Conjola and Morton National Parks Vegetation Survey and Mapping 2004

prepared by

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APPENDICES

1 INTRODUCTION

This report describes the methodology, results and conclusions of the vegetation survey and mapping of forest ecosystems of Conjola National Park and the adjoining extension of Morton National Park, in the Ulladulla Area of the South Coast Region. The report has been prepared by **ngh**environmental under contract for the NSW NPWS South Coast Region (Ulladulla Office). The project has also covered Narrawallee Creek Nature Reserve to the south of Conjola National Park, which is documented in a separate report. A report on the establishment of fire response monitoring plots has also been prepared, based on work undertaken during this project.

1.1 Background

During the Southern Comprehensive Regional Assessment (Southern CRA) in the late 1990s, a major project was undertaken to map vegetation types using full floristic site data, aerial photographic interpretation and modelling using climatic and physical environmental data. The project covered a large area within the Southern Directorate, part of which is the South Coast Region, covering all land tenure types. Methodology was previously developed for the Eden CRA and documented in a systematic review of forest ecosystem types, extent and conservation significance by Keith and Bedward (1999). A new classification and modelling methodology was developed for the Southern CRA and documented by Thomas, Gellie and Harrison (2000), which was heavily based on mapping by air photo interpretation.

Validating and where necessary re-mapping modelled forest ecosystems is necessary for conservation management of land within the National Parks Estate. This achieves a greater degree of detail and reliability that is necessary to support aspects such as pest and fire management, threatened species management and ecologically sustainable forest management. Methodology for this validation process was developed in 1999 by Nicholas Graham Higgs Pty Ltd (now **ngh**environmental) and has been applied in stages for the whole of the NPWS Estate in the Merimbula and Bombala areas together with Kooraban and Gulaga National Parks of the Far South Coast Region. Within the South Coast Region, a similar project was undertaken in 2001-2002 for the Ulladulla Office of NPWS covering Murramarang National Park and related offshore islands, Meroo National Park and Barnunj State Recreation Area.

This report is the result of the adaptation and application of previously used methodologies for the sampling and re-mapping of forest ecosystems in the Ulladulla Area. The project has involved field mapping, database entry of field data, air photo interpretation and GIS mapping as means of validating the modelled map by Thomas, Gellie and Harrison (2000) and preparing a revised map based on these findings.

1.2 Objectives

The aims as specified in the project brief are to:

- Carry out plot-based, full-floristic field surveys in Narrawallee Creek Nature Reserve, Cudmirrah and Conjola National Parks and the Morton National Park eastern addition;
- Prepare a field validated vegetation map for the study area identifying the dominant canopy and understorey vegetation associations and;
- Establish fire response monitoring plots to compliment and enhance existing operational sites for incorporation into the Vegetation Response to Fire Monitoring Project and state-wide database at sites selected as being appropriate.

The overall objective of the work is to provide a vegetation data set which includes floristic site data and updated vegetation maps of Conjola National Park, the eastern extension of Morton National Park and Narrawallee Creek Nature Reserve, with special reference to forest ecosystems of conservation management significance, supported by documentation of the methodology used and results obtained.

Specific objectives in the work were:

- to identify sites for floristic surveys to complement existing CRA data and to provide a basis for ongoing fire response monitoring;

- to sample important ecosystems that are vulnerable, rare, under-represented in the reserve system or fire sensitive;
- to undertake full-floristic plot sampling and provide an inventory of vascular flora from each of the plots and other environmental data as specified, including additional data for those sites established for fire monitoring purposes;
- to provide revised vegetation maps of the study area according to project specifications;
- to provide two reports on the vegetation mapping work, one for Conjola and Morton National Parks and one for Narrawallee Creek Nature Reserve with recommendations for managing rare or fire-sensitive vegetation associations and
- to provide a report on the fire response monitoring sites.

1.3 Project Requirements

The following specific requirements were identified in the project brief.

Standard floristic survey sites:

- In conjunction with NPWS staff and using a gap analysis method, identify 15 sites to undertake plot-based, full-floristic surveys to complement existing CRA site data.
- Undertake full-floristic plot-based sampling using the standardised botanical plot sampling methodology such as that used during the CRA including permanent plot and photo-point establishment at each site.
- Provide an inventory of vascular flora and relevant environmental data from each of the plots, ensuring that the full range of important ecosystems or vegetation associations that are vulnerable, rare, under-represented in the reserve system or fire sensitive are sampled. Detailed notes made of fuel loadings and unusual, unique or interesting features found on or near plots are also required.

Fire response monitoring sites:

- In conjunction with NPWS staff, select at least 12 fire response monitoring sites (in both burnt and unburnt areas) in a range of vegetation types, where possible selecting sites with rare or threatened plant (ROTAP) species and/ or areas of highest fire risk potential. These sites may overlap with the full-floristic sites established to validate the CRA forest ecosystem mapping or be sites where full-floristic plots were measured during the CRA;
- Undertake full-floristic plot based sampling as per methodology described in Section 5: Methodology – Systematic Survey.
- Establish photo points at each monitoring site; and,
- Provide a stand-alone report of the work outlining the basis for selection of monitoring sites, description of location and fire history of each site including map, photographs of each site and full floristic or plant species fire response and fire fuel sampling sheet(s) for each site. The report is to be a stand-alone document containing a full set of maps, tables, appendices and photographs.

Mapping:

- Using the Southern CRA forest ecosystems classification and existing forest ecosystem mapping as a basis and guide, and other Southern CRA ecosystem-related datasets provided by NPWS, prepare a validated hard copy and digital vegetation map at a scale of 1:25,000 for each reserve. This is to include floristic data collected from the 20 (approx) existing sites created from the CRA and data collected from the 40 canopy plots set up by the CSIRO and associated Kevin Mills and Associates Pty Ltd survey (The Vegetation of Cudmirrah National Park, Conjola National Park, Cudmirrah Nature Reserve). This information will also be provided by NPWS.

- A revised and reliable extant forest ecosystems map is to be prepared for the study area utilising pre-existing information as specified above and information collected in the field surveys component of this project.
- The contractor is expected to have available and utilise a sophisticated level of GIS capability and that is ESRI-ArcView compatible.

Reports:

- Prepare two project reports, one for Narrawallee Creek Nature Reserve and another for the Conjola/Cudmirrah and Morton National Park (eastern addition) including recommendations for managing rare, vulnerable or fire-sensitive vegetation associations. The reports are to be stand-alone documents containing a full set of maps, tables, appendices and photographs.

1.4 The Study Area

The study area lies north of the towns of Ulladulla and Milton and south of Jervis Bay on the NSW South Coast. It extends from the coastline to the cliff-lined escarpment west of the Princes Highway, which lies along the eastern edge of the large Morton National Park. The coastal parks, Conjola National Park and Narrawallee Creek Nature Reserve, include much of the large Conjola Lake and Swan Lake foreshores, several smaller lakes and lagoons, extensive coastal forests and portions of the coastline. The small villages of Conjola Lake, Cunjarong, Manyana, Bendalong, Berrara, Cudmirrah and Swan Haven, and associated coastlines are excluded from but surrounded by the parks and the larger village of Sussex inlet lies to the north of the study area. West of the Princes Highway, the study area extends into Morton National Park to include land along and below the coastal escarpment which was recently added to that park.

Conjola National Park has existed since 1994 as a relatively small park along the northern shores of Lake Conjola. The separate Cudmirrah National Park, also gazetted in 1994, covered the coastline and shores of Swan Lake between the village of Bendalong in the south and Sussex Inlet in the north. It absorbed and greatly expanded the former Cudmirrah Nature Reserve which occupied the coastal dunes and wetlands between Bendalong and Barrara. As an outcome of the Southern Regional Forest Agreement, the two national parks were greatly expanded in 2001 with the transfer of 7,600 hectares of land formerly within Conjola State Forest. The new park is now Conjola National Park. At the same time, 6,570 hectares of land west of the Princes Highway in portions of Yerriyong, Jerrawangala and McDonald State Forests was added to Morton National Park. This eastern extension of Morton includes land adjoining Conjola National Park, effectively connecting land under National Parks Estate, from the Budawang Range through the Clyde River gorge and Little Forest Plateau to the coastline.

Narrawallee Creek Nature Reserve lies to the south of Lake Conjola and is documented in a separate report. The study area referred to in the remainder of this report, therefore, refers to the Conjola-Morton portion only.

The majority of the study area is underlain by sedimentary rocks of the Sydney Basin, with smaller areas of Quaternary or Tertiary sediments along parts of the coastline. Granites occur only in the north west of the study area within Morton National Park.

The coastline is predominantly fringed by beaches and dunes, broken by occasional rocky headlands and minor cliff lines. Swamps are numerous but mostly small and confined to drainage lines. Conjola Lake in the south and Swan Lake in the north (the waters of which are excluded from the parks) are prominent features within the study area and estuaries exist on the lower reaches of Berrara and Nerrindillah Creeks. Conjola Lake and the connected Berringer Lake are tidal while Swan Lake appears to be only occasionally open to the sea. It was open in 1993 when the air photos were flown but was closed in more recent years (as evidenced by the orthophotos and recent field work. It is therefore likely to be brackish but not normally tidal.

As a result, Conjola National Park protects a diversity of coastal and estuarine landforms, plant communities and animal habitats including extensive dunal systems, estuaries, swamps and important bird breeding and feeding areas. The vegetation ranges from dry forests on the ridges and flatter elevated areas, moist forests and rainforests in the many gullies, to the non-forest communities of the

estuarine wetlands, lake foreshores, dunes and rocky headlands. Twenty one threatened species of fauna and eighteen regionally significant fauna species have been recorded, plus the rare *Pultenaea villifera* var *villifera*, *Grevillea maclayana* and *Cryptostylis hunteriana* and nineteen regionally significant plants, many of which have their southern limit of distribution in the area. There is a high diversity and occurrence of Aboriginal sites and some features of local historical significance are protected within the Park.

By contrast, the portion of Morton National Park within the study area, is more rugged, including the cliff-lined escarpment of Little Forest Plateau (at around 500 metres above sea level) and dissected land below the plateau. The northern part of the extension of this park falls away from the escarpment and connects with Conjola National Park while the southern part contains some cliff-rimmed outliers of the plateau and falls away to state forests and cleared rural land which separate it from Conjola National Park. The Morton National Park extension protects areas of moist heath and cycad/shrub dry forests which differ floristically from those of the coastal areas.

Being originally mostly state forests, the study area has a history of disturbance from logging and is dissected by many roads and powerlines. Wildfires have been a major environmental factor influencing the vegetation and consequently a key factor in conservation and fire management of the parks. NPWS records indicate extensive wildfires in 1968-69 and 1991-92 as well as more frequent smaller fires. Much of the study area was burned more recently during the Hylands fire in December 2001, prompting the need for ongoing fire response monitoring of the vegetation.

1.5 Previous Studies

The review of previous vegetation studies documented by Thomas, Gellie and Harrison (2000) lists only one study relating specifically to the vegetation of the study area, by Kevin Mills and Associates (1995). The report on the vegetation of the former Cudmirrah National Park and Nature Reserve and Conjola National Park, all now included in the current enlarged Conjola National Park (K. Mills & Associates, 1995), was used as a source of information on vegetation communities present, their conservation significance and the conservation significance of particular plant species in the region. Mills described and mapped the location of 18 communities including 12 eucalypt forests or woodlands, with the latter including 5 heathy communities (characterised by an open tree cover and understorey dominated by sclerophyll shrubs), and 6 wetland or littoral non-eucalypt communities. The correspondence between Mills' communities and the Southern CRA forest ecosystem types is detailed in section 1.7. The report and GIS vegetation map layers of the work by Mills were consulted during this project.

Other vegetation studies which were consulted cover much broader areas, such as the CSIRO canopy survey in the 1990s and the surveys which formed part of the Southern CRA. Floristics data arising from these have been incorporated in the NPWS floristic survey sites database which was used during the present study. The database contains around 30 canopy only sites by CSIRO. A further 25 sites within the study area have been surveyed by Kevin Mills (consultant). The remaining 14 sites are all part of the Southern CRA floristic surveys and were full floristic surveys.

Mapping of floristic types for forestry purposes in the state forests now included in the study area may have been carried out for internal purposes by State Forests, but this type of mapping is generally specific to target species for logging and generally not useful for other purposes. The most useful forestry mapping is the RN17 (Research Note 17), which is generally high quality API mapping, and was used in the Southern CRA API project.

Comprehensive mapping of the South Coast portion of the Southern CRA study area is documented in the Southern Region CRAFTI report (RACD, DUAP, 2000). This study, which was based on API assessment of forested lands, resulted in structural-based mapping related to growth stage, which was assigned broad floristic type classes This mapping provided a basis for assessing regional conservation status of vegetation communities, identification of old growth, fauna modelling, wilderness assessment and forest ecosystems modelling.

Using the CRAFTI API vegetation mapping as a basis, and drawing on methodology developed during the Eden CRA (Keith and Bedward, 1995, 1998,1999) for forest ecosystem modelling, new methodology was developed and applied to the Southern CRA area to produce a modelled layer of forest ecosystems. The methodology and a summary of vegetation profiles for each forest ecosystem are documented in the report by Thomas, Gellie and Harrison (2000). This modelling has been used as the basis for validation

and re-mapping of vegetation in the Ulladulla Area, the Conjola-Morton section of which is the subject of this report.

The results of these CRA projects were used in the process of assessing the representativeness of vegetation types in the reserve system and the adequacy of existing reserves in conserving a range of vegetation types. The CRA provided the scientific basis on which the State and Commonwealth Governments could develop a Regional Forest Agreement (RFA) for the Southern Region of New South Wales. This agreement determined the future of these forests, providing a balance between conservation and ecologically sustainable use of forest resources. The process ultimately led to additions to the NPWS Estate including extensions to Conjola and Morton National Parks in 2001.

1.6 Forest Ecosystems in the Study Area

Forest ecosystems as modelled by Thomas, Gellie and Harrison (2000), which are represented within the study area, are listed in Table 1.1 below.

Table 1.1: Forest Ecosystems in Conjola and Morton (East) National Parks

FE Code	Forest Ecosystem Type (Thomas, Gellie & Harrison, 2000)	Conjola NP	Morton NP
2	Hinterland Heath Shrub Dry Forest - *Corymbia gummifera*/*Syncarpia glomerulifera*	Y	Y
3	Northern Hinterland Shrub Dry Forest - *Syncarpia glomerulifera*/*E. scias*		Y
9	Coastal Lowlands Cycad/Shrub Dry Forest - *Corymbia maculata*	Y	Y
18	Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest - *E. cypellocarpa/E. muelleriana*		Y
19	Coastal Escarpment and Hinterland Shrub/Fern Dry Forest - *E. muelleriana*		Y
20	Coastal Hinterland Gully Rainforest	Y	Y
21	Northern Coastal Hinterland Moist Shrub Forest - *C. maculata/E. pilularis*	Y	Y
22/23	Combined Southern Coastal Hind Dune/Headland Scrub and Southern Coastal Dune Scrub Complex	Y	
23/26	Combined Southern Coastal Dune Scrub Complex and Coastal Dune Herb/Swamp Complex	Y	
24	Coastal Tall Wet Heath Swamp Forest - *Casuarina glauca/Melaleuca ericifolia*	Y	
25	South Coast Swamp Forest - *Casuarina glauca*	Y	
27	Ecotonal Coastal Swamp Forest - *Casuarina glauca/E. botryoides*	Y	
28	Coastal Sands Shrub/Fern Forest - *E. botryoides/Banksia serrata*	Y	
29	Northern Coastal Sands Shrub/Fern Forest - *E. pilularis/Banksia serrata*	Y	
57	Southern Escarpment Shrub/Fern/Herb Moist Forest - *E. cypellocarpa incl. E. fastigata & E. obliqua*		Y
137	Coastal Escarpment Moist Shrub/Fern Forest - *E. sieberi/E. piperita/Gleichenia dicarpa*		Y

FE Code	Forest Ecosystem Type (Thomas, Gellie & Harrison, 2000)	Conjola NP	Morton NP
139	Northern Coastal Hinterland Heath Shrub Dry Forest - *C. gummifera/E. sclerophylla*	Y	Y
140	Northern Coastal Tall Wet Heath	Y	
144	Northern Coast and Hinterland Moist Heath		Y
166	Central Coastal Hinterland and Lowland Warm Temperate Rainforest		Y
167	Coastal Lowland Sub Tropical/Littoral Rainforest	Y	
176	Morton Plateau Mallee Swamp Low Forest		Y
187	Coastal Headland Heathlands	Y	
190	Rock		Y

These forest ecosystem (FE) types, based on descriptions by Thomas, Gellie & Harrison (2000), are outlined below.

Eucalypt dry forest types

- Hinterland Heath Shrub Dry Forest – *Corymbia gummifera-Syncarpia glomerulifera* (FE2), which consists of red bloodwood (*C. gummifera*) and possibly other eucalypts (*E. globoidea, E. piperita, E. consideniana* or *E. sieberi*) with an sub-canopy layer of *Syncarpia glomerulifera* and a sclerophyll shrub understorey commonly including *Persoonia linearis, Acacia obtusifolia, Leucopogon lanceolatus, Bossiaea obcordata* and *Gompholobium latifolium*. Modelled as being one of the most common types in the study area.
- Northern Hinterland Shrub Dry Forest - *Syncarpia glomerulifera*/*E. scias* (FE 3) is similar to FE2 differing in the presence of large-fruited red mahogany (*E. scias* ssp *callimastha*) and dominance of turpentine (*Syncarpia glomerulifera*) in the canopy. It was modelled as occurring only in the western parts of the study area in Morton NP.
- Coastal Lowlands Cycad/Shrub Dry Forest – *Corymbia maculata* (FE9), which is dominated by spotted gum (*Corymbia maculata*) with *E. globoidea* and *E. paniculata* possibly co-dominant in places. It is said to generally occur on Ordovician metasediments. Understorey elements include a small tree layer of *Allocasuarina littoralis*, and a shrub layer with burrawang, (*Macrozamia communis*), *Persoonia linearis, Leucopogon lanceolatus, Hibbertia aspera* and *Platysace lanceolata*.
- Coastal Escarpment and Hinterland Shrub/Fern Dry Forest - *E. muelleriana* (FE19) Forest is a medium to tall forest up to 25 metres tall, dominated by *Eucalyptus muelleriana* with *Angophora floribunda*. The tall shrub layer comprises mainly *Acacia falciformis* and *A. obtusifolia*. It was modelled as occurring only in the Morton NP part of the study area
- Coastal Sands Shrub/Fern Forest – *E. botryoides/Banksia serrata* (FE28), which is largely confined to sand deposits adjoining beaches and coastal lakes. Bangalay (*E. botryoides*) is often the sole canopy species. *Banksia serrata* forms a subcanopy layer, or shares the canopy with bangalay in low wind-pruned stands. Typical shrubs are *Acacia longifolia, Breynia oblongifolia, Monotoca elliptica* and *Hibbertia obtusifolia*. Burrawangs may be present, and in long unburnt stands a mesophyll element of shrubs and small trees often develops, including *Pittosporum undulatum, Notelaea longifolia, Synoum glandulosum* and vines such as *Hibbertia scandens* and *Cissus hypoglauca*.
- Northern Coastal Sands Shrub/Fern Forest – *E. pilularis/Banksia serrata* (FE29), generally occurs on low foothills below 100m elevation, on Permian mudstones or on deep sand

deposits slightly further from the coast than FE28. Blackbutt (*E. pilularis*) is the dominant tree, but it may be joined by many other species (*C. gummifera, Syncarpia glomerulifera, E. botryoides, E. piperita, E. sclerophylla*). *Banksia serrata, Acacia longifolia* and *Allocasuarina littoralis* commonly occur in the understorey, along with tussock plants such as *Lomandra longifolia* and *Lepidosperma laterale*.

- Northern Coastal Hinterland Heath Shrub Dry Forest – *Corymbia gummifera/E. sclerophylla* (FE139), is generally a low forest occurring on shallow infertile soils derived from Permian sandstone. Scribbly gum (*E. sclerophylla*) and red bloodwood usually form the canopy, though they may be joined by *E. consideniana* or *E. sieberi*. A small tree layer may include *Allocasuarina littoralis, Leptospermum trinervium* or occasionally banksias if close to the sea. The shrubby understorey contains typical "Sydney sandstone" elements such as *Lambertia formosa, Hakea dactyloides, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Isopogon anemonifolius* and *Kunzea capitata*. Sedges are common, including *Lepyrodia scariosa* and *Xyris* spp. The small flannel-flower, *Actinotus minor* scrambles through the groundcover. This is a common type modelled as occurring throughout the study area.
- Morton Plateau Mallee Swamp Low Forest (FE176) is briefly described as a low forest dominated by a variety of mallees and eucalypts adapted to low fertility skeletal soils. The understorey comprises a mixture of heaths, sedges, and grasses. Thomas, Gellie and Harrison (2000) do not provide diagnostic species for this type, which is modelled within the study area as occurring only on the Morton plateau.

Eucalypt wet forest types

- Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest - *E. cypellocarpa/E. muelleriana* (FE18) is a tall forest over 30 metres tall, dominated by *Eucalyptus muelleriana* with *E. cypellocarpa* The understorey comprises *Hibbertia dentata, Elaeocarpus reticulatus, Notelaea venosa*, and *Acacia falciformis*. Its modelled distribution in the study area is similar to that of dry forest type FE19, which is restricted within the study area to Morton National Park.
- Northern Coastal Hinterland Moist Shrub Forest – *C. maculata/E. pilularis* (FE21), which is found on sheltered slopes and along drainage lines in coastal foothills on Permian mudstone or Ordovician metasediments. Blackbutt and spotted gum dominate the canopy, with a small tree layer including *Syncarpia glomerulifera* and *Acacia mabellae*. Mesic elements such as *Elaeocarpus reticulatus, Synoum glandulosum* and *Notelaea longifolia* occur alongside sclerophyll shrubs like *Persoonia linearis* and *Acacia longifolia*. Vines and ferns are common.
- Southern Escarpment Shrub/Fern/Herb Moist Forest - *E. cypellocarpa incl. E. fastigata & E. obliqua* (FE57) is an intermediate dry/moist shrub forest up to 35 metres tall, co-dominated by *Eucalyptus cypellocarpa* and *E. fastigata*, with occasional E. *obliqua* and *E. radiata.* These species are not typical of the study area and cast doubt on the presence of this type. Its modelled distribution was in one location in the far western part of the study area.
- Coastal Escarpment Moist Shrub/Fern Forest - *E. sieberi/E. piperita/Gleichenia dicarpa* (FE137) is a medium to tall forest up to 25 metres tall, co-dominated by *Eucalyptus sieberi* and *Eucalyptus piperita*. The understorey is an open cover of *Acacia obtusifolia, Leptospermum trinervium, Banksia paludosa*, and *Leptomeria acida*. The ground cover is a dense mat of *Gleichenia dicarpa*, with scattered *Gahnia sieberiana*, and a sparse low herbaceous/graminoid layer comprising *Playsace lanceolata, Amperea xiphoclada*, and *Gonocarpus teucrioides*. One of its few occurrences is on the edge of the eastern Morton plateau at between 500 and 800 metres.

Rainforest

- Coastal Hinterland Ecotonal Gully Rainforest (FE20). Although widespread in the region, this vegetation type is naturally fragmented, occurring only in situations which are topographically protected from fire, such as sheltered gullies. It is also sensitive to frequent burning. It consists of a mixture of rainforest and wet sclerophyll elements including trees such as lillypilly (*Acmena smithii*), cabbage palm (*Livistona australis*), *Acacia mabellae, Callicoma serratifolia, Elaeocarpus reticulatus* and *Tristaniopsis collina*, and shrubs including *Notelaea venosa,*

Eupomatia laurina and *Psychotria loniceroides*. Ferns and vines are a similar mixture of rainforest species, and those more usually found in moist eucalypt forests.

- Central Coastal Hinterland and Lowland Warm Temperate Rainforest (FE166) is a dense forest canopy up to 20 metres height, with a diverse tree canopy *of Acmena smithii, Hedycarya angustifolia, Ficus coronata, Cryptocarya glaucescens*, and other rainforest species. A secondary tree layer up to 5 metres tall, comprises rainforest shrubs or small trees *Eupomatia laurina, Synoum glandulosum,* and *Notelaea venosa*, along with Bangalow Palm *Livistona australis*, and tree ferns *Cyathea australis* and *Dicksonia antartica*. It was modelled only immediately below the plateau escarpment in far west of the study area.
- Coastal Lowland Sub Tropical/Littoral Rainforest (FE167) is a dense forest up to 15 metres high, co-dominated by *Claoxylon australe, Acmena smithii, Dendrocnide excelsa*, and *Ficus coronata*. An open secondary tree layer of *Pittosporum undulatum*, and *Notelaea venosa* is often present. Its only modelled location on a dry ridge inland from the coast casts doubt on the presence of this type in the study area.

Non-eucalypt forest types

- Coastal Wet Heath Swamp Forest – *Casuarina glauca/Melaleuca ericifolia* (FE24). This vegetation type generally occurs in a narrow band around the margins of saline coastal lakes, Diagnostic species are the canopy species *Casuarina glauca*, with an understorey of the smaller tree *Melaleuca ericifolia* and occasional *Myoporum acuminatum*. Groundcover can very from dense stands of sword-sedge (*Gahnia clarkei* or *G. sieberiana*) or other sedges and rushes such as *Baumea juncea* or *Juncus kraussii*, to bare ground. The rampant vine *Parsonsia straminea* may be present.
- South Coast Swamp Forest Complex – *Casuarina glauca* (FE25). This vegetation type generally occurs in situations which are less saline, and more frequently inundated with fresh water than FE24. It is often a taller forest, with less groundcover of sedges than the preceding type. The vine *Parsonsia straminea* is often abundant.
- Ecotonal Coastal Swamp Forest - *Casuarina glauca/E. botryoides* (FE27) is a medium forest up to 20 metres tall, dominated by *Casuarina glauca*, with *E. botryoides.* The tall shrub layer is a variable mixture of *Banksia integrifolia and Acacia longifolia*. It was modelled in the study area only around Swan Lake.

Non-forest types

- Southern Coastal Hind Dune/Headland Scrub and Southern Coastal Dune Scrub Complex (FE22 and FE23). These two types have been mapped as a complex (coded 2223 in the GIS dataset), since they tend to occur in very small or narrow patches, and are almost always found together. FE23 occurs on the beach dunes and consists of *Spinifex sericeus* and coast wattle (*Acacia sophorae*), while FE22 occurs on the hind dune and consists of coast banksia (*Banksia integrifolia*) with the shrubs *Monotoca elliptica* and *Leucopogon parviflorus* over a groundcover of bracken and spiny matrush (*Lomandra longifolia*).
- Coastal Dune Herb/Swamp Complex (FE26). This type is described as a composite group of disturbed swampy areas within coastal dunes. It was poorly sampled. It has been mapped as occurring as a composite with FE23 (coded 2326 in the GIS dataset) at Berrara Beach.
- Northern Coastal Tall Wet Heath (FE140) is a wet sedge shrubland up to 3 metres high comprising an open cover of tall shrubs *Hakea teretifolia, Allocasuarina distyla, Leptospermum trinervium, L. squarrosum* and *Xanthorrhea resinifera* and a diverse intermediate shrub layer of smaller shrubs. It was modelled as occurring in localised areas throughout most of Conjola NP.
- Northern Coast and Hinterland Moist Heath (FE144) is a heterogeneous tall shrubland dominated by *Melaleuca linearifolia*, together with *Leptospermum polygalifolium*, and *Leptomeria acida*. It was modelled within some of the lower parts of Morton NP west of the Princes Highway.
- Coastal Headland Heathlands (FE187). These are described as tall shrublands dominated by *Allocasuarina distyla* and a number of other shrubs which generally do not occur south of

Jervis Bay. Despite this, the vegetation type is described as occurring on rocky headlands as far south as Narooma. The only modelled occurrence of this type in the study area is on the headland east of Swanhaven.

- Rock (FE190) was included in the modelling in parts of Morton NP and is identified in the forest ecosystems classification as bare rocky outcrops mapped from aerial photo-interpretation where there is obvious bare rock in patch sizes greater than 2 hectares.

Not all of the above forest ecosystem types were found to be present in the study area and a number of additional types were identified, including some which are sub-types of those described by Thomas, Gellie and Harrison (2000). Details are contained in the tables in Appendix 1.

1.7 Correspondence between Mills' Vegetation Communities and Forest Ecosystem Types

Most of the non-eucalypt communities described by Kevin Mills (K. Mills & Associates, 1995), have a direct one-to-one correspondence with communities described during the Southern CRA (Thomas, Gellie and Harrison, 2000). The same is true of some of the eucalypt communities such as Cu5 (Bangalay Open Forest) which is equivalent to FE28 (Coastal Sands Bangalay-Banksia Forest) and Cu4 (Blackbutt Open Forest) which equates to FE29 (Coastal Sands Blackbutt-Banksia Forest). However, because of the smaller area of Mills' study, he has divided the remaining eucalypt communities much more finely than the CRA survey did. He also discusses where they occur in the landscape in response to soil and drainage characteristics.

The following table (1.2) gives the correspondence between Mills' and the CRA vegetation types. Mills' classification is largely based on canopy species whereas the CRA classification is derived from full floristics and gives as much or more weight to the understorey composition as it does to the dominant tree species. Hence the same suite of tree species may occur in more than one FE type, and more than one suite of canopy species may equate to the same FE type if the understorey is similar in all cases.

Table 1.2: Mills' Vegetation Communities and Forest Ecosystems in Conjola National Park

Vegetation communities (Mills, 1995)		**Vegetation communities (Thomas, Gellie and Harrison, 2000)**	
Cu1	Blue Gum Tall Open Forest	FE21	Spotted Gum-Blackbutt Moist Forest
Cu2	Blackbutt-Turpentine Open Forest/Tall Open Forest	FE2 & FE21	Lowland Red Bloodwood-Turpentine Dry Shrub Forest or Spotted Gum-Blackbutt Moist Forest depending on site quality
Cu3	Spotted Gum Tall Open Forest	FE21 or 5	Spotted Gum-Blackbutt Moist Forest or Jervis Bay Lowlands Dry Forest
Cu4	Blackbutt Open Forest	FE29	Coastal Sands Blackbutt-Banksia Forest
Cu5	Bangalay Open Forest	FE28	Coastal Sands Bangalay-Banksia Forest
Cu6	Bloodwood-Peppermint Open Forest/Woodland	FE2	Lowland Red Bloodwood-Turpentine Dry Shrub Forest
Cu7	Scribbly Gum-Casuarina Open Forest	FE139	Scribbly Gum-Red Bloodwood Heathy Woodland
Cu8	Woollybutt-Paperbark Woodland	FE144	"North Coast and Hinterland Moist Heath", but Mills' name is obviously more apt as it is not a heathland in structure
Cu9	Scribbly Gum-Bloodwood Woodland/Heathland	FE139	Scribbly Gum-Red Bloodwood Heathy Woodland
Cu10	Scribbly Gum-Hakea Open Woodland/Open Mallee Shrubland	FE139	Scribbly Gum-Red Bloodwood Heathy Woodland

Vegetation communities (Mills, 1995)		**Vegetation communities (Thomas, Gellie and Harrison, 2000)**	
Cu11	Scribbly Gum-Teatree Open Woodland/Open Shrubland	FE139	Scribbly Gum-Red Bloodwood Heathy Woodland
Cu12	Blackbutt Open Woodland/Heathland	FE139 or FE2	Scribbly Gum-Red Bloodwood Heathy Woodland or Lowland Red Bloodwood-Turpentine Dry Shrub Forest
Cu13	Paperbark Shrubland (Swampland)	FE24	Swamp Oak-Swamp Paperbark Forest
Cu14	Sedgeland (Swampland)	FE141	Northern Coast & Escarpment Wet Heath/Sedge
Cu15	Swamp Oak Forest/Woodland + Rushland/Forbland (saltmarsh)	FE25 and FE186	Swamp Oak Forest and Saltmarsh
Cu16	Banksia-Teatree Closed Shrubland	FE22	Dune/Headland Scrub
Cu17	Coast Wattle Open Shrubland/Spinifex Grassland	FE23	Beach Strand Grassland
Cu18	Ruppia Forbland (seagrass)		omitted
	omitted	FE185	Mangrove Estuarine Low Forest

These corresponding types in the Mills' classification are noted in the discussion of results in Section 3.

2 METHODOLOGY

2.1 Overview

The purpose of vegetation sampling for the Conjola-Morton study area was twofold:

- to determine the accuracy of the vegetation maps produced during the Southern CRA, particularly as they relate to vegetation types which are of regional conservation significance or of particular management concern and to make appropriate corrections to the maps based on field validation and air photo interpretation, and
- to collect baseline data from permanently marked quadrats which could be used in the future to assess the impacts of management activities such as deliberate use of fire for asset protection around the coastal villages.

Prior to commencement of the botanical work, the GIS data set for the study areas, supplied by NPWS, was reviewed and assembled to facilitate the selection of sampling sites and for field validation and mapping purposes. A set of field maps was prepared at 1:25,000 scale covering the project area (see section 2.4.1 below). These maps of the modelled forest ecosystems were overlayed with previous and proposed new survey sites, contours, drainage roads and an AMG grid. A number of new floristic sites were identified by Mr Phil Craven (Project Officer (ESFM), NPWS, Nowra) and provided a basis for refinement by the project team. A second set of field maps was also prepared using the Southern CRA API (CRAFTI) mapping on the same base as the FE maps. This mapping was also used in the validation process as explained below in sections 2.2 and 2.3.

A meeting of the project steering committee and consultant team was held in October 2003 to plan the approach to the project and to finalise the selection of floristic sampling sites. This process involved taking into account practicalities of access and time to make the field sampling as effective as possible and aimed to establish a permanent set of plots for future reference and monitoring. Approximately 30 full floristic survey sites were initially identified in the combined Conjola-Morton and Narrawallee study areas by reference to the existing vegetation mapping and locations of earlier floristic field survey sites. Of these, about one third were to be fire response monitoring sites. The sites were marked on the field maps which also showed previous (CRA and earlier) floristic survey sites.

Members of the project team, which included botanist (Ms Jackie Miles) together with NPWS Project Manager/Ranger (Ms Libby Shields) and Sustainable Management Officer (Ms Genevieve Wright) visited the project area over a number of days during two weeks in late October 2003. The work involved locating suitable sampling sites, establishing permanent markers, recording quadrat floristics and validating previously-mapped vegetation types. Vegetation sampling took the form of 20 x 20 metre quadrats, nested at one end of a 20 x 50m quadrat. The larger area was used for recording canopy species, although understorey was only recorded from the 20 x 20 quadrat. Quadrat data were recorded on data sheets and later transferred to digital format.

The field maps were used (in addition to the published topographic maps, aerial photos and GPS) for navigation and field orientation, recording of new sampling sites and noting of results of forest type validation. Opportunities were made to check the existing vegetation maps and make corrections when travelling to and from the sample sites. A further visit was made in December 2003 by Mr Phil Kendall to facilitate the re-mapping work, focussing on the coastal and estuarine areas.

For the purposes of classification and re-mapping, it was decided to use the CRA Forest Ecosystems as defined by Thomas, Gellie and Harrison (2000) with minor modifications, rather than adopt a substantially different classification. The existing FE classification appeared to work reasonably well for the vegetation in Conjola and Morton (East) National Parks. However, some of the diagnostic species lists provided by Thomas, Gellie and Harrison, 2000 had to be broadened somewhat to embrace different suites of canopy species. For example, blackbutt (*E. pilularis*) is not listed as occurring at all in FE2 (Lowland Red Bloodwood-Turpentine Dry Shrub Forest), yet in the Ulladulla area it seems to be one of the most common trees in this vegetation type. Apart from this single difference the species assemblage of this forest type in the Ulladulla area is very similar to that listed for FE2 by Thomas, Gellie and Harrison. The revised profiles for each forest ecosystem encountered in the study area are included in Appendix 4.

On the basis of the findings of the field work, re-mapping of the forest ecosystems of the study area was undertaken using GIS methodology by Mr Phil Kendall, involving adaptation of the existing mapping, re-

mapping some of the area by air photo interpretation, digital capture and processing of linework and vegetation coding and preparation of new maps for checking and refinement by the project team. This work was done in parallel with preparation of the draft report and in consultation with Ms Jackie Miles.

2.2 Vegetation Sampling Methodology

2.2.1 Floristic Site selection

Twelve full floristics quadrats were located in Conjola NP, of which six double as fire monitoring quadrats. Six were placed in Morton (East) NP, of which three double as fire monitoring quadrats. The distinction between the two types of quadrat is trivial in quadrats which have not burnt, as the fire monitoring quadrats are full floristics quadrats for which additional information on fire recovery mechanisms is collected. For unburnt quadrats, obviously this cannot be done but information about presence of seedlings, flowering and seed production is also collected, which is omitted from full floristics quadrats. However, the one can readily be converted into the other if the need arises, that is, if the area is burnt. The only difference on the ground is that fire quadrats (distinguished by an F at the end of the site name) are marked by a centrally located permanent steel marker post, while for full floristics quadrats the post was positioned, as requested, in the north-east corner of the plot. This difference could be remedied to make the plots consistent if it is subsequently decided to turn the full floristics plots into fire monitoring plots.

The placement of quadrats was broadly determined by negotiation with NPWS staff prior to commencing work, but some modifications were made during field work when access difficulties arose or when target vegetation types could not be located in the area in which they were previously mapped. A description of all the quadrats is provided in Appendix 3.

2.2.2 Quadrat survey method

A steel post was driven either centrally (for fire monitoring quadrats) or in the north-east corner of the plot and a metal tag with the name of the plot attached. The posts have a yellow plastic top to assist with relocating them, and minimise risk of injury to bushwalkers from a sharp metal end. A GPS reading was taken at the marker post to enable relocation of the plot, using the Australian Geodetic Datum (1966) and UTM projection (Australian Map Grid) in Zone 56.

20m tapes were run out from the post either to the south and west (on full floristics plots) or for 10m either side of the post on fire quadrats. In the latter case tapes were either parallel and perpendicular to the adjacent access track, or where the track was out of sight tapes were laid N-S and E-W. Site data relating to physical features and disturbance history were recorded, all plants on the quadrat were recorded and assigned a cover abundance score (modified Braun-blanquet score from 1 to 6). An additional 20 x 30m area was checked for the presence of any extra canopy species not recorded in the 20 x 20m quadrat. This methodology is consistent with that employed for Southern CRA surveys.

For fire quadrats additional information was collected on recovery mechanisms of each plant species recorded after fire. The fire response mechanisms were based on those developed by Gill and Bradstock (1992) and were the same as those used in 28 fire monitoring quadrats established in the Nowra area in 2002 (EcoGIS, 2002). They are outlined in Appendix 5. Where the site had been only partially burnt such information was recorded only for those species affected by fire. Information on which species had seedlings present, which were flowering and seeding, were collected on both burnt and unburnt fire monitoring quadrats. Proportion of plants flowering or seeding and numbers of seedlings present were recorded in broad abundance categories

Similar field data sheets to those used for the Southern CRA were used in this survey. The Braun-Blanquet cover abundance scoring system was used to assess the representation of each species in the quadrat. In addition to floristics, data about vegetation structure and age classes present were recorded, as well as physical data of topography, aspect, elevation and geology. A modified and extended version was used for fire response monitoring sites. Blank data sheets are reproduced in Appendix 2.

2.2.3 Photography

Digital photographs were taken of all quadrats. The sign proposed to be used in each photograph to identify the sites was too small to be legible in the photos and was not used. Instead each photo file has been named with the quadrat name and the bearing to the quadrat centre at which it was taken.

For full floristics quadrats three photos were taken, from 1-2m back from the corner peg. One was taken diagonally across the quadrat and one along each tape. The tapes are visible in the photo and generally the tape running south is white and the one running west is yellow. However this may not have been done invariably and if this information conflicts with the photo name then it is the name which is correct.

For fire monitoring quadrats one or two photos were taken. The location from which they were taken was documented on the field recording sheet. It varied depending on the sun angle at the time of day the plot was done and the degree to which vegetation obscured the rest of the plot from each corner. The corner chosen was that which gave the most open view of the plot. In some cases a photo was taken from the end of one of the tapes, not from a corner.

Photos have been provided as .jpg files on the data CD accompanying this report.

2.2.4 Forest Ecosystem Type Validation

Using the plot records, vegetation was assessed as either conforming to the expected species composition for the type mapped in the vicinity, or not doing so. If the vegetation did not appear to be as mapped, then an attempt was made to determine to which type (as defined by Thomas, Gellie and Harrison, 2000) it belonged. However, in some instances vegetation did not fall neatly into any of the defined types, sometimes being transitional between two or more types and occasionally not conforming to any of the types described previously.

Where additional data were considered necessary to correct the vegetation map, this was collected in the form of a species list from an area of roughly 20 x 20m, with the same Braun-Blanquet cover abundance scoring system. However, less attention was paid to recording every species present. Only enough data was gathered from these sites to determine the vegetation type. These sites were used during the vegetation analysis and re-mapping work and were not recorded on the standard survey forms and have not been entered into the database.

Species lists with cover abundance scores were available from earlier sampling used in the CRA, and these were also consulted to help confirm or refute the vegetation types mapped as occurring at the locations where these samples were taken. Some additional canopy only sites were recorded by CSIRO. The locations and site numbers of these earlier floristic survey sites were printed on the field map and floristic information was retrieved using the CRA access database - GM-Naomi.

Separate field maps of Forest Ecosystems and Southern CRAFTI API mapping derived during the Southern CRA were printed for use during field work. At the same time as the vegetation was validated in the field against the modelled forest ecosystems maps, the corresponding API maps were also consulted to determine if they provided a better fit to the observed vegetation types and boundaries. Equivalent FE types for many of the API types had previously been determined and printed on the API maps and these were checked and changed where necessary. This process is explained in more detail in section 2.3.

Any additional information about vegetation types observed during travelling through the parks and between survey sites was recorded in the form of annotations on either of the field maps, field data sheets or additional notes on the sampling plot sites.

Data obtained for the full floristics quadrats, the incidental partial floristics lists, earlier site records and annotations made during field work, were later used as the basis of a comparison between the two map versions and were used to assist with validation of the FE map. Within the budget and time constraints of this project, and given the lack of roads in some areas, it was not possible to visit all parts of the parks to check the accuracy of every mapped ecosystem. Where the FE map was found to be wrong in a particular location and the API map could not clarify the true nature of the vegetation type over the whole of the area where it was mapped, then air photos were re-examined and the existing API mapping was confirmed or changed. The API methodology is documented in Section 2.3 below.

2.3 API Methodology

Two API methodologies were employed during this study:

- Adaptation of CRA API mapping with translation of API to FE types.
- Preparation of new API linework and coding for areas that required re-mapping, mostly along the coastline, around the estuaries and coastal lakes and in cleared areas, road corridors and powerline easements.

2.3.1 Translation of CRA API Mapping to Forest Ecosystem Types

It was found during previous studies in the Far South Coast and South Coast Regions, that many of the forest ecosystem photo patterns were very similar to the boundaries mapped during the CRA API projects, despite fundamentally different classifications being used. Often, the patterns recognised on the air photos were a much more realistic representation of forest ecosystem types, than those in the forest ecosystems modelled layer. Consequently, methodology has been developed to utilise and adapt selected components of the API maps rather than re-map forest ecosystem types by undertaking entirely new API work.

It was not always easy to find equivalent API categories for all forest types. Because the FE types are based on full floristics, they are divided more finely than the API categories. There can be several FE types which consist of various combinations of the species for an API type. On a regional basis, it is therefore impossible to devise a list of direct equivalents between FE and API types. However, on a reserve by reserve basis, given a knowledge of the main vegetation types present in the area, it is possible to produce a rough correlation between the two classifications. The corresponding types also had to be established separately for different parts within each reserved area in some instances, because of local variations in geology or terrain.

During the Southern CRA, Forest Ecosystem types were assigned to API polygons by Nic Gellie and botanists Phil Gilmour and Michael Doherty. However, this process did not include all API types and a significant proportion of API polygons were not assigned to FE types. To assist in the interpretation of the API mapping for this present project, a table of the FE to CRAFTI API code correspondence was assembled by cross tabulation of the API codes and assigned FE types. In general there was agreement with our field observations, although the omission of the *E. pilularis* dominated FE29, which should correspond in some circumstances with the API code E0601, was puzzling.

Differences in classifications between the forest ecosystems modelling and API mapping projects required a close comparison based on predominant indicator species types and to a lesser extent on understorey structure and floristics. This process was validated where possible during the field work and from data from previous surveys. In this way it was possible to develop conversion code tables. While it was possible to apply API to FE conversion codes consistently for some types, there were many exceptions where the conversion codes for a particular API type converted differently depending on location. This was notably the case for separating Hinterland Heath Shrub Dry Forest (FE2) and Northern Coastal Hinterland Moist Shrub Forest (FE21) which are difficult to separate by API. These types had to be split based on field checking and general trends thought to be determined primarily by terrain and aspect such that FE21 is confined to the lower valley slopes of the larger drainage lines while FE2 occurs on the mid to upper slopes above. A number of mixed or more obscure API types did not correspond directly to forest ecosystem types and these were left unconverted for the time being. They were manually converted at a later stage.

The translation from CRAFTI API codes to FE codes used in producing the new maps of Conjola and Morton (East) is provided in the tables below. It corresponds closely to that used by Gellie, et al. but departs from it in a few instances where field observation suggested that an alternative interpretation would be more accurate. Non-eucalypt API codes did not translate into FE codes consistently, often being one vegetation type in a dry situation and another in drainage lines. Estuarine areas and the lower end of drainage lines where they entered Swan Lake had also been inconsistently labelled, and much of the re-mapping of these areas was based on re-interpretation of aerial photos and additional field work.

Table 2.1 Equivalent API and FE Codes for Conjola National Park

API code	Diagnostic canopy species	FE code	Qualifying factors
E06, E0601 and most other E06 combinations	*E. pilularis*	FE2, FE21 or FE29	FE2 unless located on sand sheets close to the sea or river mouths (FE29) or close to sizeable creeks (FE21)
E0901, E0902	*Corymbia maculata* and eucalypts (*E. pilularis*/ *paniculata/longifolia*) although none of these were present in FE5 in Conjola	FE5	
E07	*E. saligna/botryoides*	FE21 or FE28	FE21 in drainage lines, FE28 on sand sheets close to the sea or river mouths
E0805 or E0601E0805, E2606	*E. sclerophylla/C. gummifera/E. pilularis,* *E. agglomerata/ sclerophylla*	FE139	
R or RE	Rainforest and rainforest with emergent eucalypts	FE20	
S	Scrub/swamp/heath	FE140 or FE139	FE140 if on a drainage line, FE139 or FE139H (heath with scattered trees) if not
V	Rock/scrub/sparse trees	FE175 or FE139	FE139 in dry sites and FE175 in drainage lines
Y, A	Estuarine, sand or mud	FE24	Assumed Swan Lake is not tidal and therefore mangrove/saltmarsh is unlikely
FP	Estuarine	FE144	

Table 2.2 Equivalent API and FE Codes for Morton (East) National Park

API code	Diagnostic canopy species	FE code	Qualifying factors
E0601	*E. pilularis* pure stands	FE2 or FE21	FE2 on drier sites, FE21 in gullies
E0601E080 E0601E0805 E0601E1401	*E. pilularis* with other eucalypts: dry coastal complex (includes numerous eucalypts), *E. sclerophylla/* *C. gummifera* or others	FE2 or FE21	FE2 on drier sites, FE21 in gullies (not FE139 as interpreted by Gellie et al in producing the original FE map)
E07 E0701 E0704	*E. saligna/botryoides, E botryoides* plus rainforest elements, *E. botryoides/ globoidea/pilularis*	FE21	
E0901	*Corymbia maculata* sole dominant	FE9 or FE21	FE9 on dry ridges, FE21 in gullies or on steep slopes with a sheltered aspect.

API code	Diagnostic canopy species	FE code	Qualifying factors
E120, E1203, E1204	Various stringybarks dominant	FE3	
E3101, E3103	*E. sieberi*, possibly with stringybarks or *E. consideniana* and *E. sieberi* with peppermints (*E. radiata* or *E. dives*)	FE137	This correspondence was used by Gellie et al and is possibly wrong, but has not been altered due to lack of information about the areas in which it occurs.
E3204	*E. cypellocarpa/ muelleriana* or *E. cypellocarpa/longifolia*	FE3	This assemblage would usually be translated as FE18, but sites seen carrying *E. muelleriana* did not look like typical FE18.
E34, E3401	*E. piperita* complex, *E. piperita/C. gummifera*	FE3	
E3403	*Syncarpia glomerulifera*	FE3	
R, RE	Rainforest, rainforest with emergent eucalypts	FE20	FE166 was excluded as there was no basis on which to differentiate between this and FE20
S, V	Scrub/swamp/heath and rock/scrub/sparse trees	FE176 or FE139H	FE176 on top of Morton plateau and FE139H (implying heath or open woodland) at lower elevations, not FE144 as used by Gellie et al.

Instances where the conversion codes produced incorrect results were detected and corrected during the GIS work and subsequent checking using the results from field validation. Where field observations differed from the suggested conversion type, the field validated type was used. The resultant mapping was re-checked by the team and further refinements made in the final mapping. At the same time, polygons with API codes which were not included in the conversion table, were examined and manually coded according to the most likely FE type, based on their API code, type assigned in the FE model, position in the landscape, geological type or other relevant factors.

It was found that this process worked well for predominantly forested areas. Since the API mapping tended to represent the vegetation boundaries more accurately than the FE model, it was used as the preferred mapping source. However, substantial inaccuracies in both the FE and API mapping for coastal areas made it necessary to carry out new API work in these areas. Since very little of the FE model was found to contain accurate boundaries, all of the modelled map was replaced by converted API polygons or new API boundaries.

2.3.2 Re-mapping of Coastal and Estuarine Vegetation Types

Neither of the CRA vegetation maps was found to be sufficiently accurate for the areas along the coastline and around the estuaries and coastal lakes. The lack of locational accuracy relative to water bodies and unvegetated sand and rock areas made it difficult to validate and re-map the forest ecosystem types. The API mapping, while generally more accurate than the forest ecosystems model, did not delineate some of the known FE types and so a straight translation would not represent the true situation.

It was, therefore, decided to re-map all of the coastline and lake foreshores within Conjola National Park by API, focussing on the non-forest ecosystems such as dune scrub and estuarine wetland types. Because this new API work was undertaken as part of the GIS work by Phil Kendall, it was possible to capture and at the same time match these new boundaries into the converted API mapping immediately inland.

The re-mapping included delineating new boundaries for vegetation types which were not adequately represented in either of the existing maps as well as replacing the boundaries of API polygons on their seaward edges and along lake shorelines. In the latter case, the edge of vegetated areas was mapped rather than the actual high tide line, thereby excluding unvegetated rock and beach areas. It was found that most vegetation boundaries could be relatively easily recognised in digital orthophotos and mapped directly rather than having to use a standard API process of marking up acetate overlays, scanning, rectifying and digitising. However, stereo pairs of air photos were used in many instances to interpret vegetation types and to guide the digitising of boundaries from the orthophotos. The 1991 Ulladulla and 1993 Jervis Bay aerial photography (at an approximate scale of 1:25,000) provided by the NPWS, was used for this work.

The coding of new polygons was guided by the results of the field work, interpretation of previous survey sites, reference to the API maps and interpretation using stereo pairs. Field checking was carried out for some of the coastline to confirm the coding and to investigate instances of uncertainty in areas which were not readily apparent in the orthophotos, such as regenerating scrub or ecotonal situations.

To enable a more consistent coverage of the new mapping so that whole polygons could be included rather than being clipped at park boundaries, the mapping was extended beyond the study area in some instances. In particular, the whole of Conjola Lake and Swan Lake were included in the re-mapping. This also had the benefit of providing a seamless coverage of new mapping with that in the Narrawallee study area. The API mapping was in fact carried out initially for the combined study areas and separated at a later stage into the individual parks and the nature reserve.

2.3.3 Re-mapping of cleared areas and corridors

Within the inland parts of Conjola and in Morton, the linework on the CRA API map was often found to be inaccurate in delineating cleared land (usually former agricultural areas or quarries) and representing cleared powerline easements and road corridors. Re-mapping of boundaries was carried out using the digital orthophotos, with new polygons added and boundaries of existing ones changed. These polygons were allocated to a 'cleared' category in the legend for the new maps and polygons which were incorrectly included in the API maps as excluded (i.e. cleared) but in fact contain vegetation, were re-coded to their most probable type, usually that of the surrounding vegetation. This re-mapping of cleared areas was carried out as part of the GIS work and relates particularly to the definition of the study area boundary which is discussed in more detail in Section 2.4.2.

2.4 GIS Methodology

2.4.1 Field Map Preparation

Seven field maps were prepared on A3 size sheets at 1:25,000 scale, for field and API work, covering the combined areas of Conjola and Morton National Parks within the study area. By developing a new series of maps, rather than using a single large format map, it was possible to split the study area up into manageable size field maps, improve the clarity of the vegetation colour coding and show all relevant background details.

The study area falls within UTM Zone 56 and all data sets supplied by NPWS used this projection. The GIS information was compiled in Zone 56 coordinates, using the Australian Geodetic Datum (1966) and the appropriate Australian Map Grid for this zone was shown on the field maps.

The source forest ecosystems layer used was the extant forest ecosystems grid model prepared during the Southern CRA. This was converted from a grid to a polygon layer and from a version in which the boundaries had been smoothed, the relevant study area portion was clipped and attributes added for FE type and descriptive labels. Details of the map preparation using ArcView GIS software are as follows.

- For each map sheet, those FE polygons appearing on the map sheet were selected and a summary procedure used to produce a table of the unique codes appearing on that map sheet. This was used to manually trim the FE legend so that only those FE types seen on the map sheet were included in the legend.

- The colour coding for Forest Ecosystem (FE) types was developed for the range of type encountered in the study areas to provide a sufficiently wide range of colours to minimise confusion.
- Access roads and trails were classified according to classes based on surface type and function. A legend was developed to reflect this classification.
- Other background layers included were 100 metre and 10 metre contours generated from the digital terrain model (DTM), drainage from the 1:25,000 map sheets, air photo centroid points, previous and proposed vegetation survey sites and NPWS estate boundaries.
- The AMG 1 km grid (zone 56) was overlayed on the maps for easy reference in the field and API work.

A parallel series of seven maps showing Southern CRA API (CRAFTI) floristics polygons was prepared to allow checking in the field and comparison of the two maps in order to derive classification conversion codes. These were prepared on the same base maps. Because of the sheer number of API codes, it was not possible to assign colours to the polygons and they were labelled with the relevant code. Additional codes for the FE types assigned by Gellie, et al. (see section 2.3 above) were also printed on the maps.

The maps were prepared using the NPWS supplied vegetation layers derived from the CRA mapping. It was apparent from mismatches between the roads, drainage and vegetation layers that there were substantial inaccuracies in the previous mapping which required attention during the re-mapping process.

2.4.2 Study Area Definition

In preparing and using a study area boundary based on NPWS Estate boundaries, a number of problems were encountered which made substantial editing of the boundary necessary and subsequent editing of the CRA API layer which was used as the basis for re-mapping.

The main problems apparent were as follows.

- Generally, park boundaries are defined using cadastral or other previously mapped boundaries which are rarely accurate and do not match well with real boundaries as seen in air photos and orthophotos, such as the coastline, edges of tidal lakes or roads. When used as a clipping boundary they often miss slivers of land between these boundaries and the true boundary and include other slivers which should be excluded.
- Some park boundaries follow exclusion corridors such as along roads and powerlines and the omission of these corridors from the vegetation map results in gaps in the mapping which create problems where the corridors are inaccurate in the NPWS Estate mapping.
- The clipping of the vegetation maps with the external park boundary results in fragmentation of many polygons which extend beyond park boundaries, effectively splitting vegetation or natural features such as the coastline or lake margins, causing confusion and detracting from the cartographic quality of mapping using the new the vegetation map.
- Inaccuracies in the Southern CRA forest ecosystems modelling has resulted in many instances of polygons extending over or falling short of lake/estuary waters, beaches, cliffs, rock platforms, etc.

NPWS Estate boundaries are often complex polygons which exclude land parcels (private in-holdings) and corridors along non-park roads and stock routes. As such the park areas can be somewhat fragmented. The boundaries are usually mapped by interpretation of gazettal details using available topographic and cadastral maps which have inaccuracies Consequently, the boundaries do not match well with the true positions of natural features such as water bodies and coastal features or built features such as roads, infrastructure and fenced property boundaries. Corridors are usually created as fixed distance buffers either side of roads or powerlines, and do not follow actual cleared boundaries along these easements. This problem is compounded when the roads and powerlines used for buffer creation were mapped incorrectly.

Both the external and internal boundaries of Conjola and Morton (eastern extension) National Parks were found to be inaccurate when overlayed on the digital orthophotos. Inaccuracies of over 50 metres were not uncommon, consequently many roads and powerlines did not actually fit within the exclusion corridors through the parks. On examination of the supplied layer of the CRA API map, which had been

clipped to the park boundaries, many gaps were apparent where exclusion corridors had resulted in information loss from the vegetation map. Areas which carry forest had been clipped out while slivers of cleared land in the easements had been left adjacent to the corridors. This problem was further compounded where the CRA API mapping had attempted to capture these easements (often inaccurately). The resulting map was confusing and very difficult to re-code and use.

The correction of park boundary mapping was clearly beyond the scope of this project. However, boundary definition problems needed to be resolved for the purposes of vegetation re-mapping. Consequently a new study area boundary was created by editing the NPWS Estate boundaries to remove internal boundaries for road and powerline corridors and around small in-holdings and to minimise polygon splitting around the periphery of the study area. Rather than clipping out parts of polygons along the coastline, estuaries and around lakes in the vegetation maps and leaving slivers behind or including unwanted slivers, the study area has been enlarged to include all such polygons wherever possible. These boundaries could then be split or re-shaped to map an accurate edge between vegetated areas and non-vegetated areas such as rock, beach or water. New polygon topology was created in pc Arc/Info and the boundary was then used for clipping the vegetation layers. Further editing of the API layer was carried out during the re-mapping work to correct previous inaccuracies such as boundaries between cleared and forested land, as explained in section 2.4.3 below.

The resultant study area is slightly larger than the actual reserved areas but the inclusion of small portions of non-park areas within the study area has considerable benefits for vegetation re-mapping purposes. Perhaps most importantly it avoided the loss of information along park boundaries and along the coastline resulting from inaccuracies in previous mapping. The cleaning up of the boundary also enhances the final mapping product. Should the new FE layer of the study area need to be analysed to extract statistical data for areas specifically within the park (e.g. percentage areas of each FE type in the park), it is a simple process to clip it with the mapped (but inaccurate) park boundaries.

2.4.3 Preparation of GIS Layers for Re-mapping

The study area portion of the Southern CRAFTI map was extracted using the boundary extent derived from the new study area boundary as outlined above. The map used was a modified version of the original CRAFTI map which contained updates by Nic Gellie (EcoGIS) to 2001, re-named fields and an additional descriptive field for the corresponding forest ecosystem type. A clipped version of this map using NPWS Estate boundaries supplied as part of the source data by NPWS was used, however, part of Morton National Park extension was missing from this layer. The missing portion was extracted and added from the full CRAFTI South Coast layer and attribute information was adapted to match. A considerable amount of manual editing was carried out to rectify problems along road and powerline corridors to match them to the vegetation boundaries along these easements as they appeared in the digital orthophotos, to remove numerous slivers and re-code the easements as ‘cleared’ rather than excluded. At the same time additional powerline corridors were added where missing, and some non-existent road corridors were removed.

The CRAFTI map was created by merging of existing State Forests RN17 API mapping and API mapping derived from air photo overlays. This resulted in many sliver polygons, particularly around rainforest gullies. Most of these were retained but re-coded to the appropriate type of their neighbours based on the patterns evident in the orthophotos.

2.4.4 Data Capture and Processing

In summary, new API line work along the coast and around lakes and estuaries in Conjola NP, was interpreted and captured by digitising boundaries directly off the digital orthophotos during the GIS data capture and coding processes. This included digitising the boundaries of water bodies, cleared and urban areas. The new linework was incorporated directly into the CRA API linework and coded with the forest ecosystem types. The old and new API polygons were merged to create a new composite API map for the study area, coded according to FE types. This involved both digitising new polygons, splitting and re-shaping the boundaries of existing ones and making appropriate changes to the attribute tables. Editing was carried out primarily using ARCGIS 8.3 in ARCVIEW shapefile format. Additional polygon processing and re-building was carried out using pc ARC/INFO. For practical purposes, the Conjola and Morton portions of the study area were separated. The final layers are compatible with ARCVIEW 3.x and have been developed using AMG Zone 56 coordinates.

More specifically, there were three aspects to the re-mapping of vegetation in coastal areas.

- Vegetation types which were not accurately delineated in either of the two CRA vegetation maps were re-captured by identifying the patterns and digitising directly from the digital orthophotos. This process was assisted in some cases by first identifying boundaries and types from air photographs using stereo pairs. It was found that most vegetation boundaries in coastal areas could be relatively easily recognised in digital orthophotos and mapped directly rather than having to use a standard API process of marking up acetate overlays, scanning, rectifying and digitising.
- Boundaries of polygons which had a frontage to coastal lakes and estuaries or a seaward edge along beaches or rocky headlands were re-mapped by API so that the incorrect edges of these polygons could be replaced, while the landward edges could be retained. The edge of vegetated areas was mapped rather than the actual high tide line, thereby excluding unvegetated rock and beach areas. Boundaries of cleared areas were also captured.
- Further polygons in the existing maps were checked as necessary by overlaying the boundaries in outline on the orthophotos and adjusting or splitting without requiring full replacement of boundaries.

The procedure for polygon processing was as follows.

- Relevant portions of the study area boundary (which is discussed above) or portions of the CRAFTI map which were immediately outside the study area, were used in the API vegetation layer to enable polygon closure along the boundary. In some instances, polygons were allowed to extend beyond this boundary rather than being split.
- Where further processing of polygons was required in the ARCEDIT module of pc ARC/INFO, the clean command was used to build polygons with nodes automatically snapped within a set tolerance of less than 1 metre and dangling arcs removed using a 2 metre tolerance. Relatively few points had to be manually edited to close polygons and remove overshoots. This reflects the greater accuracy and automated error correction capability of on-screen digitising techniques relative to traditional digitising direct from hard copy maps.
- The polygon layer was coded in ARCGIS according to the map codes marked on the field maps or for codes to be assigned from the coastal re-mapping work. Codes were added to two new fields in the attribute table. These fields contained the new FE code and status fields for recording details update status of each polygon linework and coding. Details of the attribute table are included in Appendix 6. The polygon layer was checked against the aerial photographs, field maps or other notes, for completeness.

The resultant polygon layer represents all new polygons derived from the API work, within and adjacent to the study area and provides the basis for the new forest ecosystems map. The final map was prepared by dissolving the boundaries between polygons of the same type so as to create a neater map for presentation purposes. However, since this process results in loss of most of the attribute fields, the original re-coded API maps were retained with full attribute details for the purposes of analysis and any further re-mapping.

2.4.5 Accuracy Level

The API mapping carried out during the CRA and earlier State Forests RN17 mapping was generally regarded as being reasonably accurate although some vegetation types are difficult to distinguish by API and some significant ecotonal boundaries between forest types have been missed because of indistinguishable photo patterns. Although generally accurate to around 25 metres or better, there are instances, however, of errors of greater than 50 metres. These may relate to inaccuracies in the 1:25,000 base mapping to which the CRA API linework was rectified, or to errors in raster to vector conversion from scanned overlays.

Although this API linework was theoretically utilised in the CRA forest ecosystems modelling project, during the present project, many instances of wrongly placed boundaries in the FE model were detected which do not reflect the accuracy of the underlying API linework. Either the API linework was not fully utilised or inaccuracies were introduced during the modelling. The FE modelling does not conform well to the topographic patterns in many instances. This is compounded by the inherent inaccuracy and grid patterns along polygon edges, caused by grid data modelling. Because of the inaccuracies apparent in the FE modelled boundaries, these boundaries were not used in the new mapping. This does not imply however, that the FE model was ignored, since it was field validated and the modelled polygons were considered in the re-coding of polygons derived from API mapping.

It has already been noted that significant mis-matches between the NPWS Estate boundaries and other GIS data layers were frequently apparent. While the park boundaries are clearly defined in words by gazettal notices, the interpretation of these boundaries using available mapping has resulted in many inaccuracies. Consequently, for the purposes of this project, it was often meaningless to adopt mapped park boundaries for defining the study area.

The digitising of linework for polygons mapped from orthophotos was carried out in a manner which minimised inaccuracies. The resulting linework is generally accurate to well within 25 metres of true positions on the ground and probably in most cases to within 10 metres. This is closely dependent on the accuracy of the digital orthophotos which is likely to vary slightly as a result of the rectification process in converting the air photos to orthophotos. This accuracy level does not necessarily relate to topographic and cadastral mapping inaccuracies.

Despite some minor discrepancies between the mapping and GPS records for field survey sites, it is considered that the GIS methodology for capturing the new API work, combined with field checking using GPS readings, achieves accuracy levels which exceed those of the Southern CRA mapping.

Clipping of the new vegetation layer with the park boundary polygons may be necessary in some instances (for example, to calculate percentages of each vegetation type within the park), however, it should be realised that this will split many vegetation polygons around the periphery of the mapping and create numerous slivers.

2.4.6 Polygon Attribute Coding

Coding of the new mapping, which was based on the Southern CRAFTI layer with additions and modifications resulting from the API work, was guided by the findings of the field surveys and interpretation of the existing vegetation maps, air photos and some field checking of the API work, the latter being confined to Conjola. Coding was an iterative process of validating the coding of polygons against the many sources of information and involving several levels of subsequent checking as outlined in section 2.4.8. Comments in the attribute tables were constantly updated to reflect the information on which code allocations were based. Re-coding of the new API layer was carried out using ArcGIS 8.3. However, for compatibility with the NPWS database, legends for forest ecosystem types were developed using ArcView 3.x.

Attributes were retained from the original CRA API layer, including all original ID fields. This made it possible to link the new layer back to the original ones if required for cross-checking purposes and importing additional attributes. Attributes added or re-named by EcoGIS were also retained. The coding process was as follows.

- The API map attribute table was extended with new fields as indicated in Appendix 6 included some additional fields relating to conversion codes and notes on this process, field survey site numbers (if present), polygon and code update status (i.e changed or unchanged) and final allocated new FE type and descriptive labels.
- The new FE type was firstly coded according to the findings of the field work, using annotations on the field maps and the FE types assigned to each floristics survey site and any comments relating to this were added to the notes field. During this process several additional FE types were added to the list occurring in the study area.
- The new API work was carried out and coded based on interpretation of the orthophotos, air photos and any other available information. During this process, many polygons were split to better represent the patterns evident from the field or API work and given appropriate revised codes.
- Conversion codes, which translated API codes to FE types, were assigned according to Tables 2.1 and 2.2 and as outlined in section 2.3.1 of the report. Rather than applying the conversion codes globally, each polygon which was not already coded with a new FE type, was manually assigned a new FE code based on the conversion code and other factors. During this stage, many sliver polygons from the original API mapping were rationalised and re-coded. In most cases slivers were retained and re-coded. Very small slivers were deleted in some cases around the external study area boundary and along internal corridors and the boundary was corrected to match the air photos as necessary.
- Further confirmation or amendment of the mapping was carried out by selective checking using stereo pairs of air photos.

- The mapping was checked by the project team and the coding was further refined.

The final forest ecosystems map was prepared as a dissolved version of the modified CRAFTI maps and contains only the new FE codes and labels, together with polygon perimeter and area calculations.

A full list of attribute codes is contained in Appendix 6. Along with a description of all of the GIS layers supplied on the data CD.

2.4.7 Survey Site Mapping

The brief required field data sheets to be presented in electronic format as well as the original hard copies. The field sheets for standard floritic survey sites were initially transferred to the MS Access Database developed by NPWS staff Michael Bedward and Murray Ellis. This allowed maximum automation of data entry and provided a suitable means of analysing and re-formatting the data. The fire response monitoring site data were entered into an Excel spreadsheet database, designed by Nic Gellie (EcoGIS) for fire response monitoring in the Nowra area.

To enable the floristics data to be used in the GIS in conjunction with the forest ecosystems and other GIS layers, they were translated to a number of DBase files which could be loaded into ArcView GIS. The tables which were converted included the site details (including AMG eastings and northings), the floristics records for each site and the master table of species names and reference numbers.

The sites table was converted to a GIS point feature layer so it could be displayed and labelled for mapping purposes. Additional fields were added to the feature attribute table for old and new FE types, drawn from the field data sheets and botanical notes.

After initial removal of unnecessary fields, the floristics and species tables were permanently joined so that species reference numbers were followed by several columns of relevant species information including family, scientific and common names. The resulting floristics table can be dynamically linked to the point feature layer using the common site number field so that a listing of species recorded for each site can be readily obtained.

The sites and floristics tables were used in checking the new forest ecosystems map coding and in helping to identify and resolve anomalies. This process was greatly assisted by having easy access to the records of FE types found at each new survey site. The GIS version of the database was also used in compiling the forest ecosystem profiles.

2.4.8 Checking of Information

As noted above, several levels of checking were made during the process of conversion coding of the API polygons and during the new API work along the coast, to rationalise the coding of FE types and to ensure consistency between the new mapping, the site survey database and the information in this report. This process was assisted through the recording of notes in the various GIS layer attribute tables and in the conversion code tables. The compilation of the results section in the draft report was undertaken concurrently with the API and GIS work to ensure consistency of the information presented, with anomalies and queries resolved as a team effort. The GIS layers were checked at several points to ensure that coding had been correctly maintained during editing and polygon processing.

Some inconsistencies were detected between the mapped types and the types recorded for the corresponding field data records. In some cases this was a result of difficulties in delineating the field assessed types by API. In the majority of instances, the problems related to the placement of field survey points close to vegetation boundaries, so that they appeared either on the boundary or just outside it in a neighbouring polygon. Although the GIS mapping was accurate to around 10 metres, this level of inaccuracy may have been sufficient in some cases to cause misplacement of the boundary relative to survey site points. In a few instances, survey site map references were found to be incorrect and point locations had to be manually adjusted. GPS errors or transcription of coordinates to the field sheets may have been responsible for some mismatches of information.

As a result of the potential for mapping and field data inconsistencies, a technique for preparing the forest ecosystem profiles (contained in Appendix 4) was adopted where the field sites were only included in the species lists where they clearly fell within the mapped polygon of the same type. All other sites, including mismatching types and sites close to boundaries, where possible errors could occur, were listed as marginal sites and excluded from the consolidated species lists for that FE type.

All draft material was checked by the botanist (Jackie Miles) and further amended to remove inconsistencies between the field and API work and to check the validity of the GIS mapping.

3 RESULTS

3.1 General Findings

The following trends were apparent from the field botanical survey work and the API work, relating to inconsistencies identified in the forest ecosystems modelling by Thomas, Gellie and Harrison (2000). The forest ecosystem (FE) type names have been shortened in most cases by excluding the species names which are typical of each type.

3.1.1 Conjola National Park

Based on the findings of the work, the vegetation of Conjola National Park can be most simply described as follows.

Conjola National Park protects extensive areas of low scribbly gum (*Eucalyptus sclerophylla*) and red bloodwood (*Corymbia gummifera*) forest or woodland, which grow on shallow infertile soils. The crests of the many low ridges tend to have a dense understorey of heathy shrubs and small trees such as the paper-barked tea tree (*Leptospermum trinervium*). In places the eucalypts and bloodwoods disappear altogether, leaving dry coastal heath. Characteristic plants of this heath are the Mountain Devil (*Lambertia formosa*), waratah (*Telopea speciosissima*), grass trees (*Xanthorrhoea* species) and numerous sedges, orchids and lilies. Poorly drained areas within the drier scribbly gum woodlands may carry the paper-barked snow-in-summer (*Melaleuca linariifolia*), bottlebrushes (*Callistemon linearis*), the small blue grass tree (*Xanthorrhoea resinifera*) and native broom (*Viminaria juncea*). Areas of more fertile clay soils may carry grassy spotted gum (*Corymbia maculata*) forest and wet flats around Swan Lake have swamp mahogany (*E. robusta*) forest, or belts of swamp paperbark (*Melaleuca ericifolia*). Deeper gullies carry wet blackbutt (*E. pilularis*) or Sydney blue gum (*E. saligna*) forests with a dense tall shrub or small tree layer tangled with vines, and occasional small patches of developing rainforest. Cabbage tree palms (*Livistona australis*) are a conspicuous feature of these gullies.

The forest ecosystems modelling by Thomas, Gellie and Harrison (2000) was found not to be particularly accurate for Conjola National Park. As in earlier Southern CRA vegetation map validation in Meroo and Murramarang National Parks and Barnunj SRA, substantial mapping errors were found. These particularly related to mis-interpretation and over-mapping of non-eucalypt vegetation types, such as *Casuarina glauca* swamp forest types; Coastal Tall Wet Heath Swamp Forest (FE24) and South Coast Swamp Forest (FE25). These were again mapped as being very much more extensive than they really are, being confused with drier non-eucalypt communities such as heath and even with eucalypt forest.

Northern Coastal Tall Wet Heath (FE140), had been considerably over-mapped within the drier woodland type Northern Coastal Hinterland Heath Shrub Dry Forest (FE139). Most of the patches of FE140 which were not on drainage lines were re-interpreted as FE139 with a low tree density and heathy understorey. Within wetter eucalypt forest types, scrub within drainage lines was re-interpreted as either the paperbark woodland type, Northern Coast and Hinterland Moist Heath (FE144) or the swamp mahogany forest type, Northern Coastal Lowlands Swamp Forest (FE175).

The latter is a highly significant community with a restricted distribution which had been overlooked in both the FE and CRAFTI API maps. FE175 (in this report re-named as Coastal Swamp Mahogany Forest) is listed as an Endangered Ecological Community (as Sydney Coastal Estuary Swamp Forest Complex) in the region. A few occurrences of this community were observed around the north-western end of Swan Lake and extensive patches were mapped from new aerial photo interpretation as a result. However only some of these polygons have been ground-truthed and further work in this area would be useful to validate the new mapping. The areas visited have been subject to burning during the 2001-2002 fires and contain dense young *Melaleuca* regrowth which, together with the swampy ground and water channels, make access difficult. Parts of the area checked during the field work for the API mapping was found to contain fringing *E. robusta* but it is not clear how extensive this species is. According the Phil Craven (NPWS) *E. botryoides* occurs in this area. It possibly occurs instead of *E. robusta* in slightly drier areas fringing the swamp. Since there is no described FE type which includes this species in a swamp fringe environment, it has been assumed to be a component of FE175.

Broader eucalypt associations were also not very accurately mapped in detail during the Southern CRA. Although the main vegetation types in Conjola are correctly identified as being Hinterland Heath Shrub Dry Forest (FE2), Northern Coastal Hinterland Heath Shrub Dry Forest (FE139) and Northern Coastal Hinterland Moist Shrub Forest (FE21), their distributions were not very accurate . In the API mapping, many polygons were mapped as a combination of FE2 and FE21 while in the FE model, much of this has been interpreted as the wetter FE21, which resulted in it being considerably over-mapped. The distribution of these types has been re-mapped as explained in section 3.2.

The Southern Coastal Dune Scrub Complex/Coastal Dune Herb Swamp Complex (FE23/26) was predicted to occur behind Berrara Beach. The genuine existence of this vegetation type is quite doubtful. The dune scrub complex, FE23, is the same as Eden CRA type Beach Strand Grassland (FE62) described by Keith and Bedward (1999) and consists of *Spinifex sericeus* and other coastal grasses and herbs which typically only grow on beaches. The dune herb swamp type, FE26, as a discrete vegetation type, does not stand up to close scrutiny when the list of characteristic species (Thomas, Gellie & Harrison, 2000) is examined. The area appears to support typical dune vegetation behind which is a area of Northern Coastal Tall Wet Heath (FE140) extending along creek flats. The areas mapped as this combined vegetation complex were re-mapped as Dune Scrub-Beach Strand Grassland (FE22/23), and the mapping of this community was extended somewhat on and behind Berrara and Monument Beaches.

Some of these findings are discussed in relation to rare and under-reserved vegetation types in more detail in section 3.2.

3.1.2 Morton National Park (eastern extensions)

Based on the findings of the work, the vegetation of the eastern extensions of Morton National Park can be most simply described as follows.

Morton National Park is largely made up of flat sandstone plateaux, cliff-edged, with deep valleys between. The plateaux carry a mosaic of low woodland and heath, or in areas of deeper soils taller forests, though generally with a heathy understorey. Rainforests can be found in sheltered gullies and along the cliff bases, where the cliffs afford protection from fires and provide extra moisture and shading from sun and drying winds. The eastern extension of Morton National Park is located to the east of the main plateau and consists of numerous ridges which carry dry heathy forests dominated by red bloodwood (*Corymbia gummifera*), yertchuk (*Eucalyptus consideniana*) and various stringybarks, often with turpentine (*Syncarpia glomulifera*) in the understorey. On sheltered slopes turpentine trees become larger and may be prominent in the forest canopy. On occasional exposed ridge tops there are small treeless heath patches.

Broadly the forest ecosystem modelling by Thomas, Gellie and Harrison (2000) appears reasonably correct in its broad distribution and typing for the new extension of Morton NP. This is no doubt partly due to the near-absence of non-eucalypt forest types, which are often found to have been poorly interpreted, and which are relatively easy to prove incorrect. Eucalypt forest types are generally less clearly defined and hence less easy to prove wrong. In general it seems that the communities which are mapped as covering the bulk of this reserve are correctly predicted as being present, these being Hinterland Heath Shrub Dry Forest (FE2), Northern Hinterland Shrub Dry Forest (FE3), Northern Coastal Hinterland Heath Shrub Dry Forest (FE139) and Northern Coastal Hinterland Moist Shrub Forest (FE21). However, their distribution and the proportions of the wetter (FE3 and FE21) and drier (FE2 and FE139) types were not always correct in detail.

No additional communities were found which had not been mapped, but then the field work in Morton was considerably less detailed than in the other parts of the study area. Fewer quadrats were requested, and the road network provides fewer opportunities for ground-truthing of any vegetation types other than those found on ridges, as the topography is more rugged than that of Conjola NP or Narrawallee Creek NR.

Indeed, one whole section of the Park, that located between Martins Ridge Road and Coolabah Road, was not visited apart from some brief checking along Martins Ridge Road. Fallen trees blocked any further access from this direction and it was not considered that driving along Coolabah Road would add any useful information. Resource constraints did not permit us to spend the time required to walk into this area and check it any more thoroughly. Past surveyors have obviously suffered from the same problem, as there are no previous quadrat data from this area. There are also some rather unlikely

Southern CRAFTI API codes on the API map for this area (such as E1801 for *E. fastigata* and E1702 for *E. viminalis/dalrympleana*) which suggest that air photo interpreters were similarly handicapped in attempting to decipher the vegetation of this area.

One community which was predicted to occur, was not found to be present in at least one of the areas in which it was modelled. This was Northern Coast and Hinterland Moist Heath (FE144) which is defined (Thomas, Gellie and Harrison, 2000) as being dominated by the small tree *Melaleuca linariifolia* and various shrubs typical of either wet (*Callistemon linearis, Epacris microphylla*) or dry heath (*Banksia ericifolia, Darwinia leptantha*) with a groundcover including typical wet, low fertility soils species such as *Selaginella uliginosus, Gleichenia dicarpa* and *Leptocarpus tenax*. This was checked with two quadrats in widely-separated locations, MORJM01F on Whalebone Road and MORJM06 on Messmate Road, and in both cases the vegetation was found to be open FE139 with relatively sparse, low trees. There was no indication of poor drainage or wet heath in either area. It has therefore been assumed that all such mapped patches of FE144 are incorrect and have been re-coded as FE139H which contains a sparse tree cover and heath-like understorey, being a woodland/heath variation of the more widespread Northern Coastal Hinterland Heath Shrub Dry Forest (FE139) which occurs at lower elevations.

Other patches mapped as “scrub” on the API map had been interpreted as Morton Plateau Mallee Swamp Low Forest (FE176). No diagnostic species list has been provided for this community by Thomas, Gellie and Harrison, so it is difficult to know in what respects it differs from the heathy community of the lower elevation coastal areas, FE139. Personal experience in Morton NP suggests that floristically there is very little difference but polygons coded “S” on the API map have been re-mapped as FE139H (implying that they are heath rather than woodland) at lower elevations in Morton and as FE176 around the rim of the Morton plateau where they occur as a few slivers along the boundary between Morton (East) and Morton NP.

Rainforests occur both in gullies and at the foot of cliffs where they are protected from fire. There are substantially more rainforest polygons on the FE map than on the API map. As a decision had been made to follow the API mapping because of its greater accuracy, many modelled rainforest polygons were therefore discarded. API polygons labelled R or RE (rainforest with emergent eucalypts) had been interpreted in the FE model as FE20 (Ecotonal Gully Rainforest) in some locations and as FE166 (Warm Temperate Rainforest) in others. It is not clear what the basis for this distinction was, and again in the interests of simplicity all rainforest polygons have been re-labelled as FE20. It is quite likely that some rainforest in particularly sheltered locations is better developed Warm Temperate Rainforest but without further ground-based or aerial survey it is not possible to say which is which. The cliff-base rainforest community was checked in the adjacent McDonald State Forest, since this was more accessible than stands within the National Park. It was found to be similar in structure and species composition to the FE20 seen in gully sites. Many of the API polygons coded as rainforest in the Morton extensions were checked on air photos and confirmed as rainforest closely resembling FE20. In a few instances, the API mapping appeared incorrect and an appropriate wet eucalypt type was substituted.

Several other vegetation communities were eliminated on the grounds of improbability, although since no modelled locations were readily accessible for checking the validity of doing this is uncertain. Assessment of one area on Twelve Mile Road which carried yellow stringybark (*E. muelleriana*) and an unidentified smooth-barked eucalypt suggested that this community should not be characterised as either Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest (FE18) or Coastal Escarpment and Hinterland Shrub/Fern Dry Forest (FE19). Neither was mapped as occurring on that particular site, but both are mapped as occurring in Morton (East). The diagnostic species lists for these two communities (Thomas, Gellie and Harrison, 2000) suggest that they are derived largely from samples taken from further south, and not on Permian sandstone. Similar moist forest on sandstone in this area perhaps fits better into Northern Hinterland Shrub Dry Forest (FE3).

Similarly it was considered unlikely that Southern Escarpment Shrub/Herb/Fern Forest - *E. cypellocarpa incl. E. fastigata & E. obliqua* (FE57) would occur in the area. *E. fastigata* is easily confused with *E. piperita*, even on the ground, and this may have been a source of error in the API map which has flowed through into the FE map. FE 57 was assigned to API code E1801 which was discussed above as being an improbable code for this area.

Coastal Escarpment Moist Shrub/Fern Forest – *E. sieberi, E. piperita, Gleichenia dicarpa* (FE137) has been left as a possible interpretation of the API codes E3101 and E3103 (*E. sieberi* and peppermints, generally *E. radiata* or *E. dives*). Whether this is the correct interpretation is unknown, but few of the polygons of this community are in locations which could be checked. One is located towards the end of

Coolabah Road and could have been checked, but this was not seen as a high priority. It is also plausible to interpret this API code as FE2 in which *E. sieberi* is dominant or co-dominant with the more typical *Corymbia gummifera*. Some polygons in the Southern CRAFTI layer were interpreted as FE3 and others as FE137.

Some of these findings are discussed in relation to rare and under-reserved vegetation types in more detail below.

3.2 Findings Related to Specific Vegetation Types

Discussion of the findings of the field and API work for those vegetation communities observed in Conjola and Morton (East) National Parks is provided below. Full descriptions of these types as they relate to the study area, have been adapted from descriptions by Thomas, Gellie and Harrison (2000). They are tabulated in the form of Forest Ecosystem Profiles in Appendix 4. The list of communities present may be incomplete as only a small proportion of each of these parks could be checked.

In the descriptions below, the numbering system of the CRA classification (Thomas, Gellie and Harrison, 2000) has been retained but the community names have been simplified to make them more descriptive. While most of these types are directly equivalent to the Thomas, Gellie and Harrison types, some of the original names do not accurately reflect the types as represented in the study area. In some cases the dominant species may differ and therefore the original long names, which frequently contain a list of key species, may not be appropriate. One additional sub-type of a more comon forest type has also been added. The corresponding original names are included along with the new names in the forest ecosystem profiles contained in Appendix 4.

3.2.1 Non-eucalypt communities

Swamp Oak-Swamp Paperbark Forest (FE24)

This community generally occurs in a narrow band around the upper parts of saline or brackish coastal lakes and estuaries. Swamp paperbark (*Melaleuca ericifolia*) forms a dense low canopy 2-5 metres in height with swamp oak (*Casuarina glauca*) emergent above it at variable densities. The small tree *Myoporum acuminatum* may also occur. Other commonly associated species are salt-tolerant rushes and sedges *Juncus kraussii* and *Baumea juncea*, and herbs *Lobelia alata, Apium prostratum, Leptinella longipes, Samolus repens* and *Selliera radicans*. The tall sedge *Gahnia clarkei* may form an almost impenetrable groundcover layer to 2m high, but this is usually more typical of more freshwater wetland communities further upstream. This community was found as a narrow band around parts of the margins of Swan Lake in Conjola NP.

Swamp Oak Forest (FE25)

This community was seen only on the northern shore of Lake Conjola, and nowhere else in the Park, although it occurs in Narrawallee Creek Nature Reserve. Typically, swamp oak forms the canopy, with occasional *Myoporum acuminatum* and *Melaleuca ericifolia* forming a very open small tree layer. A shrub layer is generally absent or may consist of a patchy cover of the sprawling semi-woody herb *Rhagodia candolleana*, and the groundcover will vary depending on the frequency of inundation, but usually includes salt tolerant species ranging from couch grass (*Cynodon dactylon*) at the drier end of the spectrum, to samphire (*Sarcocornia quinqueflora*) and *Baumea juncea* at the wetter end. The herbs listed above for FE24 are likely to occur. The large vine common silkpod (*Parsonsia straminea*) is very typical of FE25, and epiphytic orchids *Dendrobium teretifolium* and elkhorn ferns (*Platycerium bifurcatum*) may grow on the casuarina trees.

Dune/Headland Scrub and Beach Strand Grassland (FE22/23)

These communities are generally mapped as a single unit because they almost invariably occur side by side as variable width bands on beach dunes. FE23 occurs on the beach, and is usually dominated by the grasses *Spinifex sericeus* and *Austrofestuca littoralis* and salt and dessication tolerant herbs including *Actites megalocarpa, Calystegia soldanella, Carpobrotus glaucescens* and the exotics **Hydrocotyle bonariensis* and **Cakile* spp. This grades via low wind-pruned coast wattle (*Acacia longifolia* ssp *sophorae*) into FE22, which occurs on the hind dunes. It generally consists of a canopy of

coast banksia (*Banksia integrifolia*) and a shrub layer of *Leucopogon parviflorus, Acacia longifolia* ssp *sophorae, Rhagodia candolleana* and occasionally *Correa alba* or the exotic bitou bush (**Chrysanthemoides monilifera*). The groundcover may include bracken (*Pteridium esculentum*), *Lomandra longifolia,* grasses *Poa poiformis*, couch (*Cynodon dactylon*) or the very similar *Zoysia macrantha* and herbs including *Carpobrotus glaucescens, Oxalis rubens, Pratia purpurascens* and *Dianella caerulea*. The vine *Kennedia rubicunda* is typical, and occasionally *Muehlenbeckia adpressa* also occurs.

The headland suite of species which has been lumped into FE22 is really quite a distinct community, although it does include a few of the same salt tolerant species. Typical small trees are *Allocasuarina verticillata* and *Melaleuca armillaris*, with shrubs *Alyxia buxifolia, Myoporum boninense, Rhagodia candolleana* and occasionally the exotics bitou bush and mirror bush (**Coprosma repens*). In long unburnt situations *Pittosporum undulatum* may become a major component of this community. Typical groundcover plants include *Lomandra longifolia, Poa poiformis, Austrostipa stipoides* and the herb *Pelargonium australe*.

FE22/23 has been re-mapped along almost all of the coastal fringe within Conjola NP. The Beach Strand Grassland component is difficult to detect in air photos and its seaward edge will vary according to beach dynamics. Consequently it has not been possible to accurately delineate this edge, however it has been assumed to extend about 20 to 30 metres beyond the visible edge of the dune scrub.

Ecotonal Gully Rainforest (FE20)

This community occurs in small patches in gullies throughout the study area, at the base of cliffs (in Morton) and on adjacent sheltered slopes in relatively fire-protected sites. There is generally an open canopy of whichever eucalypt species are dominant in the vicinity with the tall wattle *Acacia mabellae*, and a dense subcanopy of rainforest trees including *Acmena smithii, Doryphora sassafras, Cryptocarya glaucescens* and *Ceratopetalum apetalum*. Below them are smaller trees such as *Callicoma serratifolia, Tristaniopsis collina, Synoum glandulosum* and *Eupomatia laurina* and shrubs *Notelaea venosa* or *N. longifolia* and *Psychotria loniceroides*. The groundcover is generally sparse and dominated by various ferns, and vines are numerous and diverse. This community would tend to replace eucalypt forest in the absence of fire in moister locations. The above description is based on information in Thomas, Gellie and Harrison (2000) and observations in Conjola, Morton, Meroo and Murramurang National Parks.

In Morton the quadrat MORJM05F samples this community. The cliff-base rainforest community was checked in the adjacent McDonald State Forest, since this was more accessible than stands within the National Park. It was found to be similar in structure and species composition to the FE20 seen in gully sites. In Conjola the quadrat CONJM10 samples FE20 in a gully north of Red Head Road.

No true rainforest (such as Central Coastal Hinterland and Lowland Warm Temperate Rainforest (FE166) was seen during the field work or included in the re-mapping. Coastal Lowland Sub-Tropical/Littoral Rainforest (FE167) which was modelled in Conjola, appears to be an error since only dry forest was found at the modelled location. FE166 was modelled in Morton as occurring at the base of cliffs and field work tends to support this in some locations. Because the majority of rainforest polygons in the area were not field checked, and most of those that were were assessed as FE20, all rainforest polygons have been re-coded as FE 20 for present purposes. Further field validation in Morton would be needed to determine the true status of rainforests.

Wet Heath (FE140)

This community occurs in Conjola NP in a number of broad flat drainage lines and wet flats. The diagnostic species list for FE140 provided by Thomas Gellie and Harrison (2000) does not fit very well the observed vegetation in Conjola NP, but has been selected as the closest fit, since both are wet heath types. The nature of this vegetation varied quite a lot depending probably on the degree and duration of inundation. The community Cu11 (Scribbly Gum – Teatree Open Woodland/Open Shrubland described by Mills (1995) is equivalent to FE140.

The API and FE maps over-mapped this type, tending to place many areas with a sparse eucalypt cover as FE140 whereas they are more characteristic of the surrounding dry forest Scribbly Gum-Red Bloodwood Heathy Woodland (FE139). As a result many polygons of FE140, were re-coded or split between FE139 and FE140 on the basis of interpretation of the air photos and orthophotos. As a result FE140 is now confined mostly to treeless drainage lines and FE139 has been assigned to drier areas where a sparse tree cover is evident.

The quadrat CONJM11 was sited on one of the wetter areas and was dominated by sedges and the small grass tree *Xanthorrhoea resinifera*, with scattered shrubs including *Acacia elongata, Acacia longifolia, Comesperma retusum, Bauera rubioides* and *Sphaerolobium vimineum*. However, with increasing time since fire this community is likely to become more shrub-dominated. Most shrubs on this site appeared to be seeders. In other areas in the same vicinity re-sprouters such as *Callistemon linearis* were seen.

Woollybutt - Paperbark Woodland (FE144)

This community occurs in small patches in drainage lines on sandy soils, generally within a taller forest such as Lowland Red Bloodwood-Turpentine Dry Shrub Forest (FE2) or Spotted Gum-Blackbutt Moist Forest (FE21), whereas the preceding type, FE140 tends to occur within heathy woodland (FE139). There may be an open canopy of eucalypts, which may include *E. longifolia* or *E. botryoides*. If the eucalypt present was *E. robusta*, then the community would be defined as Coastal Lowlands Swamp Mahogany Forest (FE175), which is otherwise similar. Paperbarks form a sub-canopy layer 3-10 metres high, generally *Melaleuca linariifolia* but occasionally in the Jervis Bay hinterland north of Conjola NP *M. styphelioides, M. biconvexa* or *M. decora*. There may be a patchy shrub layer with *Leptospermum polygalifolium* or *Callistemon linearis*. The groundcover is generally sparse due to frequent inundation and includes a range of semi-aquatic herbs such as *Villarsia exaltata* and *Gonocarpus micranthus,* coral fern (*Gleichenia dicarpa*) and sedges such as *Baumea juncea, Schoenus brevifolius* and *Leptocarpus tenax*. However it may also consist of a dense thicket of the tall sedge *Gahnia clarkei*. The above description is based on information in Thomas, Gellie and Harrison (2000) and observations in Conjola National Park and reserves around Jervis Bay. Mills (1995) refers to the equivalent community as Cu8 (Woollybutt – Paperbark Woodland).

The FE model indicates a few polygons of FE144 in Conjola although this code was not assigned in the CRAFTI mapping where the equivalent API code 'FP' was generally assigned incorrectly as FE25. A few polygons have been re-mapped as FE144 as the most likely type based on API but this has not been confirmed in the field. Quadrat CONJM02 was located in this community at Nerrindillah Creek. It was not seen in Morton (East).

Coastal Headland Heathland (FE187)

This are described by Thomas, Gellie and Harrison (2000) as tall shrublands dominated by *Allocasuarina distyla* and a number of other shrubs which generally do not occur south of Jervis Bay. Despite this, the vegetation type is described as occurring on rocky headlands as far south as Narooma.

Headland heath is mapped at one location on the headland at the northern end of Cudmirrah Beach, mostly outside the park boundary. It was not visited so it is not known how closely it fits the description above.

Rock (FE190)

Some areas on the Morton escarpment were included in the API map with an API code 'K' which relates to rock outcrop with less than 10% vegetation cover. Rock (FE190) is identified in the forest ecosystems classification as bare rocky outcrops mapped from aerial photo-interpretation where there is obvious bare rock in patch sizes greater than 2 hectares. Examination of aerial photos for this area confirmed that the rock areas were generally associated with cliff lines on the escarpment and were generally narrow and localised. In some instances, the extent of unvegetated outcrop had been exaggerated and some polygons were split and part assigned to a rainforest or eucalpyt forest type.

3.2.2 Eucalypt communities

Coastal Sands Bangalay-Banksia Forest (FE28)

This community occurs in a restricted range of locations on deep Quaternary sand deposits behind beaches, on bars at the mouths of coastal lagoons and alongside small creeks where they flow through such sand deposits. Bangalay (*E. botryoides*) is generally the only eucalypt species. Saw banksia (*Banksia serrata*) forms a sub-canopy layer, or in wind-pruned stands mingles with the bangalay in a low tangled canopy. Typical shrubs are *Acacia longifolia* ssp *sophorae* or *A. longifolia* ssp *longifolia* and *Monotoca elliptica*. Burrawangs (*Macrozamia communis*) may be present or even dominant. Bracken is

the dominant groundcover species, with *Lomandra longifolia*, grasses, blady grass (*Imperata cylindrica*) and kangaroo grass (*Themeda triandra*) and herbs *Schelhammera undulata, Desmodium gunnii, Dianella caerulea, Gonocarpus teucrioides* and *Viola hederacea*. In long unburnt stands rainforest elements such as the trees *Glochidion ferdinandi, Elaeocarpus reticulatus, Pittosporum undulatum* and *Acmena smithii* and various vines may appear. Mills (1995) lists this community as Cu5, Bangalay Open Forest. The re-mapping has retained this community near the mouths of Nerrindillah and Berrara Creeks and on the sand sheet east of Swanhaven near the mouth of Swan Lake.

Ecotonal Coastal Swamp Forest (FE27)

This community is intermediate between FE28 and Swamp Oak Forest (FE25) and occurs where sand sheets abut coastal lakes or estuaries. A small area of this vegetation type was mapped on the northern shore of Swan Lake and it was sampled in the quadrat CONJM03F. FE27 is not really a discrete vegetation community but is merely an amalgam of two or more communities which occupy adjacent habitat.

Coastal Sands Blackbutt–Banksia Forest (FE29)

This community is very similar to FE28 but tends to occur a little further inland. This may just be a function of the relative salt tolerance of the dominant tree species, with *E. pilularis* not capable of surviving as close to the sea as *E. botryoides*. Red bloodwood (*Corymbia gummifera*) may be co-dominant and *Banksia serrata* is often present as a small tree layer. In understorey composition this community is transitional between FE28 and FE2, described below. It occurs primarily on flat sand sheets, unlike FE2 which is found on low ridges on sandstone-derived soils rather than wind-deposited sand. In Conjola it was re-mapped in only one small area on sand above the tidal reach of Nerrindillah Creek. This type is more common in Narrawallee Creek Nature Reserve. It is possible that this type also occurs east of Swan Lake and north of Cudmirrah Beach since a reference to Blackbutt tall open forest was made by Benson, Andrew and Campbell (1986). This reference has not been checked and it seems likely that the area refererred to is outside the park in an area mapped in the CRAFTI layer as corresponding to FE28. This area, if it contains Blackbutt is more likely to be FE29.

Lowland Red Bloodwood-Turpentine Dry Shrub Forest (FE2)

This community is widespread in both Morton (East) and in Conjola, occurring on ridges and slopes with a variety of aspects. It is typically dominated by either or both of red bloodwood (*Corymbia gummifera*) and blackbutt (*E. pilularis*), with turpentine (*Syncarpia glomerulifera*) present as either a component of the canopy or the understorey depending on the site quality and fire history. Under drier conditions or more frequent fire, turpentine is more frequently a small tree or mallee form, owing to its habit of coppicing after fire. The understorey is shrubby and includes some “heathy” species such as *Lambertia formosa, Gompholobium latifolium* and *Banksia spinulosa*, but also a number of shrubs more typical of dry forest than heath such as *Podolobium ilicifolium, Acacia obtusifolia* and *Tetratheca thymifolia*. Typical groundcover species are the grasses *Entolasia stricta* and *Panicum simile*, the ferns *Lindsaea linearis* and *L. microphylla* and herbs *Dianella caerulea, Phyllanthus hirtellus*, *Marsdenia suaveolens* and *Pomax umbellata*. At the wetter end of the spectrum, such as in gully heads or long unburnt sites species such as Christmas bush (*Ceratopetalum gummiferum*) and blueberry ash (*Elaeocarpus reticulatus*) may be present, with ferns *Calochlaena dubia* and *Gleichenia dicarpa*.

Many of the polygons in the CRAFTI mapping which were coded as combined FE2/FE21 have been re-coded as FE2 unless they appear to be wetter forest associated with major drainage, in which case they have been re-coded as Spotted Gum-Blackbutt Moist Forest (FE21).

Mills (1995) refers to this community as Cu2, Blackbutt-Turpentine Open Forest, and FE2 may also include his Cu6, Bloodwood-Peppermint Open Forest/Woodland, dominated by *C. gummifera* and *E. piperita*, with a heathy understorey. He places Cu2 in less harsh locations in the landscape such as gullies and areas with deeper soils, but not on dunes.

In Morton the quadrat MORJM04 samples this community and in Conjola CONJM06F and CONJM09F are in various forms of this community.

Hinterland Red Mahogany-Turpentine Moist Forest (FE3)

This community appears to be widespread in the higher western areas of Morton (East), occurring on lower slopes with a variety of aspects. It differs from FE2 in the presence of large-fruited red mahogany (*E. scias* ssp *callimastha*) and dominance of turpentine (*Syncarpia glomerulifera*) in the canopy.

However, typical FE2 canopy species such as red bloodwood (*Corymbia gummifera*) and blackbutt (*E. pilularis*), may also be present, as may *E. piperita, E. paniculata* and stringybarks including *E. globoidea* and *E. muelleriana*. The understorey is shrubby and includes some typical dry forest species such as *Acacia obtusifolia, Persoonia linearis* and *Pultenaea daphnoides*, but also a number of species typical of infrequently burnt sites such as *Zieria arborescens, Astrotricha latifolia, Astrotricha* sp. B and the small trees *Tristaniopsis collina* and *Elaeocarpus reticulatus*.

This community was not seen in Conjola NP and Mills (1995) does not discuss it. In Morton the quadrat MORJM03F samples this community.

Jervis Bay Lowlands Dry Forest (FE5)

This community may occur in Conjola NP. It is described by Thomas, Gellie and Harrison (2000) as mainly being dominated by grey gum (*E. punctata*), which is apparently present in Conjola, although not recorded on this survey. However, other common eucalypts include *C. gummifera* and *E. eugenioides*, and less commonly *C. maculata, E. paniculata, E. longifolia* and *E. globoidea*. A sub-canopy layer of the small tree *Allocasuarina littoralis* is frequently present. From the description it appears that shrubs are typically smaller species such as *Pimelea linifolia* ssp *linifolia, Pultenaea villosa, Pultenaea retusa* and *Daviesia ulicifolia*, and the understorey is predominantly grassy.

This description appears to fit some of the vegetation seen in Conjola NP. Mills (1995) describes the community Cu3 (Spotted Gum Tall Open Forest) which sounds similar, although from his description it has a prominent small tree layer of wattles and a dense shrub layer. When it was seen 22 months post-fire on this survey, the spotted gum forest in Conjola appeared much more open and grassy, because many of the component shrubs and small trees had been reduced to seedlings and were thus less prominent at the time. The quadrats CONJM07 and CONJM12 may be within this community, although the spotted gum dominated areas which CONJM07 samples were originally mapped as Coastal Lowlands Cycad/Shrub Dry Forest - *Corymbia maculata* (FE9), a dry spotted gum forest type which is common on Ordovician sediments south from about Batemans Bay. Given the absence of burrawangs (*Macrozamia communis*) and the generally grassier appearance of the spotted gum forest in Conjola, it seems to fit the description for FE5 better.

FE5 was re-mapped at seven locations in the northern parts of Conjola, which were previously mapped as FE9. It was not found in Morton (East) but was included in the re-mapping of Narrawallee Creek Nature Reserve.

Coastal Lowlands Spotted Gum-Burrawang Dry Shrub Forest (FE9)

Mapping of this community in Conjola was replaced with FE5 (see above), but in Morton (East) there were a few patches of pure spotted gum (*C. maculata*) mapped from API which were left as FE9. This was done because the areas where it was mapped were located on steeper sites than the flat areas interpreted as FE5 in Conjola, and because there were areas of non-sandstone geology within Morton (East) which may have been Ordovician metasediments. This increases the likelihood that the community present would in fact be FE9. However the mapped areas were not visited and the accuracy of the mapping has not been checked. Steep sites with a sheltered aspect were re-mapped as FE21. FE9 as it occurs on Ordovician metasediments south from Batemans Bay typically includes spotted gum, stringybarks and ironbark (*E. paniculata* or *E. tricarpa*) with burrawangs (*Macrozamia communis*) often prominent in a dry shrubby understorey. How closely the spotted gum patches in Morton (East) conform to this description is not known.

Scribbly Gum-Red Bloodwood Heathy Woodland (FE139)

This community occurs on the poorest soils, usually shallow and derived from sandstone. They may also be poorly drained. Bloodwood *(C. gummifera)* tends to dominate in drier sites, with yertchuk (*E. consideniana*) co-dominant or sometimes dominant. Silvertop ash (*E. sieberi*) is occasionally present in more elevated ridgetop sites. Scribbly gum (*E. sclerophylla*) is more likely to occur in poorly drained sites. The understorey includes a wide variety of heathy shrubs and small trees with some of the more common being *Leptospermum trinervium, Hakea sericea, Lambertia formosa, Isopogon anemonifolius, Persoonia levis, Petrophile sessilis, Kunzea capitata, Bossiaea heterophylla* and *Bossiaea ensata*. Numerous sedges, various *Lomandra* species, the grasses *Anisopogon avenaceus* and *Entolasia stricta* and numerous herbs such as *Actinotus minor* and various orchids form the groundcover.

Depending on the exposure of the site to sea winds, the shallowness of the soil and possibly fire frequency, this community may become almost treeless. Many patches in Conjola National Park were

mapped as "scrub" on the API maps and translated into heath (FE140) on the FE map. However, all those investigated proved to be FE139 with a sparse, low tree cover. Similarly in Morton (East) patches mapped as a wet heath (FE144) were found to be FE139 with few trees, or only low trees, possibly due to frequent fire or other past disturbance. In these areas the type was given a 'H' suffix (FE139H) to indicate a heath community derived from FE139 with a very sparse tree layer. It is possible that some of these areas were logged in the past for a variety of products, despite the fact that they appear to have little potential as commercial forests.

Mills (1995) divides this community into a number of variants, mostly influenced by drainage and soil depth. His Cu7 (Scribbly Gum-Casuarina Open Forest), Cu9 (Scribbly Gum-Bloodwood Woodland/Heathland), Cu10 (Scribbly Gum-Hakea Open Woodland/Open Shrubland), Cu11 (Scribbly Gum-Teatree Open Woodland/Open Shrubland) and Cu12 (Blackbutt Open Woodland/Heathland) would all be part of the FE139 complex.

Not a great deal of this type of vegetation was seen in Morton (East), although it is very common in Conjola, where it occurs on low-lying, near-flat sites and on dry ridges. As Mills points out, it tends to be dominated by *E. sclerophylla* in areas with impeded drainage and clay soils, and by *C. gummifera* or *E. consideniana* on sites with shallow sandy soils and better drainage. In Morton it occurs on a few elevated ridges on shallow dry soils where *E. consideniana* is common and one relatively low-lying and flat area on the north-east corner near Wandandian Creek, where *E. sclerophylla* is present. Two "heath" quadrats MORJM01F and MORJM0are located in FE139 in Morton and four, CONJM01F, CONJM04F, CONJM05 and CONJM08F, in Conjola.

Spotted Gum-Blackbutt Moist Forest (FE21)

This community occurs on better quality sites such as those on sheltered aspects and in gullies on either sandy soils, where blackbutt dominates, or soils with a higher clay content where spotted gum (*Corymbia maculata*) is more likely to occur. Stringybarks (*E. globoidea* and *E. eugenioides*) and Sydney peppermint (*E. piperita*) may be present. Turpentine may also be present as a canopy co-dominant and rainforest species and cabbage tree palms (*Livistona australis*) are likely to occur in the gullies. Tree wattles such as *Acacia mabellae, A. binervata, A. longifolia* ssp *longifolia* and *A. irrorata* are generally present. Mesic shrubs such as *Notelaea longifolia* are likely to occur. The groundcover is variable and may include a wide range of grasses, herbs and trailing vines.

FE21 appears to overlap with Mills' Cu2 and Cu1 (Blue Gum Tall Open Forest) although the latter appears from his description to be a wetter forest type restricted to creek flats and co-dominated by Sydney blue gum (*E. saligna*), rough-barked apple (*Angophora floribunda*) and blackbutt. His descriptions fit the observed vegetation better than the FE21 description in Thomas, Gellie and Harrison (2000). The latter appears to have been derived more from wet spotted gum forests on clay soils around Batemans Bay. One CRA quadrat close to the Princes Highway in Morton (East) clearly belongs to this community, but those further west appeared intermediate between this and FE3, which is also a community of sheltered sites. In Conjola, FE21 was seen to occur only close to watercourses, where it was apparently largely confined to a narrow band on creek flats and on adjacent lower slopes with a sheltered aspect. No quadrats were sampled this community in Conjola. FE21 was over-estimated by the FE model while in the CRAFTI mapping, relatively few polygons were mapped as this type although many were mapped as the combined type FE2/FE21. All of the latter have been re-coded as either FE2 or FE21 with some split on the basis of the topography to allocate FE21 to some of the larger gullies and FE2 to the surrounding slopes and minor gullies.

In Morton the CRA quadrat SZ22394M clearly samples this vegetation type in a gully head, while MORJM02, on a sheltered slope on a non-Permian sandstone geology could be FE21 or possibly FE3.

Coastal Lowlands Swamp Mahogany Forest (FE175)

This community occurs in flat drainage lines on sandy soils close to the sea or on swampy lake margins. It is listed as an Endangered Ecological Community (as Sydney Coastal Estuary Swamp Forest Complex) within the Sydney Basin Bioregion, which includes the Ulladulla area. Typically swamp mahogany (*E. robusta*) forms an open canopy above smaller trees with a tolerance for waterlogged soils such as *Melaleuca linariifolia, M. ericifolia, M. squarrosa* and *Acacia longifolia*. There may be a dense tall groundcover of the large sedge *Gahnia clarkei*, or of other sedges including *Baloskion tetraphyllum* ssp *meiostachyum, Schoenus brevifolius, Leptocarpus tenax* and *Baumea juncea*.

Mills does not describe this community from Conjola NP, but *E. robusta* was seen next to Old Berrara Road and on the western shore of Swan Lake north of the picnic area. Many of these areas had been burned during the 2001-2002 fires and now contain dense Melaleuca regrowth. On the basis of these sightings FE175 was mapped in several drainage lines around Swan Lake, but further field work would be useful to confirm its full extent. Further west in Conjola it appears to be replaced by Mills' Cu8, Woollybutt (*E. longifolia*) Paperbark Woodland, which occurs in drainage lines within FE139 west of the northern end of Old Berrara Road. FE175 does not occur in Morton (East) although it is present in Narrawallee Creek Nature Reserve.

Morton Plateau Mallee Swamp Low Forest (FE176)

Thomas, Gellie and Harrison (2000) include only the following brief description of this forest type:

> *Morton Plateau Mallee Swamp Low Forest is a low forest dominated by a variety of mallees and eucalypts adapted to low fertility skeletal soils. The understorey comprises a mixture of heaths, sedges, and grasses.*

FE176 was included in the re-mapping in Morton (East) on top of the Morton Plateau. It is based on the API codes S and V, which the FE map shows as FE176. However, where polygons with the same codes have been mapped in areas below the escarpment, they have been re-mapped as FE139H, which is a heath/woodland sub-type of the dry forest type FE139.

Coastal Escarpment Moist Shrub/Fern Forest (FE137)

This community had been mapped as occurring in the steeper western part of Morton (East). Thomas, Gellie and Harrison (2000) state that it occurs on the eastern Morton plateau, which presumably means that it has been sampled in this area, not merely interpreted as being there from API maps. Silvertop ash (*E. sieberi*) and Sydney peppermint (*E. piperita*) are said to be the most common canopy dominants. Shrubs or small trees *Acacia obtusifolia, Banksia spinulosa* and *Leptospermum trinervium* are commonly present, with a range of smaller shrubs. Dense stands of coral fern (*Gleichenia dicarpa*) are diagnostic of this community, implying impeded drainage or seepage areas on poor shallow soils. The fact that much of the mapping of this community is on moderately steep to very steep sites implies that this mapping is unlikely to be correct, since dense coral fern stands most typically occur on flat sites. However, due to lack of access to the sites where it is mapped its presence could not be confirmed or disproved. In the absence of strong evidence to the contrary, the polygons of this forest type have been retained, but it is possible that they are actually the more common FE3.

3.3 Overall Findings and Conclusions

The forest ecosystem types which are present in the final map, and those eliminated as not expected to be present, are summarised in Appendix 1 – Table A1.1 and A1.2. Table A1.3 sets out where changes have occurred in each of the two parks in the study area. Of the 24 FE types originally modelled as occurring, six were found not to exist in the study area, being Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest (FE18), Coastal Escarpment and Hinterland Shrub/Fern Dry Forest (FE19), the combined Southern Coastal Dune Scrub Complex and Coastal Dune Herb/Swamp Complex (FE23/26), Southern Escarpment Shrub/Fern/Herb Moist Forest (FE57), Central Coastal Hinterland and Lowland Warm Temperate Rainforest (FE166) and Coastal Lowland Sub Tropical/Littoral Rainforest (FE167). One additional type, Coastal Lowlands Swamp Mahogany Forest (FE175) was included in the re-mapping which was not in the original FE model for this area but has been mapped and described in other parts of the area covered by the CRA mapping. One additional vegetation type, which was recognised in the field, does not fall neatly into any of the existing forest ecosystem types as defined by Thomas, Gellie and Harrison (2000). This is a variation of Scribbly Gum - Red Bloodwood Heathy Woodland (FE139) which has only a sparse woodland like tree cover and heathy understorey. It has been defined as the sub-type, Scribbly Gum - Red Bloodwood Heath/Woodland (FE139H) and occurs in areas of Morton National Park below the plateau.

The forest ecosystems recognised during the project were all accommodated within the scope of previously defined types without the need for defining of entirely new types. However, some of the descriptions by Thomas, Gellie and Harrison (2000) relate more specifically to locations outside the study

area, requiring expanded or revised descriptions and lists of diagnostic species. The revised details are incorporated in the forest ecosystem profiles contained in Appendix 4.

Of the vegetation types eliminated, only three were regarded as being of particular conservation significance. The combined Southern Coastal Dune Scrub Complex and Coastal Dune Herb/Swamp Complex (FE23/26) was not recognised as a distinct type within the study area, and areas modelled as this type were found to be composed of other non-forest coastal vegetation types. The Central Coastal Hinterland and Lowland Warm Temperate Rainforest (FE166) modelled in Morton may exist but has not been confirmed as distinct from the more common Ecotonal Gully Rainforest (FE20) found throughout the study area. Coastal Lowland Sub Tropical/Littoral Rainforest (FE167) was almost certainly a modelling error and was not found in the predicted location or elsewhere in the study area. These three types were modelled over very limited extents within the study area and since they exist elsewhere in the region, there is no significant change to their conservation status in terms of number of hectares protected in parks and reserves in the region.

Based on the findings that have been discussed in detail in relation to each vegetation type and relating to the re-mapping work as discussed above, the following general conclusions are apparent.

The forest ecosystem modelling carried out for the Southern CRA has provided a general representation of the vegetation patterns occurring in the Conjola-East Morton area and has been correct in predicting the occurrence of the more common forest ecosystem types. The actual distribution of these types is somewhat different in reality and has required most of the area to be re-mapped in order to achieve more accurate boundaries and/or typing.

The modelling process has been less successful in predicting the occurrence and distribution of the less common (generally higher conservation and management priority) vegetation types, particularly the non-forest communities of the coastline, estuaries and swamps. Some types have been predicted which do not exist and others have been found which were not modelled. Substantial boundary discrepancies are also apparent. This trend was also found to exist in many areas covered by the Eden CRA forest ecosystems modelling and appears to be an inherent weakness in the modelling process to date. The failure of past modelling to reliably predict the occurrence of vegetation types of conservation importance is the main reason for validation and re-mapping at a more detailed level for park management purposes and for new modelling approaches.

The new vegetation map has been made less fragmented by re-interpretation of the CRAFTI API map, using slightly modified linework and assigning forest ecosystem types to API codes on the basis of field experience in the study area. How much of an improvement the new map is, is uncertain. It is unlikely that the correspondence between API and FE codes has been invariably correct, and the final map could be refined with additional field and API work in the future. Additional air photo interpretation was used to clarify matters in some locations and this resulted in some significant improvements over the previous CRAFTI API work

Along the coastline and around the coastal lakes and estuaries, the modelled distribution of many of the non-forest types was found to be quite inaccurate. Most of the modelled types were found to be present somewhere, if not exactly in the modelled locations. Re-mapping of these areas was necessary using air photo interpretation which had the added benefit of improving the spatial accuracy of the margins of vegetation communities with lake shorelines, estuarine waters, beaches, rock platforms and sea cliffs. Cleared areas or agricultural land and cleared easements along roads and powerlines were also re-mapped. Overall, the re-mapping of the coastline has confirmed the diversity of vegetation types present and helped to identify those areas containing vegetation of particular conservation significance.

The upgraded forest ecosystems map is a significant improvement on the former forest ecosystems modelling, in that it has the benefits of more intensive field assessments and more intensive API mapping, which hopefully improves the accuracy of boundaries and typing. There is scope for further refinement of the mapping, in inland forested areas generally and particularly in the western parts of Morton (Eastern extensions) where there were limited opportunities for field work during this project.

4 MANAGEMENT IMPLICATIONS

4.1 Conservation Significance and Fire Management

4.1.1 Non-eucalypt Vegetation Types

Swamp Oak and Swamp Paperbark Forests (FE24 and 25)

Swamp forests dominated by *Casuarina glauca* (FE24 and FE25) are regarded as being of high conservation significance in the region because they naturally occur in small fragmented stands around coastal lakes and in small coastal creeks, and because the aggregate remaining area of them in the South Coast sub-region was calculated to be low (about 10,000 ha in total for the two types). They are thought to have been relatively heavily affected by clearing, with an estimated 53% of FE24 and 78.5% of FE25 cleared. An earlier map validation project in Meroo and Murramurang National Parks has already demonstrated that these two vegetation types are considerably less common in the Ulladulla area than the CRA mapping suggests. The findings of this project are consistent with this trend, with only a fraction of the predicted distribution of these communities found to be correct. This makes the existing areas of higher conservation significance.

This vegetation can be highly flammable if it carries a dense groundcover of sedges, and if lake levels are low so that the ground is dry at the time of the fire. *Melaleuca ericifolia* would also be highly flammable, as least in young stands where there is uniform distribution of fine fuels from close to ground level to the crown. *Casuarina glauca* is not very flammable, but is readily killed by high-intensity fires. Previous observations at Meroo Lake indicated that some individuals had survived the fire there, and some had succumbed. Subsequent death or recovery may also depend to some extent on water levels after the fire, since additional stress may be placed on the plant by prolonged flooding, such as might occur in drought periods when closing of the lake mouth raises water levels. Understorey species, *Melaleuca ericifolia* and various sedges are well adapted to recovering from fire, re-sprouting rapidly from the roots. Under frequent fire regimes the understorey may be converted to very dense stands of small melaleuca stems. Fire frequency may in fact drive the distinction between FE24 and FE25, the latter developing only in less frequently burnt sites.

Fire should be kept out of these communities as far as possible. If fuel reduction burns are being undertaken in eucalypt forest in the vicinity of this vegetation type, care needs to be taken not to allow the fires to escape into it. The only location in which FE25 was observed was on the northern shore of Lake Conjola immediately south from Conjola Mount. FE24 was seen only in small scattered patches around Swan Lake, parts of which had been burnt by the 2001 fires.

Dune/Headland Scrub and Beach Strand Grassland (FE22 and 23)

These two communities are of significance because they protect the shoreline from wave erosion and because they are naturally fragmented communities which typically occur in quite small patches. They are often subjected to substantial recreational pressure when they occur close to towns, and tend to be the focal point of visitor activity in coastal conservation reserves. As such they are vulnerable to erosion and weed invasion. Significant weeds which threaten these communities are bitou bush (**Chrysanthemoides monilifera* ssp *rotundata*), bridal creeper (**Asparagus asparagoides*) and a suite of beach weeds including marram grass (**Ammophila arenaria*, formerly planted on some beaches to control erosion), beach daisy (**Arctotheca populifolia*) and sea spurge (**Euphorbia paralius*). No survey was undertaken in Conjola NP beaches or dunes so the presence or absence of these weeds has not been checked. Many of these weeds arrive independently of human disturbance, either deposited by birds or borne in ocean currents. They can therefore become established on quite remote sites. A single bitou bush seedling was seen (and removed) in one location on the shore of Swan Lake.

Beach Strand Grassland is unlikely to burn due to the high salt levels in many of the plants and its generally sparse cover. Dune and Headland Scrubs may burn in extreme conditions but this is likely to be a rare event.

Fire could be considered as a weed management method in stands which are infested with either bitou bush or bridal creeper, as long as follow-up weeding is undertaken to remove surviving plants or new

seedlings. Fire will remove the larger plants of bitou bush and improve access for controlling seedlings, which are likely to emerge abundantly after a fire. There is some evidence that regular fire would help to control bridal creeper (Willis *et al* 2003) as germination occurs more readily in the dark conditions which occur under dense vegetation or leaf litter and appears to be inhibited by light, and possibly to some extent by smoke. Since many natives display the reverse pattern of germination, regular burning could help tip the balance in favour of native plants and away from bridal creeper. However, it could also help to destabilise the dunes by removing vegetation cover.

Wet Heath (FE140)

Wet heath occurs in drainage lines within areas of Scribbly Gum-Red Bloodwood Heathy Woodland (FE139) in Conjola NP, but was not seen in Morton (East). It occurs in naturally small and fragmented stands on the coast because of its restriction to a restricted ecological niche, poorly drained sites on shallow soils of low fertility. On the Morton plateau to the west it is likely to be more common. This community is probably well reserved because it occurs primarily on poor soils in areas which have not historically been of much value for agriculture or residential development.

This is a highly flammable community because of the continuous distribution of fine fuels from ground to canopy, the density of the vegetation and the frequent occurrence of myrtaceous shrubs such as *Leptospermum, Callistemon* and *Melaleuca* species which have flammable oils in the foliage. Many of the component species are well adapted to frequent fires, being re-sprouters, such as the sedges and many of the shrubs. However some species such as the peas *Viminaria juncea* and *Sphaerolobium vimineum* are obligate seeders which have their main recruitment after fires when a suitable seed bed is temporarily bared by the fire. At other times the dense groundcover of sedges that commonly occurs in this community would prevent most seedling recruitment. Loss of species is therefore likely to occur with either too frequent or too infrequent fire in wet heath communities. Fires at intervals of less than ten years should be avoided, and a variety of different fire intervals throughout the park would be preferable. Heaths are also significant as habitat for threatened species such as the Ground Parrot and Eastern Bristlebird, both of which require a proportion of this habitat to remain unburned for long periods.

Woollybutt-Swamp Paperbark Woodland (FE144)

This community is very limited in Conjola NP, and was not seen in Morton (East). It occurs in wet sites within taller forest such as Lowland Red Bloodwood-Turpentine Dry Shrub Forest (FE2) or Blackbutt-Banksia Forest (FE29). It usually consists of a very open eucalypt canopy with a dense sub-canopy of paperbark species (*Melaleuca linariifolia* and others) and occasional rainforest elements such as cabbage tree palms (*Livistona australis*). The understorey includes numerous sedges including the large thicket-forming *Gahnia clarkei*. FE144 is more common further north in the Jervis Bay hinterland, but is not well reserved in this area. Many of its occurrences are on private property, where it has been cleared or had the understorey removed for grazing or residential subdivision. Some substantial areas are protected in Jervis Bay National Park and Woollamia Nature Reserve, but few occurrences were detected in Conjola. The listed threatened species *Melaleuca biconvexa* occurs in this community, around the Jervis Bay and St Georges Basin hinterland north of Conjola.

Paperbark Woodland is also a highly flammable community, but is well adapted to recovery from fire. The various *Melaleuca* species recover from epicormic shoots and root suckers and sedges re-sprout readily. However, observations in Woollamia Nature Reserve suggest that frequent fire can cause the degradation of this community into dense thickets of small stems. In the absence of fire the rainforest component is likely to become more prominent and this community may grade into FE20 on creek banks. Fire-free intervals should be kept as long as possible. This may require some fuel reduction burns in surrounding eucalypt forests to reduce the likelihood of fire entering the paperbark woodland. However, given the often heathy understorey of surrounding forests it may not be practicable to prevent fuel reduction burns moving into the paperbark woodland. Burning during periods when the soil is wet and the woodlands at least partially inundated would help.

Ecotonal Gully Rainforest (FE20)

Rainforest is very limited in Conjola NP, but appears to be common in Morton (East), particularly in the western part where the terrain is steeper and topographic protection from fire therefore more secure. The base of sandstone cliffs provides an additional fire-free niche in which rainforest can develop in Morton.

Rainforests provide a specialised habitat to a range of plant and animal species which cannot survive in the drier eucalypt forests. They occur in naturally small and fragmented stands on the South Coast because of their interaction with fire. Most rainforest species are sensitive to frequent fire, so stands are unlikely to persist in locations where fire occurs more than once every few decades.

Ecotonal Gully Rainforest is transitional between moist eucalypt forest and fully developed Warm Temperate or Sub-tropical Rainforest, generally having a sparse canopy of tall eucalypts over a developing rainforest understorey. It is likely to occur in narrow belts along gully floors and to include a high proportion of more fire-tolerant species and edge species such as coachwood (*Ceratopetalum apetalum*), lillypilly (*Acmena smithii*) and *Callicoma serratifolia*.

Fire should be kept out of this community as far as is practicable.

4.1.2 Eucalypt Vegetation Types

Coastal Sands Bangalay-Banksia and Blackbutt-Banksia Forests (FE28 and 29)

FE28 was identified in the CRA report (Thomas, Gellie and Harrison, 2000) as an ecosystem with a naturally restricted distribution on the South Coast. It has generally been found to be over-mapped in both the South Coast and Eden Region, making it even more restricted than CRA mapping has suggested.

FE28 should be considered to be of at least moderate conservation significance because it is a naturally fragmented ecosystem of limited distribution in the region which is coming under increasing pressure outside reserves for residential development because of its occurrence on flat land close to the sea. The same is true of FE29, which also appears to have been over-mapped. As well as coming under development pressure outside reserves, stands in reserves often bear the brunt of recreational usage in the reserve, which tends to be concentrated on the beaches and their access points. They may also be targeted for frequent hazard-reduction burning to protect coastal villages such as Conjola or Swanhaven.

The understorey of FE28 and FE29 is very similar and generally well adapted to regular fire. Bracken tends to dominate the groundcover and to become more dominant under regular burning. Some shrubs which are relatively slow growing and not capable of re-sprouting, such as *Monotoca elliptica*, are likely to be lost from frequently burnt stands, as may some other obligate seeders such as wattles, depending on the fire frequency. Even relatively fire-tolerant re-sprouters such as *Banksia serrata* may be lost from frequently burnt stands over a longer time-frame, since juvenile plants may take up to ten years to become fire-tolerant.

Scribbly Gum-Red Bloodwood Heathy Woodland (FE139)

FE139 was not identified as an ecosystem of high conservation significance in the region, but it probably should be. Although this type of vegetation is very extensive in the Sydney basin, and is well reserved in the region in Morton National Park, it is at its southern limit of distribution around Ulladulla. Many of the component species, such as *Eucalyptus sclerophylla, Lambertia formosa, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Kunzea capitata, Epacris pulchella* and *Actinotus minor* are also at or very close to their southern limit at Ulladulla.

FE139 also represents habitat for the orchid *Cryptostylis hunteriana*, listed as Vulnerable under the *Threatened Species Conservation Act*. This species has been recorded in Conjola NP. Another orchid which may be significant through being at its southern limit in the region, *Diuris aurea*, was found in coastal FE139 in Conjola.

FE139 also requires careful fire management. Having a predominantly heathy shrub understorey with a high proportion of sclerophyllous shrubs, and often a dense sedge layer as well, it is highly flammable. Fine fuels are more or less uniformly distributed from ground level to the low eucalypt crowns, via tall shrubs such as *Leptospermum trinervium*. This makes this vegetation type flammable is almost all weather conditions, and difficult to extinguish because the continuous shrubby understorey makes firebreak creation impossible except at tracks.

Such heathy vegetation is adapted to relatively frequent fire, but too short an interval between fires may eliminate obligate seeders, which are killed by fire rather than re-sprouting, from the species mix. Re-sprouting shrubs can also be eliminated over a longer period if frequent fires do not allow sufficient time to replenish seed banks, and if more fire-sensitive juvenile plants are killed. Fire intervals in the range of

7-30 years are recommended for shrubby dry sclerophyll forests (NPWS, 2003). However, frequencies close to the lower limit would tend to eliminate trees or reduce them to mallee form, converting woodlands to open heathland. This appears to have happened already in some parts of Conjola and Morton (East), although it is not known to what extent past logging may have also contributed.

Lowland Red Bloodwood-Turpentine Dry Shrub Forest (FE2)

FE2 is a common and widespread community identified in the CRA report (Thomas, Gellie and Harrison, 2000) as of low vulnerability to threatening processes such as clearing and weed invasion. It typically occurs on soils of low fertility and in drier parts of the landscape and so has been little cleared to date. It was found to be common in both Conjola and Morton (East).

One rare plant species is associated with this community in Conjola NP. This is the shrub *Pultenaea villifera* var. *villifera*. This is a ROTAP species, with the Blue Mountains population listed as an endangered population under the *Threatened Species Conservation Act*.

The predominantly shrubby understorey of this community appears well adapted to regular fires, with many re-sprouters, including some members of the Fabaceae family (peas and wattles) which are more commonly seeders. However there would be some species which could be eliminated by too frequent fire. *Pultenaea villifera* is likely to be such a species as it is recorded as re-sprouting after a cool fire, but being killed and regenerating from seed after a hot fire (NPWS Fire Response database). Some young plants were observed to be flowering 22 months post-fire, so it is likely that soil seed-banks of this species would be replenished within a few years.

Hinterland Red Mahogany-Turpentine Moist Forest (FE3)

FE3 was identified in the CRA report (Thomas, Gellie and Harrison, 2000) as being restricted to the south-east corner of Morton NP and adjacent State Forests, with an estimated area of about 16000 hectares, of which very little has been cleared. It was regarded as having low vulnerability to threatening processes such as clearing and weed invasion. It appears that it may be more common than previous mapping suggested in Morton (East), with much of the vegetation in more sheltered parts of the landscape being referrable to this vegetation type.

The more mesic understorey of this community may be more fire sensitive than the similar FE2, with some re-sprouters which might be expected to have a limited capacity to resprout if fires became too frequent. Examples of such species might be the small trees *Tristaniopsis collina* and *Elaeocarpus reticulatus*. Many obligate seeders appear to occur in this community, such as *Astrotricha latifolia, Astrotricha* sp. B, *Zieria* spp, *Boronia* spp and various peas such as *Pultenaea daphnoides, P. linophylla, Gompholobium glabratum* and *Kennedia rubicunda*.

This forest is intermediate between shrubby dry sclerophyll (recommended fire interval 7-30 years) and wet sclerophyll (25-60 years), so fire intervals averaging around 25-40 years might be approporiate.

Jervis Bay Lowlands Dry Forest (FE5)

FE5 was identified in the CRA report (Thomas, Gellie and Harrison, 2000) as being restricted to an area immediately west of Jervis Bay, where it occurs on flat sites below about 100m elevation. The original area is estimated to have been about 16000 hectares, with about half having been cleared and relatively little reserved prior to the RFA (1000ha). It was regarded as having moderate vulnerability to threatening processes such as clearing. The Jervis Bay hinterland is a growth area for residential subdivision. However, the vegetation type may be more widespread than mapping suggested since the CRA mapping did not have it extending as far south as Conjola.

The understorey of this community is likely to vary between shrubby and grassy depending on fire frequency. As described by Thomas, Gellie and Harrison (2000) it includes a number of obligate seeders such as *Allocasuarina littoralis, Pimelea linifolia, Pultenaea retusa, Pultenaea villosa, Hakea sericea* and wattles *Acacia irrorata* and *A. terminalis*. These are likely to disappear under a regime of frequent fire, leaving an open grassy understorey. Grasses are also quite prominent and diverse in this community and this may reflect the varying fire histories of the areas in which it was sampled.

Spotted Gum-Burrawang Dry Shrub Forest (FE9)

FE9 is a common and widespread community identified in the CRA report (Thomas, Gellie and Harrison, 2000) as of moderate vulnerability to threatening processes such as clearing and logging. It typically occurs on soils of lower fertility and in steeper parts of the landscape and so has been little cleared to date. It was re-mapped, however, in only a few locations in Morton (East) within the study area.

This community occurs in relatively fire-prone situations such as ridges and exposed slopes and includes a mixture of re-sprouters such as the burrawangs and various grasses and herbs, and seeders (various peas and wattles). In the continued absence of fire it can develop into FE21, Spotted Gum-Blackbutt Moist Forest, with the gradual encroachment of mesophyll shrub and tree species from adjacent drainage lines. It is relatively resilient to high frequency fires, but understorey composition is likely to change, with the loss of obligate seeders such as some peas and wattles and other shrubs such as *Pimelea linifolia*, and increased dominance of burrawangs and grasses.

Spotted Gum-Blackbutt Moist Forest (FE21)

FE21 is a common and widespread community identified in the CRA report (Thomas, Gellie and Harrison, 2000) as of moderate vulnerability to threatening processes such as clearing and weed invasion. It typically occurs on soils of lower fertility and in steeper parts of the landscape and so has been little cleared to date.

This community occurs in less fire-prone situations such as creek flats and gullies and consequently can develop an understorey of mesophyll shrubs and rainforest tree saplings. In the continued absence of fire it is likely to develop into FE20, Ecotonal Gully Rainforest, while under more frequent fire it is likely to lose the shrub component and become more open with a groundcover of grasses, sedges such as *Gahnia* spp, ferns and herbs. The community FE5 (Jervis Bay Lowlands Dry Forest) is likely to be what FE21 would develop into under frequent burning, at least in the lowland areas of Conjola NP. FE21 tends to give way to the similar moist forest FE3 with increasing distance from the coast. In Morton (East) this occurs at around Twelve Mile Road.

Coastal Escarpment Moist Silvertop Ash-fern Forest (FE137)

The presence of FE137 in the western part of Morton (East) could not be confirmed. The API classes E3103 (silvertop-peppermint) and E3101 (silvertop-stringybarks) have been interpreted as this community, but this may or may not be correct. FE137 is stated by Thomas, Gellie and Harrison (2000) to be reasonably widely distributed over three discrete patches in Monga and the Budawangs, the eastern Morton plateau and the Fitzroy Falls to Budderoo National Park area. It is well reserved.

The list of diagnostic species suggests that this community would be well adapted to reasonably frequent fires, with many re-sprouters. The range of 7-30 years suggested for shrubby dry sclerophyll forests (NPWS 2003) would be appropriate.

Coastal Lowlands Swamp Mahogany Forest (FE175)

This community is very limited in Conjola NP, and does not occur in Morton (East). It occurs in wet sites within taller forest such as FE2 or FE29. It usually consists of a very open eucalypt canopy (*E. robusta*) with a dense sub-canopy of paperbark species (*Melaleuca linariifolia* and others) and an understorey with shrubs tolerant of wet soils such as *Melaleuca squarrosa* and *Acacia longifolia* and numerous sedges including the large thicket-forming *Gahnia clarkei*. FE175 is listed as an Endangered Ecological Community within the Sydney Basin Bioregion, which includes the Ulladulla area. Its occurrences have probably not been very accurately mapped as it did not appear on the API mapping at all, implying that it is difficult to discriminate form other eucalypt communities on drainage lines. A few occurrences have been newly mapped as a result of this project.

FE175 is a highly flammable community because of the density of the understorey, although it may only burn in drought conditions as occurred in 2001-02 It is well adapted to recovery from fire. Swamp mahogany and the various *Melaleuca* species recover from epicormic shoots and root suckers and sedges resprout readily. However, to avoid development of dense thickets of small diameter melaleuca stems, fires should be kept as infrequent as possible. Fuel reduction burns in surrounding forests during wet periods when fire would be less likely to spread into the swamps may help to achieve this.

Morton Plateau Mallee Swamp Low Forest (FE176)

This community is limited to a few small slivers around cliff edges in Morton (East), although it is very common within the greater Morton National Park. It is well reserved, occurring on land which is useless for agriculture or forestry.

Like the very similar FE139 it is a highly flammable vegetation type, but one which is well-adapted to frequent fire. All the trees and many of the shrubs are re-sprouters, and the groundcover layer contains many sedges and grasses which re-sprout from the roots. Some of the component species seldom flower except after fire, such as the sedge *Cyathochaeta diandra*. Fire intervals of 7-30 years are recommended for heaths, as they are for shrubby dry sclerophyll forests (NPWS 2003). However, at the higher frequency end of this range some species are likely to be lost, such as the obligate seeder *Banksia ericifolia*. At the lower end species may also be lost, such as some orchids which may rely on the access to light and nutrients immediately post-fire to produce seed and replace old tubers. A mosaic of fire frequencies within this range is therefore desirable.

4.2 Rare and Threatened Plant Species

The study area is known to provide a habitat for several rare or threatened plant species. There are many records in the NPWS Atlas of NSW Wildlife of the ROTAP listed species *Pultenaea villifera* var *villifera*, in Conjola NP. An additional location was recently reported by NPWS between Conjola Lake and Lake Conjola Entrance Road. Another ROTAP species, Jervis Bay grevillea, *Grevillea maclayana* has been recorded at two locations in Conjola and at several locations outside the park to the south. The leafless tongue orchid, *Cryptostylis hunteriana,* recorded at several locations in the southern parts of Conjola NP, is a threatened species which is listed as vulnerable under the *Threatened Species Conservation Act*.

No other threatened or ROTAP species were evident from a search of atlas records, however, a number of additional rare or threatened species were recorded during the field work for this project as outlined below. The recorded locations of all known rare and threatened species are shown on the vegetation maps accompanying this report.

Galium australe

This small herb is listed in Schedule 2 of the *Threatened Species Conservation Act* as Presumed Extinct in NSW. However in recent years a number of confirmed records (and a few which have yet to be confirmed) have been made from the South Coast and nearby tablelands. Keith McDougall (NPWS Threatened Species Unit) has recently prepared a nomination to the Scientific Committee to change the listing to Endangered, as although the species has been found in a number of locations, all have been very small populations of one to a few plants. One of these locations was close to Conjola National Park, being on the edge of Swan Lake 1km south-south-west of Swanhaven. Other recent confirmed records on the South Coast are from Lake Windemere at Jervis Bay and Cullendulla Creek Nature Reserve north of Batemans Bay. There is an unconfirmed record from Beehive Point in Morton NP (McDougall, 2003).

During the present survey, *Galium australe* was found in two locations. It occurred in quadrat CONJM07 on Slaty Box Road in Conjola and was collected below Twelve Mile Road west from the Whalebone Road junction in Morton (East). Voucher specimens forwarded to the Herbarium of the Royal Botanic Gardens, Sydney have been confirmed as this species. In both cases only one or two plants were seen, but the plant is very inconspicuous and more could have been present. In each case only a small area was searched.

Pultenaea villifera* var *villifera

This species is reportedly common in Conjola National Park (Mills 1995) where it occurs mostly in blackbutt-bloodwood forest (probably mainly FE2). Mills implies that the species may be fire-sensitive, pointing out that the species is most common in rocky sites, which have good fire protection because of low ground fuel levels, and that some sites where it occurs had not been burnt for many years at the time of his survey. However the Bangalay Road-Cedar Road population appeared to be recovering well from fire with seedlings being quite numerous (>100 in the 20 x 20m quadrat CONJM09F). No examples of re-sprouting were seen, and it may be that *Pultenaea villifera* would be eliminated by too frequent fire. As

a small proportion of plants were flowering at the time of our survey, some 22 months after the Hylands fire, it could be assumed that the soil seed bank might be replenished within a few years.

Rulingia hermaniifolia

This ROTAP species is listed as 3RCa, with a wide distribution within NSW and many of the known populations being reserved in national parks, from the Sydney area to Morton and Jervis Bay in the south. It tends to occur in small disjunct populations but is apparently locally common in parts of Morton NP (K McDougall, pers. comm.). It grows in crevices on rock platforms and cliffs. A small population was seen in the vicinity of George Boyd Lookout at the top of the sandstone escarpment on Twelve Mile Road in Morton (East). It could be under some threat from weed invasion resulting from visitor traffic to the lookout (see below under weeds.)

***Grevillea buxifolia* species complex**

A specimen of this grevillea from Morton (East) has been identified by Peter Olde, who is currently undertaking a revision of the *Grevillea buxifolia* complex. He states that it is referrable to *G. scabrifolia*, a published name (Gandoger 1919) which has fallen out of use and is currently in synonymy with *G. buxifolia/sphacelata/phylicoides*. He intends to recognise it as a distinct taxon at species or sub-species level. It is a rare taxon, confined to the area between Conjola and Nowra. This taxon is recognisable by its oval leaves with recurved margins and small greyish flowers in erect terminal clusters. It keys to *G. buxifolia* but lacks an obvious appendage on the pollen presenter, though it does have a slight bump in this location. It was present as numerous seedlings in quadrat MORJM01F. One more advanced individual growing in wetter conditions in a roadside drain was flowering.

Eucalyptus punctata

Grey gum has its southern limit “south of Nowra” (Harden 2002), and Mills (1995) states that its southern limit is in the former Cudmirrah National Park, now part of Conjola. During this survey it was not seen in Conjola or Morton but was recorded further south in Narrawallee Creek Nature Reserve.

Diuris aurea

This species of donkey orchid was tentatively identified growing in coastal heath west from the headland between Berrara Beach and Monument Beach. It occurs in the quadrat CONJM01F. Bishop (1996) describes its distribution as “coast and tablelands north from Marulan” but Harden (1993) does not have it listed as occurring in the South Coast botanical division (that is, south of the Shoalhaven River). A voucher specimen was confirmed by the Royal Botanic Gardens herbarium.

Mirbelia rubiifolia

This small shrub is common in heath and occasional in forest in all three of the surveyed reserves. Mills (1995) states that it is at its southern limit in Cudmirrah (now part of Conjola) but this is incorrect as it also occurs well south of here in the extensive heathlands of Nadgee Nature Reserve close to the Victorian border. However, given the scarcity of heathland between Ulladulla and Nadgee, the Ulladulla area may well be a local southern limit.

4.3 Weeds

The project brief did not include searching for or recording weeds, but notes were made on the occasions when significant weeds were encountered. The following information therefore represents opportunistic sightings, not a systematic survey.

The only weeds recorded in Conjola NP were a small number of species in quadrat CONJM03F on the margin of Swan Lake. This site was close to the villages of Swanhaven and Sussex Inlet, so the presence of a few exotic species is not surprising. Access to this site was obtained by driving alongside the last house in Medlyn Avenue, and a small number of plants of the shrub **Psoralea pinnata* were seen growing next to the track leading to the lake shore. These probably arrived in dumped garden refuse. Anywhere where coastal villages are adjacent to reserves this problem is likely to occur.

The only location in Morton (East) where weeds were recorded was George Boyd Lookout on Twelve Mile Road at the top of the sandstone escarpment. A few exotic species have become established in

rock crevices at the lookout. Buffalo grass (**Stenotaphrum secundatum*) is the most abundant, with paspalum (**Paspalum dilatatum*) and the herb cats ear (**Hypochaeris radicata*) also present. This area also supports the ROTAP plant *Rulingia hermaniifolia*, a small prostrate shrub which utilises the same habitat niche of crevices between large sandstone slabs. The exotic species could ultimately pose a threat to the *Rulingia* at this site, although at present they do not overlap, as the weeds occupy the most heavily trafficked area close to the lookout, while the *Rulingia* is in untrampled areas further away from the lookout.

From a weed-management viewpoint, consideration needs to be given to closing as many non-essential tracks as possible, to reduce the scope for weed introduction on vehicles, and deliberate dumping of garden refuse in the bush.

5 PROJECT TEAM

Member	Role	Expertise
Nicholas Graham-Higgs	Project Manager	Holds a BSc Uni. Of Canb. He has managed, and been involved with a large number of large proposals relating to National Parks within South-eastern NSW.
Jackie Miles	Botanist	Holds a BSc, (Hons) from the Aust. Nat. Uni.. Has completed an extensive number of botanical and zoological assignments on contract to a number of organisations and agencies such as the National Parks and Wildlife Service.
Phil Kendall	API mapping GIS work, field data entry, report compilation	Holds a BSc Uni. Of Canb. Worked for 25 years in environmental planning and specialising in GIS for the last 12 years. Has completed many GIS and environmental projects for National Parks and Wildlife Service.

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APPENDIX 1: Forest Ecosystem Summary Tables

Table A1.1 Forest Ecosystem Types Following Re-mapping of the Conjola – Morton (East) Study Area

FE Type	Forest Ecosystem Description (as used in this project)	Validation Task	Conservation Status	No. of Polygons	Total Hectares
2	Lowland Red Bloodwood - Turpentine Dry Shrub Forest	API conversion & re-mapping		62	7532.99
3	Hinterland Red Mahogany - Turpentine Moist Forest	API conversion		35	2140.67
5	Jervis Bay Lowland Dry Forest	API conversion		8	110.27
9	Coastal Lowlands Spotted Gum - Burrawang Dry Shrub Forest	API conversion		5	23.65
20	Ecotonal Gully Rainforest	API conversion & re-mapping	Significant	59	486.80
21	Spotted Gum - Blackbutt Moist Forest	API conversion & re-mapping		66	1358.42
22/23	Dune/Headland Scrub and Beach Strand Grassland Complex	Re-mapping	Significant	4	21.01
24	Swamp Oak - Swamp Paperbark Forest	Re-mapping	Significant	5	5.94
25	Swamp Oak Forest	Re-mapping	Significant	10	24.34
27	Ecotonal Swamp Forest	Re-mapping	Significant	1	11.52
28	Coastal Sands Bangalay - Banksia Forest	Re-mapping	Significant	6	93.2
29	Coastal Sands Blackbut - Banksia Forest	Re-mapping	Significant	1	4.45
137	Coastal Escarpment Moist Shrub/Fern Forest	API conversion		28	281.69
139	Scribbly Gum - Red Bloodwood Heathy Woodland	API conversion	Significant	53	4859.32
139/2	Mixed Lowland Red Bloodwood - Turpentine Dry Shrub Forest and Scribbly Gum - Red Bloodwood Heathy Woodland	Re-mapping		6	66.39
139H	Scribbly Gum - Red Bloodwood Heath	API conversion	Significant	18	217.55
140	Wet Heath	API conversion & re-mapping	Significant	37	191.5
144	Woolybutt - Paperbark Woodland	API conversion & re-mapping	Significant	3	16.3
175	Coastal Lowlands Swamp Mahogany Forest	API conversion & re-mapping	Significant	4	48.78

FE Type	Forest Ecosystem Description (as used in this project)	Validation Task	Conservation Status	No. of Polygons	Total Hectares
176	Morton Plateau Mallee Low Forest	API conversion		19	13.72
187	Coastal Headland Heath	API conversion	Significant	1	0.8
190	Rock	API conversion		3	3.26
cleared	Cleared Land	Re-mapping		36	202.03
urban	Urban Development	Re-mapping		1	1.64
water	Water Body	Re-mapping		4	1121.51

Note: Number of polygons and total hectares refer to the expanded study area rather than the actual area of the national parks.

Table A1.2 Forest Ecosystem Types No Longer Included in the Study Area Following Re-mapping

FE Type	Forest Ecosystem Type (Thomas, Gellie & Harrison, 2000)	Conservation Status	Conjola NP	Morton NP
18	Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest - *E. cypellocarpa/E. muelleriana*			Y
19	Coastal Escarpment and Hinterland Shrub/Fern Dry Forest - *E. muelleriana*			Y
23/26	Combined Southern Coastal Dune Scrub Complex and Coastal Dune Herb/Swamp Complex	Significant	Y	
57	Southern Escarpment Shrub/Fern/Herb Moist Forest - *E. cypellocarpa incl. E. fastigata & E. obliqua*			Y
166	Central Coastal Hinterland and Lowland Warm Temperate Rainforest	Significant		Y
167	Coastal Lowland Sub Tropical/Littoral Rainforest	Significant	Y	

Table A1.3 Forest Ecosystem Types Present, No Longer Present and New Types Following Re-mapping

FE Type	Forest Ecosystem Type (Thomas, Gellie & Harrison, 2000) [New Description used in this report in brackets]	Conjola NP	Morton NP
2	Hinterland Heath Shrub Dry Forest - *Corymbia gummifera*/*Syncarpia glomerulifera* [Lowland Red Bloodwood - Turpentine Dry Shrub Forest]	Y	Y
3	Northern Hinterland Shrub Dry Forest - *Syncarpia glomerulifera*/*E. scias* [Hinterland Red Mahogany - Turpentine Moist Forest]		Y
5	[Jervis Bay Lowland Dry Forest]	New	
9	Coastal Lowlands Cycad/Shrub Dry Forest - *Corymbia maculata* [Coastal Lowlands Spotted Gum - Burrawang Dry Shrub Forest]	N	Y
18	Southern Coastal Hinterland Shrub/Vine/Grass Moist Forest - *E. cypellocarpa/E. muelleriana*		N

FE Type	Forest Ecosystem Type (Thomas, Gellie & Harrison, 2000) [New Description used in this report in brackets]	Conjola NP	Morton NP
19	Coastal Escarpment and Hinterland Shrub/Fern Dry Forest - *E. muelleriana*		N
20	Coastal Hinterland Gully Rainforest [Ecotonal Gully Rainforest]	Y	Y
21	Northern Coastal Hinterland Moist Shrub Forest - *C. maculata/E. pilularis* [Spotted Gum - Blackbutt Moist Forest]	Y	Y
22/23	Combined Southern Coastal Hind Dune/Headland Scrub and Southern Coastal Dune Scrub Complex [Dune/Headland Scrub and Beach Strand Grassland Complex]	Y	
23/26	Combined Southern Coastal Dune Scrub Complex and Coastal Dune Herb/Swamp Complex	N	
24	Coastal Tall Wet Heath Swamp Forest - *Casuarina glauca/Melaleuca ericifolia* [Swamp Oak - Swamp Paperbark Forest]	Y	
25	South Coast Swamp Forest - *Casuarina glauca* [Swamp Oak Forest]	Y	
27	Ecotonal Coastal Swamp Forest - *Casuarina glauca/E. botryoides* [Ecotonal Swamp Forest]	Y	
28	Coastal Sands Shrub/Fern Forest - *E. botryoides/Banksia serrata* [Coastal Sands Bangalay - Banksia Forest]	Y	
29	Northern Coastal Sands Shrub/Fern Forest - *E. pilularis/Banksia serrata* [Coastal Sands Blackbut - Banksia Forest]	Y	
57	Southern Escarpment Shrub/Fern/Herb Moist Forest - *E. cypellocarpa incl. E. fastigata & E. obliqua*		N
137	Coastal Escarpment Moist Shrub/Fern Forest - *E. sieberi/E. piperita/Gleichenia dicarpa* [Coastal Escarpment Moist Shrub/Fern Forest]		Y
139	Northern Coastal Hinterland Heath Shrub Dry Forest - *C. gummifera/E. sclerophylla* [Scribbly Gum - Red Bloodwood Heathy Woodland]	Y	Y
139H	[Scribbly Gum - Red Bloodwood Heath]		New
140	Northern Coastal Tall Wet Heath [Wet Heath]	Y	
144	Northern Coast and Hinterland Moist Heath [Woolybutt - Paperbark Woodland]	New	N
166	Central Coastal Hinterland and Lowland Warm Temperate Rainforest		N
167	Coastal Lowland Sub Tropical/Littoral Rainforest	N	
175	[Coastal Lowlands Swamp Mahogany Forest]	New	
176	Morton Plateau Mallee Swamp Low Forest [Morton Plateau Mallee Low Forest]		Y
187	[Coastal Headland Heath]	Y	
190	Rock		Y

Y = Originally modelled and still present after re-mapping

N = Originally modelled but no longer present after re-mapping

NEW = Not originally modelled – included in re-mapping

APPENDIX 2: Field Data Sheets – examples of blank forms

APPENDIX 3: Description of Quadrat Sites

All quadrats recorded in Conjola National Park and the eastern extensions of Morton National Park are described below. Those designated as fire monitoring quadrats are distinguished by the suffix F in the site name. Additional data was collected on regeneration mechanism in these sites, and the marker post is located centrally rather than in the corner of the plot. Other than this there is no difference between fire response and full floristics plots and the latter could be converted to fire response quadrats if desired later.

CONJOLA NATIONAL PARK

CONJM01F
This site is located in coastal heath/woodland about 100m west of Berrara Beach, in a location that was mapped as FE24 (Coastal Swamp Forest – *Casuarina glauca/Melaleuca ericifolia*), which it clearly is not. There is a narrow belt of a wetter heath type (FE140) running north-south in a drainage depression on the eastern edge of the heath patch, but this is not close in species composition to any of the wetter heath types described during the Southern CRA, being dominated by the shrub *Viminaria juncea* and sedges.

In the drier heath on the quadrat, re-sprouters dominate the shrub layer, mainly *Lambertia formosa, Banksia spinulosa, Kunzea capitata* and *Hibbertia riparia*. The main shrub species present as seedlings were *Pimelea linifolia, Micrantheum ericoides, Acacia suaveolens* and *Hakea teretifolia*, but numbers were low for all but the first of these. The groundcover is largely composed of re-sprouters (grasses and sedges) but devil's twine (*Cassytha glabella*) was also extremely common. It was not possible to determine whether this was re-sprouting or had arisen from seedlings, but the latter is more likely, since once this parasitic plant has become attached to its hosts, its connection to the ground usually withers away. Data from Sydney fires indicates that this species is killed by fire and also experiences most recruitment after fire (Benson & McDougall 1997).

The site lies within a polygon which is mostly a eucalypt forest of scattered trees with heath understorey and as such has been re-mapped as FE139. The fire history of this site indicates only that it was burnt in December 2001.

CONJM02
On a point between two arms of Nerrindillah Creek, this site is shown on the FE map as FE25 (Coastal Swamp Forest – *Casuarina glauca*). This is not correct, as no *Casuarina glauca* was seen in the vicinity. The API map suggests FE2/FE21 with a narrow band of scrub close to the creek. The area is a mixture of eucalypt forest on slightly more elevated areas and paperbark forest (*Melaleuca linariifolia, Leptospermum polygalifolium, Gahnia clarkei* and *Schoenus brevifolius*) in small depressions. The latter vegetation type has been described by Thomas, Gellie and Harrison (2000) as FE144 (North Coast and Hinterland Moist Heath) but this is something of a misnomer since it is in fact a low forest dominated by *Melaleuca* species and occasional emergent eucalypts, with no heath elements. "Paperbark wet forest" is suggested as a more appropriate name.

The fire history of this site indicates only that it was burnt in December 2001.

CONJM03F
Located about 30m back from the edge of Swan Lake, this site is mapped as FE27 (Ecotonal Coastal Swamp Forest – *Casuarina glauca/Eucalyptus botryoides*). This is reasonably accurate, although at this location such vegetation is only a narrow belt. The 20m quadrat occupies the entire width of this vegetation type. Below it is paperbark/teatree scrub (*Melaleuca linariifolia, M. ericifolia* and *Leptospermum polygalifolium*) on the lake shore, which is a hybrid of FE144 (freshwater paperbark woodland type) and FE24 (estuarine swamp oak/paperbark scrub), and above it on ground which is about 2m higher is FE139. The quadrat contains species typical of both these associations, while being dominated by *E. botryoides* and *Banksia integrifolia*, species which are typical of coastal sand deposits (dunes and lake mouth bars). There is therefore a high species diversity. A high water table had produced rapid growth, with wattle (*Acacia longifolia*) seedlings up to 2m high (though most were smaller).

Re-sprouters dominate the shrub layer, mainly *Leptospermum polygalifolium*, but surprisingly including *Banksia integrifolia*. Small trees of this species had been killed to ground level but were resprouting from the base and from the roots. No seedlings were seen. The groundcover is about equally composed of re-sprouters (grasses and lomandra/sedges, bracken) and seeders (forbs such as *Opercularia aspera* and *Hydrocotyle geraniifolia* which respond vigorously to the post-fire conditions).

The fire history of this site indicates only that it was burnt in December 2001.

CONJM04F
Located on Slaty Box Road in an area mapped as FE140 (Northern Coastal Tall Wet Heath). In this instance this is not accurate. This site is dry heath or FE139 with a relatively low cover of trees. The tree cover would have appeared greater but for the fires, which had temporarily reduced the height and cover abundance of *Corymbia gummifera* and *E. consideniana*.

Structurally re-sprouters dominate the shrub layer, including *Leptospermum trinervium*, *Kunzea capitata, Banksia spinulosa, Isopogon anemonifolius* and *Petrophile pedunculata*. However shrub seedlings were also common, but less

advanced than the re-sprouters. Common species were *Hakea sericea, Mirbelia rubiifolia, Bossiaea heterophylla* and *Acacia suaveolens*. The groundcover is dominated by re-sprouters (the grass *Anisopogon avenaceus* and the sub-shrub *Dampiera stricta*).

This site has experienced wildfires in 1991, 1992 and December 2001.

CONJM05
This site is near the junction of Mondayong and Peppermint Roads in an area correctly mapped as FE139. Dominant trees are *Corymbia gummifera* and *E. consideniana* with occasional *E. sieberi*. The understorey is heathy. The patch of FE140 (tall wet heath) mapped nearby is not present, but is just an area of FE139 with fewer trees.

This site has experienced a wildfire in 1968-69, hazard reduction in 81-82 and the December 2001 wildfire.

CONJM06F
Located about 100m east of the main north-south powerline easement through Conjola National Park, this site is mapped as FE21 (Northern Coastal Hinterland Moist Shrub Forest – *C. maculata/E. pilularis*). It was in fact transitional between FE2 (Hinterland Heath Shrub Dry Forest, which is taller than FE139, with substantial cover of *Syncarpia glomerulifera* and a slightly heathy understorey) and the wetter forest type which occurs in Conjola. However this wetter forest is not a good match to FE21, and was not described in the Southern CRA report.

As might be expected in a transitional forest type, re-sprouters and seeders are about equally abundant in the shrub layer, including *Leptospermum polygalifolium, Banksia spinulosa* and *Lambertia formosa* in the former category and *Acacia longifolia, Pultenaea daphnoides* and *Hakea sericea* as the most abundant seeders. The groundcover is about equally composed of re-sprouters (grasses and sedges, bracken) and seeders (forbs such as *Opercularia aspera* and *Goodenia heterophylla* which respond vigorously to the post-fire conditions).

This site experienced wildfires in 68-69, 80-81 and December 2001.

CONJM07
Located 100m north of Slaty Box Road in a patch of spotted gum, this site is mapped as FE9 (Coastal Lowlands Cycad/Shrub Dry Forest – *C. maculata*) based on API code E1901. This is accurate, in that spotted gum (*Corymbia maculata*) and grey ironbark (*E. paniculata*) are present. Blackbutt (*E. pilularis*) is also dominant on this site, and is not mentioned as a potential component of FE9. However, *E. pilularis* is very widespread on the sandy soils around Ulladulla and seems to occur in almost all forest types, whereas the bulk of the samples used to describe FE9 are likely to have come from further south, between Batemans Bay and Bermagui, where *E. pilularis* is less common. Because the species present in polygons with API code E0901 are a closer match to FE5 than to FE9, they have been re-mapped as the former.

Seeders are dominant in the shrub layer on this site, mainly wattles *Acacia binervata, A. terminalis* and *A. longifolia*. The groundcover is about equally composed of re-sprouters (grasses and *Lomandra* spp, bracken) and seeders (forbs such as *Opercularia aspera* and *Goodenia heterophylla* which respond vigorously to the post-fire conditions).

This site experienced wildfires in 68-69, 80-81 and December 2001.

CONJM08F
Located on Stringybark Road in an area mapped as FE140 (Northern Coastal Tall Wet Heath), which again is not accurate. This site is dry heath or FE139 with a very low cover of trees. The tree cover in this instance is naturally low, not just reduced by fire, possibly because of very shallow soils. The species list for the site is not particularly suggestive of poor drainage. Grass trees (*Xanthorrhoea australis*) are a feature of this site, and this particular species of *Xanthorrhoea* is not generally found on wet soils.

Re-sprouters dominate both the shrub and groundcover layers, with the only abundant seedlings being the shrub *Hibbertia riparia*, which can also resprout, and was doing so on the plot.

This site burnt in 68-69, was hazard reduced in 81-82 and experienced wildfires in 1991, 92 and December 2001, giving it a fire frequency of about every ten years on average.

CONJM09F
This site was chosen for the presence of the rare shrub *Pultenaea villifera*, which is abundant on the quadrat. It is located NE of Bangalay Road near the junction with Cedar Road, and two old and well regenerated tracks run through the plot, parallel to Bangalay Road. The nearer track forms the east-west axis of the plot and the other is on the edge of the plot. Fruits found on the ground indicated that many tree species are present in the vicinity but their proportions on the plot were difficult to judge because there was little to identify them by except epicormic shoots. Several of the species in the area have similar discolorous intermediate foliage (*E. piperita, E. botryoides* and stringybarks). *E. piperita* and *Corymbia gummifera* appeared to be the most common, with *Syncarpia glomerulifera* also abundant. This suggests that the site is in FE2 (Lowland Dry Shrub Forest) which generally contains the latter two tree species with a sclerophyll shrub understorey which is slightly “heathy”. It had been mapped as being borderline between FE2 and the wetter FE21, but the latter does not appear until some distance further downslope.

Notable features were the high species diversity and relatively dense cover in the shrub and ground layers and high numbers of individual plants. The site is on Permian siltstone with a more clayey soil than most other sites and is on a

south-facing slope, providing favourable growth conditions. The soil was very well worked by ants and also very much dug over by either echidnas or bandicoot and/or potoroos. *Acacia* seedlings were up to 2m high, considerably higher than on any other plot except the Swan Lake shore site (CONJM03F). *Pultenaea villifera* had regenerated freely from seed all over the plot and in the roadside drain and a few plants were flowering.

This site experienced wildfires in 1991, 1992 and 2001.

CONJM10

Located on the lower south-facing slope just above a small creek on sandstone, this site was mapped as carrying FE20 (Ecotonal Gully Rainforest) and this proved to be correct. The fire had penetrated a short distance into the NW corner of the plot, but had burnt almost to the edge of the plot right along its upper edge. On the plot a few smaller coachwood (*Ceratopetalum apetalum*) had been scorched and were coppicing from the base. Beyond the plot all the coachwood were coppicing. Several large coachwood and grey myrtle (*Backhousia myrtifolia*) dominate the canopy, with emergent *E. saligna x botryoides* above. Most coachwood trees are smaller and consist of several stems coppiced from a medium sized base, suggesting an earlier fire had burnt the site more thoroughly, probably about 20 years previously.

This site was hazard reduced in 81-82 and burnt by wildfire in 2001.

CONJM11

This site is located south of the east-west powerline easement which crosses Old Berrara Road, in an area mapped as FE24 (Coastal Swamp Forest – *Casuarina glauca/Melaleuca ericifolia*). This mapping is not accurate. This site is a low sedge-dominated wet heath, which does not fit into any of the CRA vegetation types well, though it is closest to FE141 (Northern Coast and Escarpment Wet Heath/Sedge). It has been re-mapped as FE140, since this is the type assigned to most of the wet heaths in the area.

Structurally re-sprouters dominate the site, in the form of sedges, all of which were fully recovered from the fire. *Leptocarpus tenax, Empodisma minus, Lepidosperma quadrangulata, Ptilothrix deusta* and *Schoenus brevifolius* were the dominant species. *Eleocharis sphacelata* was also tentatively identified from its dried stems which are distinctively transversely septate (hollow and separated into short segments by partitions). If the identification is correct it suggests that this site is frequently submerged, since this species is generally found only in standing water. The small grass tree *Xanthorrhoea resinifera*, a species typical of wet soils, is also common and appeared to have flowered profusely in the season immediately following the fire. Shrubs were sparse, having recovered less fully. The dead remains of wattles were emergent above the sedge layer, and seedlings of *Acacia elongata, A. longifolia* and *Hakea teretifolia* were common. The small shrubs *Comesperma retusa* and *Sphaerolobium vimineum* were also common but almost concealed within the sedge layer. Nearby the groundcover is lower and more open and occasional *E. sclerophylla* occurs, suggesting that the quadrat has been located in the wettest part of this area.

This site burnt in wildfires in 1995 and 2001.

CONJM12

This site was chosen as being representative of an open grassy forest apparently occurring on soils with a higher clay content which had not been sampled in any other quadrats. It is located near the eastern end of Slaty Box Road, in a polygon which is labelled as FE167 (Subtropical/Littoral Rainforest). This is clearly some sort of clerical error, since there is no indication of any rainforest in the vicinity. The site has been re-mapped as FE2 being part of a polygon which was coded in the API map as E0805 which is equivalent to FE139.

Dominant trees are *C. gummifera, E. pilularis* and *E. eugenioides*, with a small tree layer including *Syncarpia glomerulifera* and *Banksia serrata*. Seeders are more common in the shrub layer, including several wattles and peas (*Acacia longifolia, A. myrtifolia, A. ulicifolia, Bossiaea* spp, *Aotus ericoides, Pultenaea villosa, Mirbelia rubiifolia* and *Gompholobium* spp). However a few re-sprouters are also present. The groundcover is about equally divided between re-sprouters and seeders.

This site burnt in wildfires in 1995 and 2001.

MORTON NATIONAL PARK (EASTERN EXTENSIONS)

MORJM01F

This site is located near the junction of Whalebone and Halfway Road in an area mapped as FE144 (Northern Coast and Hinterland Moist Heath). While the site is in heath, it would be more accurately described as dry heath or FE139 with a relatively low cover of trees. The tree cover would have appeared greater but for the 2001 fire, which had temporarily reduced the height and cover abundance of *Corymbia gummifera* and *E. consideniana*.

Structurally re-sprouters dominate the shrub layer, including *Leptospermum trinervium*, *Lambertia formosa, Banksia spinulosa, B. paludosa* and *Hakea laevipes*. Shrub seedlings were present but less common, and structurally far less significant than the re-sprouters. Commonest species were *Sphaerolobium minus, Bossiaea heterophylla* and *Pimelea linifolia*. The groundcover is dominated by re-sprouters, sedges *Lepyrodia scariosa* and *Gahnia radula* and the grass *Anisopogon avenaceus*. The rare taxon *Grevillea scabrifolia* (currently part of the *G. buxifolia* species complex) was found on this site.

The area in which this site is located has been burnt in the 68-69 wildfire, hazard reduced in 1980-81 and 1981-82, and burnt in further wildfires in 1991, 1992 and 2001.

MORJM02
This site is located in a slightly disturbed area between a powerline easement and Deodar Road in an area mapped as FE21. This appears reasonably accurate, in that the site does carry the wetter forest type present in the area, even though this is not really a very good match to FE21. The API map suggests FE2 or 3, neither of which is correct.

Seeders dominate the shrub layer, including *Acacia longifolia, Acacia* sp and *Howittia trilocularis*, the latter being extremely common. However re-sprouters are also prominent in the form of *Syncarpia glomerulifera, Bursaria spinosa, Notelaea longifolia, Pomaderris aspera* and a few rainforest margins species such as *Rhodamnia rubescens, Rapanea variabilis* and *Clerodendrum tomentosum*, all of which were resprouting. The groundcover is a mixture of re-sprouters, sedge *Gahnia sieberiana* and grasses *Entolasia marginata* and *Oplismenus imbecillis* and numerous vines, along with seeders such as *Sigesbeckia orientalis, Solanum prinophyllum* and *Opercularia aspera*. The species list for this site was distinctly different from most other sites encountered during the survey. It appeared to be on a different geology form most areas, although what this was could not be determined. It appeared to be either Ordovician or Devonian metasediments, rather than the Shoalhaven or Sydney sandstone underlying much of the Ulladulla to Nowra area.

The area in which this site is located has been burnt in the 68-69 wildfire, hazard reduced in 1981-82, and burnt in further wildfires in 1991, 1992 and 2001.

MORJM03F
This site is located 320m north of Twelve Mile Road near the Jacaranda Road intersection along an old logging track. It was mapped as FE3 (Northern Hinterland Shrub Dry Forest – *Syncarpia glomerulifera/E. scias*) but is also similar to FE2, which is the dry forest type which occupies much of the eastern extension of Morton NP. The dominant tree species are *C. gummifera* and *S. glomerulifera*.

Acacia obtusifolia and *Persoonia linearis* are the dominant shrubs, both resprouting, *A. obtusifolia* being somewhat unusual among the wattles in doing this. It appeared to be resprouting from the roots rather than from a lignotuber. Seeders are also well represented, but small in numbers of individuals, and include *Pimelea linifolia, Zieria pilosa, Amperea xiphoclada, Astrotricha* sp B, *Dodonaea triquetra* and peas *Pultenaea linophylla, Bossiaea kiamensis, Gompholobium glabratum* and *Pultenaea daphnoides*. The groundcover is a mixture of re-sprouters (*Lepidosperma urophorum, Entolasia stricta* and ferns), along with seeders such as *Gonocarpus teucrioides, Hybanthus vernonii, Goodenia heterophylla* and *Opercularia aspera*.

The area in which this site is located has been burnt in the 68-69 wildfire, hazard reduced in 1980-81 and burnt in 2001.

MORJM04
This site is located in 160m north of Twelve Mile Road on a steep north-facing slope which appears to be on Devonian sandstone rather than the more usual Permian sandstone. The usual tree species of *C. gummifera, E. pilularis* and *S. glomerulifera* are present but the understorey is markedly different to that seen on most sites. Shrubs are sparse, with *Persoonia linearis, Acacia obtusifolia* and *Podolobium ilicifolium* being the only common species. The groundcover is dominated by various *Lomandra* species and forbs or subshrubs including *Pomax umbellata, Phyllanthus hirtellus* and *Hybanthus monopetalus*. The site is mapped as being FE2, and given the tree species present this has been left as correct, but the understorey is far from typical. The vegetation is about equally distributed between seeders and re-sprouters.

This area has been burnt in wildfires in 1968-69 and 2001.

MORJM05F
This site is located on a lower slope just above a gully mapped as carrying FE20 (Coastal Hinterland Gully Rainforest). The mapping is correct. The quadrat site had been little affected by fire, although it had burnt the south-west corner of the plot, and patchily in some other areas. The intensity is likely to have been low. Ferns, tree ferns and rainforest trees were resprouting from either rhizomes, roots or woody bases, with some such as bolwarra (*Eupomatia laurina*, a small rainforest tree) sprouting from both the woody base and the roots. The only seedlings seen were judged likely to have germinated independently of the fire.

There are emergent tall *Syncarpia glomerulifera* and *E. pilularis*, with a lower canopy being formed by *Acacia mabellae* and rainforest trees *Cryptocarya glaucescens* and coachwood, *Ceratopetalum apetalum*. Old fire scars on the base of the *Cryptocarya* and *Syncarpia* indicate that a more intense fire has burnt into the edge of this rainforest patch in the past.

This area has been burnt in wildfires in 1968-69 and 2001.

MORJM06
This site is located near the junction of Messmate and Cypress Roads in an area mapped as FE139, with a moist heath (FE144) polygon located within it. The quadrat was located on the boundary of the two polygons. In fact the area is all FE139, with some parts more open and with trees of smaller stature. The site gives the impression of having been burnt twice within a short period, with trees having two obvious points at which their growth has been checked. The soil also seems unusually poor, as if there had been some loss of topsoil after the first fire, such as might happen if heavy rain followed the fire while the ground was still bare.

Re-sprouters such as *Lambertia formosa, Banksia spinulosa* and *Leptospermum trinervium* dominate the shrub layer, although seedlings were also common. The groundcover was very sparse and of relatively low species diversity, perhaps due to the lack of topsoil.

This area has been burnt in wildfires in 1968-69, hazard reduced in 1981-82 and burnt in 2001.

APPENDIX 4: Forest Ecosystem Profiles

Southern CRA Profile Information

The first page of information on each forest ecosystem is reproduced from Thomas, Gellie and Harrison (2000) and refers to the FE type throughout its distribution in the Southern CRA area. Some corrections to FE descriptions, species names and spellings on these pages, have been made to improve the accuracy of the information. The diagnositic species lists have not been changed and the non-alphabetic order of the lists has been retained, since it in part reflects the fidelity classes.

Descriptive vegetation profiles include information about the floristic composition, structure, habitat, and occurrence of each ecosystem. The written description is designed to provide a general overview of the structure and floristics of each of the derived forest ecosystems. Floristic data comprises a table showing vegetation group frequency and cover-abundance of each species within the described unit, together with its frequency and abundance in all the other vegetation groups. Fidelity classes within the floristic table describe the positive or negative association of that species within the vegetation group and provide an indication of the diagnostic species within vegetation group. Please note that Fidel tables have only been generated for ecosystems 1 to 170, as these were direct outputs of the PATN classification

Vulnerability rankings were set for ecosystems in the South Coast and Western subregions to aid in CRA negotiations. These rankings were set and agreed to by the ERG and they indicate how vulnerable each ecosystem is to a range of threatening processes including:

G grazing,

C clearing,

L logging,

W weeds,

U urban development,

R recreational pressure,

F fire,

D general development,

P pigs, and

H hobby farms.

In the ranking, 1 was considered very high while 5 was very low

The mapping reliability of each mapped ecosystem was evaluated, using a score between 1 (very high) and 5 (very low). These reliability scores are indicated for each vegetation type under the heading 'Reliablity'.

For further information on the Southern CRA profiles, see the report and appendices by Thomas, Gellie and Harrison (2000).

Conjola-Morton Study Area Information

This information is specific to the Conjola-Morton Study Area and has been compiled by reference to the written reports, ArcView map layers, the MS-Access floristics database (GM-Naomi) and the Conjola-Morton site survey database created during this project. Fire sensitive species and fire management prescription information is derived from Section 4.1 of the report.

The following headings have been used in this section:

- Mills' Classification equivalent type – the corresponding type used in Kevin Mills (1996) report on vegetation mapping in Conjola and Cudmirrah National Parks
- Previous Survey Sites Represented – as included in NPWS survey sites ArcView layer and GM-Naomi database – including Southern CRA sites (full floristics), CSIRO canopy surveys and other earlier survey sites.
- Conjola-Morton 2003 Sites Represented – those sites which fall clearly within the FE type.
- Survey type - full floristics or fire response monitoring – is indicated for each site.
- Marginal Sites – those sites which are on the periphery of an FE polygon or are a hybrid with another associated FE type and therefore are not necessarily representative of a single FE type.

- Species Recorded at Representative Sites – amalgamated list from the Conjola-Morton 2003 field surveys which applies to the sites represented within the FE type excluding marginal sites which may have a mixed species composition reflecting an ecotonal situation. Weeds are shown with an asterisk in front of the species name.
- Dominant species – according to the FE description in this report
- Threatened Species – known threatened plant species recorded during the field survey or recorded in threatened species or ROTAP records
- Other Species of Conservation Significance – which have been suggested as being regionally uncommon or near their known limit of distribution, based on findings of the field survey, literature review, and records of species considered to be rare or uncommon (Southern CRA rare plants database).
- Relationship to other Forest Ecosystems – closely associated FE types
- Conservation Significance – on the basis of the vegetation assessment
- Threats – including urban interface issues, recreational pressures, weed infestation, fire sensitivity, etc
- Impacts of Fire Regimes - based on observations during the field surveys

FOREST ECOSYSTEM 2: **Lowland Red Bloodwood - Turpentine Dry Shrub Forest**

Southern CRA Profile Information

Description: Lowland Dry Shrub Forest - *Corymbia gummifera / Syncarpia glomulifera*

Lowland Dry Shrub Forest is a medium forest over 20 metres height dominated by *Corymbia gummifera*, sometimes with *E. globoidea, E. consideniana*, and *Syncarpia glomulifera* and *E .piperita* in the Clyde and Shoalhaven catchments. It has a diverse dry shrub understorey, including *Persoonia linearis, Banksia spinulosa, Acacia obtusifolia, Tetratheca thymifolia, Leucopogon lanceolatus, Lomatia ilicifolia, Acacia terminalis, Platysace lanceolata, Bossiaea obcordata*, and *Gompholobium latifolium*. The ground cover contains grasses *Entolasia stricta*, and herbs *Patersonia glabrata, Dianella caerulea* var *caerulea*, and *Gonocarpus teucriodes.*

Lowland Dry Shrub Forest occurs on shallow sandy soils on low lying ridges and moderately dry slopes in the foothills and on ridges and benches on the tops of the northern sandstone plateau areas. Austin (1978) refers to a similar type in his study of the South Coast. This forest ecosystem is equivalent to a similar type, FE46B: Lowland Dry Shrub Forest, which is found in the Eden CRA Region (Keith and Bedward 1999).

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Persoonia linearis	2	0.843	1	0.170	Positive
Entolasia stricta	2	0.814	2	0.137	Positive
Corymbia gummifera	3	0.771	3	0.038	Positive
Acacia obtusifolia	2	0.700	2	0.079	Positive
Banksia spinulosa var *spinulosa*	2	0.700	2	0.042	Positive
Tetratheca thymifolia	2	0.671	1	0.045	Positive
Pteridium esculentum	2	0.614	2	0.303	Positive
Patersonia glabrata	2	0.500	1	0.034	Positive
Dianella caerulea var *caerulea*	1	0.743	1	0.154	Uninformative
Lomatia ilicifolia	1	0.586	1	0.034	Uninformative
Leucopogon lanceolatus var *lanceolatus*	1	0.543	1	0.163	Uninformative
Billardiera scandens var *scandens*	1	0.500	1	0.129	Uninformative
Lepidosperma urophorum	2	0.486	2	0.068	Uninformative
Gonocarpus teucrioides	2	0.471	2	0.087	Uninformative
Lomandra obliqua	2	0.457	1	0.027	Uninformative
Syncarpia glomulifera	3	0.443	3	0.015	Uninformative
Acacia terminalis	1	0.414	1	0.037	Uninformative
Allocasuarina littoralis	2	0.386	2	0.097	Uninformative
Eucalyptus globoidea	2	0.386	2	0.075	Uninformative
Eucalyptus piperita	3	0.386	3	0.014	Uninformative
Phyllanthus hirtellus	1	0.386	1	0.034	Uninformative
Podolobium ilicifolium	2	0.371	2	0.071	Uninformative
Pomax umbellata	1	0.371	1	0.060	Uninformative
Bossiaea obcordata	2	0.343	2	0.020	Uninformative
Gompholobium latifolium	2	0.343	2	0.007	Uninformative
Pimelea linifolia ssp linifolia	1	0.329	1	0.054	Uninformative
Eucalyptus consideniana	3	0.314	3	0.011	Uninformative
Marsdenia suaveolens	1	0.314	1	0.017	Uninformative
Macrozamia communis	1	0.300	2	0.059	Uninformative
Amperea xiphoclada var *xiphoclada*	1	0.286	1	0.032	Uninformative
Imperata cylindrica var *major*	2	0.286	2	0.058	Uninformative
Hibbertia empetrifolia	2	0.271	1	0.020	Uninformative
Patersonia sericea	2	0.271	1	0.027	Uninformative
Eucalyptus sieberi	3	0.257	3	0.107	Uninformative

Extant area (ha): 86310

Pre-1750 area (ha): 103568

Geographic range: South Coast and small patch within eastern edge of Northern subregion

How much conserved in reserves (ha): 0 in Northern subregion, 24046 in South Coast subregion

Vulnerability: 4(C) in South Coast

Reliability: 3

FE 2 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu 2, 6 or 12

Previous Survey Sites Represented: API97, API98, CS_AU103, CS_AU104, CS_AU105, CS_AU106, CS_AU107, CS_AU109, CS_AU110, CS_AU111, CS_AU114, CS_AU116, CS_AU118, CS_AU90, CS_AU91, CS_AU92, CS_AU93, CS_AU94, CS_AU95, CS_AU96, CS_AU97, CS_AU98, CS_JM18, CS_JM19, KMCO10, KMCO11, KMCO13, KMCO2, KMCO4, KMCO5, KMCO7, KMCO8, KMCO9, KMCU11, KMCU16, KMCU4, KMCU9, SZ22395M, SZ23026M, SZ23027G, SZ23028G, SZ23029M, SZ23031, SZ23098M, SZ24279M, SZ24280M

Conjola-Morton 2003 Sites Represented : CONJM6F, CONJM9F and MORJM04

Marginal Sites: CONJM12

Species Recorded at Representative Sites:

Acacia longifolia ssp *longifolia*
Acacia myrtifolia
Acacia obtusifolia
Acacia suaveolens
Actinotus minor
Amperea xiphoclada var *xiphoclada*
Anisopogon avenaceus
Aristida vagans
Austrostipa pubescens
Austrostipa spp.
Banksia spinulosa var *spinulosa*
Billardiera scandens var *scandens*
Bossiaea heterophylla
Bossiaea obcordata
Brunoniella pumilio
Caesia parviflora var *parviflora*
Calochlaena dubia
Caustis flexuosa
Comesperma volubile
Correa reflexa
Corymbia gummifera
Cryptostylis subulata
Dampiera stricta
Dianella caerulea var *caerulea*
Drosera peltata
Entolasia stricta
Eucalyptus consideniana
Eucalyptus eugenioides
Eucalyptus pilularis
Eucalyptus piperita
Eucalyptus scias ssp *callimastha*
Gahnia radula
Glycine clandestina
Gompholobium latifolium
Gonocarpus teucrioides
Goodenia heterophylla ssp *eglandulosa*
Haemodorum corymbosum
Haemodorum planifolium
Hakea sericea
Hardenbergia violacea
Hibbertia empetrifolia
Hybanthus monopetalus
Imperata cylindrica var *major*
Kennedia prostrata
Kennedia rubicunda
Lagenifera stipitata
Lambertia formosa
Lasiopetalum ferrugineum var *ferrugineum*
Lepidosperma laterale
Lepidosperma urophorum
Leptospermum polygalifolium ssp *polygalifolium*
Leptospermum trinervium
Leucopogon lanceolatus
Lindsaea linearis
Lindsaea microphylla
Lomandra confertifolia ssp *rubiginosa*
Lomandra filiformis ssp *filiformis*
Lomandra longifolia
Lomandra multiflora
Lomandra multiflora ssp *multiflora*
Lomandra obliqua
Lomatia ilicifolia
Marsdenia suaveolens
Microlaena stipoides var *stipoides*
Opercularia aspera
Opercularia varia
Oxalis spp
Panicum simile
Patersonia glabrata
Persoonia levis
Persoonia linearis
Petrophile pedunculata
Phyllanthus hirtellus
Pimelea linifolia ssp *linifolia*
Platylobium formosum ssp *formosum*
Poa spp.
Podolobium ilicifolium
Pomax umbellata
Poranthera corymbosa
Poranthera microphylla
Pteridium esculentum
Pterostylis spp.
Pultenaea daphnoides
Pultenaea linophylla
Pultenaea rosmarinifolia
Pultenaea villifera var *villifera*
Scaevola ramosissima
Schelhammera undulata
Smilax glyciphylla
Stackhousia monogyna
Stackhousia viminea
Stylidium laricifolium
Syncarpia glomulifera

Telopea speciosissima	*Viola hederacea* forma *A*	*Zieria pilosa*
Tetratheca thymifolia	*Xanthosia pilosa*	
Themeda australis	*Xanthosia tridentata*	

Dominant species: Red bloodwood (*C. gummifera*) and/or blackbutt (*E. pilularis)* and possibly other eucalypts (*E. globoidea, E. piperita, E. consideniana* or *E. sieberi*) with a sub-canopy layer of turpentine (*Syncarpia glomulifera)* and a sclerophyll shrub understorey commonly including *Lambertia formosa, Gompholobium latifolium, Banksia spinulosa*, *Podolobium ilicifolium, Acacia obtusifolia* and *Tetratheca thymifolia*.

Threatened Species: Habitat for the orchid *Cryptostylis hunteriana*, listed as Vulnerable under the *Threatened Species Conservation Act*. *Galium australe* (listed as presumed extinct under the *Threatened Species Conservation Act)* was recorded at site CONJM07 just inside the boundary of a polygon re-mapped as FE5 but surrounded by FE2. *Pultenaea villifera* var. *villifera* (ROTAP species) was recorded at site CONJM09F. Also recorded on the ROTAP database was *Grevillea macleayana.*

Other Species of Conservation Significance: *Persoonia mollis* ssp *caleyi* and *Pultenaea rosmarinifolia* (SCRA rare plants database).

Relationship to other Forest Ecosystems: Intergrades with FE21 along gullies and commonly grades into FE139 on drier ridges.

Conservation Significance: Widely represented in Conjola and parts of Morton (east) National Parks, not of special conservation significance.

Threats: Clearing and logging in un-reserved areas.

Impacts of Fire Regimes: Shrubby understorey appears well adapted to regular fires, with many re-sprouters, including some members of the Fabaceae family (peas and wattles) which are more commonly seeders. However there would be some species which could be eliminated by too frequent fire. *Pultenaea villifera* is likely to be such a species as it is recorded as re-sprouting after a cool fire, but being killed and regenerating from seed after a hot fire (NPWS Fire Response database).

FOREST ECOSYSTEM 3: Hinterland Red Mahogany - Turpentine Moist Forest

Southern CRA Profile Information

Description: Northern Hinterland Shrub Dry Forest - *Syncarpia glomulifera / E. scias* ssp *callimastha*

This forest ecosystem is a medium to tall forest up to 30 metres in height, dominated by *Syncarpia glomulifera* and *E. scias* ssp. *callismastha,* sometimes with *E. agglomerata* and *E. paniculata* ssp *paniculata* . Tree orchids, such as *Cymbidium suave,* are found in tree hollows in the tree layer. A moderately dense shrub understorey comprises *Acacia obtusifolia, Zieria arborescens, Tristaniopsis collina, Astrotricha* species B*, Correa lawrenciana, Dodonaea triquetra* and *Elaeocarpus reticulatus.* The occasionally dense ground cover is dominated by sedges *Lepidosperma urophorum, Lepidosperma laterale* and *Lomandra longifolia,* with ferns *Pteridium esculentum* and *Calochlaena dubia* and the herb *Dianella caerulea* var *caerulea.* Vines growing in the ground cover include *Smilax glyciphylla, Billardiera scandens, Cassytha pubescens, and Cissus hypoglauca.*

This forest ecosystem occurs between 100 and 700 metres elevation to the west of Ulladulla below the sandstone escarpment. It is found on moderately deep sandy silty loams on Permian mudstones on the talus slopes in the South-East corner of Morton NP and surrounding McDonald and Flat Rock State Forests.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Syncarpia glomulifera	3	1.000	3	0.020	positive
Entolasia stricta	2	0.917	2	0.147	positive
Acacia obtusifolia	2	0.750	2	0.089	positive
Lepidosperma laterale	2	0.750	1	0.172	positive
Eucalyptus scias ssp callimastha	3	0.667	2	0.006	positive
Lepidosperma urophorum	3	0.667	2	0.074	positive
Zieria arborescens ssp arborescens	2	0.667	2	0.003	positive
Tristaniopsis collina	2	0.500	3	0.019	positive
Dianella caerulea var *caerulea*	1	0.917	1	0.163	uninformative
Persoonia linearis	1	0.917	1	0.180	uninformative
Smilax glyciphylla	1	0.667	1	0.032	uninformative
Elaeocarpus reticulatus	1	0.583	1	0.103	uninformative
Billardiera scandens var *scandens*	1	0.500	1	0.135	uninformative
Cymbidium suave	1	0.500	1	0.020	uninformative
Olearia tomentosa	1	0.500	1	0.005	uninformative
Astrotricha species B	2	0.417	2	0.002	uninformative
Cassytha pubescens	1	0.417	1	0.035	uninformative
Correa lawrenciana var *lawrenciana*	1	0.417	2	0.006	uninformative
Dodonaea triquetra	2	0.417	2	0.017	uninformative
Eucalyptus agglomerata	3	0.417	3	0.053	uninformative
Eucalyptus paniculata ssp paniculata	3	0.417	2	0.032	uninformative
Acacia mabellae	2	0.333	2	0.025	uninformative
Corymbia gummifera	3	0.333	3	0.050	uninformative
Eucalyptus piperita	3	0.333	3	0.020	uninformative
Hibbertia dentata	1	0.333	1	0.057	uninformative
Marsdenia suaveolens	1	0.333	1	0.021	uninformative
Phyllanthus hirtellus	1	0.333	1	0.040	uninformative
Pultenaea daphnoides	2	0.333	1	0.022	uninformative
Acacia longifolia	2	0.250	2	0.042	uninformative
Babingtonia plurifolia	2	0.250	1	0.008	uninformative
Hibbertia aspera	2	0.250	2	0.071	uninformative
Lasiopetalum ferrugineum var *ferrugineum*	2	0.250	4	0.001	uninformative
Lepidosperma elatius	1	0.250	1	0.004	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Lepidosperma filiforme	2	0.250	2	0.009	uninformative
Prostanthera violacea	1	0.250	1	0.001	uninformative

Extant area (ha): 16207

Pre-1750 area (ha): 16228

Geographic range: South Coast

How much conserved in reserves (ha): 12188

Vulnerability: 5

Reliability: 3

FE 3 – Conjola-Morton Study Area

Mills' Classification equivalent type: Areas do not overlap

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : MORJM03F

Marginal Sites : None

Species Recorded at Representative Sites:

Acacia obtusifolia
Amperea xiphoclada var *papillata*
Anisopogon avenaceus
Astrotricha species B
Banksia spinulosa var *spinulosa*
Billardiera scandens var *scandens*
Boronia thujona
Bossiaea kiamensis
Brunoniella pumilio
Caesia parviflora var *parviflora*
Calochlaena dubia
Corymbia gummifera
Dianella caerulea
Dodonaea triquetra
Elaeocarpus reticulatus
Entolasia stricta
Eucalyptus globoidea
Eucalyptus piperita
Gompholobium glabratum
Gonocarpus teucrioides
Goodenia heterophylla ssp *eglandulosa*
Hardenbergia violacea
Hibbertia empetrifolia
Hibbertia linearis
Hybanthus vernonii ssp *vernonii*
Kennedia rubicunda
Lagenifera stipitata
Lepidosperma urophorum
Leucopogon lanceolatus
Lindsaea linearis
Lobelia dentata
Lomandra filiformis ssp *filiformis*
Lomandra longifolia
Marsdenia suaveolens
Opercularia aspera
Persoonia linearis
Phyllanthus hirtellus
Pimelea linifolia ssp *linifolia*
Platysace lanceolata
Pteridium esculentum
Pultenaea daphnoides
Pultenaea linophylla
Scaevola ramosissima
Schelhammera undulata
Stackhousia viminea
Syncarpia glomulifera
Tetratheca juncea
Tetratheca thymifolia
Viola hederacea forma A
Xanthosia pilosa
Zieria pilosa

Dominant species: Large-fruited red mahogany (*E. scias* ssp *callimastha*) and turpentine (*Syncarpia glomulifera*) in the canopy, while red bloodwood (*Corymbia gummifera*), blackbutt (*E. pilularis*), *E. piperita, E. paniculata, E. globoidea* and *E. muelleriana* may also be present. Understorey includes shrubs *Acacia obtusifolia, Persoonia linearis, Pultenaea daphnoides, Zieria arborescens, Astrotricha latifolia* and *Astrotricha* sp. B and the small trees *Tristaniopsis collina* and *Elaeocarpus reticulatus*.

Threatened Species: *Galium australe* (listed as presumed extinct in NSW under the *Threatened Species Conservation Act*) recorded at site MORJM07

Other Species of Conservation Significance: None

Relationship to other Forest Ecosystems: Replaces FE2 in slightly wetter areas.

Conservation Significance: Restricted distribution but more widespread in Morton (East) than previous mapping suggested.

Threats: Low vulnerability to weed invasion. Mostly protected in conservation reserves and little cleared in state forests.

Impacts of Fire Regimes: The more mesic understorey of this community may be more fire sensitive than the similar FE2, with some re-sprouters such as *Elaeocarpus reticulatus* and *Tristaniopsis collina* which might be expected to have a limited capacity to resprout if fires became too frequent. This forest is intermediate between shrubby dry sclerophyll (recommended fire interval 7-30 years) and wet sclerophyll (25-60 years), so fire intervals averaging around 25-40 years might be appropriate.

FOREST ECOSYSTEM 5: Jervis Bay Lowland Dry Forest

Southern CRA Profile Information

Description: Jervis Bay Lowlands Shrub/Grass Dry Forest - mixed tree species

Jervis Bay Lowlands Shrub/Grass Dry Forest is a medium forest, mainly dominated by *Eucalyptus punctata*, along with other tree species, such as *Corymbia gummifera and Eucalyptus eugenioides.* This ecosystem has co-dominant shrub and grass layers. The Shrub layer comprises patches of *Allocasuarina littoralis*, in amongst *Daviesia ulicifolia, Melaleuca decora, Persoonia* sp*, and Pimelea linifolia* ssp *linifolia.* The ground layer contains grasses *Entolasia stricta* and *Themeda australis,* small sedges *Lomandra multiflora* ssp*. multiflora, Dianella caerulea* var *caerulea,* and *Lepidosperma laterale,* with herbs *Opercularia diphylla and Brunionella pumilio.*

Jervis Bay Lowlands Shrub/Grass Dry Forest is found on silty clay soils between 5 and 100 metres in elevation on the coastal lowlands south of the Shoalhaven River to Georges Basin up to the base of the sandstone escarpment

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Allocasuarina littoralis	3	0.818	2	0.101	positive
Brunoniella pumilio	2	0.818	1	0.014	positive
Entolasia stricta	3	0.727	2	0.148	positive
Daviesia ulicifolia	2	0.546	2	0.091	positive
Eucalyptus punctata	3	0.546	3	0.029	positive
Melaleuca decora	3	0.273	0	0.000	positive
Billardiera scandens var *scandens*	1	0.727	1	0.134	uninformative
Lomandra longifolia	1	0.727	2	0.416	uninformative
Pimelea linifolia ssp linifolia	1	0.636	1	0.058	uninformative
Lomandra multiflora ssp multiflora	1	0.546	1	0.144	uninformative
Opercularia diphylla	1	0.546	2	0.010	uninformative
Pultenaea retusa	1	0.546	1	0.007	uninformative
Corymbia gummifera	3	0.455	3	0.050	uninformative
Dianella caerulea var *caerulea*	2	0.455	1	0.164	uninformative
Eucalyptus eugenioides	3	0.455	3	0.008	uninformative
Hakea sericea	2	0.455	1	0.007	uninformative
Lepidosperma laterale	1	0.455	1	0.173	uninformative
Themeda australis	2	0.455	2	0.200	uninformative
Imperata cylindrica var *major*	2	0.364	2	0.061	uninformative
Pteridium esculentum	2	0.364	2	0.308	uninformative
Pultenaea villosa	2	0.364	1	0.004	uninformative
Bursaria spinosa	2	0.273	2	0.075	uninformative
Corymbia maculata	4	0.273	3	0.043	uninformative
Dichondra repens	2	0.273	2	0.207	uninformative
Entolasia marginata	2	0.273	2	0.053	uninformative
Eucalyptus longifolia	4	0.273	2	0.025	uninformative
Eucalyptus paniculata ssp paniculata	3	0.273	2	0.032	uninformative
Lomandra obliqua	1	0.273	1	0.034	uninformative
Persoonia levis	1	0.273	1	0.019	uninformative
Vernonia cinerea var *cinerea*	2	0.273	1	0.029	uninformative
Acacia irrorata ssp irrorata	2	0.182	2	0.024	uninformative
Acacia terminalis	2	0.182	1	0.044	uninformative
Boronia polygalifolia	2	0.182	2	0.001	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Cassytha glabella forma glabella	2	0.182	1	0.025	uninformative
Cassytha pubescens	2	0.182	1	0.035	uninformative
Eucalyptus globoidea	2	0.182	2	0.081	uninformative
Eucalyptus sclerophylla	4	0.182	3	0.009	uninformative
Gahnia sieberiana	3	0.182	2	0.020	uninformative

Extant area (ha): 8916

Pre-1750 area (ha): 16382

Geographic range: South Coast

How much conserved in reserves (ha): 1001

Vulnerability: 3(C)

Reliability: 2

FE 5 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu3

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: CONJM07

Marginal Sites: None

Species Recorded at Representative Sites:

Acacia longifolia ssp *longifolia*
Acacia terminalis ssp *angustifolia*
Austrostipa spp.
Brunoniella pumilio
Bursaria spinosa ssp *spinosa*
Calochlaena dubia
Clematis aristata
Corymbia maculata
Dianella caerulea var caerulea
Dichelachne micrantha
Digitaria sp.
Entolasia stricta
Eucalyptus paniculata ssp *paniculata*
Eucalyptus pilularis
Eucalyptus piperita
Eustrephus latifolius
Galium australe
Galium binifolium
Glycine clandestina
Goodenia heterophylla ssp *eglandulosa*
Hardenbergia violacea
Hibbertia scandens
Imperata cylindrica var *major*
Kennedia rubicunda
Leucopogon lanceolatus
Lomandra filiformis ssp *filiformis*
Lomandra longifolia
Opercularia aspera
Oplismenus imbecillis
Oxalis sp.
Pandorea pandorana
Panicum simile
Persoonia linearis
Pimelea latifolia ssp *latifolia*
Poa sp.
Podolobium ilicifolium
Pteridium esculentum
Pultenaea linophylla
Schelhammera undulata
Syncarpia glomulifera
Tylophora barbata

Dominant species: Grey gum (*E. punctata*) is normally dominant but not recorded in Conjola, other common eucalypts include *C. gummifera* and *E. eugenioides*, and less commonly *C. maculata, E. paniculata, E. longifolia* and *E. globoidea*. A sub-canopy layer of the small tree *Allocasuarina littoralis* is frequently present and shrubs are typically smaller species such as *Pimelea linifolia* ssp *linifolia, Pultenaea villosa, Pultenaea retusa* and *Daviesia ulicifolia*, and the understorey is predominantly grassy.

Threatened Species: *Galium australe* (listed as presumed extinct under the *Threatened Species Conservation Act)* was recorded at site CONJM07 which falls in an area re-mapped as FE5.

Other Species of Conservation Significance: *Eucalyptus punctata* has its southern limit in the Conjola area.

Relationship to other Forest Ecosystems: Usually adjoins FE2 or FE21.

Conservation Significance: Not of particular conservation significance but distribution and amount reserved are not fully known.

Threats: Moderate vulnerability to threatening processes such as clearing, it has been cleared in some areas for housing.

Impacts of Fire Regimes: Understorey varies between shrubby and grassy depending on fire frequency. Includes obligate seeders such as *Allocasuarina littoralis, Pimelea linifolia, Pultenaea retusa, Pultenaea villosa, Hakea sericea* and wattles *Acacia irrorata* and *A. terminalis* which are likely to disappear under a frequent fire regime leaving an open grassy understorey. Prominent and diverse grasses may reflect the varying fire histories in different sites.

FOREST ECOSYSTEM 9: Coastal Lowlands Spotted Gum - Burrawang Dry Shrub Forest

Southern CRA Profile Information

Description: Coastal Lowlands Cycad Dry Shrub Dry Forest - *Corymbia maculata / Macrozamia communis*

Coastal Lowlands Cycad Dry Shrub Dry Forest is a medium to tall forest 25 –30 metres in height, dominated by *Corymbia maculata*, with *Eucalyptus paniculata* ssp *paniculata* and *E. muelleriana* as occasional co-dominants. The shrub layer comprises the cycad *Macrozamia* communis with patches of *Allocasuarina littoralis, Breynia oblongifolia,* and *Persoonia linearis.* The smaller shrub layer contains *Hibbertia aspera, Oxylobium ilicifolium, Playsace lanceolata* and *Leucopogon lanceolatus.* The ground layer comprises grasses *Entolasia stricta, Imperata cyclindrica* and *Microlaena stipoides* intermixed with herbs and twiners *Desmodium varians, Dianella caerulea* var *caerulea, Hardenbergia violacea*, *Glycine clandestina,*and *Schelhammera undulata,* along with sedges *Lepidosperma laterale, Lomandra longifolia* and *Lomandra multiflora* ssp *multiflora*

This forest ecosystem occurs at elevations between 25 and 300 metres on undulating ridges and slopes in the coastal foothills on Ordovician and granitic sediments. It is found in fairly large patches between Termeil and Tilba Tilba on the South Coast.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Macrozamia communis	3	0.937	1	0.048	positive
Corymbia maculata	3	0.873	3	0.030	positive
Entolasia stricta	2	0.841	2	0.138	positive
Hibbertia aspera	2	0.810	2	0.059	positive
Imperata cylindrica var *major*	2	0.698	2	0.051	positive
Lepidosperma laterale	2	0.698	1	0.165	positive
Microlaena stipoides var *stipoides*	2	0.651	2	0.266	positive
Desmodium varians	2	0.635	1	0.163	positive
Platysace lanceolata	2	0.587	2	0.114	positive
Hibbertia saligna	1	0.016	0	0.000	positive
Poaceae Unknown	3	0.016	0	0.000	positive
Pterostylis alveata	1	0.016	0	0.000	positive
Senna aciphylla	4	0.016	0	0.000	positive
Dianella caerulea var *caerulea*	1	0.810	1	0.154	uninformative
Glycine clandestina	1	0.794	1	0.292	uninformative
Hardenbergia violacea	1	0.746	1	0.150	uninformative
Lomandra longifolia	1	0.651	2	0.413	uninformative
Lomandra multiflora ssp multiflora	1	0.619	1	0.137	uninformative
Persoonia linearis	1	0.587	1	0.176	uninformative
Billardiera scandens var *scandens*	1	0.571	1	0.129	uninformative
Schelhammera undulata	1	0.571	1	0.076	uninformative
Leucopogon lanceolatus var *lanceolatus*	1	0.556	1	0.163	uninformative
Pratia purpurascens	1	0.556	1	0.096	uninformative
Eustrephus latifolius	1	0.540	1	0.139	uninformative
Lagenifera stipitata	1	0.524	1	0.161	uninformative
Eucalyptus paniculata ssp paniculata	3	0.492	2	0.025	uninformative
Allocasuarina littoralis	2	0.476	2	0.096	uninformative
Dichondra repens	1	0.429	2	0.203	uninformative
Tylophora barbata	1	0.429	2	0.101	uninformative
Breynia oblongifolia	1	0.413	1	0.082	uninformative
Geitonoplesium cymosum	1	0.413	2	0.110	uninformative
Poa meionectes	2	0.413	2	0.137	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Notelaea venosa	2	0.397	2	0.123	uninformative
Pandorea pandorana	1	0.349	2	0.145	uninformative
Eucalyptus globoidea	1	0.333	2	0.077	uninformative
Clematis aristata	1	0.318	1	0.268	uninformative
Gonocarpus teucrioides	1	0.318	2	0.091	uninformative
Kennedia rubicunda	1	0.318	1	0.033	uninformative
Oxylobium ilicifolium	1	0.318	2	0.073	uninformative
Phyllanthus hirtellus	1	0.318	1	0.036	uninformative
Pteridium esculentum	2	0.318	2	0.308	uninformative
Themeda australis	2	0.318	2	0.199	uninformative
Vernonia cinerea var *cinerea*	1	0.318	1	0.024	uninformative

Extant area (ha): 55497 How much conserved in reserves (ha): 1769

Pre-1750 area (ha): 64512 Vulnerability: 3(L/C)

Geographic range: South Coast Reliability: 2

FE 9 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None

Dominant species: Spotted gum (*Corymbia maculata*) with *E. globoidea* and *E. paniculata* possibly co-dominant in places. Understorey elements include a small tree layer of *Allocasuarina littoralis*, and a shrub layer with burrawang, (*Macrozamia communis*), *Persoonia linearis, Leucopogon lanceolatus, Hibbertia aspera* and *Platysace lanceolata*.

Threatened Species: None.

Other Species of Conservation Significance: None

Relationship to other Forest Ecosystems: Adjoins FE types 2, 5, 21 and 139

Conservation Significance: Widely represented, not of special conservation significance.

Threats: Logging and clearing outside reserved areas

Impacts of Fire Regimes: Occurs in relatively fire-prone situations such as ridges and exposed slopes and includes a mixture of re-sprouters such as the burrawangs and various grasses and herbs, and seeders (various peas and wattles). In the continued absence of fire it can develop into FE21, with the gradual encroachment of mesophyll shrub and tree species from adjacent drainage lines. It is relatively resilient to high frequency fires, but understorey composition is likely to change, with the loss of obligate seeders such as some peas and wattles and other shrubs such as *Pimelea linifolia*, and increased dominance of burrawangs and grasses.

RAINFOREST ECOSYSTEM 20: Ecotonal Gully Rainforest

Southern CRA Profile Information

Description: Coastal Hinterland Ecotonal Gully Rainforest

Coastal Hinterland Ecotonal Gully Rainforest is a rainforest up to 25 metres tall with multiple layers of vegetation. The tree layer is a mixture of *Acmena smithii, Livistona australis* and *Synoum glandulosum* with an intermediate tree layer of *Elaeocarpus reticulatus, Tristaniopsis collina, Callicome serratifolia.* The lower shrub layer comprises shrubs *Notelaea venosa, Acacia mabellae,* with tree fern *Cyathea australis.* A variable ground cover includes ferns *Calochlaena dubia, Doodia aspera,* and bracken *Pteridium esculentum* intermixed with scattered vines *Cissus hypoglauca, Eustrephus latifolius, Morinda jasminoides, Tylophora barbata.*

This forest ecosystem is scattered in small patches from south of Jervis Bay to Mimosa Rocks. It has been difficult to map because of the lack of correlation with environmental variables. The sites indicate that it occurs between 50 and 500 metres in elevation in alluvium in sheltered gullies along the breadth of the South Coast.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Blechnum cartilagineum	3	0.926	2	0.080	positive
Elaeocarpus reticulatus	2	0.852	1	0.093	positive
Calochlaena dubia	2	0.815	2	0.050	positive
Cissus hypoglauca	2	0.815	2	0.095	positive
Smilax australis	2	0.722	2	0.139	positive
Cyathea australis	2	0.704	2	0.085	positive
Synoum glandulosum	2	0.630	2	0.073	positive
Acmena smithii	2	0.593	3	0.082	positive
Doodia aspera	2	0.593	2	0.100	positive
Callicoma serratifolia	3	0.519	2	0.017	positive
Psychotria loniceroides	2	0.519	2	0.052	positive
Marsdenia rostrata	2	0.500	2	0.118	positive
Pseuderanthemum variabile	2	0.500	2	0.059	positive
Tristaniopsis collina	3	0.500	2	0.013	positive
Acacia subporosa	3	0.037	0	0.000	positive
Bertya pomaderroides	2	0.019	0	0.000	positive
Blechnum indicum	3	0.019	0	0.000	positive
Carex brunnea	2	0.019	0	0.000	positive
Panicum pygmaeum	1	0.019	0	0.000	positive
Schizaea rupestris	2	0.019	0	0.000	positive
Eustrephus latifolius	1	0.630	1	0.138	uninformative
Pandorea pandorana	1	0.630	2	0.142	uninformative
Oplismenus imbecillis	1	0.574	2	0.115	uninformative
Lomandra longifolia	1	0.556	2	0.415	uninformative
Notelaea venosa	1	0.556	2	0.121	uninformative
Morinda jasminoides	1	0.537	3	0.090	uninformative
Tylophora barbata	1	0.519	2	0.100	uninformative
Hibbertia dentate	1	0.482	1	0.052	uninformative
Livistona australis	1	0.482	2	0.039	uninformative
Schelhammera undulata	1	0.482	1	0.078	uninformative
Acacia mabellae	2	0.426	2	0.020	uninformative
Gahnia melanocarpa	1	0.426	1	0.044	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Smilax glyciphylla	1	0.426	1	0.028	uninformative
Pteridium esculentum	1	0.389	2	0.307	uninformative
Geitonoplesium cymosum	1	0.370	2	0.112	uninformative
Pittosporum revolutum	1	0.370	2	0.068	uninformative
Dianella caerulea var *caerulea*	1	0.333	1	0.163	uninformative
Eupomatia laurina	2	0.333	3	0.038	uninformative
Viola hederacea	1	0.333	1	0.196	uninformative
Backhousia myrtifolia	3	0.315	4	0.053	uninformative
Clematis aristata	1	0.315	1	0.268	uninformative
Leucopogon lanceolatus var *lanceolatus*	1	0.315	1	0.168	uninformative
Persoonia linearis	1	0.315	1	0.181	uninformative

Extant area (ha): 2976

Pre-1750 area (ha): 2976

Geographic range: South Coast

Vulnerability: 3(F)

How much conserved in reserves (ha): 366

Reliability: 3

FE 20 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: SZ23099

Conjola-Morton 2003 Sites Represented: CONJM10, MORJM05F

Marginal Sites: None

Species Recorded at Representative Sites:

Acacia mabellae	*Eupomatia laurina*	*Pseuderanthemum variabile*
Acacia maidenii	*Eustrephus latifolius*	*Psychotria loniceroides*
Acmena smithii	*Gahnia melanocarpa*	*Sarcopetalum harveyanum*
Backhousia myrtifolia	*Galium binifolium*	*Schelhammera undulata*
Blechnum cartilagineum	*Geitonoplesium cymosum*	*Senecio velleioides*
Breynia oblongifolia	*Hibbertia dentata*	*Sigesbeckia orientalis*
Calochlaena dubia	*Hydrocotyle acutiloba*	*Smilax australis*
Ceratopetalum apetalum	*Lomandra longifolia*	*Smilax glyciphylla*
Cissus hypoglauca	*Marsdenia rostrata*	*Solanum pungetium*
Clematis glycinoides	*Morinda jasminoides*	*Stephania japonica* var *discolor*
Clerodendrum tomentosum	*Notelaea venosa*	*Sticherus flabellatus*
Cryptocarya glaucescens	*Opercularia aspera*	*Syncarpia glomulifera*
Cyathea australis	*Oplismenus imbecillis*	*Synoum glandulosum*
Doodia aspera	*Palmeria scandens*	*Tasmannia insipida*
Doryphora sassafras	*Parsonsia straminea*	*Tristaniopsis collina*
Elaeocarpus reticulatus	*Passiflora cinnabarina*	*Tylophora barbata*
Eucalyptus pilularis	*Phyllanthus gunnii*	*Viola hederacea*
Eucalyptus saligna X botryoides	*Plectorrhiza tridentata*	

Dominant species: Generally an open canopy of whichever eucalypt species are dominant in the vicinity with the tall wattle *Acacia mabellae*, and a dense sub-canopy of rainforest trees including *Acmena smithii, Doryphora sassafras, Cryptocarya glaucescens* and *Ceratopetalum apetalum*. Smaller trees include *Callicoma serratifolia, Tristaniopsis collina, Synoum glandulosum* and *Eupomatia laurina* and shrubs *Notelaea venosa* or *N. longifolia* and *Psychotria loniceroides*.

Threatened Species: None.

Other Species of Conservation Significance: None

Relationship to other Forest Ecosystems: Surrounded by FE2, FE3 or FE21. In other locations outside the study area it can be marginal to other rainforest types (e.g. FE166/169).

Conservation Significance: Restricted in Conjola which does not contain other rainforest types and therefore of some local significance. More common in the steeper valleys and below the escarpment in Morton where it develops from wet eucalypt forests in the prolonged absence of fire and may merge with true rainforest types. Also mapped in other areas e.g. Meroo National Park.

Threats: Sensitive to frequent burning (see below). Fire should be kept out of this community as far as is practicable.

Impacts of Fire Regimes: Vulnerable to the effects of fire, whether it be wildfire opening up the canopy and destroying the stand structure, or frequent cool burns drying the margins and encouraging the encroachment of grasses and other plants which create more fuel load around the edges. Most rainforest species are sensitive to frequent fire, so stands are unlikely to persist in locations where fire occurs more than once every few decades. Rampant vine growth can be a response to burning of rainforest stands. If fire were to be excluded from the areas for a sufficiently long period it might be expected that FE20 would develop into FE166/169.

FOREST ECOSYSTEM 21: Spotted Gum - Blackbutt Moist Forest

Southern CRA Profile Information

Description: Northern Foothills Moist Shrub Forest - *C. maculata / E. pilularis*

Northern Foothills Moist Shrub Forest is a tall forest over 30 metres tall comprising a variable tree canopy. In the southern end of its range *Corymbia maculata* and *Eucalyptus pilularis* dominate the tree canopy whereas in the north *Syncarpia glomulifera* and *E. saligna* (composite) tend to be more dominant. An intermediate tree layer comprises *Synoum glandulosum, Elaeocarpus reticulatus* and *Acacia mabellae*, and *Persoonia linearis.* An intermediate shrub layer contains *Macrozamia communis, Hibbertia aspera*, *Notelaea longifolia, Persoonia linearis* and *Breynia oblongifolia.* A variable ground cover of sedges *Gahnia melanocarpa, Lomandra longifolia* and *Lepidosperma urophorum,* is intertwined with vines *Smilax australis, Parsonsia straminea, Clematis aristata, Pandorea pandorana* and *Morinda jasminoides*. Ferns such as *Calochlaena dubia* and *Doodia aspera* form small patches in amongst the rest of the ground cover.

This forest ecosystem is found on sheltered slopes on Ordovician sediments in the rolling coastal foothills in the Clyde-Kioloa area. Further to the North, it is found in sheltered gullies and slopes on the Permian mudstone escarpment and in the lower Shoalhaven and Kangaroo Valley valleys. It is found mainly between 20 and 250 metres in elevation on deep clay soils.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Cissus hypoglauca	2	0.909	2	0.093	positive
Entolasia stricta	2	0.764	2	0.140	positive
Corymbia maculata	3	0.709	3	0.034	positive
Synoum glandulosum	2	0.673	2	0.072	positive
Pteridium esculentum	2	0.655	2	0.303	positive
Notelaea longifolia forma longifolia	2	0.582	1	0.018	positive
Eucalyptus pilularis	2	0.564	3	0.022	positive
Acacia mabellae	2	0.527	2	0.018	positive
Gahnia melanocarpa	2	0.527	1	0.042	positive
Hibbertia aspera	2	0.527	2	0.065	positive
Notelaea ovata	1	0.073	0	0.000	positive
Maytenus silvestris	1	0.055	0	0.000	positive
Poa affinis	4	0.036	0	0.000	positive
Acacia jonesii	1	0.018	0	0.000	positive
Acacia linifolia	1	0.018	0	0.000	positive
Callistemon salignus	1	0.018	0	0.000	positive
Elaeocarpus reticulatus	1	0.818	1	0.094	uninformative
Dianella caerulea var *caerulea*	1	0.764	1	0.156	uninformative
Eustrephus latifolius	1	0.746	1	0.137	uninformative
Macrozamia communis	1	0.746	2	0.053	uninformative
Leucopogon lanceolatus var *lanceolatus*	1	0.709	1	0.162	uninformative
Lomandra longifolia	1	0.691	2	0.413	uninformative
Persoonia linearis	1	0.691	1	0.175	uninformative
Schelhammera undulata	1	0.673	1	0.075	uninformative
Tylophora barbata	1	0.673	2	0.098	uninformative
Breynia oblongifolia	1	0.600	1	0.080	uninformative
Geitonoplesium cymosum	1	0.582	1	0.109	uninformative
Hibbertia dentata	1	0.582	1	0.050	uninformative
Pseuderanthemum variabile	1	0.564	2	0.058	uninformative
Smilax australis	1	0.564	2	0.141	uninformative
Parsonsia straminea	1	0.546	2	0.058	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Clematis aristata	1	0.527	1	0.265	uninformative
Desmodium varians	1	0.527	1	0.166	uninformative
Pandorea pandorana	1	0.527	2	0.143	uninformative
Morinda jasminoides	1	0.509	3	0.091	uninformative
Psychotria loniceroides	1	0.509	2	0.052	uninformative

Extant area (ha): 70036

Pre-1750 area (ha): 90370

Geographic range: South Coast

How much conserved in reserves (ha): 10570

Vulnerability: 3(L/C)

Reliability: 2

FE 21 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu1, 2 or 3

Previous Survey Sites Represented: CSAU115, CSAU117, KMCU15, KMCU6, SZ22394M

Conjola-Morton 2003 Sites Represented: MORJM02

Marginal Sites: None.

Species Recorded at Representative Sites:

Acacia longifolia ssp *longifolia*
Acacia parramattensis
Astrotricha latifolia
Breynia oblongifolia
Bursaria spinosa ssp *spinosa*
Calystegia marginata
*Centaurium erythraea**
Cissus hypoglauca
Clerodendrum tomentosum
Dianella caerulea var *caerulea*
Dichondra repens
Digitaria sp.
Entolasia marginata
Entolasia stricta
Eucalyptus globoidea
Eucalyptus paniculata ssp *paniculata*
Eucalyptus piperita
Eustrephus latifolius
Gahnia sieberiana
Geitonoplesium cymosum
Geranium solanderi var *solanderi*
Glycine clandestina
Gonocarpus teucrioides
Howittia trilocularis
Kennedia rubicunda
Livistona australis
Lomandra longifolia
Muehlenbeckia gracillima
Notelaea longifolia
Opercularia aspera
Oplismenus imbecillis
Pandorea pandorana
Panicum simile
*Passiflora edulis**
Pelargonium inodorum
Pellaea falcata
Phyllanthus gunnii
*Phytolacca octandra**
Pittosporum revolutum
Pomaderris discolor
Pteridium esculentum
Rapanea variabilis
Rhodamnia rubescens
Sarcopetalum harveyanum
Scaevola aemula
Sigesbeckia orientalis
Smilax australis
Solanum prinophyllum
Solanum vescum
*Sonchus oleraceus**
Syncarpia glomulifera
Teucrium corymbosum
Tylophora barbata
Wahlenbergia gracilis
Zieria smithii

Dominant species: Spotted gum (*C. maculata*) dominates the canopy and blackbutt (*E. pilularis*), stringybarks (*E. globoidea* and *E. eugenioides*) and Sydney peppermint (*E. piperita*) may be present, with a small tree layer including *Syncarpia glomulifera, Acacia mabellae, A. binervata, A. longifolia* ssp *longifolia* and *A. irrorata.* Mesic elements such as *Elaeocarpus reticulatus, Synoum glandulosum* and *Notelaea longifolia* occur alongside sclerophyll shrubs like *Persoonia linearis* and *Acacia longifolia*. Vines and ferns are common. The groundcover is variable and may include a wide range of grasses, herbs and trailing vines.

Threatened Species: None.

Other Species of Conservation Significance: *Persoonia mollis* ssp *caleyi* and *Pterostylis hians*.

Relationship to other Forest Ecosystems: Commonly intergrades with FE2 and adjoins types 3 and 20.

Conservation Significance: Widely represented in Conjola and Morton (East); not of special conservation significance.

Threats: Logging and clearing in non-reserved areas. Little clearing of this forest type has occurred.

Impacts of Fire Regimes: Occurs in less fire-prone situations such as creek flats and gullies and consequently can develop an understorey of mesophyll shrubs and rainforest tree saplings. In the continued absence of fire it is likely to develop into FE20, Ecotonal Gully Rainforest, while under more frequent fire it is likely to lose the shrub component and become more open with a groundcover of grasses, sedges such as *Gahnia* spp, ferns and herbs. The community FE5 (Jervis Bay Lowlands Dry Forest) is likely to be what FE21 would develop into under frequent burning, at least in the lowland areas of Conjola NP.

NON-FOREST ECOSYSTEM 22: Dune/Headland Scrub

Southern CRA Profile Information

Description: Southern Coastal Hind Dune/Headland Scrub

Southern Coastal Hind Dune/Headland Scrub is a shrubland dominated by *Banksia integrifolia*. Common shrubs are *Acacia sophorae, Leucopogon parviflorus* and *Monotoca elliptica* and a tall groundcover of bracken, *Pteridium esculentum* and *Lomandra longifolia* is interwoven with a low sparse ground cover of grasses *Poa meionectes* and *Entolasia stricta*, together with herbs *Oxalis perennans*, *Pratia purpurascens*, and *Glycine clandestina*.

Southern Coastal Hind Dune/Headland Scrub is found in coastal hind dunes. No sites of this vegetation type were sampled within the Southern CRA Region. It was mapped in the Southern CRA Region in conjunction with ecosystem number 23. An equivalent map unit 61 is found in the Eden CRA Region (Keith and Bedward 1999).

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Banksia integrifolia ssp integrifolia	2	1.000	2	0.008	positive
Muehlenbeckia adpressa	1	0.222	0	0.000	positive
Alyxia buxifolia	1	0.111	0	0.000	positive
Austrostipa flavescens	1	0.111	0	0.000	positive
Correa alba	3	0.111	0	0.000	positive
Olearia axillaris	1	0.111	0	0.000	positive
Oxalis perennans	1	0.889	1	0.081	uninformative
Acacia sophorae	1	0.778	2	0.005	uninformative
Pteridium esculentum	1	0.778	2	0.307	uninformative
Leucopogon parviflorus	1	0.667	2	0.001	uninformative
Lomandra longifolia	1	0.667	2	0.416	uninformative
Monotoca elliptica	1	0.667	1	0.013	uninformative
Dichondra repens	1	0.556	2	0.206	uninformative
Carpobrotus glaucescens	1	0.444	3	0.001	uninformative
Correa reflexa var *reflexa*	1	0.444	1	0.039	uninformative
Hibbertia obtusifolia	1	0.444	1	0.212	uninformative
Isolepis nodosa	1	0.444	2	0.006	uninformative
Kennedia rubicunda	1	0.444	1	0.037	uninformative
Lepidosperma laterale	1	0.444	1	0.173	uninformative
Poa meionectes	1	0.444	2	0.140	uninformative
Pratia purpurascens	1	0.444	1	0.103	uninformative
Dichelachne crinita	1	0.333	1	0.027	uninformative
Entolasia stricta	1	0.333	2	0.149	uninformative
Glycine clandestina	1	0.333	1	0.300	uninformative
Imperata cylindrica var *major*	3	0.333	2	0.061	uninformative
Melaleuca armillaris	4	0.333	2	0.002	uninformative
Poa poiformis	3	0.333	2	0.011	uninformative
Rhagodia candolleana ssp candolleana	1	0.333	2	0.004	uninformative
Senecio lautus ssp maritimus	1	0.333	2	0.000	uninformative
Zoysia macrantha	1	0.333	2	0.001	uninformative
Actites megalocarpa	1	0.222	2	0.001	uninformative
Arrhenechthites mixta	1	0.222	1	0.020	uninformative
Brachyloma daphnoides	1	0.222	1	0.097	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Dianella caerulea var *caerulea*	1	0.222	1	0.165	uninformative
Eucalyptus botryoides	2	0.222	3	0.027	uninformative
Gahnia radula	1	0.222	2	0.006	uninformative
Juncus continuus	1	0.222	1	0.003	uninformative
Macrozamia communis	2	0.222	2	0.063	uninformative
Opercularia aspera	1	0.222	1	0.037	uninformative
Pelargonium australe	1	0.222	1	0.004	uninformative
Spinifex sericeus	1	0.222	3	0.001	uninformative
Themeda australis	1	0.222	2	0.201	uninformative
Wahlenbergia gracilis	1	0.222	1	0.047	uninformative

Extant area (ha): 1897 (forest ecosystems 22 and 23 combined)

Pre-1750 area (ha): 2676

Geographic range: South Coast

How much conserved in reserves (ha): 583

Vulnerability: 3(C/R)

Reliability: 1

FE 22 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu16

Previous Survey Sites Represented: CSAU113

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None recorded

Dominant species: Canopy of coast banksia (*Banksia integrifolia*) and a shrub layer of *Leucopogon parviflorus, Acacia longifolia* ssp *sophorae* and *Rhagodia candolleana* The groundcover may include bracken (*Pteridium esculentum*), spiny matrush (*Lomandra longifolia),* grasses *Poa poiformis*, couch (*Cynodon dactylon*) or the very similar *Zoysia macrantha* and herbs including *Carpobrotus glaucescens, Oxalis rubens, Pratia purpurascens* and *Dianella caerulea*. The vine *Kennedia rubicunda* is typical, and occasionally *Muehlenbeckia adpressa* also occurs. Includes headland scrub which is dominated by *Allocasuarina verticillata* and *Melaleuca armillaris*, with shrubs *Alyxia buxifolia, Myoporum boninense* and *Rhagodia candolleana* with a groundcover of *Lomandra longifolia, Poa poiformis, Austrostipa stipoides* and the herb *Pelargonium australe.* Grades into Beach Strand Grassland dominated by coast wattle (*Acacia longifolia* ssp *sophorae*) on the foredunes (FE23).

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: occurs as a complex with FE23.

Conservation Significance: Significant because of their naturally limited extent, the protection they afford to beaches and dunes from wind erosion and on-shore sand creep into other vegetation.

Threats: Recreational pressure on sand dunes especially near towns and recreation areas, vulnerability to weed invasion, particularly by the noxious weed bitou bush (**Chrysanthemoides monilifera*) and bridal creeper (**Asparagus asparagoides*) and erosion by wind and waves.

Impacts of Fire Regimes: Dune and Headland Scrubs may burn in extreme conditions but this is likely to be a rare event.

Fire could be considered as a weed management method in stands which are infested with either bitou bush or bridal creeper, however, it could also help to destabilise the dunes by removing vegetation cover.

NON-FOREST ECOSYSTEM 23: Beach Strand Grassland

Southern CRA Profile Information

Description: Southern Coastal Dune Scrub complex

Southern Coastal Dune Scrub complex has a variable shrub and grass layer, made up of *Acacia sophoraea, Spinifex sericeus*, and *Banksia integrifolia*. The patchy ground cover includes *Isolepsis nodosa, Carex longebrachiata, Desmodium varians*, and *Carpobrotus glaucescens.*

It occurs from south of Kiama down to Wallaga Lake in moister dunes than forest ecosystem 22.

In the Eden Region Beach Strand Grassland (FE62) was separated from Coastal Scrub (FE61), the latter equivalent to FE22. Beach Strand Grassland occurs closer to the sea than Coastal Scrub. This seems a closer reflection of reality than the FE22/23 breakdown used in the Southern CRA.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Spinifex sericeus	3	1.000	1	0.001	positive
Acacia sophorae	5	0.750	2	0.006	positive
Actites megalocarpa	2	0.500	1	0.001	positive
Austrofestuca littoralis	2	0.500	2	0.003	positive
Calystegia soldanella	2	0.500	1	0.000	positive
Isolepis nodosa	3	0.500	2	0.006	positive
Leucopogon parviflorus	2	0.500	1	0.002	positive
Zoysia macrantha	2	0.500	2	0.001	positive
Banksia integrifolia ssp integrifolia	2	0.250	2	0.010	uninformative
Carex longebrachiata	2	0.250	2	0.025	uninformative
Carpobrotus glaucescens	3	0.250	1	0.001	uninformative
Desmodium varians	1	0.250	1	0.171	uninformative
Dianella longifolia var *longifolia*	1	0.250	1	0.017	uninformative
Dichelachne crinita	2	0.250	1	0.028	uninformative
Dichondra repens	2	0.250	2	0.207	uninformative
Monotoca elliptica	1	0.250	1	0.015	uninformative
Oxalis exilis	2	0.250	1	0.036	uninformative
Rhagodia candolleana ssp candolleana	1	0.250	2	0.005	uninformative
Viola hederacea	1	0.250	1	0.198	uninformative

Extant area (ha): 2348 (forest ecosystems 23 and 26 combined)

Pre-1750 area (ha): 3166

Geographic range: South Coast

How much conserved in reserves (ha): 711

Vulnerability: 4(R)

Reliability: 1

FE 23 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu17

Previous Survey Sites Represented: CSAU113

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None recorded.

Dominant species: Occurs on the upper parts of beaches and on foredunes, and is usually dominated by the grasses *Spinifex sericeus* and *Austrofestuca littoralis* and salt and dessication tolerant herbs including *Actites megalocarpa, Calystegia soldanella, Carpobrotus glaucescens* and the exotics **Hydrocotyle bonariensis* and **Cakile* spp. This grades via low wind-pruned coast wattle (*Acacia longifolia* ssp *sophorae*) into FE22.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: occurs as a complex with FE22.

Conservation Significance: Significant because of their naturally limited extent, the protection they afford to beaches and dunes from wind erosion and on-shore sand creep into other vegetation.

Threats: Recreational pressure on sand dunes especially near towns and recreation areas, vulnerability to weed invasion, particularly by the noxious weed bitou bush (**Chrysanthemoides monilifera*) and erosion by wind and waves.

Impacts of Fire Regimes: Beach Strand Grassland is unlikely to burn due to the high salt levels in many of the plants and its generally sparse cover.

FOREST ECOSYSTEM 24: Swamp Oak - Swamp Paperbark Forest

Southern CRA Profile Information

Description: Coastal Wet Heath Swamp Forest - *Casuarina glauca / Melaleuca ericifolia*

Coastal Wet Heath Swamp Forest is a low-medium forest up to 10 metres tall, dominated by *Casuarina glauca.* In the intermediate shrub layer *Melaleuca ericifolia* occurs along with *Myoporum acuminatum, Acacia longifolia* var *longifolia* and *Parsonsia straminea.* The ground cover is variable and includes *Gahnia clarkei, Baumea juncea,* and the herb *Viola hederacea.*

Coastal Wet Heath Swamp Forest is restricted to acid sulphate soils above semi saline flats along the edges and low lying tributaries of coastal lagoons. It occurs between Seven Mile Beach and Bermagui. Further to the south in the Eden CRA Region, Map Unit 63 (Keith and Bedward 1999) replaces this ecosystem.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Gahnia clarkei	4	1.000	2	0.019	positive
Casuarina glauca	3	0.833	3	0.007	positive
Viola hederacea	2	0.833	1	0.197	positive
Melaleuca ericifolia	4	0.667	3	0.006	positive
Myoporum acuminatum	3	0.667	0	0.000	positive
Parsonsia straminea	2	0.667	2	0.064	positive
Acacia longifolia	2	0.500	2	0.042	positive
Baumea juncea	4	0.500	3	0.001	positive
Lobelia alata	2	0.500	1	0.003	positive
Cladium procerum	5	0.167	0	0.000	positive
Ottelia ovalifolia	1	0.167	0	0.000	positive
Persicaria lapathifolia	1	0.167	0	0.000	positive
Stephania japonica var *discolor*	1	0.833	1	0.048	uninformative
Lomandra longifolia	1	0.500	2	0.417	uninformative
Juncus kraussii ssp australiensis	5	0.333	1	0.001	uninformative
Marsdenia rostrata	3	0.333	2	0.123	uninformative
Pteridium esculentum	3	0.333	2	0.308	uninformative
Baumea articulata	1	0.167	2	0.001	uninformative
Carex appressa	1	0.167	1	0.074	uninformative
Cassine australis var *australis*	3	0.167	2	0.005	uninformative
Centella asiatica	2	0.167	2	0.013	uninformative
Claoxylon australe	3	0.167	3	0.036	uninformative
Cyathea cooperi	3	0.167	2	0.001	uninformative
Desmodium brachypodum	1	0.167	1	0.017	uninformative
Eleocharis acuta	1	0.167	1	0.003	uninformative
Eucalyptus botryoides	5	0.167	3	0.027	uninformative
Eustrephus latifolius	1	0.167	1	0.145	uninformative
Ficus coronata	4	0.167	3	0.044	uninformative
Geitonoplesium cymosum	1	0.167	1	0.115	uninformative
Glochidion ferdinandi var *ferdinandi*	5	0.167	1	0.006	uninformative
Glycine clandestina	1	0.167	1	0.300	uninformative
Goodenia heterophylla ssp eglandulosa	2	0.167	1	0.003	uninformative
Hemarthria uncinata var *uncinata*	5	0.167	1	0.006	uninformative

Extant area (ha): 6241
Pre-1750 area (ha): 13293
Geographic range: South Coast
How much conserved in reserves (ha): 792
Vulnerability: 2(C/U)
Reliability: 2

FE 24 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu13

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None recorded.

Dominant species: Canopy species include *Casuarina glauca*, with lower canopy of swamp paperbark (*Melaleuca ericifolia)* and occasional *Myoporum acuminatum*. Groundcover can vary from dense stands of salt-tolerant sword-sedge (*Gahnia clarkei* or *G. sieberiana*) or other sedges and rushes such as *Baumea juncea* or *Juncus kraussii*, herbs *Lobelia alata, Apium prostratum, Leptinella longipes, Samolus repens* and *Selliera radicans* to bare ground. The rampant vine *Parsonsia straminea* may be present.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Closely associated with FE 25

Conservation Significance: Swamp forests dominated by *Casuarina glauca* (FE24 and 25) are regarded as being of high conservation significance in the region because they naturally occur in small fragmented stands around coastal lakes and in small coastal creeks, but do not extend upstream from the lakes or in other areas away from the lakes. The aggregate remaining area of them in the South Coast subregion was calculated to be low (about 10,000 ha in total for the two types). It appears from the results of this and earlier surveys that this figure may be considerably exaggerated and that they are much less common in the Ulladulla area than the previous CRA modelling suggested.

Threats: Generally vulnerable to clearing and urban development in non-reserved areas. An estimated 53% of FE 24 has been cleared. Possibly vulnerable to the effects of interference with natural lake opening regimes, since *Casuarina glauca* may be killed by prolonged flooding (J Miles, pers. obs.).

Impacts of Fire Regimes: Fire may have a severe impact on stands, changing their structure in the medium term. This and the related type FE25 can be highly flammable if they carry a dense groundcover of sedges, and if lake levels are low so that the ground is dry at the time of the fire. *Melaleuca ericifolia* would also be highly flammable, as least in young stands where there is uniform distribution of fine fuels from close to ground level to the crown. *Casuarina glauca* is not very flammable, but is readily killed by high-intensity fires. Understorey species, *Melaleuca ericifolia* and various sedges are well adapted to recovering from fire, re-sprouting rapidly from the roots. Under frequent fire regimes the understorey may be converted to very dense stands of small melaleuca stems. Fire frequency may in fact drive the distinction between FE24 and FE25, the latter developing only in less frequently burnt sites. Fire should be kept out of these communities as far as possible. If fuel reduction burns are being undertaken in eucalypt forest in the vicinity of this vegetation type, care needs to be taken not to allow the fires to escape into it.

FOREST ECOSYSTEM 25: Swamp Oak Forest

Southern CRA Profile Information

Description: South Coast Swamp Forest complex- *Casuarina glauca*

South Coast Swamp Forest complex is a medium dense forest up to 15 metres tall, dominated by *Casuarina glauca,* with *Acacia sophorae* and *Avicennia marina.* The ground cover is sparse with herbs and graminoids including *Commelina cyanea, Pratia purpurescens* and *Rhagodia candolleana* ssp*. candolleana.*

South Coast Swamp Forest complex occurs in less wet situations than vegetation type 24, in the upper reaches of major river estuaries and tributaries between Seven Mile Beach and Wallaga Lake.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Casuarina glauca	4	1.000	2	0.007	positive
Acacia sophorae	2	0.600	2	0.006	positive
Avicennia marina var *australasica*	3	0.400	0	0.000	positive
Apium prostratum ssp prostratum var *prostratum*	2	0.200	0	0.000	positive
Enchylaena tomentosa	2	0.200	0	0.000	positive
Lyperanthus suaveolens	1	0.200	0	0.000	positive
Solanum pungetium	1	0.600	1	0.055	uninformative
Commelina cyanea	2	0.400	1	0.012	uninformative
Dendrobium teretifolium	2	0.400	2	0.000	uninformative
Dichondra repens	2	0.400	2	0.207	uninformative
Pratia purpurascens	2	0.400	1	0.103	uninformative
Rhagodia candolleana ssp candolleana	3	0.400	2	0.004	uninformative
Samolus repens	2	0.400	1	0.001	uninformative
Sarcocornia quinqueflora ssp quinqueflora	2	0.400	2	0.001	uninformative
Suaeda australis	3	0.400	2	0.000	uninformative
Tetragonia tetragonoides	2	0.400	2	0.001	uninformative
Acacia mearnsii	1	0.200	2	0.060	uninformative
Acacia myrtifolia	1	0.200	2	0.004	uninformative
Acrotriche serrulata	1	0.200	1	0.073	uninformative
Allocasuarina verticillata	3	0.200	2	0.004	uninformative
Banksia integrifolia ssp integrifolia	4	0.200	2	0.010	uninformative
Banksia spinulosa var *spinulosa*	2	0.200	2	0.054	uninformative
Boronia polygalifolia	2	0.200	2	0.001	uninformative
Brachycome spathulata	1	0.200	1	0.066	uninformative
Breynia oblongifolia	2	0.200	1	0.087	uninformative
Cassytha glabella forma glabella	2	0.200	1	0.025	uninformative
Cheilanthes sieberi ssp sieberi	2	0.200	1	0.073	uninformative
Cryptostylis subulata	1	0.200	1	0.004	uninformative
Desmodium varians	2	0.200	1	0.171	uninformative
Einadia trigonos ssp trigonos	4	0.200	1	0.002	uninformative
Entolasia stricta	1	0.200	2	0.149	uninformative
Eucalyptus amplifolia ssp amplifolia	3	0.200	3	0.001	uninformative
Geitonoplesium cymosum	1	0.200	1	0.115	uninformative
Glycine clandestina	1	0.200	1	0.300	uninformative
Gonocarpus teucrioides	1	0.200	2	0.095	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Goodenia ovata	1	0.200	2	0.050	uninformative
Hibbertia aspera	3	0.200	2	0.071	uninformative
Hybanthus monopetalus	1	0.200	1	0.006	uninformative
Hypericum gramineum	1	0.200	1	0.172	uninformative
Hypoxis hygrometrica var *hygrometrica*	1	0.200	1	0.010	uninformative
Isolepis nodosa	2	0.200	2	0.006	uninformative
Juncus kraussii ssp australiensis	1	0.200	3	0.001	uninformative
Leptospermum continentale	1	0.200	2	0.012	uninformative
Lindsaea linearis	2	0.200	1	0.020	uninformative
Lobelia alata	1	0.200	1	0.004	uninformative
Lomandra longifolia	3	0.200	2	0.417	uninformative
Marsdenia rostrata	1	0.200	2	0.123	uninformative
Morinda jasminoides	2	0.200	3	0.097	uninformative

Extant area (ha): 3909

Pre-1750 area (ha): 18194

Geographic range: South Coast

How much conserved in reserves (ha): 648

Vulnerability: 1(C/W)

Reliability: 2

FE 25 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu15

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None recorded.

Dominant species: Swamp oak *Casuarina glauca* forms the canopy, with occasional *Myoporum acuminatum* and *Melaleuca ericifolia* forming a very open small tree layer. The vine *Parsonsia straminea* is often abundant. Shrub layer is generally absent or may consist of a patchy cover of the sprawling semi-woody herb *Rhagodia candolleana*, and the groundcover of salt tolerant species ranges from couch grass (*Cynodon dactylon*) in drier areas, to samphire (*Sarcocornia quinqueflora*) and *Baumea juncea* in wetter areas. The herbs listed above for FE24 are likely to occur and the large vine common silkpod (*Parsonsia straminea*) is very typical of FE25.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Closely associated with FE24

Conservation Significance: Swamp forests dominated by *Casuarina glauca* (FE24 and 25) are regarded as being of high conservation significance in the region because they naturally occur in small fragmented stands around coastal lakes and in small coastal creeks, but do not extend upstream from the lakes or in other areas away from the lakes. The aggregate remaining area of them in the South Coast sub-region was calculated to be low (about 10,000 ha in total for the two types). It appears from the results of this and earlier surveys that this figure may be considerably exaggerated and that they are much less common in the Ulladulla area than the previous CRA mapping suggested.

Threats: Generally vulnerable to clearing and urban development in non-reserved areas. An estimated 78.5% of FE 25 has been cleared, but because of errors in the mapping of this vegetation type, this figure is unreliable.. Possibly vulnerable to the effects of interference with natural lake opening regimes, since *Casuarina glauca* may be killed by prolonged flooding (J Miles, pers. obs.). Possibly vulnerable to weed infestation, although saline soils would protect against most weeds. However, sharp rush, **Juncus acutus* appears to represent a considerable threat in the South Coast Region..

Impacts of Fire Regimes: Fire may have a severe impact on stands, changing their structure in the medium term. This and the related type FE24 can be highly flammable if they carry a dense groundcover of sedges, and if lake levels are low so that the ground is dry at the time of the fire. *Casuarina glauca* is not very flammable, but is readily killed by high-intensity fires. Understorey species and various sedges are well adapted to recovering from fire, re-sprouting rapidly from the roots. Under frequent fire regimes the understorey may be converted to very dense stands of small melaleuca stems. Fire frequency may in fact drive the distinction between FE24 and FE25, the latter developing only in less frequently burnt sites. Fire should be kept out of these communities as far as possible. If fuel reduction burns are being undertaken in eucalypt forest in the vicinity of this vegetation type, care needs to be taken not to allow the fires to escape into it.

FOREST ECOSYSTEM 27: Ecotonal Swamp Forest

Southern CRA Profile Information

Description: Ecotonal Coastal Swamp Forest - *Casuarina glauca / E. botryoides*

Ecotonal Coastal Swamp Forest is a medium forest up to 20 metres tall, dominated by *Casuarina glauca*, with *E. botryoides.* The tall shrub layer is a variable mixture of *Banksia integrifolia and Acacia longifolia*

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Entolasia marginata	2	0.824	2	0.050	positive
Lomandra longifolia	2	0.824	2	0.415	positive
Oplismenus imbecillis	2	0.824	2	0.119	positive
Casuarina glauca	3	0.706	3	0.006	positive
Dichondra repens	2	0.647	2	0.205	positive
Echinopogon ovatus	2	0.647	1	0.108	positive
Banksia integrifolia ssp integrifolia	2	0.588	2	0.008	positive
Carex longebrachiata	2	0.588	2	0.023	positive
Desmodium varians	2	0.588	1	0.170	positive
Imperata cylindrica var *major*	2	0.588	2	0.060	positive
Acacia longifolia	2	0.529	2	0.041	positive
Breynia oblongifolia	2	0.529	1	0.085	positive
Commelina cyanea	2	0.529	1	0.010	positive
Glycine clandestina	2	0.529	1	0.299	positive
Isolepis nodosa	2	0.529	2	0.004	positive
Microlaena stipoides var *stipoides*	2	0.529	2	0.272	positive
Apium prostratum ssp prostratum var *filiforme*	3	0.059	0	0.000	positive
Dianella crinoides	2	0.059	0	0.000	positive
Myriophyllum simulans	5	0.059	0	0.000	positive
Parsonsia straminea	1	0.588	2	0.063	uninformative
Geranium potentilloides var *potentilloides*	2	0.471	2	0.068	uninformative
Pteridium esculentum	2	0.471	2	0.308	uninformative
Solanum pungetium	1	0.471	1	0.053	uninformative
Viola hederacea	2	0.471	1	0.197	uninformative
Dianella caerulea var *caerulea*	1	0.412	1	0.164	uninformative
Eucalyptus botryoides	4	0.412	2	0.025	uninformative
Marsdenia rostrata	1	0.412	2	0.122	uninformative
Pittosporum undulatum	2	0.412	2	0.090	uninformative
Pratia purpurascens	2	0.412	1	0.102	uninformative
Rubus parvifolius	2	0.412	1	0.111	uninformative
Stellaria flaccida	2	0.412	2	0.099	uninformative
Eustrephus latifolius	1	0.353	1	0.145	uninformative
Kennedia rubicunda	2	0.353	1	0.037	uninformative
Pittosporum revolutum	2	0.353	1	0.071	uninformative
Senecio linearifolius	1	0.353	1	0.075	uninformative
Themeda australis	2	0.353	2	0.200	uninformative
Melaleuca ericifolia	4	0.294	3	0.006	uninformative
Monotoca elliptica	1	0.294	1	0.014	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Oxalis exilis	2	0.294	1	0.035	uninformative
Solanum stelligerum	2	0.294	1	0.005	uninformative
Stephania japonica var *discolor*	2	0.294	1	0.048	uninformative
Acacia sophorae	2	0.235	2	0.006	uninformative
Centella asiatica	2	0.235	2	0.012	uninformative
Cynodon dactylon	2	0.235	2	0.009	uninformative
Entolasia stricta	2	0.235	2	0.149	uninformative
Eucalyptus tereticornis	3	0.235	3	0.020	uninformative
Geitonoplesium cymosum	2	0.235	1	0.115	uninformative
Hibbertia aspera	2	0.235	2	0.071	uninformative
Hibbertia scandens	2	0.235	1	0.031	uninformative
Rhagodia candolleana ssp candolleana	2	0.235	2	0.004	uninformative

Extant area (ha): 343

Pre-1750 area (ha): 9841

Geographic range: South Coast

How much conserved in reserves (ha): 20

Vulnerability: 1(C)

Reliability: 3

FE 27 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: CONJM03F

Marginal Sites: None

Species Recorded at Representative Sites:

Acacia longifolia ssp *longifolia*
Acacia ulicifolia
Arthropodium sp.
Austrostipa sp.
Banksia integrifolia
Baumea juncea
Billardiera scandens var *scandens*
Boronia polygalifolia
Breynia oblongifolia
Cassytha glabella
Casuarina glauca
Centella asiatica
Chrysanthemoides monilifera ssp *rotundata**
Clematis aristata
Corymbia gummifera
Cymbopogon refractus
Dianella caerulea
Dichondra repens
Digitaria sp.
Dodonaea triquetra
Echinopogon caespitosus
Echinopogon ovatus
Entolasia stricta
Eucalyptus botryoides
Eucalyptus sclerophylla
Euchiton gymnocephalus
Exocarpos strictus
Gahnia clarkei
Glycine clandestina
Gonocarpus teucrioides
Hakea sericea
Hardenbergia violacea
Hibbertia linearis
Hibbertia scandens
Hydrocotyle acutiloba
Hydrocotyle geraniifolia
*Hypochaeris radicata**
Imperata cylindrica var *major*
Kennedia rubicunda
Lagenifera gracilis
Lepidosperma laterale
Leptospermum polygalifolium ssp *polygalifolium*
Leucopogon lanceolatus
Lomandra longifolia
Microlaena stipoides var *stipoides*
Notelaea venosa
Opercularia aspera
Opercularia varia
Oplismenus imbecillis
Oxalis sp.
Panicum simile
Patersonia glabrata
Persoonia linearis
Pimelea linifolia ssp *linifolia*
Poa poiformis
Polymeria calycina
Poranthera microphylla
Pratia purpurascens
Prostanthera incisa
Pteridium esculentum
Pterostylis longifolia
Senecio hispidulus var *hispidulus*
Solanum pungetium
Themeda australis
Veronica plebeia
Viola hederacea
Wahlenbergia gracilis
Wahlenbergia multicaulis
Xanthorrhoea concava
Xanthosia tridentata

Dominant species: As an ecotonal type this community could be expected to contain elements of either or both of FE25 and FE28. This would include a canopy of Swamp oak *Casuarina glauca* and/or Bangalay (*E. botryoides)*, a sub-canopy of occasional *Myoporum acuminatum* and *Melaleuca ericifolia* and/or saw banksia (*Banksia serrata.* Typical shrubs occurring in FE28 are *Acacia longifolia* ssp *sophorae* or *A. longifolia* ssp *longifolia* and *Monotoca elliptica*. Burrawangs (*Macrozamia communis*) may be present and groundcover of bracken plus various grasses and herbs found in FE28.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: This community is intermediate between Coastal Sands Bangalay - Banksia Forest (FE28) and Swamp Oak Forest (FE25)

Conservation Significance: Swamp forests dominated by *Casuarina glauca* (FE24 and 25) are regarded as being of high conservation significance as detailed in the profile for FE25. Similarly, FE28 is considered to be at least of moderate conservation significance, therefore the overall significance of this ecotonal type is probably high. It has been mapped at only one location within the study area.

Threats: Generally vulnerable to clearing and urban development in non-reserved areas. Stands are also vulnerable to recreational pressure. Possibly vulnerable to the effects of interference with natural lake opening regimes, since *Casuarina glauca* may be killed by prolonged flooding (J Miles, pers. obs.). Possibly vulnerable to weed infestation in areas close to coastal villages, such as Swanhaven and may also be targeted for frequent hazard-reduction burning to protect these villages.

Impacts of Fire Regimes: Fire may have a severe impact on stands, changing their structure in the medium term. The related type FE25 can be highly flammable if it carries a dense groundcover of sedges, and if lake levels are low so that the ground is dry at the time of the fire. *Casuarina glauca* is not very flammable, but is readily killed by high-intensity fires. Therefore, fire should be kept out of communities in which it occurs as far as possible. The understorey is generally well adapted to regular fire but some shrubs which are relatively slow growing and not capable of resprouting are likely to be lost from frequently burnt stands, as may some other obligate seeders such as wattles, depending on the fire frequency. Occasional fires may help reduce the impact of weeds around villages, although there would need to be post-fire monitoring for weed seedlings, since the creation of bare ground and temporary nutrient boost from a fire may also encourage the germination of rapidly growing weeds which may be able to out-compete natives in some situations.

FOREST ECOSYSTEM 28: Coastal Sands Bangalay - Banksia Forest

Southern CRA Profile Information

Description: Coastal Sands Shrub/Fern Forest - *E. botryoides / Banksia serrata*

Coastal Sands Shrub/Fern Forest is a low to tall forest dominated by *E. botryoides.* It has an understorey of *Banksia serrata, Monotoca elliptica, Allocasuarina littoralis, Breynia oblongifolia*, and *Acacia longifolia.* The ground cover is predominantly bracken *Pteridium esculentum,* grasses and graminoids *Imperata cylindrica* and *Lomandra longifolia,* intermixed with herbs and twiners, such as *Gonocarpus teucrioides, Glycine clandestina,* and *Viola hederacea.*

This forest ecosystem is mainly confined to sandy soils adjoining bays, estuaries, and lagoons in Jervis Bay, Clyde, and Moruya areas.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Pteridium esculentum	3	0.933	2	0.306	positive
Lomandra longifolia	3	0.867	2	0.415	positive
Eucalyptus botryoides	4	0.800	2	0.024	positive
Banksia serrata	3	0.667	3	0.015	positive
Imperata cylindrica var *major*	2	0.667	2	0.060	positive
Monotoca elliptica	2	0.600	1	0.013	positive
Allocasuarina littoralis	3	0.533	2	0.101	positive
Banksia integrifolia ssp integrifolia	3	0.533	2	0.008	positive
Marsdenia rostrata	2	0.533	2	0.122	positive
Cyperus laevigatus	2	0.133	0	0.000	positive
Pterostylis curta	1	0.067	0	0.000	positive
Pterostylis grandiflora	1	0.067	0	0.000	positive
Gonocarpus teucrioides	1	0.533	2	0.093	uninformative
Acacia longifolia	2	0.467	2	0.041	uninformative
Glycine clandestina	1	0.467	1	0.299	uninformative
Stephania japonica var *discolor*	1	0.467	1	0.048	uninformative
Breynia oblongifolia	1	0.400	1	0.086	uninformative
Hibbertia scandens	2	0.400	1	0.030	uninformative
Lagenifera stipitata	1	0.400	1	0.166	uninformative
Lepidosperma concavum	4	0.400	2	0.009	uninformative
Themeda australis	1	0.400	2	0.200	uninformative
Viola hederacea	2	0.400	1	0.198	uninformative
Desmodium var *ians*	2	0.333	1	0.171	uninformative
Eucalyptus pilularis	3	0.333	3	0.029	uninformative
Hibbertia obtusifolia	1	0.333	1	0.212	uninformative
Macrozamia communis	3	0.333	2	0.062	uninformative
Pratia purpurascens	1	0.333	1	0.103	uninformative
Schelhammera undulata	1	0.333	1	0.083	uninformative
Desmodium brachypodum	1	0.267	1	0.016	uninformative
Dianella caerulea var *caerulea*	1	0.267	1	0.165	uninformative
Dichondra repens	1	0.267	2	0.207	uninformative
Echinopogon caespitosus var *caespitosus*	1	0.267	1	0.024	uninformative
Microlaena stipoides var *stipoides*	2	0.267	2	0.273	uninformative
Oplismenus imbecillis	2	0.267	2	0.121	uninformative
Pittosporum undulatum	2	0.267	2	0.091	uninformative
Synoum glandulosum	4	0.267	2	0.080	uninformative
Acacia maidenii	2	0.200	1	0.010	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Acacia ulicifolia	1	0.200	1	0.030	uninformative
Acianthus fornicatus	1	0.200	2	0.006	uninformative
Cissus hypoglauca	3	0.200	2	0.105	uninformative
Eustrephus latifolius	1	0.200	1	0.145	uninformative
Hibbertia aspera	1	0.200	2	0.071	uninformative
Isolepis nodosa	1	0.200	2	0.006	uninformative

Extant area (ha): 3117

Pre-1750 area (ha): 3568

Geographic range: South Coast

How much conserved in reserves (ha): 244

Vulnerability: 3(C/R)

Reliability: 3

FE 28 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu5

Previous Survey Sites Represented: CSAU112, KMCU23

Conjola-Morton 2003 Sites Represented: None

Marginal Sites: None

Species Recorded at Representative Sites: None recorded.

Dominant species: Canopy of Bangalay (*E. botryoides*); saw banksia (*Banksia serrata*) forms a sub-canopy. Typical shrubs are *Acacia longifolia* ssp *sophorae* or *A. longifolia* ssp *longifolia* and *Monotoca elliptica*. Burrawangs (*Macrozamia communis*) may be present or even dominant. Bracken is the dominant groundcover species, with *Lomandra longifolia*, grasses, blady grass (*Imperata cylindrica*) and kangaroo grass (*Themeda triandra*) and herbs *Schelhammera undulata, Desmodium gunnii, Dianella caerulea, Gonocarpus teucrioides* and *Viola hederacea*.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Often forms a band bordered by FE22/23 along the dunes and FE139 or FE2 inland.

Conservation Significance: Usually restricted distribution on sand deposits behind beaches, and around the mouths of coastal lakes. At least of moderate conservation significance because it is a naturally fragmented ecosystem of limited distribution in the region which is coming under increasing pressure outside reserves for urban development. It is substantially less widely distributed than previously thought, having been over-mapped during the Southern and Eden CRAs.

Threats: Subject to residential development pressure in un-reserved areas, being flat and close to the sea. Stands are also vulnerable to recreational pressure, and to invasion by bitou bush, and in areas close to coastal villages, by other weeds. May also be targeted for frequent hazard-reduction burning to protect coastal villages.

Impacts of Fire Regimes: The understorey, dominated by bracken, is generally well adapted to regular fire. Some shrubs which are relatively slow growing and not capable of resprouting, such as *Monotoca elliptica*, are likely to be lost from frequently burnt stands, as may some other obligate seeders such as wattles, depending on the fire frequency. Even relatively fire-tolerant re-sprouters such as *Banksia serrata* may be lost from frequently burnt stands over a longer time-frame, since juvenile plants may take up to ten years to become fire-tolerant. Occasional fires may help reduce the impact of weeds around villages, although there would need to be post-fire monitoring for weed seedlings, since the creation of bare ground and temporary nutrient boost from a fire may also encourage the germination of rapidly growing weeds such as bridal creeper (**Asparagus asparagoides*), which may be able to out-compete natives in some situations. Given a long absence of fire, FE28 can begin to develop a rainforest understorey, but it is doubtful that the fire-free period could be maintained for long enough for mature littoral rainforest to develop, unless there is some topographic feature that provides additional protection.

FOREST ECOSYSTEM 29: Coastal Sands Blackbut - Banksia Forest

Southern CRA Profile Information

Description: Northern Coastal Sands Shrub/Fern Forest - *E. pilularis / Banksia serrata*

Northern Coastal Sands Shrub/Fern Forest is a forest dominated by *E. pilularis,* with *Coyrymbia gummifera,* with some occasional patches of *Syncarpia glomulifera.* The shrub/small tree layer usually comprises *Elaeocarpus reticulatus, Banksia serrata, Monotoca elliptica,* and *Acacia longifolia.* Ground cover is mainly sedges *Lomandra longifolia* and *Lepidopserma laterale,* with the grass *Entolasia stricta,* and herbs *Dianella caerulea* var *caerulea* and *Patersonia glabrata.*

This forest ecosystem is mainly found in the low foothills behind Jervis Bay and Ulladulla. It occurs on moderately deep silty loam, derived from Permian mudstones at elevations below 100 metres. Some smaller outliers of this map unit are found further south towards Batemans Bay.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Lomandra longifolia	3	1.000	2	0.415	positive
Pteridium esculentum	3	0.923	2	0.306	positive
Eucalyptus pilularis	4	0.769	3	0.027	positive
Gonocarpus teucrioides	2	0.769	2	0.092	positive
Elaeocarpus reticulatus	2	0.692	1	0.102	positive
Banksia serrata	3	0.615	3	0.016	positive
Monotoca elliptica	2	0.615	1	0.013	positive
Corymbia gummifera	3	0.539	3	0.050	positive
Lepidosperma laterale	4	0.539	1	0.172	positive
Caladenia alata	1	0.077	0	0.000	positive
Leucopogon lanceolatus var *lanceolatus*	1	0.615	1	0.168	uninformative
Entolasia stricta	2	0.462	2	0.148	uninformative
Hardenbergia violacea	1	0.462	1	0.159	uninformative
Hibbertia scandens	1	0.462	1	0.030	uninformative
Acacia longifolia	2	0.385	2	0.042	uninformative
Dianella caerulea var *caerulea*	1	0.385	1	0.165	uninformative
Patersonia glabrata	2	0.385	2	0.041	uninformative
Persoonia linearis	1	0.385	1	0.182	uninformative
Allocasuarina littoralis	4	0.308	2	0.102	uninformative
Gahnia sieberiana	3	0.308	2	0.020	uninformative
Hibbertia linearis	1	0.308	1	0.004	uninformative
Smilax australis	1	0.308	2	0.147	uninformative
Syncarpia glomulifera	4	0.308	3	0.022	uninformative
Acacia suaveolens	1	0.231	1	0.011	uninformative
Anisopogon avenaceus	2	0.231	2	0.011	uninformative
Breynia oblongifolia	1	0.231	1	0.087	uninformative
Cissus hypoglauca	2	0.231	2	0.105	uninformative
Imperata cylindrica var *major*	2	0.231	2	0.061	uninformative
Pimelea linifolia ssp linifolia	1	0.231	1	0.059	uninformative
Schelhammera undulata	1	0.231	1	0.084	uninformative
Synoum glandulosum	2	0.231	2	0.080	uninformative
Zieria arborescens ssp arborescens	2	0.231	2	0.005	uninformative
Acacia ulicifolia	2	0.154	1	0.031	uninformative
Acianthus fornicatus	1	0.154	1	0.006	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Angophora floribunda	3	0.154	1	0.073	uninformative
Aotus ericoides	2	0.154	2	0.015	uninformative
Banksia ericifolia var *ericifolia*	2	0.154	3	0.015	uninformative
Banksia integrifolia ssp integrifolia	2	0.154	2	0.010	uninformative
Bossiaea heterophylla	1	0.154	1	0.011	uninformative
Caustis flexuosa	2	0.154	2	0.013	uninformative
Dampiera stricta	2	0.154	1	0.012	uninformative
Dianella caerulea var *producta*	1	0.154	1	0.001	uninformative
Endiandra sieberi	3	0.154	2	0.005	uninformative
Entolasia marginata	2	0.154	2	0.053	uninformative
Eucalyptus botryoides	2	0.154	3	0.027	uninformative
Eucalyptus piperita	4	0.154	3	0.020	uninformative
Eucalyptus sclerophylla	5	0.154	3	0.009	uninformative

Extant area (ha): 13245

Pre-1750 area (ha): 16948

Geographic range: South Coast Vulnerability: 3(C/U)

How much conserved in reserves (ha): 2920 Reliability: 3

FE 29 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu4

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: None but field checked at its mapped location in Conjola NP.

Marginal Sites: None

Species Recorded at Representative Sites: None recorded.

Dominant species: Blackbutt (*E. pilularis*) is the dominant tree, but it may be joined by many other species such as red bloodwood (*Corymbia gummifera*); *Banksia serrata* is often present as a small tree layer. The understorey is transitional between FE28 and FE2 and may include *Acacia longifolia* ssp *sophorae* or ssp *longifolia* and burrawangs (*Macrozamia communis*) along with tussock plants such as *Lomandra longifolia* and *Lepidosperma laterale*, bracken and grasses.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Similar to FE 28 with which FE29 is transitional. It also merges with FE2 and in Narrawallee Creek Nature Reserve with FE175.

Conservation Significance: Poorly represented in Conjola, not present in Morton but more extensive in Narrawallee Creek Nature Reserve. Has a naturally limited and fragmented distribution in the region. There has been a probable overestimation of its true extent in previous mapping and pressure from coastal development, may raise the conservation significance of this vegetation type to at least a moderate level.

Threats: Clearing and urban development in un-reserved areas. Stands are also vulnerable to recreational pressure.

Impacts of Fire Regimes: Like FE28, the understorey, dominated by Bracken is generally well adapted to regular fire. Some shrubs which are relatively slow growing and not capable of resprouting, such as *Monotoca elliptica*, are likely to be lost from frequently burnt stands, as may some other obligate seeders such as wattles, depending on the fire frequency. Even relatively fire-tolerant re-sprouters such as *Banksia serrata* may be lost from frequently burnt stands over a longer time-frame, since juvenile plants may take up to ten years to become fire-tolerant.

FOREST ECOSYSTEM 137: Coastal Escarpment Moist Shrub/Fern Forest

Southern CRA Profile Information

Description: Coastal Escarpment Moist Shrub/Fern Forest - *E. sieberi / E. piperita / Gleichenia dicarpa*

Coastal Escarpment Moist Shrub/Fern Forest is a medium to tall forest up to 25 metres tall, co-dominated by *Eucalyptus sieberi* and *Eucalyptus piperita*. The understorey is an open cover of shrubs *Acacia obtusifolia, Leptospermum trinervium, Banksia paludosa*, *Playsace lanceolata, Amperea xiphoclada* and *Leptomeria acida*. The ground cover is a dense mat of *Gleichenia dicarpa*, with scattered *Gahnia sieberiana*, and a sparse low herbaceous/graminoid layer including *Gonocarpus teucrioides*.

Coastal Escarpment Moist Shrub/Fern Forest occurs in three discrete patches on the edge of the sandstone escarpment in Monga State Forest and Budawang National Park, the eastern Morton plateau in the Upper Clyde catchment, and along the northern escarpment from Fitzroy Falls to Budderoo National Park. It usually occurs between 500 and 800 metres in elevation on partially impeded clay soils derived from Permian mudstones.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Acacia obtusifolia	3	1.000	2	0.088	positive
Gleichenia dicarpa	5	0.727	2	0.008	positive
Leptospermum trinervium	2	0.727	2	0.028	positive
Banksia paludosa	2	0.636	2	0.012	positive
Eucalyptus piperita	3	0.636	3	0.019	positive
Eucalyptus sieberi	3	0.636	3	0.108	positive
Gahnia sieberiana	2	0.636	2	0.019	positive
Tetratheca thymifolia	2	0.636	2	0.055	positive
Aotus ericoides	2	0.546	1	0.014	positive
Lepironia articulata	1	0.091	0	0.000	positive
Leucopogon amplexicaulis	1	0.091	0	0.000	positive
Platysace lanceolata	1	0.727	2	0.120	uninformative
Amperea xiphoclada var *xiphoclada*	1	0.636	1	0.035	uninformative
Lomandra longifolia	1	0.636	2	0.416	uninformative
Banksia spinulosa var *spinulosa*	1	0.546	2	0.053	uninformative
Pteridium esculentum	1	0.546	2	0.308	uninformative
Dianella caerulea var *caerulea*	1	0.455	1	0.164	uninformative
Entolasia stricta	2	0.455	2	0.149	uninformative
Gonocarpus tetragynus	1	0.455	1	0.297	uninformative
Gonocarpus teucrioides	2	0.455	2	0.094	uninformative
Leptomeria acida	1	0.455	1	0.015	uninformative
Leptospermum polygalifolium ssp polygalifolium	2	0.455	2	0.025	uninformative
Lindsaea linearis	1	0.455	1	0.019	uninformative
Pultenaea daphnoides	1	0.455	1	0.021	uninformative
Corymbia gummifera	3	0.364	3	0.050	uninformative
Empodisma minus	2	0.364	3	0.019	uninformative
Phyllota phylicoides	2	0.364	2	0.007	uninformative
Acacia elongata var *elongata*	1	0.273	1	0.005	uninformative
Banksia ericifolia var *ericifolia*	1	0.273	3	0.015	uninformative
Bauera rubioides	2	0.273	2	0.004	uninformative
Billardiera scandens var *scandens*	1	0.273	1	0.136	uninformative
Cassytha pubescens	1	0.273	1	0.035	uninformative
Cyathochaeta diandra	2	0.273	2	0.006	uninformative
Epacris impressa	2	0.273	2	0.011	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Eucalyptus radiata ssp radiata	1	0.273	3	0.065	uninformative
Lambertia formosa	1	0.273	2	0.011	uninformative
Lepidosperma laterale	1	0.273	1	0.173	uninformative
Persoonia linearis	1	0.273	1	0.182	uninformative
Persoonia mollis ssp budawangensis	1	0.273	2	0.001	uninformative
Persoonia mollis ssp caleyi	3	0.273	1	0.008	uninformative
Schoenus melanostachys	3	0.273	1	0.005	uninformative
Viola hederacea	1	0.273	1	0.198	uninformative

Extant area (ha): 14461

Pre-1750 area (ha): 15345

Geographic range: South Coast

How much conserved in reserves (ha): 8996

Vulnerability: 5 Reliability: 3

FE 137 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: None

Marginal Sites : None

Species Recorded at Representative Sites: None recorded.

Dominant species: Silvertop ash (*E. sieberi*) and Sydney peppermint (*E. piperita*) are canopy dominants with the shrubs or small trees *Acacia obtusifolia, Banksia spinulosa* and *Leptospermum trinervium* commonly present. Dense stands of coral fern (*Gleichenia dicarpa*) are diagnostic of this community,

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Mapped adjacent to FE3 and may adjoin FE20 along moist gullies.

Conservation Significance: Not present in Conjola and presence in Morton (East) could not be confirmed although mapped during the Southern CRA. FE137 is stated by Thomas, Gellie and Harrison (2000) to be reasonably widely distributed over three discrete patches in Monga and the Budawangs, the eastern Morton plateau and the Fitzroy Falls to Budderoo National Park area. It is well reserved.

Threats: Clearing and logging in un-reserved areas.

Impacts of Fire Regimes: The list of diagnostic species suggests that this community would be well adapted to reasonably frequent fires, with many re-sprouters. The range of 7-30 years suggested for shrubby dry sclerophyll forests (NPWS 2003) would be appropriate.

FOREST ECOSYSTEM 139: Scribbly Gum - Red Bloodwood Heathy Woodland

Southern CRA Profile Information

Description: Northern Coastal Hinterland Heath Shrub Dry Forest - *C. gummifera / E. sclerophylla*

This vegetation type comprises mainly medium to low forest dominated by Scribbly Gum (*Eucalyptus sclerophylla*) with Red Bloodwood (*Corymbia gummifera)* usually present as a subdominant. It has a moderately dense heathy shrub layer dominated by sandstone broad-leaved Hakea (*Hakea dactyloides)*, the Banksias (*Banksia paludosa* and *B.spinulosa)*, *Lambertia formosa,* and Rough-barked Tea-tree *(Leptospermum trinervium)*. The groundcover comprises *Lepyrodia scariosa* and *Entolasia stricta.*

This ecosystem is distributed on shallow podzolic soils on flat plateaux and low lying coastal areas from Jervis Bay down to Ulladulla. Small amounts have been cleared around Jervis Bay, although much of it is reserved within Morton National Park.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Hakea dactyloides	2	0.913	2	0.026	positive
Leptospermum trinervium	3	0.870	2	0.024	positive
Patersonia sericea	2	0.870	1	0.026	positive
Banksia spinulosa var *spinulosa*	2	0.783	2	0.050	positive
Persoonia mollis ssp leptophylla	2	0.739	1	0.005	positive
Lambertia formosa	2	0.696	2	0.007	positive
Banksia paludosa	2	0.652	2	0.009	positive
Corymbia gummifera	3	0.652	3	0.048	positive
Eucalyptus sclerophylla	2	0.652	3	0.005	positive
Lepyrodia scariosa	2	0.609	2	0.005	positive
Petrophile sessilis	2	0.609	2	0.005	positive
Entolasia stricta	2	0.565	2	0.147	positive
Banksia ericifolia var *ericifolia*	3	0.522	3	0.013	positive
Hakea teretifolia	2	0.522	2	0.006	positive
Baeckea diosmifolia	1	0.261	0	0.000	positive
Baeckea brevifolia	2	0.130	0	0.000	positive
Billardiera scandens var *sericata*	1	0.087	0	0.000	positive
Pultenaea paleacea var *paleacea*	2	0.087	0	0.000	positive
Sphaerolobium minus	2	0.087	0	0.000	positive
Boronia thujona	3	0.043	0	0.000	positive
Dampiera scottiana	2	0.043	0	0.000	positive
Eriostemon buxifolius ssp obovatus	1	0.043	0	0.000	positive
Eriostemon scaber ssp latifolius	2	0.043	0	0.000	positive
Eucalyptus multicaulis	1	0.043	0	0.000	positive
Grevillea baueri ssp asperula	1	0.043	0	0.000	positive
Grevillea linearifolia (Southern Sandstone form)	1	0.043	0	0.000	positive
Hibbertia cistiflora	1	0.043	0	0.000	positive
Leucopogon appressus	1	0.043	0	0.000	positive
Xyris Unknown	3	0.043	0	0.000	positive
Lomatia ilicifolia	1	0.826	1	0.039	uninformative
Persoonia levis	1	0.696	1	0.015	uninformative
Cassytha glabella forma glabella	1	0.609	1	0.022	uninformative
Lomandra obliqua	1	0.609	1	0.031	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Lindsaea linearis	1	0.565	1	0.017	uninformative
Pimelea linifolia ssp linifolia	1	0.565	1	0.056	uninformative
Isopogon anemonifolius	1	0.522	1	0.011	uninformative
Dampiera stricta	1	0.478	1	0.010	uninformative
Epacris microphylla var *microphylla*	2	0.478	2	0.023	uninformative
Leptospermum polygalifolium ssp polygalifolium	2	0.478	2	0.024	uninformative
Mitrasacme polymorpha	1	0.478	1	0.004	uninformative
Xanthorrhoea concava	1	0.478	1	0.023	uninformative
Actinotus minor	2	0.435	1	0.007	uninformative
Aotus ericoides	2	0.435	2	0.013	uninformative
Bossiaea heterophylla	2	0.435	1	0.009	uninformative
Cyathochaeta diandra	3	0.435	2	0.005	uninformative
Eucalyptus consideniana	3	0.391	3	0.015	uninformative
Eucalyptus obstans	2	0.217	2	0.001	uninformative
Eucalyptus mannifera	2	0.174	3	0.058	uninformative

Extant area (ha): 48899 How much conserved in reserves (ha): 15383 Sth Coast and 35 Northern

Pre-1750 area (ha): 51050 Vulnerability: 5 in South Coast

Geographic range: South Coast and Northern Reliability: 2

FE 139 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu 7, 9, 10, 11, 12 or 12

Previous Survey Sites Represented: CS_AU100, CS_AU108, CS_AU119, CS_AU99, KMCO14, KMCU12, KMCU17, KMCU2, KMCU3, KMCU5, KMCU8, SZ24224L, SZ24225U

Conjola-Morton 2003 Sites Represented : CONJM1F, CONJM4F, CONJM5 and CONJM8F.

Marginal Sites : None

Species Recorded at Representative Sites:

Acacia obtusifolia
Acacia suaveolens
Acacia ulicifolia
Actinotus minor
Allocasuarina paludosa
Amperea xiphoclada
Amperea xiphoclada var *xiphoclada*
Anisopogon avenaceus
Aotus ericoides
Austrostipa spp.
Banksia ericifolia
Banksia paludosa
Banksia serrata
Banksia spinulosa var *spinulosa*
Billardiera scandens var *scandens*
Blandfordia nobilis
Bossiaea ensata
Bossiaea heterophylla
Bossiaea obcordata
Brunoniella pumilio
Burchardia umbellata
Caesia parviflora var *parviflora*
Callistemon linearis
Calochilus campestris
Calochilus paludosus
Cassytha glabella
Cassytha glabella forma glabella
Caustis flexuosa
Ceratopetalum gummiferum
Comesperma ericinum
Conospermum taxifolium
Corymbia gummifera
Cryptandra ericoides
Cryptostylis spp.
Cryptostylis subulata
Cyathochaeta diandra
Dampiera stricta
Dillwynia phylicoides
Dillwynia retorta
Diuris aurea
Drosera peltata
Entolasia stricta
Epacris microphylla var *microphylla*
Epacris spp.
Eragrostis spp.
Eucalyptus consideniana
Eucalyptus sclerophylla
Eucalyptus sieberi
Genoplesium spp.
Gompholobium glabratum
Gompholobium pinnatum
Gonocarpus tetragynus
Goodenia bellidifolia ssp *bellidifolia*
Haemodorum corymbosum
Hakea laevipes ssp *laevipes*
Hakea sericea
Hakea teretifolia
Hibbertia riparia
Hovea heterophylla
Hovea linearis
Hybanthus vernonii ssp *scaber*
Hypericum gramineum
Isopogon anemonifolius
Kunzea capitata
Lambertia formosa
Lepidosperma filiforme
Lepidosperma laterale
Leptospermum continentale
Leptospermum trinervium
Lepyrodia muelleri
Lepyrodia scariosa
Leucopogon esquamatus
Lindsaea linearis
Lomandra filiformis ssp *filiformis*
Lomandra glauca
Lomandra longifolia
Lomandra multiflora
Lomandra obliqua
Lomatia ilicifolia
Melaleuca thymifolia
Micrantheum ericoides
Mirbelia rubiifolia
Mitrasacme polymorpha
Monotoca scoparia
Opercularia varia
Panicum simile
Patersonia sericea
Persoonia laurina
Persoonia levis
Petrophile pedunculata
Petrophile sessilis
Phyllota phylicoides
Pimelea linifolia ssp *linifolia*
Poranthera ericifolia
Prasophyllum spp.
Ptilothrix deusta
Pultenaea rosmarinifolia
Schoenus lepidosperma ssp *pachylepis*
Sphaerolobium minus
Stylidium spp.
Syncarpia glomulifera
Tetrarrhena juncea

Tetratheca thymifolia	*Thysanotus juncifolius*	*Xanthorrhoea concava*
Thelymitra media var *media*	*Trachymene incisa*	*Xanthosia tridentata*
Themeda australis	*Xanthorrhoea australis*	

Dominant species: Scribbly gum (*E. sclerophylla*) and red bloodwood usually form the canopy, though they may be joined by *E. consideniana* or *E. sieberi* with *E. botryoides* closer to the coast. The canopy may be missing altogether in some areas (see FE 139h). A small tree layer may include *Allocasuarina littoralis, Leptospermum trinervium* or occasionally banksias if close to the sea. The shrubby understorey contains typical "Sydney sandstone" elements such as *Lambertia formosa, Hakea dactyloides, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Isopogon anemonifolius* and *Kunzea capitata.* The groundcover consists of mixed sedges(including *Lepyrodia scariosa* and *Xyris* spp.), grasses (*Entolasia stricta, Austrostipa pubescens, Anisopogon avenaceus*), the fern *Lindsaea linearis* and subshrubs such as *Gompholobium pinnatum, Boronia polygalifolia* and *Xanthosia tridentata.* The small flannel-flower, *Actinotus minor* scrambles through the groundcover.

Threatened Species: Habitat for the orchid *Cryptostylis hunteriana*, listed as Vulnerable under the *Threatened Species Conservation Act*. This species has been recorded in Conjola NP. Also recorded is *Grevillea macleayana* (ROTAP).

Other Species of Conservation Significance: *Diuris aurea*, was found in coastal FE139 in Conjola (at site COJM01F) and is at its southern limit in the region. *Mirbelia rubiifolia* was recorded in Conjola, being restricted to heathlands mainly north of Ulladulla and at Nadgee Nature Reserve on the Far South Coast. Other species included *Persoonia mollis* ssp *caleyi* and *Pultenaea rosmarinifolia*.

Relationship to other Forest Ecosystems: A heath with similar species composition but lacking the tree canopy is described as FE 139H.

Conservation Significance: Well represented in Conjola and Morton (East). FE139 was not identified as an ecosystem of high conservation significance in the region, but it probably should be. Although this type of vegetation is very extensive in the Sydney basin, and is well reserved in the region in Morton National Park, it is at its southern limit of distribution around Ulladulla. Many of the component species, such as *Eucalyptus sclerophylla, Lambertia formosa, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Kunzea capitata, Epacris pulchella* and *Actinotus minor* are also at or very close to their southern limit which is possibly in or near Barnunj SRA and Meroo National Park, south of Ulladulla.

Threats: Fire (see below)

Impacts of Fire Regimes: Such heathy vegetation is adapted to relatively frequent fire, but too short an interval between fires may eliminate obligate seeders, which are killed by fire rather than re-sprouting, from the species mix. Re-sprouting shrubs can also be eliminated over a longer period if frequent fires do not allow sufficient time to replenish seed banks, and if more fire-sensitive juvenile plants are killed. Having a predominantly heathy shrub understorey with a high proportion of sclerophyllous shrubs, and often a dense sedge layer as well, it is highly flammable. Fine fuels are more or less uniformly distributed from ground level to the low eucalypt crowns, via tall shrubs such as *Leptospermum trinervium*. This makes this vegetation type flammable in almost all weather conditions, and difficult to extinguish because the continuous shrubby understorey makes firebreak creation impossible except at tracks. FE139 therefore requires careful fire management. Fire intervals in the range of 7-30 years are recommended for shrubby dry sclerophyll forests (NPWS, undated). However, frequencies close to the lower limit would tend to eliminate trees or reduce them to mallee form, converting woodlands to open heathland. This appears to have happened already in some parts of Conjola and Morton (East), although it is not known to what extent past logging may have also contributed.

FOREST ECOSYSTEM 139H: Scribbly Gum - Red Bloodwood Heath

Southern CRA Profile Information

Description: Heath derived from Scribbly Gum - Red Bloodwood Heathy Woodland (FE139)

This vegetation type, which also occurs in Barnunj SRA, contains the same diagnostic understorey species as FE 139 but is lacking in trees or has a sparse young tree cover. It is not known whether the lack of trees is a natural feature caused by shallow soils or high exposure to sea winds, or whether it has been caused by past human intervention.

FE 139H – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu 7, 9, 10, 11 or 12

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented: MORJM1F and MORJM06

Marginal Sites: CONJM12

Species Recorded at Representative Sites:

Acacia obtusifolia
Acacia suaveolens
Acacia ulicifolia
Acianthus sp.
Actinotus minor
Amperea xiphoclada var *xiphoclada*
Anisopogon avenaceus
Aotus ericoides
Banksia paludosa
Banksia serrata
Banksia spinulosa var *spinulosa*
Billardiera scandens var *scandens*
Bossiaea ensata
Bossiaea heterophylla
Bossiaea obcordata
Caesia parviflora var *parviflora*
Cassytha glabella
Caustis flexuosa
Ceratopetalum gummiferum
Corymbia gummifera
Cryptostylis subulata
Cyathochaeta diandra
Dampiera stricta
Daviesia acicularis
Daviesia corymbosa
Dianella caerulea var *caerulea*
Dillwynia phylicoides
Drosera peltata
Entolasia stricta
Epacris impressa
Epacris microphylla var *microphylla*
Eucalyptus consideniana
Gahnia radula
Genoplesium sp.
Gompholobium glabratum
Gonocarpus tetragynus
Grevillea buxifolia species complex
Haemodorum corymbosum
Hakea sericea
Hakea teretifolia
Hibbertia riparia
Hovea heterophylla
Isopogon anemonifolius
Lambertia formosa
Lepidosperma concavum
Lepidosperma laterale
Leptospermum trinervium
Lepyrodia scariosa
Lindsaea linearis
Lomandra filiformis ssp *filiformis*
Lomandra glauca
Lomandra multiflora ssp *multiflora*
Lomandra obliqua
Lomatia ilicifolia
Mitrasacme polymorpha
Patersonia sericea
Persoonia levis
Petrophile pedunculata
Phyllota phylicoides
Pimelea linifolia ssp *caesa*
Pimelea linifolia ssp *linifolia*
Poranthera ericifolia
Ptilothrix deusta
Scaevola ramosissima
Sphaerolobium minus
Syncarpia glomulifera
Tetraria capillaris
Tetrarrhena juncea
Tetratheca thymifolia
Thelymitra ixioides var *ixioides*
Thelymitra pauciflora
Viola hederacea forma A
Xanthorrhoea australis
Xanthorrhoea concava

Xanthosia tridentata

Dominant species: Essentially the same as FE139 from which it is derived, with the canopy dominants, scribbly gum (*E. sclerophylla*) and red bloodwood either very sparse or absent. The shrub layer contains typical "Sydney sandstone" elements such as *Lambertia formosa, Hakea dactyloides, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Isopogon anemonifolius* and *Kunzea capitata.* The groundcover consists of mixed sedges(including *Lepyrodia scariosa* and *Xyris* spp.), grasses (*Entolasia stricta, Austrostipa pubescens, Anisopogon avenaceus*), the fern *Lindsaea linearis* and subshrubs such as *Gompholobium pinnatum, Boronia polygalifolia* and *Xanthosia tridentata.* The small flannel-flower, *Actinotus minor* scrambles through the groundcover.

Threatened Species: *Grevillea buxifolia* (species complex) was recorded at MORJM01F, a rare species awaiting classification.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Essentially a treeless variant of FE139 occurring in Morton (East) where it is surrounded by FE2, FE3 or FE139.

Conservation Significance: Mapped only in small patches in Morton (East) but not Conjola although FE139 with a sparse tree cover there is similar. Also mapped in Meroo National Park in 2001. Like the related type FE 139, this community is of higher conservation significance than previously thought. Many of the component species, such as *Eucalyptus sclerophylla, Lambertia formosa, Persoonia mollis* ssp *caleyi, Petrophile pedunculata, Kunzea capitata, Epacris pulchella* and *Actinotus minor* are also at or very close to their southern limit which is possibly in or near Barnunj SRA and Meroo National Park, south of Ulladulla.

Threats: Fire (see below)

Impacts of Fire Regimes: This vegetation type requires careful fire management; having a predominantly heathy shrub understorey with a high proportion of highly flamable sclerophyllous shrubs, and often a dense sedge layer as well, it is highly flammable. Such heathy vegetation is adapted to relatively frequent fire, but too short an interval between fires may eliminate obligate seeders from the species mix.

NON-FOREST ECOSYSTEM 140: Wet Heath

Southern CRA Profile Information

Description: Northern Coastal Tall Wet Heath

Northern Coastal Tall Wet Heath is a wet sedge shrubland up to 3 metres high comprising an open cover of tall shrubs *Hakea teretifolia, Allocasuarina distyla, Leptospermum trinervium, L. squarrosum* and *Xanthorrhea resinifera.* It has a diverse intermediate shrub layer of smaller shrubs including *Sprengelia incarnata*, *Banksia paludosa, Dillwynia floribunda* ssp *floribunda, Bauera rubioides, Sprengelia incarnata, Epacris obtusifolia, E. microphylla* ssp *microphylla, Darwinia leptantha*, as well as sedges *Lepidosperma filiformis* and *Restio fastigiatus*, and herbs *Actinotis minor.*

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Banksia ericifolia var *ericifolia*	3	1.000	2	0.012	positive
Darwinia leptantha	2	0.938	2	0.002	positive
Epacris microphylla var *microphylla*	2	0.938	2	0.021	positive
Lepidosperma filiforme	4	0.813	2	0.007	positive
Leptospermum squarrosum	2	0.813	2	0.006	positive
Restio fastigiatus	4	0.813	3	0.001	positive
Dillwynia floribunda var *floribunda*	2	0.750	2	0.003	positive
Epacris obtusifolia	3	0.750	2	0.004	positive
Sprengelia incarnata	4	0.750	2	0.004	positive
Hakea teretifolia	2	0.688	2	0.006	positive
Allocasuarina distyla	3	0.625	3	0.002	positive
Xanthorrhoea resinifera	3	0.625	2	0.012	positive
Banksia paludosa	2	0.563	2	0.011	positive
Bauera rubioides	2	0.563	2	0.003	positive
Leptocarpus tenax	3	0.563	3	0.006	positive
Petrophile sessilis	2	0.500	2	0.006	positive
Zieria laevigata	1	0.188	0	0.000	positive
Styphelia tubiflora	1	0.063	0	0.000	positive
Actinotus minor	1	0.813	2	0.006	uninformative
Isopogon anemonifolius	1	0.500	1	0.012	uninformative
Boronia barkeriana	2	0.438	2	0.002	uninformative
Leucopogon esquamatus	1	0.438	2	0.003	uninformative
Baeckea imbricata	3	0.375	3	0.004	uninformative
Corymbia gummifera	1	0.375	3	0.050	uninformative
Empodisma minus	3	0.375	3	0.018	uninformative
Drosera spatulata	1	0.313	1	0.003	uninformative
Lepyrodia scariosa	2	0.313	2	0.008	uninformative
Melaleuca capitata	2	0.313	2	0.001	uninformative
Dampiera stricta	1	0.250	1	0.012	uninformative
Dillwynia ramosissima	1	0.250	1	0.002	uninformative
Lambertia formosa	1	0.250	2	0.010	uninformative
Persoonia mollis ssp caleyi	1	0.250	2	0.008	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Restio complanatus	3	0.250	2	0.003	uninformative
Banksia serrata	2	0.188	3	0.017	uninformative
Bossiaea ensata	1	0.188	2	0.007	uninformative
Cassytha glabella forma glabella	1	0.188	1	0.024	uninformative
Caustis flexuosa	2	0.188	2	0.013	uninformative
Chorizandra sphaerocephala	2	0.188	3	0.003	uninformative
Hibbertia riparia	1	0.188	1	0.012	uninformative
Lepidosperma concavum	2	0.188	3	0.010	uninformative
Leptospermum juniperinum	2	0.188	2	0.014	uninformative
Leucopogon rodwayi	1	0.188	1	0.001	uninformative
Lomandra glauca	1	0.188	2	0.052	uninformative
Stylidium lineare	1	0.188	1	0.004	uninformative
Eucalyptus obstans	2	0.125	2	0.002	uninformative

Extant area (ha): 6138

Pre-1750 area (ha): 6200

Geographic range: South Coast

How much conserved in reserves (ha): 333

Vulnerability: 3C/D

Reliability: 2

FE 140 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : CONJM11

Marginal Sites : None

Species Recorded at Representative Sites:

Acacia elongata
Acacia longifolia ssp *longifolia*
Allocasuarina sp.
Bauera rubioides
Burchardia umbellata
Cassytha glabella
Comesperma retusum
Cryptandra ericoides
Eleocharis sphacelata
Empodisma minus
Gonocarpus micranthus ssp *micranthus*
Goodenia paniculata
Hakea teretifolia ssp *hirsuta*
Hibbertia riparia
Hydrocotyle peduncularis
Lepidosperma quadrangulatum
Leptocarpus tenax
Melaleuca thymifolia
Opercularia varia
Ptilothrix deusta
Schoenus brevifolius
Selaginella uliginosa
Sphaerolobium vimineum
Viola sieberiana
Xanthorrhoea resinifera
Xyris operculata

Dominant species: The Southern CRA diagnostic species list for this type does not fit well with the wet heath observed in the study area at sampling sites where it is dominated by sedges and the small grass tree *Xanthorrhoea resinifera*, with scattered shrubs including *Acacia elongata, Acacia longifolia, Comesperma retusum, Bauera rubioides* and *Sphaerolobium vimineum*. However, with increasing time since fire this community is likely to become more shrub-dominated.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Often surrounded by FE139 which is restricted to drier areas.

Conservation Significance: Wet heath occurs in drainage lines within areas of Scribbly Gum-Red Bloodwood Heathy Woodland (FE139) in Conjola NP, but was not seen in Morton (East). It occurs in naturally small and fragmented stands on the coast because of its restriction to a restricted ecological niche, poorly drained sites on shallow soils of low fertility. On the Morton plateau to the west it is likely to be more common. This community is probably well reserved because it occurs primarily on poor soils in areas which have not historically been of much value for agriculture or residential development.

Threats: Fire (see below).

Impacts of Fire Regimes: In general this community would be highly flammable despite the usually high soil moisture levels, because of a continuous distribution of fine fuels between the ground and the shrub layer. Wet heaths in the Jervis Bay area often seem to include a high proportion of shrubs in the family Myrtaceae such as *Leptospermum polygalifolium, Callistemon* spp and *Melaleuca* spp. Having volatile oils in the leaves, these would tend to increase the flammability of this community. Too frequent fire would be likely to eliminate shrubs and make the community more sedge-dominated, since sedges are likely to resprout indefinitely and would be able to produce seed in the first season after fire.

NON-FOREST ECOSYSTEM 144: Woolybutt - Paperbark Woodland

Southern CRA Profile Information

Description: Northern Coast and Hinterland Moist Heath

Northern Coast and Hinterland Moist Heath is a heterogeneous tall shrubland dominated by *Melaleuca linariifolia*, together with *Leptospermum polygalifolium*, and *Leptomeria acida*. The ground layer comprises mainly sedge *Schoenus brevifolius*, together with small herbs including *Selaginella uliginosa, Gonocarpus micranthus* ssp *micranthus, Drosera spatulata, Hydrocotyle pedunculata*, and grass *Entolasia marginata*.

Diagnostic Plant Species

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Leptospermum polygalifolium ssp polygalifolium	2	1.000	2	0.026	positive
Melaleuca linariifolia	4	1.000	1	0.003	positive
Selaginella uliginosa	2	1.000	1	0.006	positive
Drosera spatulata	2	0.667	1	0.003	positive
Entolasia marginata	3	0.667	2	0.053	positive
Gonocarpus micranthus ssp micranthus	3	0.667	1	0.023	positive
Hydrocotyle peduncularis	2	0.667	2	0.027	positive
Schoenus brevifolius	6	0.667	4	0.002	positive
Leptomeria acida	1	0.667	1	0.016	uninformative
Pratia purpurascens	1	0.667	1	0.103	uninformative
Aotus ericoides	1	0.333	2	0.016	uninformative
Banksia ericifolia var *ericifolia*	3	0.333	3	0.016	uninformative
Banksia *spinulosa var spinulosa*	2	0.333	2	0.054	uninformative
Baumea articulata	2	0.333	1	0.001	uninformative
Boronia barkeriana	1	0.333	2	0.003	uninformative
Brunoniella pumilio	2	0.333	1	0.016	uninformative
Callistemon linearis	3	0.333	1	0.000	uninformative
Chorizandra sphaerocephala	1	0.333	3	0.003	uninformative
Darwinia leptantha	1	0.333	2	0.006	uninformative
Elaeocarpus reticulatus	1	0.333	1	0.104	uninformative
Epacris microphylla var *microphylla*	3	0.333	2	0.025	uninformative
Epacris pulchella	2	0.333	2	0.004	uninformative
Eragrostis leptostachya	3	0.333	2	0.018	uninformative
Eucalyptus piperita	3	0.333	3	0.020	uninformative
Gahnia sieberiana	4	0.333	2	0.021	uninformative
Gleichenia dicarpa	1	0.333	3	0.009	uninformative
Gonocarpus humilis	2	0.333	1	0.001	uninformative
Goodenia heterophylla ssp eglandulosa	2	0.333	1	0.003	uninformative
Hakea teretifolia	1	0.333	2	0.009	uninformative
Hibbertia empetrifolia	2	0.333	1	0.024	uninformative
Hibbertia fasciculata	1	0.333	2	0.001	uninformative
Hibbertia riparia	1	0.333	1	0.013	uninformative

Species	Group cover	Group freq	Non-group cover	Non-group freq	Fidelity class
Hypericum gramineum	1	0.333	1	0.172	uninformative
Lagenifera stipitata	2	0.333	1	0.167	uninformative
Lepidosperma limicola	2	0.333	2	0.001	uninformative
Leptospermum continentale	1	0.333	2	0.012	uninformative
Leptocarpus tenax	3	0.333	3	0.008	uninformative
Lepyrodia scariosa	3	0.333	2	0.009	uninformative
Leucopogon ericoides	1	0.333	1	0.016	uninformative
Leucopogon lanceolatus var *lanceolatus*	1	0.333	1	0.170	uninformative
Lindsaea dimorpha	1	0.333	2	0.002	uninformative
Lindsaea microphylla	1	0.333	1	0.021	uninformative
Lomatia ilicifolia	1	0.333	1	0.044	uninformative
Melaleuca hypericifolia	1	0.333	2	0.002	uninformative
Mitrasacme polymorpha	2	0.333	1	0.007	uninformative
Opercularia aspera	1	0.333	1	0.037	uninformative
Patersonia fragilis	1	0.333	2	0.003	uninformative

Extant area (ha): 1041

Pre-1750 area (ha): 1041

Geographic range: South Coast

How much conserved in reserves (ha): 607

Vulnerability: 5

Reliability: 2

FE 144 – Conjola-Morton Study Area

Mills' Classification equivalent type: Cu8

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : CONJM02

Marginal Sites : None

Species Recorded at Representative Sites:

Acacia longifolia ssp *sophorae*
Baumea juncea
Cassytha glabella
Centella cordifolia
Cryptostylis subulata
Dianella caerulea
Entolasia stricta
Eucalyptus botryoides
Gahnia clarkei
Gonocarpus micranthus
Gonocarpus tetragynus
Goodenia heterophylla ssp *eglandulosa*
Goodenia ovata
Hydrocotyle peduncularis
Isolepis cernua
Leptospermum *polygalifolium* ssp *polygalifolium*
Lobelia alata
Melaleuca linariifolia
Opercularia varia
Pimelea linifolia ssp *linifolia*
Schoenus brevifolius
Selaginella uliginosa
Villarsia exaltata
Viminaria juncea

Dominant species: Generally *Melaleuca linariifolia* but occasionally in the Jervis Bay hinterland north of Conjola NP *M. styphelioides, M. biconvexa* or *M. decora* occur. An open canopy of eucalypts may include *E. longifolia* or *E. botryoides*. There may be a patchy shrub layer with *Leptospermum polygalifolium* or *Callistemon linearis*. The groundcover is generally sparse and includes herbs such as *Villarsia exaltata* and *Gonocarpus micranthus,* coral fern (*Gleichenia dicarpa*) and sedges such as *Baumea juncea, Schoenus brevifolius* and *Leptocarpus tenax*.

Threatened Species: None recorded in Conjola NP, although the Vulnerable species (Schedule 2 of *TSC Act*) *Melaleuca biconvexa* occurs in the Jervis Bay and St Georges Basin hinterland.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Lowland Red Bloodwood-Turpentine Dry Shrub Forest (FE2) or Blackbutt-Banksia Forest (FE29) often surround the wetter areas in which FE144 occurs.

Conservation Significance: This community is very limited in Conjola NP, and was not seen in Morton (East). FE144 is more common further north in the Jervis Bay hinterland but many of its occurrences are on private property, where it has been cleared or had the understorey removed for grazing or residential subdivision. Some substantial areas are protected in Jervis Bay National Park and Woollamia Nature Reserve.

Threats: Clearing and grazing in non-reserved areas. Fire (see below).

Impacts of Fire Regimes: Paperbark Woodland is a highly flammable community, but is well adapted to recovery from fire. The various *Melaleuca* species recover from epicormic shoots and root suckers and sedges re-sprout readily. Fire-free intervals should be kept as long as possible to prevent the development of dense thickets of small diameter melaleuca root suckers and shrubs.

FOREST ECOSYSTEM 175: Coastal Lowlands Swamp Mahogany Forest

Southern CRA Profile Information

Description: Northern Coastal Lowlands Swamp Forest - *E. robusta*

Northern Coastal Lowlands Swamp is a forest up to 25 metres high, dominated by *Eucalyptus robusta*, as well as a variety of other eucalypts fringing the swamp forest. The understorey comprises a moderate to dense cover of *Melaleuca* species, including *Melaleuca ericifolia, M. linariifolia, M. squarrosa*, together a range of *Leptospermum* spp. The ground cover can be a dense mixed sward of grasses and sword grasses, with a fine scattering of herbs and procumbent shrubs.

Extant area (ha): 459

Pre-1750 area (ha): 465

Geographic range: South Coast subregion

How much conserved in reserves (ha): 65

Vulnerability: 1C/W/U

Reliability: 2

FE 175 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: KMCU19

Conjola-Morton 2003 Sites Represented : None

Marginal Sites : None

Species Recorded at Representative Sites: None recorded.

Dominant species: Swamp mahogany (*E. robusta*) forms an open canopy above smaller trees with a tolerance for waterlogged soils such as *Melaleuca linariifolia, M. ericifolia, M. squarrosa* and *Acacia longifolia*. There may be a dense tall groundcover of the large sedge *Gahnia clarkei*, or of other sedges including *Baloskion tetraphyllum* ssp *meiostachyum, Schoenus brevifolius, Leptocarpus tenax* and *Baumea juncea*.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Occurs in wet sites within taller forest such as FE2 or FE29. Intergrades with FE29 in Narrawallee Creek Nature Reserve.

Conservation Significance: This community is very limited in Conjola NP, and does not occur in Morton (East). FE175 is listed as an Endangered Ecological Community within the Sydney Basin Bioregion, which includes the Ulladulla area. Its occurrences have probably not been very accurately mapped previously. It had been overlooked before being newly mapped in Conjola NP and Narrawallee Creek Nature Reserve.

Threats: Clearing and logging in un-reserved areas.

Impacts of Fire Regimes: Highly flammable community because of the density of the understorey, although it may only burn in drought conditions as occurred in 2001-02 It is well adapted to recovery from fire. Swamp mahogany and the various *Melaleuca* species recover from epicormic shoots and root suckers and sedges resprout readily. However, to avoid development of dense thickets of small diameter melaleuca stems, fires should be kept as infrequent as possible.

FOREST ECOSYSTEM 176: Morton Plateau Mallee Low Forest

Southern CRA Profile Information

Description: Morton Plateau Mallee Swamp Low Forest

Morton Plateau Mallee Swamp Low Forest is a low forest dominated by a variety of mallees and eucalypts adapted to low fertility skeletal soils. The understorey comprises a mixture of heaths, sedges and grasses.

Extant area (ha): 40094

Pre-1750 area (ha): 40114

Geographic range: South Coast Subregion

How much conserved in reserves (ha): 35816

Vulnerability: 5

Reliability: 3

FE 176 – Conjola-Morton Study Area

Mills' Classification equivalent type: Areas do not overlap

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : MORJM08 (rare plant site only)

Marginal Sites : None

Species Recorded at Representative Sites: *Rulingia hermaniifolia*(ROTAP species)

Dominant species: Not listed by Thomas, Gellie and Harrison (2000).

Threatened Species: *Rulingia hermaniifolia* (ROTAP species) recorded at site MORJM08.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Adjoins FE3 or FE20, although separated by the presence of high sandstone cliffs.

Conservation Significance: Limited occurrences within the study area in Morton (East), although it is very common within the greater Morton National Park. Not present in Conjola NP. It occurs on land which is useless for agriculture or forestry and is generally well reserved.

Threats: Fire (see below).

Impacts of Fire Regimes: A highly flammable vegetation type, but one which is well-adapted to frequent fire. All the trees and many of the shrubs are re-sprouters, and the groundcover layer contains many sedges and grasses which re-sprout from the roots. Some of the component species seldom flower except after fire, such as the sedge *Cyathochaeta diandra*. Fire intervals of 7-30 years are recommended for both heaths and for shrubby dry sclerophyll forests (NPWS 2003), however, a mosaic of fire frequencies within this range is desirable to prevent species loss.

NON-FOREST ECOSYSTEM 187: Coastal Headland Heath

Southern CRA Profile Information

Description: Coastal Headland Heathlands

Coastal Headland Heathlands are tall shrublands comprising a dominant shrub layer of *Allocasuarina distyla, Calytrix tetragona, Banksia ericifolia* var *ericifolia*, and *Leptospermum epacridoideum*. The ground cover may comprise a sparse to open cover of sedges *Caustis flexuosa* and *Restio fastigiatus* (Skelton and Adam 1994).

Coastal Headland Heathlands occur on rocky headlands between Narooma and Jervis Bay.

Extant area (ha): 446

Pre-1750 area (ha): 940

Geographic range: South Coast subregion

How much conserved in reserves (ha): 109

Vulnerability: 2C/U

Reliability: 1

FE 187 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : None

Marginal Sites : None

Species Recorded at Representative Sites: None recorded

Dominant species: Not visited within the study area so it is not known how closely it fits the description above. The dominant species recorded in headland heath in Barnunj SRA were found to differ from those listed for this type, suggesting that there is considerable variability within areas which are structurally coastal heath.

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Usually borders cliffs and rock outcrops. Adjoins FE28 on inland side in the one location in Conjola where mapped.

Conservation Significance: Headland heath is mapped at one location on the headland at the northern end of Cudmirrah Beach, mostly outside the park boundary. Common around Jervis Bay, but is very uncommon south of this point. Large areas of headland heaths do not occur again on the South Coast until Green Cape and Nadgee Nature Reserve close to the Victorian border. The species composition of these more southerly heaths is rather different. The stand on Cudmirrah Headland may therefore be of conservation significance as a southern outlier of the Jervis Bay heaths, assuming that they are in fact heath and not Headland Scrub. This was not checked.

Threats: Clearing and urban development in non-reserved areas.

Impacts of Fire Regimes: Headland heathlands may suffer a loss of biodiversity in the long term through inappropriate fire regimes either through prolonged absence of fire or too frequent fire.

NON-FOREST ECOSYSTEM 190: Rock

Southern CRA Profile Information

Description: Rock

Rock is identified in the vegetation map as bare rocky outcrops mapped from aerial photo-interpretation where there is obvious bare rock in patch sizes greater than 2 hectares.

Extant area (ha): 2612

Pre-1750 area (ha): 2631

Geographic range: All subregions

How much conserved in reserves (ha): 21 in Northern subregion and 1185 in South Coast

Vulnerability: 5

Reliability: 2

FE 190 – Conjola-Morton Study Area

Mills' Classification equivalent type: None

Previous Survey Sites Represented: None

Conjola-Morton 2003 Sites Represented : None

Marginal Sites : None

Species Recorded at Representative Sites: None recorded.

Dominant species: Contains little or no vegetation, however, can be a habitat for rare flora (see below).

Threatened Species: None.

Other Species of Conservation Significance: None.

Relationship to other Forest Ecosystems: Fringing vegetation is usually wet eucalypt forests or ecotonal gully rainforest (FE20).

Conservation Significance: Represented only in the study area in Morton (East) but would be more extensive in the greater Morton NP. May be of special conservation significance for vegetation as potential habitat for the ROTAP shrub *Rulingia hermaniifolia* and other ROTAP or TSC listed species which prefer skeletal soils on sandstone such as *Eucalyptus sturgessiana, E. langleyi* and *Pultenaea villifera*, all of which occur in the greater Morton NP. Also an important scenic feature of the coastal escarpment environment and important as fauna habitat.

Threats: None apparent within reserved areas.

APPENDIX 5: Fire Response Mechanisms

Mature plants subject to 100% leaf scorch from fire die (therefore must return via seedlings) and:

Category 1	seeds are canopy-stored (eg Banksias)
Category 2	seeds are soil-stored (eg Acacia)
Category 3	no seeds remain on site after fire and must be imported
Category 8	seed status unknown

Mature plants subject to 100% canopy scorch survive fire and:

Category 4	resprout from root suckers or rhizomes
Category 5	resprout from basal stem buds (eg lignotubers)
Category 6	resprout from epicormic shoots
Category 7	resprout from terminal aerial buds (eg Xanthorrhoea)
Category 9	resprout from bulbs, corms or tubers
Category 10	resprout mechanism unknown.

APPENDIX 6: GIS Details

GIS LAYERS

The new GIS layers which are supplied on the data CD accompanying this report are briefly described below. All layers are in ArcView 3.x shapefile format. Additional ArcView legend files are also included where relevant and wherever possible have the same file name as the shapefile to which they apply. The legends will therefore load automatically on loading each shapefile into ArcView.

The material in this appendix is also included on the data CD to serve as metadata and a guide to using the GIS information.

Study Area

Conjola_morton_narrawallee_study_area.shp – reserve boundaries for the study area extracted from the current NPWS_estate layer

CRA_API_clipping_bdry – boundary used to clip the API layer so as to avoid splitting polygons along the coastline

Study_area_ext_bdry.shp – boundary of re-mapping which includes internal corridors and inholdings and includes all areas within the above clipping boundary

Sheet_layout.shp – map sheets used for the hard copy maps in the report

Background Layers

The following are included:

100m_contours.shp – generated from 25m DEM

10m_contours.shp – generated from 25m DEM

fire_history.shp – records of fire history for each floristic site

note: individual shapefiles for wildfires and hazard reduction for relevant years have been extracted for use in the analysis and are included in the sub-directory 'fire_history'

Drainage - several drainage layers are included in the sub-directory 'drainage' which were used in the mapping. NPWS coastline and drainage layers were edited to avoid overlap with new drainage mapping from API which was part of the vegetation layers.

Powerlines.shp – digitised from orthophotos

Recreation_sites.shp – extracted from NPWS recreation sites layer for the South Coast Region (from earlier work by Phil Kendall/NGH Environmental)

Floristics Site Data

Access database – set of Microsoft Access 97 database files which run under the NPWS site floristics database developed by Michael Bedward and Murray Ellis. The files are arranged in the appropriate directories but need to be linked to the main frontend file (*survey.mde*) when it is first run. The data is contained in the backend file *survey.be*. All of the following data are derived from the access database. Note: Spreadsheet versions of the access tables are contained in the spreadsheets subdirectory. For full details on the attribute information contained in the above database files, see the lookup tables in the NPWS access database.

Con_mor_nar_sites_2003.shp – full floristic survey sites which were recorded on field data sheets and entered in the Access sites database then transferred to ArcView. The attribute table includes locational information as well as the forest ecosystem types from the original modelling and the validation and re-mapping work.

Floristics_data.dbf – a database file which can be linked to the above survey sites attribute table so as to obtain species listings for each site. The data was converted from the floristics database table in the Access sites database. (note the site number needs to be used as the common field for linking the tables).

Master_species_list.dbf – database file extracted from NPWS access database – the species names and other selected attributes have been copied across to the floristics_data.dbf table.

sites_flora_(sthn_cra)z56.shp – extracted from the NPWS floristics sites database for the study area

FireMon_survdat_con_mor_nar.xls – fire response monitoring site data in an excel spreadsheet developed by Nic Gellie for NPWS.

Some additional spreadsheets are included on the CD which were created during the project along with the blank NPWS proforma data sheets.

Threatened_flora_new_sites.shp – new sites found during the field work or reported by NPWS in 2003-3004.

Vegetation

fe_clipped_z56.shp – derived from the original FE modelled layer by Thomas, Gellie and Harrison (2000) – the grid model was converted to a shapefile and clipped using the study area boundary

The legend **fe_clipped_z56.avl** applies to the above layer.

api_veg_080999_z56_clipped.shp - study area portion clipped from the Southern CRA API floristics layer, with modifications by Nic Gellie (EcoGIS)

fe_ext_ecogis56_cncm.shp- layer supplied by NPWS which contains some additional attribute information to the above layer

Morton_conjola_API.shp

Updated API data – Southern CRA API mapping adapted with additional coding and new API work, with forest ecosystems coded according to the modified SCRA classification. Legend has the same filename.

Morton_conjola_FE.shp

Versions of above with boundaries between polygons with the same fe_new code dissolved so that the resulting map is essentially a new forest ecosystems map. Legend has the same filename.

The legend file **all_fe_new_types.avl** contains all forest ecosystem types found in the study area and can be used with any of the re-mapped API layers.

POLYGON ATTRIBUTE TABLES

Vegetation Maps

The CRA API layers used for this project are those which have been adapted by Nic Gellie (EcoGIS).While there are no specific changes to the polygon boundaries or coding within the Conjola-Morton_Narrawallee study area, the additional fields in the polygon attribute tables have been utilised for the purposes of recording changes during the validation and re-mapping work.

The attribute codes used in the revised API map **Morton_conjola_API.shp** which are relevant to the re-mapping, are explained below.

Area_ha recalculated areas in hectares for all polygons.

API_code original code used in CRA API layers

FE1, FE_type, FE2, FE_type2 – fe codes and labels corresponding to FE types assigned to API codes during the southern CRA. Where a combined FE type is suggested these have been split into FE1 and FE2.

code_status these are all “changed” since FE codes have been interpreted from the API code

polygon_status reflects updates made during the re-mapping

FE_code Southern CRA forest ecosystem type assigned on the basis of API code to FE code translation tables prior to manual adjustment

notes rules and observations relating to the assignment of FE codes to API

field_site full floristics site(s) present in the polygon

FE_new the finally assigned code which is either the FE_code type unchanged, or a new code assigned on the basis of field or API work

FE_label the description used in this report.

Site Data

In the floristic sites data arcview layer **con_mor_nar_sites_2003.shp** the following attributes have been used for forest ecosystem types:

FE_old – the original modelled type

FE_new – the field assigned type

Mapped - the type used for the corresponding polygon in the new mapping

Multiple FE types separated by a '+" indicates these types are present in the vicinity

Multiple FE types separated by a '/" indicates the types intergrade and may show characteristics of both types.

Sites with intergrading types are not considered representative of a single forest ecosystem and are considered as marginal sites in the Forest Ecosystem Profiles (Appendix 4).

APPENDIX 7: Maps

MAPS