Assessment of River-Flat Eucalypt Forest on Coastal floodplains TEC on NSW Crown Forest Estate

Survey, Classification and Mapping Completed for the NSW Environment Protection Authority

www.epa.nsw.gov.au

Environment Protection Authority

Published by:

Environment Protection Authority
59 Goulburn Street, Sydney NSW 2000
PO Box A290, Sydney South NSW 1232
Phone: +61 2 9995 5000 (switchboard)
Phone: 131 555 (NSW only – environment information and publications requests)
Fax: +61 2 9995 5999
TTY users: phone 133 677, then ask for 131 555
Speak and listen users: phone 1300 555 727, then ask for 131 555
Email: info@environment.nsw.gov.au
Website: www.epa.nsw.gov.au

Report pollution and environmental incidents
Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
See also www.epa.nsw.gov.au

ISBN 978-1-76039-527-8
EPA 2016/0620
October 2016

Contents

1 Overview

River-flat Eucalypt Forest on coastal floodplains is one of several Threatened Ecological Communities (TECs) associated with coastal floodplains with a potential distribution that spans the entire NSW coastal region. River-flat Eucalypt Forest (RFEF) is a complex aggregate of a number of previously-described communities and has a very variable dominant tree stratum, with 14 eucalypts being listed as possible dominant species, depending on the location. For this report, we focus on the area south of Sydney, where widespread and common dominant species are listed as *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple), *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay), *E. elata* (river peppermint) and *E. ovata* (swamp gum). The final determination cites seven previously described communities relevant to the South Coast. For each of the communities, the determination explicitly includes only certain components, either 'dominated by eucalypts' (in three cases), 'mapped on alluvial soils' (two cases) or 'mapped on floodplains' (one community). However, there are no standard maps which may be used to make these assessments. The northern extent (Sydney north to Queensland) of this TEC is subject to a separate assessment and report.

We used a combination of an existing map of coastal landforms and geology and several models of alluvial landform features to determine the likely extent of floodplains and alluvial soils in our study area. We used aerial photograph interpretation to map vegetation patterns within floodplain and alluvial areas, and to map photo-patterns likely to indicate the presence of River-flat Eucalypt Forest outside modelled areas. Over 350,000 hectares of state forest are included in our assessment.

Our analyses of plot data assigned 520 plots (out of 6634) to either a previously defined River-flat Eucalypt Forest community or a new community, 'South Coast Creek Flat River Peppermint Forest' characterised by *Eucalyptus elata*, which we defined from additional plot data and which we regard as similar to River-flat Eucalypt Forest. Of these plots, we assessed 214 (89 of which are in state forest) as also meeting the qualifying criteria and belonging to River-flat Eucalypt Forest. We used plot data and a selection of environmental and remote-sensing variables to develop a Boosted Regression Tree (BRT) model of the probability of occurrence of River-flat Eucalypt Forest. We assigned our mapped polygons to River-flat Eucalypt Forest based on plot data, overstorey and understorey attributes, landform features and modelled probabilities. We also assessed the BRT model to ensure that all areas of potential River-flat Eucalypt Forest had been checked using API and mapped as appropriate.

From these assignments we constructed a map of the TEC that is at a scale commensurate with the needs of field operations. In total, we identified approximately 3813 hectares of River-flat Eucalypt Forest in state forest south of Sydney. We used independent samples to demonstrate that there are few stands of this TEC situated in suitable habitat outside our mapped area.

The major factors which affect the accuracy of our TEC map are the inherent uncertainty in the final determination, the variability of vegetation and relationships between vegetation and environment and inaccuracies in mapped vegetation and environmental data. We believe that both our interpretation of the TEC and our treatment of mapping uncertainty arising from variability in vegetation and environment have been precautionary. We have chosen to minimise the likelihood that areas of RFEF, as we have interpreted it, occurs outside our mapped area. This necessarily results in a higher likelihood that we have included areas which are not TEC within our RFEF operational map. We estimate that we have achieved greater than 95% accuracy of mapping RFEF where it occurs, but this results in a high likelihood that we have included some areas of native forest that are unlikely to be the TEC. The error within our mapped boundaries could be reduced through a combination of additional survey effort, higher resolution environmental data in parts of the study area, and refinements to the current determination.

2 Introduction

2.1 Project Rationale

This project was initiated by the NSW Environment Protection Authority (EPA) and Forestry

Corporation of NSW (FCNSW) as a coordinated approach to resolve long standing issues surrounding the identification, extent and location of priority NSW Threatened Ecological Communities (TECs) that occur on the NSW State Forest estate included within the coastal Integrated Forestry Operation Approval (IFOA) areas.

2.2 Final Determination

River-flat Eucalypt Forest on coastal floodplains (RFEF) is one of several Threatened Ecological Communities (TECs) associated with coastal floodplains. An assessment of the characteristics and conservation status of vegetation on coastal floodplains and associated landforms in NSW was initially made by Keith and Scott (2005). While it was *in press* at the time, this assessment provided important information for the determination of River-flat Eucalypt Forest on coastal floodplains. It was first gazetted as an Endangered Ecological Community on 17 December 2004. Minor amendments were subsequently made to the determination which were gazetted on 8 July 2011.

Paragraph 4 of the final determination (NSW Scientific Committee 2011) states that the community 'has a tall open tree layer of eucalypts'. Although neither 'tall' nor 'open' is defined, this statement implies that stands without eucalypts do not belong to the community, but leaves open the question of the scale at which this characteristic applies. RFEF has a very variable dominant tree stratum, with 14 tree species being listed as possible dominant species, depending on the location. Widespread and abundant dominants are listed as including *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). For areas south of Sydney, *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay), *E. elata* (river peppermint) and *E. ovata* (swamp gum) ‘may be common’. Other possible dominant species south of Sydney include *Eucalyptus longifolia* (woollybutt), *E. moluccana* (grey box) and *E. viminalis* (ribbon gum).

Paragraph 6 of the final determination (NSW Scientific Committee 2011) cites Keith and Scott (2005) as identifying a group of vegetation samples which belong to the community. The particular group is not explicitly stated, but it may be inferred from the context of the report and the name that the determination refers to Keith and Scott's group 7, River-flat Eucalypt Forest on coastal floodplains. It is ambiguous whether all of the 45 samples allocated to Keith and Scott's group 7 are considered to belong to the community, as 22 of them are assessed as not floodplain vegetation and none are strictly on alluvium. The results of the study are used to infer that there are a number of floristic attributes of RFEF that can be used to distinguish it from other TECs on floodplains namely the relatively low abundance or sub-dominance of Casuarina and Melaleuca species and the relatively low abundance of *Eucalyptus robusta*.

Paragraph 7 of the final determination (NSW Scientific Committee 2011) refers to other Endangered Ecological Communities which may adjoin or intergrade with RFEF and states that these collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. However, no evidence is provided to support this statement. It appears to be an assumption rather than a statement of fact.

Paragraph 8 of the final determination (NSW Scientific Committee 2011) refers to communities or map units described by previous studies, which ‘include’, are ‘included within’ or are otherwise related to River-flat Eucalypt Forest on Coastal Floodplains. These offer important information of potential diagnostic value, although in some cases there is only a partial relationship and the limits of the relationship are not clear. Although not explicit, it may be inferred from paragraph 8 that a community or map unit which is described in a cited study but not mentioned in the determination is not referable to River-flat Eucalypt Forest. This inference is consistent with the extent estimates provided in paragraph 9, but may not be consistent with statements in paragraph 7 pertaining to intermediate assemblages and transitional habitats, depending on how the terms ‘intermediate’ and ‘transitional’ are interpreted.

2.3 Initial TEC Reference Panel Interpretation

Under the *Threatened Species Conservation Act 1995* (TSC Act), TECs are defined by two characteristics: an assemblage of species and a particular location. The TEC Panel agreed that the occurrence of RFEF is constrained to the IBRA Bioregions stated in the determination, but that contiguous areas within adjacent bioregions should be included in analysis and mapping where appropriate. The panel agreed that RFEF is a TEC which has been defined primarily from previous quantitative floristic analyses. Accordingly, the assemblage of species is interpreted by reference to vegetation communities which have been previously described from quantitative floristic analysis and which have been explicitly listed in the determination. From the final determination, some previously defined assemblages are only partially included in RFEF, depending on environmental features. The panel noted that these qualifiers should be considered in assessing RFEF.

From the final determination for RFEF, Table 1 summarises the key determining features of RFEF and how they have been used in the assessment reported here, based on the interpretation of the features by the Panel.

Table 1: Key features of River-flat Eucalypt Forest of potential diagnostic value. Numbers in the left-hand column refer to paragraph numbers in the final determination.

	Feature	Diagnostic value and use for this assessment
1	NSW occurrences fall NSW North Coast, Sydney Basin and South East Corner bioregions	Explicitly diagnostic, but used with some allowance for occurrence outside. This assessment focuses on the region south of Sydney and as a result only the Sydney Basin (in part) and South East Corner bioregions are considered
1	Associated with silts, clay-loams and sandy loams	Indicative, not used
1	On periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.	Diagnostic, depending on agreed definition of landform features
1	Generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m	Implicitly diagnostic; 250 m elevation used as a threshold unless there is clear evidence otherwise
1,4	Structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees	Indicative, but used to exclude treeless vegetation
1	Characterised by the listed 86 plant species, including 14 eucalypts	Potentially diagnostic, in the context of previously described communities cited in the determination
2	Known from 28 LGAs but may occur elsewhere	Indicative, not used

	Feature	Diagnostic value and use for this assessment
4	The most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay) and *E. elata* (river peppermint) may be common south from Sydney. Other eucalypts including *Eucalyptus longifolia* (woollybutt), *E. moluccana* (grey box) and *E. viminalis* (ribbon gum) may be present in low abundance or dominant in limited areas of the distribution	Indicative, not used
4	Description of understorey, listing 6 small tree species, 8 shrub species and 9 ground cover species which may be present	Indicative, not used
6	Description of differences in tree species composition and environmental differences from other EECs on coastal floodplains	Indicative, but used to distinguish areas which are floristically similar to two or more EECs
8	On the south coast of NSW, this community includes those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) of Thomas et al. (2000) dominated by eucalypts, those parts of 'Coastal Lowlands Riparian Herb/Grass Forest' (forest ecosystem 48) and 'Southern Hinterland Shrub/Herb/Grass Riparian Forest' (forest ecosystem 49) of Thomas et al. (2000) mapped on alluvial soils, and those parts of 'Cumberland River Flat Forest' (map unit 33) and 'Floodplain Swamp Forest' (map unit 105) of Tindall et al. (2004) that are dominated by eucalypts. In the Eden region, this community includes forested parts of 'Floodplain Wetlands' (map unit 60) that are dominated by eucalypts and parts of 'Bega Wet Shrub Forest' (map unit 19) that are mapped on floodplains (Keith & Bedward 1999)	Used as the main comparative diagnostic feature, including qualifications of individual communities relating to tree species composition and environmental features, to the extent that those features can be recognised

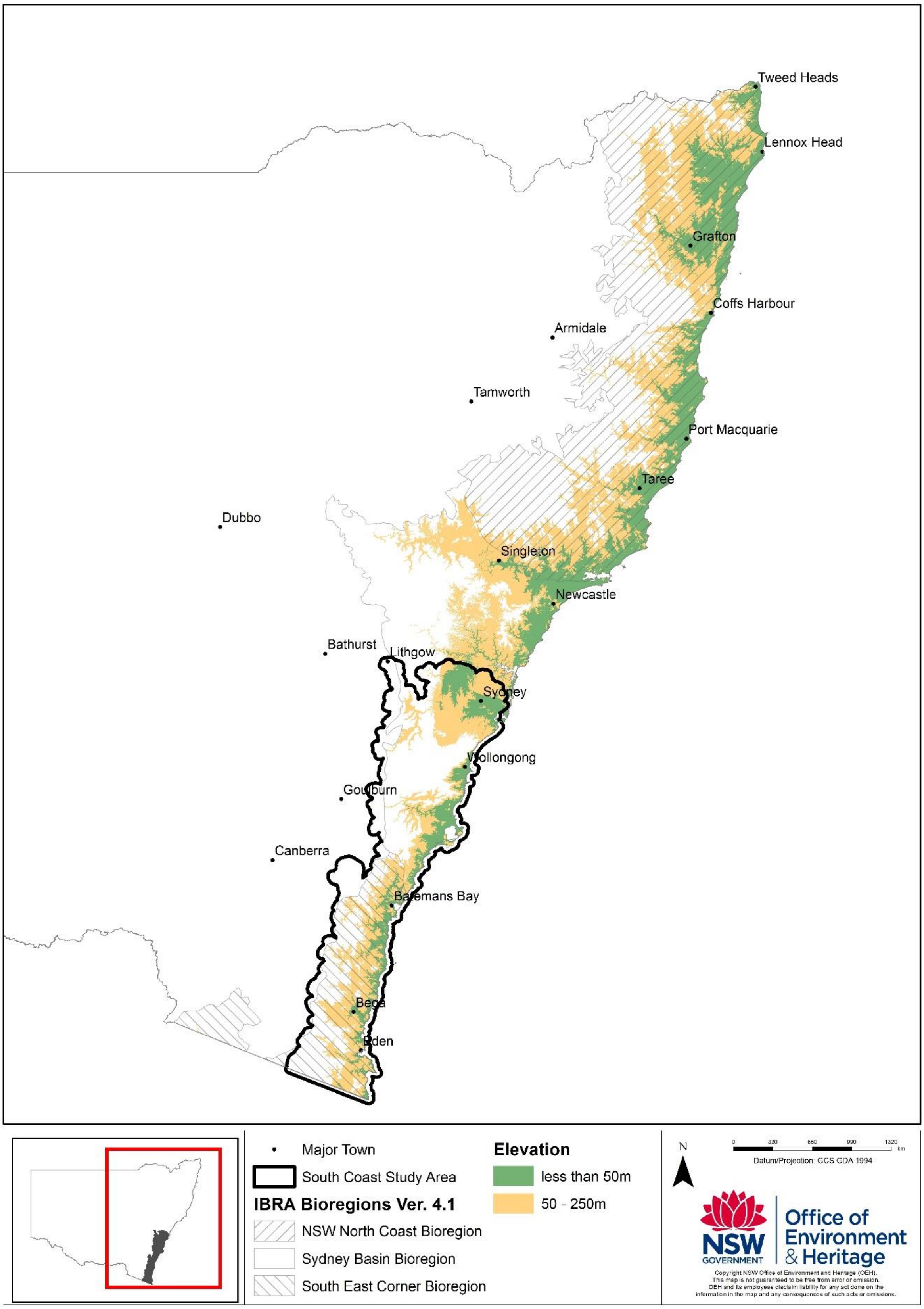
2.4 Assessment Area

2.4.1 Location and study area boundaries

We partitioned the assessment of River-flat Eucalypt Forest on coastal floodplains TEC into two study areas: the North Coast and South Coast. We did this to minimise the risk that relationships between regional vegetation communities and the TEC would be confounded or masked by geographical variation or other major ecological gradients, which might otherwise be a significant risk if we had treated the full latitudinal range of the TEC as a single study area. For our purpose, the Sydney metropolitan area provides a convenient boundary because it approximates a significant ecological boundary and because it is a highly modified landscape which does not contain any state forest to be assessed for our project.

Our South Coast study area is shown in Map 1. This area includes all of the South East Corner bioregion, all IBRA subregions south from the Hawkesbury River in Sydney Basin bioregion, a 5 kilometre-wide perimeter zone on these areas, and areas below 250 metres elevation in river valleys in South East Highlands bioregion. We considered that this would include all vegetation relevant to any TEC likely to occur in state forests on the NSW South Coast, from Sydney down to the Victorian border. Within our South Coast study area, there are no lowland state forests north of Nowra and most of our assessment of floodplain TECs was concentrated on the area south of Nowra. Many of the maps in this report show only the most relevant section of our study area, south of Nowra.

<u>Map 1</u>: South Coast assessment area showing bioregions and elevation thresholds.



2.4.2 State Forests subject to assessment

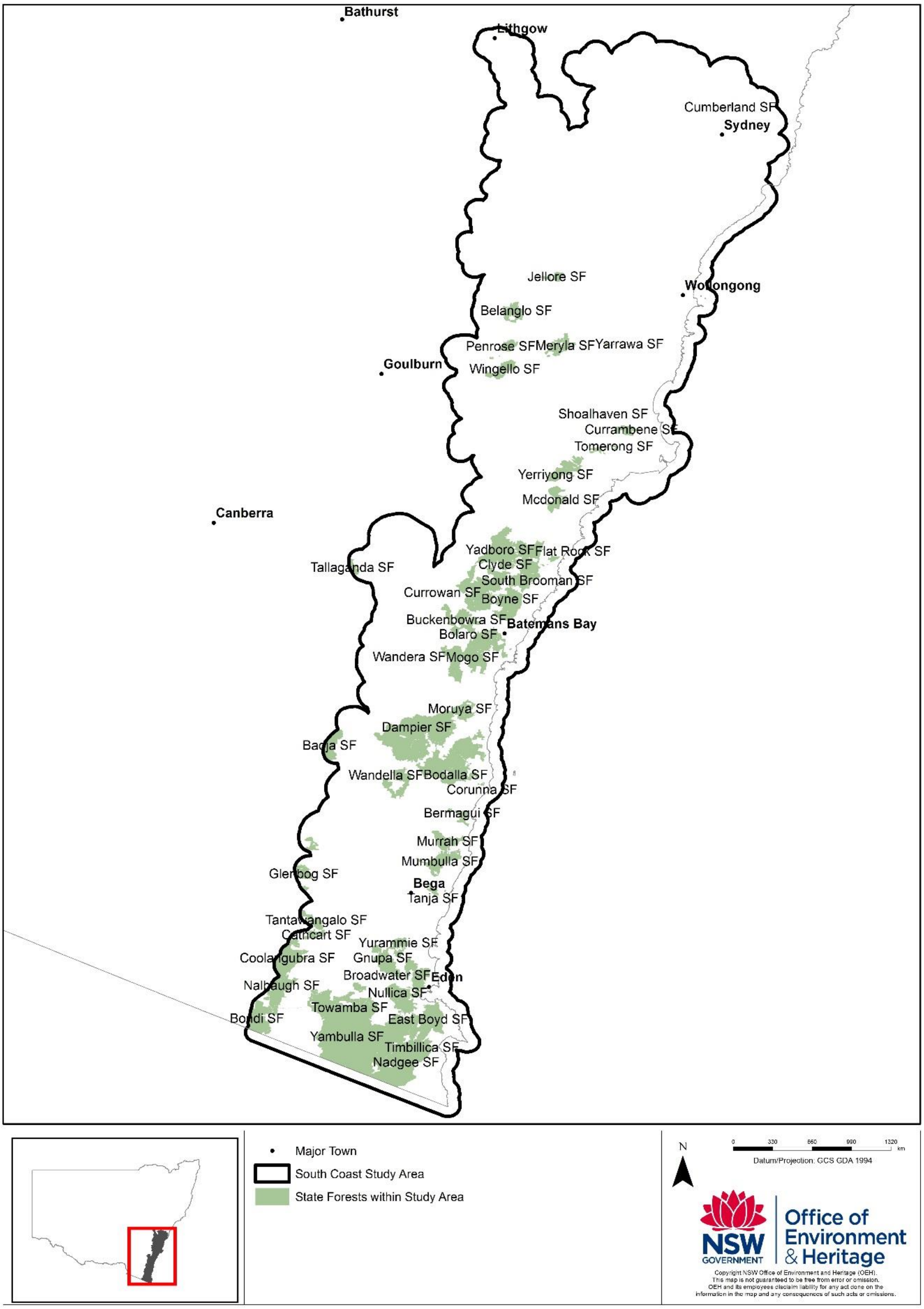
The South Coast study area includes Crown forest estate situated within Southern and Eden Integrated Forestry Operations Approval (IFOA) regions. A total of 61 state forests were included in this assessment (Table 2). State forests excluded from the assessment include those areas defined as Forest Management Zones 5 (Hardwood Plantations) and Zone 6 (Softwood Plantations). Small areas of native forest wholly enclosed or adjoining Forest Management Zone 6 (Softwoods) are also excluded from assessment as they are considered to be outside of the authority of the IFOA.

Table 2: List of candidate state forests assessed in the South Coast study area.

State Forest	Area (Ha)	State Forest	Area (Ha)
Badja State Forest	4839	Moruya State Forest	4059
Bateman State Forest	1	Mumbulla State Forest	6137
Belanglo State Forest	3891	Murrah State Forest	4215
Benandarah State Forest	2761	Nadgee State Forest	20537
Bermagui State Forest	1861	Nalbaugh State Forest	4396
Bodalla State Forest	24079	Newnes State Forest	281
Bolaro State Forest	1779	North Brooman State Forest	3631
Bombala State Forest	620	Nowra State Forest	521
Bondi State Forest	12742	Nullica State Forest	18298
Boyne State Forest	6161	Nungatta State Forest	887
Broadwater State Forest	167	Penrose State Forest	1986
Bruces Creek State Forest	791	Shallow Crossing State Forest	3855
Buckenbowra State Forest	5193	Shoalhaven State Forest	104
Cathcart State Forest	1735	South Brooman State Forest	5587
Clyde State Forest	3587	Tallaganda State Forest	1363
Coolangubra State Forest	8489	Tanja State Forest	867
Corunna State Forest	183	Tantawangalo State Forest	2466
Currambene State Forest	1695	Termeil State Forest	698
Currowan State Forest	11977	Timbillica State Forest	9144
Dampier State Forest	33746	Tomerong State Forest	212
East Boyd State Forest	21010	Towamba State Forest	5471
Flat Rock State Forest	4896	Wandella State Forest	5492
Glenbog State Forest	4641	Wandera State Forest	5198
Gnupa State Forest	1318	Wingello State Forest	3975
Jellore State Forest	1411	Woodburn State Forest	10
Jerrawangala State Forest	268	Yadboro State Forest	10750
Kioloa State Forest	171	Yambulla State Forest	47108
Mcdonald State Forest	3684	Yarrawa State Forest	179
Meryla State Forest	4554	Yerriyong State Forest	6604

Mogo State Forest	15498	Yurammie State Forest	4050
		Total	352931

<u>Map 2</u>: Candidate state forests assessed.



2.5 Project Team

This project was completed by the by the Ecology and Classification Team in the OEH Native Vegetation Information Science Branch. It was initiated and funded by the NSW Environment Protection Authority under the oversight of the Director Forestry.

The project was managed by Daniel Connolly. Doug Binns undertook the floristic analysis of survey plots, and has interpreted the relationships and relatedness between relevant vegetation communities. Allen McIlwee performed the spatial analysis including fine scale modelling of alluvial floodplain extent, and broad scale predictive distribution modelling. Owen Maguire and Bob Wilson undertook API mapping using 3D stereo imagery across the study area. Flora survey plots were completed by Jackie Miles and Paul McPherson (Eden area), with additional samples completed by Ken Turner, Jedda Lemmon and Doug Binns. Field assistance was provided by Paula Pollock (EPA), Alex Waterworth (EPA), Ken Turner, Daniel Connolly, Philip Gleeson, and Josh Madden (EPA). Dan Bowles provided GIS, mapping and technical support.

3 Methodology

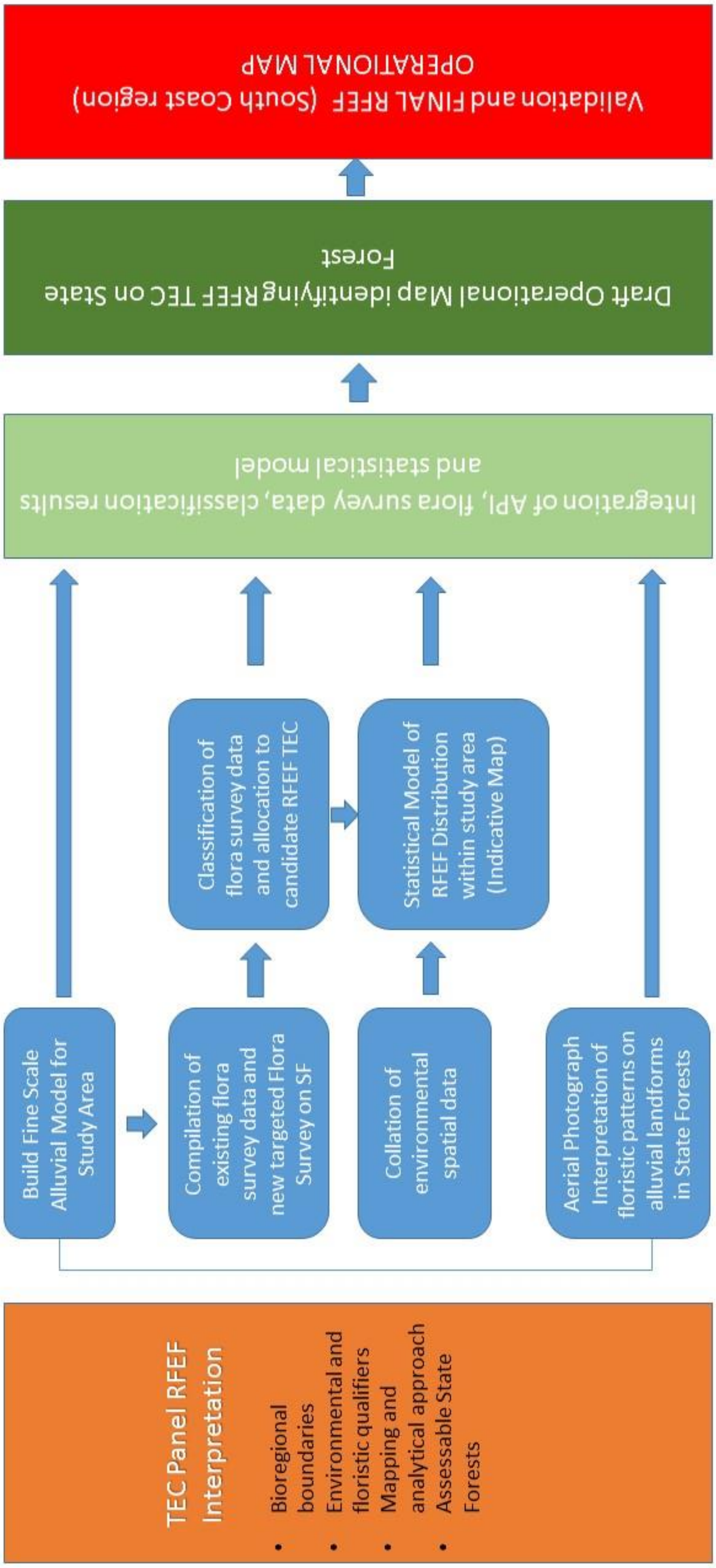
3.1 Approach

Diagram 1 provides a schematic overview of our approach. Analysis and mapping was guided by the general principles and particular interpretation of River-flat Eucalypt Forest (RFEF) TEC adopted by the TEC Reference Panel, described in Section 1.2. For the purpose of this project, RFEF is interpreted to be defined primarily by floristic plot data previously allocated to vegetation communities which have been described from quantitative floristic analysis and which have been explicitly listed in the final determination. However, because the communities relevant to the NSW South Coast are listed as only partially attributable to RFEF, conditional on landscape features or dominant tree species, these two factors have also been taken into account. The following statements from the determination provide the basis for comparative analysis: ‘On the south coast of NSW, this community includes those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) of Thomas et al. (2000) dominated by eucalypts, those parts of 'Coastal Lowlands Riparian Herb/Grass Forest' (forest ecosystem 48) and 'Southern Hinterland Shrub/Herb/Grass Riparian Forest' (forest ecosystem 49) of Thomas et al. (2000) mapped on alluvial soils, and those parts of 'Cumberland River Flat Forest' (map unit 33) and 'Floodplain Swamp Forest' (map unit 105) of Tindall et al. (2004) that are dominated by eucalypts. In the Eden region, this community includes forested parts of 'Floodplain Wetlands' (map unit 60) that are dominated by eucalypts and parts of 'Bega Wet Shrub Forest' (map unit 19) that are mapped on floodplains (Keith & Bedward 1999). However, in each case the cited studies have been superseded by more recent studies using a larger pool of data but maintaining the previously defined communities units or their equivalent. For our analyses, we used results from these more recent studies, as described below in Section 2.3.1.

The final determination does not cite a map resource that can be used as a primary layer to guide the location of suitable landscape features used in the TEC definition. Since the date of the determination a set of maps of landform features has been developed which allows parts of the cited communities that are mapped on floodplains or mapped on alluvial soils to be distinguished to some extent, although the scale is not always suitable for our purpose and finer-scale alluvial features are omitted (Troedson & Hashimoto 2008). There is no reference to these maps in the determination. In addition to these maps, we have developed a fine scale alluvial model, described in Section 2.2.2, to map areas of potential alluvial features.

Plots in which standard floristic data have been collected (comprising data already held in the OEH VIS flora survey database over all tenures and data collected specifically for this project in state forests) were compared with plots previously allocated to the communities’ equivalent to those listed in the RFEF determination. A number of methods were used for comparison, comprising both dissimilarity-based methods and methods based on multivariate regression. The results were then used to assess the likelihood that plots in state forests belonged to one or more of the communities listed in the determination. There is no single preferred method of making these comparisons and no objective threshold to determine whether or not a plot belongs to a community (and thus RFEF). Options for different methods and thresholds represent narrower or broader interpretations of RFEF, but this approach using plot-based floristic comparison provides a means of consistently allocating plots to being either RFEF or not for a range of interpretation options.

<u>Diagram 1</u>: Schematic overview of approach.



3.2 Identifying Alluvial Landforms

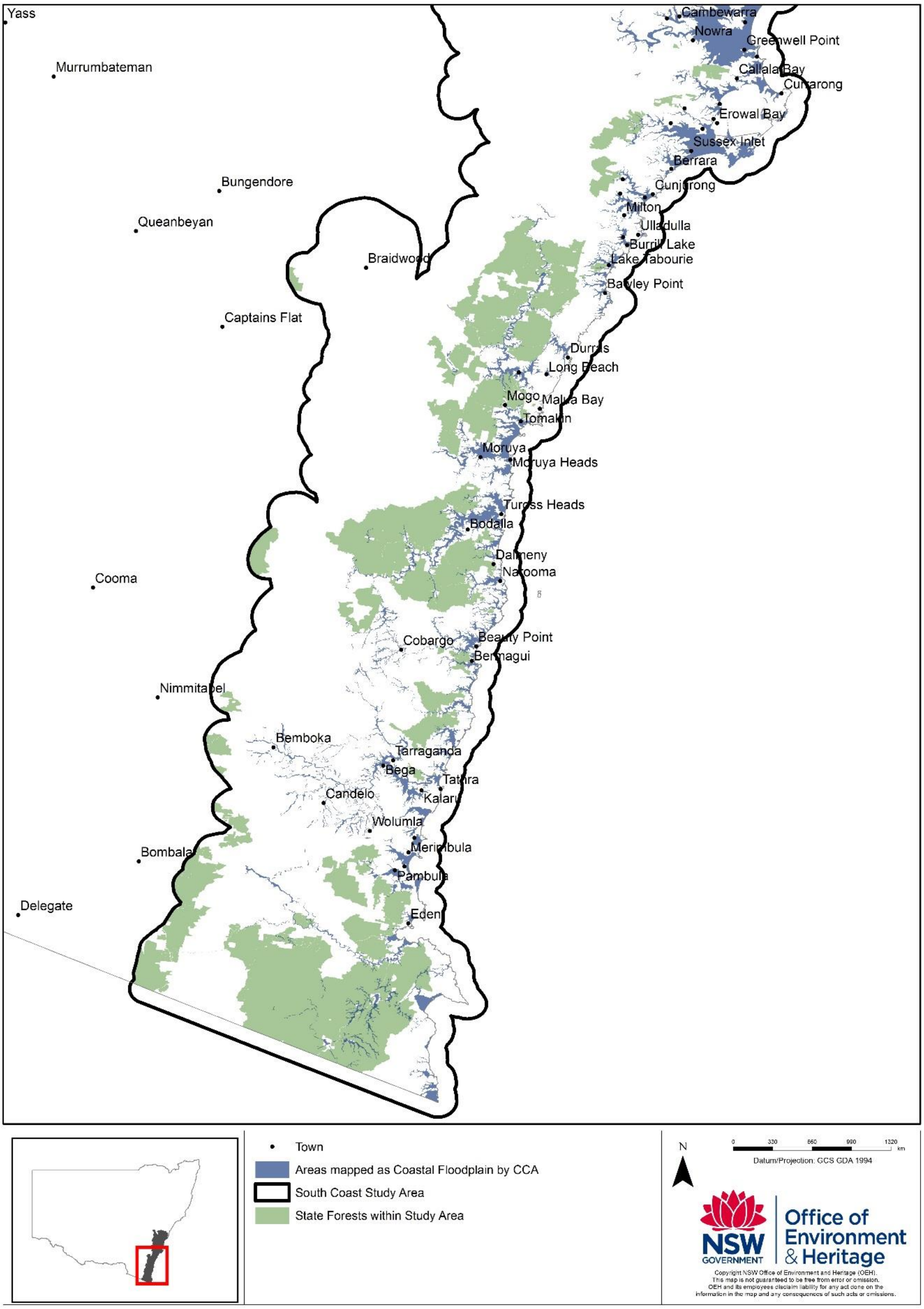
3.2.1 Coastal comprehensive assessment floodplain maps

Troedson and Hashimoto (2008) describe a series of maps of Quaternary geology and related features, used for a comprehensive coastal assessment. We have used all the alluvial surface geology units from these maps to define areas of mapped alluvium and we have used map unit descriptors to define areas of coastal floodplains at 1:25 000 scale (shown at a smaller scale in Map 2).

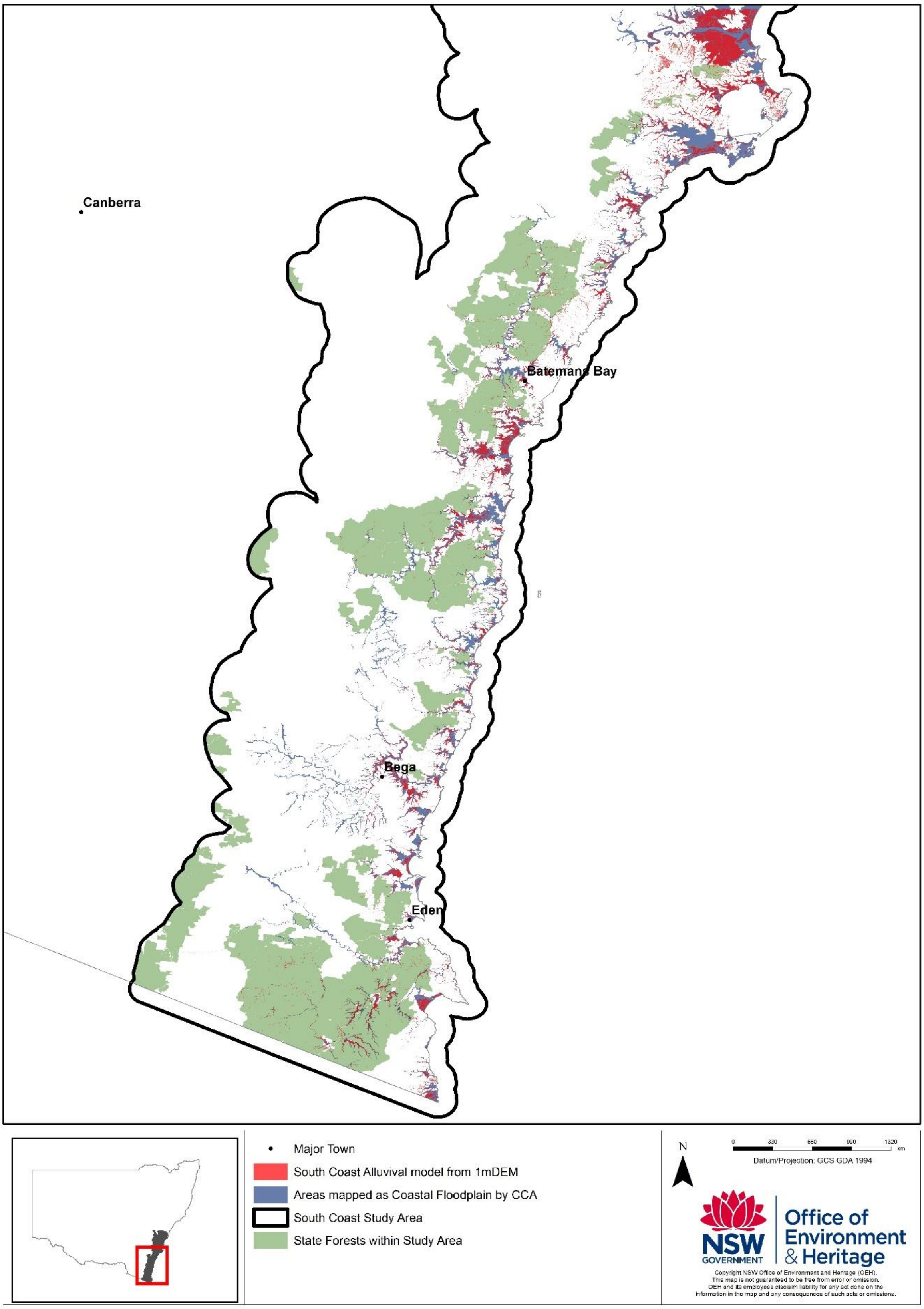
3.2.2 Fine scale alluvial model

We generated a fine scale digital representation of landscape elements in the study area that are likely to be associated with the range of floodplain and alluvial descriptors offered by the final determination for RFEF (Map 3). The concept for the model is that floodplain and alluvial environments relevant to RFEF occur in areas which are flat or have low slope and which receive either run-on flow, pooling or overbank flow at above particular thresholds, which vary with slope and catchment size. The model uses a 1 metre resolution, filled DEM derived from LiDAR data to calculate flow accumulation, elevation above stream channels along the lines of flow, and slope. Stream channels are defined at catchments >= 0.5 hectares. Thresholds are applied to combinations of the three variables to delineate areas alluvial/floodplain EECs. This includes River-flat Eucalypt Forest, Swamp Oak Forest and Swamp Sclerophyll Forest. The actual occurrence of these EECs is likely to be less than the model indicates, since some areas will have vegetation composition which is not consistent with the determinations for any of these EECs. The set of mapped polygons in map 4 were used as a starting point to identify plots for new floristic surveys, as well as API digitising and mapping.

Map 3: Coastal floodplain mapped by the Comprehensive Coastal Assessment (CCA) in the South Coast study area. Areas north of Nowra are not relevant to RFEF (see Section 3.2.5).



<u>Map 4</u>: Coverage of alluvial model overlaid on top of floodplain mapping by CCA for South Coast study area, showing the area south of Nowra.



3.3 Compilation of Existing Vegetation Data

3.3.1 Existing vegetation classification

The three classifications cited in the final determination which are most relevant to RFEF in state forests south of Sydney are those of Keith and Bedward (1999), Thomas et al. (2000) and Tindall et al. (2004). Subsequent to the final determination, each of these studies has been superseded by more recent studies (Gellie 2005 in place of Thomas et al. 2000, and Tozer et al. 2010 in place of Keith and Bedward 1999 and Tindall et al. 2004) using a larger pool of data. Previously-defined communities cited in the final determination can be traced to equivalent communities in the more recent classifications, so plot allocations for the latter are used in this project for floristic comparison. The relevant communities from the final determination and their more recent equivalents are listed in Table 3.

Table 3: Communities defined from recent analyses which are equivalent to those cited in the final determination.

Community listed in determination	Recent equivalent publication	Meets definition of RFEF when:
FE 27 Ecotonal coastal swamp forest (Thomas et al. 2000)	VG 27: Ecotonal Coastal Swamp Forest - *Casuarina glauca / E. botryoides* (Gellie 2005)	Dominated by eucalypts
FE 48 Coastal Lowlands Riparian Herb/Grass Forest (Thomas et al. 2000)	VG 48: Coastal Lowlands Riparian Herb/Grass Forest – various eucalypts (Gellie 2005)	Mapped on alluvial soils
FE 49 Southern Hinterland Shrub/Herb/Grass Riparian Forest (Thomas et al. 2000)	VG 49: Southern Hinterland Shrub/Herb/Grass Riparian Forest - *Angophora floribunda / E. elata / Acacia mearnsii* (Gellie 2005)	Mapped on alluvial soils
MU 33 Cumberland River Flat Forest (Tindall et al. 2004)	FoW p33 Cumberland River Flat Forest (Tozer et al. 2010)	Dominated by eucalypts
MU 105 Floodplain Swamp Forest (Tindall et al. 2004)	FoW p105 Floodplain Swamp Forest (Tozer et al. 2010)	Dominated by eucalypts
MU 19 Bega Wet Shrub Forest (Keith & Bedward 1999)	DSF e19 Bega Wet Shrub Forest (Tozer et al. 2010; but includes W6 of Keith & Bedward 1999, not cited in the determination)	Mapped on floodplains
MU 60 Floodplain wetlands (Keith & Bedward 1999)	FoW e60 Southeast Floodplain Wetlands (Tozer et al. 2010)	Dominated by eucalypts

3.3.2 Existing vegetation data

A recent review of OEH systematic flora survey data holdings in eastern NSW (OEH in prep) was available for the project. The review identified a subset of data suitable for use in quantitative vegetation classification on the basis that it met a set of predefined criteria, namely that plots:

- provided location co-ordinates with a stated precision of less than 100 metres in accuracy
- covered a fixed survey search area of approximately 0.04 hectares
- supported an inventory of all vascular plants
- provided a documented method that assigns a quantitative and/or semi quantitative measure of the cover and abundance of each species recorded

A total of 15,487 plots within the study area, including 171 plots surveyed specifically for our project, were in the OEH VIS Flora Survey Database at 22 July 2015. 11,558 of these had floristic data suitable for analysis.

3.3.3 Analysis data set

We chose our pool of data to ensure that it included all plots which had previously been allocated to any community that we considered relevant to south coast RFEF or to any of the other coastal TECs covered by our broader project and all other plots which had not previously been analysed or allocated to a community in a regional study. Plots were omitted which had previously been allocated to communities which we considered not relevant to the group of TECs under consideration in our study area. Communities were assessed as not relevant for one of the following reasons: tablelands communities occurring on ridges or slopes mostly above 600 metres; ridgetop dry shrubby forests; heaths with few species in common with communities of interest; communities recorded only north of the Illawarra area and not listed in any of the relevant determinations; communities which were clearly floristically and environmentally distinct from communities of interest. Appendix A lists all communities from which plot data were included. We also included all plots for which no previous community allocations were available and all plots which had not previously been classified or allocated to a community.

3.3.4 Data preparation and taxonomic review

All species in the pooled dataset was standardised for analysis using a review completed for all flora survey data compiled for the Eastern NSW Classification (OEH in prep). Nomenclature was standardised to follow Harden (1990-93; 2000-2002) and updated to reflect currently accepted

revisions using the PlantNETWebsite (Royal Botanic Gardens 2002). The data was amended to:

- exclude exotic species
- exclude species identified to genus level only
- improve consistency in assignment of subspecies or varieties to species.

Cover and abundance score data extracted from the pooled data set was standardised to a six class modified braun-blanquet score. The transformation algorithm available within the OEH VIS Flora

Survey data analysis module was applied to the analysis dataset.

3.4 New Survey Effort

3.4.1 Survey stratification and design

New flora survey effort targeted habitats within state forests likely to support alluvial and related low lying landscapes. State forests considered to be candidates for survey and assessment were identified using guidance from the TEC interpretation panel using bioregional and elevation thresholds. The purpose of new survey effort was to ensure that all candidate state forests included replicated samples of target habitats in order to assess relationships to the species list set out in the final determination. Approaches to plot selection differed by region in response to available environmental data.

Nowra to Bega Valley

Candidate state forests were assessed by using a geographic information system to display 10 metre contour lines within and adjoining state forest boundaries. Low relief landscapes adjacent to drainage channels, including creeks, streams and rivers were marked. Existing flora samples within state forests were displayed to assess existing survey effort. Digital aerial imagery was then assessed at each point to ensure that the sample was located within woody native vegetation relatively free of disturbance. A selection of samples was then chosen from the pool of identified plots based on road and trail access.

Bega Valley to Victorian border

A detailed water flow accumulation model highlighting low relief drainage channels and adjoining terraces was available for the Eden region. Existing flora survey samples were intersected with the model to assess the current survey effort within state forest.

A set of 1000 randomly located notional sample points were then generated across the distribution of the model within state forest tenures. Samples were then assessed manually for accessibility and whether the vegetation was dominated by native woody vegetation and relatively free of visible disturbance. If samples failed to satisfy the criteria the plot was discarded. Iterations of random sample points was stopped when a minimum of 5 samples were located within each state forest. Selected samples were then reviewed to ensure that the range in elevation across the modelled area within each state forest was sampled.

3.4.2 Survey method

Systematic surveys

Systematic flora survey were conducted in accordance with OEH standard methods (Sivertsen 2009). Preselected sample points were located in the field using a global positioning system (GPS). In the field, plots were assessed for the presence of heavy disturbance (such as severe disturbance through clearing or weed infestation) and were either abandoned or moved to an adjoining location in matching vegetation.

Systematic floristic sample plots were fixed to 0.04 hectares in size. The area was marked out using a 20 by 20 metre tape, although in some communities (such as riparian vegetation) a rectangular configuration of the plot (e.g. 10 by 40 metres) was required. Within each sample plot all vascular plant species were recorded and assigned estimates for foliage cover and number of individuals. Raw scores were later converted to a modified 1-8 Braun-Blanquet scale (Poore 1955) as shown in Table 4.

Table 4: Braun-Blanquet-to-cover abundance conversion table.

Modified Braun-Blanquet 6 point scale	Raw Cover Score	Raw Abundance Score
1 (<5% and few)	<5%	≤3
2(<5% and many)	<5%	≥3
3 (5-25%)	≥5 and <25%	any
4 (25%-50%)	≥25% and <50%	any
5 (50%-75%)	≥50% and <75%	any
6 (75%-100%)	≥75%	any

Species that could not be identified in the field were recorded to the nearest possible family or genus and collected for later identification. Species that could not be identified confidently were lodged with the NSW Herbarium for identification. At each plot, estimates were made of the height range, projected foliage cover and dominant species of each vegetation stratum recognisable at the plot. Measurements were taken of slope and aspect. Notes on topographic position, geology, soil type and depth were also compiled. Evidence of recent fire, erosion, clearing, grazing, weed invasion or soil disturbance was recorded. The location of the plot was determined using a hand held GPS or a topographic map where a reliable reading could not be taken. Digital photographs were also taken at each plot.

Non-systematic surveys

Non-systematic survey techniques were employed by survey teams to record observations of flora species present in likely habitat. Survey observations were made against a standard proforma which recorded a minimum of three dominant species in each of the upper, middle and ground stratum.

These partial floristic plots were identified as rapid field plots. No fixed assessment area was used and the number of species recorded was subject to time and visibility constraints. Observations were supported by a georeferenced position and a digital photograph. In addition, brief descriptions of vegetation composition and pattern were also made intermittently by field crews to identify vegetation patterns of interest. These were retained as free text descriptors attached to a georeferenced point and are known as ‘Field Note Points’.

3.5 Classification Analyses

3.5.1 Clustering

There is a range of methods available for quantitative classification of vegetation communities. Results may vary depending on which method is used and which parameters are chosen for a particular method. There is no single best method, but the most widely used method is clustering of plots based on pairwise dissimilarities. As results vary with varying dissimilarity measures, comparisons with previous classification require use of the same measures. Relationships among plots vary depending on the data pool used, so that introducing additional data may change the composition of previously defined groups.

Most clustering methods result in a plot being allocated to a single vegetation community. A plot may also be related to other communities, but these interrelationships are not evident from allocations. As an alternative, fuzzy clustering methods assign a membership value to each plot for each community, which provides a measure of the likelihood that a plot belongs to any particular community. For this project, Noise Clustering (De Cáceres, Font & Oliva 2010; Wiser & De Cáceres 2013) was selected as the most appropriate fuzzy clustering method for three reasons: it allows specification of fixed clusters defined from previously described groups and provides direct allocations to those groups; it is relatively robust to outliers (which have a large difference from all previously defined groups or communities) and allows clustering into new groups; and it is robust to the prevalence of transitional plots with relationships to two or more previously defined communities. The latter are both characteristic of data for the study area. Noise Clustering requires specification of a fuzziness coefficient (where a coefficient of 1 is equivalent to hard clustering which allocates each plot to only one community) and a threshold distance for outliers. Following a number of trial runs with different subsets of data, different fixed groups and different parameters, we chose a fuzziness coefficient of 1.1 and an outlier threshold of 0.85. These parameters resulted in results which were relatively robust to different sets of data and which had a high degree of consistency with previous classifications. Analyses were done using functions in the ‘vegclust’ package in R 3.1.1.

We conducted a number of analyses using different subsets of data and different sets of previously defined communities, as follows:

1. A subset of 1345 plots which comprised all plots previously allocated to a relevant vegetation group by Gellie (2005) plus previously unallocated plots in state forest or surveyed for this project. Relevant vegetation groups are listed in Appendix A. This provided an assessment of the membership of all state forest plots to communities which could be related to those defined by Thomas et al. (2010) which were explicitly listed in the final determination.

2. A subset of 2708 plots which comprised all plots previously allocated to a relevant vegetation group by Tozer et al. (2010) plus previously unallocated plots in state forest or surveyed for this project. Relevant vegetation groups are listed in Appendix A. This provided an assessment of the membership of all state forest plots to communities which could be related to those defined by Tindall et al. (2004) and Keith and Bedward (1999) which were explicitly listed in the final determination.

3. A subset of 6234 plots comprising all suitable plots available in VIS up to 22 July 2015 which either previously had been allocated to a relevant community by either

Gellie (2005) or Tozer et al. (2010), or had not previously been allocated. This subset included all previously unallocated plots regardless of occurrence in state forests and included all plots in both subsets 1 and 2. Two fuzzy clustering analyses were applied to this subset, one using Gellie allocations as fixed groups and the other using Tozer et al. (2010). These analysis were designed to investigate allocations in a broader context.

3.5.2 Multivariate regression

We used multivariate regression to make pair-wise comparisons of selected pairs of communities to test their degree of floristic similarity to other pairs, using the 'mvabund' package in R3.1.1 (Warton et al. 2012). This method does not rely on calculation of dissimilarities so provides an independent comparison with distance-based methods. For each pair, the difference in summed AIC is calculated, summed across all species in both communities combined, between a null model and a model using community as the factor. The difference in summed AIC provides a relative measure of the extent to which recognising two separate communities provides a better model of species occurrence than does a single combined group. A higher difference indicates communities which are more clearly distinct. A difference close to zero, or negative, indicates no distinction between groups.

We also used the results of multivariate regression to identify species which are most strongly characteristic of difference between groups. Species with the highest difference between AIC for the group model and that for the null model are those with most diagnostic value.

3.5.3 Other methods

We made a comparison between the assemblage as listed in the determination and the various communities either cited in the final determination or otherwise floristically similar or occurring in similar environments. For this comparison we used plots which could be allocated to a community with a high degree of confidence (membership >=0.5 from fuzzy clustering results) and excluded ambiguous plots. We based the comparison simply on the number and proportion of the species listed as the RFEF assemblage which were present in the group of plots comprising the community to be compared. The number in the group depends on both the degree of concordance and the number of plots from which the pool of species is drawn. To allow a valid comparison among communities, we calculated the number as the mean of the numbers from 100 repeated equal-sized random samples. This comparison was restricted to communities with at least ten plots. We also calculated the mean proportion of the assemblage species per plot for each community. These measures cannot be used in an absolute sense since the determination does not provide any indication of thresholds. However, they are potentially useful in a relative sense, in the context of communities listed as RFEF in the determination.

3.5.4 Allocation of standard floristic plots to RFEF and other communities

We assessed plots as being RFEF if their membership of any floristic community defined by Gellie (2005) or Tozer et al. (2010) and equivalent to a community cited in the final determination (we will refer to these as RFEF communities) was 0.5 or above and they met the qualifying condition for that community. In the case of the qualifying conditions that require a community to be 'mapped on floodplains' or 'mapped on alluvial soils', it is difficult to determine whether a plot has met these conditions because the final determination does not specify any particular map and there is no single, generally accepted map which may be used.

As an initial assessment, we considered a plot to meet the condition if it was within 25 metres of any area mapped as alluvial by the Comprehensive Coastal Assessment or if it was within 25 metres of any area mapped as alluvial by our fine-scale alluvial model described in Section 2.3. We used the results of this initial assessment for environmental modelling (2.6.1). For compiling an operational map, we further checked individual plots in state forest which were within 25m of Comprehensive Coastal Assessment mapped alluvium, but >25 metres from our fine-scale model, and assessed them as alluvial or not using digital imagery as described in Section 2.7.1. We believe that the broader assessment is appropriate for modelling, consistent with the 30 metres resolution of environmental data, but a finer-scale assessment is appropriate for compiling an operational map. We regarded non-alluvial plots belonging to RFEF communities as floristically related to RFEF but not meeting the qualifying condition of the determination. We assessed these plots as not RFEF TEC. We considered that plots which belonged to a RFEF community with primary membership <0.5 were potentially RFEF (no plot had a primary membership <0.1). If these potential RFEF plots had a strong membership (>0.75) of a non-RFEF community in an alternative classification (Gellie 2005 or Tozer et al. 2010, as appropriate), we assessed them as not RFEF. If their memberships were weak in both classifications or they most strongly belonged to a community which had not been previously described, we considered that they could be treated as RFEF for management purposes, using a precautionary approach to assessment.

We followed a similar procedure to allocate plots to other TECs included in our broader study. These are described in separate reports (OEH, 2016a, 2016b).

3.5.5 Allocation of partial floristic plots

For each partial floristic plot, we identified the communities with the highest number of shared species and calculated the proportion of plots within each of those communities with that maximum number of shared species. We calculated binomial confidence limits for the proportions. If only a single plot within one community had the highest number of shared species, we also identified communities with fewer species and calculated proportions for those. We assigned each partial floristic plot to the community with the highest proportion of plots with the maximum number of shared species if the proportion was significantly greater than the next highest proportion. If confidence limits of proportions substantially overlapped, we regarded the plot as ambiguous and did not assign it to any community. Calculations were done using scripts in R.

3.6 Indicative Distribution Map

A niche modelling approach (also known as species or habitat distribution modelling) was used to create indicative potential distribution map of RFEF. This approach attempts to extrapolate the fundamental niche of the TEC in question outside the locations where it is known to be present (its realised niche), by relating known occurrence and absence to environmental predictors.

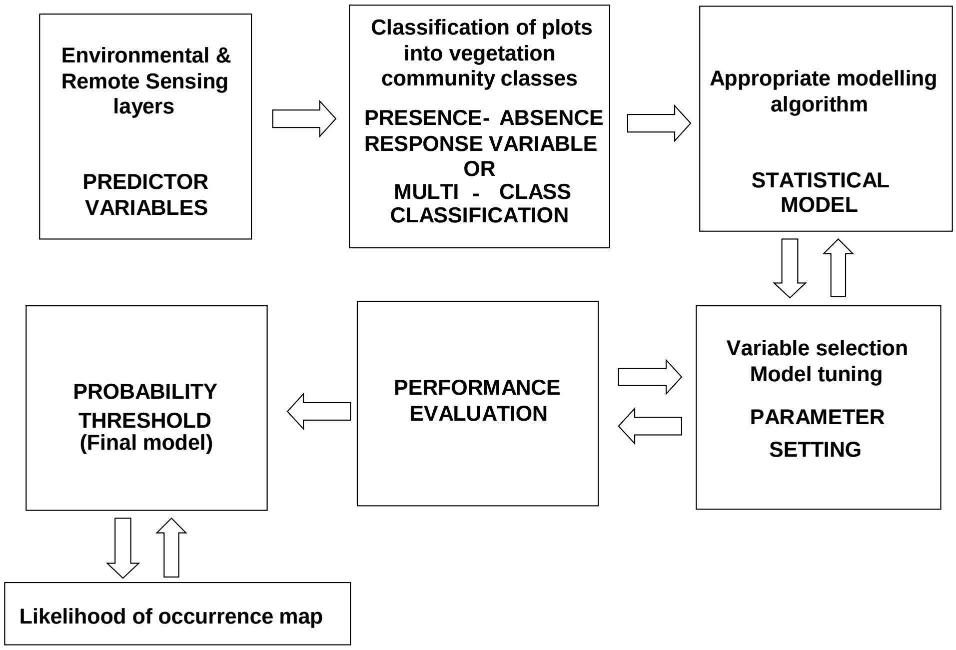
In order to model the distribution of RFEF, we need to characterise the environmental conditions that are suitable for the community to exist. The inclusion of the absence data from the plot allocation allows us to constrain the potential distribution model to a set of favourable environmental conditions that are not occupied by other existing vegetation communities. Nonetheless, without API and associated on-ground validation, it is difficult to determine the extent to which potentially suitable habitat is occupied by the TEC.

3.6.1 Modelling process

Ecological niche modelling involves the use of environmental data describing factors that are known to have either a direct (proximal) or indirect (distal) impact on a species or ecological community. Proximal variables directly affect the distribution of the biotic entity, while distal variables are correlated to varying degrees with the causal ones (Austin 2002).

To create an indicative map of the potential distribution of RFEF we used a Boosted Regression Tree (BRT) presence-absence modelling approach. BRT combines traditional regression tree techniques (Breiman et al. 1984) with ‘boosting’, a method for combining many simple regression trees to model relationships in multivariate data (Friedman 2001). Diagram 2 provides an overview of the step by step modelling process.

Diagram 2: Process for creating indicative TEC distribution maps.



3.6.2 Environmental and remote sensing predictor variables

A total of 144 environmental and 28 remote sensing variables were available for the South Coast study area. These included variables describing the climate, vegetation, topography and soils that were available across the entire modelling region at 30 metres resolution. The data consisted of raster grids, all with the same spatial extent and cell-size. The layers can be divided into 15 broad groups.

- **Location**: (5 variables - distance to coast and four distance to various stream orders)
- **Climate - Radiation and Energy** (8 variables)
- **Climate - Temperature** (17 variables)
- **Climate - Rainfall** (17 variables)
- **Geology** (2 variables)
- **Geophysics** (14 variables)
- **Landform and Terrain** (19 variables)
- **Landscape** (4 variables)
- Nine soil variables derived from the **Great Soil Group soil mapping**
- **Soil Minerals** (6 variables)
- **Soil Profile** (49 variables)
- **Soil NIR Spectra** (6 variables)
- **Soil Weather Index** (1 variable)
- **Single point in time imagery** (Remote Sensing) (3 variables)
- **Time-series analysis** (Remote Sensing) (3 variables)

3.6.3 Modelling algorithm

Boosted Regression Trees are an ensemble method for fitting statistical models (Elith et al. 2008) that differs fundamentally from more conventional techniques which aim to fit a single parsimonious model using as few uncorrelated variables as possible (e.g. GLM). A BRT model is a linear combination of many hundreds or thousands of regression trees, where a random subset of data is used to fit each new tree. Boosting works on the principal that it is easier to find and average many rough rules of thumb, than to find a single, highly accurate prediction rule. The final model is a linear regression model, where each term is a tree.

BRTs are capable of dealing with non-linear relationships and high-order interactions. This makes them particularly well suited for ecological data (Elith et al. 2008). BRT was also chosen as the preferred method for modelling because it is relatively robust to the effects of outliers and irrelevant predictors, and can handle multiple variables that are correlated with one another (Leathwick et al. 2006). The method can handle missing values in the predictors, and no scaling or normalisation of the predictors is necessary (Leathwick et al. 2006). Further details on the application of BRT to ecological data can be found in Elith et al. (2008), Leathwick et al. (2006) and De'ath (2007).

BRT models were fitted using the 'Dismo' (Hijmans et al. 2012) and 'gbm' (Ridgeway 2007) packages developed for R (v 3.2.2). Ten-fold cross-validation was used to train and test the model rather than splitting the data into a separate datasets. Models were evaluated on the basis of observed verse predicted (fitted) values, where the probability of occurrence (PO) values for all plots allocated to RFEF were plotted against the highest ranked PO values across all absence plots.

3.6.4 Variable selection TEC-habitat relationships

Many of the available predictor variables have little or no relevance to the RFEF, but this relevance is not known in advance. Elith and Leathwick (2016) provide a guide to BRT variable selection using the

R DISMO package (https://cran.r-project.org/web/packages/dismo/vignettes/brt.pdf). Following their procedures, we ran a *gbm.step* model using all available predictors, setting the learning rate (*lr*) to 0.001, the tree complexity set to 5 and bagging fraction set to 75%. All variables that returned relative influence values of > 1% (24 in this case) were then run through two alternative variable selection processes. First, the *gbm.simplify* algorithm was run to find those variables that give no evidence of improving predictive performance. Second, the VSURF in R package was also used identify a smaller subset of predictors relevant to the classification. VSURF performs a preliminary ranking of the explanatory variables using the random forests permutation-based score of importance, and proceeds using a stepwise ascending variable introduction procedure.

3.7 Operational TEC Map

3.7.1 Initial aerial photograph interpretation

The mapped extent of coastal floodplain by the Comprehensive Coastal Assessment and alluvial model derived from the 1 metre DEM were used as starting point for mapping the distribution of RFEF on state forest using API techniques. Aerial photograph interpretation (API) was used to assess both floristic and structural attributes found on modelled alluvial and related environments. In addition, API was used to modify the boundaries of the modelled alluvial area using a prescribed list of eucalypt, casuarina and melaleuca species in combination with the interpretation of landform elements relevant to alluvial and floodplain environments.

API technicians, experienced in interpretation of NSW forest and vegetation types, used recent high resolution (50 centimetre GSD) stereo digital imagery, in a digital 3D GIS environment to delineate observable pattern in canopy species dominance, understorey characteristics and landform elements. Interpreters adopted a viewing scale between 1:1000 and 1:3000 to mark boundaries to infer changes in canopy and/or understorey composition. A mapping pathway and a set of attribute codes were established to ensure consistency in approach between interpreters. New classes were established where recurring image patterns and species composition did not match predefined classes.

A minimum map polygon size of 0.25 hectares was used to inform the detection and delineation of image patterns. Interpreters were supplied with a range of environmental variables to accompany interpretation including substrate and existing vegetation maps.

These map layers included Southern CRAFTI (DUAP 2000), Southern CRA (Thomas et al. 2010), Gellie (2005), SCIVI (Tozer et al. 2010) and RN17 (Forestry Commission of New South Wales, 1989). They were also supplied with contextual layers such as roads, trails and tenure boundaries. All relevant georeferenced floristic data held in

OEH databases was extracted and supplied to aid interpretation. Floristic data was supplemented by interpreter field traverse using an iterative process to boost interpretation confidence by relating field observations to image patterns. A crown separation ratio of 3 or greater (approx. 5% crown cover (Walker and Hopkins 1990) was adopted, as the cut-off density between woody and non-woody vegetation.

The API layer was then cross-checked against the derived spatial model of RFEF. Any areas of high probability of occurrence within the spatial model not already included within the existing API layer were identified and later assessed using the mapping protocols.

Attribute codes applied to API mapping in the Eden region are presented in Table B1 and for the South Coast (Nowra to Bega) in Table B2 (both tables in Appendix B).

3.7.2 Integration of spatial data

We used the final API line work, in combination with prediction probabilities from the spatial model and floristic plot data, to develop an operational map using the following procedure:

- For each polygon, we calculated summary statistics of the number and proportion of cells above our chosen probability threshold of 0.05 which intersected the polygon, and the mean and maximum probability value for those cells.
- For each polygon code (including understorey assessment), we assessed the extent of plot sampling and the proportion of plots which we had assigned to RFEF. For codes which had been sampled but for which all plots had been assigned to communities other than RFEF, we excluded all polygons with that code from the RFEF map if the API description was consistent with the API type not being RFEF, if all polygons had at most a very small proportion (less than 10%) of intersecting probability cells with probability above the threshold of 0.05 and if the maximum threshold for any cell did not exceed 0.3.
- For polygon codes sampled by at least some plots assigned to RFEF, or unsampled codes, we assigned individual polygons to RFEF if the polygon intersected any predicted probability cell above a threshold of 0.05.
- We checked individual polygons if they were assigned to RFEF by the above procedure but belonged to an API type which was not consistent with our interpretation of RFEF, or if the maximum probability or proportion of cells over 0.05 probability that they intersected was very low. In these cases we made a subjective judgement as to whether the polygon was RFEF.

We believe that this procedure provides a precautionary operational map of RFEF. Polygons mapped as RFEF include many with a relatively low probability of being RFEF, which may indicate low likelihood for the whole polygon or that only part of the polygon is RFEF.

3.8 Validation

We identified four approaches to the validation of our mapped layer which may be useful, depending on the needs of map users and available resources.

1. **Internal validation of mapped polygons, to determine the extent to which mapped polygons include RFEF**.

Independent sampling within mapped polygons would provide an unbiased estimate of the extent of RFEF in mapped areas. However, substantial effort is required to provide a reasonably accurate unbiased estimate. Whether it is worth refining the estimate is a management or regulatory decision. Examples of relevant management considerations include: Is the estimated error rate acceptable or too high, or too uncertain, to enable the mapped area to be used in management or regulation? If it is regarded as too uncertain, would this still be the case if the precision was improved? If it is too high, what is the relative benefit of reducing it (which is likely to require extensive field inspection or further survey), compared to forgoing the map in favour of case-by-case field assessment?

2. Determination of accuracy of boundary lines.

There are two elements by which accuracy of boundary lines may be assessed, floristic community and the qualifying condition (mapped alluvium or floodplain) stated in the RFEF determination. The floristic community may be sampled and quantitatively assessed at varying distances either side of the line.
If it is found to be clearly a non-RFEF community, the accuracy of the line may be easily judged. Conversely, if it is found to be part of, or related to, a community which is included in RFEF, then there is no consistent and objective criterion by which the accuracy of boundary line may be assessed, due to the subjective and vague nature of the qualifying condition. The alluvial model which we used as the basis for guiding API mapping provides a consistent, objective and repeatable method for delineating an alluvial boundary. Even though it is somewhat arbitrary, it has been found to conform closely with subjective assessments of the boundary of alluvial environments during API work. We believe that further testing of the boundary by subjective assessment is not informative for the purpose of validation.

3. Validation of mapped polygons attributed as not RFEF.

The attribution of these polygons was tested by field assessment using a systematic sample design. If any are assessed to contain RFEF, this may inform revision of the attribution or provide an estimate of the extent to which RFEF has been under-mapped, or both. If all are assessed as not RFEF, this would provide a level of confidence that polygons have been correctly attributed.

4. Validation of the extent to which currently unknown areas of RFEF occur outside the mapped polygons.

It is not possible to obtain meaningful estimates of the extent of unknown areas of RFEF and we are not aware of any practical means of determining where, if any exist, they are likely to occur, beyond testing of mapped polygons which we have attributed as not RFEF.

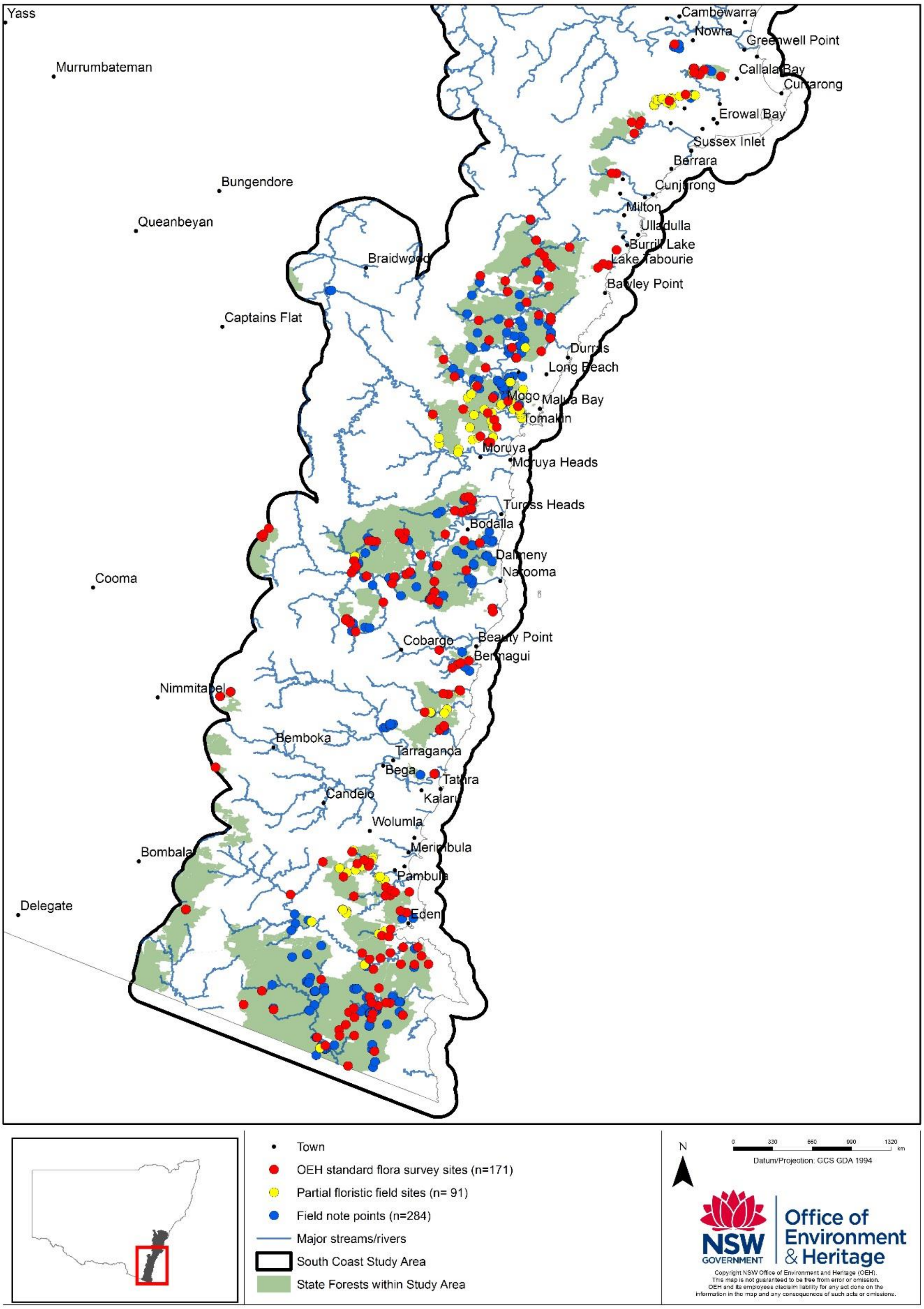
Option three provides the best assessment of the extent, if any, to which native vegetation situated in suitable habitat for the TEC has been overlooked by our mapping. We collected an independent data set by choosing plots located in mapped alluvial and floodplain environments but outside our mapped RFEF boundary. We applied a regular systematic grid over this area to provide 100 plots. We sampled 40 of the 100 plots using the OEH standard survey methods (Section 2.4.2), giving preference to those which were most accessible, but subject to ensuring a good geographical spread. We used the same fuzzy clustering methods that we used in our initial analyses (described in Section 2.5.1) to determine whether plots belonged to vegetation communities which we had included in RFEF or other TECs, or to other communities not included in any TEC.

4 Results

4.1 Survey Effort

Within our study area there were 6234 standard full-floristic plots in the OEH VIS database which we used for our initial analysis, 756 of which are in state forest. This includes 178 plots that were surveyed specifically for our project. We collected standard full-floristic data from a further 40 plots for validation, primarily designed for validation of mapping of River-flat Eucalypt Forest TEC. In addition, we collected partial floristic data and other observations for TEC assessment at a further 375 sample points in state forests and nearby areas (Map 5). Not all plots shown in Map 5 were used for River-flat Eucalypt Forest analysis. Some were not suitable for floristic analysis and some were not in relevant environments or were otherwise not relevant to this TEC.

<u>Map 5</u>: Distribution of new full-floristic and rapid surveys on state forest in the South Coast study area estate.



4.2 Classification Analyses

4.2.1 Relationships to existing classifications

Of the 6234 plots analysed, 3590 (58%) could be allocated with a high degree of confidence to an existing community described either by Gellie (2005) or Tozer et al. (2010). A further 1257 (20%) were not closely related to any of the communities selected for inclusion in the analysis, but formed additional floristic groups. In some cases these were groups corresponding to communities that have been described elsewhere but which we chose to not include in analysis because they were not relevant to any TEC in our study area. In other cases they may represent previously undescribed communities.

We examined the floristic composition of these groups and considered that two of them represent previously under-sampled and undescribed communities which may be relevant and which we investigated in more detail. These are described below. The remaining 1387 plots (22%) are not readily allocated to any single community and show a degree of relationship to two or more. Some of these may represent undescribed communities but many are likely to represent transitional vegetation.

Table 5 summarises the distribution of plots among the existing and new communities relevant to RFEF, using plots with membership of at least 0.5 in either Gellie or SCIVI communities. The two classifications generally overlap where the study areas also overlap (the Cumberland Plain community p33 is mostly outside Gellie’s study area). The most significant exception is the large number of plots, comprising mainly those sampled in state forests specifically for our project, which are allocated to Gellie vegetation group 48 but cannot readily be allocated to any existing community described by Tozer et al. (2010). We have considered these to be part of a previously undescribed community in the SCIVI classification.

Other important exceptions are plots allocated to both vg48 and p30 and both vg27 and p434. In each of these cases, the SCIVI communities are not explicitly cited in the RFEF determination but the plots allocated to the RFEF Gellie community form a significant proportion of the total plots in the SCIVI community, indicating that these SCIVI communities perhaps should have also been considered in the determination. In the former case, p30 South Coast River Flat Forest is closely related to RFEF floristically. In the latter case, p434 is Headland Grassland. This is discussed further in Section 3.2.4.

Table 5: Distribution of plots among RFEF and related communities. Numbers are the number of plots which meet the RFEF qualifying condition (alluvial or with eucalypt overstorey, as appropriate) and total number of plots in parentheses. For example, there are 69 plots allocated to both e19 and vg49, 3 of which are in mapped alluvium.

	Plots with memb >=0.5 in Gellie RFEF community			Other plots (incl membership <0.5)	Total
SCIVI community (Tozer et al. 2010)	vg27	vg48	vg49		
e18			0 (12)	0 (4)	0 (16)
e19		1 (2)	3 (69)	0 (1)	4 (72)
e60				0 (9)	0 (9)
e34		0 (11)		0 (15)	0 (26)
e20p229			0 (2)	4 (87)	4 (89)
n184		1 (7)	0	0 (15)	1 (22)
n185		2 (2)	0	0 (12)	2 (14)
p30		4 (6)	1 (4)	5 (6)	10 (16)
p33 (euc)				47 (53)	47 (53)
p63	2 (4)				2 (35)
p99		1 (1)		2 (45)	3 (46)
p105 (euc)				0 (35)	0 (35)
p434	5 (7)			2 (6)	7 (13)
xs6		41 (61)	4 (6)	4 (4)	49 (71)
other	3 (9)	0	1 (4)		
Total	8 (16)	52 (90)	9 (97)		

4.2.2 Floristic communities in alluvial environments

Table 6 lists the main communities, based on communities described by Tozer et al. (2010), in floodplain, alluvial or potentially alluvial environments, in all tenures, derived from plots occurring in mapped areas of these environments. Allocations of plots to communities is that resulting from the fuzzy clustering of 6234 plots to SCIVI communities, using a threshold membership value of 0.5 (plots below this threshold are not included in this summary).

Only communities which occur in 2 or more plots in mapped flats are listed in this table, (except for p33 which occurs on the Cumberland Plain and for which we didn't have complete data for mapped flats).

'xs6', 'xs11' and 'xs13' denote groups of plots which form communities not recognised by Tozer et al. (2010). The table includes a summary for the three Gellie units cited in the determination, but not for other allocations to Gellie units. The plots counted for these three units are also included elsewhere in the table. Communities which are floristically referable to those cited in the RFEF determination are shown in bold.

The CCA map covers all tenures but only map units assessed as alluvial are included in the table (e.g. estuarine deposits are excluded). The alluvial model derived from a 1 meter digital elevation model (DEM), covers all flat or gently sloping areas where water periodically accumulates or floods and may include non-alluvial areas such as estuarine flats.

Table 6: Main communities on alluvial flats and drainage flats, from 357 plots with community membership >=0.5, within 25m of mapped alluvial or drainage flats.

SCIVI community	Plots in mapped alluvium	Total plots	Plots in SF	Main Gellie unit	Name or Description
e19	2	66	3	g49	Bega Wet Shrub Forest
e20p229	4	89	0	g54	Southeast Lowland Grassy Woodland
e55	11	47	0	none	Southeast Coastal Lowland Heath
e56	4	10	7	none	Southeast Hinterland Heath
e57	11	23	3	g141	Southeast Lowland Swamp
e60	9	9	1	none	Southeast Floodplain Wetlands
e85	3	20	1	none	Wadbilliga Gorge Dry Forest
m15	9	11	3	g24	Eden Shrubby Swamp Woodland
p105	23	35	0	g24	Floodplain Swamp Forest (Casuarina glauca)
p106	36	58	0	none	Estuarine Fringe Forest (Casuarina glauca)
p107	13	15	0	g24	Estuarine Creekflat Scrub
p109	4	16	0	g25	Estuarine Mangrove Forest
p3	4	15		g171(pt)	South Coast Lowland Swamp Woodland
p30	10	16	6	g48	South Coast River Flat Forest
p32	8	27	0	g53	Riverbank Forest (Casuarina cunninghamiana)
p33	?	53	0	none	Cumberland River Flat Forest
p40	7	46	21	g20	Temperate Dry Rainforest
p45	10	14	1	none	Coastal Sand Swamp Forest
p64	20	46	0	g28	Coastal Sand Forest
p85	8	36	6	none	Currambene-Batemans Lowlands Forest
p86	10	21	5	g10	Murramarang-Bega Lowlands Forest
xs11 (new)	N/A	59	0	none	Eucalyptus tereticornis-Microlaena stipoides
xs13 (new)	46	97	2	none	Pittosporum undulatum-Dichondra repens
xs6 (new)	49	69	56	g48	Euc elata-Oplismenus imbecillus (South Coast Creek Flat River Peppermint Forest)
g27	10	30	0		Ecotonal Coastal Swamp Forest
g48	51	92	56		Coastal Lowlands Riparian Herb/Grass Forest
g49	10	93	11		Southern Hinterland Shrub/Herb/Grass Riparian Forest

The main groups of communities are discussed below. Only frequent dominant species are described in this discussion. More complete descriptions of previously defined communities are provided in Tozer et al. (2010).

Alluvial or riparian forests or woodlands (e19, m15, p30, p32, p33, p85, p86, xs6)

Bega wet shrub forest (e19) is most frequently dominated by *Eucalyptus elata* or *Angophora floribunda*. Despite its predecessor community being explicitly cited in the determination, Bega Wet Shrub Forest very rarely occurs on floodplains or in alluvial environments. It is predominantly a community of erosional gullies and lower slopes. As Table 6 shows, a substantial proportion of plots allocated to Gellie vg48 are also allocated to p30, but while the former is included in RFEF, the latter is implicitly excluded. This inconsistency in the determination is discussed further in 3.2.4. Group p32 Riverbank Forest is characterised by dominance of *Casuarina cunninghamiana*.

Although *C. cunninghamiana* is listed as a characteristic species of RFEF, both p32 and the equivalent vg53 are implicitly excluded from RFEF by the final determination. Community p33, Cumberland River flat forest, is explicitly included in RFEF but occurs only on the Cumberland Plain and is of little relevance to state forests on the South Coast.

Most plots in alluvial environments in state forests were allocated to a new group (designated xs6 in Table 6), only broadly related to Bega Wet Shrub Forest. Currambene-Batemans Lowlands Forest (p85) and Murramarang-Bega Lowlands Forest (p86) occur partly on alluvium or drainage flats. They had been described prior to the final determination but were not explicitly cited, with the implication they are not RFEF. Eden shrubby swamp woodland (m15) is mostly dominated by *Eucalyptus ovata*, often with dense understorey of *Melaleuca* spp. and *Gahnia clarkei*. It occurs almost exclusively on alluvial substrates, usually where there is seasonal waterlogging or inundation and often associated with floodplain landscapes. It had not been described at the time of the determination so its relationship with RFEF is unclear. It clearly occupies alluvial flats associated with coastal floodplains but is not closely similar to the assemblage list in the RFEF determination. All of these communities occur to some extent in state forest and we consider their relationship to RFEF in more detail below in Section 3.2.4.

Grassy woodlands (e20p229, xs11)

Grassy woodlands, usually dominated by *Eucalyptus tereticornis*, occurs mainly on broader valley floors away from stream channels or alluvial flats, but there are some occurrences in the latter environments. Southeast lowland grassy woodland (e20p229) is referrable to Lowland grassy woodland TEC and is the subject of a separate report. It is not considered further in this report. However, grassy woodland is floristically similar to RFEF and plots on alluvial flats may be related to both RFEF and Lowland grassy woodland TEC and could reasonably be attributed to either. We have allocated plots based on the community to which they have highest membership value from our fuzzy clustering. Group xs11 corresponds to Cumberland Plain woodland, restricted to the Sydney Basin. It is not relevant to state forests and we do not consider it further.

Southern heaths (e55, e56, e57)

Southern heath communities are mostly shrub-dominated with scattered or no eucalypts. They occur on flat to gently-sloping areas south of Bega, mostly on alluvium, colluvium or soakage areas with perched water tables. They may be associated with floodplain landscapes in a broad sense, but we consider that they do not belong to RFEF because they are floristically distinct, they usually lack eucalypts and the communities were described prior to the final determination but are not cited.

Floodplain wetlands (e60)

Generally herbaceous wetlands dominated by *Phragmites australis, Eleocharis sphacelata* and *Typha* spp., occasionally with shrub thickets or scattered *Eucalyptus ovata*. Eucalypt-dominated patches belong to RFEF according to the final determination, but none of the plots available to us had a eucalypt overstorey and this community is otherwise floristically distinct from both the assemblage list and all other RFEF communities.

Estuarine and related vegetation (p105, p106, p107, p109)

These are dominated by *Casuarina glauca* or mangroves. They are often not alluvial but are included here because the alluvial model covers estuarine flats. Eucalypt-dominated areas of p105 are included in the RFEF determination, but there are no plots which are unambiguously allocated to p105 which have eucalypt dominants. We do not discuss these communities further in this report but cover them separately in the report on Swamp oak TEC.

Rainforest (p40, xs13)

We examine rainforest in more detail in a separate report, but xs13 is discussed below because of its doubtful affinity with rainforest vegetation.

Coastal sand and swamp forests (p45, p64)

These are referrable to other TECs (Swamp Sclerophyll forest and Bangalay Sand Forest, respectively) and we discuss them in separate reports.

4.2.3 Floristic relationships of alluvial and other communities to RFEF determination assemblage

The determination assemblage is one of the two legally prescribed descriptors of any TEC.

No guidance is available on how it could be used for assessment. We chose to make comparisons between the assemblage list and related communities defined by plot data by using median and cumulative proportions of assemblage species in plots for each community, as described in Section 2.4.3. Appendix C shows the results for the communities relevant to our analyses. We had planned to use these relationships to put RFEF communities (cited in the determination) and other related communities into context and in particular, to determine whether there are other communities which could be considered to belong to RFEF. Unfortunately, the determination list is not useful for this purpose because it appears to be derived almost entirely from a single community (p33 Cumberland River flat Forest) which occurs only on the Cumberland Plain and is floristically distinct from most communities further south. Based on the determination list in this context, there are at least 15 additional communities, many not on floodplains or alluvial flats, which are floristically more similar to the determination assemblage than are the communities (other than p33) cited in the determination. As a result, we have relied almost entirely on cited communities and associated environmental qualifiers to assess presence of RFEF.

4.2.4 Assessment of plots and communities as RFEF TEC

From our floristic analysis we regard, as a minimum expression of RFEF, all plots with a membership >=0.5 of any of the communities equivalent to those cited in the determination (as described in Section 2.4.1 and listed in Table 3) which also meet the qualifying criterion. For management purposes in a precautionary context, we suggest that plots with lower membership of cited communities, but which meet the qualifying criterion, could also be regarded as RFEF.

The relationship between Gellie communities' vg48 and vg49 and groups from the SCIVI classification which occur significantly on alluvium (existing group p30 and new group xs6, Table 6) raises the question of the extent to which other plots in these groups or the groups as a whole, could be referrable to RFEF. We used multiple regression to test whether there are floristically recognisable subgroups within each of p30 and xs6 which correspond to Gellie groups. In each case, there was no clear evidence for recognising subgroups based on Gellie groups (ΔsumAIC 7548 null vs 7645 for p30, 20229 null vs 20591 for xs6). The lack of any separation within each of p30 and xs6 suggests that each should be assessed as a single unit in relation to RFEF, despite possible inconsistencies caused by p30 not being cited in the final determination. Accordingly, we suggest that communities' p30 and xs6 should be regarded as belonging to RFEF.

Group xs11 is characterised *Eucalyptus tereticornis*, *Microlaena stipoides*, *Dichondra repens*, *Bursaria spinosa, Glycine tabacina* and *Oplismenus aemulus* and comprises mostly disturbed plots. From our analysis it is most strongly related to community p33 Cumberland River Flat Forest and to a lesser extent, community p3 South Coast Lowland Swamp Woodland. However, most plots in this group are more likely to belong to Cumberland Plains Woodland which we did not include in our analysis.

Because this group is restricted to areas north of Nowra and is not relevant to our study, we do not consider it further. For other communities (m15 and xs13) not referable to any described unit at the time of the determination, but either with similar floristic composition to a determination community or occurring in similar environments, we examined relationships with RFEF communities using both distance-based and multivariate comparisons. These are summarised in Tables D1 and D2 in Appendix D. To provide adequate context for these comparisons we have included the full range of communities in alluvial environments. Results for m15 are not fully consistent between the two methods, with multivariate regression suggesting a much closer relationship with other communities than does mean dissimilarity. However, the two methods provide consistent results in a relative sense and both suggest that p45 is the most closely related of the existing communities. Because community p45 is referrable to Swamp Sclerophyll Forest TEC, we consider it further in the separate report on that TEC and do not regard community m15 as RFEF.

Group xs13 comprises a series of plots sampled by a single observer, during a survey designed to sample areas perceived as littoral rainforest. It is characterised by the presence of *Pittosporum undulatum, Rhagodia candolleana*, *Banksia integrifolia, Melaleuca armillaris*, *Tetragonia tetragonioides*, *Myrsine howittiana*, *Ficinia nodosa*, *Stephania japonica* and *Zoysia macrantha*. Of these species, only *Stephania japonica* is listed in the determination, but this may not be very informative since the determination list appears to be based on a Cumberland Plain community (p33) as noted previously. Discussion of these plots into xs13 as a separate group is retained only in that it occupies landscapes that are shared with RFEF. On closer analysis, the plots comprising this group are derived from non-systematic survey methods that span various vegetation communities with no fixed search arear. The dataset was erroneously included in the analysis as screening procedures did not detect errors in the survey method metadata within the VIS database. Due to these problems with the data, we consider group xs13 to be a methodological artefact which cannot be compared to previously-defined vegetation communities or other communities which we describe and we do not consider its relationships further in this report. Appendix E provides a list of full floristic plots which we assigned to RFEF or possible RFEF. In addition to analyses of full floristic plots, we assigned 37 partial floristic plots to a community which we regarded as belong to RFEF. Plots assigned to RFEF are shown in Map 4, in the context of all plots used in analyses.

4.2.5 Occurrence on state forest

We assessed a total of 73 plots (including 19 partial floristic plots) in state forest as belonging to RFEF with a high degree of confidence, and a further 16 plots as possibly being RFEF. We suggest the latter should be regarded as RFEF under a precautionary management approach. The distribution of plots across state forests is shown in Table 7. Photos 1 and 2 illustrate two type localities found on state forest that are most strongly related to new community 'xs6'. Photo 3 illustrates a good example of map unit p30 found on state forest.

Table 7: Distribution of plots in state forest among RFEF communities.

State Forest (SF)	Total RFEF plots within State Forest	Plots assigned to 'possible' RFEF	Plots assigned to 'definite' RFEF
Benandarah SF	2	2	
Bermagui SF	3	1	2
Bodalla SF	10		10
Bolaro SF	1		1
Boyne SF	4	2	2
Buckenbowra SF	1		1
Clyde SF	3		3
Currowan SF	3		3
Dampier SF	8		8
East Boyd SF	5	4	1
Mcdonald SF	1		1
Mogo SF	8		8
Moruya SF	6		6
Mumbulla SF	4	1	3
Murrah SF	2		2

Nadgee SF	8	3	5
North Brooman SF	1		1
Nullica SF	5	1	4
Shallow Crossing SF	1	1	
South Brooman SF	2		2
Timbillica SF	2	1	1
Wandera SF	1		1
Yadboro SF	5		5
Yurammie SF	3		3
Total	89	16	73

<u>Photo 1:</u> A type location for a previously undescribed community 'South Coast Creek Flat River Peppermint Forest' (xs6) situated in Bodalla State Forest downstream of Fox Gully Road adjoining Coila Creek. The forest here is dominated by *Eucalyptus elata* with a sparse shrub and small tree layer and a ground cover of grasses including *Poa ensiformis* and the fern *Pteridium esculentum.* These forests are included in our definition of the River flat Eucalypt Forest on coastal floodplains TEC (South Coast region).

Photo 2: Another type location for the new community 'xs6' situated on the boundary of Dampier State Forest near Comerang Road. The forest here supports a different combination of eucalypts *Eucalyptus salignaxbotryoides* and *Eucalyptus baueriana*. Characteristic is the sparse layer of taller wattles and mesic shrubs and a generous ground cover of graminoids.

Photo 3: A good example of South Coast River Flat Forest (p30; Tozer et al. 2010) located in Bolaro State Forest off Runnyford Road near the Buckenbowra River. The forest here is dominated by *Eucalyptus*

tereticornis **and supports a sparse layer of small trees, mostly wattles. What differs is the composition of the ground layer with the resilient** ***Microlaena stipoides*** **relatively abundant amongst small ferns and sedges. Although p30 is implicitly excluded by the determination, we have assessed these forests as River-flat Eucalypt Forest on coastal floodplains TEC owing to their strong association with vg48 (Gellie 2005), which is equivalent to a source classification cited in the final determination.**

4.2.6 Defining floristic attributes of South Coast RFEF

Table 8 lists the 30 species which are most strongly characteristic of south coast RFEF (excluding p33 Cumberland River Flat Forest and associated plots from group xs11) in the context of all 6234 plots used in our analysis. Species which are listed as characteristic in the RFEF determination are shown in bold. Even allowing for the few nomenclatural differences, it could be considered that there are relatively few species which characterise our interpretation of RFEF which are also listed in the determination. This may partly indicate that we have adopted a relatively broad interpretation which is not fully consistent with the assemblage list or it may reflect significant inconsistencies within the determination, between the assemblage list and communities described in the determination. The statutory consequences of the latter are beyond the scope of our study.

<u>Table 8:</u> The 30 most strongly characteristic species of South Coast RFEF in order of decreasing contribution to ΔsumAIC, plus all eucalypts recorded in RFEF, using 69 plots assigned to RFEF with a high degree of confidence compared to the remaining 1998 plots south of Kiama and below 250 m elevation, excluding those assigned to possible RFEF. Species annotated with '(D)' are listed in the determination assemblage. Mean is mean cover score over all plots including zeros. Median is derived from non-zero scores only. Zeros may represent small values, due to rounding.

Species	RFEF freq	RFEF mean	RFEF median	Other freq	Other mean	Other median	ΔsumAIC
Poa ensiformis	0.68	1.8	3	0.04	0.1	2	-424
Hypolepis muelleri (D)	0.48	1.3	3	0.04	0.1	2	-296
Carex longebrachiata	0.72	1.6	2	0.11	0.2	2	-247
Eucalyptus elata (D)	0.57	1.5	3	0.09	0.2	3	-210
Adiantum aethiopicum (D)	0.84	1.5	2	0.13	0.2	1	-208
Entolasia marginata (D)	0.75	1.5	2	0.18	0.3	2	-157
Stellaria flaccida	0.78	1.4	2	0.14	0.3	2	-157
Hypolepis glandulifera	0.25	0.7	2	0.02	0.0	2	-141
Rubus rosifolius	0.48	0.7	1	0.05	0.1	1	-127
Rubus parvifolius (D)	0.77	1.1	1	0.15	0.2	1	-123
Geranium homeanum	0.42	0.6	1	0.03	0.0	1	-118
Eucalyptus botryoides x saligna	0.17	0.6	3	0.02	0.1	3	-104
Pteridium esculentum (D)	0.88	2.2	2	0.4	0.8	2	-103
Pratia purpurascens (D)	0.80	1.3	2	0.24	0.4	1	-103
Dichondra repens (D)	0.90	1.7	2	0.31	0.5	2	-102
Eucalyptus baueriana (D)	0.23	0.7	3	0.04	0.1	3	-100
Tylophora barbata	0.74	1.3	2	0.22	0.3	2	-98
Oplismenus imbecillis	0.93	1.8	2	0.33	0.6	2	-94
Prostanthera lasianthos	0.33	0.5	1	0.04	0.1	1	-90
Viola banksii	0.20	0.3	2	0.01	0.0	2	-85
Oxalis chnoodes	0.23	0.4	2	0.02	0.0	1	-81
Acacia filicifolia	0.10	0.3	3	0.01	0.0	1	-77
Pomaderris aspera	0.45	0.6	1	0.07	0.1	1	-73
Myrsine howittiana	0.58	0.9	1	0.14	0.2	1	-72
Sannantha pluriflora	0.28	0.5	3	0.05	0.1	1	-65
Melicytus dentatus (D)	0.48	0.8	1	0.14	0.2	1	-60
Prostanthera incisa	0.19	0.4	2.5	0.03	0.1	2	-58
Microlaena stipoides (D)	0.88	2.0	2	0.39	0.8	2	-98
Scutellaria mollis	0.17	0.3	1	0.01	0.0	1	-57
Cissus hypoglauca	0.54	1.2	3	0.21	0.4	2	-55

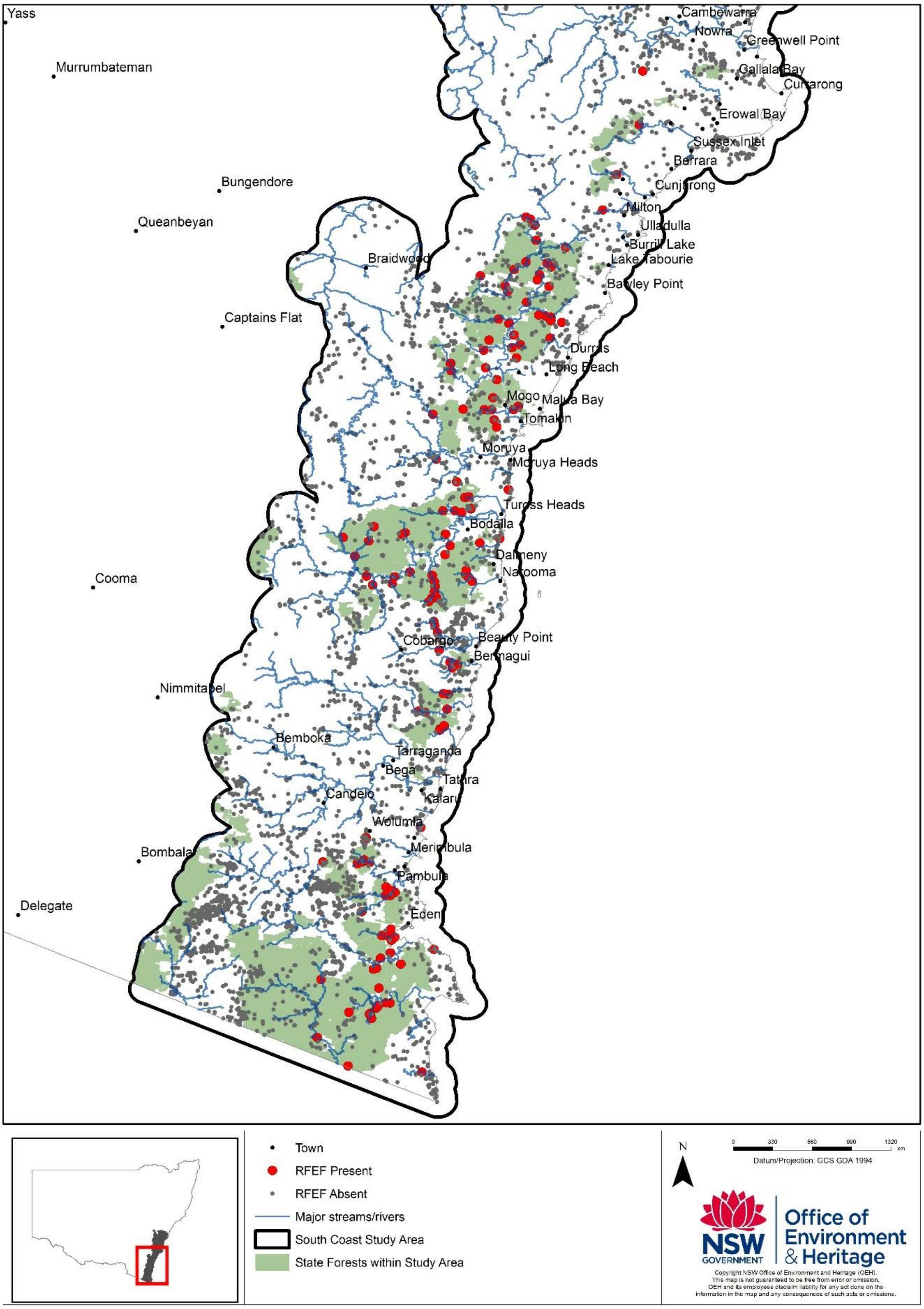
Species	RFEF freq	RFEF mean	RFEF median	Other freq	Other mean	Other median	ΔsumAIC
Eucalyptus botryoides	0.25	0.7	3	0.1	0.3	3	-37
Corymbia maculata	0.03	0.1	2	0.13	0.4	3	-26
Eucalyptus viminalis	0.07	0.2	3	0.01	0.0	3	-26
Eucalyptus globoidea	0.06	0.1	2	0.21	0.4	2.5	-21
Eucalyptus cypellocarpa	0.17	0.5	3	0.09	0.2	3	-15
Eucalyptus pilularis	0.03	0.1	3	0.12	0.3	3	-13
Eucalyptus angophoroides	0.07	0.2	3	0.02	0.0	1	-11
Eucalyptus muelleriana	0.07	0.1	1	0.12	0.3	3	-9
Angophora floribunda	0.28	0.6	3	0.2	0.4	1	-6
Eucalyptus saligna	0.04	0.1	3	0.02	0.1	2	-4
Eucalyptus amplifolia	0.01	0.0	3	0	0.0	3	-3
Eucalyptus ovata	0.01	0.0	3	0.01	0.0	3	0
Eucalyptus bosistoana	0.07	0.2	3	0.06	0.1	1	0
Eucalyptus longifolia	0.13	0.3	3	0.1	0.2	3	1
Eucalyptus tereticornis	0.09	0.2	3	0.08	0.2	3	1
Eucalyptus maidenii	0.03	0.1	2	0.02	0.0	3	2
Eucalyptus scias	0.01	0.0	3	0.02	0.0	1	2
Eucalyptus smithii	0.01	0.0	3	0.02	0.0	1	2
Eucalyptus piperita	0.04	0.1	3	0.05	0.1	3	2

Floristic characteristics of the group of plots which we have assigned to a previously undescribed community South Coast Creek Flat River Peppermint Forest ('xs6') are listed in Appendix F. The most strongly diagnostic species for this group, in relation to broadly similar communities, are *Poa ensiformis*, *Hypolepis muelleri*, *Eucalyptus elata*, *Eucalyptus botryoides x saligna*, *Adiantum aethiopicum*, *Cissus hypoglauca*, *Rubus rosifolius*, *Acacia irrorata* and *Carex longebra*chiata which are more frequent in xs6, and *Themeda triandra* which is more frequent in other communities. Species which most strongly diagnose the difference between RFEF and non-alluvial components of communities e19 and xs6 are *Hypolepis muelleri*, *Prostanthera incisa*, *Eucalyptus botryoides x saligna*, *Cissus hypoglauca*, *Sannantha pluriflora* and *Poa ensiformis* which are more frequent in RFEF and *Arthropodium milleflorum*, *Eucalyptus globoidea*, *Geranium solanderi* and *Oxalis perennans* which are more frequent in the non-alluvial component.

Communities p85 Currambene-Batemans Lowlands Forest and p86 Murramarang-Bega Lowlands Forest are superficially similar to RFEF and occur in broadly similar environments. RFEF may be distinguished from these two communities by the presence of *Poa ensiformis*, *Eucalyptus elata*, *Stellaria flaccida*, *Hypolepis muelleri* and *Rubus parvifolius*, the more frequent occurrence of *Carex longebrachiata* and *Tylophora barbata* and the absence or less frequent occurrence of *Allocasuarina littoralis*, *Corymbia gummifera*, *Entolasia stricta* and *Banksia cunninghamii*.

A field key to identify South Coast RFEF, using our interpretation, is provided in Appendix G. Selecting rules around diagnostic species which minimise the likelihood of incorrectly concluding that RFEF is absent will always result in a relatively high likelihood that an area will be identified as RFEF when it is not, due to the floristic overlap between RFEF and related communities. This may be appropriate if a conservative outcome is desired, or if the key is used as a preliminary filter. If greater certainty is required that a patch of vegetation is not RFEF, it will be necessary to conduct full floristic surveys.

Map 6: Standard floristic plots allocated to South Coast RFEF.



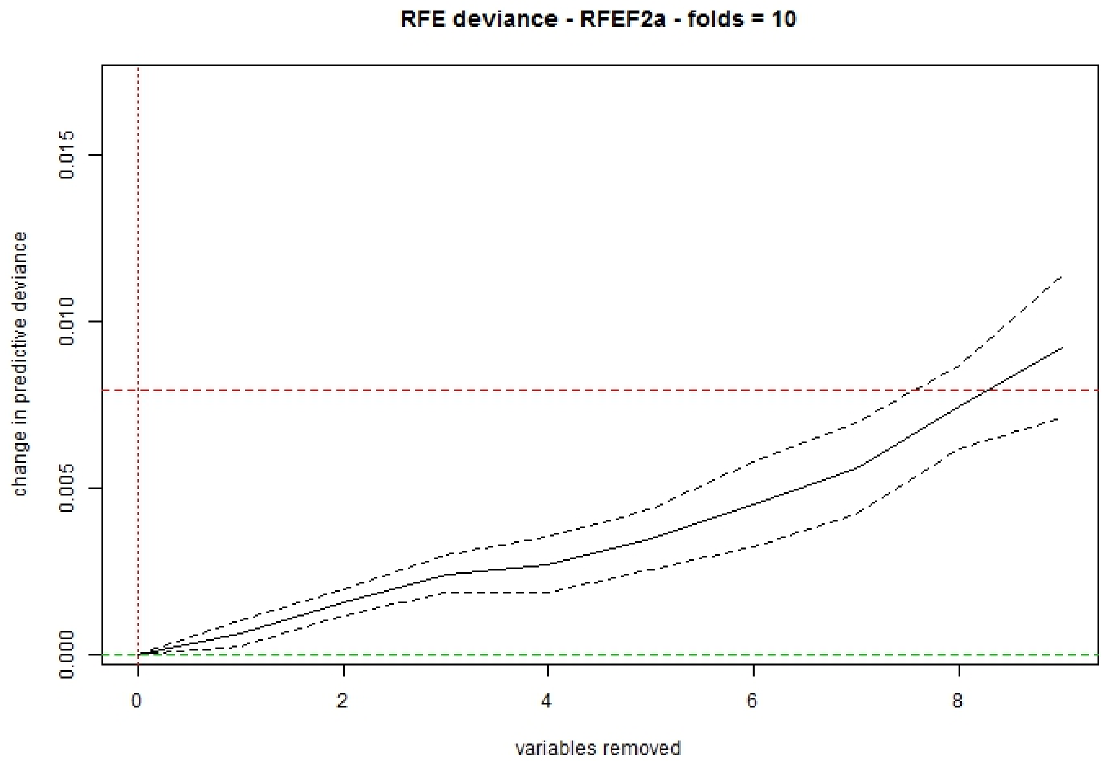
4.3 Indicative TEC mapping

4.3.1 Variable selection

A series of Boosted Regression Tree (BRT) models were run using the 143 OEH standard floristic plots allocated to RFEF as presence plots, and the remaining 6262 plots as absences. To identify a suitable subset of predictors for modelling, we followed the recommendations outlined in Elith and Leathwick (2016).

First, a *gbm.step* algorithm was run using all available predictors, setting the learning rate (*lr*) to 0.001, the tree complexity set to 5 and bagging fraction set to 75%. All variables that returned relative influence values of > 1% (24 in this case) were then subjected to an additional two (alternative) variable selection processes. Second, a *gbm.simplify* algorithm was run to find those variables that give no evidence of improving predictive performance. This takes an initial cross-validated model produced by *gbm.step* and performs backwards elimination of variables. The function returns a list containing the mean change in deviance and its standard error as a function of the number of variables removed. Figure 2 shows no improvement in predictive performance when variables with the lowest relative influence values were removed sequentially (one by one) from the model, resulting in all 24 initial variables being retained.

<u>Figure 2</u>: Output from *gbm.simplify* algorithm showing mean change in predictive deviance and its standard error as a function of the number of variables removed.

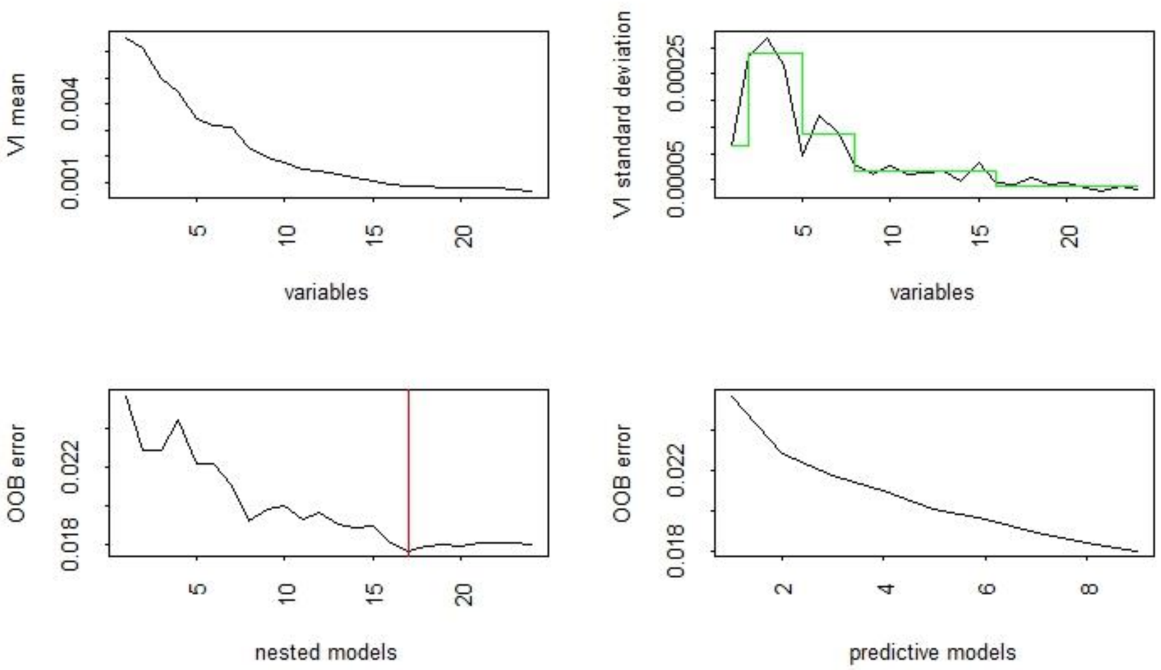


As an alternative approach to *gbm.simplify*, the VSURF in R package was used to try to identify a smaller subset of variables relevant to the classification. VSURF performs a preliminary ranking of the explanatory variables using the random forests permutation-based score of importance, and proceeds using a stepwise ascending variable introduction procedure.

Figure 3 shows the VSURF results. The two graphs of the top row correspond to the 'thresholding step' dedicated to eliminating irrelevant variables from the dataset. The top left graph plots the mean variable importance in decreasing order (black curve), while the top right graph plots the standard deviation of variable importance with variables ordered according to their mean variable importance in decreasing order (black curve). The green line represents the predictions given by a CART tree fitted to the black curve (the standard deviations).

The bottom left graph shows the mean OOB error rate of embedded random forests models (from the one with only one variable as predictor, to the one with all variables kept after the 'thresholding step'). The vertical red line indicates that 17 predictors should be retained in the model. The bottom right graph plots the mean OOB error rate of embedded random forests 'prediction step', which is designed to find and eliminate any redundancy among the set of variables chosen in the thresholding step. In this case, 9 variables were selected, representing the minimum set of variables that could be retained in a model.

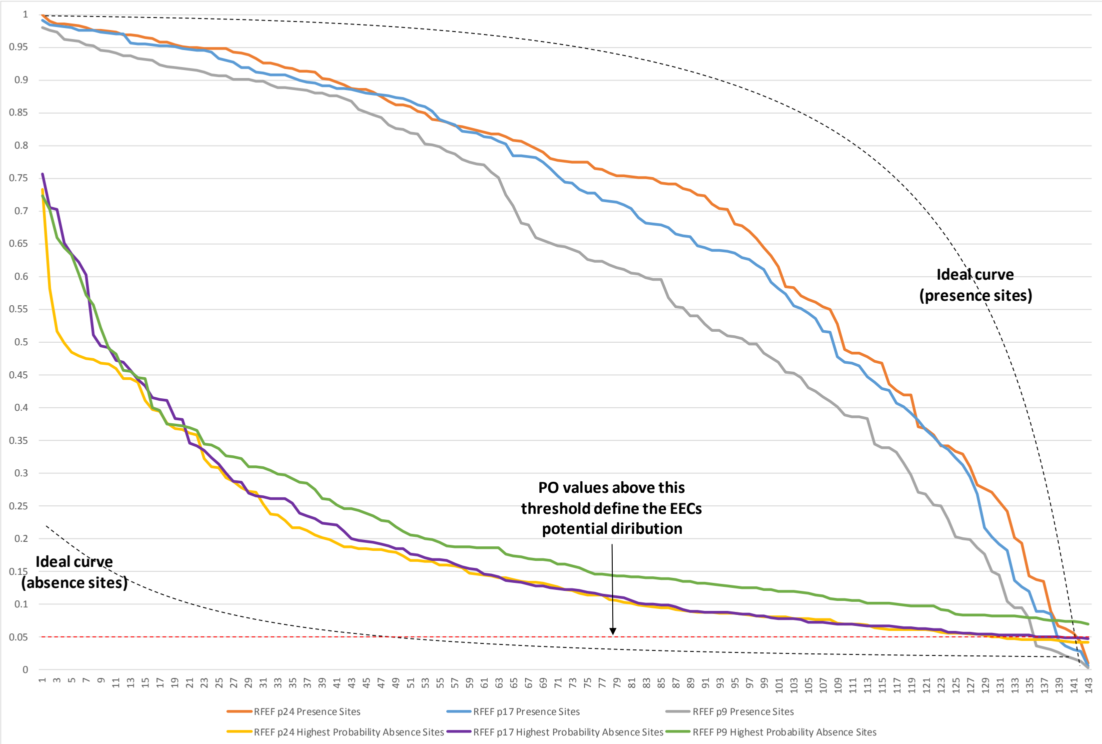
Figure 3: Outputs from VSURF algorithm showing mean change in predictive deviance and its standard error as a function of the number of variables removed.



Separate *gbm.step* models were run for each of the three predictor sets (9, 17 and 24 variables). The performance of the models are compared in Figure 4. Modelled probability of occurrence (PO) values for all plots allocated to RFEF are shown in descending order along with PO values for the same number of highest ranked absence plots. A good model can be defined as having high PO values across the majority of RFEF reference plots, dropping sharply at the end for those plots that occupy marginal environmental space (these could potentially be misclassified false positives). Likewise, absence plots should ideally have a PO values as close to zero as possible, with the vast majority of plots below the 0.05 threshold. The p17 and p24 models are relatively similar, and more reliable than the p9 model. A final model with 17 predictors was chosen as it is the more parsimonious of the two.

In terms of the likelihood that RFEF occurs in any given state forest, the 'potential' distribution of the TEC is defined as any 30 x 30 metre pixel that lies above a 0.05 (5%) PO threshold. At this threshold, using a model with 17 predictors (Table 9), 96.5% of the 143 plots allocated to RFEF and 97.7% of the 6262 absence plots are correctly predicted (Figure 4).

<u>Figure 4</u>: Evaluation of the performance of three BRT models used to predict the distribution RFEF. The models have 9, 17 and 24 predictors.



4.3.2 TEC-habitat relationships

The fitted functions can be used to check if modelled relationships make sense based on what we know about the distribution and habitat requirements of RFEF. For example, we know from the determination that RFEF '*Generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level'* and is associated with *'silts, clay-loams and sandy loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains*'.

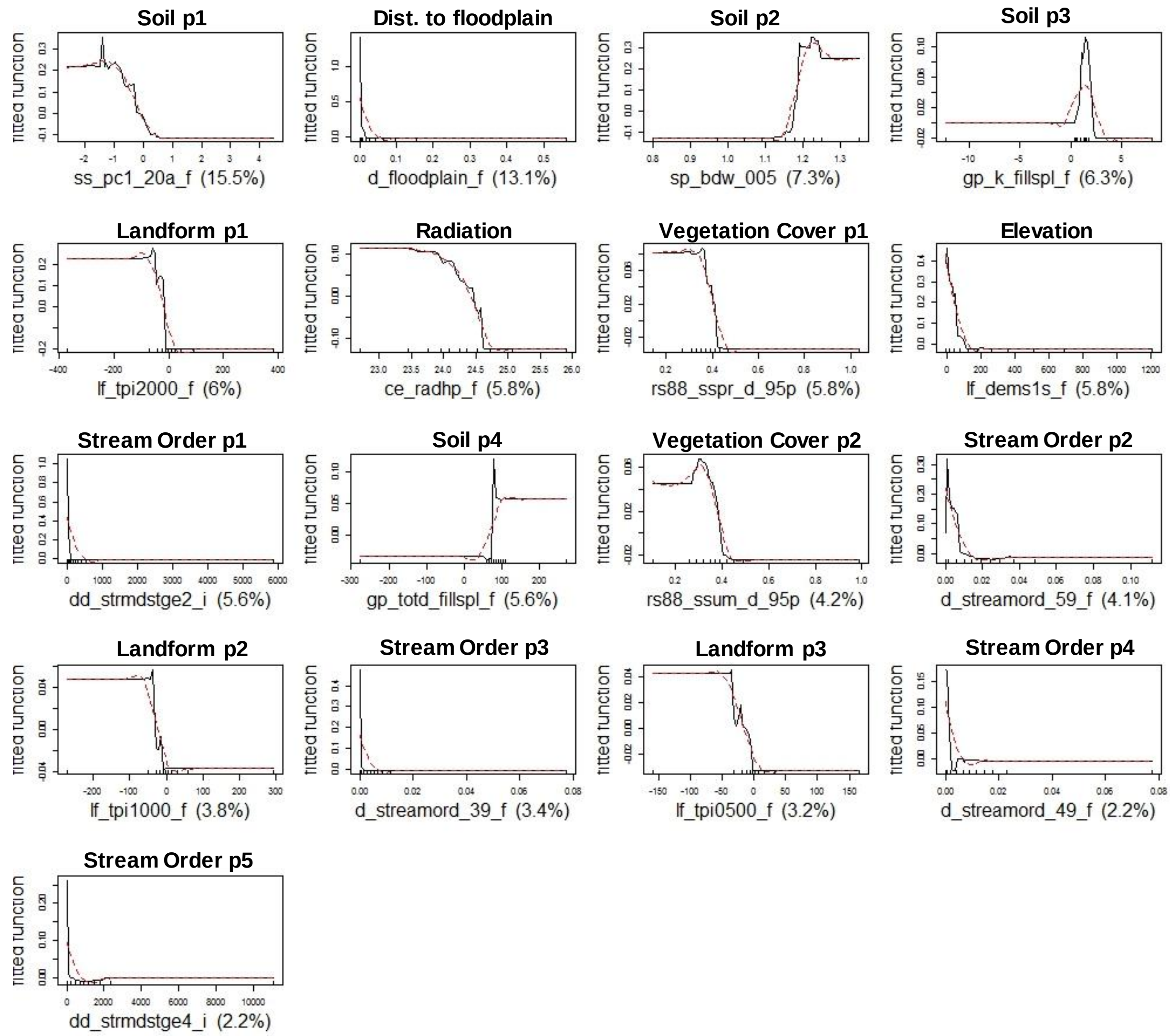
Figure 5 shows the fitted functions across all 17 predictors used in the model. The predictors themselves are described in Table 9. A number of relationships stand out that make ecological sense. These can be grouped in relationships that exist with elevation (1 variable), distance to floodplain mapped by the CCA (1 variable), distance to a range of stream orders (5 variables), soil parameters

(4 variables), maximum non-green vegetation cover in spring and summer (2 variables), topographic position index (3 variables) and highest period radiation (1 variable).

Table 9: Description of predictors used in final BRT model.

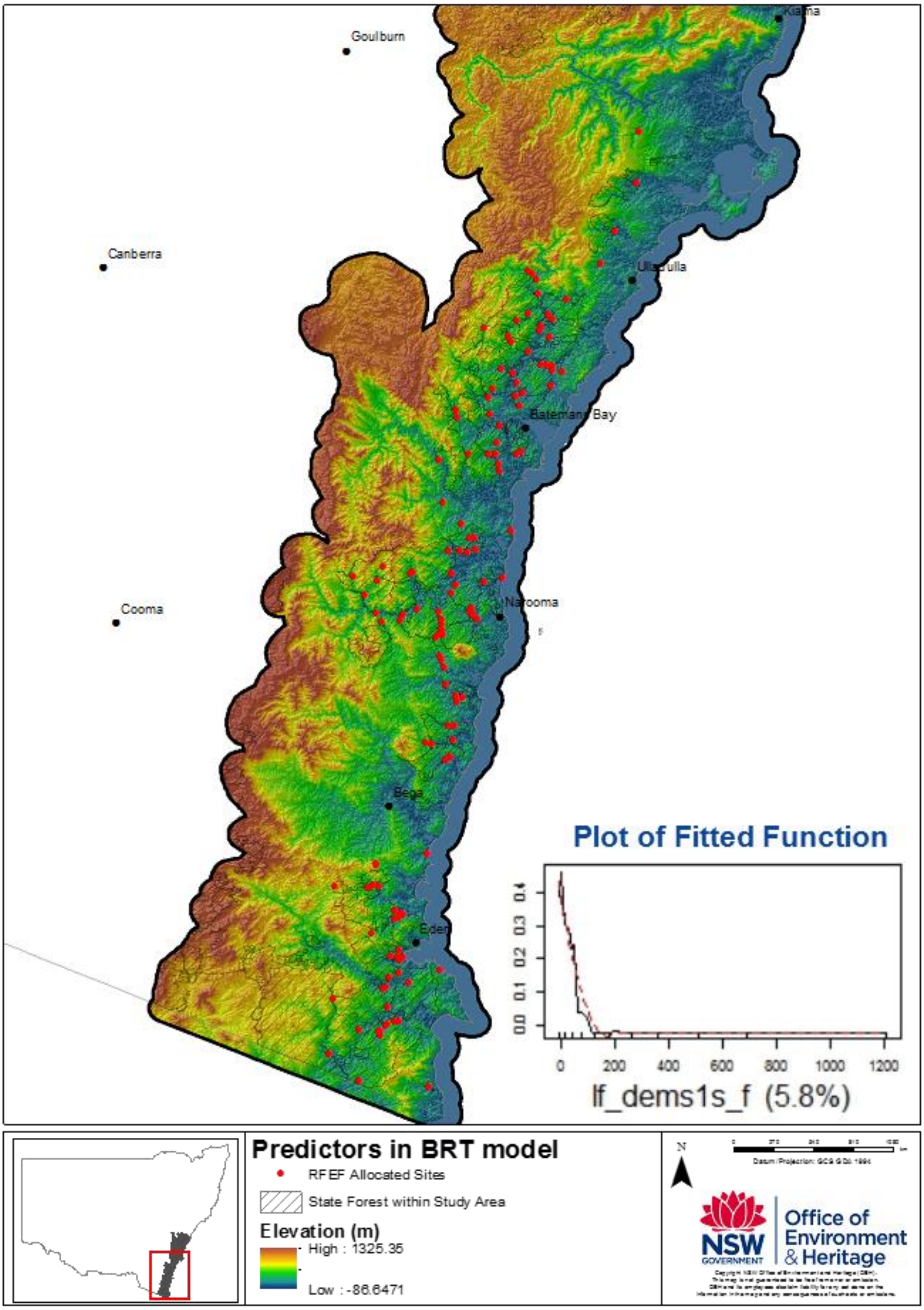
Code	Description
lf_dems1s_f	1 sec SRTM smoothed DEM (DEM-S)
d_floodplain	Euclidean distance to polygons mapped as 'floodplain' by the CCA program
Stream Order 1 (dd_strmdistge2_i)	Euclidean distance to Strahler 2nd order streams and above, where flow paths at very top of catchment assigned a stream order of 1
Stream Order 2 (dd_streamord_59_f)	Euclidean distance to Strahler order streams 5 to 9
Stream Order 3 (dd_streamord_39_f)	Euclidean distance to Strahler order streams 3 to 9
Stream Order 4 (dd_streamord_49_f)	Euclidean distance to Strahler order streams 4 to 9
Stream Order 5 (dd_strmdistge4_i)	Euclidean distance to 4th order streams and above
Soil 1 (ss_pc1_20a_f)	PCA of NIR Spectra of surficial topsoils 0-20cm (Principal component 1)
Soil 2 (sp_bdw_005)	Bulk density estimate of surface soils (top 5cm)
Soil 3 (gp_k_fillspl_f)	Filtered potassium (K) from radiometric data, with gaps filled in using geographically weighted regression model and spline function.
Soil 4 (gp_totd_fillspl_f)	Total dose rate, gaps filled in using GWR model and spline function
Veg. Cover 1 (rs88_sspr_d_95)	95th percentile (max) dry vegetative cover in spring (25 years Landsat data)
Veg. Cover 2 (rs88_ssum_d_95)	95th percentile (max) dry vegetative cover in spring (25 years Landsat data)
Landform 1 (lf_tpi500_f)	Topographic position index using neighbourhood of 500m radius
Landform 2 (lf_tpi1000_f)	Topographic position index using neighbourhood of 1000m radius
Landform 3 (lf_tpi2000_f)	Topographic position index using neighbourhood of 2000m radius
ce_radhp_f	Highest Period Radiation (bio21)

<u>Figure 5</u>: Fitted functions in the final BRT model.

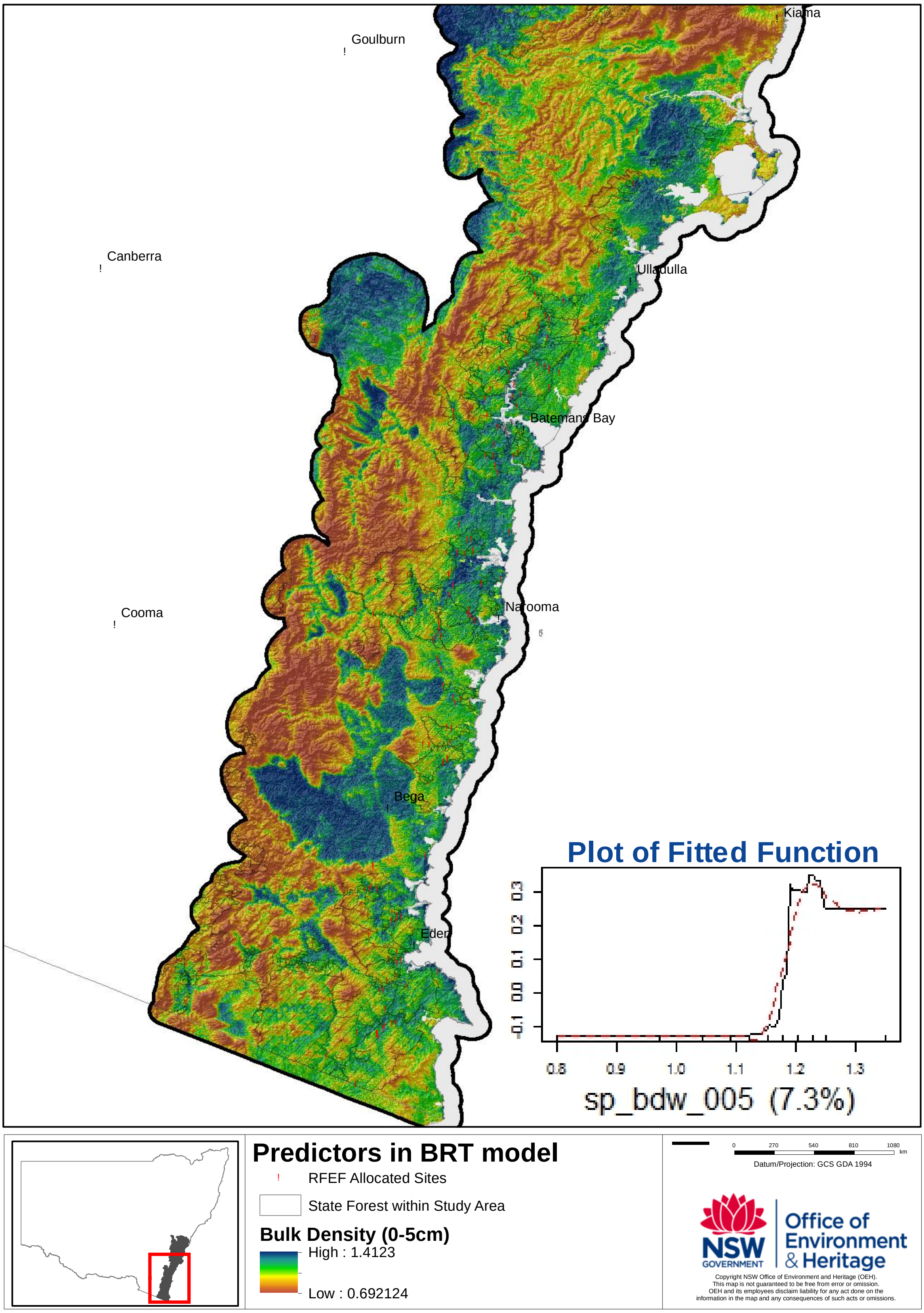


Spatial relationships with three predictors are highlighted in Maps 7 to 9. Map 7 shows where plots allocated to RFEF sit in relation to elevation, along with the fitted function for elevation used in the BRT model. In line with the determination, the fitted function plot shows that RFEF has zero probability of occurrence above 230 metres and a very low PoC between 180 and 230 metres. Map 8 shows the fitted function along a Bulk Density gradient for the top 5 centimetres of the soil profile. Bulk density (the dry weight of soil per unit volume of soil) is a simple measure of soil structure which decreases as mineral soils become finer in texture. High bulk density soils contain more mineral solids and are generally more fertile. The fitted function plot shows that RFEF does not grow on soils with bulk densities less than 1.1 and the highest likelihood of occurrence occurs on soils with bulk densities > 1.2. Map 9 shows fitted function in relation to distance from stream orders 5 to 9. As expected, the highest probability of occurrence occurs on or adjacent to the stream channel and drops to zero at around 0.02.

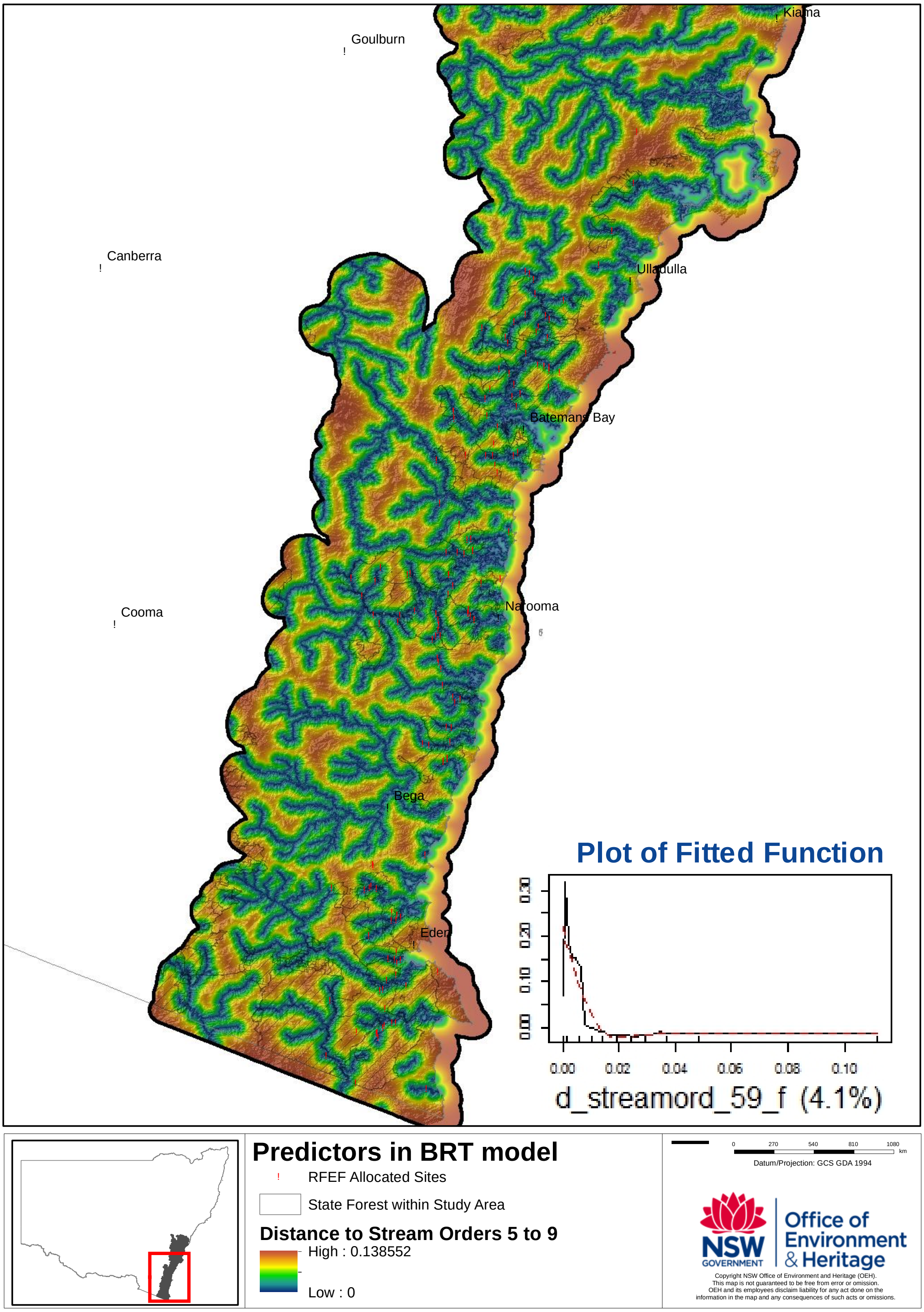
<u>Map 7</u>: Distribution of plots allocated to South Coast RFEF in relation to elevation, and corresponding fitted function in the BRT model.



<u>Map 8</u>: Distribution of plots allocated to South Coast RFEF in relation to bulk density (0-5cm in soil profile) and corresponding fitted function in the BRT model.



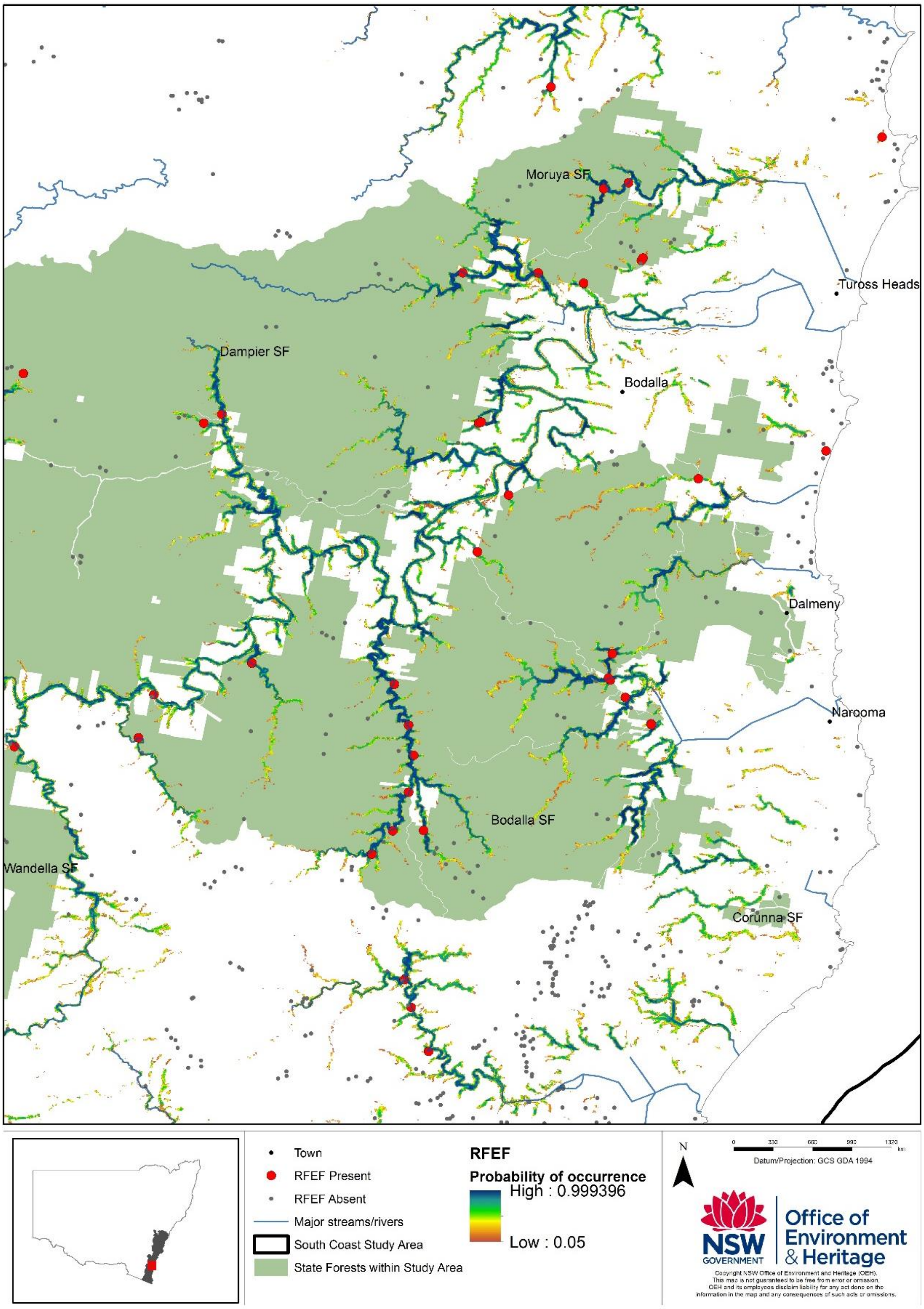
Map 9: Distribution of plots allocated to South Coast RFEF in relation distance from stream orders 5 to 9 and corresponding fitted function in the BRT model.



4.3.3 Predicted distribution map

An example of the potential distribution model for RFEF, as defined by the area with a probability of occurrence value of 0.05 and greater is shown in Map 10. The map covers Bodalla State Forest, Dampier State Forest and Moruya State Forest.

<u>Map 10</u>: Predicted distribution of RFEF in the Bodalla area, as defined by a probability of occurrence value of 0.05 and greater.



4.4 Aerial Photograph Interpretation

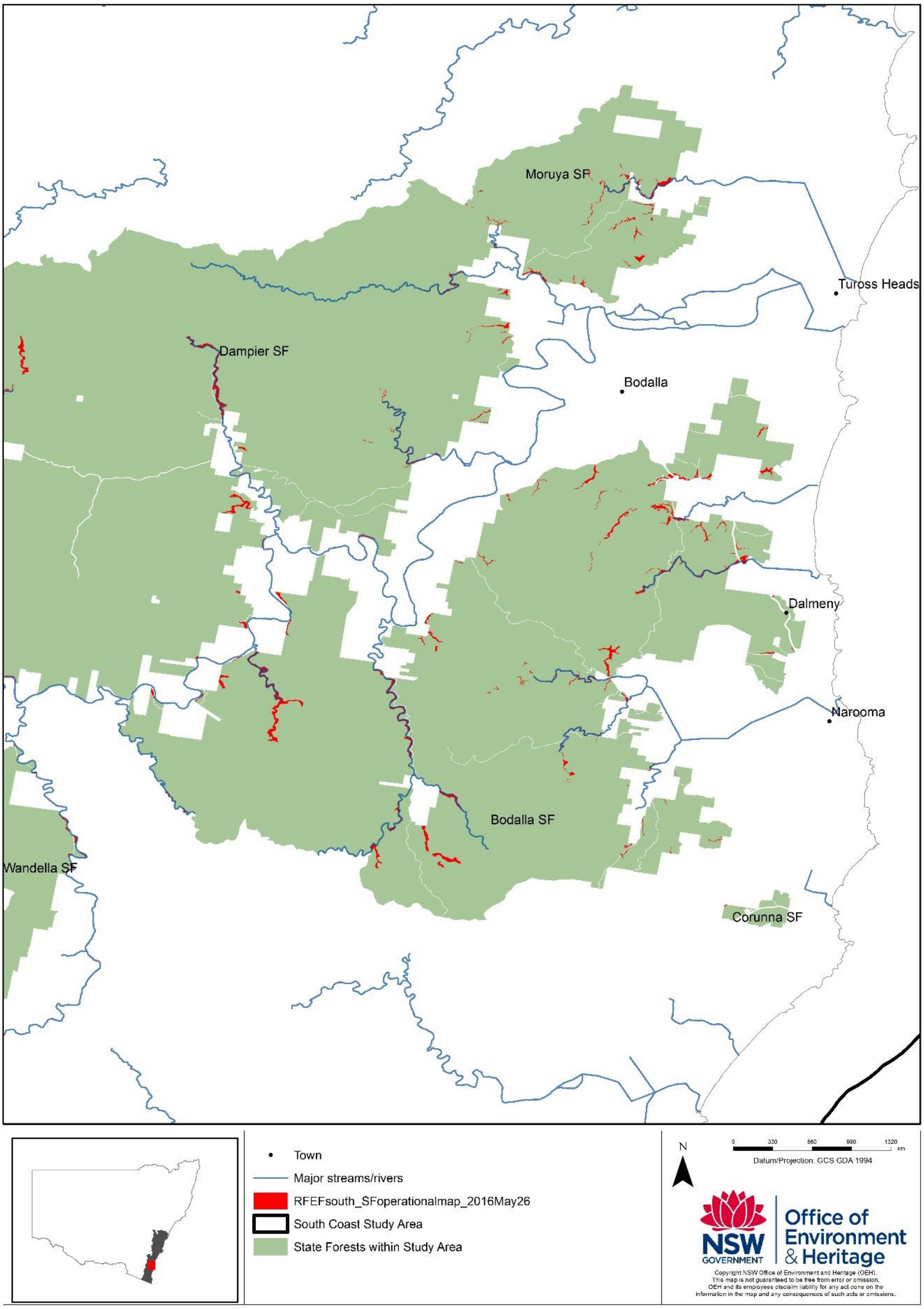
A total of 5945.1 hectares of modelled alluvial and floodplain habitat was initially assessed using aerial photograph interpretation to identify structural and floristic attributes of the vegetation cover. This comprised 3538.6 hectares in state forests south of the Bega Valley and 1956.5 hectares to the north. Assessment also included the identification of additional candidate habitat outside the modelled areas and within the 250,000 hectares of state forest in the study area. This resulted in an additional 1030.9 hectares being identified in the area south of Bega Valley, whilst this same process north of Bega Valley resulted in an additional 2371.2 hectares being added. Overall, as a result of 3D API, almost 50% more habitat was identified than the model using the prescribed mapping pathway. This was to be expected as the fine scale DEM that supported the model was not available for all state forest areas. In total 8897.2 hectares (5384 polygons) was identified as meeting the landscape, canopy species and understorey characteristics criteria relevant to further assessment of RFEF. This comprised 4569.5 hectares (3728 polygons) in state forests south of the Bega Valley and 4327.7 hectares (1656 polygons) to the north. The average polygon size for the entire South Coast study area was 1.65 hectares. Fifty-one classes were used to describe patterns in canopy (mainly eucalypt) composition across alluvial areas in the study area.

4.5 Operational TEC Map

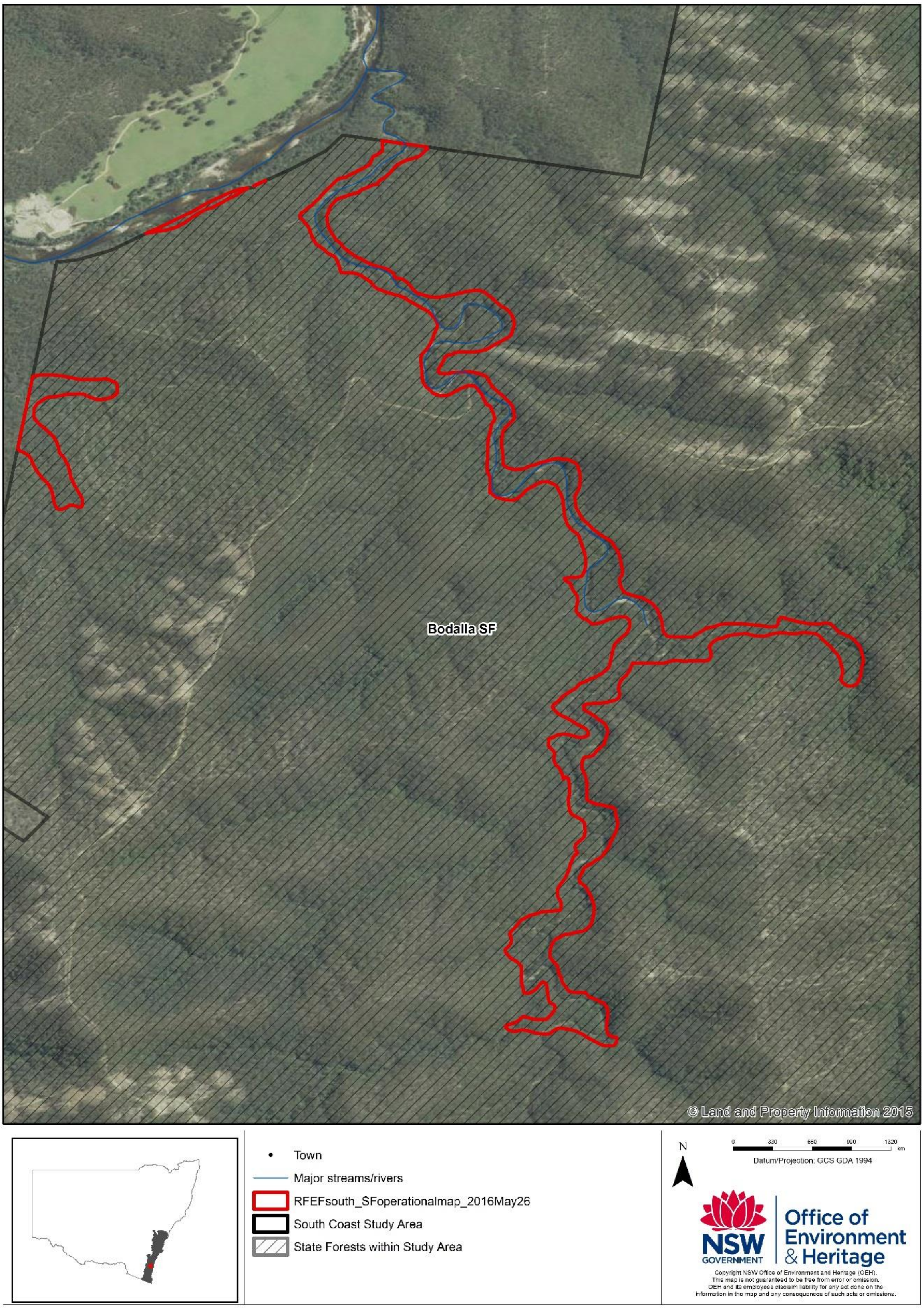
After integrating information from API results, plot data and predictive models, using the method described in Section 2.8.2, we mapped 3813 hectares of South Coast River-flat Eucalypt Forest TEC in state forests in our study area, comprising 1374 polygons with a mean size of 2.8 hectares. There are 573 patches <0.5 hectare, with a combined area of 81 hectares. The API units which we excluded from the final map are predominantly those dominated by *E. pilularis*, *Corymbia maculata* or *E. cypellocarpa*, and those dominated by *E. longifolia*, *E. botryoides* or *E. elata* but which floristically belong to communities not cited in the final determination (especially SCIVI p85, p86, e13 and e14). In the Eden area, we also excluded large areas on alluvial landscapes which belonged to shrubby wet heath communities (SCIVI e56 and e57) or were swamp forests dominated by *E. ovata* (m15). Map 12 shows the state forests in which we mapped at least one patch of River-flat Eucalypt Forest TEC, while maps 11a and 11b show more detailed examples of mapped River-flat Eucalypt Forest TEC in the Bodalla area, including a close-up view of Bodalla State Forest.

Based on mean probabilities and mean proportions above the threshold, we believe that our mapping is precautionary. Our efforts to minimise the likelihood that RFEF occurs outside our mapping area also results in the high likelihood that some forests may not meet the RFEF definition applied in this project. This uncertainty would be substantially reduced if the final determination was revised to reduce uncertainty and ambiguity in its interpretation. However, even if RFEF were to be relatively well-defined by the determination, it may still require a large investment of resources to substantially refine the map to reduce the extent to which non-RFEF is included in mapped areas, while ensuring that the likelihood of RFEF occurring outside mapped areas is very low.

Map 11a: Example of operational map for South Coast RFEF in the Bodalla area.



Map 11b: Close up view in Bodalla State Forest.

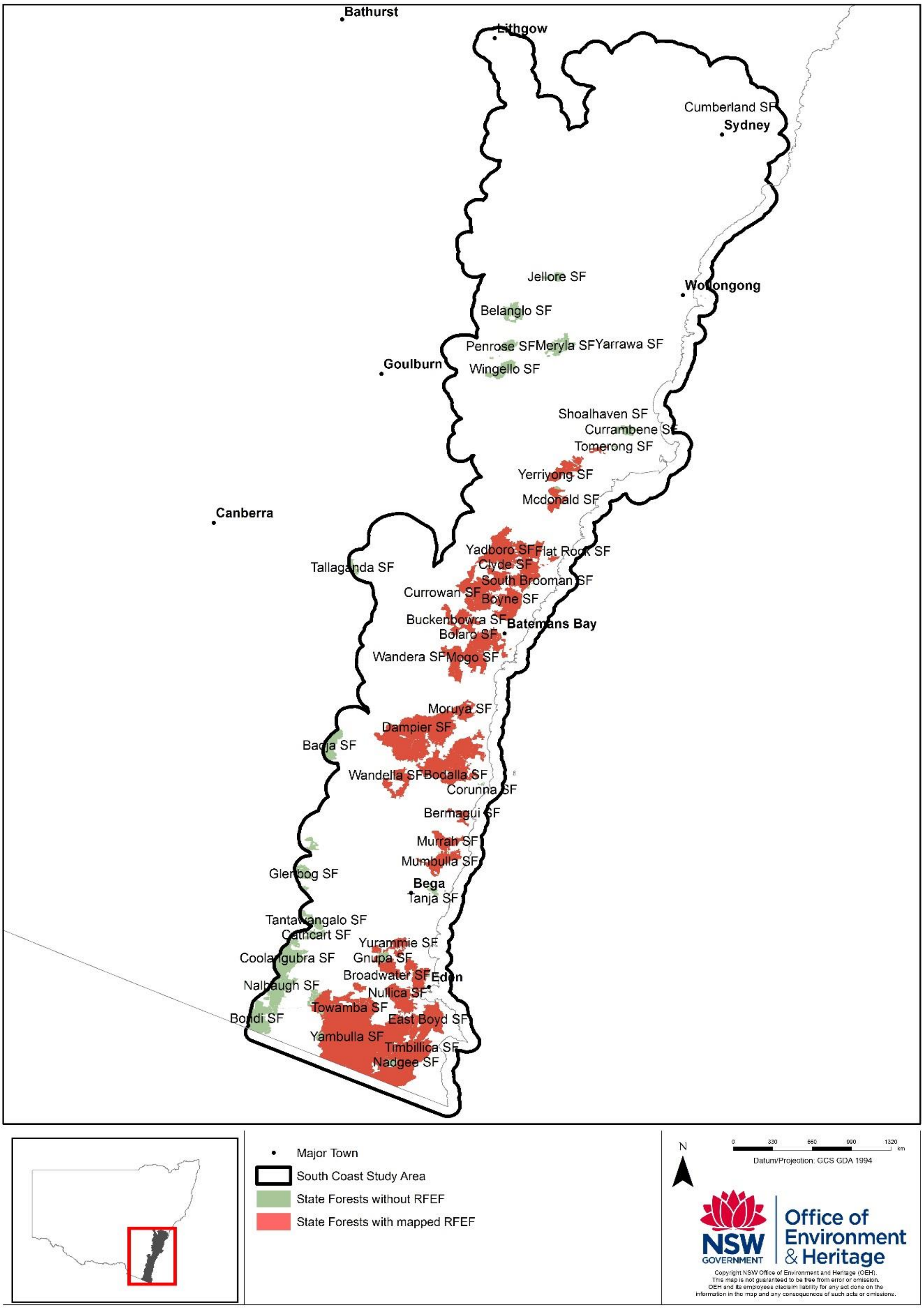


4.6 Validation

Primary membership of each of the 40 validation plots in communities previously defined by Gellie (2005) or Tozer et al. (2010), and the assessment of these plots as TEC or otherwise, are listed in Appendix H. The majority of plots do not belong to any TEC. We assigned a single plot, in the eastern part of Mogo State Forest, as RFEF. This plot is marginally RFEF. It has a relatively low membership of RFEF community g48 and was assessed in the field, by a surveyor with very extensive experience in south coast vegetation, as not TEC. We assigned two plots in Currambene State Forest as possible TEC (RFEF and Illawarra Lowlands Grassy Woodland respectively) although the relationships of these and other plots in alluvial environments in Currambene State Forest are not clear, partly because these environments have not been comprehensively sampled and their constituent communities are poorly defined.

The validation results indicated that in most areas there is very low likelihood that we have overlooked RFEF or other TECs in areas which we mapped as alluvial environments but excluded as TEC. The exceptions are parts of Mogo State Forest and Currambene State Forest. We used the validation results to revise the map of RFEF in Mogo State Forest, to include the sampled polygon and a nearby unsampled polygon with similar API and environmental characteristics to RFEF. In the northern part of Currambene State Forest, as a precautionary approach, we have assigned mapped areas with similar API characteristics to the validation plots assigned as possible RFEF. We have excluded the mapped areas in the southern part of the forest based on initial sample data and validation plots being not TEC.

<u>Map 12</u>: State forests with mapped occurrences of South Coast RFEF.



5 Discussion

5.1 Summary

5.1.1 Cited vegetation communities and determination species assemblage list

We experienced difficulties applying the TEC reference panel interpretation principles to the floristic attributes of River-flat Eucalypt Forest TEC to the south coast region. Firstly, we found that the list of characteristic species used in the final determination is not strongly associated with the vegetation communities that are either cited as River-flat Eucalypt Forest on the South Coast or to new samples we collected from alluvial and floodplain environments in the region. The strongest relationships between the species assemblage list and existing vegetation communities were achieved with river flat forests and grassy woodlands on the Cumberland Plain in Western Sydney. Our project resolved the problem by relying on the cited south coast vegetation communities as definitive River-flat Eucalypt Forest using the floristic and environmental qualifiers as described. However, the determination contains a significant omission because a vegetation community described as South Coast River Flat Forest (Tindall et al. 2004) is not included in the list of South Coast communities. We were able to overcome this omission by demonstrating that sample data used to define this community were also used in the classification of related vegetation communities that are listed in the determination.

Our strongest lines of evidence were obtained from existing vegetation classifications in the region that were constructed using systematically collected field data. These provided primary data against which we compared new samples from state forests and elsewhere. We identified a new river flat forest assemblage in the region (South Coast Creek Flat River Peppermint Forest) characterised by the frequent occurrence of *Eucalyptus elata* in the canopy. The assemblage was found to be associated with alluvial soils situated in elevated parts of coastal catchments between Eden and Nowra. This assemblage shares common species with components of earlier classifications described by Gellie (2005) and cited by the final determination. We also confirmed that the South Coast River Flat Forest (Tindall et al. 2004 and later Tozer et al. 2010) is also present in the region where it occupies lower lying alluviums and floodplains. We concluded that both river flat communities met the definition of River-flat eucalypt TEC in the South Coast region.

The project relied on several assumptions to provide some certainty with the interpretation of the TEC. We found that some samples located on alluvial soils were related to vegetation communities in existing studies that are not cited in the final determination. The project assumed that where there was weak association with other existing vegetation communities and they were not included in either the list of communities relevant to the south coast or in the threat assessment then these were definitively not River Flat Eucalypt Forest TEC. There are no statements in the final determination to explicitly identify how vegetation classification sources have been assessed and which communities have been examined and excluded, however, without the adoption of these rule sets effectively any native vegetation found on alluvial or floodplain landscapes would be a candidate for the TEC. Such an outcome would conflict with the Panel interpretation principles that the threat assessment parameters used to underpin the TEC are not significantly exceeded. The final determination for River Flat Eucalypt Forest TEC includes a general statement in Paragraph 7 ‘the Determinations for these (floodplain) communities collectively encompass the full range of intermediate assemblages in transitional habitats’. However, the panel was unable to resolve the meaning of the statement as it conflicted with the stated species assemblage, the cited vegetation communities and the threat assessment parameters. Even if these conflicts are ignored, it would not be possible to apply this statement alone to define the TEC in any practical sense because of the vagueness of what limits a ‘floodplain’ and what the term ‘transitional habitats’ means.

5.1.2 Distribution and habitat descriptors

The final determination includes a set of environmental descriptors that assist in locating River-flat Eucalypt Forest on the South Coast. However, there is considerable uncertainty as to whether these criteria had to be satisfied in order to assign the TEC. The panel addressed this uncertainty by adopting those criteria which were accompanied by statements that suggested a definitive association; bioregion, alluvial flats and floodplains and elevation.

Notwithstanding these decisions, the inclusion of floodplain and alluviums as a prescribed condition of the panel interpretation of the TEC required the identification of suitable landscapes on the South Coast. There is no reference in the final determination to mapped information defining floodplain and alluvial landscapes. The determination contains insufficient detail to apply a diagnostic rule to a site. The project adopted a precautionary interpretation of the landscape criteria by using the best available published maps, models of water flow accumulation using fine scale digital models and aerial photographic interpretation. We believe that the layers that we generated offer the best available representation of candidate alluvial and floodplain landscapes on state forest. Less refined floodplain mapping remains on other tenures as API assessment has not been completed.

We found general agreement with the elevation thresholds described in the final determination. On the South Coast our indicative model suggested a very low likelihood of suitable River-flat Eucalypt Forest habitat occurring above 200 metres above sea level. We believe that this threshold together with floristic data can be used as a useful field key to diagnose the River-flat Eucalypt Forest TEC to reasonable levels of certainty.

5.2 TEC Panel Review and Assessment

5.2.1 Summary of discussions

The results of the community analysis and map products were subject to a review process by the TEC panel. Table 10 presents the summary of the findings.

Table 10: Summary of issues and Panel review of RFEF, meeting held 14 October 2015.

Final Determination	TEC Panel Principles	Our Project	TEC Panel Review
Occurs in '….Sydney Basin, South East Corner Bioregions'	Accept Bioregional Qualifiers	Adopted	Accepted
Occurs on 'on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence…'	Assess habitat descriptors and whether these constrain or define the limits of the TEC which otherwise may have a broader distribution	Floodplain and alluvial landform elements represented by a alluvial model derived from 1m Lidar DEM, supplemented by stereoscopic digital aerial photograph interpretation	Noted
Occurs Floodplains generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m	Assess habitat descriptors and whether these constrain or define the limits of the TEC which otherwise may have a broader distribution	Sample plots that conform to the TEC generally meet the elevation qualifier, though the model may predict suitable habitats occur at higher elevations	Noted and accepted in principle

Final Determination	TEC Panel Principles	Our Project	TEC Panel Review
Cited vegetation sources Gellie types (FE27, FE48,FE49) and Tindall (MU33, MU105, MU19, MU60) and applies qualifiers based on landform element and canopy characteristics	Assess references to existing vegetation classification sources in the Determination. The panel will note whether the existing classifications are 'included within' are 'part of' or 'component of' the determination. Classifications developed using traceable quantitative data will be recognised as primary data upon which to assess floristic, habitat and distributional characteristics. Where data has been sourced and used in alternate regional or local classification studies the results will be considered by the panel to assist in the development of the TEC definitional attributes	Analysed relationships between new samples collected on state forest and samples used to define source classifications. Alluvial models used to define included and excluded components of particular cited vegetation types, consistent with explicit qualifiers stated in the determination	Relationships noted and use of explicit qualifiers for particular vegetation types accepted.
Characterised by the list of 86 plant species	Be guided by the species lists presented in the determination	Compared species assemblage data drawn from source classifications with that presented in the determination Found that the determination species list is strongly associated with Cumberland Plain River-flat Forests in western Sydney, more so than any eucalypt dominated assemblage found on alluvial environments on the NSW South Coast Consequently relied on cited classification sources and environmental and floristic qualifiers to define RFEF on the South Coast. Main qualifying vegetation units are (Gellie vg27, vg48 and vg49) and SCIVI (p30, e60, e19)	Noted limitations of assemblage list and agreed that where conflicts exist, assessment should be also guided by community relationships, not solely assemblage list
	Other Issues: New Included Vegetation Communities	New vegetation types associated with 'alluvial and floodplain environments' not described by SCIVI Xs6 (Eucalyptus elata/Oplismenus imbecillus/Poa ensiformis/Entolasia marginata) Included as RFEF TEC on the basis of similarities between cited classifications and xs6 and their relationship to the species list in the determination	Accepted inclusion of new group xs6 as RFEF, where it occurred on or close to alluvium
	Other issues: Excluded Vegetation Communities	A pool of data situated on modelled alluviums in the Nowra area SFs were most strongly	Agreed that exclusion

Final Determination	TEC Panel Principles	Our Project	TEC Panel Review
		related to SCIVI groups p85 and p86. Dominated by E. longifolia, C. maculata +/-E. botryoides+/ -E. paniculata these stands have been excluded as they are not explicitly referenced in the Determination and have a weaker association with the determination species list than other referenced classification sources SCIVI group p32 dominated by river oak Casuarina cunninghamiana excluded as neither sourced in determination or meets the floristic qualifiers SCIVI group m15 dominated by Eucalyptus ovata above an understorey of Gahnia spp and/or Melaleuca spp. occupies poorly drained alluvial soils in the Eden region. These swamp forests are not explicitly referenced nor are they strongly related to the determination species list Field traverse and plot survey identified stands of E. ignorabilis and E. consideniana on seepage flats in the Eden region. We were unable to relate the assemblage to an existing SCIVI group as we had too few plots. These forests were excluded from our operational map as the canopy species and associated floristics were poorly matched to the determination assemblage and the stands occurred in areas of low modelled probability for RFEF	of these groups is appropriate.
		A set of communities associated with alluvial environments in the Eden region have also been excluded. These cover e55, e56 and e57 as they bear little resemblance to the species list and have not been cited Xs13; a grouping of floristic data characterised by a single observer sampling native vegetation perceived as 'littoral rainforest'. Comprises an unusual combination of species that samples a wide variety of coastal environments some of which include alluvial landscape elements. Suspected transect data based on species richness scores and species combinations. Grouping is a likely artefact of survey method and these plots are not considered beyond the initial analysis	Agreed that exclusion of e55, e56 and e57 is appropriate and that xs13 be excluded from further consideration

5.3 Final State Forest - TEC Occurrence Matrix

Table 11: Total area of South Coast RFEF present within each state forest within the study area.

State Forest	Area (Ha)	AREA RFEF (Ha)	State Forest	Area (Ha)	AREA RFEF (Ha)
Badja State Forest	4839		Moruya State Forest	4059	61.5
Bateman State Forest	1		Mumbulla State Forest	6137	54.6
Belanglo State Forest	3891		Murrah State Forest	4215	32.2
Benandarah State Forest	2761	58.5	Nadgee State Forest	20537	661.4
Bermagui State Forest	1861	17.5	Nalbaugh State Forest	4396	
Bodalla State Forest	24079	351.0	Newnes State Forest	281	
Bolaro State Forest	1779	10.8	North Brooman State Forest	3631	122.8
Bombala State Forest	620		Nowra State Forest	521	
Bondi State Forest	12742		Nullica State Forest	18298	74.8
Boyne State Forest	6161	104.4	Nungatta State Forest	887	
Broadwater State Forest	167		Penrose State Forest	1986	
Bruces Creek State Forest	791	0.6	Shallow Crossing State Forest	3855	32.1
Buckenbowra State Forest	5193	40.3	Shoalhaven State Forest	104	
Cathcart State Forest	1735		South Brooman State Forest	5587	171.4
Clyde State Forest	3587	79.3	Tallaganda State Forest	1363	
Coolangubra State Forest	8489		Tanja State Forest	867	
Corunna State Forest	183	0.5	Tantawangalo State Forest	2466	
Cumberland State Forest	40		Termeil State Forest	698	4.5
Currambene State Forest	1695	97.4	Timbillica State Forest	9144	158.9
Currowan State Forest	11977	94.3	Tomerong State Forest	212	
Dampier State Forest	33746	324.1	Towamba State Forest	5471	0.1
East Boyd State Forest	21010	385	Wandella State Forest	5492	19.5
Flat Rock State Forest	4896	54.6	Wandera State Forest	5198	48
Glenbog State Forest	4641		Wingello State Forest	3975	
Gnupa State Forest	1318		Woodburn State Forest	10	
Jellore State Forest	1411		Yadboro State Forest	10750	197.9
Jerrawangala State Forest	268		Yambulla State Forest	47108	261.2
Kioloa State Forest	171	7.5	Yarrawa State Forest	179	
Mcdonald State Forest	3684	20.8	Yerriyong State Forest	6604	83.4
Meryla State Forest	4554		Yurammie State Forest	4050	25.8
Mogo State Forest	15498	156.2	**Total**		3813

6 References

Austin, M. (2002). Spatial prediction of species distribution: an interface between ecological theory and statistical modelling. *Ecological Modelling,* 157(2), pp. 101-118.

Breiman, L., Friedman, J., Stone, C.J. & Olshen, R.A. (1984). *Classification and regression trees*. USA: CRC Press.

De'ath, G. (2007). Boosted trees for ecological modeling and prediction. *Ecology*, 88(1), pp. 243-251.

De Cáceres, M., Font, X. & Oliva, F. (2010). The management of vegetation classification with fuzzy clustering. *Journal of Vegetation Science*, 21, pp. 1138-1151.

Elith, J. & Leathwick, J. (2016). A working guide to boosted regression trees. Unpublished

Elith, J., Leathwick, J. R. & Hastie, T. (2008). A working guide to boosted regression trees. *Journal of Animal Ecology,* 77(4)*, pp.* 802-813.

Friedman, J.H. (2001). Greedy function approximation: a gradient boosting machine. *Annals of Statistics*, pp. 1189-1232.

Gellie, N.J.H. (2005). Native vegetation of the Southern Forests: South-east Highlands, Australian Alps, South-west Slopes and SE Corner bioregions. *Cunninghamia,* 9(2), pp. 219-253.

Hijmans, R.J., Phillips, S., Leathwick, J. & Elith, J. (2012). dismo: Species distribution modeling. *R package version 0.7-17*.

Keith, D.A. & Bedward, M. (1999). Native vegetation of the South East Forests region, Eden New South Wales. *Cunninghamia,* 6, pp. 1-218.

Keith, D.A. & Scott, J. (2005). Native vegetation of coastal floodplains? a diagnosis of the major plant communities in New South Wales. *Pacific Conservation Biology,* 11(2), pp. 81-104.

Leathwick, J., Elith, J., Francis, M., Hastie, T., & Taylor, P. (2006). Variation in demersal fish species richness in the oceans surrounding New Zealand: an analysis using boosted regression trees. *Marine Ecology Progress Series,* 321, pp. 267-281.

NSW Scientific Committee (2011). River-flat Eucalypt Forest on Coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Determination to make a minor amendment to Part 3 of Schedule 1 of the *Threatened Species Conservation Act*. Hurstville: NSW Scientific Committee.

OEH (2016a). Assessment of Swamp Oak Forest on Coastal Floodplains TEC on NSW Crown Forest Estate (South Coast Region). Survey, Classification and Mapping completed for the NSW EPA. Sydney: Office of Environment and Heritage.

OEH (2016b). Assessment of Swamp Sclerophyll Forest on Coastal Floodplains TEC on NSW Crown Forest Estate (South Coast Region). Survey, Classification and Mapping completed for the NSW EPA. Sydney: NSW Office of Environment and Heritage.

Poore, M.E.D. (1955). The use of phytosociological methods in ecological investigations: II. Practical issues involved in an attempt to apply the Braun-Blanquet system. *The Journal of Ecology*, pp. 245-269.

Ridgeway, G. (2007). Generalized Boosted Models: A guide to the gbm package. *Update,* 1(1), 2007.

Royal Botanic Gardens (2002). PlantNET-The Plant Information Network System of The Royal Botanic Gardens, Sydney (Version 1.4). First accessed 2/10/14, from http://plantnet.rbgsyd.gov.au

Sivertsen, D. (2009). Native Vegetation Interim Type Standard. Sydney: Department of Environment, Climate Change and Water.

Thomas, V., Gellie, N. & Harrison, T. (2000). Forest ecosystem classification and mapping for the southern Comprehensive Regional Assessment. Queanbeyan: NSW National Parks and Wildlife Service.

Tindall, D., Pennay, C., Tozer, M.G., Turner, K., & Keith, D.A. (2004). Native vegetation map report series. No. 4. Araluen, Batemans Bay, Braidwood, Burragorang, Goulburn, Jervis Bay, Katoomba, Kiama, Moss Vale, Penrith, Port Hacking, Sydney, Taralga, Ulladulla, Wollongong. NSW Sydney: Department of Environment and Conservation and NSW Department of Infrastructure, Planning and Natural Resources.

Tozer, M.G., Turner, K., Simpson, C., Keith, D.A., Beukers, P., MacKenzie, B., Cox, S. & Pennay, C. (2010). Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia,* 11(3), pp. 359-406.

Troedson, A.L. & Hashimoto, T.R. (2008). Coastal Quaternary Geology - north and south coast of NSW *Bulletin 34*. Sydney: Geological Survey of New South Wales.

Warton, D.I., Wright, S.T. & Wang, Y. (2012). Distance-based multivariate analyses confound location and dispersion effects. *Methods in Ecology and Evolution,* 3, pp. 89-101.

Wiser, S.K. & De Cáceres, M. (2013). Updating vegetation classifications: an example with New Zealand’s woody vegetation. *Journal of Vegetation Science,* 24, pp. 80-93.

Appendix A

Communities for which all previously allocated plots were included in one or more analyses.

Table A1: Vegetation groups described by Gellie (2005).

CODE	VEGETATION COMMUNITY NAME
VG 1	Southern Coastal Foothills Dry Shrub Forest
VG 2	Coastal Lowland Dry Shrub Forest
VG 3	Northern Hinterland Dry Shrub Forest
VG 5	Jervis Bay Lowlands Dry Shrub-Grass Forest
VG 6	Southern Coastal Lowlands Shrub/Tussock Grass Dry Forest
VG 7	Southern Coastal Hinterland Dry Shrub-Tussock Grass Forest
VG 8	Far Southern Coastal Dry Shrub Forest
VG 9	Coastal Lowlands Cycad Dry Shrub Dry Forest
VG 10	Southern Coastal Lowlands Shrub-Grass Dry Forest
VG 11	Coastal Shrub/Grass Dry Forest
VG 12	Coastal Hinterland (Buckenbowra) Dry Shrub-Cycad Forest
VG 13	Deua-Belowra Rainshadow Dry Shrub-Tussock Grass Forest
VG 18	Southern Coastal Hinterland Moist Shrub-Vine-Grass Forest
VG 19	Coastal Escarpment and Hinterland Dry Shrub-Fern Forest
VG 20	Coastal Hinterland Ecotonal Gully Rainforest
VG 21	South Coast Foothills Moist Shrub Forest
VG 24	Coastal Wet Heath Swamp Forest
VG 25	South Coast Swamp Forest Complex
VG 26	Coastal Dune Herb/Swamp Complex
VG 27	Ecotonal Coastal Swamp Forest
VG 28	Coastal Sands Shrub-Fern Forest
VG 29	Northern Coastal Sands Shrub-Fern Forest
VG 30	Jervis Bay Moist Shrub-Palm Forest
VG 33	South Coast Hinterland Gully Head Shrub Forest
VG 35	South Coast and Byadbo Acacia Scrubs
VG 47	Southern Escarpment Herb - Grass Moist Forest
VG 48	Coastal Lowlands Riparian Herb-Grass Forest
VG 49	South Coast Hinterland Shrub-Herb-Grass Riparian Forest
VG 50	South Coast Escarpment Dry Herb-Grass Forest
VG 51	Araluen Acacia Dry Herb-Grass Forest
VG 52	Bega Valley Shrub/Grass Forest
VG 53	Riparian Acacia Shrub-Grass-Herb Forest
VG 54	Far Southern Dry Grass-Herb Forest-Woodland (171)
VG 56	Tableland and Escarpment Moist Herb-Fern Grass Forest
VG 57	Southern Escarpment Shrub-Fern-Herb Moist Forest
VG 58	Tableland and Escarpment Wet Layered Shrub Forest
VG 59	Eastern Tableland and Escarpment Shrub-Fern Dry Forest

CODE	VEGETATION COMMUNITY NAME
VG 61	Southern Escarpment Edge Moist Shrub Forest
VG 62	Southern Escarpment Edge Moist Shrub-Fern Forest
VG 64	Southern East Tableland Edge Shrub-Grass Dry Forest
VG 136	08a Sandstone Plateau Heath Forests
VG 137	08a Sandstone Plateau Heath Forests
VG 138	08a Sandstone Plateau Heath Forests
VG 139	08a Sandstone Plateau Heath Forests
VG 143	08b South Coast/Hinterland Heathlands/Tall Shrublands
VG 165	Southern Escarpment Cool-Warm Temperate Rainforest
VG 166	Central Coastal Hinterland and Lowland Warm Temperate Rainforest
VG 167	Coastal Lowland Sub Tropical-Littoral Rainforest
VG 168	Araluen Ecotonal Granite Dry Rainforest
VG 169	Coastal Hinterland Sub Tropical Warm Temperate Rainforest
VG 170	Southern Coastal Hinterland Dry Gully Rainforest
VG 171	Coastal Shrub/Grass Forest
VG 179	Eastern Deua Dry Shrub Forest

Table A2: Communities described by Tozer et al. (2010).

CODE	MAPUNIT NAME
e1	Southeast Dry Rainforest
e13	Southeast Hinterland Wet Fern Forest
e14	Southeast Hinterland Wet Shrub Forest
e15	Southeast Mountain Wet Herb Forest
e17	Southeast Flats Swamp Forest
e18	Brogo Wet Vine Forest
e19	Bega Wet Shrub Forest
e20 p229	Southeast Lowland Grassy Woodland
e25	Southeast Sandstone Dry Shrub Forest
e26	Southeast Tableland Dry Shrub Forest
e27	Waalimma Dry Grass Forest
e28	Wog Wog Dry Grass Forest
e29	Nalbaugh Dry Grass Forest
e3	Rocky Tops Dry Scrub Forest
e30	Wallagaraugh Dry Grass Forest
e31	Southeast Hinterland Dry Grass Forest
e32a	Deua-Brogo Foothills Dry Shrub Forest
e32b	Far South Coastal Foothills Dry Shrub Forest
e33	Southeast Coastal Range Dry Shrub Forest
e34	Southeast Coastal Gully Shrub Forest
e35	Southeast Escarpment Dry Grass Forest
e37	Southeast Lowland Gully Shrub Forest
e38	Far Southeast Riparian Scrub

CODE	MAPUNIT NAME
e39	Bega-Towamba Riparian Scrub
e4	Brogo Shrub Forest
e42	Southeast Inland Intermediate Shrub Forest
e43	Southeast Mountain Sandstone Shrub Forest
e44	Southeast Foothills Dry Shrub Forest
e46b	Southeast Lowland Dry Shrub Forest
e47	Eden Dry Shrub Forest
e48	Mumbulla Dry Shrub Forest
e49	Southeast Coastal Dry Shrub Forest
e50	Genoa Dry Shrub Forest
e52	Southeast Mountain Rock Scrub
e57	Southeast Lowland Swamp
e60	Southeast Floodplain Wetlands
e6e7	Southeast Warm Temperate Rainforest
m15	Eden Shrubby Swamp Woodland
n183	South Coast Hinterland Wet Forest
n184	Clyde-Tuross Hinterland Forest
n185	Wadbillga Dry Shrub Forest
p100	Escarpment Foothills Wet Forest
p103	Clyde Gully Wet Forest
p104	Southern Lowland Wet Forest
p105	Floodplain Swamp Forest
p106	Estuarine Fringe Forest
p107	Estuarine Creekflat Scrub
p110	Warm Temperate Layered Forest
p111	Subtropical Dry Rainforest
p112	Subtropical Complex Rainforest
p113	Coastal Warm Temperate Rainforest
p114	Sandstone Scarp Warm Temperate Rainforest
p116	Intermediate Temperate Rainforest
p148	Shoalhaven Sandstone Forest
p3	South Coast Lowland Swamp Woodland
p30	South Coast River Flat Forest
p31	Burragorang River Flat Forest
p32	Riverbank Forest
p33	Cumberland River Flat Forest
p34	South Coast Grassy Woodland
p38	Grey Myrtle Dry Rainforest
p40	Temperate Dry Rainforest
p44	Sydney Swamp Forest
p45	Coastal Sand Swamp Forest

CODE	MAPUNIT NAME
p58	Sandstone Riparian Scrub
p63	Littoral Thicket
p64	Coastal Sand Forest
p85	Currambene-Batemans Lowlands Forest
p86	Murramarang-Bega Lowlands Forest
p89	Batemans Bay Foothills Forest
p90	Batemans Bay Cycad Forest
p91	Clyde-Deua Open Forest
p95	Southern Turpentine Forest
p99	Illawarra Gully Wet Forest

Appendix B

Aerial Photo Interpretation Attribution
Table B1: Eden Region Canopy Species API Codes (South of Bega Valley).

ALLUVIAL API CODE	Common Dominant / Co-dominants	Common associates (subsidiary and minor) and may occasionally be co-dominant
POTENTIAL TARGET TYPES, TO BE MAPPED WITHIN AND OUTSIDE ALLUVIAL MODEL		
108	*E. elata, A floribunda*	*E. cypellocarpa, E. baueriana, E. tereticornis, E. ovata* *E. longifolia (E. viminalis riparian)*
109	*E. longifolia*	*E. cypellocarpa (often co dominant) A floribunda,* *E. angophoroides, E. viminalis (sometimes occasional patches of E. ovata)*
110	*E. ovata*	*E. cypellocarpa E. elata E. muelleriana, E. radiata/croajingolensis, E. globoidea (M. squarrosa/Gahnia common components)*
153	Swamp shrubland (T to VT)	*Typically M. squarrosa (fresh water, frequently with E.ovata) sometimes M. ericifolia (sub saline to saline)*
156	Intermediate shrubland (T to VT)	*Tall shrubs dominant in large canopy openings e.g. Pomaderis etc.*
115	Viney Scrub	*Mesic shrubs/vines dominant in large canopy openings*
150	Freshwater Wetlands	
154x	Riparian complex	*Complex comprising several riparian associated features such as water, gravel, rock, streambank shrubs/trees e.g. Tristaniopsis etc.*
154	Riparian streamside shrub/low tree complex	*Vegetated riparian zones such as streamside embankments/stream beds that are frequently inundated by high energy flood water. Commonly dominated by Tristaniopsis and may include occasional trees (commonly E. elata,* *E. cypellocarpa, E. viminalis) Callistemon, Melaleuca and various shrubs etc.*
155	Riparian streambed complex	*Streambed complex which essentially comprises water, gravel, rock and very sparsely scattered shrubs/trees etc.*
NON-TARGET TYPES, ONLY MAPPED WHERE THEY OCCUR WITHIN ALLUVIAL MODEL		
218	Rainforest (unidentified type)	*Unidentified*
202	*Acmena smithii*	
216	*Acacia*	Typically *Acacia mearnsii*
211	*E. sieberi*	*E. globoidea, E. muelleriana*
215	*E. globoidea +/- A. littoralis*	*E. consideniana, E. sieberi*
219	*E. globoidea +/- A.littoralis*	*E. cypellocarpa, E. longifolia, A. floribunda, E. obliqua, E. sieberi, E. consideniana*

ALLUVIAL API CODE	Common Dominant / Co-dominants	Common associates (subsidiary and minor) and may occasionally be co-dominant
214	Seepage zone woodland	*E. ignorabilis, E. consideniana, E. globoidea, A. floribunda Occasional E. ovata and E. croajigolensis*
217	*E. cypellocarpa +*	*E. obliqua, E. elata, E. croajigolensis, A. floribunda E. muelleriana (E. viminalis E. angophoroides riparian)*
220	*E. obliqua, E. radiata/ croajingolensis*	*E. cypellocarpa, E. viminalis, E. sieberi, E. fastigata, E. globoidea (E. ovata)*

Table B2: Eden Region understorey attributes.

Understorey label	CODE	Additional Comments
MOIST ALLUVIAL TYPES		
General	M0	May include localised swampy patches
Ferny (+)	M1	Commonly presents as Gahnia directly associated with minor watercourse/s and grading to ferns / Lomandra etc from streambank to more (slightly) elevated flats. May include localised swampy or mesic patches
Vine Scrub	M2	
Mesic shrubs and or palms	M3	
Rain Forest Sub-canopy	M4	
Acacia	M5	Typically *A. mearnsii*
Intermediate Grasses/Forbs/Sedges/Rushes	M6	Relatively high soil moisture, scattered Lomandra typically a feature, somewhat grassy (occasional ferns)
DRY TYPES		
General	D0	
Grassy	D1	
Shrub/Grass	D2	
Allocasurina + dry shrub/grass	D3	
Intermediate to dry grass/shrub +/- ferns, Lomandra	D4	Drier than M6. Applied to stringybark +/- occasional *E. consideniana*, *E. sieber*i, *E. cypellocarpa* occurring in drainage depression. Typically at gully heads. Slightly more moist than surrounding type usually RN113, RN112, RN123.
SWAMPY		
General	S0	May include a mosaic swamp shrubs sometimes tending mesic. Gahnia, scattered melaleuca, sedges, rushes etc.
Paperbark		
Melaleuca	S1	
Swampy to dry shrubs sedges grasses	S2	Non-alluvial seepage zones. e.g. *E. consideniana E. ignorabilis* woodland

Understorey label	CODE	Additional Comments
Other		
Disturbed	X0	
Exotics Dominant	X1	
Riparian complex	X2	
Saline/subsaline	X3	
Not Applicable	9999	

Table B3: South Coast canopy species API codes (Nowra to Bega)

ALLUVIAL API CODE	CANOPY1 Common Dominant / Co-dominants	CANOPY 2 Common associates (subsidiary and minor)
POTENTIAL TARGET TYPES, TO BE MAPPED WITHIN AND OUTSIDE ALLUVIAL MODEL		
101	***A. floribunda***	*E. tereticornis*
102	***E. tereticornis, A. floribunda***	*E. globoidea*
103	***E. tereticornis***	*Angophora floribunda, E. globoidea*
104	***E. baueriana, E. angophoroides***	*E. angophoroides, E. elata, E. globoidea, A. floribunda*
105	***E. bosistoana***	*E. longifolia, E. botryoides*
106	***E. botryoides***	*E. longifolia, E. elata*
107	***E. elata***	*A. floribunda, E. baueriana, E. tereticornis, E. viminalis*
108	***E. elata, A. floribunda***	*E. baueriana, E. tereticornis, E. cypellocarpa*
109	***E. longifolia***	*A. floribunda, E. cypellocarpa, E. angophoroides, E. viminalis*
111	***E. robusta***	*E. longifolia, E. botryoides*
112	***C. glauca***	not present
113	***C. glauca***	*E. longifolia,* other euc spp.
114	***C. glauca, Melaleuca spp.***	
116	**Viney Scrub**	
150	**Freshwater Wetlands**	
151	**Saltmarsh**	
152	**Grasslands**	
153	**Freshwater Wetlands**	
154	**Riparian streamside shrub/low tree complex**	
154x	**Riparian complex**	
155	**Riparian streambed complex**	
156	**Intermediate Shrubland**	

ALLUVIAL API CODE	CANOPY1 Common Dominant / Co-dominants	CANOPY 2 Common associates (subsidiary and minor)
157	**Freshwater Wetlands**	
NON-TARGET TYPES, ONLY MAPPED WHERE THEY OCCUR WITHIN ALLUVIAL MODEL		
200	**Unidentified**	Unidentified
201	***Backhousia myrtifolia***	*Acmena smithii*
202	***Acmena smithii***	
204	***C. maculata***	*S. glomulifera, E. longifolia*
205	***E. globoidea***	*E. pilularis*
206	***E. muelleriana, E. cypellocarpa***	*E. maidenii*
208	***E. pilularis***	
209	***E. piperita***	
210	***E. saligna or E. salignaxbotryoides***	*E. pilularis, E. piperita, S. glomulifera, E. elata, E. longifolia, A. floribunda*
212	***E. sclerophylla, C. gummifera***	
213	***E. scias (pellita) or E. resinifera***	
214	**Mangrove**	
215	***C. cunninghamiana***	
216	**Acacia scrub**	
217	***E. paniculata***	

Appendix C

Vegetation Community TEC Status

Mean and cumulative proportions of RFEF determination species in plots of vegetation communities (SCIVI, Tozer et al. 2010) analysed for the study area. Only communities with proportion >=0.13 (the lowest value for a community cited in the RFEF determination) and five or more plots are shown. Additional communities which we derived from analyses for our project but which do not closely match SCIVI communities have 'xs' prefix.

SCIVI Community	Number of plots	Mean proportion	Cumulative number of species	Status in Study Area
p33	53	0.65	66.7	RFEF on Cumberland Plain, not present in SF
xs11	59	0.64	49.7	Cumberland Plain Woodland TEC, not present in SF
p29	10	0.57	na	Cumberland Plain woodland TEC, not present in SF
p31	7	0.54	na	RFEF Warragamba catchment, not present in SF
p3	19	0.52	47.92	Considered under Illawarra Lowlands Grassy Woodland TEC
p34	31	0.48	51.64	Considered under Illawarra Lowlands Grassy Woodland TEC
e20p229	89	0.48	46.08	Considered under Lowland Grassy Woodland TEC
p30	16	0.46	47.14	Included in RFEF
p32	27	0.45	40.08	Excluded, not cited in determination
xs17	90	0.44	43.06	Excluded, grassy woodland not present in SF
p87	38	0.43	53.68	Sydney Turpentine Ironbark Forest TEC, not present in SF
p105	35	0.42	28.42	Considered under Swamp Oak TEC
e19	66	0.42	47.62	Included in RFEF if alluvial
p38	40	0.41	43.56	Excluded, rainforest, not cited in determination
p434	13	0.41	36.34	Themeda grassland TEC, not present in SF
xs6	69	0.40	43.86	Included as RFEF if alluvial, due to relationship with Gellie communities g48 and g49, cited in the determination
p343	10	0.40	na	Considered under Araluen Scarp Grassy Forest TEC
p36	9	0.40	na	Excluded, not cited in determination
p44	5	0.40	na	Excluded, not cited in determination
p39	6	0.39	na	Excluded, not cited in determination
e18	16	0.38	46.14	Considered under Brogo Wet Vine Forest TEC
e85	20	0.38	42.42	Excluded, not cited in determination
p66	5	0.37	na	Excluded, not cited in determination
p64	46	0.37	31.78	Considered under Bangalay Sand Forest TEC
e1	19	0.36	38.66	Considered under Dry Rainforest of South East Forests TEC
xs20	51	0.36	40.2	Sydney area, not present in SF
p63	35	0.36	29.74	Considered under Bangalay Sand Forest TEC
p99	46	0.35	45.46	Excluded, not cited in determination

SCIVI Community	Number of plots	Mean proportion	Cumulative number of species	Status in Study Area
n184	22	0.35	43.04	Excluded, not cited in determination
n185	14	0.35	39.66	Excluded, not cited in determination
xs5	47	0.34	42.02	Sydney area, not present in SF
e34	26	0.33	41.08	Excluded, not cited in determination
xs13	97	0.33	43.32	Excluded, inconsistent data collection method
e35	28	0.32	34.18	Excluded, not cited in determination
xs10	12	0.32	34.6	Sydney area, not present in SF
p168	18	0.31	31.88	Excluded, not cited in determination
e39	12	0.31	32.38	Excluded, not cited in determination
e33	17	0.3	21.48	Excluded, not cited in determination
p35	5	0.3	na	Excluded, not cited in determination
p90	55	0.3	36.08	Excluded, not cited in determination
p86	21	0.3	31.76	Excluded, not cited in determination
p210	17	0.28	23.98	Considered under Littoral Rainforest TEC
p91	33	0.27	22.7	Excluded, not cited in determination
p45	14	0.26	30.04	Considered under Swamp sclerophyll forest TEC
e13	20	0.26	31.28	Excluded, not cited in determination
p104	51	0.26	34.38	Excluded, not cited in determination
p100	22	0.25	28.94	Excluded, not cited in determination
p40	46	0.24	24.06	Excluded, not cited in determination
e15	7	0.24	na	Excluded, not cited in determination
xs19	31	0.23	28.12	Related to e32, excluded, not cited in determination
n183	48	0.23	30.88	Excluded, not cited in determination
p103	32	0.23	29.58	Excluded, not cited in determination
xs8	61	0.23	16.78	Related to e6e7, excluded, not cited in determination
e32a	37	0.23	26.36	Excluded, not cited in determination
e17	14	0.23	33.8	Excluded, not cited in determination
p111	67	0.22	28.94	Excluded, not cited in determination
p143	6	0.22	na	Excluded, not cited in determination
e6e7	36	0.22	33.44	Excluded, not cited in determination
xs9	69	0.22	23.42	Related to e15, excluded, not cited in determination
e12	48	0.22	25.86	Excluded, not cited in determination
xs7	33	0.22	16.72	Excluded, inconsistent data collection method
p102	14	0.22	27.72	Excluded, not cited in determination
p516	18	0.22	12.98	Excluded, not cited in determination
e44	28	0.22	21.54	Excluded, not cited in determination
p110	64	0.21	26.56	Excluded, not cited in determination

SCIVI Community	Number of plots	Mean proportion	Cumulative number of species	Status in Study Area
e4	5	0.21	na	Excluded, not cited in determination
p85	36	0.21	27.08	Excluded, not cited in determination
e28	10	0.21	na	Excluded, not cited in determination
e14	18	0.20	29.82	Excluded, not cited in determination
e26	18	0.20	23.14	Excluded, not cited in determination
p107	15	0.20	16.36	Considered under Swamp Oak TEC
e29	22	0.20	23.74	Excluded, not cited in determination
e11	22	0.18	10.32	Excluded, not cited in determination
e81	8	0.18	na	Excluded, not cited in determination
p114	34	0.18	19.44	Excluded, not cited in determination
p146	20	0.18	25.66	Excluded, not cited in determination
e10	8	0.18	na	Excluded, not cited in determination
p116	17	0.17	23.64	Excluded, not cited in determination
m15	11	0.17	16.32	Excluded, not cited in determination
xs2	63	0.16	23.82	Related to e10, excluded, not cited in determination
p246	26	0.16	20.88	Excluded, not cited in determination
p109	16	0.16	14.14	Considered under Swamp Oak TEC
e3	17	0.15	21.46	Excluded, not cited in determination
p58	22	0.15	24.74	Excluded, not cited in determination
e42	42	0.15	22.38	Excluded, not cited in determination
xs18	64	0.15	23.02	Related to p140, excluded, not cited in determination
xs1	40	0.14	25.34	Related to e48/e49, excluded, not cited in determination
xs14	23	0.14	7.28	Highly disturbed, Sydney area, not present in SF
p95	46	0.14	17.48	Excluded, not cited in determination
p113	81	0.14	13.72	Excluded, not cited in determination
xs4	95	0.14	15.16	Related to p113, excluded, not cited in determination
p78	16	0.13	9.88	Excluded, not cited in determination
p98	36	0.13	15.34	Excluded, not cited in determination
e60	9	0.13	na	Included in RFEF if dominated by eucalypts, or Swamp Oak TEC
p106	58	0.13	7.08	Considered under Swamp Oak TEC
p112	59	0.13	11.96	Excluded, not cited in determination

Appendix D

Vegetation Community Relationships

<u>Table D1</u>: Change in Δsum AIC for pairwise comparisons of alluvial and related communities.

	e19	e20 p229	m15	p3	p30	p32	p33	p40	p45	p64	p85	p86	xs11	xs13	xs6
e19	NA	2023	985	1627	468	1411	2720	3904	1547	3316	4282	1864	3614	3621	2310
e20 p229	2023	NA	1107	1053	1136	1782	2528	5235	1572	3605	4140	1948	2237	6611	5416
m15	985	1107	NA	661	397	334	725	632	86	357	621	347	745	1037	782
p3	1627	1053	661	NA	674	1071	813	2151	632	1228	1094	491	700	2359	2112
p30	468	1136	397	674	NA	313	658	1098	487	906	1373	594	1107	758	189
p32	1411	1782	334	1071	313	NA	813	1455	580	1363	2036	1137	1150	2004	1501
p33	2720	2528	725	813	658	813	NA	3602	919	2504	3104	1548	585	4421	3481
p40	3904	5235	632	2151	1098	1455	3602	NA	1206	2657	3702	1952	3758	3623	2233
p45	1547	1572	86	632	487	580	919	1206	NA	360	597	296	1021	1570	1340
p64	3316	3605	357	1228	906	1363	2504	2657	360	NA	1624	656	2589	3548	3113
p85	4282	4140	621	1094	1373	2036	3104	3702	597	1624	NA	382	3056	5839	4573
p86	1864	1948	347	491	594	1137	1548	1952	296	656	382	NA	1636	2405	1899
xs11	3614	2237	745	700	1107	1150	585	3758	1021	2589	3056	1636	NA	5518	4536
xs13	3621	6611	1037	2359	758	2004	4421	3623	1570	3548	5839	2405	5518	NA	3395
xs6	2310	5416	782	2112	189	1501	3481	2233	1340	3113	4573	1899	4536	3395	NA

<u>Table D2</u>: Mean group dissimilarity for pairwise comparisons of alluvial and related communities (where numbers closest to 1 are most dissimilar to each other).

	e19	e20 p229	m15	p3	p30	p32	p33	p40	p45	p64	p85	p86	xs11	xs13	xs6
e19	0.61	0.74	0.94	0.81	0.7	0.83	0.79	0.89	0.92	0.86	0.9	0.84	0.85	0.75	0.7
e20 p229	0.74	0.64	0.97	0.76	0.79	0.87	0.79	0.96	0.94	0.9	0.89	0.86	0.77	0.84	0.85
m15	0.94	0.97	0.71	0.96	0.92	0.96	0.96	0.95	0.86	0.9	0.94	0.91	0.98	0.93	0.91
p3	0.81	0.76	0.96	0.61	0.8	0.91	0.8	0.95	0.89	0.86	0.83	0.76	0.78	0.85	0.86
p30	0.7	0.79	0.92	0.8	0.65	0.81	0.78	0.88	0.88	0.84	0.88	0.82	0.83	0.76	0.69
p32	0.83	0.87	0.96	0.91	0.81	0.71	0.84	0.93	0.94	0.92	0.95	0.93	0.88	0.86	0.85
p33	0.79	0.79	0.96	0.8	0.78	0.84	0.67	0.96	0.92	0.91	0.92	0.88	0.73	0.83	0.82
p40	0.89	0.96	0.95	0.95	0.88	0.93	0.96	0.64	0.96	0.93	0.97	0.94	0.98	0.83	0.82
p45	0.92	0.94	0.86	0.89	0.88	0.94	0.92	0.96	0.73	0.84	0.87	0.84	0.95	0.91	0.9
p64	0.86	0.9	0.9	0.86	0.84	0.92	0.91	0.93	0.84	0.66	0.83	0.8	0.94	0.84	0.85
p85	0.9	0.89	0.94	0.83	0.88	0.95	0.92	0.97	0.87	0.83	0.67	0.76	0.93	0.93	0.91
p86	0.84	0.86	0.91	0.76	0.82	0.93	0.88	0.94	0.84	0.8	0.76	0.68	0.9	0.86	0.85
xs11	0.85	0.77	0.98	0.78	0.83	0.88	0.73	0.98	0.95	0.94	0.93	0.9	0.67	0.88	0.89
xs13	0.75	0.84	0.93	0.85	0.76	0.86	0.83	0.83	0.91	0.84	0.93	0.86	0.88	0.63	0.75
xs6	0.7	0.85	0.91	0.86	0.69	0.85	0.82	0.82	0.9	0.85	0.91	0.85	0.89	0.75	0.61

Appendix E

Plots assessed as River-Flat Eucalypt Forest on Floodplains (south)

Plots assessed as south coast River-flat Eucalypt Forest (RFEF) are those which are strongly matched floristically to a community cited in the determination and for which habitat features match environmental descriptors in the determination. We have a high degree of confidence that these belong to south coast (RFEF) using our interpretation of the determination.

Other plots assessed as possible RFEF are those with a weaker floristic relationship to a community cited in the determination, or habitat features which may not match environmental descriptors, or both. We are less confident that these belong to RFEF.

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
Plots assessed as River-flat Eucalypt Forest						
BGO02O0F	-36.58371	149.982	xs6	0.75	g48	0.74
BGO03A0F	-36.54223	149.9442	xs6	0.42	g48	0.43
BGO04O8F	-36.57836	149.9922	e34	0.41	g48	0.58
BGO05A0F	-36.57594	149.9922	xs6	0.95	g48	0.70
BMG03O5F	-36.43298	150.0119	xs6	0.90	g48	0.73
BMG07A0F	-36.49794	150.0027	xs6	0.99	g48	0.91
BMN03O0F	-35.47565	150.222	xs6	0.75	g48	0.81
BMN04O0F	-35.43102	150.1939	xs6	0.89	g48	0.72
BMN06A0F	-35.37774	150.2194	xs6	0.90	g48	0.67
BOD02O7F	-36.12472	150.0799	xs6	0.35	g48	0.50
BOD08A0F	-36.04924	150.0356	xs6	0.91	g49	0.40
BOD09O7L	-36.04532	150.0181	xs6	0.95	g48	0.85
BOD11A0F	-36.04062	150.0579	xs6	0.94	g48	0.67
BOD12A0F	-36.03953	150.0585	xs6	0.94	g48	0.78
BOD14O0F	-36.01277	150.0434	xs6	0.99	g48	0.94
BOD15O0F	-36.01054	150.0529	xs6	1.00	g48	0.97
BOD41Q3D	-36.11399	150.1292	p63	0.39	g27	1.00
BRO01P8L	-35.46545	150.0817	xs6	0.95	g48	0.69
BUM09D5V	-35.80702	149.9642	xs6	0.49	g49	0.53
CBG01O0F	-36.38859	149.9802	xs6	0.63	g49	0.87
CBG02O7L	-36.49664	149.9901	xs6	0.61	g48	0.87
CDE05O7L	-36.19594	149.9076	xs6	0.91	g48	0.67
CDE06A0F	-36.20815	149.8698	e1	0.27	g49	0.58
CDE10O0F	-36.20637	149.8008	e19	0.70	g49	0.93
CRG01A0F	-35.32588	150.2053	xs6	0.70	g48	0.60
CUW01P0F	-35.56226	150.2257	xs6	0.89	g48	0.82
CUW02P0F	-35.58292	150.152	xs6	0.89	g48	0.84
CUW04O7L	-35.53066	150.1955	xs6	0.96	g48	0.87
ED21084	-36.85516	149.8003	e19	0.31	g49	0.36
EDN06O0F	-37.0937	149.8387	xs6	0.34	g48	0.50
EP007G	-35.99284	150.1508	p30	0.76	g27	0.74

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
JMBER03	-36.41925	150.0063	xs6	0.96	g48	0.66
KIA05A0F	-37.17643	149.8176	xs6	0.41	g48	0.45
KIA08O0F	-37.13614	149.8594	xs6	0.81	g48	0.58
KIA09O0F	-37.14917	149.8351	xs6	0.87	g48	0.50
KIO03O0F	-35.56769	150.2553	xs6	0.91	g48	0.50
MOG016A	-35.79573	150.1094	p30	0.74	g49	0.38
MOG23O1L	-35.82087	150.1158	xs6	0.57	g48	0.53
MOG24O1L	-35.83872	150.1219	p30	0.51	g49	0.62
MOG25O4V	-35.79436	150.0392	xs6	0.97	g48	0.92
MOG26O5L	-35.76609	150.1125	xs6	0.96	g48	0.72
MOG28A1F	-35.7877	150.1744	p30	0.42	g48	0.78
NEL09P0F	-35.62383	150.1028	xs6	0.97	g48	0.87
NEL11A0F	-35.69257	150.0948	p30	0.73	g48	0.61
NGH01O0F	-36.10326	149.9951	xs6	0.99	g48	0.95
NGH02O0F	-36.11968	149.806	xs6	0.51	g49	0.81
NGH03A0F	-36.09989	149.896	xs6	0.95	g48	0.60
NRB04G0F	-37.25955	149.8586	xs6	0.34	g48	0.47
NRB06Q0F	-37.26669	149.8292	xs6	0.63	g49	0.33
NRM01O5L	-36.19228	150.0467	xs6	0.86	g48	0.61
PMB02R5F	-36.9942	149.8596	e19	0.41	g48	0.41
PMB03R0F	-36.99501	149.8473	e19	0.28	g48	0.65
PMB05R0F	-36.98149	149.8625	e34	0.21	g48	0.58
PMB07A0F	-36.91586	149.7778	xs6	0.54	g48	0.87
PMB12D5L	-36.90676	149.7948	n185	0.53	g48	0.61
PMPAMB01	-36.91163	149.7905	xs6	0.34	g48	0.70
SFZ010	-35.32029	150.1942	xs6	0.68	g48	0.63
SZ22099G	-35.722	150.1221	p30	0.66	g48	0.53
SZ22254G	-34.96007	150.4821	p30	0.55	g48	0.77
SZ22349G	-36.10287	149.996	xs6	0.90	g48	0.98
SZ24031	-36.08418	149.8193	xs6	0.80	g48	0.54
SZ24068G	-35.97351	150.023	xs6	0.79	g48	0.89
SZ24277F	-35.21551	150.4179	p99	0.57	g48	0.60
TAB09O0F	-35.49137	150.2509	xs6	0.72	g48	0.50
TAB11O0F	-35.44324	150.2561	xs6	0.43	g48	0.51
TLL04A2V	-37.34471	149.6791	xs6	0.46	g49	0.41
WDL03A0F	-36.26067	149.962	xs6	0.76	g49	0.42
WNM02A3F	-36.91178	149.6932	e19	0.40	g49	0.55
YUR06	-36.85142	149.799	n184	0.51	g48	0.61
Plots assessed as possible River-flat Eucalypt Forest						
1NAD9	-37.4299	149.9374	e6e7	0.29	g48	0.23
6EDE01F	-37.0976	149.8705	e19	0.08	xg7	0.15

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
BGO01O0F	-36.58631	149.9812	xs6	0.24	g48	0.28
BMG01A0F	-36.424	150.0254	xs6	0.40	g48	0.40
DBNULL44	-37.03448	149.7889	n185	0.51	g48	0.45
EDENJM06	-37.10492	149.8618	e60	0.23	g48	0.14
EDN009AG	-37.12729	149.9673	e34	0.10	g48	0.31
EDN026BG	-37.17401	149.8256	e34	0.26	g48	0.35
EDN07Q0F	-37.09545	149.8555	xs6	0.25	g48	0.37
JMBIA21	-36.53985	149.9286	p40	0.37	g48	0.34
KIA04O0F	-37.16381	149.8856	xs6	0.35	g48	0.18
KIA06A0F	-37.22326	149.8312	xs6	0.25	g48	0.21
KIO01P0F	-35.57585	150.2554	xs6	0.76	g48	0.45
KIO02P0F	-35.61916	150.2539	xs6	0.35	g48	0.35
MIL014B	-35.30281	150.3834	p30	0.37	g48	0.27
MTI01A0F	-37.20192	149.6886	n185	0.23	g48	0.19
NDG02D0F	-37.41521	149.7551	xs6	0.68	g48	0.39
NEL07P7V	-35.66795	150.1709	xs6	0.32	g48	0.17
NEL08P0F	-35.6428	150.1596	p30	0.47	g27	0.25
NRB01D0F	-37.29753	149.8131	xs6	0.67	g48	0.26
NRB05G0F	-37.25936	149.8487	e34	0.22	g48	0.26
NRB08A0F	-37.28271	149.7576	e13	0.31	g49	0.21
NTura03	-36.82634	149.9348	e19	0.12	xg6	0.19
PMB04O0F	-36.97352	149.8487	xs6	0.50	g48	0.48
SAS10C7V	-35.09225	150.4736	p99	0.29	g48	0.41
SZ21030C	-35.5804	150.2824	p30	0.28	g48	0.32
SZ22071G	-35.91781	149.9724	p32	0.64	g48	0.14
SZ22422G	-36.34579	149.9758	e19	0.12	xg7	0.15
SZ22423G	-36.32884	149.969	e1	0.12	g49	0.17
SZ22425G	-36.31809	149.9664	e19	0.15	g53	0.29
6BEG01F	-36.72502	149.8723	e60	0.21	g53	0.69

Appendix F

Characteristic Species

Characteristic species of groups South Coast River-flat Forest (p30) and South Coast Creek Flat River Peppermint Forest (xs6), both of which we used as the primary communities to define the TEC on the south coast. The 30 most strongly characteristic species of each group, plus all other eucalypts recorded in the group, are listed in order of decreasing contribution to ΔsumAIC, using all plots in the group with membership >=0.5 compared to all other plots not allocated to the group. In each case, only plots south of Kiama and below 250 metres elevation are used and plots with membership <0.5 of the group being characterised are excluded. Plots from a littoral rainforest survey with prefix BPLRF are also excluded because of doubts about the extent to which they include multiple vegetation communities. For each table, mean is mean cover score over all plots including zeros. Median is derived from non-zero scores only. Zeros may represent small values, due to rounding.

Table F1: Characteristic species of South Coast River-flat Forest (p30) as defined by 16 plots with membership >=0.5 compared to 2091 plots allocated to other communities. The 16 plots include 6 plots not on mapped alluvium.

species	p30 freq	p30 mean	p30 median	other freq	other mean	other median	ΔsumAIC
Carex longebrachiata	0.81	2.1	3	0.13	0.2	2	-81
Oplismenus aemulus	0.62	1.3	2	0.04	0.1	1	-73
Eucalyptus tereticornis	0.44	1.5	3	0.08	0.2	3	-58
Hypolepis muelleri	0.5	1.2	2	0.05	0.1	2	-49
Microlaena stipoides	0.94	2.4	3	0.4	0.8	2	-33
Centella asiatica	0.44	0.8	2	0.05	0.1	1	-31
Dichondra repens	1	1.9	2	0.32	0.6	2	-31
Hypolepis glandulifera	0.25	0.7	3	0.03	0.1	2	-30
Acacia mearnsii	0.62	1.6	3	0.2	0.4	2	-29
Acacia filicifolia	0.12	0.4	3	0.01	0.0	1	-26
Poa labillardierei	0.5	1.1	2	0.11	0.2	2	-25
Eucalyptus saligna	0.19	0.6	3	0.02	0.1	2	-24
Entolasia marginata	0.62	1.3	2	0.2	0.3	2	-23
Poa ensiformis	0.31	0.9	3	0.07	0.2	2	-22
Rubus parvifolius	0.69	1.0	1	0.17	0.2	1	-20
Pteridium esculentum	0.75	2.1	3	0.41	0.9	2	-19
Hydrocotyle tripartita	0.25	0.4	1.5	0.02	0.0	1	-18
Echinopogon ovatus	0.69	1.0	1	0.17	0.3	1	-18
Casuarina cunninghamiana	0.19	0.4	3	0.01	0.0	3	-17
Juncus usitatus	0.25	0.3	1	0.02	0.0	1	-16
Lomandra longifolia	0.88	1.9	2	0.47	0.8	1	-16
Glycine clandestina	0.94	1.5	2	0.39	0.6	1	-16
Pellaea falcata	0.56	1.1	2	0.19	0.4	2	-15
Rumex brownii	0.38	0.4	1	0.05	0.1	1	-15
Hydrocotyle laxiflora	0.56	0.9	2	0.16	0.3	2	-15
Oplismenus imbecillis	0.75	1.6	2	0.36	0.6	2	-15

species	p30 freq	p30 mean	p30 median	other freq	other mean	other median	ΔsumAIC
Pratia purpurascens	0.81	1.1	1	0.26	0.4	1	-13
Commelina cyanea	0.31	0.4	1	0.05	0.1	1	-13
Geranium solanderi	0.38	0.5	1	0.07	0.1	1	-11
Pseuderanthemum variabile	0.5	0.9	2	0.17	0.3	2	-11
Eucalyptus viminalis	0.06	0.2	3	0.02	0.0	3	-3
Eucalyptus smithii	0.06	0.2	3	0.02	0.0	1	-3
Eucalyptus cypellocarpa	0.06	0.1	1	0.1	0.2	3	-1
Eucalyptus paniculata	0.06	0.1	1	0.08	0.2	3	0
Eucalyptus globoidea	0.12	0.3	2	0.2	0.4	2.5	1
Angophora floribunda	0.31	0.6	1	0.2	0.4	1	1
Eucalyptus bosistoana	0.06	0.1	1	0.06	0.1	2	1
Corymbia maculata	0.12	0.3	2	0.13	0.4	3	1
Eucalyptus elata	0.19	0.4	1	0.11	0.3	3	2
Eucalyptus piperita	0.06	0.2	3	0.05	0.1	3	2
Eucalyptus longifolia	0.06	0.2	3	0.11	0.2	3	2
Eucalyptus angophoroides	0.06	0.1	1	0.03	0.1	1	2
Eucalyptus botryoides	0.06	0.3	4	0.1	0.3	3	2

Table F2: Characteristic species of South Coast Creek Flat River Peppermint Forest (xs6) as defined by 69 plots with membership >=0.5 compared to 2024 plots allocated to other communities. The 69 plots includes 20 plots not on mapped alluvium.

species	xs6 freq	xs6 mean	xs6 median	other freq	other mean	other median	ΔsumAIC
Poa ensiformis	0.72	1.9	3	0.04	0.1	2	-495
Hypolepis muelleri	0.57	1.6	3	0.03	0.1	2	-415
Eucalyptus elata	0.8	2.2	3	0.08	0.2	3	-394
Adiantum aethiopicum	0.9	1.7	2	0.14	0.2	1	-252
Carex longebrachiata	0.74	1.6	2	0.11	0.2	2	-248
Rubus rosifolius	0.58	0.9	1	0.05	0.1	1	-184
Stellaria flaccida	0.81	1.5	2	0.14	0.2	2	-177
Geranium homeanum	0.52	0.7	1	0.03	0.0	1	-169
Entolasia marginata	0.8	1.6	2	0.18	0.3	2	-161
Hypolepis glandulifera	0.29	0.7	2	0.02	0.0	1	-157
Rubus parvifolius	0.78	1.2	2	0.15	0.2	1	-147
Viola banksii	0.28	0.4	2	0.01	0.0	1	-127
Eucalyptus botryoides x saligna	0.2	0.6	3	0.02	0.1	3	-125
Oxalis chnoodes	0.32	0.5	1.5	0.02	0.0	1	-123
Pratia purpurascens	0.84	1.4	2	0.24	0.4	1	-111
Oplismenus imbecillis	0.99	1.9	2	0.33	0.6	2	-108
Prostanthera lasianthos	0.36	0.6	1	0.04	0.1	1	-107
Acacia irrorata	0.36	0.9	3	0.07	0.1	2	-107

species	xs6 freq	xs6 mean	xs6 median	other freq	other mean	other median	ΔsumAIC
Eucalyptus baueriana	0.26	0.7	3	0.04	0.1	3	-103
Dichondra repens	0.91	1.7	2	0.31	0.5	2	-103
Melicytus dentatus	0.54	1.0	2	0.14	0.2	1	-102
Pteridium esculentum	0.9	2.1	2	0.4	0.8	2	-97
Myrsine howittiana	0.62	1.0	1	0.14	0.2	1	-93
Acacia trachyphloia	0.16	0.4	3	0.01	0.0	1	-92
Cissus hypoglauca	0.68	1.4	1	0.2	0.4	2	-88
Tylophora barbata	0.71	1.2	2	0.23	0.4	2	-86
Prostanthera incisa	0.25	0.5	2	0.03	0.1	2	-83
Hydrocotyle acutiloba	0.32	0.5	1	0.03	0.1	1	-77
Pseuderanthemum variabile	0.7	1.1	2	0.16	0.3	2	-76
Clematis glycinoides	0.68	0.9	1	0.15	0.2	1	-72
Eucalyptus angophoroides	0.14	0.3	3	0.02	0.0	1	-46
Eucalyptus globoidea	0.03	0.1	2	0.21	0.4	2	-34
Eucalyptus muelleriana	0.01	0.0	1	0.13	0.3	3	-29
Corymbia maculata	0.03	0.1	2	0.13	0.4	3	-25
Angophora floribunda	0.42	0.8	1	0.2	0.4	1	-24
Eucalyptus pilularis	0.03	0.1	3	0.12	0.3	3	-13
Eucalyptus tereticornis	0.04	0.0	1	0.08	0.2	3	-10
Eucalyptus botryoides	0.19	0.5	3	0.1	0.3	3	-8
Eucalyptus viminalis	0.04	0.1	3	0.01	0.0	3	-5
Eucalyptus saligna	0.04	0.1	3	0.03	0.1	2	-3
Eucalyptus bosistoana	0.01	0.0	3	0.07	0.1	2	-3
Eucalyptus amplifolia	0.01	0.0	3	0	0.0	3	-3
Eucalyptus cypellocarpa	0.16	0.3	1	0.09	0.2	3	0
Eucalyptus ovata	0.01	0.0	3	0.01	0.0	3	0
Eucalyptus radiata	0.01	0.0	3	0.01	0.0	1	1
Eucalyptus piperita	0.06	0.2	3	0.05	0.1	3	1
Eucalyptus scias	0.01	0.0	3	0.02	0.0	1	2
Eucalyptus longifolia	0.13	0.3	1	0.1	0.2	3	2

Appendix G

Field key for identification of River-flat Eucalypt Forest on coastal floodplains of the NSW South Coast region including Sydney Basin (south of the Shoalhaven River) and South East Corner bioregions.

This key assumes the vegetation to be assessed is in one of the bioregions listed in the title. Assessment should be done in 20 metre x 20 metre plots or areas of similar size. The more plots assessed, the more reliable the result. Likelihoods given below use a 95% confidence interval and are for a single plot. This key and the likelihoods provided are based on distinguishing RFEF from vegetation not currently listed as any TEC. Vegetation identified as RFEF by this key may also, or alternatively depending on degree of floristic overlap, belong to other EECs.

1. Is the area in mapped alluvium* and at or below 250 metres elevation?

   If yes, go to 2.
   If no to either condition, the area is not RFEF.

2. Are any of the species *Banksia spinulosa*, *Corymbia gummifera*, *Melaleuca linariifolia*, *Smilax glyciphylla*, *Pimelea linifolia*, *Leptospermum trinervium*, *Lindsaea linearis*, *Melaleuca squarrosa*, *Patersonia glabrata*, *Lomandra confertifolia*, *Leptocarpus tenax*, *Aristida vagans*, *Cheilanthes sieberi*, *Glochidion ferdinandii*, *Banksia serrata*, *Burchardia umbellata*, *Stylidium graminifolium*, *Xanthorrhoea concavum*, *Pomax umbellata* or *Pultenaea retusa* present?

   If yes, the vegetation is NOT RFEF, with a likelihood of incorrect diagnosis of 0-3%.
   If no, the vegetation is RFEF, with a likelihood of 44-57%; go to 3.

3. Are at least three of the species *Adiantum aethiopicum*, *Stellaria flaccida*, *Rubus parvifolius*, *Poa ensiformis*, *Dichondra repens*, *Eucalyptus elata*, *Oplismenus imbecillus*, *Rubus rosifolius*, *Carex longebrachiata*, *Geranium homeanum*, *Pomaderris aspera*, *Glycine clandestina*, *Tylophora barbata*, *Pratia purpurascens*, *Solanum pungetium*, *Entolasia marginata*, *Eucalyptus baueriana*, *Microlaena stipoides*, *Hydrocotyle laxiflora* and *Clematis glycinoides* present?

   If yes, the vegetation is RFEF, with a likelihood of 54-69%.
   If no, the vegetation is NOT RFEF, with a likelihood of incorrect diagnosis of 0-3%.

*As identified in s2.2 Alluvial Landforms

Appendix H

Floristic Relationships of Validation Plots

SiteNo	Latitude	Longitude	Gellie	memb	SCIVI	memb	RFEF assessment	Notes
BMN08O2L	-35.469821	150.084943	g20	0.97	p103	0.96	not RFEF	
BMN09O5L	-35.465928	150.271824	g20	0.81	p103	0.99	not RFEF	
BMN10O7F	-35.494668	150.155075	g20	0.88	p103	0.95	not RFEF	
BOD51G3V	-36.110730	150.094564	M3	0.64	e46b	0.41	not RFEF	
HUS19P0F	-35.029701	150.543678	g2	0.28	p85	0.68	not RFEF	
KIA12B8F	-37.160796	149.936582	M2	0.99	e55	0.41	not RFEF	
KIA13O8M	-37.155486	149.908603	M2	0.94	e47	0.71	not RFEF	
KIA14O5V	-37.169269	149.913774	M2	1.00	e47	0.23	not RFEF	
KIA15Q6M	-37.183617	149.946980	M2	0.55	e46b	0.66	not RFEF	
KIA16Q7F	-37.225812	149.838241	M2	0.98	e46b	0.63	not RFEF	
KIA17Q8F	-37.234849	149.837853	g1	0.58	e46b	0.51	not RFEF	
MOG29O8L	-35.801656	150.017576	g18	0.40	p40	0.65	not RFEF	
MOG30O0F	-35.810522	150.185579	g48	0.66	p30	0.70	RFEF	Field note: 'FE9, dry spotted gum forest'
MOG31O8F	-35.845374	150.021562	g48	0.63	n184	0.67	not RFEF	field note: ecotonal FE48/49/18, not TEC; gully forest, not mapped alluvial
MTI03G5V	-37.170272	149.621005	M2	0.83	e30	0.76	not RFEF	
MTI04G6V	-37.240645	149.561480	M2	0.90	e37	0.21	not RFEF	
MTI05G3V	-37.147596	149.616366	g24	0.35	m15	1.00	not RFEF	Allocate to m15, not TEC
MTI06G7V	-37.144131	149.650276	g68	0.17	m15	0.83	not RFEF	
MTI07Q4V	-37.161304	149.621362	M2	1.00	e26	0.22	not RFEF	

MTI08G5M	-37.244464	149.538746	M2	0.98	p168	0.11	not RFEF	
MTI09G1F	-37.235571	149.539113	g47	0.22	p66	0.34	not RFEF	
MTI10G3F	-37.221960	149.539698	g49	0.40	e17	0.71	not RFEF	closest plot (6NUN1F) is e17/g56; no precedents in previous data
NEL12O0V	-35.741791	150.162586	g10	0.61	p30	0.20	not RFEF	Secondarily p40; weak relationship with p30 cf g10; field note: narrow gully, not TEC
NOW59P1V	-34.959609	150.659346	g48	0.26	p30	0.48	possible RFEF	Secondarily g11/p86; other p30/g48 plots assessed as RFEF but membership of g48 is weak for this plot
NOW60P7V	-34.954775	150.655028	g171	0.32	p3	0.37	not RFEF	Secondarily g27/p86
NOW61A7V	-34.969274	150.671622	g27	0.33	p86	0.31	not RFEF	Secondarily g11/p30
NOW62P1V	-34.955070	150.628467	g21	0.71	p104	0.43	not RFEF	
NRB11Q6V	-37.358643	149.753537	M2	0.99	e56	0.35	not RFEF	
NRB12Q7S	-37.358829	149.759226	M2	0.99	e55	0.79	not RFEF	
NRB13Q6S	-37.251883	149.803257	M2	0.98	e30	0.60	not RFEF	
NRB14Q6V	-37.274125	149.791074	M2	1.00	e56	0.59	not RFEF	
NRB15Q8F	-37.256396	149.803157	M2	0.97	p85	0.12	not RFEF	
TAB15P6F	-35.445599	150.383540	M1	0.96	p103	0.88	not RFEF	
TAB16P2F	-35.440820	150.382649	M1	0.84	p103	0.93	not RFEF	
TLL07G1F	-37.294447	149.553495	g56	0.18	e17	0.27	not RFEF	
TLL08Q8V	-37.370600	149.696654	M2	1.00	e56	0.15	not RFEF	
TLL09Q6F	-37.370774	149.702340	M2	1.00	e47	0.14	not RFEF	
TLL10Q2F	-37.335784	149.737704	M2	0.91	e47	0.45	not RFEF	
TLL11Q1V	-37.353605	149.736840	M2	1.00	e56	0.41	not RFEF	
TNJ08A7F	-35.126131	150.409177	M1	0.86	p99	0.31	not RFEF	