Eurobodalla Shire Council

Endangered Ecological Communities Survey and Mapping in Eurobodalla Shire

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							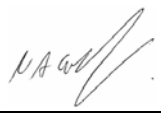
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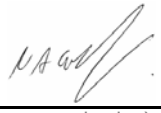
						Sign.	

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1 INTRODUCTION

This report describes the results of the re-mapping of vegetation communities found within Eurobodalla Shire which are listed as Endangered Ecological Communities (EECs) under the *Threatened Species Conservation Act*, in southern NSW. The report has been prepared by NGH Environmental under contract to Eurobodalla Shire Council. The project has been undertaken to enable the Council to increase its knowledge of significant ecosystems in the Shire and to be able to more fully assess the impacts and legal implications of proposed developments, including land subdivisions and private development applications. This report has been prepared in a format suitable for general use by Council staff and it may be adapted as a public document. Technical material relating to methodology has been kept to a minimum in the body of the report and details have been confined to appendices.

While the project has resulted in improved mapping of EECs within the Shire, only limited fieldwork was included as the majority of the EECs occur primarily on private property. The maps should therefore not be taken as absolutely accurate in terms of EEC boundaries, and in many instances areas have been mapped as potential rather than definite EEC. If the presence of an EEC is in contention then field work will generally be require to resolve this, rather than relying on the accuracy of this mapping. In the case of EECs which have been substantially degraded by clearing and farming, remnant native vegetation may be present and clearly derived from one of the EECs but too degraded to be considered to currently belong to the EEC. This information cannot be obtained from maps, but only from on-ground surveys.

1.1 Background

Native vegetation communities in Eurobodalla Shire have been described and mapped under three recent broad-scale mapping exercises and are currently the subject of a fourth. During the Southern Comprehensive Regional Assessment (Southern CRA or SCRA) 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 proportion of south-eastern NSW and included 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) for the Eden region, which lies to the south of the Shire. A new classification and revised 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 (API). The SCRA vegetation classification described about 200 vegetation communities (referred to as Forest Ecosystems, although not all of them are in fact forest), of which around 70 are relevant to Eurobodalla Shire. This study has been updated and published (Gellie, 2005), with the latest version including some minor modifications of the original classification relevant to a discussion of local EECs.

Subsequently an alternative vegetation mapping scheme for the area between Sydney and Moruya has been jointly undertaken by the Department of Environment and Conservation (DEC) and the Department of Planning, Infrastructure and Natural Resources (DPINR), known as the P5MA (Priority 5 Mapping Area) map (Tindall *et al*, 2005). This study is based on a similar methodology to the CRA projects, partly utilising air photo interpretation and partly modelling of vegetation community distribution derived from quadrat-based vegetation sampling. However, the two study areas overlap only partially, with the P5MA map extending further north and excluding the southern and western parts of the SCRA map. Within the area of overlap of the two maps some of the described vegetation communities have a direct one to one correspondence, while others do not. The Shire is therefore in the confusing position of having two alternative regional-scale vegetation maps, with many points of disagreement and both with obvious areas of inaccuracy.

In 2006 the South Coast-Illawarra Vegetation Integration (SCIVI) project produced an integration of the P5MA and Eden CRA mapping. This project has basically retained the P5MA classification and extended its coverage over the southern parts of Eurobodalla Shire which were previously not mapped under this scheme. While this project drew on the data used for the Southern CRA it has discarded many of the Forest Ecosystems described under the SCRA and the correspondence between the two classifications can be confusing.

In 2004-05 another major project was started by the Department of Environment and Conservation (DEC) in the Far South Coast Region, to amalgamate the Southern and Eden CRA vegetation classifications (Beukers and Miles, in prep.) and to map vegetation more accurately, incorporating the results of numerous re-mapping efforts for individual conservation reserves which had been undertaken by contractors in the intervening years. This third mapping scheme aims to rectify these problems and while it has compiled and consolidated all of the relevant vegetation data, the modelling process is not sufficiently refined for use in the present project, mainly as a result of technical computing difficulties.

While the mapping has not been completed for this project, the results of its re-analysis of vegetation data have been incorporated in the SCIVI classification.

The problems of accuracy in the SCRA forest ecosystems modelling and other broad-scale mapping when applied at the local scale have necessitated re-mapping of many of the DEC managed parks and reserves so as to identify vegetation types of conservation significance on a finer scale. Validation and re-mapping of forest ecosystems has been undertaken since the SCRA for many of the coastal parks and reserves along the NSW coastline south of Sussex Inlet. Methodology for this validation process on DEC estate was developed in 1999 by Nicholas Graham Higgs Pty Ltd (now ngh environmental) and has been applied in stages by this and other consultants. Three of these projects include areas within Eurobodalla Shire; a survey of Murramarang National Park (Nicholas Graham Higgs Pty Ltd, 2002a), Kooraban and Gulaga National Parks (Nicholas Graham Higgs Pty Ltd 2002b) and Clyde River National Park (Douglas and Bell, 2003). However, EECs were not specifically included in these maps and the maps are not incorporated in the new mapping for the Shire.

Since there was no accurate or validated CRA mapping for Eurobodalla National Park, Cullendulla Creek Nature Reserve or non-park sections of the coastline, a mapping exercise was undertaken as part of the DEC modelling project, to complete mapping of the coastline from Batemans Bay south to the border. This has involved accurately mapping the boundaries of coastal features (sand, rock, lakes and estuaries) as a basis for delineating vegetation types along the coastal strip. Polygons within the Eden and Southern CRA API map layers were corrected by re-mapping from digital orthophotos. Adjoining vegetation polygons were assigned a forest ecosystem type based on API codes, the results of field investigations or local knowledge. For the Eurobodalla coastline, which is covered by the Southern CRA, polygons were assigned a forest ecosystem type initially using the FE codes assigned by an expert group following the SCRA. In re-mapping the coastline, some of the polygon boundaries were redrawn and the forest ecosystem types confirmed or changed for those of the more readily identifiable non-forest vegetation types such as mangrove, saltmarsh, estuarine wetland scrub and freshwater wetlands, recognising that these would need subsequent field checking and refinement.

For Eurobodalla National Park and Eurobodalla Shire Council areas, the modified SCRA API mapping was considered to form the best available starting point for validating and re-mapping EECs. The mapping basis for the EECs mapping was therefore primarily based on API rather than forest ecosystems modelling although the Forest Ecosystem codes have been applied rather than less meaningful API codes. Additional vegetation mapping resources available to this project were mapping of tidal and littoral wetlands (seagrass, saltmarsh and mangroves) undertaken by West et al (1985), mapping of Eurobodalla National Park by Charles Sturt University (Lockwood et al 1996) and re-mapping of Clyde River National Park by Douglas and Bell (2003). Also available were numerous floristics site data collected for the SCRA and subsequent projects, although most of this data was collected within State Forest or conservation reserves. However, it could be used in lieu of field work to validate the mapped vegetation communities in some areas.

Coastal wetlands are protected under *State Environmental Protection Policy (SEPP) 14* and Littoral Rainforests under *SEPP 26*, and mapping of protected areas in both these categories was also available. However, it is known that not all areas of littoral rainforest were mapped under *SEPP 26* (NSW Scientific Committee, 2004) and *SEPP 14* wetlands include mangroves, which are not listed as an EEC, so the *SEPP 14* and *SEPP 26* mapping provides only a rough guide to the distribution of the relevant EECs.

A project to validate and re-map two EECs (Coastal Saltmarsh and Littoral Rainforest) along the NSW coastline south of Kiama for the Department of Environment and Conservation, has been undertaken concurrently with this project and has involved some data sharing. The botanical, vegetation mapping and GIS methodology has been fully documented in the DEC report (NGH Environmental, 2006) and a summary of the material relevant to the ESC project, is included in Appendix 2.

This report is the result of the adaptation and application of previously used methodologies for the sampling and re-mapping of forest ecosystems in south-eastern NSW. The project has involved preparation of field maps to support field surveys, collection of field data and general field sampling to detect the presence and extent of EECs, orthophoto interpretation and GIS mapping as means of validating the various vegetation maps. The project has resulted in preparing a revised API-based map for all of the Shire, incorporating the results of our field validation findings for both the DEC and ESC projects and a consolidated map of EECs throughout the Shire. This report describes the results of this work.

Since part of the information in the new mapping is the property of DEC, the maps should not be copied, reproduced or passed to additional parties without the permission of DEC and due acknowledgement of the information sources.

1.2 Objectives and Scope

The overall objective of the work is to provide updated vegetation mapping, particularly of endangered ecological communities (EECs), for key areas of the Eurobodalla Shire where the Council is responsible for planning and management, supported by a review of the definition of these EECs, field investigation, GIS mapping and documentation of the findings.

The broad aims of the project from the Council's perspective are as follows.

- Identify, name and map locally occurring EECs.
- Identify Council managed lands supporting EECs and review management regimes for these areas.
- Determine consistent nomenclature (naming) of ecosystems across the landscape for the Southern region.
- Identify correct compliance with the relevant Acts relating to the management of flora and fauna.
- Validate vegetation communities of suspect and high profile localities.
- Develop in-house skills and expertise relating to the management of flora and fauna.
- Determine the appropriateness of Assessment of Significance and other assessments involved with development applications.

The original scope of the project as specified in the Council's brief was modified in the light of the project outline submitted by nghenvironmental, which aimed to draw on work which was already underway to map EECs in the coastal national parks and reserves for DEC.

Specific tasks listed in the project brief which have been undertaken during the work are as follows.

- Participate in a scoping meeting with Council staff in Moruya during the first week of the project to confirm project methodology, tasks, timing, risk and information management issues.
- Identify and map the Endangered Ecological Communities occurring in Eurobodalla Shire and align Council's existing vegetation layers with the EECs described under the Act.
- Address anomalies in ecosystem nomenclature as established via the DEC project works.
- Validate existing mapping by field work and ground truth identified ecosystems in high priority areas as required across a variety of land tenures.
- Identify lands that are high priority due to association with EECs and vulnerable ecosystems located throughout the Eurobodalla and particularly on public lands or adjacent.
- Write a brief report on the project outcomes on information collected during the research, which will become a public document.
- Liaise with the Eurobodalla Shire Council contact personnel, SRCMA, DEC and other relevant organisations managing vegetation data for the project.

Within the Shire, 17 localities were initially nominated by the Council in the project brief. The majority of these are located on or near the coast throughout the length of the Shire and a few are located in inland areas such as Araluen and Belowra Valley. These sites do not include locations within parks and reserves and State Forests. The localities included Bingie, Bergalia, Meringo, Congo, Tilba, Akolele, Glenduart, North Moruya, Waldrons Swamp, Yarragee, Araluen, Buckenboura/Runnyford, Belowra Valley, Nelligen, Bengello, Dalmeny and Malua Bay. A more detailed list of locations was subsequently supplied by the Council and is reproduced in Appendix 1.

1.3 The Study Area

The study area extends along the NSW South Coast from just north of Batemans Bay and Nelligen to Wallaga Lake and Gulaga Mountain excluding the various portions of Eurobodalla National Park. It extends inland to the southern edge of the Araluen valley in the north and the Belowra area along the Tuross River in the south and excludes the large Deua and Wadbilliga National Parks and State Forests. Within this area, certain localities were suggested by the Council staff at the scoping meeting, and these have been the focus of field work, although many additional areas have been visited and re-mapped during the course of the project as opportunities arose.

Key areas of concern in the work have included (from north to south):

- the shoreline of the Clyde River Estuary extending from Maloneys Beach in the east inland to Nelligen and for some distance upstream along the Buckenbowra River, excluding Clyde River National Park and Cullendulla Creek Nature Reserve;
- the coastal fringe south from Batemans Bay to Broulee and along the Tomaga River estuary;
- the sand plains and swamps north of Moruya Heads;
- the Moruya River floodplain;
- Moruya Heads and the Congo - Bingie coastal strip;
- Coila and Tuross lake foreshores and the lower estuary of the Tuross River;
- the coastline around Potato Point, Brou Lake, Lake Mummuga, Dalmeny and Kianga;
- the shoreline of Wagonga Inlet;
- Nangudga and Corunna Lakes;
- potential areas of closer development around Narooma;
- the lower slopes of Gulaga Mountain and west from Corunna Lake;
- the Tuross River valley near Cadgee and at Belowra.

The Araluen Valley lies outside the Shire and although some information was collected, this area was not included in the re-mapping work. However, this is one of the few valleys with remnant forest cover in the region and has similarities to the Belowra and Buckenbowra valleys and consequently is referred to in some parts of this report.

The coastline of the study area is predominantly fringed by beaches and small backing dunes, broken by rocky headlands and cliff lines. Large tidal estuaries and bays include the estuaries of the Clyde River, Moruya River, Tuross River plus Tuross and Coila Lakes, Wagonga Inlet and Wallaga Lake. Smaller lakes are numerous and in many cases only intermittently open to the sea. Some of the larger lakes such as Wallaga Lake may also occasionally close for long periods in times of drought, being then non-tidal, but still saline. There are numerous towns and villages along the coastal strip which, along with farming activities, have fragmented the natural vegetation cover, resulting in many small remnant stands in varying condition. Further inland, many remnant forest stands and areas of regrowth forest exist within a mosaic of cleared farmland, either as isolated occurrences or merging with larger stands of forest on hills and ridges. Endangered Ecological Communities occur in many of these situations and are particularly significant because they are the last remaining relics of vegetation patterns which were much more widely distributed prior to European settlement in the region.

1.4 Methodology

The purpose of vegetation sampling for the target EECs in the Shire was twofold:

- to determine the accuracy of the vegetation maps currently available as they relate to target EECs, with a view to re-mapping these and surrounding vegetation more accurately and
- to collect sufficient botanical data from appropriate locations, to provide more information about the species composition of the target communities throughout their distribution in the Shire.

Prior to commencement of the botanical work, a set of field maps was prepared at 1:25,000 scale covering the parts of the shire thought to contain EECs, which were of particular interest to the Council (see Appendix 1). These maps were based on the same vegetation data sets used in the EEC mapping for DEC, being based on air photo interpretation (API) carried out during the Southern Comprehensive Regional Assessment (SCRA) and the descriptions of forest ecosystems by Thomas, Gellie and Harrison (2000). On these maps were overlayed previous floristic survey sites, contours, drainage, roads and an AMG grid. Proposed locations for investigation were identified jointly by Council staff and the contractor and these were also shown on the field maps. A second set of maps was prepared for the area north of Moruya based on mapping for the P5MA project (Tindall *et al*, 2005).

Field work was undertaken in April 2006 by botanist, Jackie Miles, with assistance from Council staff. Prior to this in December 2005 and February 2006, some API-orientation field work was undertaken by Phil Kendall, mainly along the coastline. This made it possible to undertake some refinement of the API

mapping prior to the preparation of field maps and assisted in the recognition of EECs on air photographs.

On the basis of the findings of the field work and all available data sources, re-mapping of the target EECs was undertaken by Phil Kendall, involving adaptation of the existing mapping, re-mapping some of the EEC subject areas by orthophoto interpretation, assembly of the mapping as GIS layers and full attribute coding to record the changes made. The re-mapping was checked with Jackie Miles prior to the preparation of the maps accompanying this report.

More details on the methodology used is contained in Appendix 2. This is primarily intended as guide for the Council for interpretation of the mapping and GIS data.

2 THE TARGET COMMUNITIES

Endangered Ecological Communities (EECs) are essentially those vegetation communities which, as a result of their naturally limited distribution in the region, and the reduction in their extent due to various land use pressures, are now much depleted in the region. They are often also poorly represented in conservation reserves and therefore a high priority for conservation. Many EECs are associated with river valleys and floodplains and coastal environments which traditionally have been used for farming and more recently for urban and recreational developments along the coastline. Few EECs are located within the large conservation reserves and state forests of the coastal hinterland and escarpment. Without the protection of national parks and nature reserves, these remnant EECs on private and Council-managed lands are vulnerable to the impacts of development and land use pressures, as well as farming practices, often inadvertently because they are not recognised or given the status they deserve.

In an attempt to apply this much needed status with legal backing EECs are now listed under the NSW Government's *Threatened Species Conservation Act (TSCA)* in the same manner as threatened flora and fauna. The listing is gradually being extended and is under the control of the NSW Scientific Committee, which undertakes rigorous assessment and definition of nominated EECs.

Twelve Endangered Ecological Communities are mapped as occurring, or thought to possibly occur in Eurobodalla Shire at the time of compiling this report, based on previous and current mapping projects. They are:

- Bega Dry Grass Forest
- Candelo Dry Grass Forest
- Brogo Wet Vine Forest
- Dry Rainforest of the South East Forests
- River-flat Eucalypt Forest on Coastal Floodplains
- Swamp Oak Floodplain Forest
- Freshwater Wetlands on Coastal Floodplains
- Coastal Saltmarsh
- Littoral Rainforest
- Themeda Grassland on Seacliffs and Coastal Headlands
- Bangalay Sand Forest

The earlier communities to be listed as EECs under the *TSCA* are ones that have suffered primarily from the impacts of clearing for farming and subsequent deterioration of the remnants due to the pressures of farming activities. As such, these communities are very poorly represented in conservation reserves such as National Parks, having occurred primarily on the more fertile parts of the landscape which were taken up early for farming. The latter four communities which occur on less productive lands are listed because of other factors such as a naturally restricted distribution and more recent developmental and recreational pressure, and are better represented in conservation reserves, although often in small fragmented areas.

Field work to identify and map the Eurobodalla EECs has concentrated particularly on the Moruya area and the coastal strip to the east, where the under-recognition of EECs in the Southern CRA mapping was most apparent. Additional work was undertaken in some locations where potential for River-flat Eucalypt Forest on Coastal Floodplains to occur was indicated by the mapping of large patches of coastal lowlands riparian forest types (SCRA forest ecosystems 48 and 49), such as in the Nelligen – Runnyford – Buckenbowra area and at the inland extreme of Wagonga Inlet. Some areas designated as likely future development sites, such as Dalmeny, Kianga and Malua Bay were also included in the survey. Remnants of native vegetation which seemed likely to belong to EECs within the greater Batemans Bay area were also investigated. In the hinterland, the Belowra and Buckenbowra valleys, both on more fertile soils derived from granitoid rocks and largely cleared for agriculture, were checked. Areas targeted for field validation are outlined in Appendix 1.

2.1 Southern CRA and P5MA mapping units and their relation to EECs

The forest ecosystems for the Southern CRA mapping area were described in the appendices to the report by Thomas, Gellie and Harrison in 2000 and subsequently published as Gellie (2005). Forest ecosystems which were under threat in Eurobodalla Shire, were reviewed in a report to the Council by Nic Gellie (EcoGIS) in 2001. A new classification for mapping units was developed for the P5MA project which departs from the forest ecosystems classification but is more closely aligned with EEC definitions and is described in the report by Tindall *et al* (2005).

Table 1 below lists the "forest ecosystems" identified by Gellie (EcoGIS, 2001) as being of greatest conservation significance in the coastal areas of Eurobodalla Shire, being the communities most affected by clearing and least adequately protected in reserves. Table 1 is based on that report, with the order of the communities rearranged to reflect their natural associations with each other. All were regarded by Gellie as being less than fully functional ecological communities, due to clearing, fragmentation, farming impacts, loss of associated native fauna and general human interference with ecological processes.

The table attempts to clarify the relationship between the communities described by the SCRA report (Thomas, Gellie and Harrison, 2000) or subsequently erected by Gellie (EcoGIS, 2001), those described during the more recent P5MA mapping project (Tindall *et al.,* 2005) and subsequent SCIVI revision (Tozer *et al.*, 2006) and the EECs listed at the time of this project. However, there is not always a direct one to one relationship, and some of the SCRA forest ecosystems are difficult to relate to communities in other classifications. This is further discussed below.

Table 1 Relationship of SCRA, P5MA communities and EECs

FE No.	Name of Forest Ecosystem	P5MA equivalent	SCIVI equivalent	EEC**
54	Coastal Forest Red Gum Shrub/Grass Forest	South Coast Grassy Woodland (GW34)	South East Lowland Grassy Woodland (GWe20p229)	Bega and Candelo Dry Grass Forests
50	Southern Escarpment RB Apple-Forest Red Gum Herb-Grass Dry Forest			Not covered by Bega or Candelo Dry Grass Forest listing
171	Coastal Shrub/Grass Forest – *E. tereticornis*	Unclear originally, but as used by us, included as part of South Coast River Flat Forest (FOW30)	May include parts of South Coast Lowland Swamp Woodland (GWp3) and South Coast River Flat Forest (FOWp30)	Should be covered within River-flat Eucalypt Forest of Coastal Floodplains
51	Araluen Yellow Box-Maidens Blue Gum Acacia Herb-Grass Dry Forest	Araluen Scarp Grassy Forest (GW343)	Araluen Scarp Grassy Forest (DSFp343)	Not covered by Bega or Candelo Dry Grass Forest listing.
	Not recognised in region	Araluen Valley Grassy Woodland (GW229)		Candelo (and perhaps Bega) Dry Grass Forest

FE No.	Name of Forest Ecosystem	P5MA equivalent	SCIVI equivalent	EEC**
	Not recognised in region	Not recognised in region		Brogo Wet Vine Forest
	Not recognised in region	Not recognised in region		Dry Rainforest of the South East Forests
197	Littoral Rainforest (originally included in 167, Subtropical and Littoral Rainforest)	Temperate Littoral Rainforest (RF210)	Temperate Littoral Rainforest (RFp210)	Littoral Rainforest
187	Coastal Headland Shrublands (unlikely that 187 is the same entity as the EEC)	Headland Grassland (GL434) – equivalent to EEC but not to FE187	Headland Grassland (GLp434) – equivalent to EEC but not to FE187	Themeda Grassland on Seacliffs and Coastal Headlands
28	Coastal Sands Bangalay-Old Man Banksia Grassy Bracken Shrub Forest	Coastal Sand Forest (DSF64, which appears to include FE29)	Coastal Sand Forest (DSFp64, which may include FE29)	Bangalay Sand Forest (which apparently does not include FE29)
27	Ecotonal Coastal Hind Dune Swamp Oak-Bangalay Shrub Forest			Drier stands may be included within Bangalay Sand Forest, wetter stands in Swamp Oak Floodplain Forest
2223	Southern Coastal Hind Dune/Headland Scrub & Beach Strand Grassland	Coastal Foredune Scrub (HL65) and parts of Littoral Thicket (HL63)	Coastal Foredune Scrub (DSFe61) and parts of Littoral Thicket (HLp63)	Not listed, relatively well reserved
188	Sand Dune Wetlands	Coastal Freshwater Lagoon (FRW313), in part	Coastal Freshwater Lagoon (FRWp313), in part	Not covered?
189	Coastal Alluvial Valley Floor Wetlands	Coastal Freshwater Lagoon (FRW313)	Coastal Freshwater Lagoon (FRWp313)	Freshwater Wetlands on Coastal Floodplains
4849	Coastal Lowlands Riparian Herb-Twiners-Grass Forest - various eucalypts (originally two similar FEs, combined)	South Coast River Flat Forest (FOW30)	South Coast River Flat Forest (FOWp30)	River-flat Eucalypt Forest of Coastal Floodplains (in part, when growing on a floodplain)
203	Dignams Creek Blue Box-Sydney Blue Gum Moist Shrub Forest (variant of 4849)	Should be included within South Coast River Flat Forest (FOW30), though outside P5MA study area		River-flat Eucalypt Forest of Coastal Floodplains (in part, when growing on a floodplain)
53	Riparian River Oak Acacia Shrub-Grass-Herb Forest	Riverbank Forest (FOW32)	Riverbank Forest (FOWp32)	Not listed, though clearing is probably underestimated.
25	South Coast Swamp Oak Forest Complex	Floodplain Swamp Forest (FOW105) and Estuarine Fringe Forest (FOW106)	Floodplain Swamp Forest (FOWp105) and Estuarine Fringe Forest (FOWp106)	Swamp Oak Floodplain Forest
24	Coastal Swamp Oak-Swamp Melaleuca Wet Heath Swamp Forest	Estuarine Creekflat Scrub (FOW107)	Estuarine Creekflat Scrub (FOWp107)	Swamp Oak Floodplain Forest
186	Mudflats/Saltmarshes	Estuarine Saltmarsh (SL509)	Estuarine Saltmarsh (SLp509)	Coastal Saltmarsh

FE No.	Name of Forest Ecosystem	P5MA equivalent	SCIVI equivalent	EEC**
185	Mangrove Estuarine Low Forest	Estuarine Mangrove Forest (SL109)	Estuarine Mangrove Forest (SLp109) and River Mangrove (SLe65)	Not listed.

** EECs are those listed in NSW under the *Threatened Species Conservation Act 1995*. Some have also been assessed for listing nationally under the *Environment Protection and Biodiversity Conservation Act 1999*, but had not yet been so listed at the time of completion of this report.

The correlation between the SCRA and P5MA vegetation communities and the EECs known to occur in Eurobodalla Shire is summarised in the table above, but is rarely straightforward and requires some further explanation. Cases of one to one correspondence between vegetation types in the three classifications are uncommon. The only categories for which this occurs are Coastal Saltmarsh, and possibly Littoral Rainforest which Gellie (EcoGIS, 2001) appears to have re-defined as FE197 at some point, since it was formerly lumped in FE167 with non-littoral subtropical rainforest.

The EECs as defined by the NSW Scientific Committee which have been recognised in the Shire are discussed below with reference to the SCRA and P5MA classifications. The SCRA classification was used as the basis for the mapping of EECs as explained in Appendix 2.

2.2 Bangalay Sand Forest

Bangalay Sand Forest appears at first glance to have a reasonably straightforward relationship between the EEC and the two vegetation classifications, but closer investigation shows that this is not so. The SRCA classification includes two very similar communities, FE28 (Coastal Sands Bangalay-Old Man Banksia Grassy Bracken Shrub Forest) dominated by bangalay (*Eucalyptus botryoides*) and FE29 (Northern Coastal Sands Shrub/Fern Forest) dominated by blackbutt (*E. pilularis*), the latter generally occurring further inland on sand or sandy soils and having a very similar understorey. It appears that the P5MA and SCIVI forest type, Coastal Sand Forest (DSF64) covers both FE28 and FE29, since *E. pilularis* is listed among its component species, but that the EEC Bangalay Sand Forest does not. The Final Determination of the NSW Scientific Committee to list Bangalay Sand Forest as an EEC specifically mentions FE28 and the drier end of FE27 (those stands not dominated by *Casuarina glauca*) as being covered by the listing, but does not mention FE29. To further confuse the question of which SCRA communities are covered by this listing, the Final Determination states that part of the P5MA community DSF64 is covered by the listing, but does not state which part. There may therefore be some doubt about the EEC description covering stands in which *E. pilularis* is the dominant species in the tree canopy. For the purposes of the current project, FE29 has been mapped as a potential EEC (but not a definite EEC) only when occurring very close to the coast.

2.3 Themeda Grasslands

Themeda Grassland on Seacliffs and Coastal Headlands appears not to have been recognised in the region in the SCRA study, though Gellie (2001) does include as threatened a community referred to as FE187, Coastal Headland Shrublands. Under this title it could almost be assumed to be equivalent to Themeda Grassland on Seacliffs and Coastal Headlands since this community frequently includes a component of coastal dune or headland scrub species such as *Acacia sophorae* and *Banksia integrifolia*. However, FE187 was originally described in the SCRA report as a heathland dominated by *Allocasuarina distyla* and *Banksia ericifolia*. It is very doubtful that such a community occurs anywhere in Eurobodalla Shire, since such heaths are generally confined to sandstone geology, such as occurs around Jervis Bay. Although the SCRA API mapping included it on many rocky headlands, it has generally been replaced in the re-mapping work undertaken for DEC in reserves along the coastline by coastal scrub or unvegetated rock. Headland grasslands were previously included in coastal scrub or were excluded areas (which were assumed to have been cleared) in the SCRA mapping. We have restricted the use of the label FE187 to a few locations which contain small heathland patches and use instead FE22A for headland grasslands, reflecting the similarities in species composition and topographic location between Themeda Grassland on Seacliffs and Coastal Headlands and FE22, Southern Coastal Hind Dune/Headland Scrub. The P5MA and SCIVI studies record this community as Headland Grassland (GL434) and state that it has a scattered distribution on headlands from Sydney to south of Narooma.

2.4 Swamp Oak Floodplain Forest

Among the floodplain EECs, Swamp Oak Floodplain Forest is relatively straightforward, with both FE24 (Coastal Swamp Oak- Swamp Melaleuca Wet Heath Swamp Forest) and FE25 (South Coast Swamp Oak Forest Complex) being included within the EEC description, along with the wetter end of FE27 (Ecotonal Coastal Hind Dune Swamp Oak-Bangalay Shrub Forest), if dominated by *Casuarina glauca*. This is stated in the Final Determination of this community (NSW Scientific Committee, 2004). How FE24 and FE25 are related to the three *Casuarina glauca-Melaleuca ericifolia* communities described in the P5MA study is less clear, but it seems likely that the P5MA Estuarine Fringe Forest (FOW106) represents the most saline end of FE25 such as occurs around the margins of coastal lakes, while Floodplain Swamp Forest (FOW105) is the more freshwater version of FE25 such as is found on the Moruya River floodplain. Estuarine Creekflat Scrub (FOW106) appears roughly equivalent to FE24, in having *Melaleuca ericifolia* as the dominant species and *Casuarina glauca* a subdominant. The three relevant communities are unchanged from the P5MA report in the SCIVI report.

2.5 Freshwater Wetlands

The EEC Freshwater Wetlands on Coastal Floodplains has a fairly straightforward one to one relationship with FE189 (Coastal Alluvial Valley Floor Wetlands) and one might assume that the EEC excludes FE188 (Sand Dune Wetlands) since these are not usually directly associated with coastal floodplains. However, the P5MA (and SCIVI) category Coastal Freshwater Lagoon (FRW313) appears to include both these categories of herbaceous wetlands. Its description refers to wetlands occurring in "depressions in coastal sandplains and river flats" (Tindall *et al.* 2004). The Final Determination for this EEC states that the EEC includes those parts of FRW313 that are dominated by herbaceous aquatic plants, with no reference to their location. The inclusion of herbaceous freshwater wetlands associated with sand dunes in the EEC may therefore be open to debate. For the purposes of the current project, FE188 has been noted as a potential EEC. Council may wish to seek clarification from the NSW Scientific Committee as to the inclusion of such wetlands in the EEC.

2.6 River-flat Eucalypt Forest

River-flat Eucalypt Forest on Coastal Floodplains is another EEC with a confusing relationship to communities described in the SCRA and P5MA studies. In the Scientific Committee's Final Determination it is described as having forest red gum (*E. tereticornis*) as a widespread and abundant dominant tree species, along with *Angophora floribunda, E. baueriana, E. elata* and *E. botryoides*. The latter species are all characteristic of the communities FE48, FE49 (Coastal Lowlands Riparian Herb-Twiners-Grass Forest - various eucalypts) and the latterly described FE203 (Dignams Creek Blue Box-Sydney Blue Gum Moist Shrub Forest) in Eurobodalla Shire, but none of these three Forest Ecosystems are said to contain forest red gum in the SCRA report. The Final Determination specifically lists FE48 and FE49 as being included within the EEC definition (when they occur on alluvial soils). The Final Determination also mentions those parts of FE27 (Ecotonal Coastal Hind Dune Swamp Oak-Bangalay Shrub Forest) which are eucalypt-dominated as being included, and it may be here that red gum dominated floodplain forests fall, since Thomas, Gellie and Harrison list *E. tereticornis* as an occasional dominant in this community (present in 20% of samples). Our field work suggests that River-flat Eucalypt Forest in Eurobodalla Shire is dominated by either *E. tereticornis* or *E. botryoides*, but that they seldom grow together. We have therefore chosen to use the label FE171 for floodplain red gum forests (see discussion in Section 2.7 below) and FE27 only for floodplain bangalay forests.

The SCIVI report recognises two communities which could overlap with this EEC, FOWp30 (South Coast River Flat Forest) which appears to be equivalent to the SCRA FE48/49, and GWp3 (South Coast Lowland Swamp Woodland), said to occur around Lake Illawarra and in the Moruya-Congo and Nelligen areas in coastal valleys and on floodplains. Although the dominant eucalypts are listed as *E. globoidea* and *E. longifolia* rather than *E. tereticornis*, the discussion of its distribution implies that this community is equivalent to the one we have mapped as FE171, and *E. tereticornis* is in fact recorded from 58% of sample sites. The short floristic summary in the SCIVI report includes mostly species typical of drier forest red gum woodland, but the full indicator species list includes several species typical of floodplain red gum forests. A preponderance of data from the Illawarra area may explain the differences between SCIVI description of this community and the composition of remnant stands around Moruya.

2.7 Dry Grass Forests

The EECs Bega and Candelo Dry Grass Forests, both basically forest red gum woodlands, appear to have some overlap with as many as five separate forest ecosystems described in the SCRA report. The differences between these five are not immediately apparent from a perusal of the diagnostic plant species lists provided in the SCRA report. Some rationalisation of these communities is attempted here.

Four of the five communities FE50 (Southern Escarpment RB Apple-Forest Red Gum Herb-Grass Dry Forest), FE52 (Bega Valley Shrub/Grass Forest), FE54 (Coastal Forest Red Gum Shrub/Grass Forest) and FE171 (Coastal Shrub/Grass Forest – *E. tereticornis)* are described as being dominated by forest red gum (*Eucalyptus tereticornis*), rough-barked apple (*Angophora floribunda*) and white stringybark (*E. globoidea*), with the fifth, FE51 (Araluen Yellow Box-Maidens Blue Gum Acacia Herb-Grass Dry Forest), including these species but more often dominated by yellow box (*E. melliodora*) and Maiden's gum (*E. maidenii*).

FE50 is described as occurring primarily away from the coast, in the Araluen and Belowra valleys. It appears to differ from the other three red gum dominated communities in the low cover of kangaroo grass (*Themeda australis*) and frequent dominance of the understorey by the low shrub *Leucopogon juniperinus*. FE50 does describe a variant of the red gum woodlands which tends to occur on poorer soils, sometimes not derived from granitoids, and located more remote from farming areas, such as along the upper Tuross River west of Tinpot where it was mapped by API in Kooraban National Park, and field validated, on the southern valley slope of the Tuross River (Nicholas Graham Higgs, 2002b) and could be expected to extend on to private land and state forest north of the river. The SCRA API does not reliably map FE50 in this area so it has not been feasible to undertake any further validation or re-mapping. It would probably not be covered by the EEC listing of Bega or Candelo Dry Grass Forests. Whether it occurs in the Belowra or Araluen valleys is open to question, and these areas appear to have been re-mapped subsequently by Gellie as mostly FE54. Most remnants in these areas are now highly modified, making their affiliations difficult to determine, although some roadside remnants in the Araluen valley strongly suggest Candelo Dry Grass Forest.

FE52 and FE54 are described in the SCRA report as occurring only in Bega Valley Shire, outside the SCRA study area. It appears from the diagnostic species list that both are equivalent to Candelo Dry Grass Forest. As FE52 and 54 were initially thought not to occur in Eurobodalla, the community FE171 was created during the SRCA to cover coastal red gum woodlands of Eurobodalla Shire, but Thomas, Gellie and Harrison (2000) do not include a diagnostic species list for this community, so it is difficult to be sure how it differs from FE50, 52 or 54. Subsequent mapping now in use by Eurobodalla Shire Council does show some areas of FE54 and very little FE171, so presumably at some point this assumption that FE54 does not occur in Eurobodalla was abandoned.

This leaves the label FE171 under-utilised in mapping of Eurobodalla, so we have chosen to use it to describe the wetter form of red gum forest not described by Thomas, Gellie and Harrison (or previously lumped into FE27 with wetter bangalay forest), as discussed above. Gellie (EcoGIS, 2001) appears to have had a similar intention, since the only area originally mapped as FE171 is located on the banks of the Tomaga River. The best example of this community can be seen on the northern edge of the Moruya River floodplain about 0.5km east of the industrial area and south of the Princes Highway. This floodplain red gum forest type is quite distinct in species composition from the grassy red gum woodland found on low hills on granite south and east from Moruya. It may contain an appreciable component of swamp-loving species such as swamp oak (*Casuarina glauca*), swamp paperbark (*Melaleuca ericifolia*) and the vine common silkpod (*Parsonsia straminea*) with a dense groundcover of grasses, sedges and ferns, as on the Moruya River floodplain, or in areas with a more saline influence in estuaries such as the Tomaga and Clyde Rivers, it may have very little understorey due to occasional scouring by floods or king tides. FE171 as we have chosen to apply the label should fall within the River-flat Eucalypt Forest on Coastal Floodplains EEC. It appears to be roughly equivalent to the SCIVI vegetation category GWp3 (South Coast Lowland Swamp Woodland), which does include *E. tereticornis* in 58% of sites and *Casuarina glauca* in 32%.

We have chosen to follow Gellie (EcoGIS, 2001) in using FE54 for red gum grassy woodland or forest on granite or basalt substrates around Moruya, Congo and Bingie, as well as for some remnants in the Belowra and Araluen valleys. The use of a single label for all these red gum remnants does mask some variation in red gum woodlands which was brought out in the more intensively surveyed Bega Valley Shire. In the latter region three red gum woodland types were recognised, Bega Dry Grass Forest, Candelo Dry Grass Forest and Brogo Wet Vine Forest (Keith and Bedward, 1999), all now individually listed as EECs. There is some evidence that all these red gum woodland variants occur in Eurobodalla Shire. Brogo Wet Vine Forest tends to include Port Jackson fig (*Ficus rubiginosa*) and there are areas around Gulaga Mountain on monzonite, south of Moruya on granite and north of Coila Lake on basalt

where Port Jackson figs are part of the remnant vegetation in farming areas, suggesting the former presence of this community. However, remnants around Gulaga have been invaded by the noxious weed lantana, and remnants in other areas are highly modified by their farming history, so it is difficult to say how closely they would have resembled Brogo Wet Vine Forest as seen in Bega Valley Shire.

All these communities are listed as EECs, so the distinction is not crucial. Candelo Dry Grass Forest has not been identified separately in our re-mapping, since the only location it was definitely identified was in the Araluen Valley, outside the Shire boundary, and Bega Dry Grass Forest has been the main type re-mapped as FE54. A few small occurrences of Brogo Wet Vine Forest have been recognised and mapped as FE54A, although these tend to have a mixed species composition which includes species typical of both Bega Dry Grass Forest and Brogo Wet Vine Forest.

The P5MA report did not recognise a Brogo Wet Vine Forest community, but the SCIVI report includes it as GWe18, said to occur only in the Bega Valley. The SCIVI report has revised the P5MA dry red gum woodland vegetation type, GW34 (South Coast Grassy Woodland), which originally included Bega Dry Grass Forest. GW34 now covers a moister red gum woodland found north from Milton, and a new category, GW e20p229 (Southeast Lowland Grassy Woodland) covers the drier red gum woodlands found in the Bega Valley and Eurobodalla Shires. The p229 component of the name indicates that the former GW229 (Araluen Valley Grassy Woodland) is also included, with e20 (Bega Dry Grass Forest).

One remaining question is whether FE51, described by Thomas Gellie and Harrison as occurring on steep slopes above the Araluen valley on granitic soils, is equivalent to Candelo Dry Grass Forest. The fact that Gellie estimates that none of this community has been cleared suggests that it is a separate entity from Candelo Dry Grass Forest, which, if it did occur in the Araluen valley, has apparently been largely removed except for a few roadside remnants. The SCIVI report includes an apparently equivalent vegetation unit called Araluen Scarp Grassy Forest (DSFp343), which grows on the steeper valley margins. Since the Araluen valley lies outside the shire, we have not mapped any of this type.

2.8 Littoral Rainforest

In the case of littoral rainforests, some adjustments to the FE descriptions have been made to accommodate this EEC because the existing descriptions are not sufficiently specific. In the Southern CRA forest ecosystems classification by Thomas, Gellie and Harrison, littoral rainforests are included in FE167, which was applied to both subtropical and northern littoral rainforest samples. This type has been split to recognise littoral rainforests as distinct from the more widespread inland type of rainforest. The code FE167L has been used in re-mapping for littoral rainforest, with the suffix L to indicate that only the littoral component of FE167 is referred to while the original SCRA code FE167 has been retained for the inland form of rainforest, or for polygons originally coded as FE167 which have not yet been checked for littoral rainforest occurrences. This is preferable to the FE197 type allocated by Gellie (EcoGIS 2003) for littoral rainforest since it seems that FE197 was previously allocated to the un-mapped type Deua Escarpment Herb/Grass Forest on Limestone - *E. viminalis*, creating some confusion. The P5MA and SCIVI reports include a specific Temperate Littoral Rainforest type, RFp210.

2.9 Dry Rainforest

Dry Rainforest of the South East Forests dominated by Port Jackson fig (*Ficus rubiginosa*) was not detected in Eurobodalla during the SCRA survey and was not included in the SCRA classification. In the P5MA classification there is a community called Temperate Dry Rainforest (RF38), but this is dissimilar to the EEC Dry Rainforest of the South East Forests as it includes a number of species not found on the far south coast, and also includes grey myrtle (*Backhousia myrtifolia*) as a substantial component. RF38 appears to occur mostly around cliffs and scree slopes of coastal river gorges such as the Shoalhaven and Wollondilly Rivers, a quite different topographic location to the granite outcrops among rolling hills frequented by the Dry Rainforest which occurs on the far south coast. In the SCIVI report the Dry Rainforest vegetation unit from the Eden region has been included as RFe1 (Southeast Dry Rainforest).

There is some doubt as to whether the EEC could be said to occur much in the Shire, as all occurrences of Port Jackson fig seen during field work for this project were restricted to scattered single trees in paddocks, where grazing impacts have probably reduced the species diversity of the stands. Stands in less disturbed parts of the Bega Valley are more typical of the community (described as Dry Rainforest, Map Unit 1 in the Eden CRA), and may be larger too, though many consist of a single large, spreading fig. As figs are also a component of Brogo Wet Vine Forest, areas where figs were recorded have been mapped as this community in our re-mapping, rather than as Dry Rainforest. The community should not be confused with the Gully Dry Rainforest dominated by grey myrtle, which is very common in gullies in the rugged hinterland of Eurobodalla Shire (FE170 in the SCRA classification).

2.10 Coastal Saltmarsh

Coastal Saltmarsh is a relatively straightforward and readily recognisable vegetation community, and for once the EEC description, the SCRA community (FE186, Mudflats/ Saltmarshes) and the P5MA and SCIVI community (SL509 or SLp509, Estuarine Saltmarsh) are all directly equivalent. All three include both the more obvious low herbland dominated by samphire (*Sarcocornia quinqueflora*) which most people would recognise as saltmarsh, and the taller reed or sedgelands which occur on the drier upper edge of saltmarsh within their definition of the community.

3 DESCRIPTIONS AND LOCATIONS OF EECS

The EECs mapped during this project are shown on the 1:25,000 scale maps reproduced in Appendix 5. These maps are based on the forest ecosystems described by Thomas, Gellie and Harrison (2000) with additional types defined during this project and the DEC EECs project (NGH Environmental, 2006). The maps are also included in PDF format on the data CD and are based on the GIS data supplied on the same CD. Details are contained in Appendices 3 and 4.

The EECs of the Shire are described according to EEC type below and should be read in conjunction with the maps which show the full distribution of each type.

3.1 Bega and Candelo Dry Grass Forests

Bega Dry Grass Forest and Candelo Dry Grass Forest in the South East Corner Bioregion are two similar EECs first described from the Bega Valley, which also appeared likely to occur in Eurobodalla Shire, most conspicuously in remnant forest or woodland patches in the farming areas around Moruya. Field work for this project verified that this is the case, at least for Bega Dry Grass Forest.

The two communities are broadly similar, consisting of a grassy woodland or open forest dominated by forest red gum (*E. tereticornis*), white stringybark (*E. globoidea*) and rough-barked apple (*Angophora floribunda*). They differ in that Candelo Dry Grass Forest includes a greater diversity of grasses and herbs, and two additional tree species, yellow box (*E. melliodora)* and snow gum (*E. pauciflora*) which are more typical of the tablelands than of coastal vegetation. However, past management and grazing history can mask these differences by eliminating the distinctive species found in better quality Candelo Dry Grass Forest remnants. During recent discussion of whether these two communities should also be listed as EECs under the Commonwealth *Environment Protection and Biodiversity Conservation Act*, it was decided that the two are sufficiently similar that they could be lumped into a single entity, Lowland Grassy Woodlands and Derived Grasslands of the South East Corner Bioregion. The reference to derived grasslands indicates that remnants which lack trees or shrubs because of past clearing but still have a good degree of native plant diversity in the groundcover layer may be included as examples of this community. This is because much of the plant species diversity of these EECs is typically contained within the grass and herb component of the understorey, at least in relatively undisturbed stands. The EEC listing under the *TSC Act* will also probably convert the listing to a single entity called Lowland Grassy Woodland in the near future. At the time of completing this report a Preliminary Determination to list this community had been made.

Bega Dry Grass Forest remnants have been recorded in three main areas of Eurobodalla Shire.

- The most conspicuous remnants are on granite derived soils around Moruya, principally to the south and the east of the town, with similar vegetation occurring through the Bergalia area right to the coast at Congo and Bingie, and remnants indicate it formerly occurred on basalt-derived soils north of Coila Lake.
- The granite-derived soils in the Belowra valley west of Bodalla also appear to have carried a combination of Bega Dry Grass Forest and the riparian eucalypt communities FE48/49.
- Remnant forest red gums suggest that the community also occurred in the Buckenbowra valley and in the Mogendoura area north-west of Moruya, although these areas have been extensively modified.

Bega or Candelo Dry Grass Forest has also been detected in a few locations in the Araluen and Neringla valleys (beyond the Shire boundary), though not on the steeper slopes surrounding these valleys.

With the exception of road verges, an area of former private property now in Crown Land and the old cemetery reserve at Glenduart on the north bank of the Moruya River, the bulk of the Bega Dry Grass Forest remnants are in private ownership.

3.2 Brogo Wet Vine Forest

Brogo Wet Vine Forest in the South East Corner Bioregion was also originally described from the Bega Valley. It is similar to Bega Dry Grass Forest in being dominated by forest red gum and rough-barked apple, but it often occurs on steeper slopes with large outcropping granitoid tors and carries some distinctive additional components such as Port Jackson fig (*Ficus rubiginosa*), sweet pittosporum (*Pittosporum undulatum*) and hillside burrgrass (*Cenchrus caliculatus*). This community has been less affected by clearing than the preceding two communities in Bega Valley Shire because it occurs in landscapes which are more marginal for agricultural activities. However, remaining areas are now coming under greater pressure for rural residential development. Extensive patches remain in the Brogo area of Bega Valley Shire, but elsewhere remnants are more fragmented and degraded. Remnants with species composition suggesting this community were recorded in two areas of Eurobodalla Shire:

- Remnants immediately south of Moruya on ridges to the east and west of Dwyers Creek Road, contain numerous granite outcrops and remnant fig trees and appear likely to be this community, although loss of species diversity due to grazing makes them now more similar to Bega Dry Grass Forest in composition.
- The lower slopes of Gulaga Mountain around the upper limit of past clearing, carry remnant red gums and figs. However, in this area the community has been almost eliminated by lantana invasion. Remnants on outcrops within paddocks suggest that this was formerly the dominant community on monzonite-derived soils around Cental Tilba.
- The presence of figs on basalt derived soils north of Coila Lake suggests that some small remnants of this community may occur in this area.

All of this community appears to be in private ownership. The community appears more restricted in distribution and more degraded in Eurobodalla Shire compared with Bega Valley Shire.

Brogo Wet Vine Forest was not included in the SCRA classification and has been included in the re-mapping as a sub-type of FE54 labelled as FE54A (Brogo Wet Vine Forest), or in combination with Bega Dry Grass Forest as FE54/54A.

3.3 Dry Rainforest

Dry Rainforest of the South East Forests in the South East Corner Bioregion is largely a sub-community of Brogo Wet Vine Forest. It generally has a low non-eucalypt canopy dominated by Port Jackson fig, or rarely by other species such as sweet pittosporum or kurrajong (*Brachychiton populneus*), though there may be emergent eucalypts or wattles. Over-mapping of this community during the Eden CRA, based on mis-interpretation of aerial photos, led to the assumption that it can occur in stands of greater than 0.5 hectare, but such stands would be very rare, and patches which consist of only one or two large spreading fig trees and the species which grow under them are more typical. If one accepts that a single fig tree can constitute a remnant of Dry Rainforest, then remnants of this community occur in the same locations as those described above for Brogo Wet Vine Forest. There are no known larger patches of this community in Eurobodalla Shire.

3.4 Littoral Rainforest

Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions is a dense forest with a closed canopy dominated by non-sclerophyll rainforest species, which occurs in close proximity to the coast. It may be difficult to distinguish it from other rainforest types such as Warm Temperate, Subtropical or Dry Rainforest in some locations, but classic examples of this community are distinctive in being located on coastal dunes or headlands within a very short distance of the sea. Patches may also occur on the margins of coastal lakes and estuaries (NSW Scientific Committee 2004), where it becomes more difficult to decide whether they are truly littoral or not. In northern NSW there are some tree species which are largely confined to littoral rainforest, but in southern NSW much the same species occur in both littoral and other rainforest types, making the distinction more difficult. However, a few species are more typical of littoral rainforest stands, such as the trees red olive plum (*Cassine australis*), black plum (*Diospyros australis*) and cheese tree (*Glochidion ferdinandi*). These all reach their southern limit of distribution within Eurobodalla Shire and more southerly stands are dominated by species which are typically also common in Warm Temperate Rainforest, lillypilly (*Acmena smithii*), sweet pittosporum (*Pittosporum undulatum*), muttonwood (*Rapanea howittiana*) or yellowwood (*Acronychia oblongifolia*), and very rarely the dry rainforest species grey myrtle (*Backhousia myrtifolia*).

Prior to listing under the *Threatened Species Conservation Act,* Littoral Rainforest was protected under *State Environmental Planning Policy (SEPP) 26*. Stands covered by *SEPP26* were mapped, but such

mapping was not exhaustive, and additional stands may occur (NSW Scientific Committee, 2004). Littoral rainforest stands may also be very small, and may be in the process of developing beneath a sclerophyll (typically eucalypt or banksia) canopy. Such early stages in the development of littoral rainforest are unlikely to be mapped because they cannot be detected below the sclerophyll canopy on aerial photos.

The only areas of *SEPP26* Littoral Rainforest mapped within Eurobodalla Shire are five small patches in gullies on the northern shore of Tuross Lake, in a Council managed reserve, which have been checked and re-mapped as such but with more accurate boundaries. Numerous small patches have been located in National Parks and Nature Reserves along the Eurobodalla coastline, as part of an EEC mapping contract to the Department of Environment and Conservation, and with the assistance of earlier field work by Bill Peel (East Gippsland CMA, Peel, in prep.). Similar small patches may occur off-reserve, but intensive searching would be required to locate them. Likely locations are coastal headlands, sandspits at the mouths of coastal lakes, many of which are within Eurobodalla National Park, and gullies running into estuaries and lakes. Off-park examples have been recorded from the following areas:

- on the eastern side of the mouth of Cullendulla Creek just north of the nature reserve boundary;
- Tuross Heads where there are two additional patches to those mapped under *SEPP26* in gullies now surrounded by suburban development just north of the lake entrance (in Chatham Park and Clive Park);
- the eastern shoreline of Coila Lake west of Bingie Beach;
- the mouth of Flying Fox Bay on Wagonga Inlet (although the littoral nature of this stand might be disputed, being located 4km inland from the sea).

Occurring as it does along the sea or estuary shore, this community is likely to be primarily represented on public lands. It seems likely that the main factor contributing to the development of littoral rainforest patches is the protection from fire conferred by the sea or other coastal water body, many rainforest species being less well adapted than sclerophyll species to recovering after fire. In some instances cleared farming land may have provided the necessary firebreak to allow littoral rainforest to develop, as appears to have occurred south of Bingie Bingie Point in Eurobodalla National Park. Development of small littoral rainforest patches could potentially occur over quite short periods of a few decades if fire is excluded and remaining old eucalypts or banksias senesce and collapse, or if rainforest species colonise natural canopy gaps. Conversely stands can be lost to fires. This community may therefore vary in its extent over quite short time frames. The NSW Scientific Committee (2004) suggests that regenerating stands should also be included within the definition of the EEC, but give no guidance as to whether newly developing stands under a sclerophyll canopy are included.

Littoral rainforest is included in the re-mapping as FE167L, a sub-type of warm-temperate rainforest (FE167). The P5MA and SCIVI reports identify it as a discrete rainforest community, RF210 or RFp210 (Temperate Littoral Rainforest).

3.5 Themeda headland grassland

Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions is a grassy community dominated by kangaroo grass (*Themeda australis*) sparsely scattered on headlands with clay-rich soils throughout the NSW coastline. In Eurobodalla Shire it is best developed on basalt headlands, such as at Bingie Bingie Point, Jemisons Point and Mullimburra Point in Eurobodalla National Park, but it may occur on other substrates besides basalt-derived clay soils. The community also occurs at Moruya Heads, partly on Council-managed land south of the National Park.

This community was widely used for agricultural production, both grazing and occasionally cropping, up until quite recently. This has probably resulted in some loss of species unable to tolerate this degree of disturbance. More recently there has been pressure for residential development, and higher recreational pressure resulting from an increased population, the latter usually in the form of vehicle use on headlands, where this is not prevented by fencing or bollards.

An additional threat to headland grassland communities discussed by the NSW Scientific Committee is invasion by shrubs, both exotic species such as bitou bush and natives such as coast wattle (*Acacia sophorae*), coast banksia (*Banksia integrifolia*) and sheoaks (*Casuarina glauca, Allocasuarina littoralis* and *A. verticillata*) from adjacent forest or dune or headland scrub. Grassy headlands frequently have a fringe of such scrub on the steeper cliff faces, with grassland being restricted to the most exposed parts of the top of the headland. It is likely that the original grassy headlands were kept in this state by Aboriginal burning practices, since in the absence of active management they tend to become shrubby

quite rapidly. Misguided planting efforts by community groups such as occurred on Moruya South Head can accelerate this process. Lack of active management may therefore see these headland grasslands gradually revert to scrub, as in fact many have partially done already. The fact that they were formerly grassland is suggested by the continuing presence of a rare and threatened species, austral toadflax (*Thesium australe*), which only occurs in kangaroo grass grasslands or grassy woodlands, on several headlands in Eurobodalla National Park.

Most stands in Eurobodalla Shire are within Eurobodalla National Park, but there are a few small grassy patches on minor headlands between Dalmeny and Narooma which are in Council reserves. The headland closest to Narooma's Bar Beach is covered in kikuyu but on the remaining headlands sufficient indicator species were found to say that most of them do still fall within the definition of this EEC, except in areas which have been degraded by vehicle use. Being driven on will eliminate kangaroo grass and generally it is replaced by the exotic Parramatta grass (**Sporobolus africanus*). There are also patches of kikuyu and the exotic pasture species carpet grass (**Axonopus affinis*) on some headlands, and paspalum is scattered throughout. However, there are substantial patches dominated by kangaroo grass on most of the headlands. Council's policy of mowing the headlands has helped to prevent shrub invasion in some instances, although there has been some planting of non-indigenous trees such as Monterey cypress and Norfolk Island pine. One of the headlands has been substantially overgrown by native shrubs, but two have been kept largely clear of them. However, it appears that this has been at the expense of herb diversity, since the resulting mulch of mown grass is likely to suppress herbs. Most of the few herbs recorded in these areas were located on the roadside cuttings or under shrubs or planted trees, where mowing cannot reach. Fire would be an ecologically preferable way to manage the grasslands, but burning is likely to encourage greater foot and vehicle traffic before the grass recovers its previous density, which could be detrimental too. These areas therefore have some difficult management issues to be resolved. None of the Council managed grassy headlands are in sufficiently good condition for it to be worth much expenditure of resources to improve their condition, given the occurrence of larger areas generally in better condition within Eurobodalla National Park.

3.6 Bangalay Sand Forest

Bangalay Sand Forest of the NSW Sydney Basin and South East Corner Bioregions is found growing on sand close to the sea, usually on old dune systems immediately behind beaches or on sand barriers at the mouths of coastal lakes. Less commonly stands may occur on top of sea cliffs or on low hills near the sea, where there are deep deposits of sand present, such as at Burrewarra Point and behind Long Nose Point.

Bangalay (*Eucalyptus botryoides*) is generally the dominant tree species, and stands may include some blackbutt (*E. pilularis*), though it appears that stands dominated by this species may not fall within the definition of this EEC. Rarely other species may be dominant, such as silvertop ash (*E. sieberi*) at Burrewarra Point, although there is also some doubt as to whether such stands would be included within the EEC definition. There is often a subcanopy layer of the smaller tree saw banksia (*Banksia serrata*) and tree broom heath (*Monotoca elliptica*). The groundcover may include burrawangs (*Macrozamia communis*) and is typically dominated by bracken (*Pteridium esculentum*), blady grass (*Imperata cylindrica*), kangaroo grass (*Themeda australis*) and mat-rush (*Lomandra longifolia*).

The most extensive area of this community in Eurobodalla Shire (and indeed on the NSW coast south of Nowra) occurs on the large sand sheet between the Moruya and Tomaga River mouths, west of Broulee. However, there are small pockets scattered in other locations. North of Guerilla Bay the coastline is more rugged with few areas of suitable habitat, while south from Moruya many of the small occurrences of this community are protected within Eurobodalla National Park. Most of the occurrences in the Clyde estuary have already been eliminated by residential development. One small strip however, occurs along the southern shoreline of the lake behind Long Beach, to the north of the estuary, although this is dominated by forest red gum rather than bangalay, and may therefore be excluded from the EEC definition.

No additional occurrences above those already mapped were searched for during this project, since mapping of this community from air photo interpretation has previously been found to be reasonably accurate. Some small areas mapped north from the Tomaga River were checked and found in some cases to be incorrect.

One small occurrence of FE29, in which blackbutt is dominant, occurs on an elevated site north of Bingie Bingie. This has been mapped as potential EEC, but as discussed in Section 2.2 above, there is some doubt as to whether the EEC definition includes FE29.

3.7 Swamp Sclerophyll Forest

Swamp Sclerophyll Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions is a community found in drainage lines on sandy soils close to the coast, generally within areas where heath or heathy woodland is the predominant vegetation type, such as the Jervis Bay hinterland. It is dominated by swamp mahogany (*Eucalyptus robusta*), with an understorey of paperbarks (*Melaleuca* spp), shrubs tolerant of waterlogging such as *Leptospermum polygalifolium* and sedges. Swamp mahogany is very similar in appearance to bangalay, and the latter may also grow in wet situations on sand. This has given rise to the misconception that swamp mahogany occurs from about Moruya northwards, whereas in fact it does not appear to occur south of Ulladulla (J. Miles, pers. obs.). Records of swamp mahogany from Illawong Nature Reserve and from drainage lines near Congo were checked and found to be bangalay. It seems unlikely that this EEC occurs in Eurobodalla Shire.

3.8 Swamp Oak Floodplain Forest

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions is a closed forest to low scrub community generally dominated by swamp oak (*Casuarina glauca*), growing on wet flats where there is a saline influence. It may include a substantial proportion of swamp paperbark (*Melaleuca ericifolia*), or even be dominated by this species in some locations, such as localised depressions where flooding persists longer. The understorey will vary depending on the degree of salinity. At the more saline extreme this EEC grades into Coastal Saltmarsh, with many typical saltmarsh species in the understorey, such as the sedge *Baumea juncea*, sea rush *Juncus kraussii* and succulent herbs *Selliera radicans, Sarcocornia quinqueflora* and *Suaeda australis*. The only shrub or small tree component in such situations is likely to be *Melaleuca ericifolia* or *Myoporum acuminatum*. In areas with a more freshwater influence there is likely to be some shrub understorey including species not particularly tolerant of salinity such as *Coprosma quadrifida, Hymenanthera dentata* and saplings of rainforest species such as muttonwood (*Rapanea howittiana*). The groundcover layer is more likely to include freshwater sedges such as *Gahnia clarkei, Cyperus* spp and *Carex* spp, and herbs with less salt tolerance such as *Centella asiatica* and *Viola banksii*.

There may also be some intergradation of this community with surrounding eucalypt forest, with forest red gum, bangalay and woollybutt (*E. longifolia*) being the species most likely to occur in waterlogged soils. Such ecotonal stands (described as FE27 by Thomas, Gellie and Harrison) are included within either this EEC (if swamp oak is the dominant canopy species) or in River-flat Eucalypt Forest on Coastal Floodplains if eucalypts are dominant (NSW Scientific Committee, 2004).

This EEC is quite widespread along the coastal strip and on the floodplains of larger rivers such as the Moruya and Tuross Rivers. Typical situations include the margins of coastal lakes and lower parts of small creeks draining into them, the upper edge of saltmarsh or mangrove communities on tidal estuaries and depressions at the lower end of the larger floodplains. Remnants are still common in undeveloped pockets within the greater Batemans Bay area and around the edges of coastal villages such as Congo and Potato Point. Remnants on the larger floodplains, which are largely in private ownership, have been substantially degraded by past clearing (although swamp oak regrows readily from root suckers following clearing) and livestock impacts, and by deliberate draining or filling of some wet areas. Remnants around towns are less likely to have been affected by agricultural use, but are highly likely to be weedy, with fertile soils and reliable soil moisture levels making them very susceptible to weed invasion.

3.9 Freshwater Wetlands on Coastal Floodplains

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions refers to a generally herbaceous wetland vegetation type which lacks woody plants such as swamp oak and swamp paperbark. It includes a range of different species assemblages depending on the depth and degree of permanence of the swamp and the influence of saline water.

Common freshwater wetland types in Eurobodalla are areas of more or less permanent standing water such as Waldron's Swamp, which are dominated by tall emergent sedges such as *Cladium procerum, Eleocharis sphacelata* and *Typha orientalis*, and more ephemeral shallow wetlands which tend to be more grassy, with mat-forming grasses such as water couch (*Paspalum distichum*) and *Pseudoraphis paradoxa*, and herbs such as the water milfoils (*Myriophyllum* spp) and *Crassula helmsii*, which may grow either in water or prostrate on mud at the water's edge. The more permanent swamps are more likely to be in good condition than ephemeral swamps, since they are less likely to be subject to grazing and trampling by livestock, and are less prone to invasion by non-aquatic weed species, which can get a foothold in ephemeral swamps during dry periods. Aquatic weeds can be highly problematic in more permanent wetlands, and some Eurobodalla wetlands have had infestations of salvinia which have proved difficult to control.

The Moruya and Tuross floodplains are the site of some large freshwater swamps, including Waldron's Swamp and Old Man Bed Swamp on the Moruya floodplain and numerous smaller unnamed wetlands on the lower Tuross. Most of these are in private ownership, with only Illawong Nature Reserve protecting a very small proportion of these swamps. Remnant swamps occur within the suburban areas of the greater Batemans Bay area, such as at Long Beach, Catalina and Sunshine Bay. Other examples occur north east of Mossy Point and possibly at one location south west of Brou Lake.

It can sometimes be difficult to determine whether water bodies on floodplains are naturally occurring wetlands or farm dams. In some cases natural swamps may have been enhanced by creation of an artificial wall so that they hold more water. Aquatic plants generally colonise artificially constructed dams in time, blurring the distinction between natural and artificial wetlands. Identification of this EEC may therefore occasionally be problematic. Some natural wetlands may have been omitted from our mapping due to resembling an artificial dam in shape.

The question of whether wetlands are on floodplains or in dune swales (and therefore probably not covered by the EEC listing in the latter case) may also occasionally be difficult to determine. An example is the large wetland behind Long Beach, which is separated from the mouth of the Clyde estuary by a dune. It therefore appears to be a dune wetland, but it could also be interpreted as being part of the Clyde River floodplain.

3.10 River-flat Eucalypt Forest on Coastal Floodplains

River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions is a community dominated by eucalypts other than swamp mahogany (*E. robusta*). Typical dominant species mentioned in the Final Determination for this EEC which occur in Eurobodalla Shire are forest red gum, rough-barked apple (*Angophora floribunda*), river peppermint (*E. elata*), bangalay (*E. botryoides*) and blue box (*E. baueriana*). Additional species which might occur are apple-topped box (*E. angophoroides*), white or yellow stringybark (*E. globoidea* or *E. muelleriana*), ribbon or manna gum (*E. viminalis*) and, at the extreme northern end of the Shire, cabbage gum (*E. amplifolia*). River oak (*Casuarina cunninghamiana*) or swamp oak (*C. glauca*) may be present but should not be dominant. The understorey may include mesophyll (soft-leaved) shrubs such as tree violet (*Hymenanthera dentata*), coffee bush (*Breynia oblongifolia*), riparian scrub species such as sallee wattle (*Acacia floribunda*) and rainforest trees such as grey myrtle (*Backhousia myrtifolia*), lillypilly (*Acmena smithii*) and cabbage palm (*Livistona australis*), above a groundcover of mixed grasses, ferns and herbs.

The communities described for Eurobodalla Shire which most resemble the description of this EEC are FE48 and 49, some instances of FE27 and FE203. The latter is a variant of FE4849 which is said to occur only on Dignams Creek (EcoGIS, 2001), but is likely to be much more widespread. All of these communities can occur in situations other than on floodplains. For example FE4849 and FE203 can extend some distance up slopes with a sheltered aspect near rivers, even on to low ridge tops, and FE27 might occur in wet depressions behind beach dunes. Stands in situations such as this would not fall within the definition of this EEC.

A floodplain is a flat landform feature which goes under water during some floods, though this may occur only infrequently. Stands of FE4849 on slopes would definitely not qualify as the EEC because they are not on a flat, but the status of stands in smaller gullies which are tributaries of a larger floodplain is more equivocal. A case could be made for either including or excluding them from the EEC, where the gully floor is flat, with the case for inclusion being strongest where flooding on the larger floodplain downstream from the gully might back up into the gully.

Another area of ambiguity is the size of the drainage line involved. Does "floodplain" only refer to the more major rivers, or can a drainage line of any size be said to have a floodplain at its lower end? Are small flats adjacent to the higher parts of rivers part of their floodplain, if floodwaters spill over onto them at times? Are coastal saline lakes part of the floodplains of the creeks which drain into them? None of these questions are definitively answered within the Scientific Committee's Final Determination, although it does state that floodplains may occur up to an elevation of 250m above sea level, suggesting that not only the lower reaches of rivers are included. The community is only stated in the Final Determination to have definitely occurred on the Moruya River floodplain within Eurobodalla Shire, but "many smaller floodplains and river flats also contain examples of the community" (NSW Scientific Committee, 2004), so it can be expected to occur as small remnants on numerous other sites.

Previous mapping of FE4849 showed substantial areas of this community west of Nelligen and much of this appears to be correct, although as much of this area is on slopes rather than river flats, not much of it would fit the EEC definition. Most of the stands of this community on floodplains have in fact been cleared, leaving only small remnants around the edges of both large and smaller floodplains and in minor

gullies. The most conspicuous remnant is at the northern edge of the Moruya River floodplain, near the Moruya industrial area, but there are likely to be numerous smaller patches, not all of which may have been detected.

These communities have been mapped as combined forest ecosystems 48 and 49 which are the closest description to the observed species composition. The two types as essentially the same and have been combined and re-named (Eco GIS, 2000) as Coastal Lowlands Riparian Herb-Twiners-Grass Forest - various eucalypts (FE48/49). The main occurrences included in our re-mapping are in the Buckenbowra valley west of Nelligen, in scattered locations on the Mourya River Floodplain, in areas west and south of Wagonga Inlet and on the southern slopes of Little Dromedary. Along the coastline it has been found as far north as Rosedale.

Earlier mapping suggests river flat eucalypt forest occurs along parts of the Tuross River valley although it has been checked only at Belowra where it is present in remnant stands within cleared farming areas. Large areas in Kooraban National Park, on the southern valley slope of the Tuross River west of Tinpot were previously mapped by API (Nicholas Graham Higgs, 2002b) and could be expected to extend on to private land and state forest north of the river. The SCRA API does not reliably map FE48/49 in this area so it has not been feasible to undertake any further validation or re-mapping. This area is not a floodplain and so any of these vegetation communities would not constitute an EEC in this location.

3.11 Coastal Saltmarsh

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions occurs in the intertidal zone of estuaries and around the margins of intermittently opening coastal lakes and lagoons. The species composition is restricted to a relatively small number of species that can tolerate the extremes of salinity and waterlogging which occur in these locations. Some of these species can also occur in other saline locations such as on sea cliffs but the NSW Scientific Committee's Final Determination for this EEC specifically excludes such occurrences.

Saltmarsh on permanently open tidal estuaries is frequently sandwiched between the mangrove zone at the seaward side and swamp oak (*Casuarina glauca*) forest on the landward side. As such, it may frequently include scattered trees or pockets of seedlings of swamp oak, grey mangrove (*Avicennia marina*) or less commonly, river mangrove (*Aegiceras corniculatum*). Problems of definition of saltmarsh areas may arise along the interface with the mangrove and swamp oak communities. Saltmarsh may also be somewhat fluid in its extent over time, particularly in lakes which are often closed to the sea. Water levels in such lakes can rise for long periods when the mouth is closed, drowning swamp oaks and returning the lower part of the swamp oak zone to saltmarsh. Once water levels fall again, young swamp oaks will begin to recolonise the upper saltmarsh zone. Fires sweeping into the flammable sedge understorey of swamp oak stands from surrounding forest, as happened in Eurobodalla Shire in 1994, can have a similar effect.

The interface between saltmarsh and mangroves has been observed to be shifting throughout the NSW coastline in recent years (Saintilan and Williams, 2000), with mangrove seedlings invading many saltmarshes. Various possibilities have been put forward to explain this phenomenon, including nutrient-rich runoff, increased sediment supply to estuaries as a result of soil erosion in their catchments or the gradual delivery of sediment slugs in rivers created by early European clearing to the downstream end of the catchment, and sea level rise as a result of global climate change. Whatever the cause, this phenomenon may see many saltmarsh patches squeezed out of existence on the NSW south coast, since the majority of our lakes and estuaries have steeply sloping shores, leaving nowhere for saltmarsh to retreat to as the mangroves advance.

Saltmarsh has been mapped during this project as having a very patchy distribution along the length of the Shire's coastline and around some but not all tidal lakes and estuaries in both National Park and non-park areas. Some of the occurrences are on private land where it has been reduced in area or modified by drainage works or agricultural use. Despite the number of occurrences of saltmarsh it occupies a very small proportion of the estuarine areas in the shire.

4 SUMMARY AND CONCLUSIONS

Previous re-mapping projects in parks and reserves along the NSW coastline south of Nowra had found that vegetation communities in coastal and estuarine areas had been poorly mapped and in fact the coastline itself, with respect to beaches, rocky headlands and water bodies, was inaccurately delineated. These earlier findings suggested that the uncorrected versions of the Southern CRA and P5MA maps were of little utility in determining the location of the coastal EECs. For example, in the current project it was observed that discrimination between mangrove and saltmarsh was very poor in the SCRA map and that it showed little correspondence to either the P5MA map or the saltmarsh map of West *et al* (1985). Its mapping of saltmarsh in areas which are clearly mangrove, swamp oak or swamp paperbark wetlands could be either misidentification of air photo patterns or reflect physical and botanical changes over the past 20 years since West undertook his quite detailed mapping. On the basis of the findings of this current project, the latter possibility of botanical change over time could be more significant than previously recognised.

There are obviously substantial problems with most of the previous maps for determining the occurrence of EECs in Eurobodalla Shire. The West *et al* (1985) mapping has some spatial accuracy problems in many areas and covers only estuarine saltmarsh, mangroves and seagrass vegetation. The SEPP14 and SEPP26 maps suffer from spatial accuracy problems, with the SEPP14 mapping being too generalised and the SEPP26 mapping missing most of the known littoral rainforest occurrences. The CRA and P5MA API maps have easily demonstrated inadequacies, both in predicting occurrences where there are none, and in failing to detect genuine occurrences of the communities. The grid-modelled maps from the SCRA and P5MA projects were found useful as an initial guide on where to look for EECs and were utilised in some of the field maps. However, they have both boundary inaccuracies and many incorrect vegetation type assignments which make them of very limited use in EEC mapping.

The Eurobodalla coastal re-mapping, using modified SCRA mapping and containing validated mapping of two EECs for DEC parks and reserves, has provided a good starting point for the re-mapping of EECs in the Shire. Because it was originally only a coastline features map designed as a vegetation modelling input layer, it has limited reliability for vegetation typing away from the coastline and is largely uncorrected from the original. However it has, particularly in its edited form, provided a source of polygon boundaries for re-mapping and a basis on which to build a new vegetation map with a forest ecosystems classification.

Limitations of the Current Project

The re-mapping undertaken during this project has involved the use of a large number of previous mapping and information sources, the results of previous forest ecosystem validation projects, additional field site sampling and API work. Most of this information was undertaken for the Department of Environment and Conservation, and has been made available by DEC for the present work for the Council. New information on EECs has been compiled for both the DEC and Eurobodalla Shire Council EEC projects simultaneously and consolidated into the same mapping base. Because of the large geographic extent of the Shire, the API work has been limited to a small amount of re-mapping based on digital orthophotos. It was not possible within the scope and financial constraints of the project to use hard copy colour air photos under stereoscopic examination. This approach has some limitations which are discussed below.

Saltmarsh, mangrove and swamp oak communities are generally easily identifiable in orthophotos and the different patterns had already been determined by reference to stereo air photo pairs for a number of areas in previous work. It was found however, that the photo patterns of saltmarsh are highly variable in response to water levels, amount of bare sand or mud, species composition, the inter-mixing with mangrove and wetland scrub and condition related to land use. Many saltmarsh occurrences on private lands have been partially changed by grazing and may no longer fit the EEC definition. The patterns change at a local level as well as from one part of the study area to another, placing some limitations on the mapping accuracy for this community.

Considerable variability is also apparent in littoral rainforest communities, depending on the degree of understorey development and the presence of non-eucalypt emergents. Many of the littoral rainforest patches identified in the field were not mappable from orthophotos and approximate boundaries had to be mapped based on field descriptions. This would explain why this community has been largely ignored in earlier API work. Where rainforest is obvious on air photos, it had generally been mapped as warm temperate rainforest rather than littoral. Some of the variability in littoral rainforests was accommodated by mapping as a hybrid with one of the eucalypt canopy types and a littoral rainforest understorey (eg. FE28/167L). This recognises a developing littoral rainforest community but not one which currently fully

satisfies the EEC definition. Some littoral rainforest patches nominated by previous sources which were not field checked during this project have been included in the re-mapping as potential EECs.

Sand dune wetlands and freshwater floodplain wetlands are often difficult to separate using air photos and sometimes not obviously different from open water. Earlier API work has frequently confused them with swamp paperbark wetlands (FE24) or even farm dams. Some wetlands were field checked, but it was sometimes debatable whether to call them sand dune wetlands or floodplain wetlands in some areas where the two topographic situations tend to merge.

Eucalypt forest types are generally much harder to separate by API and it is not possible to map these from orthophotos. With field guidance it was possible to recognise some of the main coastal forest types such as Bangalay Sand Forest (FE28), spotted gum forests (FE9) and spotted gum - blackbutt forest (FE21) although the ecotonal swamp forest (FE27) is very difficult, and in fact was frequently wrongly mapped (and generally over-mapped) during the SCRA API work. The forest red gum forest types similarly are not mappable from orthophotos and were often interpreted as other forest types in earlier API work.

Overall, it was found that the SCRA API mapping was generally sufficiently good at delineating boundaries between forest types to form a reasonable basis for assigning forest ecosystem types and for EEC mapping. This mapping has been greatly enhanced through field checking and some modification of polygons, or creation of new polygons, based on orthophotos and this has proved to be much more efficient than starting from scratch, even in the coastal areas where the earlier API work was generally poor. Most of the hard work in fixing mapping errors along the coastline has now been done, and the present project has greatly contributed to the mapping of coastal vegetation in areas where validation and re-mapping projects had not previously been undertaken. The vegetation mapping in Eurobodalla Shire has evolved greatly during the past two years, from both the preliminary API mapping phase and from incorporating the findings of the DEC and Eurobodalla Shire Council EEC mapping projects.

At the same time, it is important to be aware that only a small portion of the SCRA API layer has been corrected and many errors in boundaries and vegetation types remain from the original work. Spatial inaccuracies, duplicate polygon boundaries and numerous slivers still exist as a result of GIS processing errors. Despite intensive editing along the coastline, some spatial inaccuracies still exist and minor mis-matches occur when compared to tenure boundaries. The P5MA mapping suffers from many of the same problems and additionally introduces a classification system which is not readily comparable to the forest ecosystems. The API mapping for the P5MA study, however, does attempt in some areas to split SCRA API polygons to more accurately show remnant vegetation in agricultural and urban areas. Within the Shire alone, it shows several thousand additional remnant vegetation polygons. It would be beneficial in future studies to identify those which may be potential EECs and to incorporate these into the SCRA based map with identification of their FE type by API. The same may also be true of the more recent SCIVI project, which post-dated the present EEC project.

Since not all locations where EECs are thought to occur in the Shire could be field checked within the scope of this project, there remains some uncertainty of vegetation type and condition and whether it constitutes one of the defined EECs in a some areas. Unless positively identified by field work or local knowledge, the relevant polygons have been flagged as potential EECs or unchecked potential EECs rather than as validated EECs.

Recommendations

For the purposes of this project, a 'validated EEC' is taken as one which has been field or API assessed as fitting the description of the corresponding forest ecosystem type. Since the vegetation at these locations will change over time as a result of dynamic environmental factors and the condition could be affected by land use or management activities (including fire and weed invasion), it is important that each location be re-assessed at an appropriate time prior to any development or management actions which could have an impact on the vegetation. The EEC work is therefore intended as an indication of the probable presence of vegetation constituting an EEC rather than a definitive statement that each occurrence fully satisfies the Scientific Committee's determination and the associated legislative provisions.

Some additional areas of uncertainty remain at the conclusion of this exercise. The question of which Forest Ecosystems are covered by various EEC definitions is still unclear in a few instances. Council may wish to seek clarification from the NSW Scientific Committee. The most important questions to resolve are whether forest dominated by blackbutt (FE29 under the SCRA classification) is included within the Bangalay Sand Forest EEC definition and whether freshwater wetlands which are located behind sand dunes could be considered as part of the Freshwater Wetlands on Coastal Floodplains EEC, when they occur close to a river or lake mouth.

The present array of EECs appears to cover the threatened ecological communities found in Eurobodalla Shire reasonably thoroughly. There is one other community which has not been listed in NSW yet but has been substantially cleared and degraded throughout its occurrence. This is the riparian river oak (*Casuarina cunninghamiana*) community found above the tidal limit on larger rivers (FE53 in the SCRA, FOWp32, Riverbank Forest in the SCIVI classification). It is somewhat better conserved than many communities associated with farming areas, being found on sections of rivers such as the Tuross, Deua and Wadbilliga which are within National Parks. Outside of such undeveloped areas it is almost invariably severely degraded, but it may not be sufficiently depleted to be eligible for listing.

It appears that Council is directly responsible for the management of some lands which carry EECs. Management plans should be prepared for these Council reserves so that limited resources can be allocated most efficiently to their maintenance.

A lot of GIS work on the new API map would be required to fix spatial inaccuracies and correct polygon anomalies throughout the shire, however, this is well beyond the scope of the present EEC work. The API layer is simply the most up to date and convenient GIS layer in which to map EECs and can be progressively updated and improved in future studies by the Council, DEC and others land managers. The EEC polygons have been lifted out of the API layer and can be used independently or merged with other forest ecosystem layers as needed. For example, in GIS terms, it would be relatively straight forward to incorporate it into the Council's vegetation GIS layer.

Future work could benefit from the use of stereo photo pairs to confirm the forest ecosystem types in some instances where it is not practical to field check them, such as in areas remote from roads or on private property where access arrangements are lacking. Eucalypt forest EECs cannot be mapped with any certainty using orthophotos and for these, a conventional API approach may be necessary. However, for efficiency, this could be combined with the amendment of linework in existing API layers overlayed on orthophotos, without having to rectify and digitise the air photo overlays.

In the final determination of EEC status in areas which are under threat from land use or development pressures, it will be necessary to undertake further botanical work to confirm EEC type and condition and the EEC mapping should be updated accordingly. Since this process may involve several State and Local Government agencies, there needs to be a process for information sharing and updating which avoids the proliferation of numerous different map versions. This is one of the reasons why the present project has utilised existing mapping and floristic site data sets used by the Department of Environment and Conservation and updated them in a consistent manner using the same methodology.

5 PROJECT TEAM

Member	Role	Expertise
Nicholas Graham-Higgs	Project Manager	Holds a BSc (U. Canberra). He has managed, and been involved with numerous development proposals and vegetation mapping exercises in South-eastern NSW.
Jackie Miles	Botanist	Holds a BSc (Hons) from ANU.. Has completed an extensive number of botanical and zoological assignments on contract to organisations and agencies such as the Department of Environment and Conservation Parks and Wildlife Service and Bega Valley Shire Council.
Phil Kendall	API, GIS mapping, and report compilation	Holds a BSc (U. Canberra). Worked for 25 years in environmental planning and specialising in GIS for the last 17 years. Has completed many GIS and environmental projects for Department of Environment and Conservation Parks and Wildlife Service and other agencies.

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Appendix 1:- EUROBODALLA SHIRE COUNCIL LOCATIONS FOR VEGETATION LAYER VERIFICATION

LOCALITY	ACCESS	COMMUNITY TO BE INVESTIGATED
Tilba Tilba	Spring Hill Road/Blue Hills Lane	Brogo Wet Vine Forest/Littoral Rainforest
Central Tilba	Punkalla Road/Mt Dromedary Trail	Brogo Wet Vine Forest/Littoral Rainforest
Mystery Bay	Mystery Bay Road	Bangalay Sand Forest/Swamp Oak Floodplain Forest
Mystery Bay	Sunnyside Road/Sneider Drive	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Nangudga	Old South Coast Road	Brogo Wet Vine Forest/Littoral Rainforest/River Flat Eucalypt Forest
Corunna (west)	Ridge Road/Old Highway	Brogo Wet Vine Forest/Littoral Rainforest/River Flat Eucalypt Forest
Wagonga (west)	Wagonga Scenic Drive	River Flat Eucalypt Forest
Kianga	Kianga Forest Road	River Flat Eucalypt Forest/Brogo Wet Vine Forest
Kianga	Princes Highway	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Dalmeny	Dalmeny Drive	Themeda Grasslands
Dalmeny	Mort Avenue	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Coila Lake	Foreshore	Saltmarsh/Swamp Oak Floodplain Forest
Meringo	Meringo Road/Spring Place	Bega/Candello Dry Grass Forest
Congo		Bega/Candello Dry Grass Forest
Bergalia	Donnellys Lane	Bega/Candello Dry Grass Forest
Bergalia	Beashels Lane	Bega/Candello Dry Grass Forest
Noggarula	Princes Highway/Noggarula Drive	Swamp Oak Floodplain Forest
Moruya South	Francis Street	Bega/Candello Dry Grass Forest/Brogo Wet Vine Forest
Moruya South	Summer Hill Road	Bega/Candello Dry Grass Forest/Brogo Wet Vine Forest
Mynora	South Head Road	Saltmarsh/Swamp Oak Floodplain Forest/Freshwater Wetland
Halyard	South Head Road, Halyard Drive	Bega/Candello Dry Grass Forest
Anchorage	Spinaker Place	Bega/Candello Dry Grass Forest
Pedro Swamp	Pedro Road	Freshwater Wetland/Swamp Oak Floodplain Forest/Bangalay Sand Forest
Wamban	Donkey Hill	Bega/Candello Dry Grass Forest
Wamban	Spring Creek Road	River Flat Eucalypt Forest
Moruya West	Turnbulls Lane	Bega/Candello Dry Grass Forest
Moruya West	Myrtle Gully	Bega/Candello Dry Grass Forest
Yarragee	River Street West	Bega/Candello Dry Grass Forest
Yarragee	Cutharich Place	Freshwater Wetland
Glenduart	McLean Place	Bega/Candello Dry Grass Forest/River Flat Eucalypt Forest
Mullenderee	Larrys Mountain Road	River Flat Eucalypt Forest/Freshwater Wetland
Mogendoura	Larrys Mountain Road, Meadows	River Flat Eucalypt Forest/Freshwater Wetland

LOCALITY	ACCESS	COMMUNITY TO BE INVESTIGATED
Moruya North	Princes Highway	Bega/Candello Dry Grass Forest/River Flat Eucalypt Forest
Waldrons Swamp	Princes Highway	Freshwater Wetland/Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Bengello	George Bass Drive	Bangalay Sand Forest
Broulee	Illawong Swamp	Freshwater Wetland
Candalagan	Riparian areas	Saltmarsh/Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Jeremadra	Maulbrooks Road	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Tomaga River	Riparian areas	Saltmarsh/Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Rosedale/Tomakin	Bevian Road/Roseby Drive	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Clyde	River	Saltmarsh/Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Catalina	Glenella Road/Curtis Road	Swamp Oak Floodplain Forest
Malua Bay	Yowani Road	Bangalay Sand Forest/Swamp Oak Floodplain Forest
Cullendulla	The Outlook Road	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest
Surfside/Maloneys Beach	The Outlook Road	Swamp Oak Floodplain Forest/River Flat Eucalypt Forest, Freshwater Wetland
Buckenbowra	Hanns Road	Brogo Wet Vine Forest
Nelligen	Paradise Road	Brogo Wet Vine Forest
Nelligen	Bolaro Road	River Flat Eucalypt Forest
Buckenbowra/Runnyford	Quartpot Road/Runnyford Road	Bega/Candello Dry Grass Forest/River Flat Eucalypt Forest
Tinpot/Yowrie	Wattlegrove Road	Brogo Wet Vine Forest
Belowra	Belowra Road	Brogo Wet Vine Forest
Nerringla		Brogo Wet Vine Forest
Araluen	Araluen Road	Bega/Candello Dry Grass Forest/River Flat Eucalypt Forest
Merricumbene	Araluen Road	Bega/Candello Dry Grass Forest/River Flat Eucalypt Forest

Appendix 2 Methodology

VEGETATION SAMPLING METHODOLOGY

Floristics Site Sampling

The areas of particular interest to the Council, with regard to potential locations of EECs in areas where developments or subdivisions may be proposed, were identified at the scoping meeting in March 2006. The Council's list of locations, reproduced in Appendix 1, was used as a basis for this process. As the field work progressed, more sites were added in an attempt to visit as many potential EEC locations as possible within the scope of the project.

The project brief did not require quadrat-based full floristics surveys, installation of plot markers or photography and the intention was to visit as many sites as possible and record only those details necessary to validate the forest ecosystem type present and whether it fitted the EEC definition. Data sheets to record location (from GPS records), a diagnostic species list and the assessed FE and EEC types, were completed at over 100 sites. This information was recorded on field data sheets and the completed data sheets have been provided to Council as an appendix to this report. The data sheets were used in the re-mapping work as discussed later in this appendix.

Forest Ecosystem Type Validation

Using the diagnostic species lists, the vegetation at each location was allocated to the closest matching forest ecosystem type, or a combination of forest ecosystems representing an ecotonal situation. Where it matched a corresponding EEC, this was indicated on the data sheets. Species lists available from various earlier mapping projects were also consulted to help confirm or refute the vegetation types mapped as occurring at the locations where these samples were taken. The locations and site numbers of these earlier floristic survey sites were printed on the field map and floristic information was retrieved using the DEC floristics sites database. In addition, quadrat-based species lists were provided by Bill Peel (East Gippsland CMA), taken in a survey of littoral rainforest and developing littoral rainforest between the Victorian border and Batemans Bay and were also added to the field maps. These lists were used to determine the location of additional small littoral rainforest patches undetectable by API and hence missing from earlier mapping.

Field maps were annotated during field work with observations on map accuracy and any obvious errors in interpretation of API which had been made in producing the maps. Often, one of the various maps used in producing the field maps would indicate the presence of an EEC, although they frequently disagreed about the extent and position of the polygon boundaries. There were, however, instances found in the field where none of the information to hand had suggested the presence of one of the target EECs, and it is still possible that other small undiscovered stands could occur in the Shire.

In particular, it was found that large areas had been excluded from vegetation typing during the CRA presumably because they contained mainly cleared or modified vegetation. These areas often contain remnants of native vegetation either as a scattered tree cover with or without native understorey or as small pockets of remnant more or less intact native vegetation. The P5MA API work has attempted to map and classify some of these remnants of native vegetation and more work has been done during this project to map those associated with EECs within areas previously mapped as excluded or cleared.

Within the budget and time constraints of this project it was not possible to visit all parts of the Shire to check the accuracy of every mapped location of the target ecosystems. However, both field checked and unchecked locations where EECs potentially occur were assessed on the orthophotos and the API mapping was confirmed or changed, as outlined below.

API METHODOLOGY

Two API methodologies were employed during this study:

- Adaptation of CRA API mapping with reallocation of polygon labels to the correct FE type,
- Preparation of new or revised API linework and coding for areas that required re-mapping.

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 ecosystem types. For example, air photo interpreters during the SRCA used the code Y to refer to both saltmarsh, mangrove and bare mud, so the API maps are not sufficiently detailed with respect to these two communities. Patches of swamp oak forest and swamp paperbark scrub (FE25 and 24) also crept into this estuarine complex as well as having separate API types such as FP or S). However, additional API work subsequently undertaken by Phil Kendall has attempted to clarify the distribution of these communities within the Shire and has been further refined during this project. Initially, API polygons have been assigned forest ecosystem codes based on the work by Gellie, Gilmour and Doherty and these have been validated or changed to reflect the new work. A shire-wide extract of the SCRA layer has been used for re-mapping of EECs for both the DEC and ESC projects.

API is unlikely to detect developing young stands of littoral rainforest, which are likely to occur under a substantial canopy of eucalypts or coastal banksia scrub. Stands are also frequently very small. For this reason the SCRA API map has been of limited assistance in detecting littoral rainforest stands and most are detectable only in the field, often by intuition or by chance.

Re-mapping

Neither the original Southern CRA vegetation map, nor the P5MA map were found to be sufficiently accurate for mapping the EECs for the reasons outlined above. The Southern CRA API mapping was the logical choice because it was generally fairly accurate for forested areas and methodology had already been developed and tested for interpretation of FE types from API codes. For non-forested areas such as coastal scrub and estuarine vegetation, cleared and urban areas and coastline features such as sand, rock and water bodies, the API mapping had already been corrected for areas south of Batemans Bay. The DEC EEC mapping had also been carried out using this layer. The P5MA mapping was, on the other hand, unmodified and untested, covered only a small part of the Shire and used a different classification which was not directly aligned with the SCRA forest ecosystems.

Additional API work was undertaken in conjunction with the GIS work by Phil Kendall. The re-mapping included delineating new boundaries for vegetation types which were not adequately represented in the existing maps as well as re-digitising some of the boundaries of polygons which were inaccurately mapped during the CRA. Work had already been undertaken to re-digitise vegetation polygon boundaries 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 (which became separate polygons). It was found that most non-eucalypt 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.

In re-mapping the EECs, many of the coastal vegetation types surrounding these were also re-mapped on the basis of field notes or API interpretation using the orthophotos. Where these types were other EECs, they were also coded accordingly or an FE code followed by a '?' was entered, denoting that this was a preliminary API identification requiring field confirmation.

The coding of polygons was guided by the results of the field work, interpretation of previous survey sites and reference to the other vegetation maps. While stereoscopic interpretation of air photo pairs would have been an advantage in some situations of doubt, the inefficiencies of this technique (large number of photos, difficulties in transferring photo boundaries to rectified GIS polygons etc), made it un-realistic for this project given the large study area, cost and time constraints.

The following sources of information were consulted in the API and GIS work:

- Digital orthophotos for the relevant parts of the Shire (mosaiced from approximately 1999 aerial photography)
- Published topographic maps and orthophotos at 1:25,000 scale
- NGH Environmental validation mapping for parks and reserves on the far south coast
- Southern CRA CRAFTI mapping with FE codes by Gellie, Gilmour and Doherty
- Additional API mapping for the coastline south of Batemans Bay by Phil Kendall
- Southern CRA forest ecosystems modelling by Thomas, Gellie and Harrison with particular reference to those FE types which could potentially contain EECs

- P5MA modelled map units
- P5MA modified SCRA API mapping for parts of the P5MA covered areas
- Estuarine vegetation mapping by West *et al* (1985)
- SEPP 14 and SEPP 26 mapping
- Clyde River NP vegetation mapping by Douglas and Bell (2003)
- Eurobodalla NP vegetation mapping by Lockwood et al (CSU, 1996)
- Arcview points layer of sites nominated by Council staff for field investigation
- Arcview point feature layer of the NPWS floristic sites survey database and P5MA sites database
- Arcview point feature layer of sites visited during the project field work
- Arcview point features layer of littoral rainforest quadrat data by Bill Peel
- The annotated API and P5MA field maps used in this project
- The data sheets for the floristic sites recorded during this project
- Draft material in this report.

GIS METHODOLOGY

Field Map Preparation

Fifteen field maps were prepared on A3 size sheets at 1:25,000 scale, for field and API work, covering the main areas of interest to the Council, in which EECs were likely to be found. The API polygons were assigned colours based on the unvalidated corresponding FE codes. For all map sheets within the P5MA mapping area (north of Moruya) an additional map was prepared showing the P5MA mapping units, with those corresponding to EECs being colour coded.

Mapping was retained in AMG Zone 56 coordinates during the course of the project, with the exception of the Belowra area which lies within Zone 55, so as to align with orthophotos and in the field maps so as to align with GPS readings and topographic maps. The two zones were eventually combined into a Zone 56 layer. All GIS information was compiled using the Australian Geodetic Datum (1966) and the appropriate Australian Map Grid for this zone was shown on the field maps.

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, previous and proposed vegetation survey sites and State Forest and DEC estate boundaries. An AMG 500m grid (zone 55 or 56) was overlayed on the maps.

Preparation of GIS Layers for Re-mapping

The Southern CRA API map used was a modified version of the original SCRA map which contained updates by Nic Gellie (EcoGIS) to 2002. Attributes were added to show FE codes for most polygons based on the work by Gellie, Gilmour and Doherty. The Eurobodalla coastline mapping which had previously been amended with coastline features was further enhanced with preliminary API mapping of coastal scrub and estuarine vegetation types based on the API orientation field work, prior to preparation of the field maps. The coverage was extended to include the whole of Eurobodalla Shire.

The SCRA map supplied by Nic Gellie was created by merging of existing State Forests RN17 API mapping and several layers of CRA API mapping derived from air photo overlays. This resulted in many sliver polygons, particularly around rainforest gullies and water bodies, making this a messy and difficult GIS layer to work with. Much editing of these slivers has taken place during previous coastline feature re-mapping, however many still remain and are difficult to remove or re-code. The re-building of correct polygon topology combined with a lot of manual editing, is beyond the scope of the present project.

Data Capture and Processing

In summary, new API line work for EECs and neighbouring vegetation 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 existing API linework and immediately coded with the forest ecosystem 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.

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

- Vegetation types which were not accurately delineated in the existing vegetation maps were re-captured by digitising directly from the digital orthophotos.
- 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.
- Polygons in the existing maps were checked as necessary by overlaying the boundaries in outline on the orthophotos and re-digitising or splitting without requiring full replacement of boundaries.
- The polygon layer was coded in ARCGIS according to the map codes marked on the field maps or interpreted from the orthophotos. Codes were added to eight new fields in the attribute table. These fields contained the quadrat number (if applicable), new FE code and status fields for recording details and update status of each polygon linework and coding and any other notes. Details of the attribute table are included in Appendix 3. The polygon layer was checked against the aerial photographs, field maps or other notes, for completeness.

The EECs map was derived from selecting out the relevant polygons from the API map and 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 must be retained with full attribute details for the purposes of analysis and any further re-mapping.

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. Significant errors were detected in the northern coastline of Eurobodalla Shire and were corrected during the API work.

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, being more likely to result from insufficient ground control points or errors in the digital elevation model used for the rectification process.

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.

Polygon Attribute Coding

Coding of the new mapping was guided by the findings of the field surveys and interpretation of the existing vegetation maps and orthophotos as listed above. Coding was an iterative process of validating the coding of polygons against the many sources of information. Comments in the attribute tables were updated to reflect the information on which code allocations were based.

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 3, including some additional fields relating to polygon and code update status (i.e changed or unchanged), final allocated new FE type and descriptive labels, field and API validation (person and date) and corresponding EEC type if applicable.

- The new FE type was firstly coded according to the findings of the field work 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 and a number of hybrid types were recognised where the vegetation did not fit neatly into one FE type. This includes those with a developing littoral rainforest understorey under a eucalypt, banksia or casuarina canopy.
- EECs which had been field validated or validated with reasonable certainty by API were indicated in the 'EEC_val' field with the corresponding FE number and the label assigned according to the title allocated by the Scientific Committee. Where there remains uncertainty of the status of an EEC, it has been re-mapped so the most probable type appears under the FE_new field and the same type followed by a '?' appears in the 'EEC_val' field. This applies in situations where a potential EEC has not yet been field validated, is not clearly identifiable on the orthophotos or may possibly be in poor condition due to farming or other land use impacts. Generally, the reason for listing as a potential EEC is specified in the 'notes' field. This may also apply to littoral rainforests which are still in a development stage and do not yet fulfil the EEC definition. A further category of potential EECs has been included by adding a double question mark ('??') after the FE number in the 'EEC_val' field. Such polygons occur throughout the Shire in all tenures and relate to the original coding by Gellie et al. Since these locations lie outside the priority areas for re-mapping, they have not been field or API checked. They have been assigned the category 'Unchecked Potential EECs' which require further investigation to determine their true FE type. The purpose of including unvalidated EECs is to recognise that these polygons are potentially EECs but further investigation would be needed to confirm or refute this. This would need to be done if there are any developments proposed in the vicinity or changes in management policy. During the re-mapping process, many polygons were split to better represent the patterns evident from the field or API work and each new polgon was given appropriate revised codes.
- The mapping was checked by Jackie Miles and the coding was further refined and anomalies rectified.

A full list of attribute codes is contained in Appendix 3 along with a description of the GIS layers supplied on the data CD.

Survey Site Mapping

Field data sheets were completed during the field work with partial species lists. To facilitate the mapping work through having ready access to this information in electronic format, the field sheets were entered to a Microsoft Access Database developed by DEC, which allowed maximum automation of data entry and provided a suitable means of analysing and re-formatting the data into GIS format.

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 and GDA eastings and northings), 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. The sites and floristics tables were used in checking the new forest ecosystems map coding and in helping to identify and resolve anomalies. Additional GPS readings during the field surveys were entered into a spreadsheet with appropriate comments and converted to a GIS point layer. This proved invaluable in the API work, particularly where the vegetation patterns were hard to distinguish on orthophotos.

Appendix 3

GIS Details - including list of GIS layers and sources, explanation of attribute tables

The data set included on the CD, which accompanies this report, includes the edited API layer, together with extracted EEC layers in a variety of projections and datums. The work was carried out in the old AGD 66 datum and AMG Zone 55/56 projection and later converted to ISG Zone 56-1 and GDA (MGA) Zone 56. The files are all in ArcView GIS shapefile format which can be converted directly to MapInfo.

Since some of the information in the new mapping is the property of DEC or derived from DEC GIS data, it should not be reproduced or passed to additional parties without the permission of DEC and due acknowledgement to the information sources.

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 but have additionally been converted to MapInfo MIF files. 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.

Floristics Site Data

The following data are derived from the DEC access database.

floristic_sites_02-06_z55.shp and *floristic_sites_02-06_z56.shp - s*urvey sites which were recorded on field data sheets and entered in the Access sites database then transferred to ArcView. The sites in Eurobodalla Shire have been extracted from the DEC floristics database.

floristics_data_02-06.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).

Eurobodalla_sites_2007_z56.shp and Eurobodalla_sites_2007_z55.shp : Site records layers in GIS form, derived from the field survey work and used in the re-mapping work.

Eurobodalla_floristics_2007.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).

API_Vegetation_Maps

These are the individual layers updated during the DEC and ESC EEC projects. They are based on a SCRA API layer for the Eurobodalla coastline which was initially used to re-map coastline features (water bodies, rock and sand areas) and has been progressively updated to re-map coastal vegetation including EECs. The layer has been extended to cover the whole of Eurobodalla Shire. It included new mapping for Eurobodalla NP, Clyde River NP, Cullendulla Creek, Broulee Island and Illawong Nature Reserves as well as Shire lands and non-validated FE mapping for other areas including state forests and the large inland national parks.

Eurobodalla_api_z56_agd_01-07.shp - Eurobodalla Shire API mapping containing validated and potential EECs in AMG Zone 56 (AGD66).

Eurobodalla_api_z55_agd_01-07.shp - the equivalent of the above - converted to AMG zone 55 for mapping of inland areas. The two layers are otherwise identical.

The Arcview legend Eurobodalla_api_FE_new.avl is also included.

The above layers are in AGD 66 datum in AMG coordinates . Equivalent layers in ISG Zone56 - 1 and GDA (MGA Zone 56) are also included on the CD.

EEC_map_layers

These have similar file names as the source API layers and are a subset of the API layers which include validated and potential (non-validated) EECs, with full attribution and in Arcview, the same FE legends can be used. The layers include:

Zone56_EECs.shp and Zone56_*EECs.shp*

Zone56_validated_EECs.shp, Zone56_*potential_EECs.shp and Zone56_unchecked potential_EECs.shp*

Zone55_validated_EECs.shp, Zone55_*potential_EECs.shp and Zone55_unchecked potential_EECs.shp*

The above layers are in AGD 66 datum in AMG coordinates. Equivalent layers in ISG Zone56 - 1 and GDA (MGA Zone 56) are also included on the CD.

Dissolved polygon versions of the individual EEC layers have also been prepared for use in the final maps but require further editing and will be included on the data CD with the final report.

POLYGON ATTRIBUTE TABLES

The SCRA API layer used for this project is one which has been adapted by Nic Gellie (EcoGIS 2002) and all attributes from this work have been retained. Additional fields in the polygon attribute tables were used in the DEC FSC modelling project and have been utilised for the purposes of recording changes during the EEC validation and re-mapping work for Eurobodalla. They include **code_stat, poly_stat, review_stat, origin** and **layer**. The attribute codes added for the EEC mapping, which are common to all layers, are explained below.

FE_new the newly 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 based on CRA mapping classifications with some additions during this project

quadrat floristics site(s) present in the polygon either from previous surveys or the present project (excluding Bill Peel's sites which are not yet in a final database form)

EEC_val the FE type corresponding to an EEC which has been validated or may potentially be present on the basis of existing information. A '?' indicates the type is still uncertain, the location has not been field checked or positively identified by API or the condition of the vegetation is doubtful such as to question EEC status. Hybrid vegetation types where one of the types is an EEC and the other is not, are generally excluded from this field. FE types followed by a '??' indicate the location has not been investigated either in the field or by API and the FE type is included on the basis of earlier mapping only.

EEC_label a shortened version of the NSW Scientific Committee's name for the EEC as specified in the Schedule 1 - Part 3 of the *Threatened Species Conservation Act* - which corresponds to the FE type which has been validated. Only validated EECs have been given a label while non-validated EECs are indicated only in the EEC_val field.

field_val who by and when locations in a polygon were field inspected

API_val who by and when the polygon was validated by API

notes further information relating to the validation and re-mapping which explain some of the decisions made or add to the information contained in other fields.

In the API GIS layer, polygons are coded in the attribute tables under 'FE_new', with the corresponding FE label, and are assigned colours which are coded according to these FE types. However, those polygons which correspond to the two target EECs may be either validated or unvalidated EECs and this is apparent in the attribute tables under the field 'EEC_val', which contains the corresponding FE code. If the polygon has been field validated or validated by API with reasonable confidence, then it has been labelled as a validated EEC and the appropriate name assigned by the Scientific Committee has been added as an EEC label. However, if the polygon is a non-validated EEC then the FE type is followed with

a '?' or '??" and there is no entry in the EEC label field. Unvalidated EECs are included to recognise that they may be potential EECs which require further investigation. This could be because of a number of reasons which include:

- the FE type is a hybrid with another type and as such may not meet the EEC definition;
- the location has not been field validated or not confirmed on the orthophotos;
- the condition of the vegetation is likely to be reduced as a result of past disturbance, and it may not meet the EEC definition;
- it has been reported as a potential EECs in earlier vegetation maps or reports but needs further investigation.

The 'notes' field may provide further information where relevant.

Hybrid FE types are have been mapped in some instances where the vegetation types do not fit neatly within the forest ecosystems classification or an EEC definition. It is debatable whether or not hybrid types constitute an EEC. In the re-mapping, where a polygon has been field validated as having components of two EECs, it has been included as a validated EEC.

Appendix 4 Information included on Data CD

The following information is included on the CD accompanying this report.

- Appendix 3 in the form of a Microsoft Word document file which serves as a guide to the data set contents.
- The GIS data layers as outlined in Appendix 3 in Arcview GIS format.
- The forest ecosystems maps for twenty (20) 1:25,000 map sheets covering the key parts of the Shire where EECs have been re-mapped. These are in high resolution PDF format suitable for on screen viewing or printing.
- This report in the form of a Microsoft Word document (compatible with Word 97/2000).

Appendix 5

Maps

Map 1:- Long Beach Area

Map 2:- Clyde Estuary North

Map 3:- Buckenbowra North

Map 4:- Buckenbowra South

Map 5:- Clyde Estuary South

Map 6:- Batemans Bay

Map 7:- Tomaga River Area

Map 8:- Broulee Area

Map 9:- Moruya Heads, Congo

Map 10:- Moruya Floodplain

Map 11:- Bergalia Area

Map 12:- Meringo, Bingie

Map 13:- Bodalla, Tuross River

Map 14:- Tuross, Potato Point

Map 15:- Brou Lake, Dalmeny

Map 16:- Narooma, Wagonga Inlet

Map 17:- Corunna Lake

Map 18:- Mystery Bay, Wallaga Lake

Map 19:- Belowra North

Map 20:- Belowra South