E, T), *Scolopia braunii*, *Synoum glandulosum* subsp. *glandulosum*, *Cyclophyllum longipetalum*, *Myrsine variabilis*, *Wilkiea huegeliana*, *Eupomatia laurina*, *Archontophoenix cunninghamiana*, *Endiandra sieberi*, *Euroschinus falcatus* var. *falcatus*, *Pittosporum revolutum*, *Acronychia oblongifolia*, *Endiandra discolor*, *Maclura cochinchinensis*, *Clerodendrum floribundum* var. *floribundum*, *Cryptocarya microneura*, *Denhamia celastroides*, *Podocarpus elatus*, *Rhodomyrtus psidioides*, *Syzygium australe*, *Jagera pseudorhus* var. *pseudorhus*, *Psychotria loniceroides*, *Rhodamnia rubescens*, *Acronychia imperforata*, *Alectryon coriaceus*, *Arytera divaricata*, *Beilschmiedia obtusifolia*, *Cryptocarya triplinervis*, *Elaeocarpus obovatus*, *Eucalyptus robusta*, *Ficus obliqua*, *Livistona australis*, *Alphitonia excelsa*, *Celtis australis*, *Celtis paniculata*, *Cinnamomum camphora**, *Cinnamomum oliveri*, *Elaeocarpus reticulatus*, *Endiandra muelleri* subsp. *muelleri*, *Glochidion ferdinandi*, *Gmelina leichhardtii*, *Lophostemon suaveolens*, *Neolitsea dealbata*, *Pittosporum multiflorum*.

Grasses: *Oplismenus imbecillis* (L1), *Oplismenus aemulus*.

Ferns: *Platycerium bifurcatum*, *Pyrrosia confluens* var. *confluens*, *Pellaea falcata*, *Ophioglossum pendulum*, *Asplenium australasicum*, *Davallia solida* var. *pyxidata*, *Platycerium superbum*.

Sedges and rushes: *Cyperus tetraphyllus*.

Epiphytes: *Platycerium bifurcatum*, *Cymbidium madidum*, *Davallia solida* var. *pyxidata*, *Pyrrosia confluens* var. *confluens*, *Ophioglossum pendulum*, *Asplenium australasicum*, *Davallia solida* var. *pyxidata*, *Platycerium superbum*, *Peristeranthus hillii*.

Herbs and shrubs: *Lomandra spicata* (L1), *Cordyline stricta*, *Dianella caerulea* var. *producta*, *Tripladenia cunninghamii*, *Lomandra longifolia*, *Tmesipteris truncata*, *Xanthorrhoea macronema*, *Calanthe triplicata*, *Viola banksii*, *Breynia oblongifolia*, *Alpinia arundelliana*, *Desmodium nemorosum*, *Gloriosa superba**, *Gymnostachys anceps*, *Linospadix monostachya*.

Climbers: *Cissus sterculiifolia* (L1), *Smilax australis*, *Ripogonum album* (L1), *Eustrephus latifolius*, *Smilax*

glyciphylla, *Dioscorea transversa*, *Geitonoplesium cymosum*, *Celastrus subspicata*, *Cissus hypoglauca*, *Hibbertia scandens*, *Marsdenia rostrata*, *Ripogonum brevifolium*, *Ripogonum discolor*, *Sarcopetalum harveyanum*, *Calamus muelleri*, *Cissus antarctica*, *Embelia australiana*, *Morinda jasminoides*, *Trophis scandens* subsp. *scandens*.

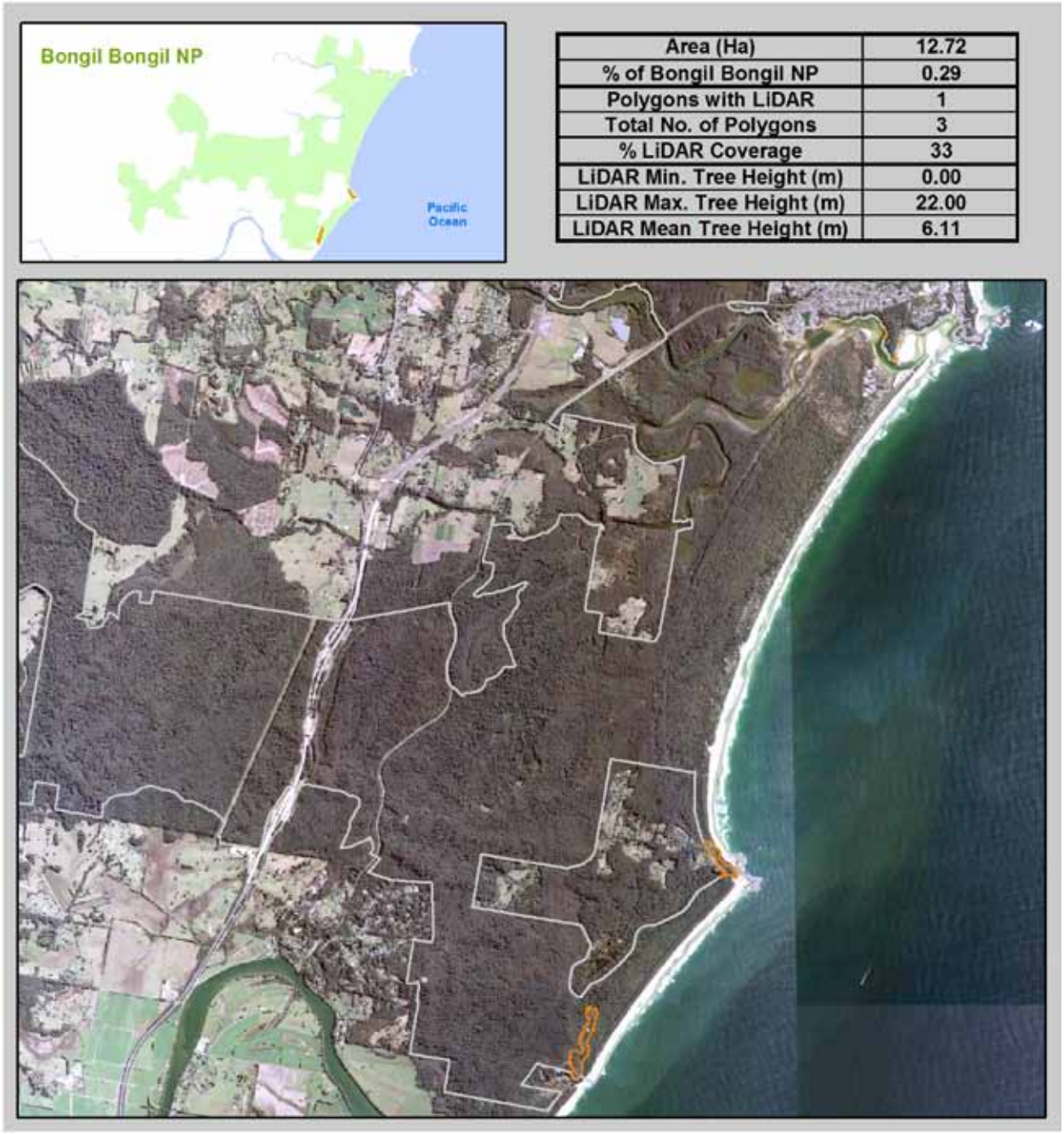
Number of native taxa: 108 **Number of taxa per plot**: 30–63 (49 ± 9)

Number of exotic species: 2

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Alpinia arundelliana	1	0.1111	0	0	positive
Beilschmiedia obtusifolia	1	0.2222	0	0	positive
Celtis paniculata	1	0.2222	0	0	positive
Cissus sterculiifolia	3	1	1	0.08247	positive
Corymbia intermedia	2	0.7778	2	0.2268	positive
Cyperus tetraphyllus	1	0.1111	0	0	positive
Denhamia celastroides	1	0.4444	0	0	positive
Diospyros pentamera	3	0.8889	1	0.03093	positive
Endiandra muelleri subsp. *muelleri*	1	0.1111	0	0	positive
Eucalyptus grandis	2	0.5556	2	0.2371	positive
Euroschinus falcatus var. *falcatus*	1	0.6667	0	0	positive
Ficus obliqua	1	0.2222	0	0	positive
Gmelina leichhardtii	1	0.1111	0	0	positive
Guioa semiglauca	2	0.8889	1	0.2062	positive
Litsea australis	3	1	1	0.02062	positive
Litsea reticulata	2	0.5556	1	0.02062	positive
Lomandra spicata	2	0.8889	1	0.1443	positive
Mischocarpus pyriformis subsp. *pyriformis*	4	0.8889	1	0.06186	positive
Notelea longifolia	2	0.8889	1	0.2062	positive
Ophioglossum pendulum	1	0.4444	0	0	positive
Peristeranthus hillii	1	0.2222	0	0	positive
Platycerium bifurcatum	2	0.7778	1	0.2371	positive
Podocarpus elatus	1	0.3333	0	0	positive
Smilax australis	2	0.8889	1	0.4433	positive
Syzygium luehmannii	3	1	1	0.05155	positive
Syzygium oleosum	2	0.7778	1	0.04124	positive
Tmesipteris truncata	1	0.4444	0	0	positive
Tristaniopsis laurina	4	0.2222	0	0	positive

Community 19 Headland Brushbox Littoral Rainforest



Area (Ha)	12.72
% of Bongil Bongil NP	0.29
Polygons with LiDAR	1
Total No. of Polygons	3
% LiDAR Coverage	33
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	22.00
LiDAR Mean Tree Height (m)	6.11

Coastal Brushbox (*Lophostemon confertus*) Littoral Rainforest on Permian metasediments

Sites (2): DN830DN075, PM830SH084

Rapid Data Points: –

Equivalent communities

Community 3002: *Lophostemon confertus* mid-high to very tall, open to closed forest (Griffith & Wilson 2007); Suballiance 18: *Lophostemon confertus* (Floyd 1990); Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004c).

Description

A Brushbox (*Lophostemon confertus*) dominant closed forest growing on sheltered aspects on sediments and footslopes on coastal barrier sands. Emergent Pink Bloodwood (*Corymbia intermedia*) is present. Other common canopy trees include Scentless Rosewood (*Synoum glandulosum*), Cheese Tree (*Glochidion ferdinandi*), Tuckeroo (*Cupaniopsis anarcardioides*), Guioa (*Guioa semiglauca*) and Red Bean (*Dysoxylum mollissimum* subsp. *molle*). This community had the highest species richness per site of all communities in the survey.

Distribution and Habitat

Habitat: Most examples occur on a steep ridge of metasediments with a sheltered aspect but also recorded on a footslope on the transition between sediments and sand.

Disturbance: Weeds such as Lantana (*Lantana camara*) and Winter Senna (*Senna septemtrionalis*) occur in the understorey of one site (DN830DN075) and there was evidence of gravel run-off from the Tuckers Rock access road deposited in another site (DN830DN075). During heavy rains areas of this community were subjected to extensive land-slips (see photo opposite).

Locations: Bundagen Headland and along the Bluff Trail.

Area: 13 ha.

Conservation

Threats: Land-slips and run-off from roads, which can lead to weed infestation.

Conservation status: This community is an example of Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	6–25	55–75	*Lophostemon confertus, Corymbia intermedia, Glochidion ferdinandi*
Middle 1	2–6	70	
Lower 1	0.2–2	30	*Alpinia caerulea*, *Cordyline stricta*
Lower 2	0–0.2	20–25	*Oplismenus imbecillis, Doodia aspera*

Floristics

Trees and shrubs: *Lophostemon confertus* (T), *Synoum glandulosum* subsp. *glandulosum*, *Corymbia intermedia* (T), *Glochidion ferdinandi* (T), *Guioa semiglauca*, *Dysoxylum mollissimum* subsp. *molle*, *Cupaniopsis anacardioides*, *Pittosporum revolutum*, *Rhodomyrtus psidioides*, *Trochocarpa laurina*, *Archontophoenix cunninghamiana*, *Arytera divaricata*, *Claoxylon australe*, *Clerodendrum floribundum* var. *floribundum*, *Elaeocarpus obovatus*, *Eucalyptus microcorys*, *Ficus coronata*, *Ficus watkinsiana*, *Maclura cochinchinensis*, *Notelaea longifolia*, *Rhodamnia rubescens*, *Scolopia braunii*, *Syzygium australe*, *Syzygium oleosum*, *Wilkiea huegeliana*, *Acacia maidenii*, *Acmena smithii*, *Callicarpa pedunculata*, *Cinnamomum camphora**, *Cryptocarya microneura*, *Cryptocarya triplinervis*, *Cyclophyllum longipetalum*, *Diospyros pentamera*, *Elaeodendron australe*, *Endiandra discolor*, *Eupomatia laurina*, *Litsea australis*, *Livistona australis*, *Myrsine howittiana*, *Myrsine variabilis*, *Neolitsea dealbata*, *Psychotria loniceroides*.

Grasses: *Oplismenus imbecillis* (L2), *Entolasia marginata*, *Oplismenus aemulus*.

Ferns: *Doodia aspera* (L2), *Blechnum cartilagineum*, *Asplenium australasicum*, *Cyathea australis*, *Cyathea cooperi*, *Adiantum formosum*, *Pellaea falcata*, *Psilotum nudum*, *Pyrrosia confluens* var. *confluens*, *Sticherus lobatus*.

Sedges and rushes: *Gahnia aspera*, *Lomandra longifolia*, *Lomandra spicata*.

Epiphytes: *Platycerium bifurcatum*, *Cymbidium madidum*, *Dendrobium aemulum*, *Platycerium superbum*.

Herbs and shrubs: *Alpinia caerulea* (L1), *Cordyline stricta* (L1), *Gymnostachys anceps*, *Senna septemtrionalis**, *Tabernaemontana pandacaqui*, *Alocasia brisbanensis*, *Commelina cyanea*, *Lantana camara**, *Lobelia trigonocaulis*, *Breynia oblongifolia*, *Calanthe triplicata*, *Crinum pedunculatum*, *Desmodium varians*, *Dianella caerulea* var. *producta*, *Gloriosa superba**, *Pratia purpurascens*, *Tripladenia cunninghamii*, *Viola banksii*.

Climbers: *Austrosteenisia blackii* var. *blackii*, *Calochlaena dubia*, *Cephalaralia cephalobotrys*, *Cissus antarctica*, *Morinda jasminoides*, *Smilax australis*, *Tetrastigma nitens*, *Cayratia clematidea*, *Calamus muelleri*, *Cissus hypoglauca*, *Dioscorea transversa*, *Eustrephus latifolius*, *Geitonoplesium cymosum*, *Hibbertia scandens*, *Stephania japonica* var. *discolor*, *Celastrus subspicata*, *Clematis aristata*, *Embelia australiana*, *Flagellaria indica*, *Mucuna gigantea* subsp. *gigantea*, *Parsonsia straminea*, *Ripogonum discolor*, *Trophis scandens* subsp. *scandens*.

Number of native taxa: 104 **Number of taxa per plot**:78–80 (79 ± 1)

Number of exotic species: 4

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Adiantum formosum	1	0.5	0	0	positive
Alpinia caerulea	3	1	1	0.2115	positive
Arytera divaricata	2	0.5	1	0.01923	positive
Austrosteenisia blackii var. *blackii*	3	1	1	0.009615	positive
Blechnum cartilagineum	3	0.5	1	0.2692	positive
Callicarpa pedunculata	1	0.5	0	0	positive
Calochlaena dubia	2	1	2	0.2981	positive
Cephalaralia cephalobotrys	2	1	1	0.09615	positive
Cissus antarctica	3	0.5	1	0.1731	positive
Claoxylon australe	3	1	2	0.01923	positive
Commelina cyanea	2	0.5	1	0.1346	positive
Cordyline stricta	3	1	1	0.4712	positive
Corymbia intermedia	3	1	2	0.2596	positive
Cupaniopsis anacardioides	2	1	1	0.2019	positive
Cyathea australis	2	0.5	1	0.06731	positive
Cyathea cooperi	1	0.5	0	0	positive
Dendrobium aemulum	2	0.5	0	0	positive
Doodia aspera	3	0.5	1	0.1058	positive
Doodia caudata	3	0.5	1	0.009615	positive
Dysoxylum mollissimum subsp. *molle*	2	1	0	0	positive
Elaeodendrons australe	2	0.5	1	0.08654	positive
Eucalyptus micocorys	2	0.5	2	0.2115	positive
Glochidion ferdinandi	3	1	1	0.01923	positive
Guioa semiglauca	3	1	1	0.25	positive
Gymnostachys anceps e	2	1	1	0.1635	positive
Lophostemon confertus	5	1	3	0.1154	positive
Morinda jasmoides	2	1	2	0.3654	positive
Oplismenus imbecillis	3	1	2	0.3654	positive
Pittosporum revolutum	2	1	1	0.09615	positive
Platycerium bifurcatum	2	1	1	0.2692	positive
Rhodomyrtus psidioides	3	0.5	1	0.03846	positive
Smilax australis	2	1	1	0.4712	positive
Sticherus lobatus	1	0.5	0	0	positive
Synoum glandulosum	4	1	2	0.375	positive
Syzygium australe	2	0.5	1	0.04808	positive
Tetrastigma nitens	3	0.5	0	0	positive
Trochocarpa laurina	2	1	1	0.2981	positive

Community 20 Tallowwood–Blackbutt–Turpentine Dry Open Forest

Area (Ha)	34.33
% of Bongil Bongil NP	0.80
Polygons with LiDAR	9
Total No. of Polygons	10
% LiDAR Coverage	90
LiDAR Min. Tree Height (m)	0.18
LiDAR Max. Tree Height (m)	31.27
LiDAR Mean Tree Height (m)	14.05

Tallowwood (*Eucalyptus microcorys*), Blackbutt (*Eucalyptus pilularis*), Turpentine (*Syncarpia glomulifera*) Dry Sclerophyll Forest

Sites (4): AL830FL030, DNV830027, DNV830031, PM830EX062

Rapid Data Points (4): rdp-172, rpd-173, rdp-174, rdp-175

Equivalent communities

Wet Sclerophyll Forest–Northern Hinterland Wet Sclerophyll Forests (Keith 2004); Forest Ecosystem 155: Wet Foothills Blackbutt–Turpentine (NPWS 1999).

Description

A dry open forest with a tree layer of Blackbutt (*Eucalyptus pilularis*), Tallowwood (*Eucalyptus microcorys*) and Turpentine (*Syncarpia glomulifera*). A sparse middle layer is present and includes Forest Oak (*Allocasuarina torulosa*). There is a dense primary lower layer of Blady Grass (*Imperata cylindrica* var. *major*), Basket Grass (*Oplismenus aemulus*) and Bracken Fern (*Calochlaena dubia*) and a sparse secondary lower layer of *Hibbertia aspera*, Basket Grass (*Oplismenus imbecillis*) and Pastel Flower (*Pseuderanthemum variabile*).

Distribution and Habitat

Habitat: Exposed aspects on upper slopes and ridges on Devonian metasediments.

Disturbance: Sites have been subjected to logging, past clearing and fire, and some sites occur in former plantation sites.

Distribution within the park: The northern section of the park at North Bonville, between Lyons Road and the North West Fire Trail.

Area: 34 ha.

Conservation

Threats: Clearing associated with urban subdivision, and construction of roads.

Conservation status: Forest Ecosystem 155 was well reserved according to an assessment during the Comprehensive Regional Assessment (NPWS 1999). This community is probably the least well reserved of the eucalypt forest communities in Bongil Bongil NP, and appears to have been heavily cleared locally at Boambee and Toormina.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	10–30	35–40	*Eucalyptus pilularis*, *Eucalyptus microcorys*, *Syncarpia glomulifera*
Middle 1	1.5–12	5–10	*Allocasuarina torulosa*
Lower 1	0.3–5	45–60	*Imperata cylindrica* var. *major*, *Oplismenus aemulus*, *Calochlaena dubia*
Lower 2	0–1	5–15	*Hibbertia aspera*, *Oplismenus imbecillis*, *Pseuderanthemum variabile*

Floristics

Trees: *Eucalyptus microcorys* (T), *Eucalyptus pilularis* (T), *Syncarpia glomulifera* (M1), *Allocasuarina torulosa*, *Corymbia intermedia*, *Eucalyptus carnea*, *Melaleuca quinquenervia*.

Small trees and shrubs: *Elaeocarpus reticulatus*, *Cinnamomum camphora*, *Acacia elongata*, *Acacia myrtifolia*, *Acmena smithii*, *Alphitonia excelsa*, *Banksia integrifolia* subsp. *integrifolia*, *Callicoma serratifolia*, *Callistemon salignus*, *Guioa semiglauca*, *Polyscias elegans*, *Polyscias sambucifolia*.

Grasses: *Imperata cylindrica* var. *major* (L1), *Oplismenus imbecillis* (L2), *Entolasia marginata* (L2), *Themeda australis* (L1), *Oplismenus aemulus*, *Setaria distans*, *Andropogon virginicus**, *Cymbopogon refractus*, *Panicum effusum*, *Paspalidium gracile*, *Paspalum mandiocanum** (L2).

Ferns: *Calochlaena dubia* (L1), *Pteridium esculentum*, *Blechnum cartilagineum*, *Nephrolepis cordifolia**, *Polyscias elegans*.

Sedges and rushes: *Lomandra longifolia*, *Lepidosperma laterale*, *Gahnia clarkei*, *Gahnia aspera*, *Lomandra filiformis* subsp. *filiformis*, *Lomandra multiflora* subsp. *multiflora*.

Epiphytes: *Platycerium bifurcatum*, *Cymbidium madidum*, *Polyscias elegans*.

Shrubs: *Hibbertia aspera* (L2), *Lantana camara** (M1), *Breynia oblongifolia*, *Xanthorrhoea macronema*, *Lomatia silaifolia*, *Persoonia stradbrokensis*, *Pultenaea retusa*, *Clerodendrum floribundum* var. *floribundum*, *Hibbertia vestita*, *Hovea acutifolia*, *Leptospermum polygalifolium* subsp. *cismontanum*, *Leucopogon lanceolatus*, *Notelaea longifolia*, *Seringia arborescens*, *Trochocarpa laurina*.


Hibbertia aspera

Herbs: *Pseuderanthemum variabile* (L2), *Dianella caerulea* var. *producta*, *Pratia purpurascens*, *Desmodium varians*, *Dipodium variegatum*, *Vernonia cinerea*, *Cordyline stricta*, *Dodonaea triquetra*, *Duboisia myoporoides*, *Alpinia caerulea*, *Caesia parviflora*, *Commelina cyanea*, *Dampiera stricta*, *Oxalis exilis*, *Patersonia glabrata*, *Tripladenia cunninghamii*.

Climbers: *Eustrephus latifolius*, *Kennedia rubicunda*, *Smilax australis*, *Billardiera scandens* (L2), *Cissus hypoglauca*, *Desmodium brachypodum*, *Morinda jasminoides*, *Smilax glyciphylla*, *Stephania japonica* var. *discolor*, *Parsonsia straminea*, *Clematis aristata*, *Dioscorea transversa*, *Geitonoplesium cymosum*, *Glycine clandestina*, *Goodenia heterophylla* subsp. *eglandulosa*, *Lobelia trigonocaulis*, *Marsdenia rostrata*, *Viola banksii*.

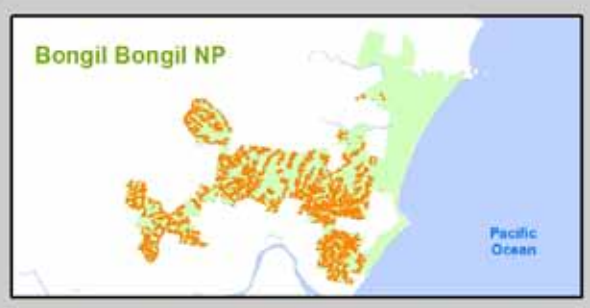
Number of native taxa: 89 **Number of taxa per plot**: 38–52 (43 ± 6)

Number of exotic species: 4

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia myrtifolia	1	0.25	0	0	positive
Allocasuarina torulosa	2	0.75	2	0.2647	positive
Billardiera scandens	2	0.5	1	0.02941	positive
Caesia parviflora	1	0.25	0	0	positive
Calochleana dubia	3	1	1	0.2843	positive
Corymbia intermedia	2	0.5	2	0.2647	positive
Dampiera stricta	1	0.25	0	0	positive
Dianella caerulea	2	0.5	1	0.4314	positive
Dipodium varians	2	0.5	1	0.03922	positive
Entolasia marginata	3	1	1	0.2059	positive
Eucalyptus micocorys	4	0.75	2	0.1961	positive
Eucalyptus pilularis	3	1	3	0.2157	positive
Goodenia heterophylla subsp. *eglandulosa*	1	0.25	0	0	positive
Hibbertia aspera	2	0.75	1	0.009804	positive
Hibbertia scandens	2	1	1	0.2745	positive
Hibbertia vestita	1	0.25	0	0	positive
Imperata cylindrica	3	1	2	0.2647	positive
Lomandra longifolia	2	1	1	0.3725	positive
Lomandra multiflora	1	0.25	0	0	positive
Lomatia silaifolia	2	0.25	0	0	positive
Morinda jasmoides	2	0.5	2	0.3725	positive
Oplismenus imbecillis	3	0.75	2	0.3627	positive
Patersonia glabrata	1	0.25	0	0	positive
Pseuderanthemum variabile	2	0.75	2	0.2745	positive
Pteridium esculentum	2	0.75	1	0.2549	positive
Pultenaea retusa	2	0.25	0	0	positive
Setaria distans	2	0.25	0	0	positive
Stephania japonica var. *discolor*	2	0.5	1	0.2549	positive
Syncarpia glomulifera	2	1	2	0.2157	positive
Vernonia cinerea	2	0.5	1	0.1078	positive

Community 21 Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest



Area (Ha)	858.29
% of Bongil Bongil NP	19.97
Polygons with LiDAR	140
Total No. of Polygons	219
% LiDAR Coverage	64
LiDAR Min. Tree Height (m)	1.29
LiDAR Max. Tree Height (m)	42.67
LiDAR Mean Tree Height (m)	21.90

Blackbutt (*Eucalyptus pilularis*), Turpentine (*Syncarpia glomulifera*), Tallowwood (*Eucalyptus microcorys*) and Small-fruited Grey Gum (*Eucalyptus propinqua*) Grassy/Ferny Dry Open Forest

Sites (7): PM8300SH039, PM830EX040, PM830SH041, PM830EX042, PM830EX057, PM830SH061, PM830SH088

Rapid Data Points (10): rdp-3, rdp-13, rdp-16, rdp-17, rdp-31, rdp-73, rdp-91, rdp-98, rdp-110, rdp-171

Equivalent communities

Wet Sclerophyll Forest–Northern Hinterland Wet Sclerophyll Forest (Keith 2004); Ecosystem 32: Dry Foothills Blackbutt–Turpentine; and Ecosystem 34: Dry Grassy Blackbutt–Tallowwood (NPWS 1999).

Description

This community is a tall, dry open forest, most commonly dominated by Blackbutt (*Eucalyptus pilularis*) with associated tree species including Turpentine (*Syncarpia glomulifera*), Tallowwood (*Eucalyptus microcorys*) and Small-fruited Grey Gum (*Eucalytpus propinqua*). The overstorey can vary from Grey Gum in areas such as the Whipstick Trail, to Blue-leaved Mahogany (*Eucalyptus carnea*) and Grey Ironbark (*Eucalyptus siderophloia*) near Mailmans Track. Floristically, some of the species of small trees, grasses and ferns are more important in delineating this community than the overstorey. An open to moderately dense layer of Forest Oak (*Allocasuarina torulosa*), Scentless Rosewood (*Synoum glandulosum* subsp. *glandulosum*) and Tree Heath (*Trochocarpa laurina*) is evident. False Bracken (*Calochlaena dubia*), Gristle Fern (*Blechnum cartilagineum*), Blady Grass (*Imperata cylindrica* var. *major*), *Ottochloa gracillima*, Basket Grass (*Oplismenus imbecillis*), *Entolasia marginata* , White Root (*Pratia purpurascens*) and Pastel Flower (*Pseuderanthemum variabile*) are common in the lower layers.

Distribution and Habitat

Habitat: Occurs on exposed and intermediate aspects on Permian metasediments, mostly on ridges and upper to mid-slopes.

Disturbance: There is evidence of intense logging and disturbance by fire.

Distribution within the park: Widely distributed in the National Park in drier and more disturbed forest areas. In some parts of the park, this community is probably an artefact of frequent logging and fire disturbance where the layer of mesic shrubs has been reduced.

Area: 857 ha.

Conservation

Threats: Ecologically inappropriate fire regimes, encroachment of the exotic weeds Broad-leaved Paspalum (*Paspalum mandiocanum*) and Lantana (*Lantana camara*).

Conservation status: The equivalent community, Forest Ecosystem 32 was noted as being reserved in Ulidarra, Willi Willi and Kumbatine NPs (NPWS 1999).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	8–35	10–55	*Eucalyptus pilularis*, *Syncarpia glomulifera, Eucalyptus microcorys*, *Eucalytpus propinqua*
Middle 1	2–15	10–40	*Allocasuarina torulosa*, *Synoum glandulosum* subsp. *glandulosum*, *Trochocarpa laurina*
Lower 1	0–2	5–55	*Imperata cylindrica* var. *major*, *Calochlaena dubia*, *Blechnum cartilagineum*, *Doodia aspera*, *Pseuderanthemum variabile*
Lower 2	0–0.4	15–35	*Ottochloa gracillima*, *Oplismenus imbecillis*, *Entolasia marginata*, *Desmodium varians*

Floristics

Trees: *Eucalyptus pilularis* (T), *Syncarpia glomulifera* (M1), *Eucalyptus microcorys* (T), *Eucalyptus propinqua* (T), *Archontophoenix cunninghamiana*, *Corymbia intermedia*, *Eucalyptus carnea*, *Eucalyptus siderophloia*, *Eucalyptus acmenoides*, *Eucalyptus eugenioides*, *Eucalyptus fusiformis*, *Eucalyptus grandis*, *Eucalyptus resinifera* subsp. *hemilampra*, *Livistona australis*, *Lophostemon confertus.*

Small trees and shrubs: *Synoum glandulosum* subsp. *glandulosum* (M1), *Allocasuarina torulosa* (M1), *Trochocarpa laurina* (M1), *Cryptocarya rigida*, *Acacia maidenii*, *Archirhodomyrtus beckleri* (M1), *Archidendron grandiflorum*, *Guioa semiglauca*, *Rhodamnia rubescens*, *Acacia irrorata*, *Acacia melanoxylon*, *Acmena smithii*, *Alphitonia excelsa*, *Cupaniopsis anacardioides*, *Pittosporum revolutum*, *Pittosporum undulatum*.

Grasses: *Imperata cylindrica* var. *major* (L1), *Ottochloa gracillima* (L2), *Oplismenus imbecillis* (L2), *Entolasia marginata* (L2), *Themeda australis*, *Panicum simile*, *Paspalum mandiocanum**, *Cymbopogon refractus*, *Microlaena stipoides* var. *stipoides.*

Ferns: *Calochlaena dubia* (L1), *Pteridium esculentum*, *Blechnum cartilagineum* (L1), *Doodia aspera* (L1), *Platycerium bifurcatum*, *Adiantum hispidulum*, *Adiantum atroviride*, *Asplenium australasicum*, *Cyathea australis*, *Pyrrosia confluens* var. *confluens*.

Sedges and rushes: *Lomandra longifolia*, *Gahnia aspera*, *Lomandra filiformis* subsp. *filiformis*, *Gahnia clarkei*, *Lepidosperma laterale*, *Lomandra confertifolia*.

Epiphytes: *Platycerium bifurcatum*, *Pyrrosia confluens* var. *confluens.*

Shrubs: *Lantana camara**, *Cordyline stricta*, *Breynia oblongifolia*, *Clerodendrum floribundum* var. *floribundum*, *Elaeocarpus reticulatus*, *Gymnostachys anceps*, *Tabernaemontana pandacaqui*, *Notelaea longifolia*, *Endiandra sieberi*, *Indigofera australis*, *Leucopogon lanceolatus*, *Linospadix monostachya*, *Persoonia stradbrokensis*, *Astrotricha latifolia*, *Cyclophyllum longipetalum*, *Dodonaea triquetra*, *Maytenus silvestris*, *Persoonia conjuncta*, *Pilidiostigma glabrum*, *Polyscias sambucifolia*, *Wikstroemia indica*, *Wilkiea huegeliana*.

Herbs: *Pratia purpurascens*, *Pseuderanthemum variabile* (L1), *Desmodium varians* (L2), *Dianella caerulea* var. *producta*, *Hydrocotyle peduncularis*, *Vernonia cinerea*, *Viola banksii*, *Alpinia caerulea*, *Lobelia trigonocaulis*, *Hybanthus stellarioides*, *Pomax umbellata*, *Geranium solanderi*, *Senna septemtrionalis**, *Ageratina adenophora**, *Dipodium variegatum*, *Pterostylis nutans*, *Solanum mauritianum**, *Tripladenia cunninghamii*.

Climbers: *Clematis aristata*, *Desmodium brachypodum*, *Dioscorea transversa*, *Smilax australis*, *Hibbertia scandens*, *Eustrephus latifolius*, *Cissus hypoglauca*, *Hibbertia dentata*, *Stephania japonica* var. *discolor*,

Morinda jasminoides, *Geitonoplesium cymosum*, *Glycine clandestina*, *Parsonsia straminea*, *Sarcopetalum harveyanum*, *Cayratia clematidea*, *Cissus antarctica*, *Hardenbergia violacea*, *Pandorea pandorana*, *Celastrus subspicata*, *Cephalaralia cephalobotrys*, *Smilax glyciphylla*, *Cissus sterculiifolia*, *Austrosteenisia blackii* var. *blackii*, *Galactia tenuiflora* var. *lucida*, *Kennedia rubicunda*, *Rubus moluccanus* var. *trilobus*.

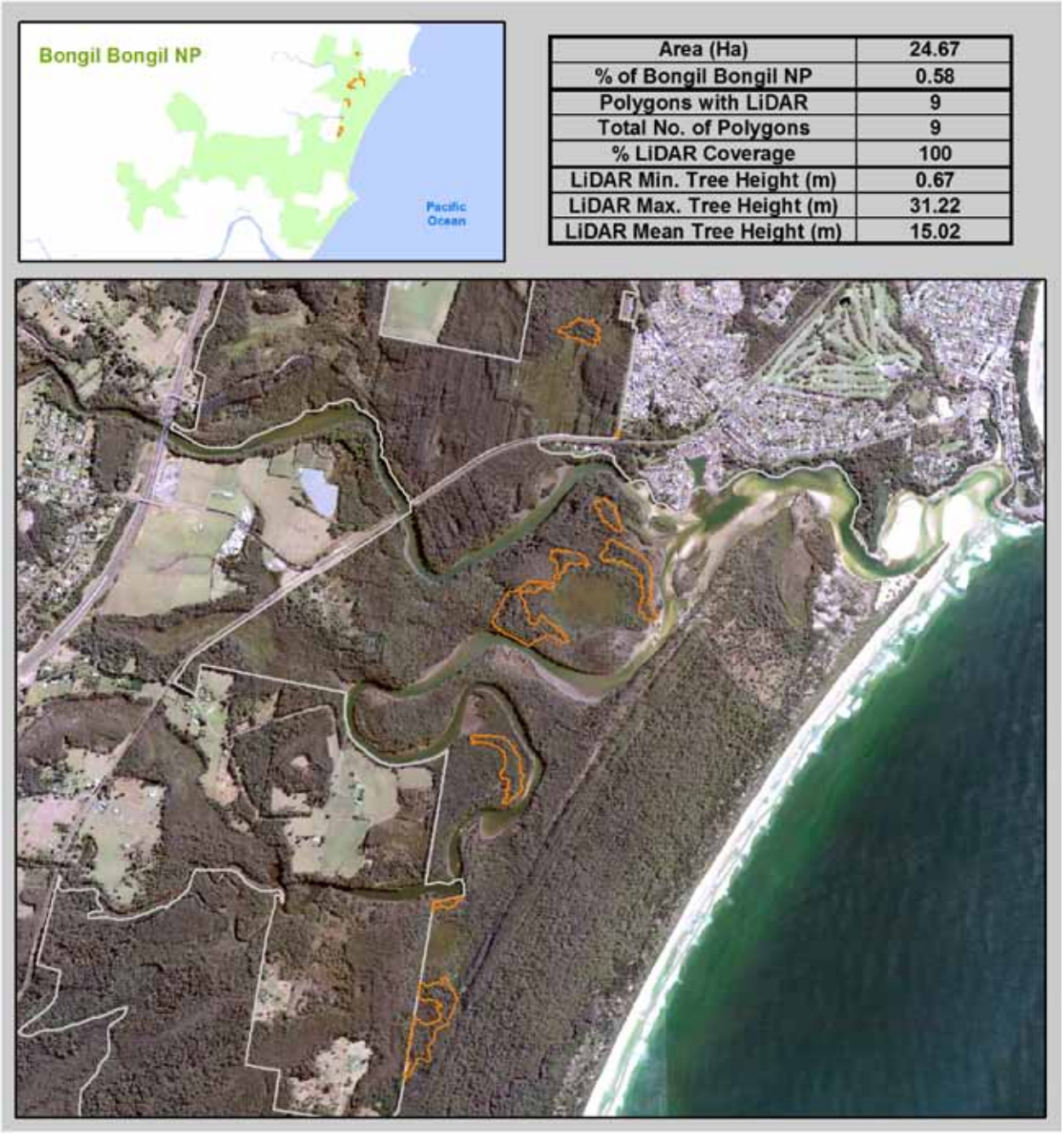
Number of native taxa: 122 **Number of taxa per plot**: 45–66 (56 ± 7)

Number of exotic species: 5

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Adiantum atroviride	1	0.1429	0	0	positive
Allocasuarina torulosa	2	1	2	0.2323	positive
Calochlaena dubia	2	1	2	0.2626	positive
Clematis aristata	2	0.8571	1	0.05051	positive
Desmodium brachypodum	2	0.8571	1	0.0404	positive
Dioscorea transversa	2	0.8571	1	0.2626	positive
Doodia aspera	2	0.5714	2	0.08081	positive
Entolasia marginata	2	1	1	0.1818	positive
Eucalyptus microcorys	2	0.7143	2	0.1818	positive
Eucalyptus pilularis	3	1	3	0.1919	positive
Eucalyptus propinqua	2	0.7143	3	0.0404	positive
Eucalyptus siderophloia	2	0.1429	0	0	positive
Eustrpehus latifolius	2	0.8571	1	0.4343	positive
Geitonoplesium cymosum	2	0.5714	1	0.1111	positive
Geranium solanderi	1	0.2857	0	0	positive
Hardenbergia violacea	2	0.2857	0	0	positive
Hibbertia scandens	2	0.8571	1	0.2626	positive
Imperata cylindrica var. *major*	3	1	2	0.2424	positive
Lomandra confertifolia	1	0.1429	0	0	positive
Maytenus silvestris	1	0.1429	0	0	positive
Oplismenus imbecillis	3	0.8571	2	0.3434	positive
Ottochloa gracillima	4	0.5714	2	0.1717	positive
Ozothamnus diosmifolius	1	0.2857	0	0	positive
Persoonia conjuncta	1	0.1429	0	0	positive
Pratia purpurascens	2	1	1	0.2222	positive
Pseuderanthemum variabile	2	0.8571	2	0.2525	positive
Pteridium esculentum	2	0.8571	1	0.2323	positive
Pterostylis nutans	1	0.1429	0	0	positive
Smilax australis	2	1	1	0.4444	positive
Syncarpia glomulifera	2	0.7143	2	0.2121	positive
Synoum glandulosum	3	1	2	0.3434	positive
Wikstroemia indica	1	0.1429	0	0	positive

Community 22 Pink Bloodwood–Turpentine Meander Plain Forest



Area (Ha)	24.67
% of Bongil Bongil NP	0.58
Polygons with LiDAR	9
Total No. of Polygons	9
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.67
LiDAR Max. Tree Height (m)	31.22
LiDAR Mean Tree Height (m)	15.02

Pink Bloodwood (*Corymbia intermedia*)–Turpentine (*Syncarpia glomulifera*) Meander Plain Forest

Sites (1): AL830FL049

Rapid Data Points (2): rdp-167, rpd-177

Equivalent communities

Wet Sclerophyll Forest–Northern Hinterland Wet Sclerophyll Forest (Keith 2004); NPWS NSW Coastal Vegetation community 3571: *Syncarpia glomulifera* subsp. *glomulifera–Corymbia intermedia* Dry sclerophyll forest & woodland (Griffith & Wilson 2007).

Description

A tall, open forest dominated by Turpentine (*Syncarpia glomulifera*) and Pink Bloodwood (*Corymbia intermedia*).

Distribution and Habitat

Habitat: Occurs on a meander plain of Pine Creek, adjacent to the active floodplain, and also on a raised sandy bank on the transition from the floodplain to more waterlogged Pleistocene sandy soils. A higher crescentic bank of sandy soils has been deposited enabling a wet sclerophyll forest to develop. A northern outlier of this community at North Bonville had a heathy understorey more typical of the adjoining Swamp Mahogany–*Melalueca seiberi* Shrubland (community 33).

Disturbance: None observed.

Distribution in the park: Pine Creek area on the Thumb Peninsula and also in the park adjoining Jeffreys Land.

Area: 25 ha.

Conservation

Threats: None observed.

Conservation status: Poorly known, but probably rare owing its occurrence on the floodplain. Areas of similar landform have been extensively cleared elsewhere. A dry sclerophyll forest of *Syncarpia glomulifera* and *Corymbia intermedia* has been recorded in Crowdy Bay NP (Griffith & Wilson 2007).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	8–18	35	*Syncarpia glomulifera*, *Corymbia intermedia*
Middle	2–8	10	*Elaeocarpus reticulatus*
Lower 1	0.2–2	55	*Imperata cylindrica* var. *major*, *Lomandra longifolia*
Lower 2	0–0.2	15	*Ottochloa gracillima*, *Desmodium brachypodum*

Floristics

Trees: *Syncarpia glomulifera* (T), *Corymbia intermedia* (T).

Small trees and shrubs: *Callistemon salignus*, *Cupaniopsis anacardioides*, *Elaeocarpus reticulatus* (M1), *Guioa semiglauca*, *Acmena smithii*, *Alphitonia excelsa*, *Synoum glandulosum* subsp. *glandulosum*.

Grasses: *Imperata cylindrica* var. *major* (L1), *Ottochloa gracillima* (L2), *Entolasia marginata*, *Paspalum*

*mandiocanum**, *Themeda australis*.

Ferns: *Hypolepis muelleri*, *Calochlaena dubia.*

Sedges and rushes: *Lomandra longifolia* (L1), *Gahnia clarkei*.

Herbs: *Hybanthus stellarioides*, *Hydrocotyle peduncularis*, *Pratia purpurascens*, *Pseuderanthemum variabile*.

Shrubs: *Cordyline stricta*, *Lantana camara**, *Leucopogon lanceolatus*, *Notelaea longifolia*.

Climbers: *Desmodium brachypodum* (L2), *Hibbertia scandens*, *Marsdenia rostrata*, *Morinda jasminoides*, *Smilax australis*, *Eustrephus latifolius*, *Glycine clandestina*, *Parsonsia straminea*, *Smilax glyciphylla*.

Number of native taxa: 35 **Number of taxa per plot**: 35 (n = 1 plot)

Number of exotic species: 2

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Baumea juncea	2	0.5	3	0.04587	positive
Callistemon salignus	3	1	3	0.1743	positive
Calochlaena dubia	2	1	2	0.2844	positive
Casuarina glauca	3	0.5	3	0.156	positive
Cordyline stricta	2	1	1	0.4771	positive
Corymbia intermedia	2	1	2	0.2569	positive
Cupaniopsis anacardioides	2	0.5	1	0.211	positive
Desmodium brachypodum	3	0.5	2	0.08257	positive
Elaeocarpus reticulatus	2	0.5	1	0.1835	positive
Eucalyptus robusta	3	0.5	2	0.1193	positive
Gahnia clarkei	4	1	2	0.3303	positive
Guioa semiglauca	2	0.5	1	0.2569	positive
Hibbertia scandens	2	1	1	0.2844	positive
Hypolepis muelleri	2	0.5	1	0.07339	positive
Imperata cylindrica	3	1	2	0.2752	positive
Lomadra longifolia	3	1	1	0.3945	positive
Marsdenia rostrata	2	1	1	0.156	positive
Morinda jasminoides	2	1	2	0.367	positive
Oplismenus imbecillis	4	0.5	2	0.367	positive
Ottocloa gracillima	2	0.5	2	0.1927	positive
Parsonsia straminea	3	1	1	0.3211	positive
Pseuderanthemum variabile	2	1	2	0.2752	positive
Pteridium esculentum	2	0.5	1	0.2661	positive
Smilax australis	2	1	1	0.4587	positive
Syncarpia glomilifera	3	0.5	2	0.2294	positive
Tabernaemontana pandacaqui	2	0.5	1	0.2661	positive
Viola banksii	2	0.5	1	0.367	positive

Community 23 Pink Bloodwood Sand Open Forest

Area (Ha)	22.84
% of Bongil Bongil NP	0.53
Polygons with LiDAR	2
Total No. of Polygons	4
% LiDAR Coverage	50
LiDAR Min. Tree Height (m)	0.33
LiDAR Max. Tree Height (m)	30.33
LiDAR Mean Tree Height (m)	11.17

Pink Bloodwood (*Corymbia intermedia*) Open Forest on Holocene Dunes

Sites (2): CB830DN083, CB830DN107

Rapid Data Points (1): rpd-4

Equivalent communities

Dry Sclerophyll Forests–North Coast Dry Sclerophyll Forests (Keith 2004); NPWS NSW Coastal Vegetation community 3528: *Eucalyptus intermedia* mid-high to very tall, woodland to closed forest (Griffith & Wilson 2007).

Description

A dry open forest dominated by Pink Bloodwood (*Corymbia intermedia*) with a mid-layer of Tuckeroo (*Cupaniopsis anacardioides*), a dense lower layer of Bracken Fern (*Pteridium esculentum*) and Grass tree (*Xanthorrhoea glauca* subsp. *glauca*), and a sparse ground layer of *Pomax umbellata* and Basket Grass (*Oplismenus aemulus*). Tangles of Wait-a-while (*Smilax australis*) are common.

Distribution and Habitat

Habitat: Holocene dunes between Headland Brushbox Littoral Rainforest (community 19) and Coast Banksia Shrubland (community 4).

Disturbance: There is evidence of disturbance to this part of the park. Lantana (*Lantana camara*), Bitou Bush (*Chyrsanthemoides monolifera* subsp. *rotundata*) and Glory Lily (*Gloriosa superba*) are present and there are dense tangles of Lawyer Vine (*Smilax australis*) and large areas of Blady Grass (*Imperata cylindrica*) and Bracken Fern (*Pteridium esculentum*).

Distribution in the park: South of Bundagen Headland to Tuckers Rocks.

Area: 23 ha.

Conservation:

Threats: Infestation of weeds, including Bitou Bush (*Chyrsanthemoides monolifera* subsp. *rotundata*), Lantana and Glory Lily.

Conservation status: Reserved in Broadwater NP, Bundjalung NP, Iluka NR, Hat Head NP, Lake Innes NR and Limeburners Creek NR. This community is probably adequately protected in reserves.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	6–15	30–40	*Corymbia intermedia*
Middle	1–6	10–20	*Cupaniopsis anacardioides*, *Banksia integrifolia* subsp. *integrifolia*
Lower 1	1–3	45–60	*Oplismenus aemulus*, *Xanthorrhoea glauca* subsp. *glauca*, *Ottochloa gracillima*
Lower 2	0.2–1	10–15	*Viola banksii*, *Pteridium esculentum*, *Pomax umbellata*

Floristics


Viola banksii

Trees: *Corymbia intermedia* (T), *Cupaniopsis anacardioides* (M1), *Banksia integrifolia* subsp. *integrifolia*, *Eucalyptus grandis*, *Lophostemon confertus*.

Small trees and shrubs: *Guioa semiglauca*, *Synoum glandulosum* subsp. *glandulosum*, *Acacia maidenii*, *Acronychia imperforata*, *Archontophoenix cunninghamiana*, *Diospyros pentamera*, *Glochidion ferdinandi*, *Mischocarpus pyriformis* subsp. *pyriformis*, *Pisonia umbellifera*, *Syzygium luehmannii*, *Trochocarpa laurina*.

Grasses: *Ottochloa gracillima*, *Oplismenus aemulus* (L1), *Imperata cylindrica* var. *major*, *Cymbopogon refractus*, *Entolasia marginata*, *Eragrostis leptostachya*, *Paspalidium gracile*.

Ferns: *Pteridium esculentum* (L2), *Davallia solida* var. *pyxidata*.

Sedges and rushes: *Lomandra longifolia*.

Epiphytes: *Cymbidium madidum*, *Davallia solida* var. *pyxidata*, *Platycerium superbum*, *Pyrrosia confluens* var. *confluens*.

Herbs: *Viola banksii*, *Pomax umbellata*, *Pratia purpurascens*, *Acianthus fornicatus*, *Commelina cyanea*, *Dianella caerulea* var. *producta*, *Hybanthus stellarioides*, *Pomax umbellata* (L2).

Shrubs: *Xanthorrhoea glauca* subsp. *glauca* (L1), *Breynia oblongifolia*, *Lantana camara**, *Leucopogon margarodes*, *Myrsine variabilis*, *Acacia elongata*, *Acacia ulicifolia*, *Alpinia caerulea*, *Cordyline stricta*, *Cyclophyllum longipetalum*, *Gloriosa superba**, *Leucopogon lanceolatus*, *Maclura cochinchinensis*, *Notelaea longifolia*, *Persoonia stradbrokensis*, *Pittosporum revolutum*, *Polyscias sambucifolia*, *Senna septemtrionalis**.

Climbers: *Smilax australis*, *Eustrephus latifolius*, *Hibbertia scandens*, *Cissus sterculiifolia*, *Marsdenia rostrata*, *Parsonsia straminea*, *Stephania japonica* var. *discolor*, *Billardiera scandens*, *Cayratia clematidea*, *Glycine clandestina*, *Ripogonum brevifolium*, *Smilax glyciphylla*.

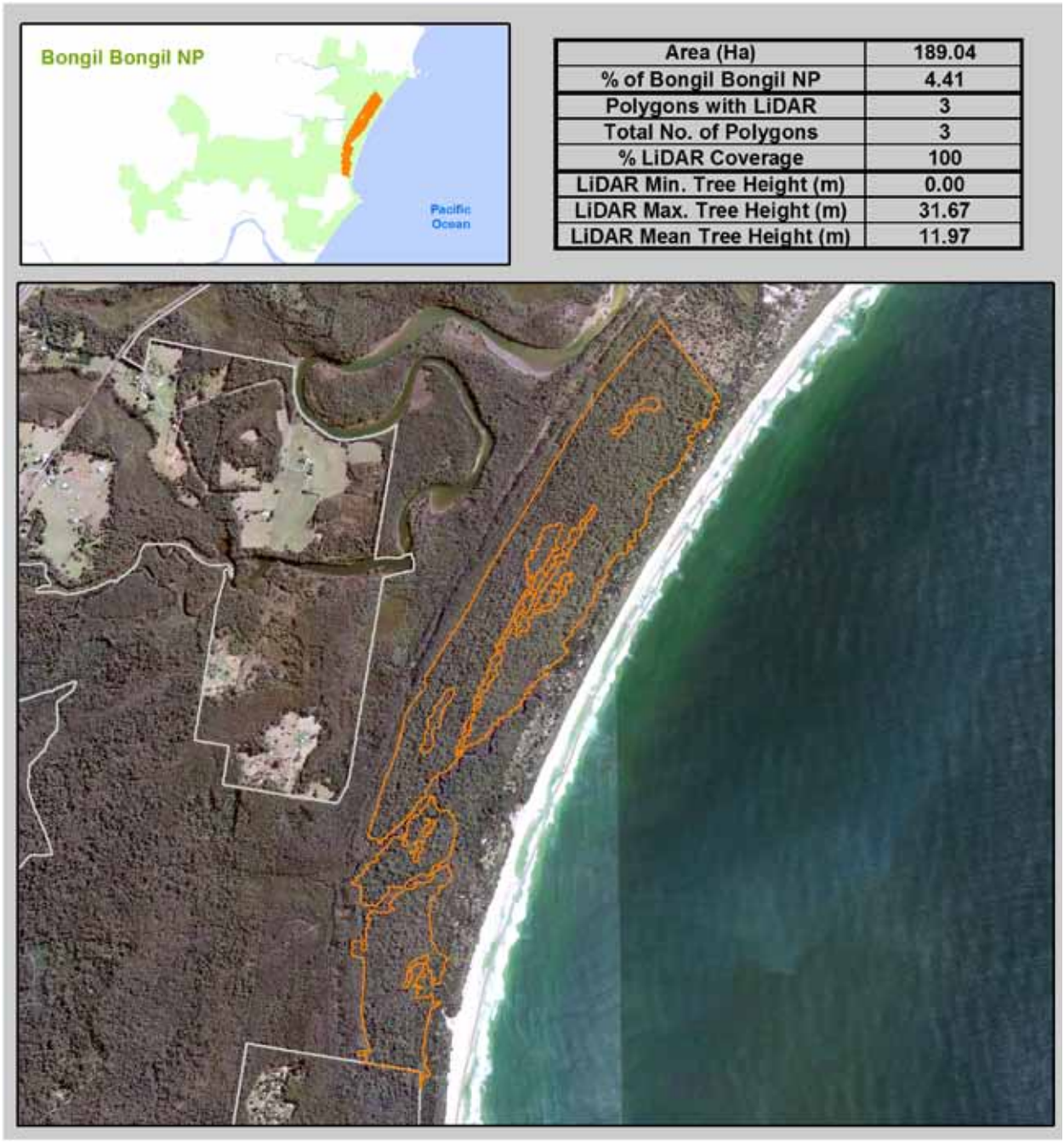
Number of native taxa: 68 **Number of taxa per plot**: 37–53 (45 ± 11.3)

Number of exotic species: 3

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia elongata	1	0.3333	0	0	positive
Banksia integrifolia subsp. *integrifolia*	2	0.6667	2	0.06604	positive
Breynia oblongifolia	2	0.6667	1	0.2264	positive
Corymbia intermedia	4	1	2	0.2547	positive
Cupaniopsis anacardioides	2	1	1	0.1981	positive
Guioa semiglauca	2	1	1	0.2453	positive
Hibbertia scandens	2	1	1	0.283	positive
Lomandra longifolia	3	1	1	0.3774	positive
Ottochloa gracillima	3	0.6667	2	0.1887	positive
Pisonia umbellifera	1	0.3333	0	0	positive
Pomax umbellata	2	0.6667	1	0.07547	positive
Pteridium esculentum	3	0.6667	1	0.2642	positive
Smilax australis	4	1	1	0.4623	positive
Viola banksii	2	0.6667	1	0.3679	positive
Xanthorrhoea glauca subsp. *glauca*	1	0.3333	0	0	positive

Community 24 Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest



Area (Ha)	189.04
% of Bongil Bongil NP	4.41
Polygons with LiDAR	3
Total No. of Polygons	3
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	31.67
LiDAR Mean Tree Height (m)	11.97

Pink Bloodwood (*Corymbia intermedia*), Flooded Gum (*Eucalyptus grandis*), Blackbutt (*Eucalyptus pilularis*) and Tallowwood (*Eucalyptus microcorys*) Open Forest on Holocene Dunes and Swales

Sites (3): CB830DN032, CB830DN033, CBDN830SP037

Rapid Data Points: –

Equivalent communities

Dry Sclerophyll Forests–North Coast Dry Sclerophyll Forest (Keith 2004); Ecosystem 72: Low Relief Coastal Blackbutt (NPWS 1999); NPWS NSW Coastal Vegetation community 3529: *Eucalyptus pilularis – E. intermedia* mid-high to very tall, woodland to closed forest (Griffith & Wilson 2007).

Description

An open forest community dominated by Pink Bloodwood (*Corymbia intermedia*), Flooded Gum (*Eucalyptus grandis*), Broad-leaved Paperbark (*Melaleuca quinquenervia*), Blackbutt (*Eucalyptus pilularis*) and Tallowwood (*Eucalyptus microcorys*). There is a sparse and open middle stratum of shrubs, including Willow Bottlebrush (*Callistemon salignus*), Broad-leaved Paperbark, and Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*). An open to dense layer of Blady Grass (*Imperata cylindrica* var. *major*), Bracken Fern (*Pteridium esculentum*) and Hopbush (*Dodonaea triquetra*) with dense tangles of Lawyer Vine (*Smilax australis*) is also present.

Distribution and Habitat

Habitat: This community is found north of Bundagen Headland on Holocene dunes and swales. In the swales, Broad-leaved Paperbark and Willow Bottlebrush are more common, whereas on the dune ridges Blackbutt and Pink Bloodwood predominate.

Disturbance: There appears to have been severe disturbance by fire in this community. There are dense tangles of Lawyer Vine and infestations of Lantana (*Lantana camara*) and Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) with Blady Grass (*Imperata cylindrica* var. *major*).

Distribution within the park: Eastern Peninsula Trail from Scrub Creek north to Pine Creek.

Area: 189 ha.

Conservation:

Threats: Encroachment by invasive weeds, and too-frequent fire.

Conservation status: Well reserved, with examples in Broadwater NP, Bundjalung NP, Hat Head NP, Lake Innes NR and Limeburners NR.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	10–28	25–35	*Corymbia intermedia*, *Eucalyptus grandis*, *Melaleuca quinquenervia*, *Eucalyptus pilularis*, *Eucalyptus microcorys*
Middle	2–8	10	*Callistemon salignus*, *Melaleuca quinquenervia*, *Banksia integrifolia* subsp. *integrifolia*
Lower 1	1–4	5–25	*Dodonaea triquetra*, *Lantana camara*, *Smilax australis*
Lower 2	0.5–1	45–55	*Pteridium esculentum*, *Lomandra longifolia*

Floristics

Trees: *Corymbia intermedia* (T), *Eucalyptus grandis* (T), *Melaleuca quinquenervia* (T), *Callistemon salignus* (M1), *Acmena smithii*, *Cupaniopsis anacardioides*, *Eucalyptus pilularis* (T), *Eucalyptus microcorys* (T).

Small trees and shrubs: *Guioa semiglauca*, *Alphitonia excelsa*, *Banksia integrifolia* subsp. *integrifolia* (M1), *Myrsine variabilis*, *Trochocarpa laurina*, *Acacia melanoxylon* (L1), *Cyclophyllum longipetalum*, *Elaeodendron australe*, *Jagera pseudorhus* var. *pseudorhus*, *Mischocarpus pyriformis* subsp. *pyriformis*, *Rhodamnia rubescens* (M1), *Syzygium luehmannii*.

Grasses: *Imperata cylindrica* var. *major*, *Oplismenus imbecillis*, *Entolasia marginata*, *Themeda australis*.

Ferns: *Pteridium esculentum* (L2), *Platycerium bifurcatum*, *Platycerium superbum*.

Sedges and rushes: *Lomandra longifolia* (L2), *Ficinia nodosa*.

Epiphytes: *Cymbidium madidum*, *Platycerium bifurcatum*, *Platycerium superbum*.

Herbs and shrubs: *Dodonaea triquetra* (L1), *Lantana camara** (L1), *Chrysanthemoides monilifera* subsp. *rotundata**, *Breynia oblongifolia*, *Cordyline stricta*, *Commelina cyanea*, *Dianella caerulea* var. *producta*, *Notelaea longifolia*, *Pomax umbellata*, *Tripladenia cunninghamii*, *Viola banksii*, *Dipodium variegatum*, *Leucopogon lanceolatus*, *Leucopogon margarodes*, *Maclura cochinchinensis*, *Pratia purpurascens*, *Psychotria loniceroides*, *Wilkiea huegeliana* (M1).

Climbers: *Smilax australis* (L1), *Eustrephus latifolius*, *Hibbertia scandens*, *Kennedia rubicunda*, *Cayratia clematidea*, *Glycine clandestina*, *Hydrocotyle peduncularis*, *Ripogonum album*, *Sarcopetalum harveyanum*, *Stephania japonica* var. *discolor*, *Billardiera scandens*.

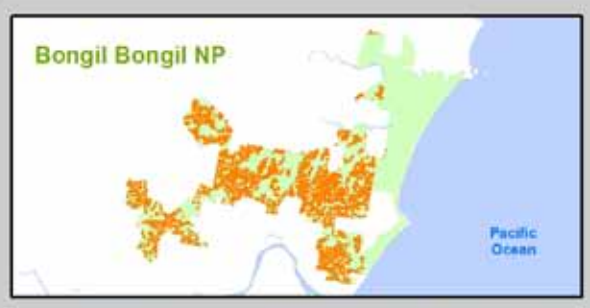
Number of native taxa: 61 **Number of taxa per plot**: 35–41 (36 ± 5)

Number of exotic species: 2

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Callistemon salignus	2	0.6667	3	0.1845	positive
Corymbia intermedia	2	1	2	0.2524	positive
Dodonaea triquetra	3	1	1	0.03883	positive
Entolasia marginata	3	0.6667	1	0.2233	positive
Eucalyptus grandis	3	0.6667	2	0.2524	positive
Eucalyptus microcorys	2	0.6667	2	0.2039	positive
Eustrephus latifolius	2	1	1	0.4466	positive
Guioa semigluaca	2	0.6667	1	0.2524	positive
Hibbertia scandens	2	0.6667	1	0.2913	positive
Imperata cylindrica	4	1	2	0.2718	positive
Melaleuca quinquenervia	3	0.6667	3	0.1845	positive
Pteridium esculentum	2	1	1	0.2524	positive
Smilax australis	3	1	1	0.466	positive

Community 25 Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest



Area (Ha)	971.07
% of Bongil Bongil NP	22.55
Polygons with LiDAR	198
Total No. of Polygons	338
% LiDAR Coverage	59
LiDAR Min. Tree Height (m)	1.60
LiDAR Max. Tree Height (m)	42.63
LiDAR Mean Tree Height (m)	21.28

Blackbutt (*Eucalyptus pilularis*), Flooded Gum (*Eucalyptus grandis*), Turpentine (*Syncarpia glomulifera*), Sydney Blue Gum (*Eucalyptus saligna*), Tallowwood (*Eucalyptus microcorys*) Wet Sclerophyll Forest

Sites (14): AL830FN044, AL830VF073, PM830EX050, PM830EX059, PM830G043, PM830IN052, PM830IN074, PM830IN087, PM830SH051, PM830SH055, PM830SH058, PM830SH060, PM830SH072, PM830IN103

Rapid Data Points (42): rdp-1, rdp-7, rdp-10, rdp-11, rdp-12, rdp-18, rdp-20, rdp-21, rdp-22, rdp-24, rdp-25, rdp-29, rdp-30, rdp-34, rdp-43, rdp-44, rdp-46, rdp-47, rdp-50, rdp-51, rdp-54, rdp-56, rdp-57, rdp-59, rdp-60, rdp-64, rdp-74, rdp-75, rdp-79, rdp-87, rdp-99, rdp-105, rdp-116, rdp-117, rdp-118, rdp-121, rdp-124, rdp-125, rdp-127, rdp-131, rdp-182, rdp-183

Equivalent communities

Forest–North Coast Wet Sclerophyll Forest (Keith 2004); Forest Ecosystem 154: Wet Flooded Gum–Tallowwood (NPWS 1999).

Description

A tall, open, wet sclerophyll forest dominated by Blackbutt (*Eucalyptus pilularis*), Flooded Gum (*Eucalyptus grandis*), Turpentine (*Syncarpia glomulifera*), Tallowwood (*Eucalyptus microcorys*) and, occasionally, Small-fruited Grey Gum (*Eucalyptus propinqua*), White Mahogany (*Eucalyptus acmenoides*), Nambucca Ironbark (*Eucalyptus fusiformis*) and Pink Bloodwood (*Corymbia intermedia*). Sydney Blue Gum (*Eucalyptus saligna*) replaces Flooded Gum in the higher western section of the park. A sparse to open mid-canopy of trees is present, including Brushbox (*Lophostemon confertus*), Forest Oak (*Allocasuarina torulosa*), Bangalow Palm (*Archotonphoenix cunninghamiana*), Forest Maple (*Cryptocarya rigida*), Scentless Rosewood (*Synoum glandulosum* subsp. *glandulosum*) and Black Wattle (*Callicoma serratifolia*). There is also a second, open to dense layer of shrubs and rainforest trees, including Forest Maple (*Cryptocarya rigida*), Tree Heath (*Trochocarpa laurina*), Scentless Rosewood, Black Wattle, Banana Bush (*Tabernaemontana pandacaqui*) and Lantana (*Lantana camara*). A first lower layer consists of Narrow-leaved Palm Lily (*Cordyline stricta*), Fishbone Fern (*Blechnum cartilagineum*), False Bracken Fern (*Calochlaena dubia*), Native Ginger (*Alpinia caerulea*), Flax Lily (*Dianella caerulea* var. *producta*) and Settler's Flax (*Gymnostachys anceps*). The ground cover consists of grasses *Oplismenus imbecillis*, *Ottochloa gracillima*) and Pastel Flower (*Pseuderanthemum variabile*). Climbers are common, including Sweet Morinda (*Morinda jasminoides*), Native Yam (*Dioscorea transversa)*, Water Vine (*Cissus hypoglauca*) and Small Supplejack (*Ripogonum fawcettianum*).

Distribution and Habitat

Habitat: Sheltered and intermediate aspects, and rarely on exposed aspects, from upper, through mid- to lower slopes and occasionally in gullies; mainly on Permian metasediments and less commonly on alluvial fans and valley floors.

Disturbance: Past disturbance from logging, plantation establishment and infestation by Lantana is common in this community.

Distribution with the park: Widespread throughout the forested areas of Bongil Bongil NP. Flooded Gum dominates the lower eastern section of the park; Sydney Blue Gum replaces this species west of

the Pacific Highway, and is particularly common in the Tower Road–Seaview Road section of the park.

Area: 968 ha.

Conservation

Threats: Weed encroachment.

Conservation status: Forest Ecosystem 154: Wet Flooded Gum–Tallowwood (NPWS 1999), of which this community is an example, was assessed as highly inadequately reserved and was a priority for private land acquisition to meet Regional Forest Agreement reservation targets.

Significant taxa: *Niemeyera whitei* (TSC: Vulnerable); *Eucalytpus fusiformis* (ROTAP: 2RC–).

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	12–35	20–40	*Eucalyptus pilularis, Eucalyptus grandis, Syncarpia glomulifera, Eucalyptus microcorys, Lophostemon confertus, Eucalyptus fusiformis*
Middle 1	5–18	5–30	*Lophostemon confertus, Allocasuarina torulosa, Archotonphoenix cunninghamiana, Cryptocarya rigida, Synoum glandulosum* subsp. *glandulosum, Callicoma serratifolia*
Middle 2	1–8	22–55	*Cryptocarya rigida, Trochocarpa laurina, Callicoma serratifolia, Cryptocarya microneura, Ceratopetalum apetalum, Croton verreauxii*
Lower 1	0.2–2	10–35	*Oplismenus imbecillis, Calochlaena dubia, Cordyline stricta, Alpinia caerulea, Morinda jasminoides, Ripogonum fawcettianum, Blechnum cartilagineum, Calochlaena dubia*
Lower 2	0–0.4	5–35	*Oplismenus imbecillis, Ottochloa gracillima, Blechnum cartilagineum, Pseuderanthemum variabile, Gymnostachys anceps*

Floristics

Trees: *Eucalyptus pilularis* (T), *Eucalyptus grandis* (T), *Syncarpia glomulifera* (T, M1), *Eucalyptus microcorys* (T), *Lophostemon confertus* (M1), *Eucalyptus fusiformis* (T), *Eucalyptus acmenoides*, *Eucalyptus propinqua*, *Corymbia intermedia* (T), *Eucalyptus carnea* (T), *Livistona australis*, *Eucalyptus eugenioides*.


Pseuderantherum variabile

Sub-canopy trees and shrubs: *Synoum glandulosum* subsp. *glandulosum* (M2), *Allocasuarina torulosa* (M1), *Cryptocarya rigida* (M1, M2), *Archontophoenix cunninghamiana* (M1), *Trochocarpa laurina* (M2), *Callicoma serratifolia* (M1, M2), *Acacia maidenii*, *Cryptocarya microneura* (M2), *Eucalyptus propinqua*, *Rhodamnia rubescens*, *Guioa semiglauca*, *Archirhodomyrtus beckleri*, *Archidendron grandiflorum*, *Atractocarpus benthamianus*, *Jagera pseudorhus* var. *pseudorhus*, *Acmena smithii*, *Callistemon salignus*, *Ceratopetalum apetalum* (M2), *Claoxylon australe*, *Niemeyera whitei*, *Schizomeria ovata*, *Croton verreauxii* (M2), *Dysoxylum rufum*, *Endiandra sieberi*, *Acronychia oblongifolia*, *Alphitonia excelsa*, *Cupaniopsis anacardioides*, *Cyclophyllum longipetalum*, *Elaeodendron australe*, *Endiandra discolor*, *Neolitsea dealbata*, *Sloanea australis*, *Syzygium luehmannii*, *Caldcluvia paniculosa*.

Grasses: *Oplismenus imbecillis* (L1, L2), *Ottochloa gracillima* (L2), *Imperata cylindrica* var. *major*, *Entolasia marginata*, *Entolasia stricta*.

Ferns: *Blechnum cartilagineum* (L1, L2), *Calochlaena dubia* (L1), *Doodia aspera*, *Hypolepis muelleri*, *Platycerium bifurcatum*, *Adiantum silvaticum*, *Cyathea australis*, *Todea barbara*, *Adiantum hispidulum*, *Davallia solida* var. *pyxidata*, *Adiantum aethiopicum*, *Asplenium australasicum*, *Cyathea leichhardtiana*, *Platycerium superbum*, *Pteridium esculentum*.

Sedges and rushes: *Gahnia clarkei*, *Lomandra spicata*, *Lomandra longifolia*, *Cyperus filipes*, *Lomandra filiformis* subsp. *filiformis*, *Lepidosperma laterale*, *Gahnia aspera*.

Epiphytes: *Platycerium bifurcatum*, *Davallia solida* var. *pyxidata*, *Asplenium australasicum*, *Cymbidium madidum*, *Platycerium superbum*.

Shrubs: *Lantana camara**, *Tabernaemontana pandacaqui* (M2), *Eupomatia laurina*, *Wilkiea huegeliana*, *Pilidiostigma glabrum*, *Myrsine variabilis*, *Clerodendrum floribundum* var. *floribundum*, *Rhodamnia rubescens*, *Linospadix monostachya*, *Elaeocarpus reticulatus*, *Breynia oblongifolia*, *Ficus coronata*, *Notelaea longifolia*, *Pittosporum multiflorum*, *Pittosporum undulatum*, *Sarcopteryx stipata*, *Tasmannia insipida*, *Indigofera australis*, *Astrotricha latifolia*, *Hibiscus diversifolius*, *Hovea acutifolia*, *Maclura cochinchinensis*, *Melicope hayesii*, *Myrsine howittiana*, *Pittosporum revolutum*, *Seringia arborescens*, *Syzygium oleosum*, *Zieria smithii*.

Herbs: *Cordyline stricta* (L1), *Pseuderanthemum variabile* (L1, L2), *Alpinia caerulea* (L1), *Dianella caerulea* var. *producta*, *Viola banksii*, *Gymnostachys anceps* (L1), *Lobelia trigonocaulis*, *Pratia purpurascens*, *Tripladenia cunninghamii*, *Desmodium varians*, *Hydrocotyle peduncularis*, *Calanthe triplicata*, *Vernonia cinerea*, *Chiloglottis sylvestris*, *Dichondra repens*, *Hybanthus stellarioides*, *Oxalis exilis*, *Rubus rosifolius*, *Sigesbeckia orientalis* subsp. *orientalis*, *Solanum densevestitum*.

Climbers: *Morinda jasminoides* (L1, L2), *Dioscorea transversa*, *Ripogonum fawcettianum* (L1), *Smilax australis*, *Eustrephus latifolius*, *Cissus hypoglauca*, *Calamus muelleri*, *Cissus antarctica*, *Parsonsia straminea*, *Stephania japonica* var. *discolor*, *Galactia tenuiflora* var. *lucida*, *Cephalaralia cephalobotrys*, *Hibbertia dentata*, *Pandorea pandorana*, *Smilax glyciphylla*, *Clematis aristata*, *Ripogonum album*, *Cayratia clematidea*, *Celastrus subspicata*, *Embelia australiana*, *Cissus sterculiifolia*, *Hibbertia scandens*, *Ripogonum discolor*, *Rubus nebulosus*, *Embelia australiana*, *Geitonoplesium cymosum*, *Glycine clandestina*, *Ripogonum elseyanum*, *Rubus moluccanus* var. *trilobus*, *Clematis glycinoides*, *Marsdenia longiloba*, *Petermannia cirrosa*, *Rubus parvifolius*, *Sarcopetalum harveyanum*, *Trimenia moorei*, *Trophis scandens* subsp. *scandens*.

Number of native taxa: 155 **Number of taxa per plot**: 33–68 (49.6 ± 8.7)

Number of exotic species: 1

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Adiantum atroviride	1	0.0625	0	0	positive
Allocasuarina torulosa	2	0.9375	2	0.1667	positive
Archontophoenix cunninghamiana	2	0.8125	1	0.2333	positive
Blechnum cartilagineum	2	0.9375	1	0.1556	positive
Calamus muelleri	2	0.5625	3	0.1222	positive
Chiloglottis sylvestris	1	0.0625	0	0	positive
Clematis glycinoides	1	0.0625	0	0	positive
Cordyline stricta	2	1	1	0.3889	positive
Cryptocarya rigida	3	0.875	1	0.1	positive
Cyathea leichhardtiana	1	0.0625	0	0	positive
Cyperus filipes	4	0.0625	0	0	positive
Dichondra repens	1	0.0625	0	0	positive
Dioscorea transversa	2	0.9375	1	0.1889	positive
Dysoxylum rufum	1	0.125	0	0	positive
Entolasia stricta	1	0.125	0	0	positive
Eucalyptus grandis	2	0.8125	2	0.1667	positive
Eucalyptus micocorys	2	0.6875	2	0.1333	positive
Eucalyptus pilularis	3	0.75	3	0.1556	positive
Marsdenia longiloba	1	0.0625	0	0	positive
Morinda jasminoides	2	0.9375	1	0.2778	positive
Niemeyera whitei	2	0.125	0	0	positive
Oplismenus imbecillis	3	0.625	1	0.3333	positive
Ottochloa gracillima	2	0.5	2	0.1444	positive
Pseuderanthemum variabile	2	0.9375	2	0.1778	positive
Ripogonum fawcettianum	2	0.625	2	0.06667	positive
Rubus rosifolius	1	0.0625	0	0	positive
Sigesbeckia orientalis	1	0.0625	0	0	positive
Solanum densevestitum	1	0.0625	0	0	positive
Syncarpia glomulifera	2	0.6875	2	0.1667	positive
Synoum glandulosum	3	1	1	0.2778	positive
Zieria smithii	1	0.0625	0	0	positive

Community 26 Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest

Area (Ha)	396.58
% of Bongil Bongil NP	9.30
Polygons with LiDAR	90
Total No. of Polygons	149
% LiDAR Coverage	60
LiDAR Min. Tree Height (m)	1.55
LiDAR Max. Tree Height (m)	43.32
LiDAR Mean Tree Height (m)	21.51

Flooded Gum (*Eucalyptus grandis*), Bangalow Palm (*Archontophoenix cunninghamiana*) Riparian Wet Sclerophyll Forest

Sites (4): AL830FN053, AL830FN079, AL830FN080, PM830GL086

Rapid Data Points (11): rdp-26, rdp-28, rdp-33, rdp-35, rdp-62, rdp-88, rdp-89, rdp-93, rdp-115, rdp-126, rdp-129

Equivalent communities

Wet Sclerophyll Forest–Northern Hinterland Wet Sclerophyll Forest (Keith 2004); NPWS NSW Coastal Vegetation community 3004: *Eucalyptus grandis* very tall open forest (Griffith & Wilson 2007); Ecosystem 154: Wet Flooded Gum–Tallowwood (NPWS 1999).

Description

A tall, open to closed forest dominated by Flooded Gum (*Eucalyptus grandis*), Pink Bloodwood (*Corymbia intermedia*) and Bangalow Palm (*Archontophoenix cunninghamiana*). An open to dense mid-layer of rainforest trees is present, including Rose Walnut (*Endiandra discolor*), Native Gardenia (*Atractocarpus benthamianus*), Crabapple (*Schizomeria ovata*) and Green Native Cascarilla (*Croton verreauxii*). Forest Oak (*Allocasuarina torulosa*) is often present in the middle layer. There is a sparse to open secondary mid-layer of Narrow-leaved Palm Lily (*Cordyline stricta*) and Walking Stick Palm (*Linospadix monostachya*). The sparse to open lower layer consists of Pastel Flower (*Pseuderanthemum variabile*), Gristle Fern (*Blechnum cartilagineum*) and Basket Grass (*Oplismenus imbecillis*). Lawyer Vine (*Calamus muelleri*), Small Supplejack (*Ripogonum fawcettianum*) and White Supplejack (*Ripogonum album*) are common in the lower and mid-layers.

Distribution and Habitat

Habitat: Grows along broad flat creek valleys on alluvial fans and floodplains.

Disturbance: There is evidence of logging and clearing, attempted plantation establishment, and infestation by weeds, in particular Lantana (*Lantana camara*).

Distribution within the park: Pettits Trail, Whipstick Trail, Winters Trail, Balls Ridge Road.

Area: 398 ha.

Conservation

Threats: Weed invasion.

Conservation status: Small areas are reserved in Bindarri NP and Bollanolla NR (NPWS 1999).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	6–32	15–70	*Eucalyptus grandis*, *Corymbia intermedia*, *Archontophoenix cunninghamiana*
Middle 1	2–14	35–55	*Endiandra discolor*, *Atractocarpus benthamianus*, *Schizomeria ovata*, *Croton verreauxii*, *Allocasuarina torulosa*
Middle 2	0.2–5	10–40	*Cordyline stricta*, *Linospadix monostachya*
Lower 1	0–1	10–35	*Pseuderanthemum variabile*, *Blechnum cartilagineum*, *Oplismenus imbecillis*, *Calamus muelleri*, *Ripogonum fawcettianum*, *Ripogonum album*

Floristics

Trees and shrubs: *Archontophoenix cunninghamiana* (T, M1, L2), *Eucalyptus grandis* (T), *Endiandra discolor*, *Atractocarpus benthamianus*, *Croton verreauxii*, *Allocasuarina torulosa*, *Schizomeria ovata* (M1), *Callicoma serratifolia* (T), *Corymbia intermedia* (T), *Sloanea australis* (T), *Cryptocarya rigida* (M2), *Synoum glandulosum* subsp. *glandulosum* (M2), *Acmena smithii*, *Archidendron grandiflorum*, *Ceratopetalum apetalum* (M1), *Cryptocarya microneura*, *Syncarpia glomulifera* (T), *Syzygium luehmannii*, *Cinnamomum oliveri*, *Guioa semiglauca*, *Lophostemon confertus* (T), *Melicope hayesii*, *Cyclophyllum longipetalum*, *Diospyros pentamera*, *Eucalyptus acmenoides*, *Eucalyptus microcorys* (T), *Ficus coronata*, *Jagera pseudorhus* var. *pseudorhus*, *Litsea australis*, *Livistona australis*, *Mischocarpus pyriformis* subsp. *pyriformis*, *Symplocos thwaitesii*.

Grasses: *Oplismenus imbecillis* (L1), *Ottochloa gracillima*, *Entolasia marginata*, *Paspalum mandiocanum**.

Ferns: *Blechnum cartilagineum* (L1), *Adiantum silvaticum* (L2), *Calochlaena dubia*, *Platycerium bifurcatum*, *Adiantum hispidulum*, *Asplenium australasicum*, *Blechnum minus*, *Cyathea australis*, *Histiopteris incisa*, *Hypolepis muelleri*, *Todea barbara*.

Sedges and rushes: *Lomandra spicata*, *Gahnia clarkei*.

Epiphytes: *Platycerium bifurcatum*, *Cymbidium madidum*, *Plectorrhiza tridentata*, *Pyrrosia confluens* var. *confluens*.

Herbs and shrubs: *Cordyline stricta* (M2, L1), *Pilidiostigma glabrum*, *Pseuderanthemum variabile* (L2), *Linospadix monostachya* (M2, L1), *Wilkiea huegeliana*, *Tabernaemontana pandacaqui*, *Alpinia caerulea*, *Eustrephus latifolius*, *Trochocarpa laurina*, *Cephalaralia cephalobotrys*, *Pratia purpurascens*, *Commelina cyanea*, *Lantana camara** (M2), *Pittosporum undulatum*, *Tasmannia insipida* (M2, L1), *Dianella caerulea* var. *producta*, *Breynia oblongifolia*, *Calanthe triplicata*, *Clerodendrum floribundum* var. *floribundum*, *Eupomatia laurina*, *Gymnostachys anceps*, *Hydrocotyle peduncularis*, *Ligustrum sinense**, *Lobelia trigonocaulis*, *Veronica plebeia*.

Climbers: *Morinda jasminoides*, *Ripogonum fawcettianum*, *Calamus muelleri* (M2), *Ripogonum album* (L1), *Ripogonum elseyanum*, *Cissus hypoglauca*, *Dioscorea transversa*, *Petermannia cirrosa* (L2), *Smilax australis*, *Smilax glyciphylla*, *Cissus sterculiifolia*, *Embelia australiana*, *Rubus nebulosus*, *Sarcopetalum harveyanum*, *Stephania japonica*, *Trophis scandens* subsp. *scandens*, *Cissus antarctica*, *Flagellaria indica*, *Galactia tenuiflora* var. *lucida*, *Marsdenia rostrata*, *Mucuna gigantea* subsp. *gigantea*, *Trimenia moorei*, *Tylophora paniculata*.

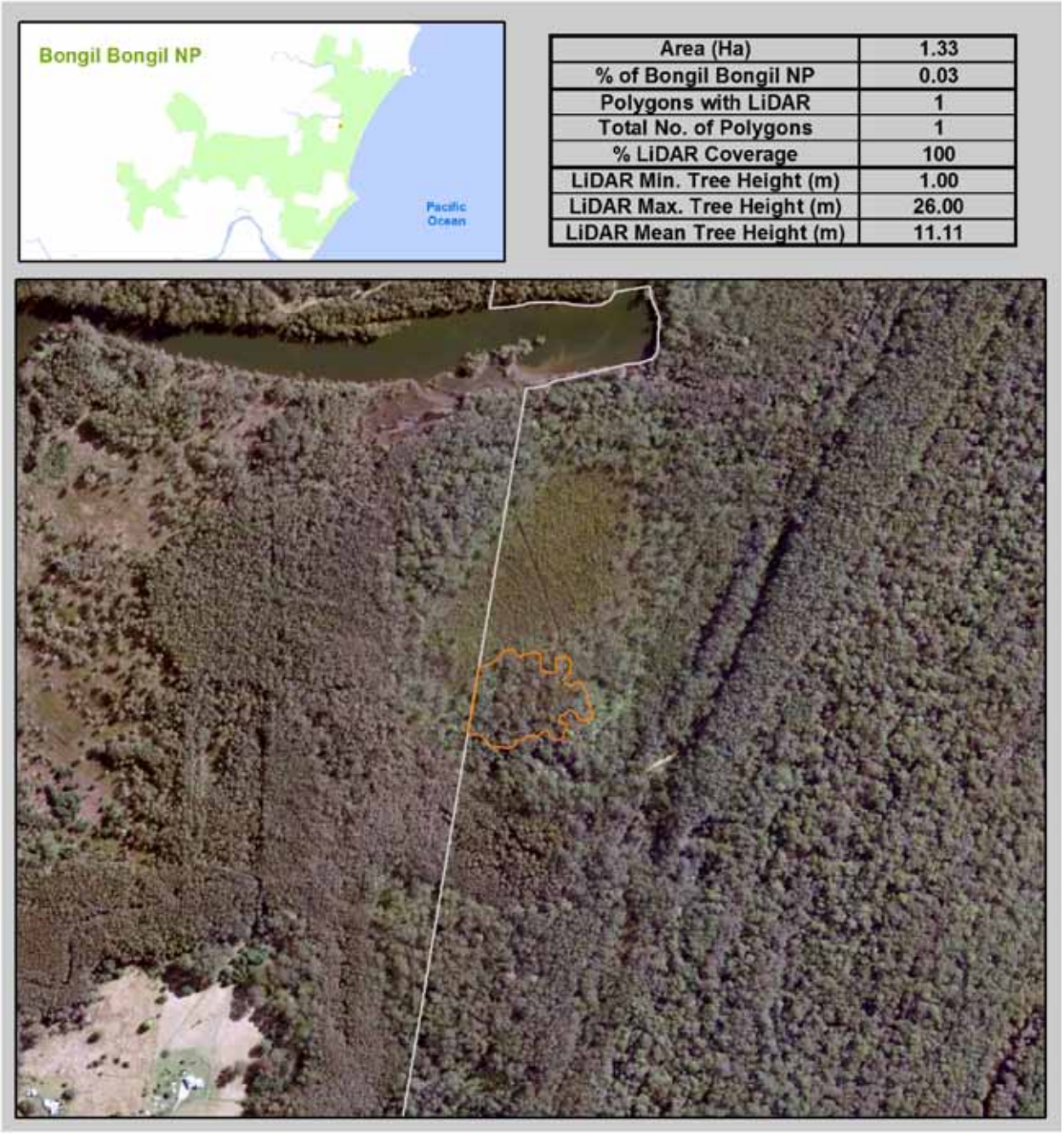
Number of native taxa: 104 **Number of taxa per plot**:46–68 (51.5 ± 10.5)

Number of exotic species: 3

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Allocasuarina torulosa	2	0.8	2	0.2574	positive
Archontophoenix cunninghamiana	3	1	1	0.2871	positive
Archidendron grandiflorum	2	0.6	1	0.05941	positive
Atractocarpus benthamianus	3	0.8	1	0.0495	positive
Blechnum minus	1	0.2	0	0	positive
Calamus muelleri	4	0.8	2	0.1584	positive
Clerodendrum tomentosum	1	0.2	0	0	positive
Cordyline stricta	2	1	1	0.4554	positive
Corymbia intermedia	2	1	2	0.2376	positive
Croton verreauxii	3	0.8	1	0.0396	positive
Cryptocarya rigida	2	0.8	2	0.1881	positive
Endiandra discolor	2	1	2	0.0396	positive
Eucalyptus grandis	3	0.8	2	0.2376	positive
Linospadix monostachya	2	0.8	1	0.1089	positive
Morinda jasminoides	2	1	2	0.3465	positive
Pilidiostigma glabrum	2	0.8	1	0.1089	positive
Pseuderanthemum variabile	2	1	2	0.2574	positive
Ripogonum album	2	0.6	1	0.08911	positive
Ripogonum fawcettianum	2	1	2	0.1089	positive
Schizomeria ovata	3	0.8	1	0.0396	positive
Sloanea australis	2	0.6	3	0.0396	positive
Symplocos thwaitesii	1	0.2	0	0	positive
Synoum glandulosum	2	0.8	3	0.3663	positive
Tasmannia insipida	2	0.6	1	0.0495	positive
Tylophora paniculata	1	0.2	0	0	positive
Veronica plebeia	1	0.2	0	0	positive

Community 27 Scribbly Gum Sand Forest



Area (Ha)	1.33
% of Bongil Bongil NP	0.03
Polygons with LiDAR	1
Total No. of Polygons	1
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	1.00
LiDAR Max. Tree Height (m)	26.00
LiDAR Mean Tree Height (m)	11.11

Scribbly Gum (*Eucalyptus signata*) Swamp Sclerophyll Forest on Pleistocene Backbarrier Sands

Sites (1): UN830UN105

Rapid Data Points: –

Equivalent communities

Community No. 41: *Eucalyptus robusta/E. signata – Baloskion tetraphyllum* subsp. *meiostachyum* swamp sclerophyll mallee shrubland, mallee forest and mallee woodland (Griffith *et al*. 2003).

Description

Floristically, this community was grouped with Tantoon Tea-tree Shubland (community 9). However, it was decided to map the occurrence of Scribbly Gum (*Eucalyptus signata*) as a vegetation map unit given its rarity within Bongil Bongil NP. The one site sampled included an open forest cover of Scribbly Gum, with a middle stratum of shrubs including Tantoon Tea-tree (*Leptospermum polygalifolium* subsp. *cismontanum*), Slender Tea-tree (*Leptospermum trinervium*) and Satinwood (*Nematolepis squamea* subsp. *squamea*). The lower layer contained Tassel Rush (*Baloskion tetraphyllus* subsp. *meiostachyum*), Saw Sedge (*Gahnia sieberiana*) and Grass tree (*Xanthorrhoea fulva*).

Distribution and Habitat

Habitat: Waterlogged soils on Pleistocene barrier sands.

Disturbance: No evidence of disturbance observed.

Distribution within park: Only known site is adjacent to a White's Tea-tree Shrubland community (community 8) on the Western Peninsula Trail.

Area: 1.33 ha.

Conservation

Threats: None apparent.

Conservation status: Probably well reserved.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	8–22	25	*Eucalyptus signata*
Middle 1	2–6	45	*Leptospermum polygalifolium* subsp. *cismontanum*, *Leptospermum trinervium*, *Nematolepis squamea* subsp. *squamea*
Lower 1	1–2	60	*Leucopogon lanceolatus*, *Leucopogon magarodes*
Lower 2	0–1	30	*Baloskion tetraphyllum* subsp. *meiostachyum*, *Gahnia sieberiana*, *Xanthorrhoea fulva*

Floristics

Trees: *Eucalyptus signata*, *Eucalyptus robusta*.

Small trees and shrubs: *Leptospermum polygalifolium* subsp. *cismontanum*, *Leptospermum trinervium*, *Banksia aemula*, *Nematolepis squamea* subsp. *squamea*.

Ferns: *Pteridium esculentum*.

Sedges and rushes: *Baloskion tetraphyllum* subsp. *meiostachyum*, *Gahnia sieberiana*, *Hypolaena fastigiata*.

Shrubs: *Leucopogon lanceolatus*, *Leucopogon margarodes*, *Leptospermum whitei*, *Xanthorrhoea fulva*, *Oxylobium robustum*, *Acacia ulicifolia*, *Oxylobium robustum*, *Pimelea linifolia*.

Climbers: *Cassytha filiformis*.

Number of native taxa: 20 **Number of taxa per plot**: 20 (n = 1 plot)

Number of exotic species: 0

Indicator taxa

Map unit only and no indicator species recorded.

Community 28 Blackbutt Creek-bank Forest

Area (Ha)	26.09
% of Bongil Bongil NP	0.61
Polygons with LiDAR	16
Total No. of Polygons	15
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	30.53
LiDAR Mean Tree Height (m)	14.05

Blackbutt (*Eucalyptus pilularis*) Creek-bank Dry Open Forest

Sites (1): UN830UN104

Rapid Data Points (2): rdp-147, rdp-150

Equivalent communities

Wet Sclerophyll Forests–Northern Hinterland Wet Sclerophyll Forests (Keith 2004); NPWS NSW Coastal Vegetation community 3006: *Eucalyptus pilularis* very tall open forest (Griffith & Wilson 2007).

Description

A tall open forest dominated by Blackbutt (*Eucalyptus pilularis*), Turpentine (*Syncarpia glomulifera*) and Brushbox (*Lophostemon confertus*). A mid-layer of Turpentine, Blueberry Ash (*Elaeocarpus reticulatus*) and Scentless Rosewood (*Synoum glandulosum* subsp. *glandulosum*) is present. The lower layer comprises Mat Rush (*Lomandra longifolia*), Bracken Fern (*Pteridium esculentum*) and Grass tree (*Xanthorrhoea macronema*). Climbers such as Native Sarsparilla (*Smilax glyciphylla*) and Lawyer Vine (*Smilax australis*) are common.

Distribution and Habitat

Habitat: Occupies high creek-banks with outcroppings of clay soils, mapped as the alluvial floodplain (Troedsen *et al.* 2004).

Disturbance: Fire, grazing, plantation establishment.

Distribution within the park: Pine Creek and Bonville Creek.

Area: 26 ha.

Conservation

Threats: None noted.

Conservation status: Reserved in Bundjalung NP and Yuraygir NP.

Significant taxa: *Marsdenia fraseri* (ROTAP: 3RC–).

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	10–18	35	*Eucalyptus pilularis*, *Syncarpia glomulifera*, *Lophostemon confertus*
Middle 1	2–10	20	*Syncarpia glomulifera*, *Elaeocarpus reticulatus*, *Synoum glandulosum* subsp. *glandulosum*
Lower 1	0–2	50	*Lomandra longifolia*, *Pteridium esculentum*, *Xanthorrhoea macronema*

Floristics

Trees: *Syncarpia glomulifera* (T, M1), *Eucalyptus pilularis* (T), *Lophostemon confertus* (T), *Eucalyptus robusta*, *Allocasuarina torulosa*.

Sub canopy trees and shrubs: *Elaeocarpus reticulatus* (M1), *Synoum glandulosum* subsp. *glandulosum*, *Schefflera actinophylla**, *Melaleuca sieberi*, *Cyclophyllum longipetalum*, *Cinnamomum camphora**, *Acmena smithii*.

Ferns: *Pteridium esculentum*.

Sedges and rushes: *Lomandra longifolia* (L1), *Gahnia clarkei* (L1), *Baloskion tetraphyllum* subsp. *meiostachyum*.

Epiphytes: *Cymbidium suave*.

Shrubs: *Xanthorrhoea macronema*, *Leucopogon margarodes*, *Platysace lanceolata*, *Pimelea linifolia*, *Oxylobium robustum*, *Notelaea longifolia*, *Listea reticulata*, *Hibbertia obtusifolia*, *Dillwynia retorta*, *Baeckea frutescens*, *Alpinia caerulea*, *Acacia ulicifolia*, *Acacia suaveolens*.

Herbs: *Dianella caerulea* var. *producta*.

Climbers: *Smilax glyciphylla*, *Smilax australis*, *Parsonsia straminea*, *Marsdenia fraseri*, *Hibbertia scandens*, *Eustrephus latifolius*, *Cissus hypoglauca*.

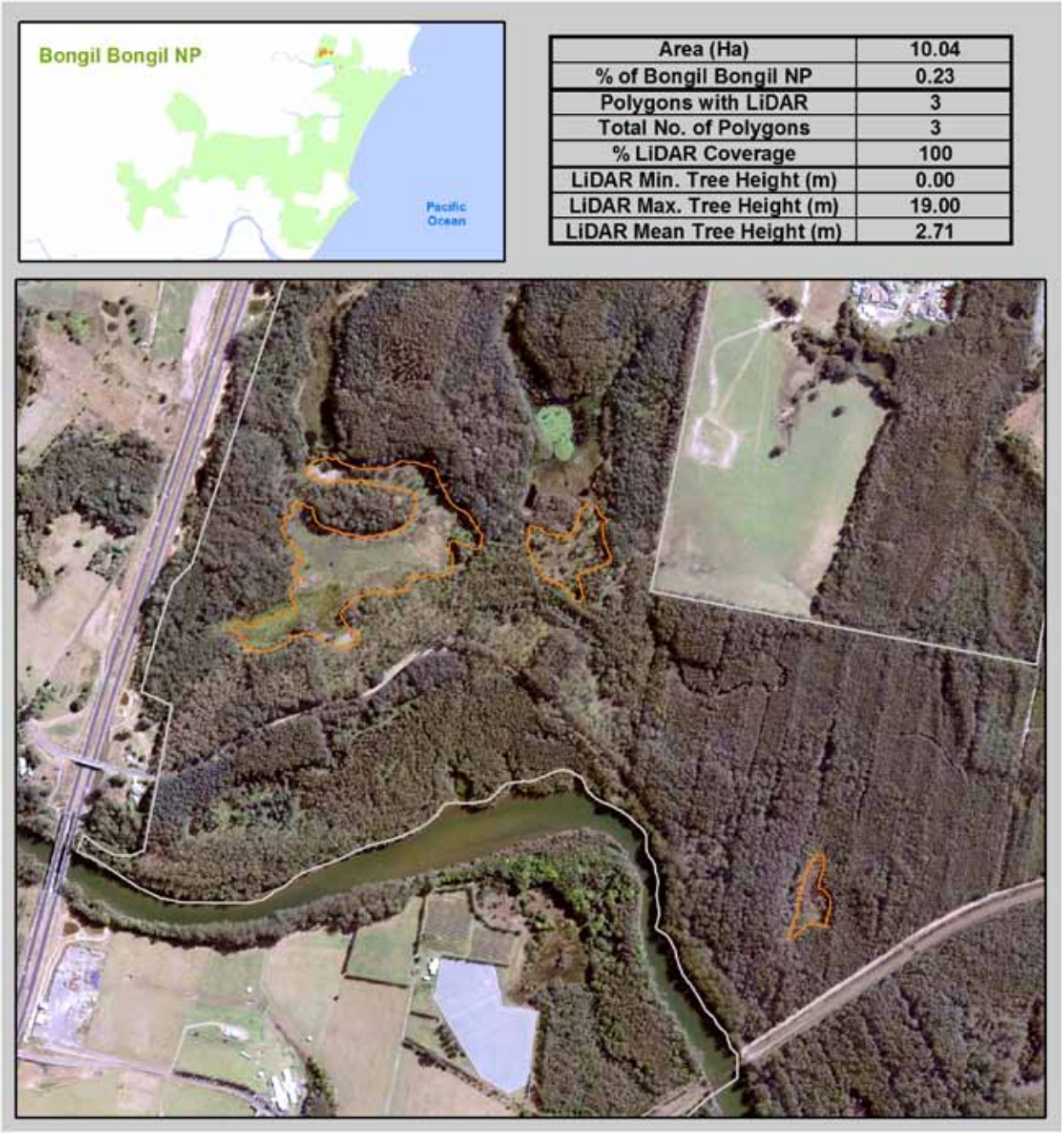
Number of native taxa: 41 **Number of taxa per plot**: 41 (n = 1 plot)

Number of exotic species: 2

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Acacia suaveolens	1	1	0	0	positive
Acianthus fornicatus	1	1	0	0	positive
Cymbidium suave	1	1	0	0	positive
Dianella caerulea	2	1	1	0.4286	positive
Dillwynia retorta	1	1	0	0	positive
Elaecarp reticulatus	3	1	1	0.1905	positive
Eucalyptus pilularis	3	1	3	0.2381	positive
Gahnia clarkei	2	1	2	0.3524	positive
Hibbertia obtusifolia	1	1	0	0	positive
Leucopogon margarodes	2	1	1	0.06667	positive
Lomandra longifolia	4	1	1	0.3905	positive
Lophostemon confertus	2	1	3	0.1238	positive
Marsdenia fraserii	1	1	0	0	positive
Parsonsia straminea	2	1	1	0.3143	positive
Platysace lanceolata	1	1	0	0	positive
Pteridium esculentum	2	1	1	0.2667	positive
Smilax australis	2	1	1	0.4762	positive
Smilax glyciphylla	3	1	1	0.2667	positive
Syncarpia glomulifera	3	1	2	0.2381	positive
Xanthorrhoea macronema	2	1	1	0.05714	positive

Community 29 Derived Native Grassland



Area (Ha)	10.04
% of Bongil Bongil NP	0.23
Polygons with LiDAR	3
Total No. of Polygons	3
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	19.00
LiDAR Mean Tree Height (m)	2.71

Common Reed (*Phragmites australis*) – Pigeon Grass (*Setaria* spp.) Derived Grassland

Sites (0): This was a vegetation map unit only, and not recorded during the flora survey.

Rapid Data Points: –

Equivalent communities

None. This is a derived community and no equivalents recorded.

Description

A tall grassland/sedgeland community that is an artefact of past clearing of swamp sclerophyll vegetation, with a varying zonation of native and exotic grasses, sedges and rushes across the mapped area. There is a layer of emergent Broad-leaved Paperbark (*Melaleuca quinquenervia*) over the dense layer of sedges, reeds and grasses.

Distribution and Habitat

Habitat: Occurs in swampy areas subject to past clearing or artificial inundation.

Disturbance: Weeds are present within the grassland and the area has been affected by past clearing and possibly altered drainage.

Distribution within the park: Located at North Bonville, off the North West Fire Trail. **Area**: 10 ha.

Conservation

Threats: None noted. **Conservation status**: Not relevant. **Significant taxa**: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Emergent	0	5	*Melaleuca quinquenervia*
Lower 1	0.2	90	*Phragmites australis*, *Setaria* spp.

Floristics

Emergent small trees and shrubs: *Melaleuca quinquenervia.*

Sedges and rushes: *Eleocharis acuta*, *Cyperus haspan* subsp *juncoides*, *Phragmites australis*, *Setaria* spp., *Typha orientalis*.

Herbs and shrubs: *Persicaria strigosa*, *Philydrum lanuginosum*. **Ferns**: *Hypolepis muelleri*.

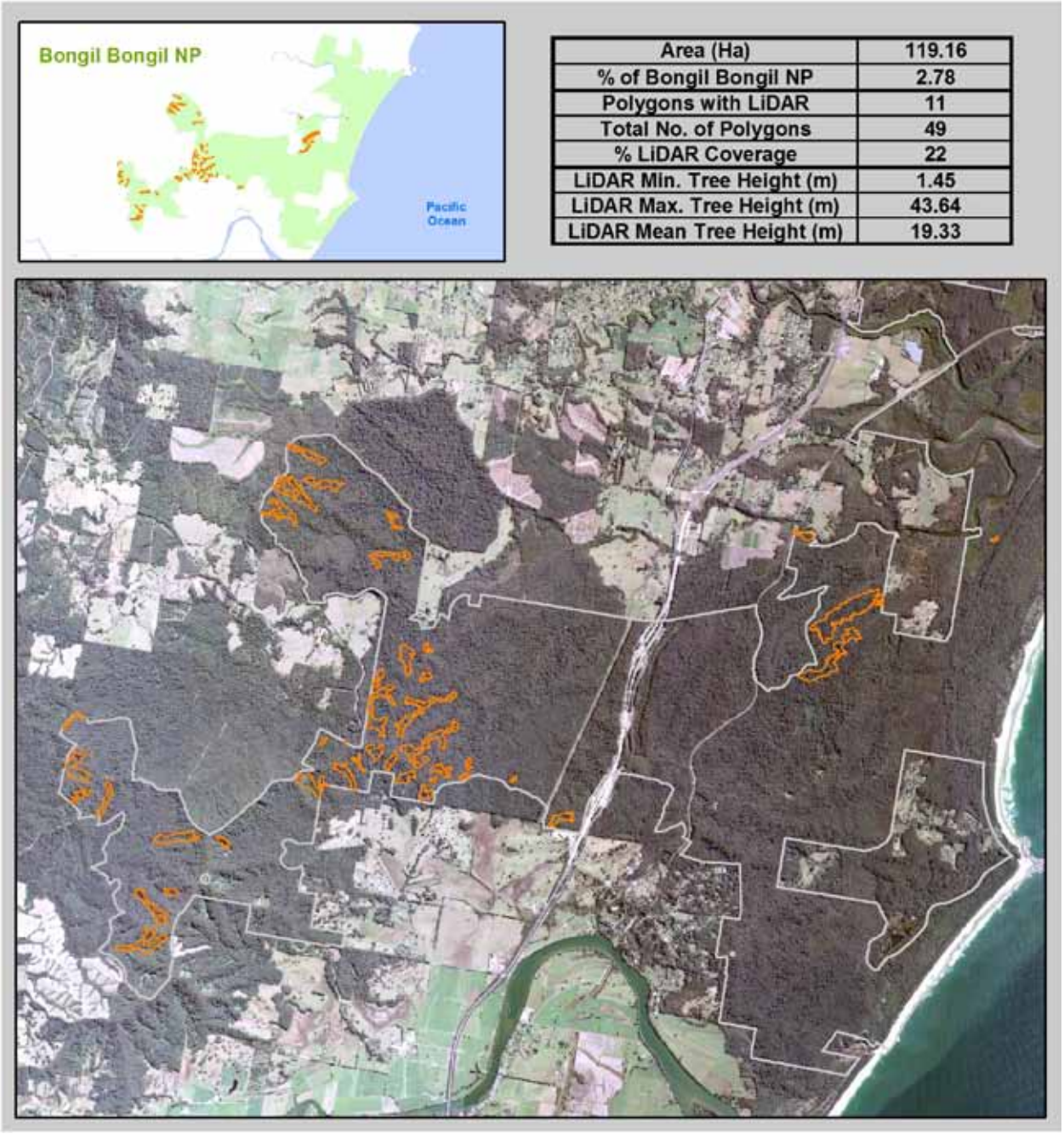
Number of native taxa: Not surveyed **Number of taxa per plot**: Not surveyed

Number of exotic species: Not surveyed

Indicator taxa

Not surveyed.

Community 30 Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest



Area (Ha)	119.16
% of Bongil Bongil NP	2.78
Polygons with LiDAR	11
Total No. of Polygons	49
% LiDAR Coverage	22
LiDAR Min. Tree Height (m)	1.45
LiDAR Max. Tree Height (m)	43.64
LiDAR Mean Tree Height (m)	19.33

Bangalow Palm (*Archontophoenix cunninghamiana*), Coachwood (*Ceratopetalum apetalum*), Maiden's Blush (*Sloanea australis*) Gully Rainforest

Sites (4): AL830VF0101, PM830GL102, PM830GL108, PM830GL109

Rapid Data Points (12): rdp-36, dp-37, rdp-40, rdp-42, rdp-45, rdp-48, rdp-49, rdp-55, rdp-58, rdp-63, rdp-65, rdp-107

Equivalent communities

Rainforest–Subtropical Rainforest (Keith 2004); NPWS NSW Coastal Vegetation community 0004: *Archontophoenix cunninghamiana* simple, mid-high to tall, closed feather palm forest (Griffith & Wilson 2007); Suballiance 6: *Archontophoenix–Livistona* (Floyd 1990); Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion EEC, and Lowland Rainforest on Floodplain in the NSW North Coast Bioregion EEC (NSW Scientific Committee 1999, 2006; see Conservation status below).

Description

A riparian forest community dominated by Bangalow Palm (*Archontophoenix cunninghamiana*), Maiden's Blush (*Sloanea australis*), Coachwood (*Ceratopetalum apetalum*) and White Bolly Gum (*Neolitsea dealbata*). Lawyer Vine (*Calamus muelleri*) is abundant in many forest strata. Other common shrubs and small trees in the sparse mid-layer include Pear-fruited Tamarind (*Mischocarpus pyriformis* subsp. *pyriformis*), *Atractocarpus benthamianus*, Bolly Gum (*Litsea reticulta)*, Green Native Cascarilla (*Croton verreauxii*) and Pink Laceflower (*Archidendron grandiflorum*). In the lower layer, Narrow-leaved Palm Lily (*Cordyline stricta*) and Walking Stick Palm (*Linospadix monostachya*) are most abundant. The ground layer is also sparse, with common species including Mat Rush (*Lomandra spicata*), Rough Maiden Hair Fern (*Adiantum hispidulum*) and Strap Water Fern (*Blechnum patersonii* subsp. *patersonii*). *Pothos longipes* and Climbing Fern (*Lygodium microphyllum*) commonly grow on rainforest trees.

Note. There is an interesting occurrence of Hoop Pine (*Araucaria cunninghamii*) mapped within this community at Pine Creek. These are apparently a remnant of a larger area of these trees that occurred before clearing for agriculture (Alex Floyd, pers. comm.). The age and size of the extant trees suggests that they are much older than the Hoop Pine established in nearby plantations and are of natural origin (Alex Floyd, pers. comm.). This stand possibly represents a modified example of Hoop Pine Floodplain Rainforest (suballiance 3 of Floyd 1990), which occurs at Woolgoolga and on the Bellinger River. Pine Creek is believed to be named after this patch of Hoop Pine. This occurrence of Hoop Pine within Bongil Bongil NP is therefore of very high conservation significance.

Distribution and Habitat

Habitat: This community occurs in the narrow valleys of the headwaters of drainage lines of the park. These areas are often mapped as alluvial valley fill, colluvial and alluvial fans, or included within areas of Permian metasediments.

Disturbance: Examples of this community near Halls Road have been heavily disturbed and areas of regrowth are smothered with native vines.

Distribution within the Park: Occurs around Mailmans Track, Cabbage Tree Road and Seaview Road within the park.

Area: 119 ha.

Conservation

Threats: Encroachment by the weed Lantana (*Lantana camara*)

Conservation status: Occurrences of this community on Permian metasediments are examples of Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion EEC; occurrences on alluvial soils are examples of Lowland Rainforest on Floodplain in the NSW North Coast Bioregion EEC (see Equivalent communities, above).

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Tallest	10–30	70	*Archontophoenix cunninghamiana*, *Sloanea australis*, *Ceratopetalum apetalum*, *Neolitsea dealbata*
Middle 1	2–10	20	*Mischocarpus pyriformis* subsp. *pyriformis*, *Atractocarpus benthamianus*, *Litsea reticulta*, *Croton verreauxii*, *Archidendron grandiflorum*
Lower 1	0.5–2	15	*Cordyline stricta*, *Linospadix monostachya*
Lower 2	0–0.5	15	*Lomandra spicata*, *Adiantum hispidulum*, *Blechnum patersonii* subsp. *patersonii*, *Pothos longipes*, *Lygodium microphyllum*

Floristics

Trees: *Archontophoenix cunninghamiana* (T, M1), *Sloanea australis* (T, M1), *Ceratopetalum apetalum* (T, M1, L1), *Diploglottis cunninghamii*, *Neolitsea dealbata*, *Eucalyptus grandis*, *Corymbia intermedia*, *Lophostemon confertus*.


Lygodium microphyllum

Shrubs: *Linospadix monostachya* (M2, L1), *Ficus coronata*, *Mischocarpus pyriformis* subsp. *pyriformis*, *Atractocarpus benthamianus*, *Litsea reticulata*, *Syzygium australe*, *Tabernaemontana pandacaqui*, *Archidendron grandiflorum*, *Dysoxylum rufum*, *Croton verreauxii*, *Neolitsea dealbata*, *Sarcopteryx stipata*, *Synoum glandulosum* subsp. *glandulosum*, *Wilkiea huegeliana*, *Caldcluvia paniculosa*, *Callicoma serratifolia*, *Claoxylon australe*, *Clerodendrum tomentosum*, *Croton verreauxii*, *Cryptocarya microneura*, *Cryptocarya rigida*, *Endiandra discolor*, *Eupomatia bennettii*, *Eupomatia laurina*, *Flindersia schottiana*, *Jagera pseudorhus* var. *pseudorhus*, *Lantana camara**, *Pittosporum revolutum*, *Pilidiostigma glabrum*, *Schizomeria ovata*, *Sarcopteryx stipata*, *Syncarpia glomulifera*, *Syzygium oleosum*, *Tabernaemontana pandacaqui*, *Tasmannia insipida*.

Ferns: *Lygodium microphyllum*, *Adiantum hispidulum* (L1, L2), *Blechnum patersonii* subsp. *patersonii*, *Cyathea australis*, *Diplazium dilatatum* (L1), *Histiopteris incisa*, *Blechnum cartilagineum*, *Hypolepis muelleri*, *Pyrrosia confluens* var. *confluens*.

Sedges and rushes: *Lomandra spicata* (L1, L2), *Cyperus filipes*, *Lomandra spicata*, *Gahnia clarkei*.

Grasses: *Oplismenus aemulus*, *Oplismenus imbecillis*.

Herbs and shrubs: *Cordyline stricta* (L1), *Alocasia brisbanensis*, *Alpinia caerulea*, *Hydrocotyle pedicellosa*, *Linospadix monostachya* (L1), *Lobelia trigonocaulis*, *Aneilema biflorum*, *Bidens pilosa**, *Commelina cyanea*, *Homalanthus populifolius*, *Maclura cochinchinensis*, *Pratia purpurascens*, *Pseuderanthemum variabile*, *Solanum mauritianum**, *Wilkiea huegeliana*.

Climbers: *Pothos longipes*, *Calamus muelleri* (M2), *Trophis scandens* subsp. *scandens*, *Cissus antarctica*, *Morinda jasminoides*, *Piper novae-hollandiae*, *Ripogonum album*, *Sarcopetalum harveyanum*, *Cephalaralia cephalobotrys*, *Ripogonum fawcettianum*, *Morinda jasminoides*, *Stephania japonica* var. *discolor*, *Cayratia clematidea*, *Cissus hypoglauca*, *Clematis aristata*, *Dioscorea transversa*, *Ripogonum brevifolium*, *Ripogonum discolor*, *Smilax glyciphylla*.

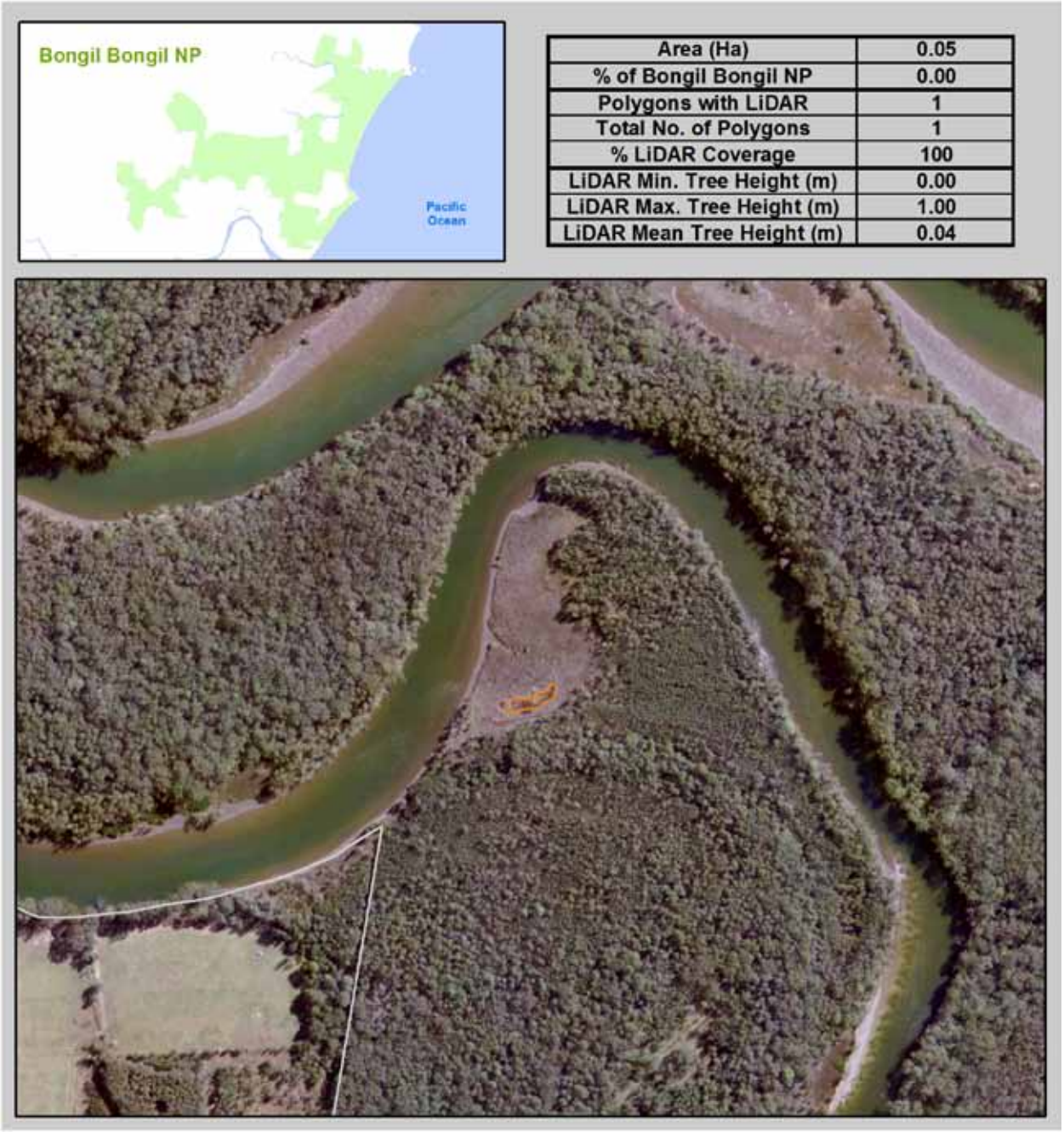
Number of native taxa: 67 **Number of taxa per plot**: 27–42 (34 ± 7.6)

Number of exotic species: 3

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Adiantum hispidulum	3	1	1	0.04673	positive
Archontophoenix cunninghamiana	4	1	1	0.3178	positive
Atractocarpus benthamianus	2	1	2	0.07477	positive
Blechnum patersonii subsp. *patersonii*	3	0.5	1	0.01869	positive
Calamus muelleri	3	1	2	0.1869	positive
Cissus antarctica	2	1	1	0.1682	positive
Diplazium dilatatum	2	0.5	0	0	positive
Eupomatia bennettii	1	0.5	0	0	positive
Ficus coronata	2	1	1	0.1121	positive
Flindersia schottiana	1	0.5	0	0	positive
Linospadix monostachya	4	1	1	0.1308	positive
Lygodium microphyllumr	3	0.5	2	0.02804	positive
Mischocarpus pyriformis subsp. *pyriformis*	2	0.5	3	0.1308	positive
Neolitsea dealbata	2	0.5	3	0.05607	positive
Pothos longipes	3	1	4	0.02804	positive
Riponum album	2	1	1	0.1028	positive
Ripogonum fawcettianum	2	0.5	2	0.1495	positive
Sloanea australis	3	1	3	0.06542	positive
Trophis scandens subsp. *scandens*	3	0.5	2	0.04673	positive

Community 31 *Schoenoplectus subulatus* Saltmarsh



Area (Ha)	0.05
% of Bongil Bongil NP	0.00
Polygons with LiDAR	1
Total No. of Polygons	1
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	1.00
LiDAR Mean Tree Height (m)	0.04

Schoenoplectus subulatus Saltmarsh

Sites: None. Observed only during field inspection.

Rapid Data Points: –

Equivalent communities

Saline Wetlands–Saltmarsh (Keith 2004); NPWS NSW Coastal Vegetation community 6415: *Schoenoplectus litoralis* tall closed sedgeland (Griffith & Wilson 2007); Community 7: Prickly Couch–Sea Rush–*Schoenoplectus subulatus* saltmarsh (Sheringham *et al.* 2008); Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (NSW Scientific Committee 2004d).

Description

A dense rushland in which *Schoenoplectus subulatus* is the only species present. The community was not sampled during floristic surveys or rapid data points but included as a vegetation mapping unit.

Distribution and Habitat

Habitat: Saline soils in standing water. Seems to occur at the most waterlogged and lowest lying point of the saltmarsh zonation.

Disturbance: None evident.

Distribution within the park: A very small area located within an area of Sea Rush Saltmarsh (community 15).

Area: 0.05 ha.

Conservation

Threats: Rises in sea level and climate change.

Conservation status: This community is an example of Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (see Equivalent communities, above). A small area (1 ha) of an equivalent community is mapped in Broadwater NP (Griffith & Wilson 2007). Unreserved occurrences of a saltmarsh community dominated by *Schoenoplectus subulatus* with Saltwater Couch (*Sporobolus virginicus*) are found in the estuary of the Evans River.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0–1	85	*Schoenoplectus subulatus*

Floristics

Sedges and rushes: *Schoenoplectus subulatus*.

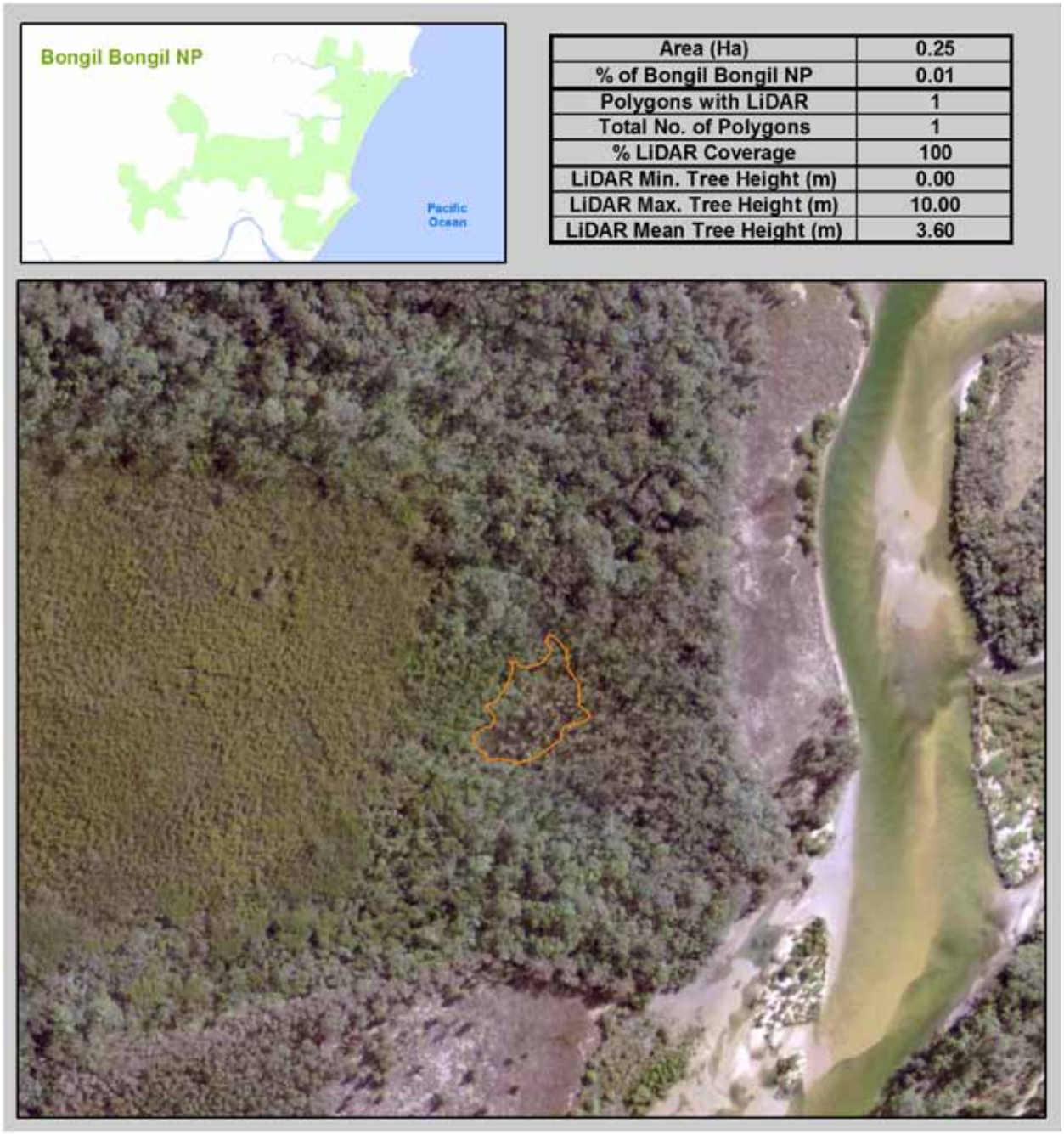
Number of native taxa: 1 **Number of taxa per plot**: Not recorded during surveys

Number of exotic species: 0

Indicator taxa

Not recorded during surveys.

Community 32 *Baloskion pallens–Blechnum indicum* Sedgeland



Area (Ha)	0.25
% of Bongil Bongil NP	0.01
Polygons with LiDAR	1
Total No. of Polygons	1
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	10.00
LiDAR Mean Tree Height (m)	3.60

Baloskion pallens – Blechnum indicum Sedgeland with emergent Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*Eucalytpus robusta*)

Sites (0): None, identified as a mapping unit only.

Rapid Data Points (1): rdp-158

Equivalent communities

Community No. 36: *Melaleuca quinquenervia – Baumea teretifolia* swamp sclerophyll shrubland (Griffith *et al*. 2003); NPWS NSW Coastal Vegetation community 5102: Swamp sclerophyll mallee forest & woodland (Griffith & Wilson 2007).

Description

A dense sedgeland dominated by *Baloskion pallens*, *Blechnum indicum*, *Baumea rubiginosa* and *Chorizandra sphaerocephalus,* with Tassell Rush (*Baloskion tetraphyllus* subsp. *meiostachys*) also present. The sedgeland is interspersed with emergent Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*Eucalyptus robusta*).

Distribution and Habitat

Habitat: Peaty sand soils in a freshwater swamp on Pleistocene sands. Grows at lowest point of a large area of wet, heath/shrubland, where water from the swamp discharges and collects and is present for extended periods.

Disturbance: None evident.

Distribution within the park: Apparently restricted to a small area adjacent to White's Tea-tree Shrubland community on the Fist Peninsula. This area was sampled during accuracy assessment rapid data points and was added to the list of vegetation classification as a mapping unit.

Area: 0.025 ha.

Conservation

Threats: None noted.

Conservation status: Map-occurrences of related communities are found in Newrybar Swamp (primarily Aboriginal freehold land), Bundjalung NP, Yuraygir NP, Hat Head NP and Limeburners Creek NR.

Significant taxa: None recorded.

Structure

Layer	Height (m)	Cover (%)	Dominant species
Lower 1	0–1	85–90	*Baloskion pallens*, *Blechnum indicum*, *Baloskion tetraphyllus* subsp. *meiostachys*

Floristics

Ferns: *Blechnum indicum*.

Sedges and rushes: *Baloskion pallens*, *Baloskion tetraphyllus* subsp. *meiostachyum*, *Baumea articulata*, *Chorizandra sphaerocephalus*, *Baumea rubginosa*.

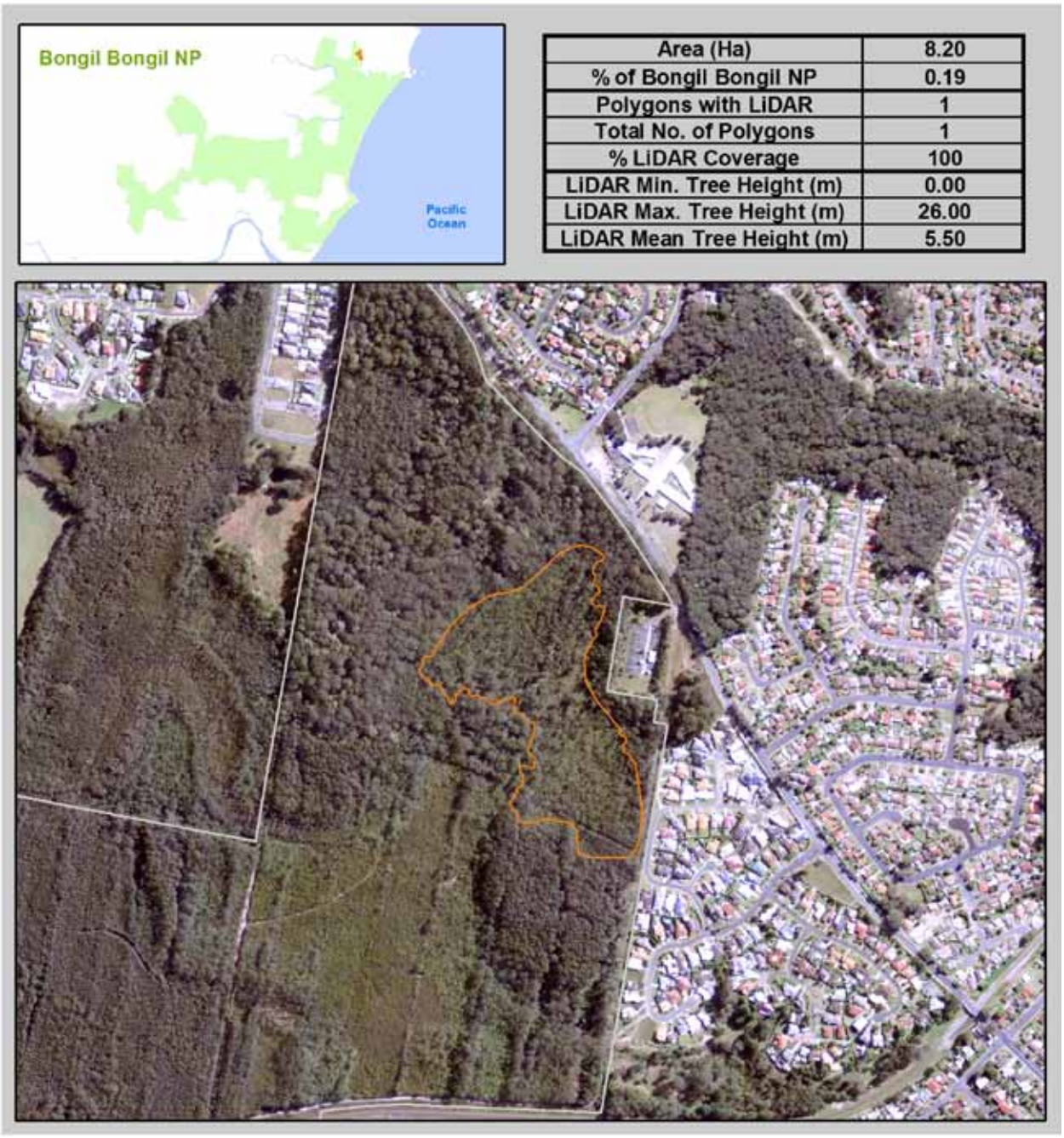
Number of native taxa: 5 **Number of taxa per plot**: Not surveyed

Number of exotic species: 0

Indicator taxa

No data; identified as a mapping unit only.

Community 33 Swamp Mahogany–*Melaleuca sieberi* Shrubland



Area (Ha)	8.20
% of Bongil Bongil NP	0.19
Polygons with LiDAR	1
Total No. of Polygons	1
% LiDAR Coverage	100
LiDAR Min. Tree Height (m)	0.00
LiDAR Max. Tree Height (m)	26.00
LiDAR Mean Tree Height (m)	5.50

Melaleuca sieberi Swamp Sclerophyll Shrubland with emergent Swamp Mahogany (*Eucalyptus robusta*)

Sites (2): UN28UN110, UN28UN111

Rapid Data Points (1): rdp-176

Equivalent communities

Forested Wetlands–Coastal Swamp Forests, Freshwater Wetlands–Coastal Heath Swamps (Keith 2004); Community No. 35: *Melaleuca sieberi/Banksia ericifolia* subsp. *macrantha* – *M. thymifolia* swamp sclerophyll shrubland (Griffith *et al*. 2003).

Description

This community has an emergent sparse cover of tall Swamp Mahogany (*Eucalyptus robusta*), rarely with Red Mahogany (*Eucalyptus resinifera* subsp. *hemilampra*). There is a shrubland mid-layer dominated by an open cover of *Melaleuca sieberi*, *Melaleuca linariifolia* and *Baeckea frustescens*, and a second shrub layer with *Banksia oblongifolia*, Grass tree (*Xanthorrhoea fulva*), Hairpin Banksia (*Banksia spinulosa* var. *collina*) and Wallum Bottlebrush (*Callistemon pachyphyllus*). In the lower layer *Hibbertia vestita*, *Baumea articulata*, *Gonocarpus micranthus* subsp. *ramosissimus* and Grass tree (*Xanthorrhoea fulva*) are most abundant.

Distribution and Habitat

Habitat: Occurs in poorly drained sites on undifferentiated Pleistocene sediments with an apparent clay influence from adjoining metasediment hillslopes.

Disturbance: None recorded.

Distribution within the park: Recorded in survey sites at North Bonville south-east of Lyons Trail.

Area: 8 ha.

Conservation

Threats: None recorded.

Conservation status: Similar communities are recorded in Bundjalung NP, Yuraygir NP and Limeburners Creek NR.

Significant taxa: *Lindsaea incisa* (TSC: Endangered).

Structure

Layer	Height (m)	Cover (%)	Dominant species
Emergent	6–15	10	*Eucalyptus robusta*
Middle 1	2–6	20–30	*Melaleuca sieberi*, *Melaleuca linariifolia*, *Baeckea frutescens*
Lower 1	1–2	30–60	*Banksia oblongifolia*, *Xanthorrhoea fulva*, *Banksia spinulosa* var. *collina*, *Callistemon pachyphyllus*
Lower 2	0–1	35–60	*Hibbertia vestita*, *Baumea articulata*, *Gonocarpus micranthus* subsp. *ramosissimus*, *Xanthorrhoea fulva*

Floristics

Emergent: *Eucalyptus robusta* (E), *Eucalyptus resinifera* subsp. *hemilampra*, *Melaleuca quinquenervia*.

Small trees and shrubs: *Melaleuca sieberi* (T), *Banksia oblongifolia* (L1), *Banksia spinulosa* var. *collina* (L1), *Callistemon pachyphyllus* (L1), *Baeckea frutescens*, *Melaleuca linariifolia* (T), *Leptospermum polygalifolium* subsp. *cismontanum*.

Grasses: *Themeda australis*, *Entolasia stricta*.

Ferns: *Gleichenia dicarpa*.

Wallum Bottlebrush (Callistemon pachyphyllus)

Sedges and rushes: *Gahnia sieberiana* (L1), *Baumea articulata* (L2), *Lepyrodia* sp. A, *Lomandra longifolia*, *Sporadanthus interruptus* (L2), *Empodisma minus*, *Chorizandra sphaerocephala*.

Herbs and shrubs: *Hibbertia vestita* (L2), *Xanthorrhoea fulva* (L1), *Gonocarpus micranthus* subsp. *ramosissimus* (L2), *Dampiera stricta*, *Pultenaea retusa*, *Tricoryne elatior*, *Caesia parviflora*, *Cryptostylis subulata*, *Drosera spatulata*, *Goodenia heterophylla* subsp. *eglandulosa*, *Leptospermum juniperinum*, *Melaleuca thymifolia*, *Spartothamnella juncea*.

Climbers: *Cassytha racemosa* f. *muelleri*, *Parsonsia straminea*, *Selaginella uliginosa*, *Smilax glyciphylla*.

Number of native taxa: 39 **Number of taxa per plot**: 20–31 (23 ± 5)

Number of exotic species: 0

Indicator native taxa

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Baeckea frutescens	2	1	3	0.05505	positive
Banksia oblongifolia	3	1	3	0.05505	positive
Banksia spinulosa	3	0.5	1	0.009174	positive
Baumea articulata	3	1	1	0.0367	positive
Caesia parviflora	1	0.5	0	0	positive
Callistemon pachyphyllus	3	1	0	0	positive
Cassytha racemosa	2	1	0	0	positive
Chorizandra cymbaria	1	0.5	0	0	positive
Crypstylis subulata	1	0.5	0	0	positive
Empodisma minus	2	0.5	0	0	positive
Entolasia stricta	2	1	1	0.01835	positive
Eucalyptus ressinifera subsp. *hemilampra*	2	0.5	1	0.01835	positive
Eucalyptus robusta	3	1	2	0.1101	positive
Gahnia sieberiana	3	1	0	0	positive
Gleichenia dicarpa	1	0.5	0	0	positive
Gonocarpus micranthus	3	0.5	0	0	positive
Hibbertiia vestita	3	1	1	0.009174	positive
Leptospermum juniperinum	1	0.5	0	0	positive

Species	Group score	Group frequency	Non-group score	Non-group frequency	Fidelity class
Lepyrodia sp. A	2	1	0	0	positive
Lomandra longifolia	2	1	1	0.3945	positive
Melaleuca linariifolia	2	1	0	0	positive
Melalueca sieberi	4	1	1	0.02752	positive
Melaleuca thymifolia	1	0.5	0	0	positive
Spartothamnella juncea	1	0.5	0	0	positive
Sporadanthus interruptus	3	0.5	4	0.05505	positive
Themeda australis	2	1	1	0.08257	positive
Tricoryne elatior	2	0.5	0	0	positive
Xanthorrhoea fulva	4	1	3	0.08257	positive

Appendix 3 The Species of Vascular Plants Recorded in Bongil Bongil National Park

The following lists all species of plants recorded from Bongil Bongil National Park during the current floristic surveys and available records for the National Park from previous surveys, the Atlas of NSW Wildlife and the YETI Database. The common names are largely extracted from PlantNET – New South Wales Flora Online (available at http://plantnet.rgbsyd.nsw.gov.au), although a few commonly used alternative names not included in PlantNet have been added.

In the following list, threatened taxa are indicated ǂ, and exotic species *. For threatened and significant taxa, the following abbreviations are used to indicate status: TSC: V and TSC: E are species listed as Vulnerable or Endangered, respectively, under the *Threatened Species Conservation Act 1995* (NSW); standard codes (e.g. 2RCa) are given for ROTAP species (see Briggs & Leigh 1995); and S = other significant species in the study area.

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Club Mosses		
	Selaginellaceae		
	Selaginella uliginosa (Labill.) Spring		Swamp Selaginella
	Fern Allies		
	Psilotaceae		
	Psilotum nudum (L.) P.Beauv.		Skeleton Fork-Fern
	Tmesipteris truncata (R.Br.) Desv.		
	Pines		
	Araucariaceae		
	Araucaria cunninghamii Aiton ex A.Cunn.		Hoop Pine
	Cupressaceae		
	Callitris macleayana (F.Muell.) F.Muell.	S	Stringybark Pine, Brush Cypress, Stringybark Cypress Pine
	Pandanaceae		
	Pandanus tectorius Parkinson ex Du Roi		Screw Pine
	Podocarpaceae		
	Podocarpus elatus R.Br. ex Endl.		Plum Pine, Brown Pine
	Pinaceae		
*	*Pinus elliottii* Engelm.		Slash Pine
	Cycads		
	Zamiaceae		
	Lepidozamia peroffskyana Regel	S	Burrawang
	Ferns		
	Adiantaceae		
	Adiantum aethiopicum L.		Common Maidenhair
	Adiantum formosum R. Br.		
	Adiantum hispidulum Sw.		Rough Maidenhair Fern
	Adiantum silvaticum Tindale		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Cheilanthes sieberi subsp. *sieberi* Kunze		Rock Fern
	Pellaea falcata (R.Br.) Fée		
	Aspleniaceae		
	Asplenium australasicum (J.Sm.) Hook.		Bird's Nest Fern
	Asplenium polyodon G.Forst.		Sickle Spleenwort, Mare's Tail Fern
	Athryriaceae		
	Diplazium dilatatum Blume		
	Azollaceae		
	Azolla filiculoides Lam.		
	Blechnaceae		
	Blechnum camfieldii Tindale		
	Blechnum cartilagineum Sw.		Gristle fern, Soft Water Fern
	Blechnum minus (R.Br.) Ettingsh.		Soft Water Fern
	Blechnum patersonii subsp. *patersonii* (R.Br.) Mett.		Strap Water fern
	Blechnum wattsii Tindale		Hard Water Fern
	Blechnum indicum Burm.f.		Swamp Water Fern
	Doodia aspera R.Br.		Prickly Rasp Fern
	Doodia caudata (Cav.) R.Br.		Small Rasp fern
	Cyatheaceae		
	Cyathea australis (R.Br.) Domin		Black Tree-fern, Rough Tree-fern
	Cyathea cooperi (F.Muell.) Domin		Straw Water Fern
	Cyathea leichhardtiana (F.Muell.) Copel.		Prickly Tree-fern, Prickly Tree Fern
	Davalliaceae		
	Davallia solida var. *pyxidata* (Cav.) Noot.		Hare's Foot Fern
	Nephrolepis cordifolia (L.) Presl		
	Dennstaedtiaceae		
	Histiopteris incisa (Thunb.) J.Sm.		Bat's Wing Fern
	Hypolepis glandulifera Brownsey & Chinnock		Downy Ground fern
	Hypolepis muelleri N.A.Wakef.		Soft Ground fern
	Pteridium esculentum (G.Forst.) Cockayne		Bracken Fern
	Dicksoniaceae		
	Calochlaena dubia (R.Br.) M.D.Turner & R.A.White in R.A.White & M.D.Turner		Rainbow Fern
	Dryopteridaceae		
	Arachniodes aristata (G.Forst.) Tindale		Prickly Shield Fern
	Lastreopsis acuminata (Houlston) C.V.Morton		
	Lastreopsis microsora subsp. microsora (Endl.) Tindale		Creeping Shield Fern
	Gleicheniaceae		
	Gleichenia dicarpa R.Br.		Pouched Coral Fern
	Sticherus lobatus N.A.Wakef.		Spreading Sheild Fern
	Lindsaceae		
‡	*Lindsaea incisa* Prent.	TSC: E	Slender Screw Fern
	Lindsaea linearis Sw.		Screw Fern
	Marsileaceae		
	Marsilea mutica Mett.		Nardoo
	Ophioglossaceae		
	Ophioglossum pendulum L.	S	Ribbon Fern

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Osmundaceae		
	Todea barbara (L.) T.Moore		King Fern
	Polypodiaceae		
	Microsorum scandens (G.Forst.) Tindale		
	Platycerium bifurcatum (Cav.) C.Chr.		Elkhorn
	Platycerium superbum de Jonch. & Hennipman		Staghorn
	Pyrrosia confluens (R.Br.) Ching		
	Pyrrosia rupestris (R.Br.) Ching		
	Schizaeaceae		
	Lygodium microphyllum (Cav.) R.Br.		Climbing Fern
	Schizaea bifida Willd.		Forked Comb Fern
	Thelypteridaceae		
	Christella dentata (Forssk.) Brownsey & Jermy		Binung, Binung
	Cyclosorus interruptus (Willd.) H.Itô		
	Dicots		
	Acanthaceae		
	Avicennia marina subsp. *australasica* (Walp.) Everett		Grey Mangrove
	Pseuderanthemum variabile (R.Br.) Radlk.		Pastel Flower
	Aizoaceae		
	Carpobrotus glaucescens (Haw.) Schwantes		Pigface
	Tetragonia tetragonioides (Pall.) Kuntze		New Zealand Spinach, Native Spinach
	Sesuvium portulacastrum L.	S	Ice Plant
	Akaniaceae		
	Akania bidwillii (Hogg) Mabb.		Turnipwood
	Amaranthaceae		
	Alternanthera denticulata R.Br.		Lesser Joyweed
	Deeringia arborescens (R.Br.) Druce		
	Anacardiaceae		
	Euroschinus falcatus Hook.f.		Ribbonwood, Blush Cudgerie
	Annonaceae		
	Meiogyne stenopetala subsp. *stenopetala* (F.Muell.) Heusden		
	Aphanopetalaceae		
	Aphanopetalum resinosum Endl.		
	Apiaceae		
	Actinotus helianthi Labill.		Flannel Flower
	Apium prostratum var. *prostratum* Labill. ex Vent.		
	Centella asiatica (L.) Urb.		
	Hydrocotyle bonariensi Lam.		
	Hydrocotyle pedicellosa F.Muell.		Pennywort
	Hydrocotyle peduncularis R.Br. ex A.Rich.		
	Platysace lanceolata (Labill.) Druce		
	Apocynaceae		
*	*Araujia sericifera* Brot.		Moth Vine
*	*Asclepias curassavica* L.		Red Cottonbush
*	*Gomphocarpus fruticosus* (L.) W.T.Aiton		Cotton Bush

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
‡	*Marsdenia fraseri* Benth.	3RC–	Narrow-leaved Milk Vine
‡	*Marsdenia longiloba* Benth.	TSC: E / 3RC–	
	Marsdenia rostrata R.Br.		Milk Vine
	Parsonsia induplicata F.Muell.		
	Parsonsia straminea (R.Br.) F.Muell.		Common Silkpod
	Tylophora benthamii Tsiang		Coast Tylophora
	Tylophora paniculata R.Br.		Thin-leaved Tylophora
	Tabernaemontana pandacaqui Lam.		Banana Bush
	Araliaceae		
	Astrotricha latifolia Benth.		
	Cephalaralia cephalobotrys (F.Muell.) Harms		
	Polyscias elegans (C.Moore & F.Muell.) Harms		
	Polyscias sambucifolia (Sieber ex DC.) Harms		
*	*Schefflera actinophylla* (Endl.) Harms		
	Asteraceae		
*	*Ageratina adenophora* (Spreng.) R.M.King & H.Rob.		
*	*Ageratum houstonianum* Mill.		
*	*Ambrosia tenuifolia Spreng.*		Lacy Ragweed
*	*Baccharis halimifolia* L.		Groundsel Bush
*	*Bidens pilosa* L.		
	Centipeda minima var. *minima* (L.) A.Braun & Asch.		Spreading Sneezeweed
*	*Chrysanthemoides monilifera* subsp. *rotundata* (DC.) Norl.		Bitou Bush
*	*Cirsium vulgare* (Savi) Ten.		Spear Thistle
*	*Conyza bonariensis* (L.) Cronquist		Flax-leaved Fleabane
*	*Conyza parva* Cronquist		
	Coronidium elatum subsp. elatum (A.Cunn. ex DC.) Paul G.Wilson		
	Enydra fluctuans DC.		
	Epaltes australis Less.		
*	*Erechtites valerianifolia* (Wolf) DC.		Brazilian Fireweed
	Euchiton involucratus (G.Forst.) Holub		
	Leptinella longipes Hook.f.	S	
*	*Hypochaeris glabra* L.		Smooth Cat's Ear
*	*Hypochaeris radicata* L.		Cat's Ear
	Olearia nernstii (F.Muell.) F.Muell. ex Benth.		
	Ozothamnus diosmifolius (Vent.) DC.		
	Senecio lautus subsp. *maritimus* Ali		
*	**Senecio madagascariensis* Poir.		
	Sigesbeckia orientalis subsp. *orientalis* L.		Indian Weed
*	*Sonchus oleraceus L.*		Common Sowthistle
*	*Taraxacum officinale* Weber		Dandelion
	Youngia japonica (L.) DC.		
	Vernonia cinerea (L.) Less.		
	Bignoniaceae		
*	*Macfadyena unguis-cati* (L.) A.H.Gentry		Cat's Claw Creeper
	Pandorea pandorana (Andrews) Steenis		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Boraginaceae		
*	*Echium plantagineum* L.		Paterson's Curse
	Brassicaceae		
*	*Cakile edentula* (Bigelow) Hook.		American Sea Rocket
*	*Rorippa palustris* (L.) Besser		Yellow Cress
	Campanulaceae		
	Wahlenbergia gracilis (G.Forst.) A.DC.		Sprawling Bluebell, Australian Bluebell
	Capparaceae		
	Capparis arborea (F.Muell.) Maiden		Native Pomegranate, Wild Lime, Wild Lemon, Brush Caper Berry, Noble Caper
	Casuarinaceae		
	Casuarina equisetifolia subsp. *incana* (Benth.) L.A.S.Johnson		Horse-tail She Oak
	Casuarina glauca Sieber ex Spreng.		Swamp Oak
	Allocasuarina littoralis (Salisb.) L.A.S.Johnson		Black She-Oak
	Allocasuarina torulosa (Aiton) L.A.S.Johnson		Forest Oak
	Celastraceae		
	Celastrus subspicata Hook.		
	Denhamia celastroides (F.Muell.) Jessup		Orange Boxwood
	Elaeodendron australe Vent.		Red Olive Plum
	Hippocratea barbata F.Muell.		Knot Vine
	Maytenus silvestris Lander & L.A.S.Johnson		Narrow-leaved Orangebark, Orange Bush, Orange Bark
	Chenopodiaceae		
	Einadia hastata (R.Br.) A.J.Scott		Berry Saltbush
	Enchylaena tomentosa R.Br.		Ruby Saltbush
	Sarcocornia quinqueflora subsp. *quinqueflora* (Bunge ex Ung.-Sternb.) A.J.Scott		Samphire, Glasswort
	Sesuvium portulacastrum L.		
	Clusiaceae		
	Hypericum japonicum Thunb.		
	Convolvulaceae		
	Dichondra repens J.R.Forst. & G.Forst.		Kidney Weed
	Ipomoea brasiliensis (L.) Sweet		
*	*Ipomoea cairica* (L.) Sweet		
	Polymeria calycina R.Br.		
	Crassula sieberiana (Schult. & Schult.f.) Druce		
	Cunoniaceae		
	Bauera capitata Ser. ex DC.		
	Caldcluvia paniculosa (F.Muell.) Hoogland		
	Callicoma serratifolia Andrews		Black Wattle
	Ceratopetalum apetalum D.Don		Coachwood
	Doryphora sassafras Endl.		Sassafras
	Schizomeria ovata		Crabapple, White Birch, White Cherry, Snowberry
	Dilleniaceae		
	Adrastaea salicifolia DC		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Hibbertia aspera DC.		Rough Guinea Flower
	Hibbertia dentata R.Br. ex DC.		Trailing Guinea Flower
	Hibbertia obtusifolia (DC.) A.Gray		
	Hibbertia scandens		
	Hibbertia vestita Benth.		
	Droseraceae		
	Drosera spatulata Labill.		
	Ebenaceae		
	Diospyros pentamera (Woolls & F.Muell.) F.Muell.		Myrtle Ebony, Grey Persimmon, Black Myrtle, Grey Plum
	Elaeocarpaceae		
	Elaeocarpus obovatus G.Don		Hard Quandong
	Elaeocarpus reticulatus Sm.		Blueberry Ash
	Sloanea australis (Benth.) F.Muell.		Madien's Blush
	Sloanea woollsii F.Muell.		Yellow Carabeen
	Epacridaceae		
	Epacris obtusifolia Sm.		
	Epacris pulchella Cav.		
	Leucopogon lanceolatus var. *gracilis* Benth.		
	Leucopogon margarodes R.Br.		
	Leucopogon parviflorus (Andrews) Lindl.		Coastal Beard-heath, Native Currant
	Monotoca elliptica (Sm.) R.Br.		Tree Broom-heath
	Sprengelia sprengelioides (R.Br.) Druce		
	Trochocarpa laurina R.Br.		Tree Heath
	Euphorbiaceae		
	Amperea xiphoclada var. xiphoclada (Spreng.) Druce		
	Breynia oblongifolia Muell.Arg.		Coffee Bush
‡	*Chamaesyce psammogeton* (P.S.Green) P.I.Forst. & R.J.F.Hend.	TSC: E	
	Claoxylon australe Baill.		Brittlewood
	Croton verreauxii Baill.		Green Native Cascarilla
	Excoecaria agallocha L.		
	Glochidion ferdinandi (Muell.Arg.) F.M.Bailey		
	Homalanthus populifolius Graham		
	Micrantheum ericoides Desf.		
	Phyllanthus gunnii Hook.f.		Scrubby Spurge
	Ricinocarpos pinifolius Desf.		Wedding Bush
*	*Ricinus communis* L.		Castor Oil Plant
	Escallionaceae		
	Anopterus macleayanus F.Muell.		Macleay Laurel
	Polyosma cunninghamii Benn.		Featherwood
	Eupomatiaceae		
	Eupomatia bennettii F.Muell.		
	Eupomatia laurina R.Br.		
	Fabaceae (Caesalpinoideae)		
‡	*Senna acclinis* (F.Muell.) Randell	TSC: E / 3RC–	Rainforest Cassia

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
*	*Senna pendula* var. *glabrata* (Vogel) H.S.Irwin & Barneby		
*	*Senna septemtrionalis* (Viv.) H.S.Irwin & Barneby		Arsenic Bush
	Fabaceae (Mimosoideae)		
	Acacia concurrens Pedley		Curracabah
	Acacia disparrima M.McDonald & Maslin		
	Acacia floribunda (Vent.) Willd.		White Sally
	Acacia elongata Sieber ex DC.		
	Acacia irrorata subsp. *irrorata* Sieber ex Spreng.		Green Wattle, Sydney Green Wattle, Blueskin
	Acacia irrorata subsp. *velutinella* Tindale		Green Wattle
	Acacia longifolia subsp. *sophorae*		Coast Wattle
	Acacia maidenii F.Muell.		Maiden's Wattle
	Acacia melanoxylon R. Br.		Blackwood
	Acacia myrtifolia (Sm.) Willd.		Red-stemmed Wattle
	Acacia ulicifolia (Salisb.) Court		Prickly Moses
	Archidendron grandiflorum (Sol. ex Benth.) I.C.Nielsen		Pink Lace Flower, Laceflower Tree, Tassel Tree, Fairy Paint Brushes
	Pararchidendron pruinosum var. *pruinosum* (Benth.) I.C.Nielsen		Snow Wood, Stinkwood, Malla Waundie, Talingora
	Fabaceae (Faboideae)		
	Aotus ericoides (Vent.) Don		
	Austrosteenisia blackii var. *blackii* (F.Muell.) R.Geesink		Blood Vine
	Callerya australis (Endl.) Schot		
	Derris involuta (Sprague) Sprague		
	Desmodium brachypodum A.Gray		
	Desmodium gunnii Benth. ex Hook.f.		Slender tick trefoil
	Desmodium nemorosum Benth.		
	Desmodium rhytidophyllum Benth.		
*	*Desmodium uncinatum* (Jacq.) DC.		
	Desmodium varians (Labill.) G.Don		Slender Tick-trefoil
	Dillwynia retorta (J.C.Wendl.) Druce		
*	*Erythrina sykesii* Barneby & Krukoff		Coral Tree
	Galactia tenuiflora var. *lucida* Bakh.		
	Glycine clandestina J.C.Wendl.		
	Glycine cyrtoloba Tindale		
	Glycine microphylla (Benth.) Tindale		Small-leaf glycine
	Glycine sp. A		
	Glycine tomentella Hayata		Woolly Glycine
	Gompholobium latifolium Sm.		Golden Glory Pea
	Goodia lotifolia Salisb.		
	Hardenbergia violacea (Schneev.) Stearn		Purple Coral Pea, False Sarsparilla
	Hovea acutifolia A.Cunn. ex G.Don		
	Hovea linearis (Sm.) R.Br.		
	Indigofera australis Willd.		Native Indigo
	Jacksonia scoparia R.Br.		Winged Broom Pea
	Kennedia rubicunda Vent.		Dusky Coral Pea

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
*	*Lupinus cosentinii* Guss.		Sandplain Lupin
	Mucuna gigantea (Willd.) DC.		Burny Bean
	Oxylobium robustum Joy Thomps.		Tree Shaggy Pea
	Pultenaea retusa Sm.		
	Pultenaea villosa Willd.		Hairy Bush Pea
	Vigna marina (Burm.) Merr.	S	Dune Bean
	Viminaria juncea (Schrad.) Hoffmanns.		Native Broom
	Flacourtiaceae		
	Scolopia braunii (Klotzsch) Sleumer		Flintwood, Mountain Cherry, Brown Birch, Scolopia
	Geraniaceae		
*	*Geranium molle* subsp. *molle* L.		
	Geranium solanderi Carolin		Native Geranium
	Goodeniaceae		
	Dampiera stricta (Sm.) R.Br.		
	Goodenia heterophylla subsp. *eglandulosa* Carolin		
	Goodenia paniculata Sm.		
	Haloragaceae		
	Gonocarpus chinensis subsp. *verrucosus* (Maiden & Betche) Orchard	S	
	Gonocaprus micranthus subsp. *ramosissimus* Orchard		
	Gonocarpus teucrioides DC.		Raspwort
	Lamiaceae		
	Callicarpa pedunculata R.Br.		Velvet Leaf
	Clerodendrum floribundum R.Br.		
	Clerodendrum tomentosum R.Br.		
	Gmelina leichhardtii (F.Muell.) Benth.		White Beech
	Spartothamnella juncea (A.Cunn. ex Walp.) Briq.		Bead Plant
	Lauraceae		
	Beilschmiedia elliptica C.T.White & W.D.Francis		Grey Walnut
	Beilschmiedia obtusifolia (F.Muell. ex Meisn.) F.Muell.		Blush Walnut
	Cassytha filiformis L.		
	Cassytha glabella R.Br.		
*	*Cinnamomum camphora* (L.) T.Nees & C.H.Eberm.		Camphor Laurel
	Cinnamomum oliveri F.M.Bailey		Oliver's Sassafras
	Cryptocarya glaucescens R.Br.		Jackwood
	Cryptocarya microneura Meisn.		Murrogun
	Cryptocarya obovata R.Br.		Pepperberry
	Cryptocarya rigida Meisn.		Forest Maple
	Cryptocarya triplinervis R.Br.		Three-veined Cryptocarya
	Endiandra discolor Benth.		Rose Walnut, Domatia Tree
	Endiandra muelleri Meisn.		Green-leaved Rose Walnut
	Endiandra sieberi Nees		Hard Corkwood
	Litsea australis B.Hyland		Brown Bolly Gum
	Litsea reticulata (Meisn.) F.Muell.		Bolly Gum
	Neolitsea dealbata (R.Br.) Merr.		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Lentibulariaceae		
	Utricularia australis R.Br.		
	Utricularia uniflora R.Br.		Bladderwort
	Lobeliaceae		
	Lobelia alata Labill		
	Lobelia trigonocaulis F.Muell.		Forest Lobelia
	Pratia purpurascens (R.Br.) E.Wimm.		White Root
	Loganiaceae		
	Mitrasacme paludosa R.Br.		
	Mitrasacme polymorpha R.Br.		
	Loranthaceae		
	Amyema congener subsp. *congener* (Sieber ex Schult. & Schult.f.) Tiegh.		
	Amyema miquelii (Lehm. ex Miq.) Tiegh.		
	Amylotheca dictyophleba (F.Muell.) Tiegh.		
	Benthamina alyxifolia (F.Muell. ex Benth.) Tiegh.		
	Muellerina celastroides (Sieber ex Schult. & Schult.f.) Tiegh.		
	Malvaceae		
	Hibiscus diversifolius Jacq.		
	Hibiscus heterophyllus Vent.		Native Rosella
	Hibiscus splendens C.Fraser ex Graham		
	Hibiscus tiliaceus L.		
*	*Sida rhombifolia* L.		Paddy's Lucerne
	Melastomaceae		
	Melastoma affine D.Don		Native Lasiandra
	Meliaceae		
	Dysoxylum mollissimum subsp. *molle* (Miq.) Mabb.		Red Bean
	Dysoxylum rufum (A.Rich.) Benth.		
	Melia azedarach L.		
	Synoum glandulosum subsp. *glandulosum* (Sm.) Juss.		Scentless Rosewood
	Toona ciliata M.Roem.		
	Menispermaceae		
	Legnephora moorei (F.Muell.) Miers		Round-leaf Vine
	Sarcopetalum harveyanum F.Muell.		Pearl Vine
	Stephania japonica var. *discolor* (Blume) Forman		Snake Vine
‡	*Tinospora tinosporoides* (F.Muell.) Forman	TSC: V / 3RC–	Arrowhead Vine, Arrow-head Vine
	Menyanthaceae		
	Nymphoides geminata (R.Br.) Kuntze		A Marshwort
	Nymphoides indica (L.) Kuntze		Water Snowflake
	Villarsia exaltata (Sol. ex Sims) G.Don		Yellow Marsh Flower
	Monimiaceae		
	Doryphora sassafras Endl.		Sassafras
	Wilkiea huegeliana (Tul.) A.DC.		Veiny Wilkiea

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Moraceae		
	Ficus coronata Spin		Sandpaper Fig, Creek
	Ficus fraseri Miq.		Sandpaper Fig
	Ficus macrophylla subsp. *macrophylla* Desf. ex Pers.		Moreton Bay Fig
	Ficus obliqua G.Forst.		Small-leaved Fig
	Ficus rubiginosa Desf. ex Vent.		Port Jackson Fig
	Ficus superba var. *henneana* (Miq.) Corner		Decidious Fig
	Ficus watkinsiana F.M.Bailey		Strangling Fig
	Maclura cochinchinensis (Lour.) Corner		Cockspur Thorn
	Trophis scandens (Lour.) Hook. & Arn		
	Myrtaceae		
	Acmena smithii (Poir.) Merr. & L.M.Perry		Lilly Pilly
‡	*Anetholea anisata* (Vickery) Peter G.Wilson	2RCa	Ringwood, Aniseed Tree, Aniseed Myrtle
	Angophora costata(Gaertn.) Britten		Smooth-barked Apple
	Archirhodomyrtus beckleri (F.Muell.) A.J.Scott		Rose Mrytle
	Backhousia myrtifolia Hook. & Harv.		Grey Myrtle, Ironwood
	Baeckea frutescens L.		
	Callistemon pachyphyllus Cheel		Wallum Bottlebrush
	Callistemon linearis (Schrad. & J.C.Wendl.) Sweet	S	Narrow-leaved Bottlebrush
	Callistemon salignus (Sm.) Sweet		Willow BottlebrushWhite Bottlebrush,
	Corymbia gummifera (Gaertn.) K.D.Hill & L.A.S.Johnson		Red Bloodwood
	Corymbia intermedia (R.T.Baker) K.D.Hill & L.A.S.Johnson		Pink Bloodwood
	Decaspermum humile (G.Don) A.J.Scott		Silky Myrtle
	Eucalyptus acmenoides Schauer		White Mahogany
	Eucalyptus carnea R.T.Baker		Thick-leaved Mahogany
	Eucalyptus eugenioides Sieber ex Spreng.		Thin-leaved Stringybark
	Eucalyptus fibrosa F.Muell.		Red Ironbark
‡	*Eucalyptus fusiformis* Boland	2RC–	Nambucca Ironbark, Grey Ironbark
	Eucalyptus grandis W.Hill ex Maiden		Flooded Gum, Rose Gum
	Eucalyptus microcorys F.Muell.		Tallowwood
	Eucalyptus pilularis Sm.		Blackbutt
	Eucalyptus propinqua H.Deane & Maiden		Small-fruited Grey Gum, Grey Gum
	Eucalyptus resinifera subsp. *hemilampra* (F.Muell.) L.A.S.Johnson & K.D.Hill		Red Mahogany
	Eucalyptus robusta Sm.		Swamp Mahogany
	Eucalyptus saligna Sm.		Sydney Blue Gum
	Eucalyptus siderophloia Benth.		Grey Ironbark
	Eucalyptus signata F.Muell.		Scribbly Gum
	Eucalyptus tereticornis Sm.		Forest Red Gum,
	Leptospermum juniperinum Sm.		
	Leptospermum laevigatum (Gaertn.) F.Muell.		Coastal Tea tree
	Leptospermum liversidgei R.T.Baker & H.G.Sm.		
	Leptospermum polygalifolium subsp. *cismontanum* Joy Thomps.		Tantoon

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	Species and Authority	**Status**	**Common name**
	Leptospermum trinervium (Sm.) Joy Thomps.		
	Leptospermum whitei Cheel		
	Lophostemon confertus (R.Br.) Peter G.Wilson & J.T.Waterh.		Brush Box, Brushbox
	Lophostemon suaveolens (Sol. ex Gaertn.) Peter G.Wilson & J.T.Waterh.		Swamp Mahogany, Swamp Turpentine
	Melaleuca linariifolia Sm.		Flax-leaved Paperbark
	Melaleuca quinquenervia (Cav.) S.T.Blake		Broad-leaved Paperbark
	Melaleuca sieberi Schauer		
	Melaleuca styphelioides Sm.		Prickly-leaved Tea Tree
	Melaleuca thymifolia Sm.		Fringe Honey Myrtle
	Pilidiostigma glabrum Burret		
	Rhodomyrtus psidioides (G.Don) Benth.		Native Guava
	Rhodamnia argentea Benth.		Silver Mrytle
	Rhodamnia rubescens (Benth.) Miq.		Scrub Turpentine
	Syncarpia glomulifera (Sm.) Nied		Turpentine
	Syzygium australe (J.C.Wendl. ex Link) B.Hyland		Brush Cherry
	Syzygium crebrinerve (C.T.White) L.A.S.Johnson		Rose Satinash
	Syzygium luehmannii (F.Muell.) L.A.S.Johnson		Small-leaved Lilly Pilly
	Syzygium oleosum (F.Muell.) B.Hyland		Blue Lilly Pilly
	Tristaniopsis laurina (Sm.) Peter G.Wilson & J.T.Waterh.		Water Gum, Kanooka, Kanuka
	Myrsinaceae		
	Aegiceras corniculatum (L.) Blanco		River Mangrove
*	*Ardisia crenata* Sims		Coral Berry
	Embelia australiana (F.Muell.) F.M.Bailey		
	Myrsine howittiana (F.Muell. ex Mez) Jackes		Brush Muttonwood
	Myrsine variabilis R.Br.		Muttonwood
	Oleaceae		
*	*Ligustrum sinense* Lour.		Small Leaved Privet
	Notelaea longifolia Vent.		Large Mock-olive, Large-leaved Olive
	Notelaea venosa F.Muell.		Large-leaved Mock Olive
	Olea paniculata L.		Native Olive, Maulwood
	Onagraceae		
*	*Oenothera affinis* Cambess.		
*	*Oenothera drummondii* Hook.		
*	*Oenothera indecora subsp. bonariensis W.Dietr.*		
	Oxalidaceae		
*	*Oxalis corniculata* L.		
	Oxalis exilis A.Cunn.		
	Oxalis perennans Haw.		
	Oxalis rubens Haw.		
	Passifloraceae		
*	*Passiflora edulis* Sims		Common Passionfruit
	Passiflora herbertiana Ker Gawl.		Native Passionfruit
*	*Passiflora subpeltata* Ortega		White Passionflower

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Petermanniaceae		
	Petermannia cirrosa F.Muell.		
	Phyllanthaceae		
	Bridelia exaltata F.Muell.		Brush Ironbark, Scrub Ironbark, Grey Birch, Brown Birch
	Phytolaccaceae		
*	*Phytolacca octandra* L.		Ink Weed
	Piperaceae		
	Piper novae-hollandiae Miq.		Giant Pepper Vine
	Pittosporaceae		
	Billardiera scandens Sm.		Hairy Apple Berry
	Pittosporum multiflorum (A.Cunn. ex Loudon) L.W.Cayzer et al.		
	Pittosporum revolutum Dryand. ex W.T.Aiton		
	Pittosporum undulatum Vent.		Sweet Pittosporum, Mock Orange
	Plantaginaceae		
*	*Plantago lanceolata* L.		Plantain
	Veronica plebeia R.Br.		Hairy Speedwell
	Polygalaceae		
*	*Polygala paniculata* L.		
	Comesperma defoliatum F.Muell.		
	Polygonaceae		
	Persicaria dichotoma (Blume) Masam.		
	Persicaria strigosa (R.Br.) H.Gross		
	Portulacaceae		
	Portulaca oleracea L.		Pigweed, Munyeroo, Purslane
	Proteaceae		
	Banksia aemula R. Br.		Wallum Bansksia
	Banksia integrifolia subsp. *integrifolia* L.f.		Coast Banksia
	Banksia oblongifolia Cav.		Fern-leaved Banksia
	Banksia spinulosa var. *collina* (R.Br.) A.S.George		Hairpin Banksia
	Lomatia silaifolia (Sm.) R.Br.		Crinkle Bush, Fern-leaved Lomatia, Parsley Bush
	Orites excelsus R.Br.		Mountain Silky Oak, Prickly Ash
	Persoonia conjuncta P.H.Weston & L.A.S.Johnson	S	
	Persoonia cornifolia A.Cunn. ex R.Br.		
	Persoonia stradbrokensis Domin		
	Stenocarpus sinuatus (Loudon) Endl.		
	Triunia youngiana (C.Moore & F.Muell.) L.A.S.Johnson & B.G.Briggs		Spice Bush, Native Honeysuckle, Red Nut
	Putranjivaceae		
	Drypetes deplanchei (Brongn. & Gris) Merr.		Yellow Tulipwood, Greybark, Yellow Tulip, Grey Boxwood, White Myrtle, Grey Bark
	Quintiniaceae		
	Quintinia verdonii F.Muell.		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Ranunculaceae		
	Clematis aristata Ker Gawl.		Old Man's Beard
	Clematis glycinoides DC.		Headache Vine
	Ranunculus inundatus R.Br. ex DC.		River Buttercup
	Rhamnaceae		
	Alphitonia excelsa (Fenzl) Benth		Red Ash
	Rosaceae		
	Rubus moluccanus var. *trilobus* A.R.Bean		Molluca Bramble
	Rubus moorei F.Muell.		Silky Bramble
	Rubus nebulosus A.R.Bean		Green-leaved Bramble
	Rubus parvifolius L.		Native Raspberry
	Rubus rosifolius Sm.		Rose-leaf Bramble, Native Raspberry
	Rubiaceae		
	Atractocarpus benthamianus (F.Muell.) Puttock		Native Gardenia
	Cyclophyllum longipetalum S.T.Reynolds & R.J.F.Hend.		
	Hodgkinsonia ovatiflora F.Muell.		
	Morinda jasminoides A.Cunn.		
	Pomax umbellata (Gaertn.) Sol. ex A.Rich.		
	Psychotria loniceroides Sieber ex DC.		
*	*Richardia brasiliensis* Gomes		
	Rutaceae		
	Acronychia imperforata F.Muell.		Logan Apple
	Acronychia pubescens (F.M.Bailey) C.T.White		
‡	*Acronychia littoralis* T.G.Hartley & J.B.Williams	TSC: E / 3ECi	Scented Acronychia
	Acronychia oblongifolia (A.Cunn. ex Hook.) Endl. ex Heynh.		White Aspen, Yellow Wood
	Boronia falcifolia A.Cunn. ex Endl.		Wallum Boronia
*	*Citrus* × *taitensis* Risso		Bush Lemon, Rough Lemon, Rangpur Lime, Wild Lemon
	Flindersia schottiana F.Muell.		Cudgerie
	Melicope hayesii T.G.Hartley		Small-leaved Doughwood
	Nematolepis squamea subsp. *squamea* (Labill.) Paul G.Wilson		Satinwood
	Zieria smithii Jacks.		Sandfly Zieria
	Santalaceae		
	Exocarpos cupressiformis Labill.		Cherry Ballart
	Sapindaceae		
	Alectryon coriaceus (Benth.) Radlk.		Beach Alectryon, Beach Birds Eye
	Alectryon subcinereus (A.Gray) Radlk.		Native Quince
	Arytera divaricata F.Muell.		Coogera, Rose Tamarind
	Cupaniopsis anacardioides (A.Rich.) Radlk.		Tuckeroo
	Diploglottis cunninghamii (Hook.) Hook.f. ex Benth.		Native Tamarind
	Dodonaea triquetra J.C.Wendl.		Large-leaf Hop-bush
	Guioa semiglauca (F.Muell.) Radlk.		Guioa

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	Species and Authority	**Status**	**Common name**
	Jagera pseudorhus var. *pseudorhus* (A.Rich.) Radlk.		Foambark Tree
	Mischocarpus pyriformis subsp. *pyriformis* (F.Muell.) Radlk.		Pear-fruited Tamarind
	Sarcopteryx stipata (F.Muell.) Radlk.		
	Sapotaceae		
	Planchonella australis (R.Br.) Pierre		Black Apple
‡	*Niemeyera whitei* (Aubr,v.) Jessup	TSC: V	Rusty Plum, Plum Boxwood
	Scrophulariaceae		
	Bacopa monnieri (L.) Pennell		
	Artanema fimbriatum D.Don	S	
	Solanaceae		
*	*Solanum capsicoides* All.		Devils Apple
	Duboisia myoporoides R. Br.		Corkwood
*	*Solanum chenopodioides* Lam.		
	Solanum densevestitum F.Muell. ex Benth.		
	Solanum inaequilaterum Domin		
*	*Solanum mauritianum* Scop.		Wild Tobacco Bush
*	*Solanum nigrum* L.		Black-berry Nightshade
	Solanum prinophyllum Dunal		Forest Nightshade
*	*Solanum rostratum*		
	Stackhousiaceae		
	Stackhousia nuda Lindl.		
	Sterculiaceae		
	Brachychiton acerifolius (A.Cunn. ex G.Don) Macarthur & C.Moore		Flame Tree
	Commersonia fraseri J.Gay		Brush Kurrajong
	Heritiera trifoliolata (F.Muell.) Kosterm.		White Booyong
	Seringia arborescens (Aiton) Druce		
	Symplocaceae		
	Symplocos thwaitesii F.Muell.		Buff Hazelwood
	Theophrastaceae		
	Samolus repens (J.R.Forst. & G.Forst.) Pers.		
	Thymelaeaceae		
	Pimelea linifolia subsp. *linifolia* Sm.		
	Wikstroemia indica (L.) C.A.Mey.		Riceflower
	Tremandraceae		
	Tetratheca thymifolia Sm.		Black-eyed Susan
	Trimeniaceae		
	Trimenia moorei (Oliv. ex Benth.) Philipson		Bitter Vine
	Ulmaceae		
	Celtis paniculata (Endl.) Planch.		
	Trema tomentosa var. *viridis* (Planch.) Hewson		Peach-leaf Poison-bush, Native Peach, Poison Peach
	Urticaceae		
	Boehmeria macrophylla Hornem.		
	Dendrocnide excelsa (Wedd.) Chew		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Dendrocnide photinophylla (Kunth) Chew		
	Urtica incisa Poir.		Stinging Nettle
	Winteraceae		
	Tasmannia insipida R.Br. ex DC.		Brush Pepperbrush
	Verbenaceae		
	Clerodendrum tomentosum R.Br.		Hairy Clerodendrum
*	*Lantana camara* L.		Lantana
*	*Verbena bonariensis* L.		Purple Top
	Violaceae		
	Hybanthus stellarioides (Domin) P.I.Forst.		
	Viola banksii K.R.Thiele & Prober		Ivy-leaved Violet
	Viola hederacea Labill.		
	Viscaceae		
	Notothixos incanus (Hook.) Oliv.		
	Notothixos subaureus Oliv.		
	Vitaceae		
	Cayratia clematidea (F.Muell.) Domin		Kangaroo Vine, Water Vine
	Cissus antarctica Vent.		Water Vine
	Cissus hypoglauca A.Gray		
	Cissus sterculiifolia (F.Muell. ex Benth.) Planch.		Long-leaved Water Vine Yaroong
	Tetrastigma nitens (F.Muell.) Planch.		
	Monocots		
	Araceae		
	Alocasia brisbanensis (F.M.Bailey) Domin		Cunjevoi, Spoon Lily
*	*Colocasia esculenta* (L.) Schott		Taro
	Gymnostachys anceps R.Br.		Settlers' Twine, Boorgay
	Pothos longipes Schott		
	Amaryllidaceae		
	Crinum pedunculatum R.Br.		River Lily
	Antheriaceae		
	Caesia parviflora var. parviflora R.Br.		Pale Grass Lily
	Thysanotus tuberosus R.Br.		Common Fringe Lily
	Tricoryne elatior R.Br.		
	Arecaceae		
	Archontophoenix cunninghamiana (H.Wendl.) H.Wendl. & Drude		Bangalow Palm, Piccabeen
	Calamus muelleri H.Wendl. & Drude		Southern Lawyer Cane, Wait-a-while
	Linospadix monostachya (C.Mart.) H.Wendl.		Walking Stick Palm
	Livistona australis (R.Br.) Mart.		
	Asparagaceae		
	**Asparagus aethiopicus* L.		
	Asteliaceae		
	Cordyline stricta (Sims) Endl.		Narrow-leaved Palm Lily

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Blandfordiaceae		
	Blandfordia grandiflora R.Br.		Christmas Bells
	Cochliaceae		
	Burchardia umbellata R.Br.		Milk Maids
	**Gloriosa superba* L.		Glory Lily, Climbing Lily
	Commelinaceae		
	Aneilema biflorum R. Br.	S	
	Aneilema acuminatum R.Br.		
	Commelina cyanea R.Br.		Native Wandering Jew
*	*Tradescantia fluminensis* Vell		Wandering Jew
	Cyperaceae		
	Baumea articulata (R.Br.) S.T.Blake		Jointed Twig-rush
	Baumea gunnii (Hook.f.) S.T.Blake	S	
	Baumea muelleri (C.B.Clarke) S.T.Blake		
	Baumea juncea (R.Br.) Palla		
	Baumea rubiginosa (Spreng.) Boeck.		
	Bolboschoenus fluviatilis (Torr.) Sojak		
	Carex appressa R.Br.		
	Carex fascicularis Sol. ex Boott		Tassell Sedge
	Carex gaudichaudiana Kunth		
	Carex maculata Boott		
	Carex pumila Thunb. ex Murray		
	Caustis recurvata var. *recurvata* Spreng.		
	Chorizandra cymbaria R.Br.		
	Cladium procerum S.T.Blake		
	Cyperus enervis R.Br.		
	Cyperus filipes Benth.		
	Cyperus eragrostis Lam.		
	Cyperus gracilis R.Br.		
	Cyperus haspan subsp. *juncoides* (Lam.) Kuek.		
	Cyperus laevigatus L.		
	Cyperus leiocaulon Benth.		
	Cyperus polystachyos Rottb.		
	Cyperus stradbrokensis Domin		
	Cyperus subulatus R.Br.		Pointed Flat-sedge
	Cyperus tetraphyllus R.Br.		
	Eleocharis acuta R.Br.		
	Eleocharis sphacelata R. Br.		Tall Spike Rush
	Ficinia nodosa (Rottb.) Goetgh. et al.		Knobby Club-rush
	Fimbristylis dichotoma (L.) Vahl		Common Fringe Sedge
	Gahnia aspera (R.Br.) Spreng.		Rough Saw-sedge
	Gahnia sieberiana Kunth		Red-fruit saw-sedge
	Isolepis cernua (Vahl) Roem. & Schult.		Nodding Club-rush

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Isolepis fluitans	S	Floating Club-rush
	Isolepis inundata R.Br.		
	Lepidosperma filiforme Labill.		
	Lepidosperma laterale R.Br.		
	Lepironia articulata (Retz.) Domin		
	Rhynchospora corymbosa (L.) Britton		Grassy Beak-rush
	Schoenoplectus subulatus (Vahl) Lye		
	Schoenoplectus validus (Vahl) A.L"ve & D.L"ve		
	Schoenoplectus mucronatus (L.) Palla ex A.Kern.	S	
	Schoenus brevifolius R.Br.		Black Bog-rush, Zig-zag Bog-rush
	Schoenus lepidosperma subsp. *pachylepis* (S.T.Blake) K.L.Wilson	S	
	Schoenus nitens (R.Br.) Roem. & Schult.		Shiny Bog-rush
	Dioscoraceae		
	Dioscorea transversa R.Br.		Native Yam
	Flagellariaceae		
	Flagellaria indica L.		Whip Vine, Bush Cane
	Haemodoraceae		
	Haemodorum planifolium R.Br.		Bloodroot
	Hypoxidaceae		
	Hypoxis hygrometrica Labill.		Golden Weather Grass
	Iridaceae		
	Patersonia glabrata R.Br.		
	Patersonia fragilis (Labill.) Asch. & Graebn.	S	Swamp Iris
	Sisyrinchium sp. A sensu James & Brown (1993		
	Juncaceae		
	Juncus bufonius L.		Toad Rush
	Juncus kraussii subsp. *australiensis* (Buchenau) Snogerup		Sea Rush
	Juncus planifolius R.Br.		
	Juncus polyanthemus Buchenau		Tussock Rush
	Juncus usitatus L.A.S.Johnson		
	Luzula meridionalis H.Nordensk.		Field Woodrush
	Juncaginaceae		
	Triglochin procerum R. Br.		Water Ribbons
	Triglochin striata Ruiz & Pav.		
	Lomandraceae		
	Lomandra confertifolia subsp. *pallida* A.T.Lee		
	Lomandra filiformis subsp. *filiformis* (Thunb.) Britten		
	Lomandra hystrix (R.Br.) L.R.Fraser & Vickery		
	Lomandra longifolia Labill.		Spiny-headed Mat-rush, Honey Reed
	Lomandra multiflora subsp. *multiflora* (R.Br.) Britten		Many-flowered Mat-rush
	Lomandra spicata A.T.Lee		
	Luzuriagaceae		
	Eustrephus latifolius R.Br. ex Ker Gawl.		Wombat Berry

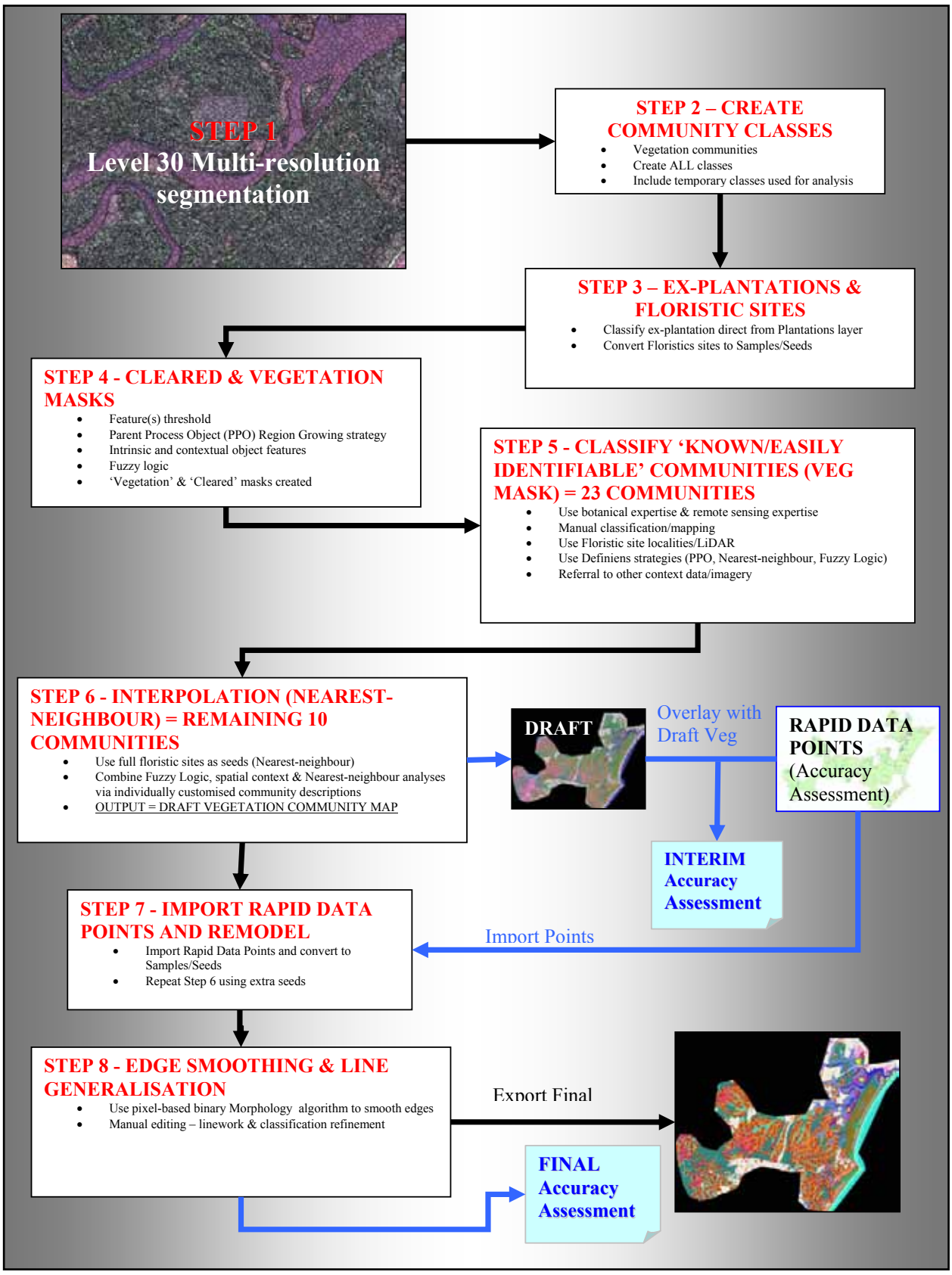
Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
	Geitonoplesium cymosum (R.Br.) A.Cunn. ex Hook.		Scrambling Lily
	Orchidaceae		
‡	*Acianthella amplexicaulis* (F.M.Bailey) D.L.Jones & M.A.Clem.	3RC–	
	Acianthus exiguus D.L.Jones		
	Acianthus fornicatus R.Br.		Pixie Caps
	Caladenia carnea R.Br.		
	Caladenia catenata (Sm.) Druce		White Caladenia, White Fingers
	Calanthe triplicata (Willemet) Ames		Christmas Orchid
	Calochilus campestris R.Br.		Copper Beard Orchid
	Chiloglottis sylvestris D.L.Jones & M.A.Clem.	S	Bird Orchid
	Corybas aconitiflorus Salisb.		Spurred Helmet Orchid
	Corybas fimbriatus (R.Br.) Rchb.f.		Fringed Helmet Orchid
	Cryptostylis erecta F.Muell. ex Benth.		Bonnet Orchid, Tartan Tongue Orchid
	Cryptostylis subulata (Labill.) Rchb.f.		Large Tongue Orchid
	Cymbidium canaliculatum R.Br.		Tiger Orchid
	Cymbidium madidum Lindl.		
	Cymbidium suave R.Br.		Snake Orchid
	Dendrobium aemulum R.Br.		Ironbark Orchid, White Feather Orchid
	Dendrobium linguiforme Sw.		Tongue Orchid
	Dendrobium tetragonum A.Cunn.		Tree Spider Orchid
	Dendrobium teretifolium R.Br.		Rat's tail Orchid
	Dipodium variegatum M.A.Clem. & D.L.Jones		
	Microtis unifolia (G.Forst.) Rchb.f.		Common Onion Orchid
‡	*Oberonia titania* Lindl.	TSC: V	
‡	*Peristeranthus hillii* (F.Muell.) T.E.Hunt	TSC: V	Brown Fairy Chain Orchid, Great Climbing Orchid
	Plectorrhiza tridentata (Lindl.) Dockrill		Tangle Orchid
	Pseudovanilla foliata (F.Muell.) Garay		
	Pterostylis nutans R.Br.		Nodding Greenhood
	Pterostylis ophioglossa R.Br.		Snake Tongue Orchid
	Sarcochilus falcatus R.Br.		Orange-blossom Orchid
	Spiranthes australis (R.Br.) Lindl.		Ladies's Tresses
	Nymphaeaceae		
*	*Nymphaea caerulea* subsp. *zanzibarensis* (Casp.) S.W.L.Jacobs		Cape Waterlily
	Philydraceae		
	Philydrum lanuginosum (Banks & Sol.) Gaertn.		Wooly Frogsmouth
	Phormiaceae		
	Dianella caerulea var. *producta* Sims		
	Dianella congesta R.Br.		
	Dianella longifolia var. *longifolia* R.Br.		
	Poaceae		

Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
‡	*Alexfloydia repens* B.K.Simon	TSC: E / 2K	Floyd's Grass
*	*Andropogon virginicus* L.		Whisky Grass
	Cenchrus caliculatus Cav.		Hillside Burrgrass
*	*Cenchrus echinatus* L.		Spiny Burr Grass
*	*Cenchrus incertus* M.A.Curtis		Spiny Burr Grass
*	*Chloris gayana* Kunth		Rhodes Grass
	Cymbopogon refractus (R.Br.) A.Camus		Barbed Wire Grass
	Cynodon dactylon (L.) Pers.		Blue Couch
	Dichelachne crinita (L.) Hook.f.		Longhair Plume Grass
	Dichelachne micrantha (Cav.) Domin		
	Digitaria parviflora (R.Br.) Hughes		
	Digitaria ramularis (Trin.) Henrard		
	Echinopogon caespitosus C.E.Hubb.		Bushy Hedgehog-grass
	Entolasia marginata (R.Br.) Hughes		Wiry Panic
	Entolasia stricta (R.Br.) Hughes		
	Eragrostis elongata (Willd.) J.Jacq.		Clustered Lovegrass
	Eragrostis leptostachya Steud.		Paddock Lovegrass
*	*Eragrostis mexicana* (Hornem.) Link		
	Hemarthria uncinata R.Br.		MatGrass
	Imperata cylindrica P.Beauv.		Blady Grass
	Ischaemum australe var. *villosum* (R.Br.) Benth.		
	Lachnagrostis filiformis (G.Forst.) Trin.		
*	*Melinis minutiflora* P.Beauv.		Molasses Grass
*	*Melinis repens* (Willd.) Zizka		Red Natal Grass
	Microlaena stipoides var. stipoides (Labill.) R.Br.		Weeping Meadow Grass
	Oplismenus aemulus (R.Br.) Roem. & Schult.		
	Oplismenus imbecillis (R.Br.) Roem. & Schult.		
	Ottochloa gracillima C.E.Hubb.		
	Panicum bisulcatum Thunb.		
	Panicum simile Domin		Two-colour Panic
*	*Panicum schinzii Hack.*		
	Paspalidium distans (Trin.) Hughes		
*	*Paspalum dilatatum* Poir.		Paspalum
*	*Paspalum urvillei* Hack.		Vasey Grass
*	*Paspalum mandiocanum* Trin.		Broad-leaved Paspalum, Broad-leaf or Broadleaf Paspalum, Warrel Grass
	Phragmites australis (Cav.) Trin. ex Steud.		Common Reed
*	*Setaria palmifolia* (J.Koenig) Stapf		Palm Grass
*	*Setaria sphacelata* (Schumach.) Stapf & C.E.Hubb.		South African Pigeon Grass
	Spinifex sericeus R.Br.		Hairy Spinifex
*	*Sporobolus africanus* (Poir.) Robyns & Tournay		Parramatta Grass
	Sporobolus elongatus R.Br.		Slender Rat's Tail Grass
	Sporobolus virginicus (L.) Kunth		

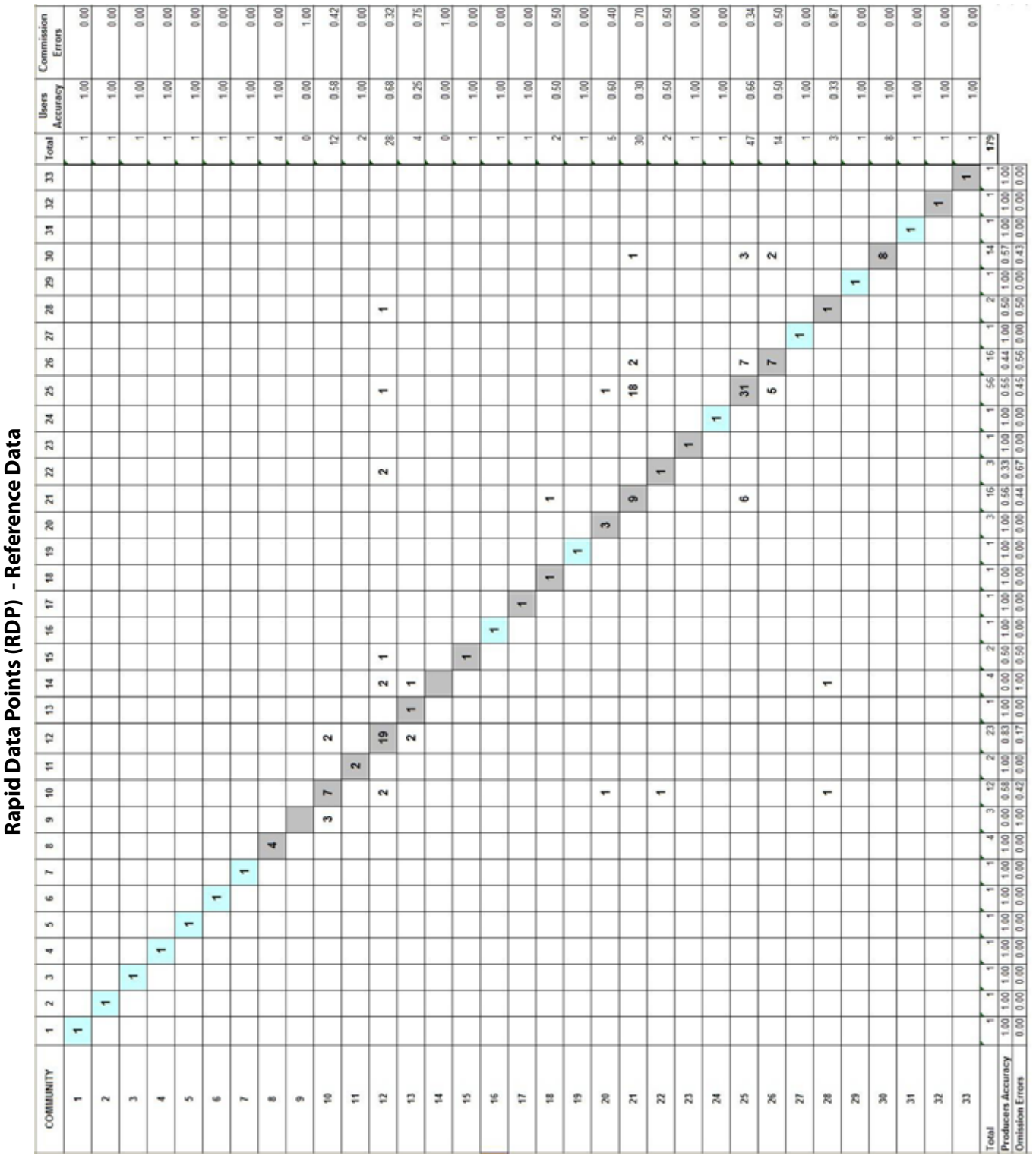
Appendix 3 Species of vascular plants recorded in Bongil Bongil National Park			
	Species and Authority	**Status**	**Common name**
*	*Stenotaphrum secundatum* (Walter) Kuntze		Buffalo Grass
	Themeda australis (R.Br.) Stapf		Kangaroo Grass
	Zoysia macrantha Desv.		Prickly Couch
	Restionaceae		
	Baloskion tetraphyllum subsp. *meiostachyum* (L.A.S.Johnson & O.D.Evans) B.G.Briggs & L.A.S.Johnson		
	Hypolaena fastigiata R.Br.		
	Lepyrodia sp. A sensu Harden (1994)		
	Sporadanthus interruptus (F.Muell.) L.A.S.Johnson & B.G.Briggs		
	Ripogonaceae		
	Ripogonum album R.Br.		White Supplejack
	Ripogonum brevifolium Conran & Clifford		Small-leaved Supplejack
	Ripogonum discolor F.Muell.		Prickly Supplejack
	Ripogonum elseyanum F.Muell.		
	Ripogonum fawcettianum F.Muell. ex Benth.		Small Supplejack
	Smilacaceae		
	Smilax australis R.Br.		Lawyer Vine, Wait-a-while, Barbwire Vine
	Smilax glyciphylla Sm.		Sweet Sarsaparilla
	Sparganiaceae		
	Sparganium subglobosum Morong		
	Typhaceae		
	Typha orientalis C.Presl.		Broadleaf Cumbingi
	Typha domingensis Pers.		Narrow-leaved Cumbungi
	Uvulariaceae		
	Tripladenia cunninghamii D.Don		
	Xanthorrhoeaceae		
	Xanthorrhoea fulva (A.T.Lee) D.J.Bedford		Grass tree
	Xanthorrhoea glauca subsp. *glauca* D.J.Bedford		
	Xanthorrhoea malacophylla D.J.Bedford		
	Xanthorrhoea macronema F.Muell. ex Benth.		
	Xyridaceae		
	Xyris gracilis R.Br.		
	Xyris operculata Labill.		
	Zingiberaceae		
	Alpinia arundelliana (F.M.Bailey) K.Schum.		Native Ginger
	Alpinia caerulea (R.Br.) Benth.		
	Total species	**674**	
	Number of threatened or ROTAP species	**14**	
	Additional species of significance	**17**	
	Total number of exotic species (86-14)	**72**	

Appendix 4 Definiens Interpolation–Interpretation Pathway

A detailed expansion of the flow-chart showing the Definiens interpolation–interpretation process (see Methods: 2.6.1 Definiens – Interpolation and spatial interpretation method, including Figure 2.1).



Appendix 5 Interim Accuracy Assessment– Confusion Matrix



Overall Accuracy 62.57%

NB Overall Accuracy = Total Sites / Sum of Diagonals = 112 / 179

MATRIX LEGEND

NB All shaded squares are n the matrix diagonal.

All non-shaded squares with values are RDP's

RDP Sites on Diagonal

Pseudo Sites Only

Community	Name
1	Derived Freshwater Wetland
2	Strandline Grassland
3	Coast Wattle Shrubland
4	Coast Banksia Shrubland
5	Prickly Couch Grassland of Intermittent Coastal Lagoons
6	Dune Soak Shrubland
7	Dune Soak Sedgeland
8	White's Tea-tree Shrubland
9	Tantoon Tea-tree Shrubland
10	Swamp Mahogany–Satinwood Sand Swamp Forest
11	Grey Mangrove Shrubland/Woodland/Closed Forest
12	Broad-leaved Paperbark–Willow Bottlebrush Floodplain Swamp Sclerophyll Forest
13	Broad-leaved Paperbark–Willow Bottlebrush Channel Swamp Sclerophyll Forest
14	Swamp Oak Swamp Sclerophyll Forest
15	Sea Rush Saltmarsh
16	Saltwater Couch Saltmarsh
17	Maiden's Blush–White Booyong Floodplain Subtropical Rainforest
18	Small-leaved Lilly Pilly–Pear-fruited Tamarind Littoral Rainforest
19	Headland Brushbox Littoral Rainforest
20	Tallowwood–Blackbutt–Turpentine Dry Open Forest
21	Blackbutt–Turpentine–Tallowwood Grassy Ferny Dry Open Forest
22	Pink Bloodwood–Turpentine Meander Plain Forest
23	Pink Bloodwood Sand Open Forest
24	Pink Bloodwood–Blackbutt–Tallowwood Sand Open Forest
25	Blackbutt–Flooded Gum–Turpentine–Tallowwood Wet Sclerophyll Forest
26	Flooded Gum–Bangalow Palm Riparian Wet Sclerophyll Forest
27	Scribbly Gum Sand Forest
28	Blackbutt Creek-bank Forest
29	Derived Native Grassland
30	Bangalow Palm–Coachwood–Maiden's Blush Gully Rainforest
31	*Schoenoplectus subulatus* Saltmarsh
32	*Baloskion pallens–Blechnum indicum* Sedgeland
33	Swamp Mahogany–*Melaleuca sieberi* Shrubland