Assessment of Swamp Oak Floodplain Forest TEC on NSW Crown Forest Estate (South Coast Region)

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

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Published by:

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ISBN 978-1-76039-528-5
EPA 2016/0621
October 2016

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1 Overview

Swamp Oak Floodplain Forest is one of several TECs associated with coastal floodplains with a potential distribution that spans the entire NSW coastal region. According to the final determination, Swamp Oak Floodplain Forest has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui. In this report we focus on the distribution of the TEC in the NSW South Coast region, an area that extends from Sydney to the Victorian border. Our study area includes over 350,000 hectares of state forest.

The final determination cites eight previously described communities relevant to the South Coast region. In two of these, only vegetation dominated by *Casuarina glauca* is included in Swamp Oak Floodplain Forest and in a third, only vegetation in which either *Casuarina glauca* or *Melaleuca ericifolia* is present is included. The other communities are not qualified and are wholly included.

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. We used aerial photograph interpretation (API) to map vegetation patterns within floodplain and alluvial areas, and to map photo-patterns likely to indicate the presence of Swamp Oak Floodplain Forest outside modelled areas.

Our analyses of plot data assigned 167 plots (out of 6635) to Swamp Oak Floodplain Forest, based on allocation to a previously defined community cited in the final determination. 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 Swamp Oak Floodplain Forest. We assigned mapped polygons to Swamp Oak Floodplain Forest based on plot data, overstorey and understorey patterns and landform features. We used the BRT model to ensure that all areas of potential Swamp Oak Floodplain Forest had been checked using API and mapped as appropriate.

From these assignments and mapping, in our study area we identified approximately 80 hectares of Swamp Oak Floodplain Forest in state forest, distributed among 87 patches. We believe that our assessment accurately reflects the true extent of Swamp Oak Floodplain Forest as we have interpreted it, because the photo patterns which the community displays in state forests are relatively distinct and have sharp interpretable boundaries. North of Bermagui, most of the mapped area has *Casuarina glauca* as canopy dominant, or co-dominant with eucalypts. South of Bermagui, beyond the natural range of *C. glauca*, the mapped area comprises mostly shrubland dominated by *Melaleuca ericifolia*. However, within the study area, we have also mapped as Swamp Oak Floodplain Forest, 7 hectares (in 10 patches) which is dominated by eucalypts situated in estuarine habitats with an understorey of saltmarsh species and 19 hectares (in 11 patches) which is saltmarsh with mangrove canopy. We have adopted a precautionary interpretation of Swamp Oak Floodplain Forest TEC and included these because of their floristic relationships, even though one or both of these variations may not be regarded as Swamp Oak Floodplain Forest under a stricter interpretation, given the low cover or absence of *C. glauca*. Because of uncertainty in the final determination, we have also been precautionary in our interpretation of habitat characteristics, particularly where *C. glauca* occurs on estuarine fringes or on marine rather than alluvial deposits. Although we have resolved the uncertainty by including all occurrences in state forests where *C. glauca* is dominant, these uncertainties remain on other tenures and our interpretation may not be appropriate in other contexts.

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 eastern Regional Forest Agreements.

2.2 Current Determination

This is one of several determinations relating to vegetation 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 final determination of Swamp Oak Floodplain Forest. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (SOAK) was first gazetted as an Endangered Ecological Community on 17 December 2004. Minor amendments were subsequently made and the determination to make a minor amendment was gazetted on 8 July 2011.

Paragraph 4 of the final determination (NSW Scientific Committee 2011) states that the community 'has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui.'

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 2, Swamp Oak Floodplain Forest. It is ambiguous whether all of the 60 samples allocated to Keith and Scott's group 2 are considered to belong to the community, as 26 of them are assessed as not floodplain vegetation. Keith and Scott also recognise an estuarine fringe community in a separate group, which is possibly included in SOAK.

Paragraph 7 of the final determination (NSW Scientific Committee 2011) refers to other Endangered Ecological Communities which may adjoin or intergrade with SOAK 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 on the South Coast, are wholly or partially included within SOAK. These offer important information of potential diagnostic value and in most cases where there is a partial relationship, the limits of the relationship are reasonably 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 Swamp Oak Floodplain 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* (TSC ACT) 1995, TECs are defined by two characteristics: an assemblage of species and a particular location. The TEC Panel agreed that the occurrence of SOAK is constrained to the IBRA bioregions stated in the final determination. The panel agreed that SOAK 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 determination, some previously defined assemblages are only partially included in SOAK, depending on dominant species. The panel noted that these qualifiers should be considered in assessing SOAK. From the final determination for SOAK, Table 1 summarises the key determining features of SOAK 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 Swamp Oak Floodplain 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. 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 grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline	Indicative, except that saline or sub-saline is potentially diagnostic, but not used in this study
1	On waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains	Potentially diagnostic, though 'margins' and 'fringes' are likely to be difficult to define and ‘associated with’ is a vague phrase subject to varying interpretation; used indicatively in this study
1	Generally occurs below 20 m elevation, rarely above 10 m	Indicative, not used
1,4	Structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees	Indicative, not used, except that some plots with few or no trees are included in SOAK in this assessment, consistent with paragraph 1 but possibly contrary to paragraph 4
1	Characterised by the listed 45 plant species	Potentially diagnostic, in the context of previously described communities cited in the determination
2	Known from 46 LGAs but may occur elsewhere	Indicative, not used
4	Has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui	Potentially diagnostic, used to distinguish parts of communities not wholly included in SOAK, except that some plots with eucalypt dominants but strong floristic affinity are included in SOAK in this assessment
4	Description of understorey, listing 3 vine tree species and 14 ground cover species which may be present	Indicative, not used
6	Description of differences in tree species composition and environmental differences from other TECs on coastal floodplains	Indicative, but used to distinguish areas which are floristically similar to two or more TECs

8	In southern New South Wales (Thomas et al. 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by *Casuarina glauca.* In the Sydney - South Coast region, this community includes parts of 'Floodplain Swamp Forest' (map unit 105) dominated by *Casuarina glauca*, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall et al. (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include *Casuarina glauca* or *Melaleuca ericifolia* (Keith & Bedward 1999)	Used as the main comparative diagnostic feature, including explicit qualifications of individual communities relating to tree species composition

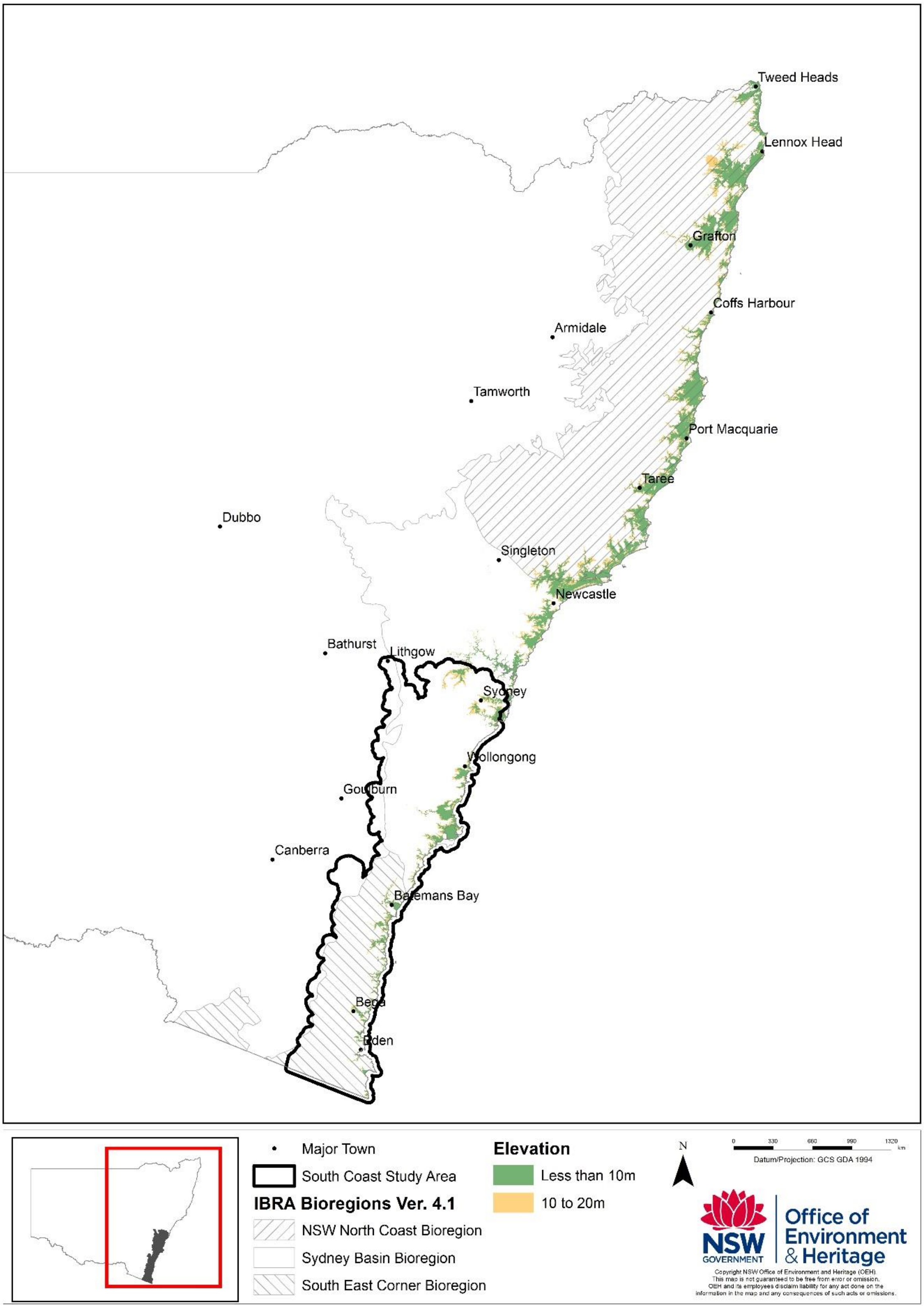
2.4 Assessment Area

2.4.1 Location and study area boundaries

We partitioned the assessment of Swamp Oak Floodplain Forest 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, including Swamp Oak Floodplain Forest, 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.

Map 1: Assessment area showing bioregions and elevation thresholds.



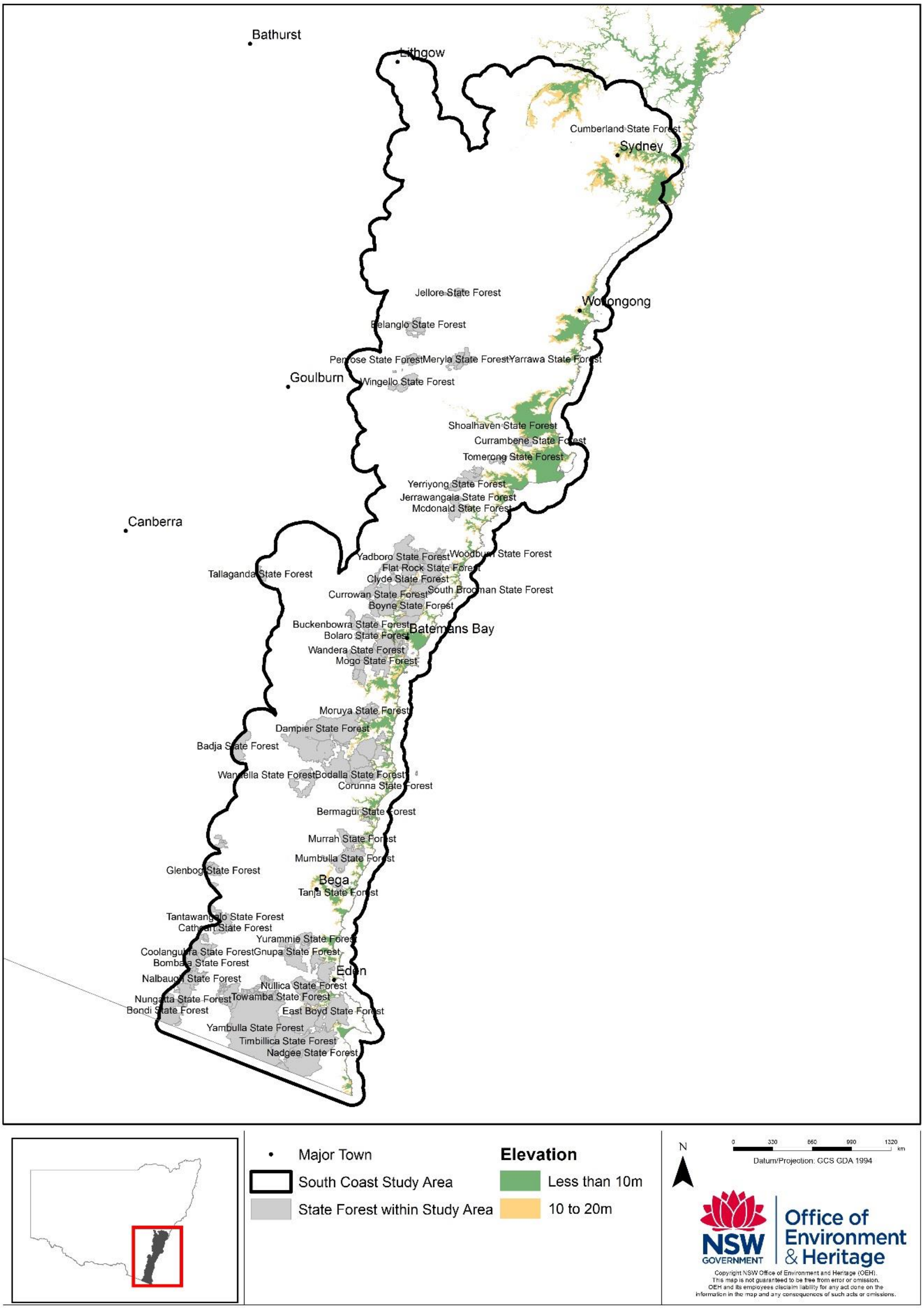
2.4.2 State forests subject to assessment

The Project 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.

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

Map 2: 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 (EPA) 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 and Philip Gleeson. Dan Bowles provided GIS, mapping and technical support.

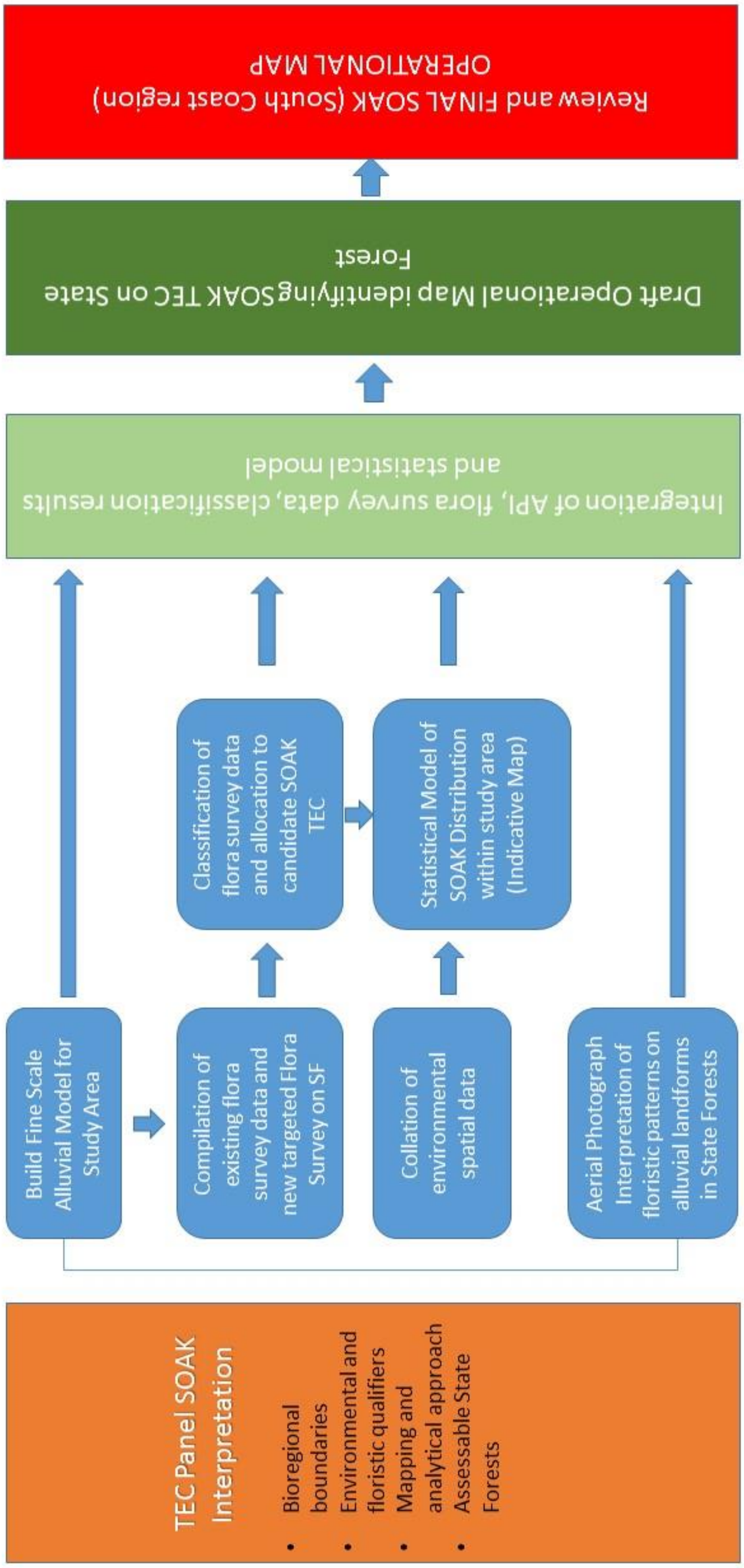
3 Methodology

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 Swamp Oak Floodplain Forest (SOAK) TEC adopted by the TEC Reference Panel, described in Section 1.2. For the purpose of this project, SOAK is interpreted to be defined primarily by floristic plot data previously allocated to vegetation communities which have been previously described from quantitative floristic analysis and which have been explicitly listed in the final determination. The following statements from the determination provide the basis for comparative analysis: in southern New South Wales (Thomas et al. 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by Casuarina glauca. In the Sydney - South Coast region, this community includes parts of 'Floodplain Swamp Forest' (map unit 105) dominated by Casuarina glauca, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall et al. (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include Casuarina glauca or Melaleuca ericifolia (Keith & Bedward 1999).

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, as described in Sections 2.3.2 and 2.4.1 below) were compared with plots previously allocated to the communities' equivalent to those listed in the SOAK final 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 SOAK). Options for different methods and thresholds represent narrower or broader interpretations of SOAK, but this approach using plot-based floristic comparison provides a means of consistently allocating plots to being either SOAK or not for a range of interpretation options. We made allocations as part of analyses involving allocation of plots to all TECs which we considered could possibly occur in state forests in our South Coast study area.

Diagram 1: Schematic overview of approach.



3.2 Identifying Alluvial Landforms

3.2.1 Coastal comprehensive assessment floodplain maps

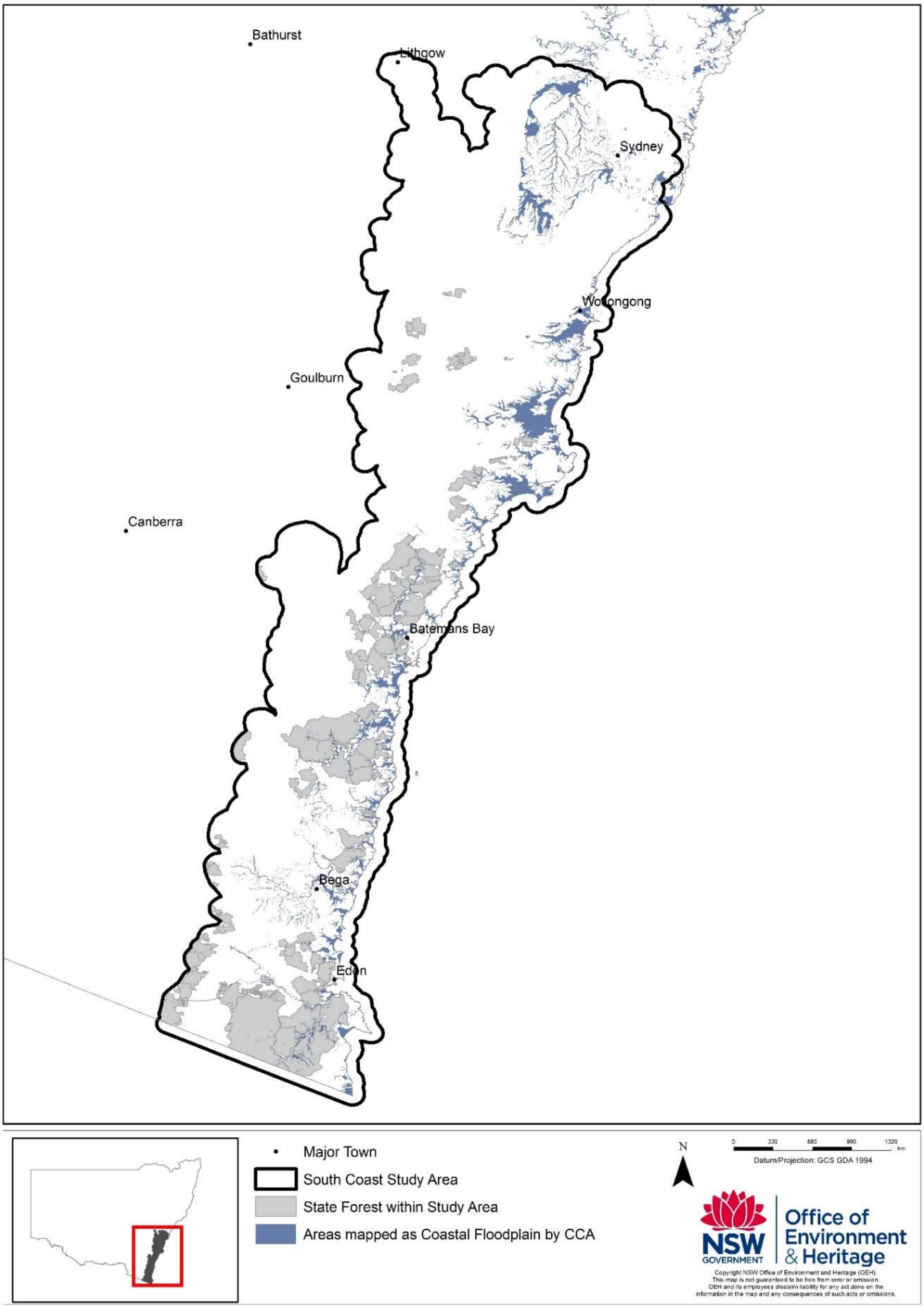
Troedson and Hashimoto (2008) describe a series of maps of Quaternary geology and related features, used for a comprehensive coastal assessment. We have used all the alluvial surface geology units from these maps to define areas of mapped alluvium and we have used map unit descriptors to define areas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

3.2.2 Fine scale alluvial model

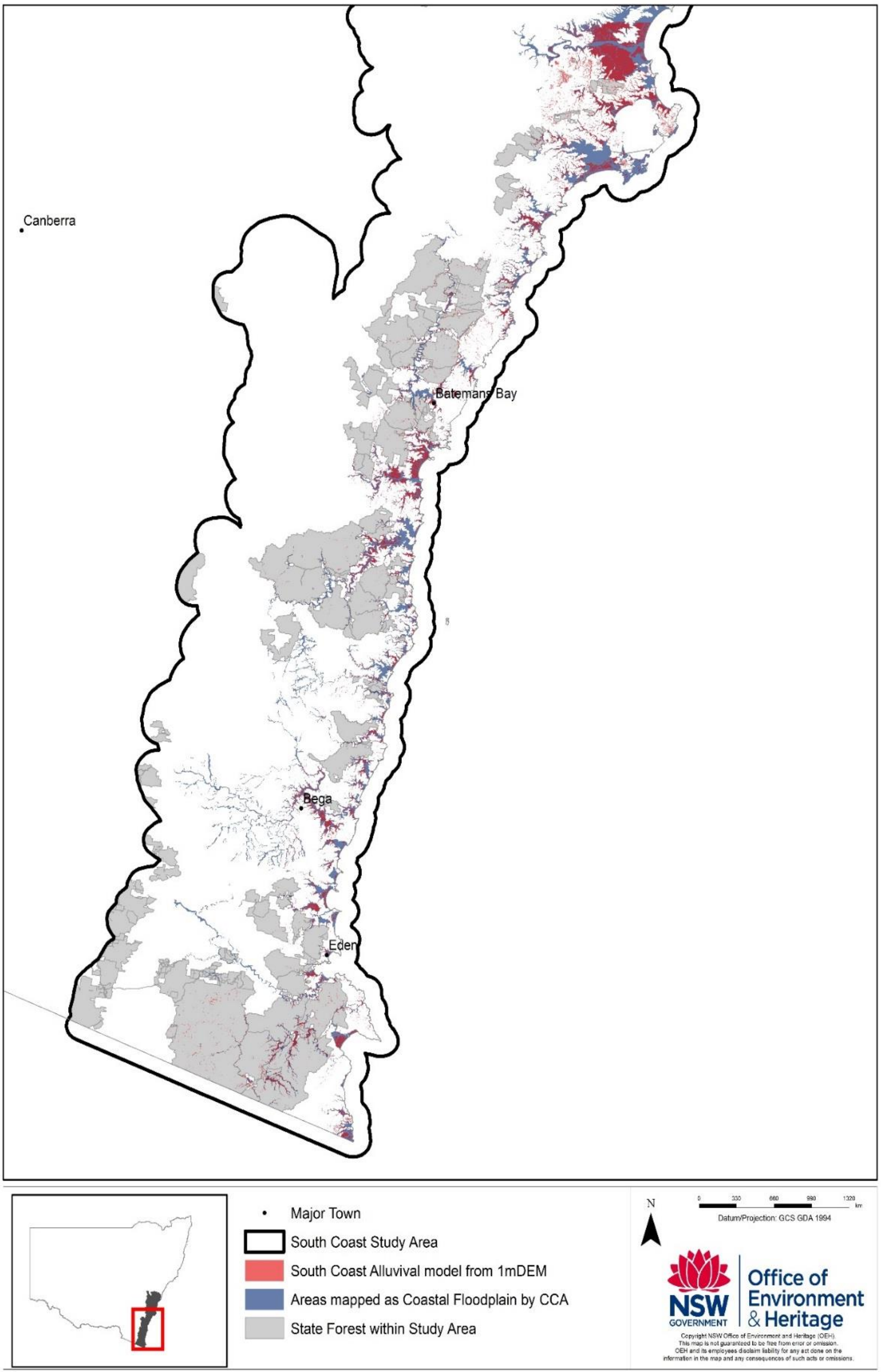
We generated a fine scale digital representation of landscape elements in the study area that are likely to be associated with the range of floodplain and alluvial descriptors offered by the final determination for SOAK (Map 3). The concept for the model is that floodplain and alluvial environments relevant to

SOAK 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 ha. Thresholds are applied to combinations of the three variables to delineate areas alluvial/floodplain TECs. This includes River-flat Eucalypt Forest, Swamp Oak Forest and Swamp Sclerophyll Forest. The actual occurrence of these TECs 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 TECs. The set of mapped polygons in map 2 was used as a starting point to identify plots for new floristic surveys, as well as API digitising and mapping.

<u>Map 3</u>: Coastal floodplain mapped by the comprehensive coastal assessment (CCA).



<u>Map 4</u>: Alluvial model overlaid on top of floodplain mapping by CCA in the South Coast study area.



3.3 Existing Vegetation Data

3.3.1 Existing vegetation classification

The three classifications cited in the final determination which are most relevant to SOAK in the South Coast region are those of Keith and Bedward (1999), Thomas et al. (2000) and Tindall et al. (2004). Subsequent to the 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 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 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 determination.

Community listed in the final determination	Recent equivalent	Qualifier as Swamp oak forest on coastal floodplains (SOAK)
FE 24 Coastal Wet Heath Swamp Forest (Thomas et al. 2000)	VG 24: Coastal Wet Heath Swamp Forest - Casuarina glauca /Melaleuca ericifolia (Gellie 2005)	None, all included
FE 25 South Coast Swamp Forest (Thomas et al. 2000)	VG 25: South Coast Swamp Forest complex - Casuarina glauca (Gellie 2005)	None, all included
FE 27 Ecotonal Coastal Swamp Forest (Thomas et al. 2000)	VG 27: Ecotonal Coastal Swamp Forest - Casuarina glauca / E. botryoides - Angophora floribunda / E. elata / Acacia mearnsii (Gellie 2005)	Where dominated by Casuarina glauca
MU 105 Floodplain Swamp Forest (Tindall et al. 2004)	FoW p105 Floodplain Swamp Forest (Tozer et al. 2010)	Where dominated by Casuarina glauca
MU 106 Estuarine Fringe Forest (Tindall et al. 2004)	FoW p106: Estuarine Fringe Forest	None, all included
MU 107 Estuarine Creek Flat Scrub (Tindall et al. 2004)	FoW p107: Estuarine Creekflat Scrub	None, all included
MU 60 Floodplain wetlands (Keith & Bedward 1999)	FoW e60 Southeast Floodplain Wetlands (Tozer et al. 2010)	Where Casuarina glauca or Melaleuca ericifolia is present
MU 63 Estuarine Wetland Scrub	included in FoW p105 Floodplain Swamp Forest (Tozer et al. 2010)	

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 plot:

- 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.

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 SOAK 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 indicates 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.

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, 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 five 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 forests 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.

<u>Table 4</u>: BB-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 et al. 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. (2000) which were explicitly listed in the final determination.

2. A subset of 2708 plots which comprised all plots previously allocated to a relevant vegetation community by Tozer et al. (2010) plus previously unallocated plots in state forest or surveyed for this project. Relevant vegetation communities 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 analyses 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 final determination and the various communities either cited in the 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 SOAK 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 SOAK in the determination.

3.5.4 Allocation of standard floristic plots to SOAK and other communities

We assessed plots as being SOAK 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 SOAK communities) was 0.5 or above and they met the qualifying condition, if any, for that community. In the case where a plot belonged to one qualified community and one unqualified, but did not meet the qualifying condition, we assessed the plot on the basis of its membership of the unqualified community. We considered that plots which belonged to a SOAK community with primary membership <0.5 were potentially SOAK (no plot had a primary membership <0.1). If these potential SOAK plots had a strong membership (>0.75) of a non-SOAK community in an alternative classification (Gellie 2005 or Tozer et al. 2010, as appropriate), we assessed them as not SOAK. 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 SOAK for management purposes, using a precautionary approach to assessment.

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 SOAK. This approach attempts to extrapolate the fundamental niche of the TEC in question outside the locations where it is known to be present (its realized niche), by relating known occurrence and absence to environmental predictors.

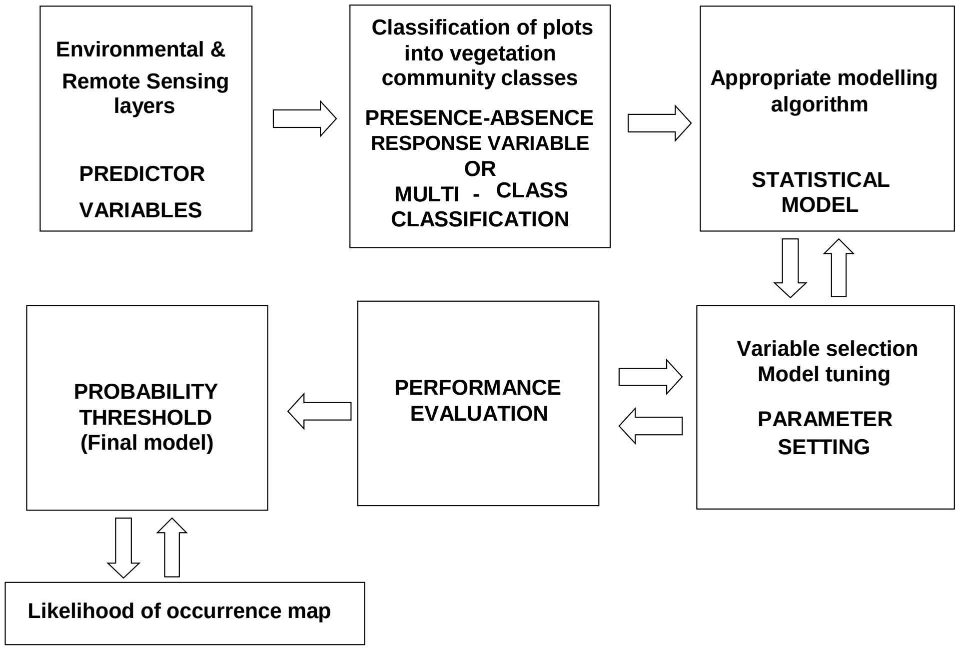
In order to model the distribution of SOAK, we need to characterize the environmental conditions that are suitable for the community to exist. The inclusion of the absence data from the plot allocation allows us to constrain the potential distribution model to a set of favourable environmental conditions 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 SOAK 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). Since their early application in species distribution modelling (De'Ath 2007; Elith et al. 2008; Leathwick et al. 2006). 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 NA 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 SOAK 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 SOAK, but this relevance is not known in advance. Elith and Leathwick (2015) 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 proceedures, 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 a 1m Digital Elevation Model (DEM) were used as starting point for mapping the distribution of SOAK 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 existing vegetation community maps including (RN17), substrate maps, roads and 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.

The API layer was then cross-checked against the derived spatial model of SOAK. 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 Tables B1 and B2 (Appendix B) and for the South Coast (Nowra to Bega) in Table B3 (Appendix B).

3.7.2 Integration of spatial data

We used the API line work in combination with floristic plot data (both full and partial floristic plots) and field notes, to develop an operational map using the following procedure:

- For each polygon code (defined by unique combinations of canopy composition and understorey characteristics) we assessed the extent of plot sampling and the proportion of plots which we had assigned to SOAK. For codes which had been sampled but for which all plots had been assigned to communities other than SOAK, we excluded all polygons with that code from the SOAK map if the API description was consistent with the API type not being SOAK.
- For unsampled polygon codes, we considered the API description in relation to our interpretation of the final determination, sampling in other codes with similar canopy composition and location of individual polygons in relation to landscape features and composition of adjacent polygons, to make a subjective judgement whether polygons were likely to belong to SOAK. We did this assessment by individual polygons for those with matching canopy composition.

We believe that this procedure provides a precautionary operational map of SOAK. Polygons mapped as SOAK may include some which do not belong to this TEC using either our interpretation or an alternative interpretation.

3.8 Validation

We did not conduct any formal validation of our mapping of Swamp Oak Floodplain Forest, due partly to the expected limited extent in state forests and partly because the canopy and landscape position of SOAK makes it readily interpretable from API relative to communities which are less well-defined from canopy composition.

As a limited form of validation, we extracted all records of *Casuarina glauca* (as the main characteristic canopy species) from the NSW Wildlife Atlas (extracted 1 Feb 2016). We assessed the extent to which records of this species in state forests were covered by areas which we had mapped as SOAK, as an indication of the extent, if any, to which we may have overlooked areas of SOAK. We did not conduct any validation of the extent to which areas we mapped as SOAK may include other communities.

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 171 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 292 sample points in state forests.

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) ('SCIVI' community). 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. 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 or vegetation which belongs to communities not included in our analysis.

Table 5 summarises the distribution of plots among the existing and new communities relevant to SOAK, including all plots in which *Casuarina glauca* is dominant or codominant in the overstorey and all in which *Melaleuca ericifolia* is dominant. In most cases where the two classifications do not overlap in the context of the SOAK final determination, it is because there is no equivalent Gellie community. There is one significant exception, for SCIVI community p109 (not cited in the determination) which is partly matched to Gellie vg 25 (which is included). This is because the only component of the original p109 (Mangroves) which we included in our analysis comprised a few plots which had been previously allocated to vg27 and which represent transitional vegetation with *Casuarina glauca*-dominated communities. Thus, p109 as defined by our fuzzy clustering differs from p109 as described by Tozer et al. (2010) and is predominantly a *Casuarina glauca* community which occasionally includes some mangrove species. With respect to the final determination, p105 and vg27 are included in SOAK only where *Casuarina glauca* is dominant. Eight plots in group xs13 have *Casuarina glauca* as a major canopy dominant. This group comprises plots which also have a high proportion of rainforest elements but are otherwise a heterogeneous mixture with high species richness. We believe that the plots in this group are not necessarily fixed-area plots, may each sample across vegetation community boundaries and that their grouping may be an observer artefact. Although we used them in analyses in the belief they were consistent with other samples, we have excluded them from further assessment.

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

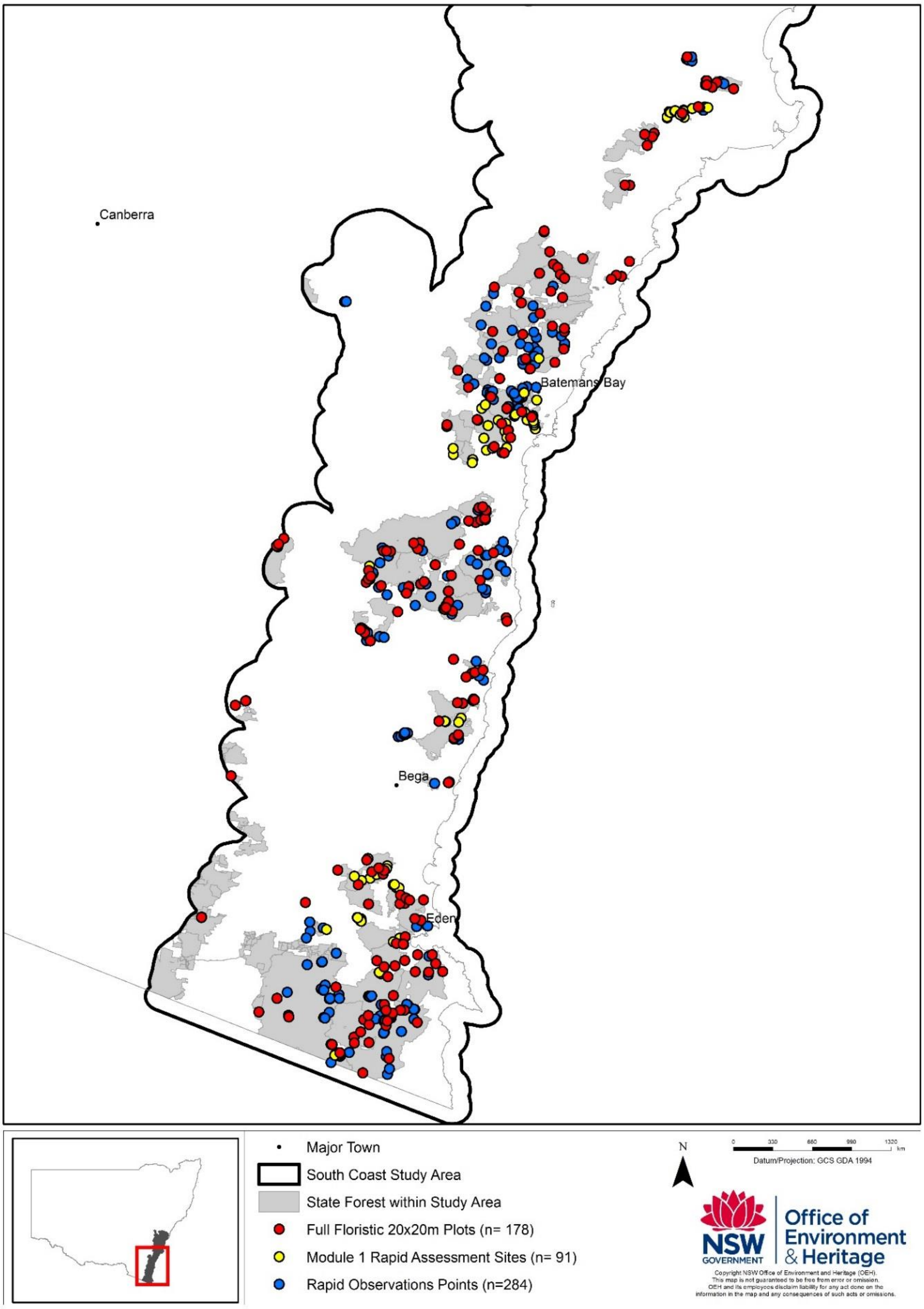


Table 5: Distribution of plots among SOAK and related communities, including all plots in which *Casuarina glauca* is dominant or co-dominant in the overstorey and all in which *Melaleuca ericifolia* is dominant. Numbers are the numbers of plots with overstorey dominants indicated by the letter suffixes: c *Casuarina glauca*, e eucalypts, m Melaleuca spp, n no tree dominant (shrub, herb or grass dominant), a mangrove, r rainforest species. Community e63 is omitted because it is included in p105.

	Plots with memb >=0.5 in Gellie SOAK community			Other plots (incl membership <0.5)	Total
SCIVI community (Tozer et al. 2010)	vg24	vg25	vg27		
e60				7m,2n	7m,2n
m15	1e			6e,4m	7e,4m
p3			1c	1c,17e	2c,17e
p29				4c	4c
p30			1e	14e,1n	15e,1n
p33				5c	5c
p63			2n,1e	6c,5e,20n.1m	6c,6e,22n,1m
p105	6c	8c	1c	19c,1m	34c,1m
p106	1c			35c,1e,2m,19n	36c,1e,2m,19n
p107	1c,2e			7c,4m,1e	8c,3e,4m
p109		5c, 2a		4c,3a,2n	9c,5a,2n
p210				3c/r	3c/r
p434			1n,1c,5e	2c,1e,3n	3c,6e,4n
xs13			1c	7c,15m,42e,32r	8c,15m,42e,32r
xs14				4c	4c
other (incl. scivi memb<0.5)	1r,2c,1e	4c	1c,1e	19c, 2m	26c,2e,2m,1r

4.2.2 Floristic relationships of communities to Swamp Oak Floodplain Forest determination assemblage

The final 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 2.5.3. Appendix C shows the results for the SCIVI communities relevant to our analyses. Communities p105, p106, p107 and e60, with xs14, are the communities which are most similar to the determination assemblage, consistent with the determination. Group xs14 comprises wetland or wetland fringes, sometimes dominated by *Melaleuca quinquenervia* but predominantly treeless. It is a heterogeneous group characterised by *Typha orientalis*, *Isachne globosa*, *Hypolepis muelleri*, *Acacia longifolia* and *Schoenoplectus validus*. Most plots in this group sample a highly disturbed area around Botany wetland in urban Sydney. It has a relatively high mean proportion of species per plot in the assemblage list, but a lower cumulative proportion. This is because some plots have very low species richness and contribute little to a cumulative proportion. Some components of this group may be referrable to SOAK, but the relationships of the group are confounded by disturbance and in any case, this group is not relevant to state forests.

Assessment of plots and communities as Swamp Oak Floodplain Forest and other TECs

In total, we assessed 167 plots as SOAK TEC. From our floristic analysis we regard as SOAK, all plots with a membership >=0.5 in any of our analyses, of any of the communities listed in Table 3 and meeting the qualifying condition of the particular community where such a condition is stated. We have assessed 145 full floristic plots (Appendix D) as SOAK based on this criterion. An additional 22 partial floristic plots are also most strongly related to SOAK communities and we have assessed these plots as SOAK using similar criteria.

Our interpretation for both full and partial floristic plots is based on floristic relationships and may not be consistent with other interpretations of the final determination which give more emphasis to environmental factors. There is uncertainty in the determination due to ambiguity and inconsistency between floristic and general environmental descriptors. Where there is conflict between floristic relationships and potentially important vegetation structural or environmental factors, we have taken a precautionary approach and resolved the conflict in favour of the floristic component. In particular, we have included as SOAK, vegetation which may conflict with structural or environmental descriptors of the determination (depending on how these are interpreted) in the following cases:

- vegetation not necessarily ‘associated with’ coastal floodplains (e.g. some estuarine systems; 50 plots allocated to SOAK are not on mapped alluvium)
- vegetation above 20 metres elevation and not necessarily ‘associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline’ (vegetation dominated by *Melaleuca ericifolia* in the Bega Valley, which occurs up to 150 m elevation; four plots are >20 metres elevation)
- treeless vegetation which also satisfies the description of Saltmarsh TEC, which conflicts with paragraph 4 of the final determination but is consistent with paragraph 1 and with previous allocations to cited communities (20 plots are treeless vegetation)
- vegetation dominated by eucalypts but which is floristically closely similar to SOAK communities (e.g. vegetation dominated by *Eucalyptus bosistoana* with saltmarsh understorey and adjacent
- to tidal flats; seven plots are dominated by eucalypts).

As Table 5 shows, there are 51 plots with *Casuarina glauca* as a canopy dominant but which are not allocated to any community cited in the final determination. Apart from those which belong to group xs13 (excluded from further consideration due to data inconsistencies) and the Botany wetlands group xs14, the majority belong to communities cited in determinations for a range of other TECs, including Bangalay Sand Forest (plots allocated to p63) and River-flat Eucalypt Forest (plots allocated to p33). We have assessed some, such as those allocated to p109 Mangrove but not matching a Gellie SOAK community, as not belonging to any TEC

We regard as reference plots for SOAK (Appendix D, subset headed ‘Reference plots’), those 45 plots with high membership of a community cited in the final determination, with either *Casuarina glauca* or *Melaleuca ericifolia* dominant in the overstorey and which match the environmental descriptors in the determination. As noted above, for management purposes, we have assessed 100 additional plots as SOAK which do not have all of these characteristics. We believe our assessment is appropriately precautionary for the purpose of our project, considering the uncertainty in the determination and potential conflicts between floristic and environmental descriptors. However, our interpretation may not be appropriate in other contexts.

4.2.3 Evidence of occurrence on state forest

Within state forests we have assessed all vegetation in which either *Casuarina glauca* or *Melaleuca ericifolia* or the two species combined are the dominant tree species, as Swamp

Oak Floodplain Forest. This is not necessarily the case outside state forest, where vegetation dominated by either of these species may belong to other TECs, or rarely, not belong to any TEC. We consider that some vegetation in state forests dominated by eucalypts (usually *E. bosistoana*) also belongs to Swamp Oak Floodplain Forest. Where vegetation is dominated by eucalypts, in the state forest study area, SOAK can be diagnosed if one or more saltmarsh species (*Selliera radicans*, *Samolus repens*, *Sarcocornia quinqueflora* or *Zoysia macrantha*) occur in the ground cover.

We allocated a single full floristic plot in state forest to SOAK, in Bermagui State Forest. This plot, BMG02A0F, represents vegetation with saltmarsh understorey, dominated by eucalypts. It was dominated by *Eucalyptus bosistoana*, with only a minor component of *Casuarina glauca* but a ground cover of saltmarsh species such as *Zoysia macrantha*. In addition, we assessed four partial floristic plots in State forest as SOAK, one in each of Bodalla, Moruya, Bolaro and Boyne State Forests, all with *Casuarina glauca* dominant. There were also two SOAK partial floristic plots just outside the boundary of Currowan State Forest.

Photo 1: A typical example of Swamp Oak Floodplain Forest TEC is found here at Trunketabella Creek in Moruya State Forest. A dense stand of *Casuarina glauca* forms a distinct pattern on the low lying alluvial soils that fringe the headwaters of the creek. The creek water is brackish and the ground cover plants must tolerate some salt influence. Visible here are tussocks of *Juncus kraussii* and *Baumea juncea* but a number of other smaller estuarine species are also found including *Samolus*

<u>Photo 2</u>: At several locations along the Bermagui River in Bermagui State Forest we found a combination of salt tolerant ground covers typical of Swamp Oak Floodplain Forest TEC growing with an open cover of *Eucalyptus bosistoana*. *Casuarina glauca* was either sparsely distributed or absent. There is uncertainty as to whether stands dominated by eucalypts meet the definition of the TEC, however we have included them because we found that the overall floristic composition is strongly related.

4.2.4 Defining floristic attributes and field key

Table 6 lists the 30 species which are most strongly characteristic of South Coast SOAK (as defined by 145 plots allocated to SOAK) in the context of all 6234 plots used in our floristic analysis. Species which are listed as characteristic in the SOAK final determination are annotated with '(D)'. Less than half (13) of the species which characterise our interpretation of SOAK are also listed in the determination.

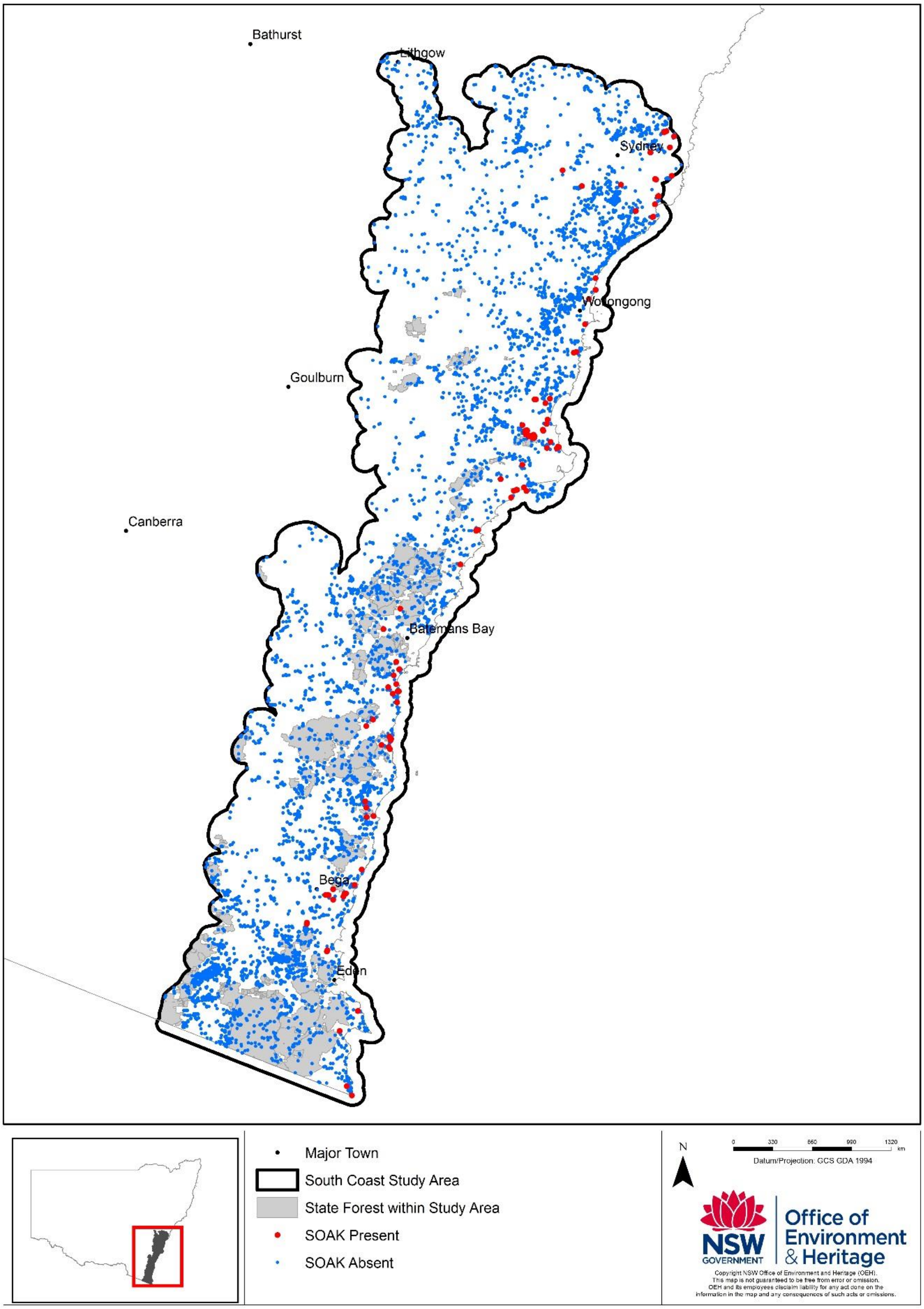
Though the four species with the highest contribution are listed in the determination assemblage, the overall proportion might be considered relatively low. This low proportion may be partly because the assemblage list is comprised of species which occur through the wide latitudinal range of SOAK and includes assemblages which are likely to differ floristically from our interpretation because of latitudinal differences in species occurrence. It may also partly indicate that our precautionary approach to resolving internal conflicts in the determination has led to a broader interpretation than would be made from the assemblage list alone, especially in including saltmarsh vegetation covered by SCIVI community p106 and in including vegetation dominated by eucalypts where it was floristically similar to SOAK communities.

<u>Table 6</u>: The 30 most strongly characteristic species of South Coast SOAK, plus the four most frequent eucalypts, in order of decreasing contribution to ΔsumAIC, using 145 SOAK plots compared to all other 6089 plots used in the floristic analysis. Species annotated with '(D)' are listed in the final 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	SOAK freq	SOAK mean	SOAK median	other freq	other mean	other median	ΔsumAIC
Casuarina glauca (D)	0.72	2.21	3	0.02	0.04	2	-1632
Juncus kraussii subsp. *australiensis* (D)	0.54	1.52	3	0	0	2	-1506
Melaleuca ericifolia (D)	0.33	1.12	3.5	0.01	0.03	2	-776
Selliera radicans (D)	0.26	0.56	2	0	0	2	-529
Samolus repens	0.27	0.57	2	0	0	2	-505
Sarcocornia quinqueflora subsp. *quinqueflora*	0.25	0.54	2	0	0.01	3	-451
Phragmites australis (D)	0.3	0.65	2	0.01	0.02	2	-414
Sporobolus virginicus	0.17	0.46	2	0	0	2	-384
Baumea juncea (D)	0.19	0.59	3	0.01	0.02	2	-380
Suaeda australis	0.19	0.39	2	0	0.01	3	-307
Avicennia marina subsp. *australasica*	0.14	0.29	2	0	0	2	-225
Leptinella longipes	0.11	0.23	2	0	0	2	-197
Triglochin striata	0.11	0.21	2	0	0	1.5	-182
Atriplex australasica	0.11	0.18	2	0	0	1	-174
Lobelia anceps (D)	0.26	0.32	1	0.01	0.02	1	-165
Cynodon dactylon (D)	0.18	0.48	2	0.03	0.06	2	-147
Cladium procerum	0.03	0.11	5	0	0	NA	-118
Tetragonia tetragonioides	0.12	0.26	2	0.01	0.02	2	-110
Alternanthera denticulata (D)	0.14	0.19	1	0.01	0.01	1	-102
Gahnia filum	0.07	0.11	1	0	0	3	-102
Gahnia clarkei (D)	0.12	0.41	3.5	0.03	0.07	2	-101
Apium prostratum	0.07	0.14	2	0	0	1	-94
Myoporum acuminatum (D)	0.1	0.21	2	0.01	0.01	1	-93
Parsonsia straminea (D)	0.32	0.64	2	0.11	0.19	1	-93
Wilsonia backhousei	0.02	0.08	3	0	0	NA	-81
Carex appressa (D)	0.17	0.37	2	0.06	0.08	1	-68
Calystegia sepium subsp. *roseata*	0.05	0.09	2	0	0	1	-68
Eleocharis acuta	0.04	0.08	1	0	0	1.5	-66
Persicaria praetermissa	0.07	0.12	2	0	0.01	1	-61
Zoysia macrantha	0.04	0.13	3	0	0.01	2	-60
Eucalyptus robusta	0.03	0.08	3	0	0.01	3	-16
Eucalyptus amplifolia	0.02	0.06	3	0.01	0.02	3	-6
Eucalyptus bosistoana	0.03	0.08	3	0.04	0.08	2	2
Eucalyptus botryoides	0.04	0.12	3.5	0.06	0.14	3	2

A field key to identify South Coast SOAK, using our interpretation, is provided in Appendix E. Selecting rules around diagnostic species which minimise the likelihood of incorrectly concluding that SOAK is absent will always result in a relatively high likelihood that an area will be identified as SOAK when it is not, due to the floristic overlap between SOAK 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 SOAK, it will be necessary to conduct full floristic surveys.

Map 6: Standard floristic plots allocated to Swamp Oak Floodplain Forest (SOAK).



4.3 Indicative TEC Mapping

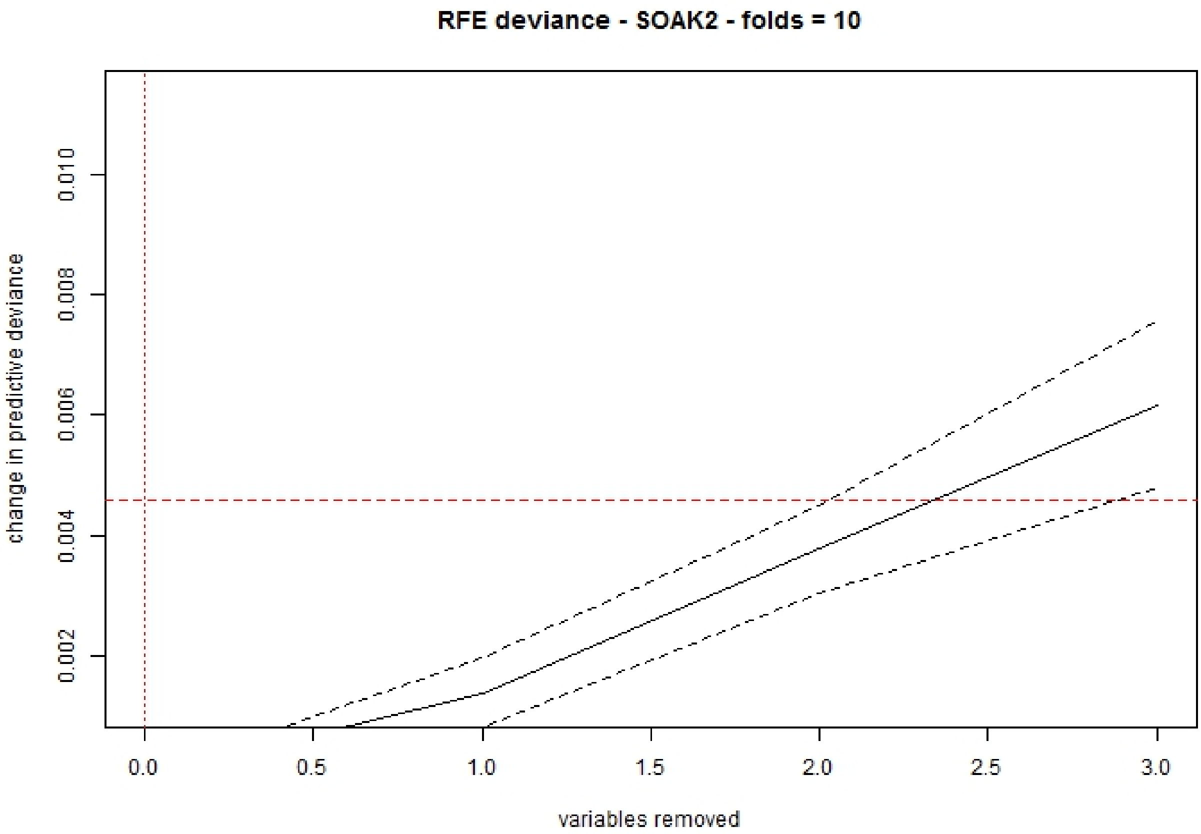
4.3.1 Variable selection

A series of Boosted Regression Tree (BRT) models were run using the 138 standard floristic plots allocated to SOAK 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 (2015).

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% (11 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 11 initial variables being retained.

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

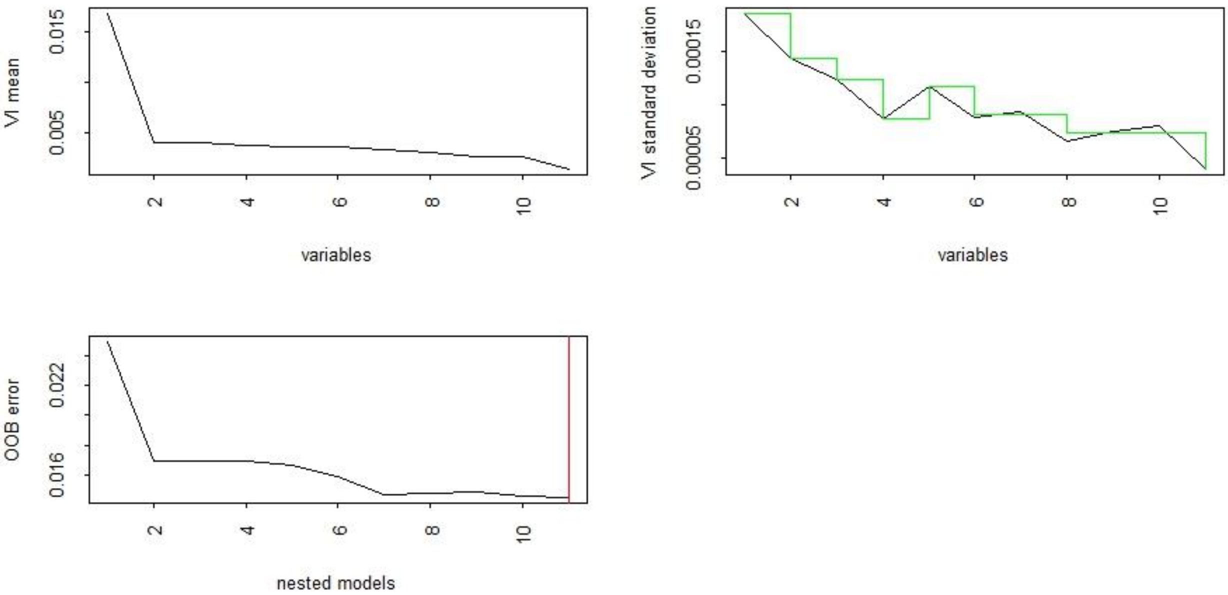


As an alternative approach to *gbm.simplify*, the VSURF in R package was used to try to identify a smaller subset of variables relevant to the classification. VSURF performs a preliminary ranking of the explanatory variables using the random forests permutation-based score of importance, and proceeds 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 all 11 predictors should be retained in the model.

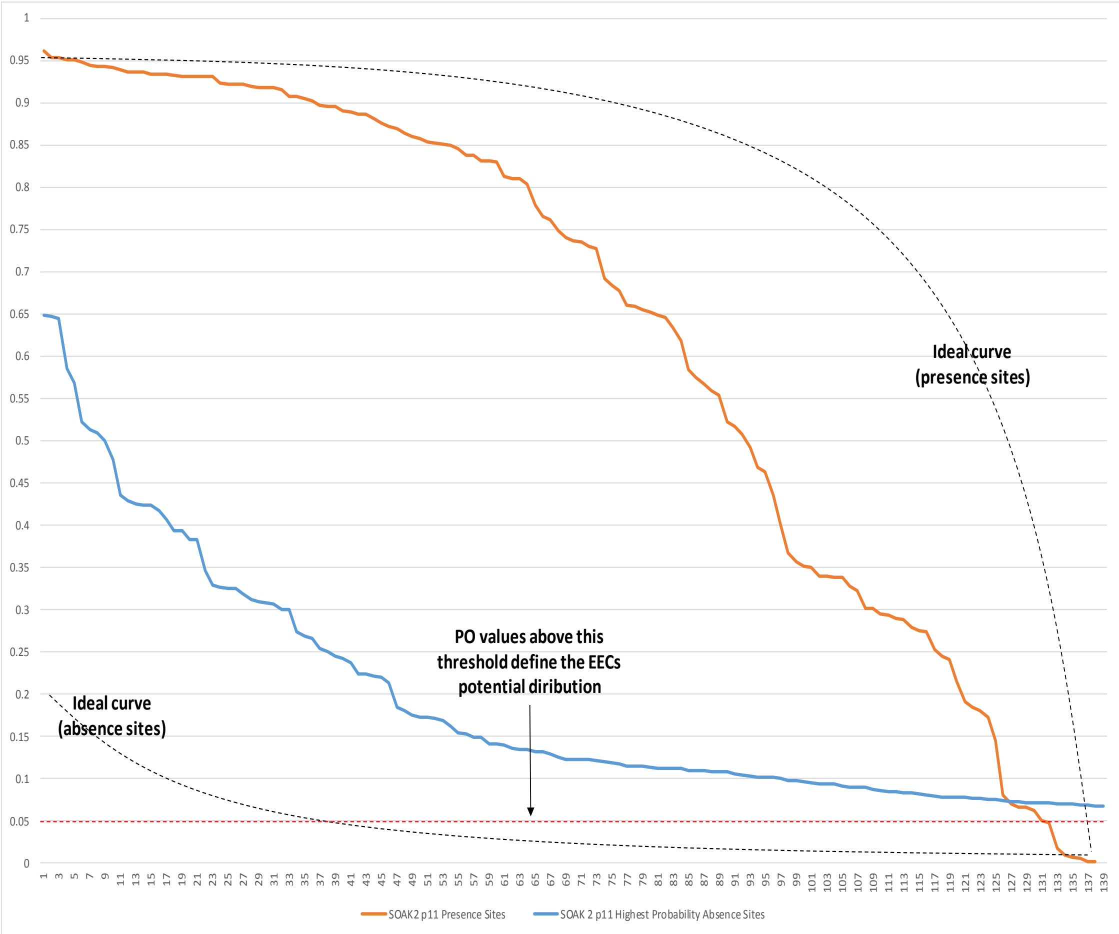
<u>Figure 3</u>: Outputs from VSURF algorithm showing mean change in predictive deviance and its standard error as a function of the number of variables removed.



The performance of the model with 11 predictors is show in Figure 4. Modelled probability of occurrence (PO) values for all plots allocated to SOAK 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 SOAK 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.

In terms of the likelihood that SOAK 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 11 predictors listed in Table 7, 94.92% of the 138 plots allocated to SOAK and 96.75% of the 6262 absence plots are correctly predicted (Figure 4).

Figure 4: Evaluation of the performance of BRT model used to predict the distribution SOAK.



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 SOAK. For example, we know from the final determination that '*Swamp Oak Floodplain Forest generally occurs below 20 m elevation, rarely above 10 m on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains*'.

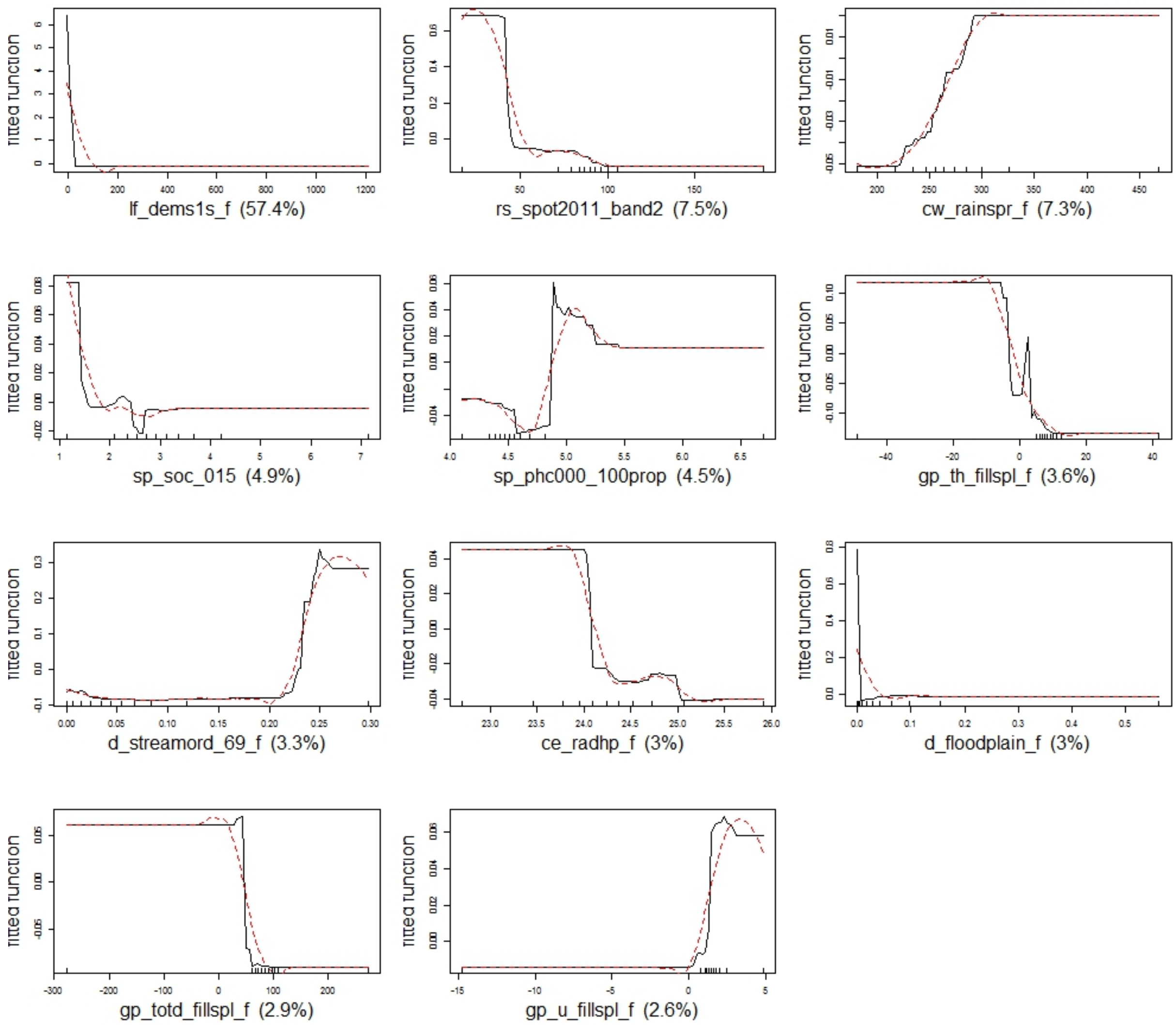
Figure 5 shows the fitted functions for the 11 predictors used in the model (Table 7). These relationships reflect constraints that relate to elevation, distance to stream orders 6 to 9, as well as the nearest floodplain mapped by CCA. Average rainfall in spring, highest period radiation and five soil parameters also influence where the TEC can potentially occur.

Table 7: Description of predictors used in final BRT model.

Code	Description
lf_dems1s_f	1 sec SRTM smoothed DEM (DEM-S)
rs_spot2011_band2	2011 Spot band 2
cw_rainspr_f	Average rainfall in spring
sp_soc_015	Soil Organic Carbon at depths from 0 to 15 cm
sp_phc000_100prop	Soil pH (calcium chloride) proportionally combined depths from 0 to 100 cm
gp_th_fillspl_f	filtered thorium (Th) with gaps filled in using geographically weighted regression
d_streamord_69_f	Euclidean distance to Strahler order streams 6 to 9

Code	Description
ce_radhp_f	Highest Period Radiation (bio21)
d_floodplain_f	Euclidean distance to polygons mapped as 'floodplain' by the CCA program
gp_totd_fillspl_f	Total dose rate, gaps filled in using GWR model
gp_u_fillspl_f	filtered uranium (U), gaps filled in using GWR model

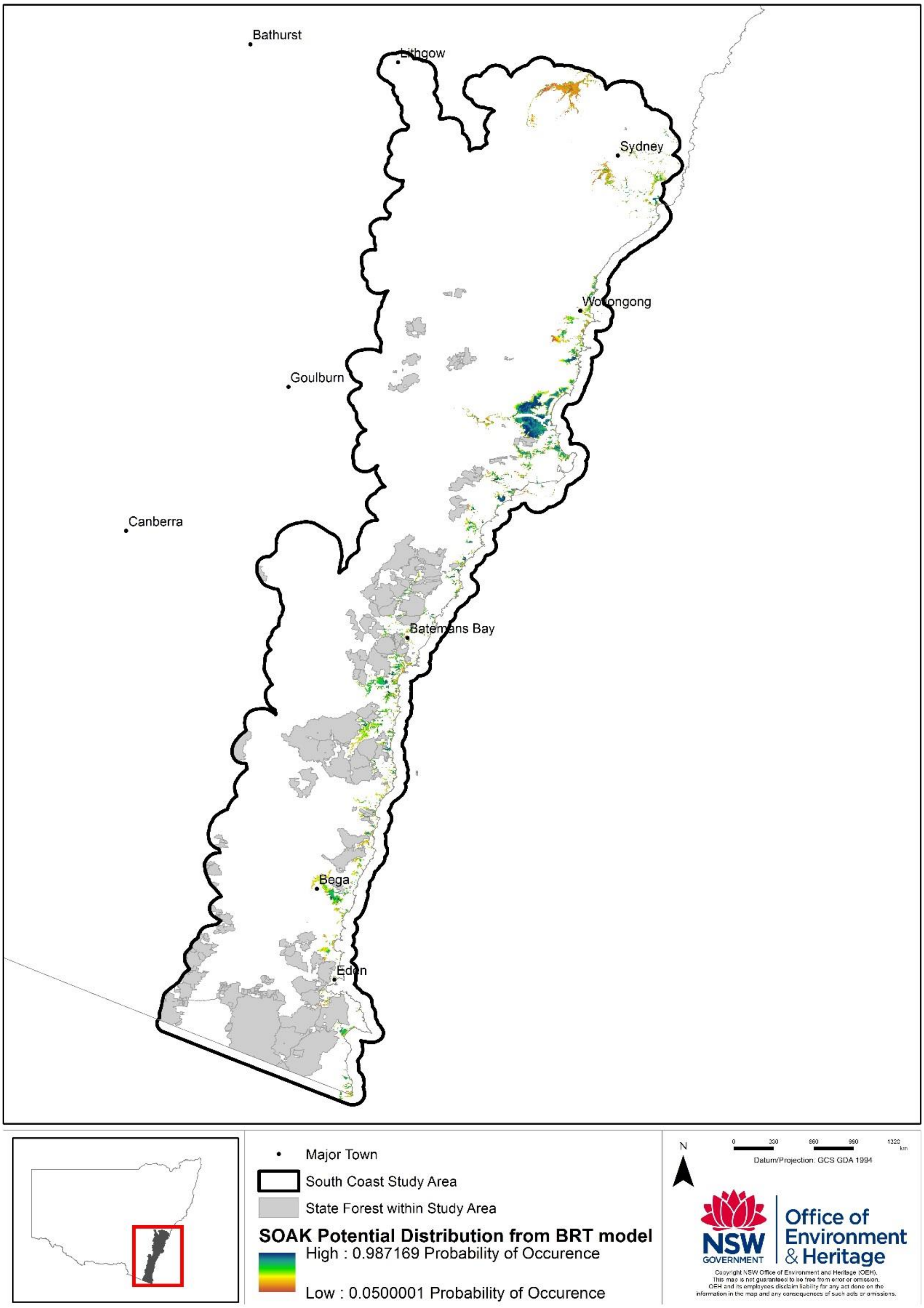
<u>Figure 5</u>: Fitted functions in the final BRT model.



4.3.3 Predicted distribution map

A map of the potential distribution of SOAK as defined by the area with a probability of occurrence value of 0.05 and greater is shown in Map 9.

<u>Map 7</u>: Predicted distribution of SOAK as defined by the area with a probability of occurrence value of 0.05 and greater.


Bathurst
Lithgow
Sydney
Wollongong
Goulburn
Canberra
Batemans Bay
Bega
Eden
Major Town
South Coast Study Area
State Forest within Study Area
SOAK Potential Distribution from BRT model
High : 0.987169 Probability of Occurence
Low : 0.0500001 Probability of Occurence
N
0
330
660
990
1320
km
Datum/Projection: GCS GDA 1994
NSW GOVERNMENT
Office of Environment & Heritage
Copyright NSW Office of Environment and Heritage (OEH).
This map is not guaranteed to be free from error or omission.
OEH and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.

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. Fifty-one classes were used to describe patterns in canopy (mainly eucalypt) composition across alluvial areas in the study area.

4.5 Operational TEC Mapping

After integrating information from API results (including checking against predictive models), plot data and environmental features, using the method described in Section 2.7.2, we mapped 79.8 hectares of Swamp Oak Floodplain Forest in state forests in our study area, comprising 98 polygons with a mean size of 0.8 hectares. Areas which we mapped as SOAK comprised all polygons in state forests which had any of the following characteristics:

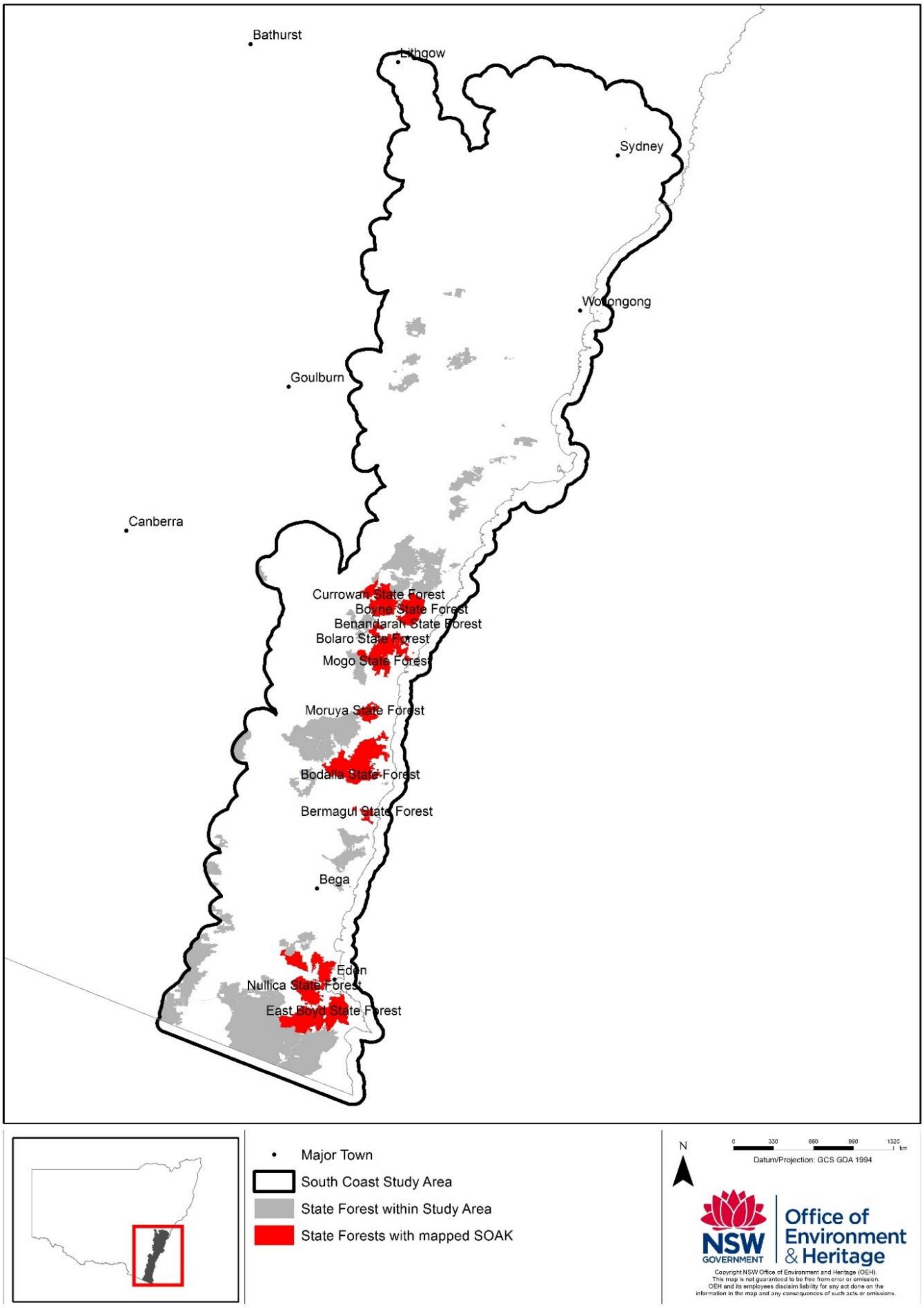
- *Casuarina glauca* as canopy dominant or codominant (38.7 ha)
- *Melaleuca ericifolia* (or other species of Melaleuca if API confidence was low) as canopy dominant and located on a flat to gently sloping area in an estuarine fringe (12.6 ha)
- *Eucalyptus bosistoana* as canopy dominant, or occasionally other eucalypts, with or without *Casuarina glauca*, but with saltmarsh species understorey (6.6 ha)
- Saltmarsh with mangrove canopy or saltmarsh/mangrove mosaic (but excluding saltmarsh alone and areas clearly dominated by mangroves with no saltmarsh evident from aerial imagery) (18.8 hectares)
- Unidentified shrubby vegetation on estuarine fringes, which may be dominated by *Melaleuca ericifolia*, adjacent to other areas mapped as SOAK. (3.1 hectares)

Map 10 shows the state forests in which we mapped at least one patch of Swamp Oak Floodplain Forest TEC, while map 11 show examples for individual state forest areas.

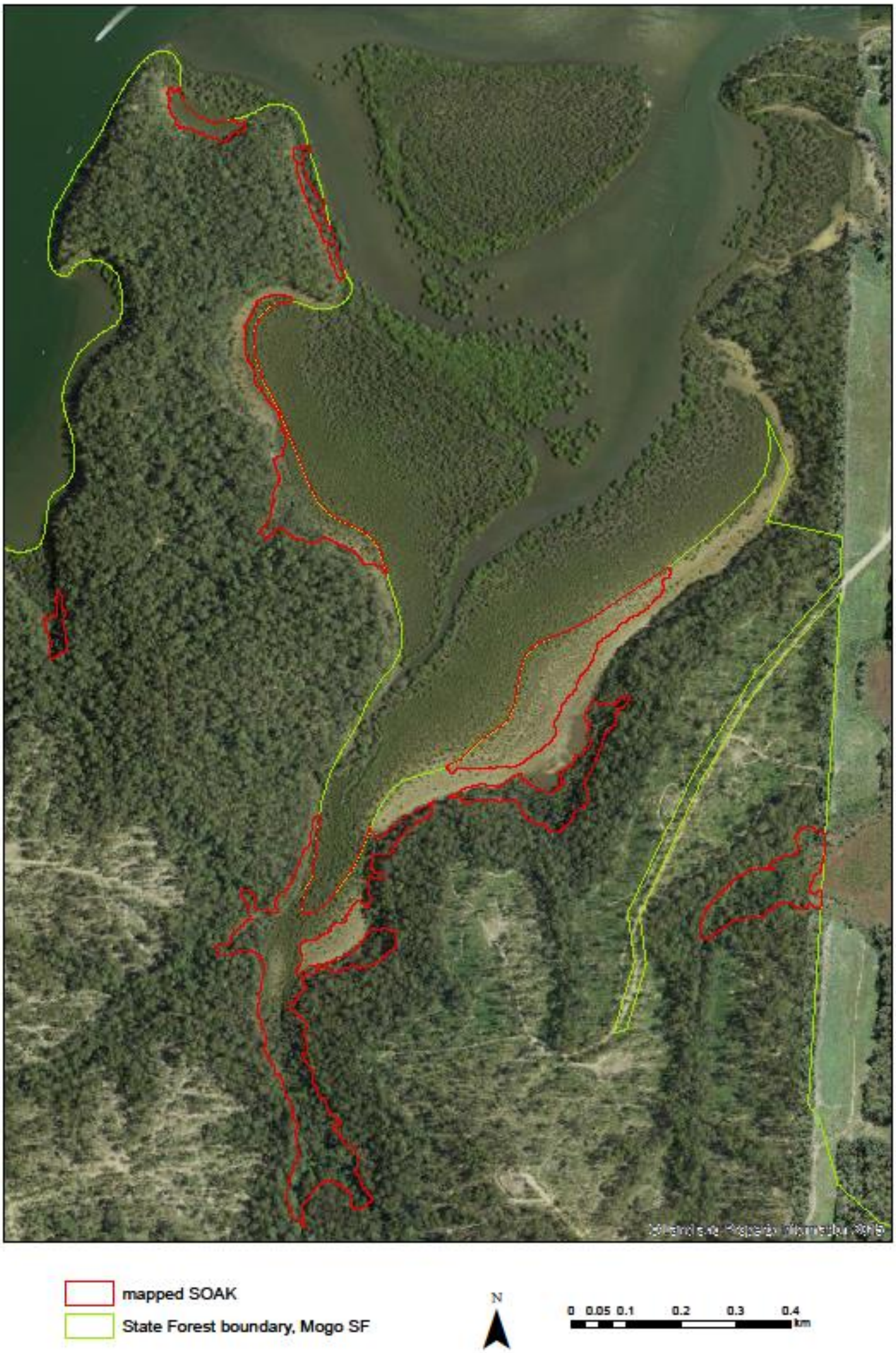
4.6 Validation

Of 1227 Wildlife Atlas records of suitable locational accuracy (<100 m) south of Sydney for *Casuarina glauca*, only four were in state forest. We had assigned one of these to SOAK and three to River-flat Eucalypt Forest TEC. The latter three each had very low cover of *C. glauca* (cover code of 1). There are not sufficient plot data from state forests to allow an estimate of the likelihood that we have failed to map SOAK where it occurs on state forests, but the very low proportion of records of *C. glauca* in state forests suggests that the likelihood is low.

<u>Map 10</u>: State forests with mapped occurrences of Swamp Oak Floodplain Forest (SOAK).



<u>Map 11</u>: Example of Operational Mapping of SOAK in Mogo State Forest.



5 Discussion

5.1 Summary

5.1.1 Cited vegetation communities and final determination species assemblage list

The application of TEC reference panel principles to the floristic attributes of Swamp Oak Floodplain Forest TEC in the South Coast region was successful. Our analysis identified strong agreement between the characteristic species listed in the determination and the cited vegetation communities identified as Swamp Oak Floodplain Forest. This provided an unambiguous foundation to assess the relationships between new samples and these cited communities.

The project did rely 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 Swamp Oak Floodplain Forest on the South Coast or in the threat assessment then these were definitively not the TEC. There are no statements in the 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 determination for Swamp Oak Floodplain 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.

We also identified some unusual forests on estuarine fringes that were dominated by eucalypts but featured a ground and shrub layer typical of estuarine examples of Swamp Oak Floodplain Forest TEC. We were uncertain in these circumstances whether the final determination precluded the identification of stands dominated by eucalypts as the TEC. The panel resolved to include them as there are no statements in the determination to suggest they do not meet the definition of the TEC.

5.1.2 Distribution and habitat descriptors

The final determination includes a set of environmental descriptors that assist in locating Swamp Oak Floodplain 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 an interpretation of what comprised these landscapes on the South Coast. There is no reference in the final determination to mapped information defining floodplain and alluvial landscapes. The definition provided 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 difficulties assessing habitat characteristics on parts of the South Coast where drowned river valleys dominate the coastal landscape but where parts of the catchments of those valleys could be regarded as floodplains. Stands of *Casuarina glauca* fringe the estuaries and other parts of the major river systems. The final determination states that the TEC includes estuarine fringes associated with coastal floodplains, but does not provide any guidance on how to interpret the extent of association and does not explicitly address whether these are included. Similarly, some estuarine environments on the South Coast include *Casuarina glauca* stands on low lying landforms derived from marine rather than fluvial deposits. The panel overcame the uncertainty on state forest tenure by concluding that they both met the definition for the TEC. Uncertainties with these interpretations remain on other tenures.

We found general agreement with the elevation thresholds described in the determination. On the South Coast our indicative model suggested a very low likelihood of suitable Swamp Oak Floodplain Forest habitat occurring above 20 metres above sea leavel. However south of Bermagui, the elevation threshold was extended above 100 metres above sea level, primarily in the Bega and Towamba Valleys. We believe that these thresholds together with floristic data can be used as a useful field key to diagnose the Swamp Oak Floodplain Forest TEC on state forest 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 8 presents the summary of the findings.

Table 8: Summary of issues and Panel review of SOAK, 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	
Is 'associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains'	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 an alluvial model derived from 1m Lidar DEM, supplemented by stereoscopic digital aerial photograph interpretation .	
Generally occurs below 20 m (rarely above 10 m) elevation	Assess habitat descriptors and whether these constrain or define the limits of the TEC which otherwise may have a broader distribution	Determination does not define a fixed upper elevation threshold. We included samples to 130 metres ASL in the Bega Valley	

Final Determination	TEC Panel Principles	Our Project	TEC Panel Review
On the Illawarra Plain, 'Coastal Swamp Oak Forest' (map unit 36) of NPWS (2002) occurs within this community. In the Comprehensive Regional Assessment of southern New South Wales (Thomas et al. 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by *Casuarina glauca*. In the Sydney - South Coast region, this community includes parts of 'Floodplain Swamp Forest' (map unit 105) dominated by *Casuarina glauca*, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall et al. (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include *Casuarina glauca* or *Melaleuca ericifolia* (Keith & Bedward 1999)	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	We analysed relationships between new samples collected on state forest and samples used to define source classifications We found strongest relationships between new samples and SCIVI units p105 (Floodplain Swamp Forest), p106 'Estuarine Fringe Forest' and p107 Estuarine Creek Flat Scrub'. All are explicitly defined in the determination with the only qualifier applying to p105 to limit the community to stands dominated by *Casuarina glauca*. We encountered only one sample allocated to p105 which was dominated by eucalypts. This was assigned to River-flat eucalypt TEC	
Characterised by the list of 86 plant species	Be guided by the species lists presented in the determination	We compared species assemblage data drawn from source classifications with that presented in the determination. We found strongest relationships between the determination assemblage and SCIVI types p105, p106 and p107. All samples have been included where they meet the floristic qualifiers We found a weaker relationship between the determination assemblage and e60 'Eden Floodplain Wetlands'. However as it explicitly cited in the determination it has been included where it meets the stated floristic qualifiers	

Final Determination	TEC Panel Principles	Our Project	TEC Panel Review
	Other Issues: New Included Vegetation Communities	A number of samples allocated to SCIVI unit p107 are dominated by eucalypts but may or may not include *Casuarina glauca*. As the assemblage of these samples unambiguously relates to the swamp oak assemblage they have been included within the allocations for this TEC Their inclusion may be contrary to the intent of the determination which indicates that *C. glauca* and *M. ericifolia* are the only dominant trees We also included a number of plots that are treeless but are characterised by an assemblage of reeds, sedges and herbs of estuarine environments. We considered these met the determination assemblage and structural characteristics	
	Other issues: Excluded Vegetation Communities	Nil	

5.3 Final State Forest-TEC Occurrence Matrix

Table 9: Total area of Swamp Oak Floodplain Forest TEC mapped across all state forests in the study area.

State Forest	Area (Ha)	AREA SOAK (Ha)	State Forest	Area (Ha)	AREA SOAK (Ha)
Badja State Forest	4839		Moruya State Forest	4059	7.6
Bateman State Forest	1		Mumbulla State Forest	6137	
Belanglo State Forest	3891		Murrah State Forest	4215	1.5
Benandarah State Forest	2761	5.4	Nadgee State Forest	20537	
Bermagui State Forest	1861	8.8	Nalbaugh State Forest	4396	
Bodalla State Forest	24079	5.4	Newnes State Forest	281	
Bolaro State Forest	1779	3.5	North Brooman State Forest	3631	
Bombala State Forest	620		Nowra State Forest	521	
Bondi State Forest	12742		Nullica State Forest	18298	2.2
Boyne State Forest	6161	1.6	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	0.2
Corunna State Forest	183		Tantawangalo State Forest	2466	
Currambene State Forest	1695		Termeil State Forest	698	
Currowan State Forest	11977	2.0	Timbillica State Forest	9144	
Dampier State Forest	33746		Tomerong State Forest	212	
East Boyd State Forest	21010	7.7	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	37.2	Yurammie State Forest	4050	
			Total		79.8

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Appendix A

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

<u>Table A1</u>: Vegetation groups described by Gellie (2005)

vg	VEG_GROUP
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 DryHerb-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	VEG_GROUP
VG 59	Eastern Tableland and Escarpment Shrub-Fern Dry Forest
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).

SCIVI_ALLO	MAPUNIT
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
e20p229	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

SCIVI_ALLO	MAPUNIT
e38	Far Southeast Riparian Scrub
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

SCIVI_ALLO	MAPUNIT
p45	Coastal Sand Swamp Forest
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, Angophora floribunda*	*E.cypellocarpa, E.baueriana, E.tereticornis, E. ovata E.longifolia (Eviminalis riparian)*
109	*E. longifolia*	*E. cypellocarpa(often co dom) Angophora floribunda, E.angophoroides, E.viminalis (sometimes oc 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. eric (sub saline to saline)*
156	Intermediate shrubland (T to VT)	*Tall shrubs dom in large canopy openings e.g. Pomaderis etc.*
115	Viney Scrub	*Mesic shrubs / vines dom 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 oc trees (commonly E. elata, E. cyp, E. vim) Callistemon Melaleuca 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. litto*	*E. consideniana, E. sieberi*

219	*E. globoidea +/- A. litto*	*E. cypellocarpa, E.l ongifolia, A. floribunda, E. obliqua E. sieberi E. considеniana*
214	Seepage zone woodland	*E. ignorabilis, E. consideniana, E. globoidea, A. floribunda Oc: E. ovata, 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	
RF 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 (oc ferns)
Dry Types		
General	D0	
Grassy	D1	
Shrub/Grass	D2	
Allocas + dry shrub / grass	D3	
Intermediate to dry grass/shrub +/- ferns, Lomandra	D4	Drier than M6. Applied to stringybark +/- oc yertchuk silvertop ash monkey gum 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
Other		
Disturbed	X0	
Exotics Dominant	X1	
Riparian complex	X2	
Saline/subsaline	X3	
Not Applicable	9999	

<u>Table B3</u>: South Coast Canopy Species API Codes (Nowra to Bega).

ALLUVIAL API CODE	**CANOPY1 Common Dominant / Co-dominants**	**CANOPY 2 Common associates (subsidiary and minor)**
101	*Angophora floribunda*	*E. tereticornis*
102	*E. tereticornis, Angophora floribunda*	*E. globoidea*
103	*E. tereticornis*	*Angophora floribunda, E. globoidea*
104	*E. baueriana, E. angophoroides*	*E. angophoroides, E. elata, E. globoidea, Angophora floribunda*
105	*E. bosistoana*	*E. longifolia, E. botryoides*
106	*E. botryoides*	*E. longifolia, E. elata*
107	*E. elata*	*Angophora floribunda, E. baueriana, E. tereticornis, E. viminalis*
108	*E. elata, Angophora floribunda*	*E. baueriana, E. tereticornis, E. cypellocarpa*
109	*E. longifolia*	*Angophora 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	
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, Angophora 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

Comparison of SCIVI floristic communities (Tozer et al. 2010) with the species assemblage list in the Swamp Oak Floodplain Forest (SOAK) final determination.

	Original allocation			Nclust allocation			
SCIVI code	**Number of plots**	**Mean proportion**	**Cumulative number of species**	**Number of plots**	**Mean proportion**	**Cumulative number of species**	
p105	22	0.41	24.8	35	0.47	24	Included as SOAK
p106	19	0.47	14.3	58	0.38	13	Included as SOAK
p107	12	0.28	22.9	15	0.33	21.4	Included as SOAK
xs14		0	0	23	0.31	16.8	Highly disturbed, Sydney area, not present in SF
e60	11	0.21	13.7	9	0.28	na	Included as SOAK if dominated by Melaleuca ericifolia
p45	11	0.23	21.1	14	0.28	19.8	Considered under Swamp Sclerophyll Forest TEC
p109	3	0.21	na	16	0.26	11.7	Included as SOAK if related to Gellie communities g25 or g27.
p63	28	0.2	14.9	35	0.24	14.8	Considered under Bangalay Sand Forest TEC
m15	8	0.18	na	11	0.18	12.8	Excluded, not cited in determination
xs10		0	0	12	0.17	15.8	Sydney area, not present in state forest
p30	37	0.15	19.2	16	0.16	19.2	Considered under River-flat eucalypt forest TEC
p434	9	0.17	na	13	0.15	14.2	Themeda grassland TEC, not present in state forest
p210	11	0.12	12.7	17	0.15	15	Considered under Littoral rainforest TEC
p64	51	0.15	16.1	46	0.14	16.7	Considered under Bangalay Sand Forest TEC

	Original allocation			Nclust allocation			
SCIVI code	**Number of plots**	**Mean proportion**	**Cumulative number of species**	**Number of plots**	**Mean proportion**	**Cumulative number of species**	
p99	71	0.13	13.7	46	0.13	13.3	Excluded, not cited in determination
p44	3	0.13	na	5	0.13	na	Excluded, not cited in determination
xs6		0	0	69	0.12	13.9	Considered under River-flat Eucalypt Forest TEC
p111	52	0.12	12.7	67	0.12	11.6	Excluded, not cited in determination
p31	9	0.12	na	7	0.12	na	Excluded, not cited in determination
p86	21	0.11	10.7	21	0.12	9.8	Excluded, not cited in determination
xs13		0	0	97	0.12	17.1	Excluded, inconsistent data collection method
p39	2	0.13	na	6	0.12	na	Excluded, not cited in determination

Appendix D

Plots assessed as Swamp Oak Floodplain Forest (SOAK).
Reference plots are those which are strongly matched floristically to a community cited in the final determination and for which habitat features match environmental descriptors in the determination. We have a high degree of confidence that these belong to SOAK.
Other plots are those with a weaker floristic relationship to any community cited in the final determination, or habitat features which may not match environmental descriptors, or both. We are less confident that these belong to SOAK.

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
Reference plots						
ALB002A	-34.61507	150.8388	p105	1.00	g25	0.35
ALB20A9O	-34.61237	150.8486	p106	0.86	xg4	0.99
ALP23Q0D	-34.50455	150.882	p107	0.99	g24	0.31
ALP27A7F	-34.5365	150.8655	p106	0.94	xg4	0.97
BD0000F5	-35.1483	150.6176	p107	0.90	g24	1.00
BD000FC3	-35.14861	150.6156	p107	0.93	g24	1.00
BD000FC4	-35.1521	150.605	p106	0.84	g24	1.00
BLL28A2F	-34.37144	150.9227	p105	0.95	g25	0.64
BRUN02	-34.93021	150.6562	p105	0.96	xg4	0.35
BRUN08	-34.91793	150.6569	p106	1.00	xg4	0.97
BRUN09	-34.91789	150.6538	p106	0.99	xg4	1.00
BRY032SW	-34.81187	150.7277	p105	0.81	g24	0.80
BRY035	-34.86828	150.7467	p106	1.00	xg4	1.00
BRY050A	-34.79739	150.6856	p105	1.00	g25	0.24
BRY051A	-34.79712	150.6914	p105	0.98	xg4	0.56
BTN31A2V	-33.97874	151.0247	p106	0.99	xg4	0.99
BTN96Q0D	-33.94037	151.1557	p109	0.99	g25	0.57
BTNA2Q0D	-33.9407	151.1545	p105	0.92	g25	0.96
CN25A21D	-36.36022	150.0266	p107	0.94	g27	0.50
CRNPSD03	-35.69295	150.1316	p106	1.00	xg4	0.99
CUR015A	-35.61615	150.1395	p106	0.60	xg4	0.79
EP011G	-35.91632	150.1164	p107	0.96	g27	0.39
ESMA207	-34.08306	151.1322	p106	1.00	xg4	1.00
ESMA213	-34.08332	151.1315	p106	1.00	xg4	0.99
HUS014A	-35.10707	150.5534	p105	0.86	g25	0.35
JMBEG03	-36.74251	149.9021	e60	0.98	xg7	0.35
JMILL01	-35.84689	150.1597	p105	0.98	g24	1.00
JMNA126	-37.4677	149.9549	p107	0.99	xg4	0.66
KIO001LQ	-35.50151	150.3916	p105	0.92	g27	0.31
MURRAA01	-35.52625	150.3997	p106	0.98	xg4	0.98

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
NOW004A	-34.94318	150.6759	p105	0.99	g25	0.61
NOW006A	-34.91946	150.7194	p106	1.00	xg4	0.99
NOW008A	-34.9156	150.7178	p105	0.97	g27	0.44
PHC34A0D	-34.08638	151.1478	p106	0.89	xg4	0.93
PHC71A7D	-34.03814	151.1541	p105	0.83	g25	0.67
PHC85Q6V	-34.00242	151.1634	p106	0.96	xg4	0.96
PHC88Q3F	-34.00824	151.1679	p106	0.98	xg4	0.87
PMPAMB03	-36.93914	149.8804	p106	0.84	xg4	0.98
SALT01	-34.94089	150.6854	p105	0.99	g25	0.68
SALT06	-34.93994	150.6768	p105	0.82	xg4	0.61
SALT07	-34.94522	150.6848	p106	0.99	xg4	0.99
SALT08	-34.94109	150.6635	p106	0.98	xg4	0.99
SZ24066F	-35.84592	150.1599	p105	0.90	g24	1.00
WLLA7S7F	-34.49252	150.8396	p109	0.97	g25	0.85
WOL130	-34.49292	150.8474	p109	0.91	g25	0.99
Other plots assessed as Swamp Oak Floodplain Forest						
120601-1	-33.90622	150.7951	p105	0.44	xg10	0.21
6BEG02F	-36.72409	149.8734	e60	0.38	g53	0.83
6WOL01F	-36.83128	149.8	e60	1.00	xg7	0.23
BD000FC1	-35.15316	150.6545	p105	0.50	g24	0.33
BD000FC2	-35.13962	150.644	p105	0.79	g24	0.97
BD00RF18	-35.17825	150.5944	p210	0.09	g24	0.90
BLL19A1F	-34.32593	150.9232	p106	0.91	xg4	0.98
BLL29A2F	-34.37133	150.9235	p105	0.86	g24	0.75
BM02A21D	-36.38467	150.0312	e60	0.31	g53	0.91
BM03A21D	-36.38379	150.0324	p105	0.73	g53	0.93
BMG02A0F	-36.4211	150.0331	p106	0.24	xg4	0.80
BOD06Q3B	-35.97498	150.1511	p434	0.18	g25	0.72
BOD30Q3D	-36.07781	150.1239	p109	1.00	g25	0.93
BOD45Q3D	-36.05406	150.1103	p109	1.00	g25	0.87
BRUN01	-34.93362	150.6517	p107	0.48	g24	0.38
BRUN03	-34.92031	150.6566	p106	0.94	xg4	0.98
BRUN05	-34.91832	150.6504	p107	0.99	xg4	0.29
BTN18W1V	-33.96218	151.0216	p107	0.44	xg4	0.41
BTN29A7V	-33.97881	151.0222	p106	0.52	xg4	0.58
BTN92Q0D	-33.93975	151.1543	p106	0.67	xg4	0.91
BTN93Q0D	-33.93985	151.1548	p106	0.83	xg4	1.00
BTN95Q0D	-33.942	151.1588	p109	0.41	g25	0.78
BTNE5Q0F	-33.92791	151.219	xs15	0.16	g25	0.31

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
CINRCS04	-34.89248	150.7328	p106	0.97	xg4	1.00
CINRCS06	-34.86533	150.7409	p106	0.72	xg4	1.00
CRNPCS07	-35.66808	150.1571	p106	1.00	xg4	1.00
ELAGAR09	-35.3084	150.4586	p105	0.26	g24	0.71
ELAGAR12	-35.30418	150.4661	p106	0.52	xg4	0.50
ELAGAR15	-35.30582	150.4588	p105	0.61	g27	0.29
ENPCS11	-36.12259	150.1254	p106	1.00	xg4	1.00
ESMA206	-34.08315	151.1321	p106	1.00	xg4	1.00
ESMA211	-34.0835	151.1315	p106	1.00	xg4	1.00
ESMA217	-34.06448	151.0792	p106	1.00	xg4	0.99
ESMA218	-34.06439	151.0793	p106	1.00	xg4	1.00
GARW_021	-33.77446	151.2284	p106	0.79	xg4	0.99
GARW_022	-33.75418	151.198	p105	0.39	g25	0.34
GARW_023	-33.75902	151.1893	p109	0.97	g25	0.84
JBNPCS01	-34.98603	150.7343	p106	0.49	xg4	0.98
JBNPCS02	-34.98479	150.7761	p106	0.94	xg4	1.00
JMBEN80	-36.94334	149.8781	p106	0.57	xg4	0.92
JMBEN98	-37.17504	149.9981	m15	0.96	g24	0.85
JMGUL04	-36.35897	150.0311	p107	0.80	xg4	0.65
JMGUL08	-36.36021	150.0277	p106	0.98	xg4	1.00
JMMIM05	-36.68486	149.9853	p107	0.95	g27	0.24
JMNA117	-37.50371	149.9751	p106	0.78	xg4	0.90
JMPP155	-36.70132	149.9022	e60	0.99	xg7	0.31
JMPP156	-36.8366	149.7996	e60	1.00	xg7	0.42
JMPP160	-36.72466	149.8849	e60	0.99	xg7	0.32
JMPP161	-36.72355	149.8813	e60	1.00	xg7	0.38
JMPP162	-36.72477	149.8835	e60	0.99	xg7	0.29
JMPP208	-36.42379	150.0554	p106	0.96	xg4	1.00
JMPP209	-36.41706	150.0596	p106	0.95	xg4	0.93
JMPP210	-36.73034	149.9422	p106	1.00	xg4	1.00
JMPP211	-36.71973	149.9458	p106	1.00	xg4	1.00
JMPP212	-36.71817	149.9521	p107	0.67	xg7	0.19
LIV04SCV	-33.96807	150.8702	p105	0.95	g53	0.18
MER4016T	-34.9346	150.6821	p106	0.98	xg4	1.00
MER4022C	-36.06703	150.0314	p105	0.66	g25	0.51
MER4026T	-34.8734	150.7391	p105	0.67	xg4	0.46
MER4027T	-34.87558	150.7361	p106	0.88	xg4	1.00
MER4029T	-34.79377	150.7453	p105	0.53	xg7	0.30
MOG017SW	-35.87002	150.1383	xs14	0.42	g24	0.75

Site name	Latitude	Longitude	SCIVI	SCIVI memb	Gellie	Gellie memb
MOR03Q3B	-35.93191	150.1581	p63	0.47	g25	0.57
MOR08S3D	-35.93207	150.1531	p107	0.95	g27	0.26
MOR32H3D	-35.90355	150.1479	p105	0.47	g25	1.00
MOR33H3B	-35.90829	150.1577	p105	0.73	g25	1.00
MOR53S3D	-35.93239	150.1556	p107	0.94	xg7	0.31
MRNPCS01	-36.62489	150.0133	p106	0.98	xg4	1.00
NAR16Q3C	-36.14928	150.1185	e34	0.24	g27	0.56
NNRCS09	-37.2528	149.9274	p106	0.97	xg4	0.94
NOW009LQ	-34.89732	150.6382	p105	0.94	g25	0.24
NOW010A	-34.92572	150.6523	p106	0.97	xg4	0.97
NOW011A	-34.92461	150.6481	p107	0.81	xg7	0.26
NOW018A	-34.96251	150.7483	p106	0.67	xg4	0.99
NSYD_L1	-33.81857	151.2259	p105	0.67	g25	0.90
NSYD_T1	-33.81725	151.2118	p106	0.77	xg4	0.89
PHC63A8F	-34.00827	151.0581	p105	0.63	xg4	0.35
PHC87Q7F	-34.00597	151.1674	p106	0.94	xg4	0.90
PHC89Q8F	-34.00819	151.1657	p105	0.50	g24	0.66
PHCD4D8A	-34.00794	151.1662	p63	0.28	g24	0.41
PMPAMB05	-36.94248	149.8783	p106	0.19	xg4	0.89
PMPAMB10	-36.89961	149.8784	p106	0.89	xg4	0.99
PRR59	-33.837	151.1365	p106	0.84	xg4	0.98
SALT02	-34.93681	150.6617	p106	0.99	xg4	1.00
SALT03	-34.93782	150.6759	p105	0.95	g25	0.32
SALT04	-34.94134	150.6853	p105	0.25	g27	0.30
SALT05	-34.93977	150.6628	p106	0.99	xg4	1.00
SALT09	-34.9473	150.6786	p107	0.30	g27	0.39
SALT11	-34.94216	150.6637	p105	0.81	g27	0.60
SCBRUSH1	-35.52819	150.4148	p105	0.97	g24	0.74
SPOTCS07	-36.10797	150.1211	p106	0.71	xg4	0.99
SPOTLR04	-36.15719	150.1235	p105	0.79	g25	0.30
SPOTLR06	-36.11687	150.128	p105	0.64	g25	0.21
SPOTLR08	-36.06673	150.1027	p105	0.41	xg6	0.37
SPOTSM01	-36.61918	150.0158	p106	0.55	xg4	0.99
SPOTSM02	-36.61952	150.0151	p106	0.98	xg4	0.98
SWFL207	-34.08838	151.1444	p107	0.97	xg7	0.32
WLL19A0F	-34.40693	150.8969	p105	0.86	xg4	0.87
WLLB1S7F	-34.49276	150.8462	p109	0.53	g25	0.81
WOL131	-34.49199	150.838	p106	0.83	xg4	0.99

Appendix E

Field key for identification of Swamp Oak Floodplain Forest 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. Vegetation identified as SOAK by this key may also, or alternatively depending on degree of floristic overlap, belong to other TECs, most likely Salt Marsh or Swamp Sclerophyll Forest.

1. Are at least two of the species *Casuarina glauca*, *Juncus kraussii* subsp. *australiensis, Melaleuca ericifolia, Selliera radicans* or *Samolus repens* present?

   If yes, the vegetation is SOAK, with a likelihood of 46-58%, or either SOAK or a related TEC, with a likelihood of 61-74%.
   If no, the vegetation is NOT SOAK, with a likelihood of
   incorrect diagnosis of 0-4%.