Assessment of Lowland Grassy Woodland, Brogo Wet Vine Forest and Dry Rainforest of the South East Forests TECs on NSW Crown Forest Estate

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

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1 Overview

Lowland Grassy Woodland, Brogo Wet Vine Forest and Dry Rainforest of the South East Forests are three Threatened Ecological Communities (TECs) found on the New South Wales far south coast. Broadly, they occupy dry coastal valleys and hinterland ranges below 500 metres above sea level within the South East Corner Bioregion. Two of the TECs, Lowland Grassy Woodland (LGW) and Brogo Wet Vine Forest (BWVF) are eucalypt-dominated communities characterised by *Eucalyptus tereticornis,* but are distinguished from each other by either a dry grassy ground cover or mesic elements including vines, twiners and shrubs. The third, South East Dry Rainforest (SEDRF) is a low closed forest dominated by *Ficus rubiginosa*.

We assessed whether 296,000 hectares of state forest in the South East Corner Bioregion was likely to support native vegetation that could satisfy the final determination of any of the three TECs. Assessment by the project's TEC Reference Panel (the Panel) identified a set of agreed diagnostic parameters from each determination that were used to discriminate the TECs. Our interpretation relied on comparative analysis between plots located on state forest and plots defining vegetation communities cited within the relevant final determinations. We sampled candidate areas from existing vegetation maps to identify potential areas of occurrence on state forest and undertook additional mapping work using two independent mapping methods. Random Forest models (predictive habitat models) were generated for each TEC using plot data and a selection of environmental variables. Aerial photo interpretation targeted stands of forests dominated by *Eucalyptus tereticornis* or *Ficus rubiginosa* to refine the potential boundaries of relevant TECs.

We tested whether any of the TECs were present on state forest by completing systematic plot surveys within mapped areas indicating potential presence. We compared collected data to a large regional pool of plot data that contained a subset of plots assigned to vegetation map units cited in each of the final determinations (see Gellie 2005, Tozer et al. 2010, Keith and Bedward 1999). Our analysis of data confidently assigned only a few plots present on state forest to either Lowland Grassy Woodland (6/145), Brogo Wet Vine Forest (2/43), and Dry Rainforest in the South East Corner Bioregion (2/21).

From these results, we were able to construct operational maps for Brogo Wet Vine Forest and Dry Rainforest. Our models indicate a very limited extent on state forest and the areas of candidate TEC presented photo patterns suitable for interpretation. A total of 17 hectares and 0.5 hectares respectively has been mapped for these two TECs. The results for Lowland Grassy Woodland (LGW) were less successful. Relationships between existing mapping cited in the final determinations and plot data on state forest were poor and not suitable as a basis for mapping the TEC. We also found *Eucalyptus tereticornis* could not reliably be used as an indicator of Lower Grassy Woodland (LGW) in state forests. As a result, we were unable to map this TEC from the few confirmed sampling points without including a significant area of forest that was highly unlikely to be LGW. Consequently, our LGW map is indicative only.

2 Introduction

2.1 Project rationale

The NSW Environment Protection Authority (EPA) and Forestry Corporation NSW (FCNSW) initiated this project as a coordinated approach to resolve long-standing issues surrounding the identification, extent and location of priority NSW Threatened Ecological Communities (TECs) that occur on the NSW state forest estate included within the eastern Regional Forest Agreements.

2.2 Final determinations

This report covers three Threatened Ecological Communities (TECs) found on the far south coast of NSW: Lowland Grassy Woodland (LGW), Brogo Wet Vine Forest (BWVF) and Dry Rainforest of the South East Corner Bioregion (DYRF).

BWVF and DYRF were first gazetted as an Endangered Ecological Communities in November 2000 (NSW Scientific Committee 2000a, 2000b), and LGW was first gazetted in August 2007 (NSW Scientific Committee 2007). The provenance of these final determinations is a study of native vegetation in the Eden region by Keith and Bedward (1999). Lowland Grassy Woodland was originally described as ‘Bega Dry Grass Forest’ and ‘Candelo Dry Grass Forest’, these being gazetted in November 2000. It underwent significant revisions in 2007 to expand the distribution and species characteristics and was renamed. BWVF and DYRF have remained unchanged, although minor amendments have been made to each of the determinations in late 2011.

Paragraph 1 in both BWVF and DYRF cite Keith and Bedward (1999) as the primary source of the descriptive information provided in the final determinations for these TECs. Lowland Grassy Woodland cites additional sources from a greater number of studies, notably Gellie (2005) and Tozer et al. (2010). All cited references are accompanied by descriptions and map products.

Paragraph 5 of both LGW and BWVF include statements to aid field identification, in particular the dominance of forest red gum (*Eucalyptus tereticornis*).

Paragraph 4 (BWVF) and Paragraph 5 (DYRF) include statements that suggest that these TECs are restricted to Bega Valley Local Government Area (LGA).

2.3 Initial TEC Reference Panel interpretation

Under the *Threatened Species Conservation (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 Lowland Grassy Woodland is constrained to the IBRA Bioregions stated in the final determination. The Panel also agreed that both Brogo Wet Vine Forest and Dry Rainforest of the South East Forests are constrained by the bioregions stated in the determination, but noted that it remained ambiguous as to whether these two TECs should be constrained to the Bega Valley LGA. The Panel agreed that in this instance, the broader of the areas used to circumscribe the TECs should apply.

The Panel agreed that LGW, BWVF and DYRF are TECs that have 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 determinations. From the final determination, Tables 1, 2 and 3 summarise the key determining features of each of the TECs 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 Lowland Grassy Woodland 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 within the South East Corner Bioregion	Explicitly diagnostic
1	Occurs in rain shadow areas of the south coast and hinterland. Rainfall typically in the range of 700-1100 mm per annum	Indicative only
1	Typically occurs on undulating terrain up to 500 metres elevation on granitic substrates. May also occur on locally steep sites and on acid volcanic and fine grained sedimentary substrates	Indicative, not used
1	Typically comprises an open tree canopy, a near continuous ground cover of grasses and herbs, sometimes with layers of shrubs and/or small trees. Undisturbed stands may have a woodland or forest structure. Small trees or saplings may dominate the community in relatively high densities after clearing	Indicative, not used
1,4	The community includes derived native grasslands which result from removal of woody strata from the woodlands and forests	Potentially diagnostic in areas of suitable habitat
2	Characterised by the listed 115 plant species including 6 eucalypt species	Potentially diagnostic. in the context of previously described communities cited in the final determination
4	Description of overstorey characteristics. Lowland Grassy Woodland is usually dominated by *Eucalyptus tereticornis* (Forest Red Gum), often with *Eucalyptus globoidea* (White Stringybark) and/or *Angophora floribunda* (Rough-barked Apple) and other eucalypts at some sites. For example, *Eucalyptus melliodora* (Yellow Box) and *E. pauciflora* (White Sally) may be locally common within the community. Other tree species include *E. baueriana* (Blue Box), *E. bosistoana* (Coastal Grey Box) and *E. maidenii* (Maiden's Blue Gum), which may occur in transitional stands with adjacent communities in which they are more common, and *E. viminalis* (Ribbon Gum) associated with lower slopes adjacent to major streamlines	Indicative only, not used. The Panel noted that several species identified as important in Paragraph 4 e.g. *Angophora floribund*a and *Eucalyptus pauciflora* are not included in the species assemblage list in Paragraph 2
4	Description of understorey characteristics including 6 shrub species, 4 grass species and 6 ground cover species	Indicative only, not used. The panel noted that dominance of ground cover composition is assigned to grass species
5	Bega Dry Grass Forest (map unit 20) and Candelo Dry Grass Forest (map unit 21) of Keith and Bedward (1999); those parts of South Coast Grassy Woodland (map unit 34) of Tindall et al. (2004) in the South East Corner bioregion; Bega Valley Shrub/Grass Forest (Vegetation Group 52), and those parts of Southern Escarpment Herb/Grass Dry Forest (forest ecosystem 50) and Far South Coast Forest Red Gum Grass/Herb Dry Forest/Woodland (Vegetation Group 54) that occur within the South East Corner bioregion (all as in Thomas, Gellie & Harrison 2000 and Gellie 2005); and Far South Coast Grassy Woodland of Tozer et al. (2010)	Used as the main comparative diagnostic feature, including qualifications of individual communities constrained to the South East Corner Bioregion

	Feature	Diagnostic value and use for this assessment
5	May usually be distinguished from other assemblages in the South East Corner bioregion by the current or former dominance of *Eucalyptus tereticornis,* a grassy ground cover dominated by *Themeda australis* with *Microlaena stipoides*, and other species listed in paragraph 2. However, *E. tereticornis* is absent from some stands of the community which may include Angophora floribunda*, E. melliodora, E. pauciflora* or lack trees altogether	Indicative only, used to refine searches for candidate stands of this EEC

<u>Table 2:</u> Key features of Brogo Wet Vine 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 within the South East Corner Bioregion	Explicitly diagnostic
1	Is the name of a forest type described by Keith and Bedward (1999). Further details may be found in this paper	Used as the main comparative diagnostic feature. Additional information adopted from cited paper
2	The upper storey of the forest is dominated by *Eucalyptus tereticornis* with occasional *Eucalyptus bosistoana* and *Eucalyptus baueriana*, with rainforest elements such as *Alectryon subcinereus* and *Ficus rubiginosa*	Explicitly diagnostic for *Eucalyptus tereticornis*
2	Understorey description includes 5 shrub species, a statement indicating a highly diverse ground cover species assemblage and the identification of 5 species of vines or twiners	Indicative, not used
2	Characterised by the listed 39 plant species including 5 eucalypt species.	Potentially diagnostic. in the context of previously described communities cited in the final determination
5	Brogo Wet Vine Forest is distinguished from other communities in the south east forests of New South Wales by the dominance of *Eucalyptus tereticornis* and the abundance of mesophyll shrubs and vines	Explicitly diagnostic
4	Brogo Wet Vine Forest is found in the Brogo - Bega Area and the Candelo - Myrtle Area in the Bega Valley Local Government Area	Potentially diagnostic, the panel chose to accept that the bioregion overrode the conflict with the qualifier restricting the distribution to the LGA
5	The majority of the community is found on private land	Indicative only

<u>Table 3:</u> Key features of Dry Rainforests of the South East Forests of potential diagnostic value, Numbers in the left-hand column refer to paragraph numbers in the final determination.

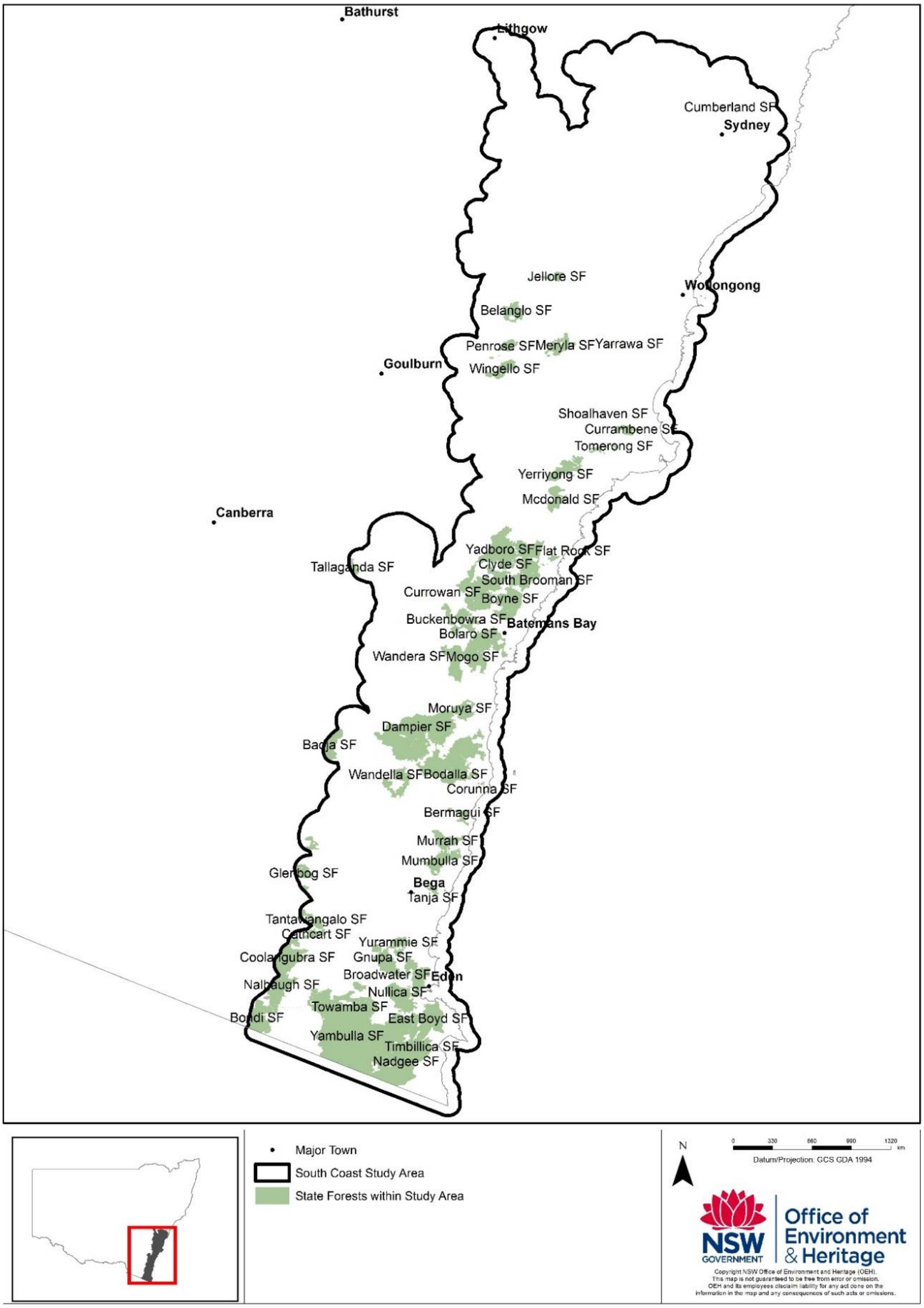
	Feature	Diagnostic value and use for this assessment
1	NSW occurrences fall within the South East Corner Bioregion	Explicitly diagnostic.
1	Dry Rainforest of the South East Forests is the name given to a forest community described by Keith and Bedward (1999).	Used as the main comparative diagnostic feature
2	The community is a rainforest with a dense canopy to 10 m tall with occasional emergent eucalypts. The upper storey is dominated by *Ficus rubiginosa* with occasional *Pittosporum undulatum* and *Brachychiton populneus* and scattered emergent eucalypts	Explicitly diagnostic using the dominance of *Ficus rubiginosa* and rainforest tree height. Other species indicative.
2	The sparse understorey shrub layer includes *Alectryon subcinereus, Notelaea venosa* and *Hymenanthera dentata, Dendrocnide excelsa* and *Deeringia amaranthoides* may be locally common in the northern part of the range.	Indicative, not used
2	The ground cover is patchy with scattered patches of *Plectranthus graveolens* and *Sigesbeckia orientalis*, with the fern *Pellaea falcata* var. *falcata* and grass *Oplismenus imbecillis* among rocks	Indicative, not used
3	Characterised by the listed 25 plant species including 3 eucalypts.	Potentially diagnostic. in the context of previously described communities cited in the final determination
5	Dry Rainforest of the South East Forests is found between Cobargo and Bega, south of Candelo and in the upper Towamba Valley, all in the Bega Valley Local Government Area, on steep upper granite slopes or heads of north facing gullies. A small stand may also occur in the Araluen Valley (Austin & Sheaffe, 1976).	Potentially diagnostic, the panel chose to accept that the bioregion overrode the conflict with the qualifier restricting the distribution to the LGA.
6	Most Dry Rainforest is restricted to small patches of less than 10 ha. Some stands occur in Coolangubra National Park but much of the Dry Rainforest is on private land.	Indicative only

2.4 Assessment area

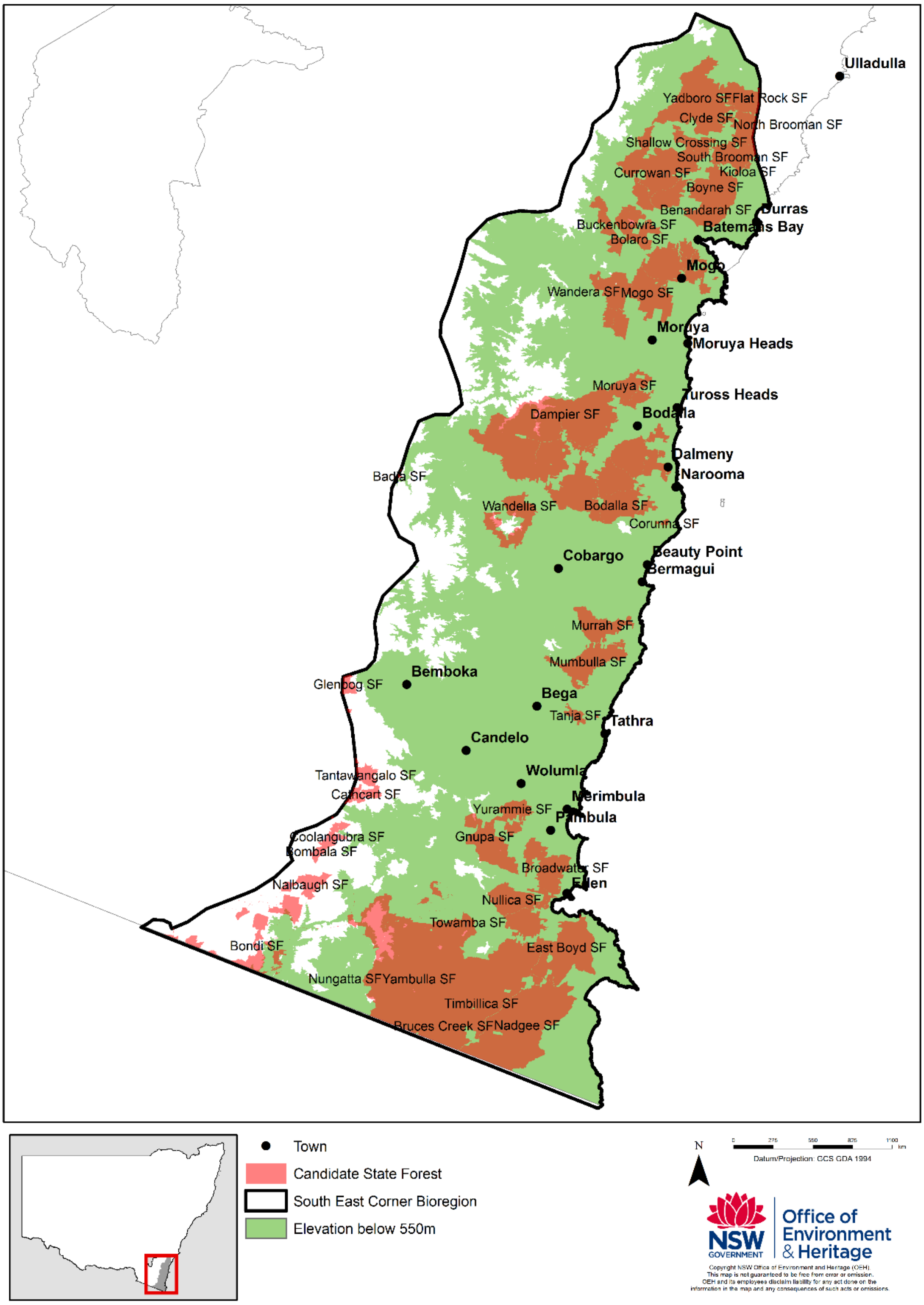
2.4.1 Location and study area boundaries

Our study area is shown in Map 1. This area covers all IBRA subregions south from the Hawkesbury River in the Sydney Basin Bioregion, a five kilometre wide perimeter zone on these areas, and areas below 250 metre elevation in river valleys of the 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. For this assessment, we focus on the South East Corner Bioregion (Map 2) as each of the TECs considered are constrained to this boundary.

Map 1: South Coast study area



Map 2: **South East Corner Bioregion Assessment Area showing candidate state forests and elevation threshold of 550m.**



2.4.2 State forests subject to assessment

The study area includes all Crown Forest estate situated within the Southern and Eden Integrated Forestry Operations Approval (IFOA) regions and the South East Corner Bioregion. Forty-one state forests were included in this assessment (Table 4), covering 296,496 hectares. State forests excluded from the assessment include those areas defined as Forest Management Zone 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 the authority of the IFOA.

Table 4: List of candidate state forests assessed within the South East Corner Bioregion.

State Forest (SF)	Area (ha)	State Forest	Area (ha)
Badja SF	59	Mogo SF	15,499
Benandarah SF	2,760	Moruya SF	4,060
Bodalla SF	24,060	Mumbulla SF	6,147
Bolaro SF	1,779	Murrah SF	4,221
Bombala SF	339	Nadgee SF	20,603
Bondi SF	6,772	Nalbaugh SF	2,281
Boyne SF	6,160	North Brooman SF	2,824
Broadwater SF	168	Nullica SF	18,344
Bruces Creek SF	793	Nungatta SF	889
Buckenbowra SF	5,192	Shallow Crossing SF	3,854
Cathcart SF	1,544	South Brooman SF	4,544
Clyde SF	3,586	Tanja SF	868
Coolangubra SF	1,889	Tantawangalo SF	1,446
Corunna SF	184	Timbillica SF	9,173
Currowan SF	11,974	Towamba SF	1,638
Dampier SF	33,766	Wandella SF	5,497
East Boyd SF	21,070	Wandera SF	5,199
Flat Rock SF	3,251	Yadboro SF	10,745
Glenbog SF	940	Yambulla SF	46,882
Gnupa SF	1,321	Yurammie SF	4,059
Kioloa SF	116	Total	296,496

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   Authority under the oversight of the Director, Forestry Branch.

The project was managed by Daniel Connolly. Doug Binns undertook the floristic analysis of survey plots and interpreted the relationships and relatedness between relevant vegetation communities. Allen McIlwee performed the spatial analysis and broad scale predictive distribution modelling. Owen Maguire undertook API mapping using 3D stereo imagery across the study area. Jackie Miles and Paul McPherson completed flora survey plots with assistance from Paula Pollock.

Body text – use body text style rather than ‘Normal’ style – Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived

3 Methodology

3.1 Approach

Analysis and mapping were guided by the general principles and particular interpretation of TECs adopted by the TEC Reference Panel, as described in Section 2.3. For the purpose of this project, all three TECs were interpreted to be defined primarily by floristic plot data previously allocated to vegetation communities which have been described from quantitative floristic analysis, and which have been explicitly listed in respective final determinations. An exception was Lowland Grassy Woodland, which included two cited communities that are explicitly restricted by the determination to the South East Corner Bioregion. Statements from each of the determinations provide the basis for comparative analysis and have been listed in Tables 1-3. However, in each case, the cited studies have been superseded by more recent studies using a larger pool of data, but maintaining the previously defined communities and units or their equivalent. For our analyses, we used results from these more recent studies, as described in Section 3.3.1

Plots in which standard floristic data have been collected (comprising data already held in the OEH VIS flora survey database over all tenures and data collected specifically for this project in state forests) were compared with plots assigned to previously defined communities of relevance to the final determinations. Dissimilarity-based methods were used as a basis for comparison. 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 one of the three TECs). Options for different methods and thresholds represent narrower or broader interpretations of TECs, but this approach using plot-based floristic comparison provides a means of consistently allocating plots to being either TEC or not for a range of interpretation options.

3.2 Existing vegetation data

3.2.1 Vegetation classification

The three classifications cited in the final determinations which are most relevant to each of the TECs in state forests south of Sydney are those of Keith and Bedward (1999), Thomas, Gellie & Harrison (2000) and Tindall et al. (2004). Subsequent to the determination, each of these studies has been superseded by more recent studies using a larger pool of data; Gellie (2005) in place of Thomas, Gellie & Harrison (2000), and Tozer et al. (2010) in place of Keith and Bedward (1999) and Tindall et al. (2004). 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 5.

Table 5: Communities defined from recent analyses that are equivalent to those cited in the south coast final determinations.

TEC	Community listed in final determination	Recent equivalent publication	Meets definition of TEC when:
Dry Rainforest of the South East Forests	Map Unit 1 Dry Rainforest (Keith and Bedward 1999)	RF e1 Southeast Dry Rainforest (Tozer et al. 2010)	All
Brogo Wet Vine Forest	Map Unit 18 Brogo Wet Vine Forest	e18 Brogo Wet Vine Forest (Tozer et al. 2010)	All

TEC	Community listed in final determination	Recent equivalent publication	Meets definition of TEC when:
Lowland Grassy Woodland	Bega Dry Grass Forest (map unit 20) and Candelo Dry Grass Forest (map unit 21) of Keith and Bedward (1999)	E20/p229 Southeast Lowland Grassy Woodland (Tozer et al. 2010)	All
	those parts of South Coast Grassy Woodland (map unit 34) of Tindall et al. (2004) in the South East Corner bioregion	E20/p229 Southeast Lowland Grassy Woodland (Tozer et al. 2010)	All
	Far South Coast Grassy Woodland of Tindall et al. (2004)	E20/p229 Southeast Lowland Grassy Woodland (Tozer et al. 2010)	All
	Bega Valley Shrub/Grass Forest (Vegetation Group 52) (all as in Thomas, Gellie & Harrison 2000 and Gellie 2005)	N/A	All
	and those parts of Southern Escarpment Herb/Grass Dry Forest (forest ecosystem 50) and Far South Coast Forest Red Gum Grass/Herb Dry Forest/Woodland (Vegetation Group 54) that occur within the South East Corner bioregion (all as in Thomas, Gellie & Harrison 2000 and Gellie 2005)	N/A	In South East Corner Bioregion only

3.2.2 Vegetation data

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

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

A total of 15,487 plots within the study area, including 246 plots surveyed specifically for our TEC project, were in the OEH VIS Flora Survey Database at 22 April 2016. Of these, 8432 plots had floristic data suitable for analysis.

3.2.3 Analysis data set

We chose our pool of data to ensure that it included all plots that had previously been allocated to any community that we considered relevant to either the LGW, BWVF and DYRF TECS, or to any of the other coastal TECs covered by our broader project. It included all other plots that had not previously been analysed or allocated to a community in a regional study. Plots from our study area dataset were omitted if they had previously been allocated to communities that 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 m;
- 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 final determinations;
- communities that were clearly floristically and environmentally distinct from communities of interest.

Appendix A lists all communities from which plot data were included.

3.2.4 Data preparation and taxonomic review

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

3.3 Identifying candidate areas of TECs on state forest

3.3.1 Existing information

We identified an initial list of state forests that may support candidate areas of any of the three TECs by applying diagnostic filters based on statements in the final determinations relating to bioregion, elevation and existing vegetation maps. We identified those state forests located below an elevation threshold of 550 metres above sea level. We identified other potential areas by overlaying the cited vegetation maps (see Gellie 2005 and Tozer et al. 2010) and Forest Types (Forestry Commission 1984) dominated by or including *Eucalyptus tereticornis* (FT65, 92 or 93) which suggested a possible relationship to Lowland Grassy Woodlands or Brogo Wet Vine Forest

3.3.2 Aerial photograph interpretation

Two of the three TECs (LGW and BWVF) make reference to the dominance of *Eucalyptus tereticornis* as a distinguishing feature of the assemblage. The third TEC, DYRF, describes a low closed forest dominated by *Ficus rubiginosa*.

We used aerial photo interpretation (API) to identify structural characteristics and overstorey and understorey attributes to identify candidate areas likely to support the TECs. An API technician, 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 assess observable patterns in canopy species dominance, understorey characteristics and landform elements across all candidate forests within the South East Corner Bioregion. The interpreter sought to identify forest stands dominated by or including *Eucalyptus tereticornis,* and assessed whether the forest was open and grassy or whether mesic shrubs or figs were visible as sub canopy species. In addition, stands of rainforests of low height and/or dominated by the distinctive sprawling canopies of *Ficus rubiginosa* were also mapped.

Detailed aerial photograph interpretation was completed across the state forests set out in Table 6. The interpreter adopted a viewing scale between 1:1000 and 1:3000 to mark boundaries to infer changes in canopy and/or understorey composition. The interpreter used available substrate maps, floristic data showing known locations of each of the TECs and indicative TEC models to identify suitable vegetation patterns on and adjoining state forest boundaries. Tracks and trails data was used to identify access points for field traverse.

A minimum polygon size of 0.5 hectares was used as a guide for detection and delineation of eucalypt stands dominated by *Eucalyptus tereticornis* or *Ficus rubiginosa*. The interpreter derived a digital map of likely areas and then completed field traverses to relate field observations to image patterns. Interpreted lines and polygons were adjusted as required. Each mapped polygon discriminating *E. tereticornis* was also assessed and attributed to describe broad understorey characteristics and interpretation confidence (Tables 7 and 8).

Table 6: State forests subject to assessment using aerial photograph interpretation.

State Forest	LGW	BWVF	DYRF
Nalbaugh State Forest	✓	✓	✓
Bondi State Forest	✓	✓	✓
Bateman State Forest	✓	✓	
Benandarah State Forest	✓	✓	
Bermagui State Forest	✓	✓	✓
Bodalla State Forest	✓	✓	✓
Bolaro State Forest	✓	✓	
Bondi State Forest		✓	✓
Boyne State Forest	✓		
Broadwater State Forest		✓	✓
Bruces Creek State Forest		✓	✓
Buckenbowra State Forest	✓	✓	✓
Corunna State Forest	✓	✓	✓
Currowan State Forest	✓		
Dampier State Forest	✓	✓	✓
East Boyd State Forest		✓	✓
Gnupa State Forest	✓	✓	✓
Mogo State Forest	✓	✓	✓
Moruya State Forest	✓	✓	✓
Mumbulla State Forest	✓	✓	✓
Murrah State Forest	✓	✓	✓
Nadgee State Forest		✓	✓
Nalbaugh State Forest		✓	✓
North Brooman State Forest	✓		
Nullica State Forest	✓	✓	✓
Nungatta State Forest		✓	✓
South Brooman State Forest	✓		

State Forest	LGW	BWVF	DYRF
Tanja State Forest	√	√	√
Timbillica State Forest		√	√
Towamba State Forest	√	√	√
Wandella State Forest	√	√	√
Wandera State Forest	√	√	√
Yambulla State Forest		√	√
Yurammie State Forest	√	√	√

Table 7: Understorey classes assessed during API mapping.

Understorey Class	Description
M1	Open understorey, based on high reflectance from sparse or grassy ground cover
M2	As above but with dry shrubs and small trees visible
M3	Lower reflectance and dense dry shrubs
M4	Mesic elements visible and clear evidence of higher soil moisture as a result of increase fertility or shelter
M5	Rainforest elements clearly visible including closed sub canopy.

Table 8: Confidence classes assigned during API mapping.

Confidence Class	Description
1	High: visited areas and/or photo patterns are high contrast features that are separable on structural characteristics and require limited interpretation
2	High-Medium: Confident Extrapolation based on field sampling where interpretability of features is high and consistent with patterns confirmed elsewhere through field sampling
3	Medium-Low: Not visited. Similarity with features sampled elsewhere, but species interpretation not always possible or inconsistent resulting in some uncertainties. Environmental niche important indicator of species composition
4	Low: Remote or Unvisited area showing photo pattern inconsistent with features sampled elsewhere, low confidence in species interpretation, and represents best call using available classes and known habitat relationships.

3.4 New survey effort

3.4.1 Survey stratification and design

We adopted a targeted field survey method to assess the presence of the TECs based on the predicted occurrence of each using the compilation of existing maps, new API work and predictive models. Survey effort was conducted in phases as new information became available. The targeted approach was required because the predicted spatial pattern for the TECs suggested a small, patchy and isolated distribution on state forest tenure.

We aimed to sample all areas of existing mapping that contained no existing samples and were reasonably accessible (within 1.5 kilometres from a trail). We ensured that any areas on state forest identified from predictive models were sampled where these were greater than one hectare in size. We targeted a random subset of mapped API polygons characterised by the presence of one of the prescribed canopy attributes in each of the state forests where they occurred.

3.4.2 Survey method

Systematic surveys

Systematic flora surveys 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 at 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 9.

Table 9: Braun-blanquet-to-cover abundance conversion table.

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

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

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 classifications require use of the same measures. Relationships among plots vary depending on the data pool used, so that introducing additional data may change the composition of previously defined groups.

Most clustering methods result in a plot being allocated to a single vegetation community. A plot may also be related to other communities, but these interrelationships are not evident from allocations. As an alternative, fuzzy clustering methods assign a membership value to each plot for each community, which provides a measure of the likelihood that a plot belongs to any particular community. For this project, Noise Clustering (De Cáceres, Font, & Oliva 2010; Wiser & De Cáceres 2013), was selected as the most appropriate fuzzy clustering method for three reasons:

1. it allows specification of fixed clusters defined from previously described groups and provides direct allocations to those groups,
2. 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
3. it is robust to the prevalence of transitional plots with relationships to two or more previously defined communities.

The latter are both characteristics of data for the study area. Noise Clustering requires specification of a fuzziness coefficient (where a coefficient of one 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) or Keith and Bedward (1999), plus previously unallocated plots in state forest and new plots 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, Gellie & Harrison (2000) and which were explicitly listed in the final determination.
2. A subset of 2708 plots, which comprised all plots previously allocated to a relevant vegetation group by Tozer et al (2010) or the parent classification, plus previously unallocated plots in state forest and new plots surveyed for this project. Relevant vegetation groups are listed in Appendix A. This provided an assessment of the membership of all state forest plots to communities which could be related to those defined by Tindall et al. (2004) and Keith & Bedward (1999) which were explicitly listed in the final determination.

3. A subset of 8452 plots comprising all suitable plots available in VIS up to 20 June 2016 which had either previously been allocated to a relevant community by Gellie (2005), Keith and Bedward (1999) 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 one and two. Two fuzzy clustering analyses were applied to this subset, one using Gellie (2005) and Keith and Bedward (1999) 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 Allocation of standard floristic plots to TECs and other communities

We assessed plots as being one of the three TECs if their membership of any floristic community defined by Gellie (2005), Keith and Bedward (1999) or Tozer et al. (2010) and equivalent to a community cited in the final determination (we will refer to these as TEC communities) was 0.5 or above and they met the qualifying condition for that community. For LGW we assigned plots that met our threshold of 0.5 against community g171 (Thomas, Gellie & Harrison 2000) on the basis that it is strongly related to the determination assemblage list although it is not cited.

We assessed an additional six new plots targeting BWVF and DYRF collected after our analysis by applying the diagnostic test described in Tozer et al. (2010). Plots were assigned if they exceeded the minimum number of diagnostic species required for a match to the parent communities used to define BWVF and DYRF.

3.5.3 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

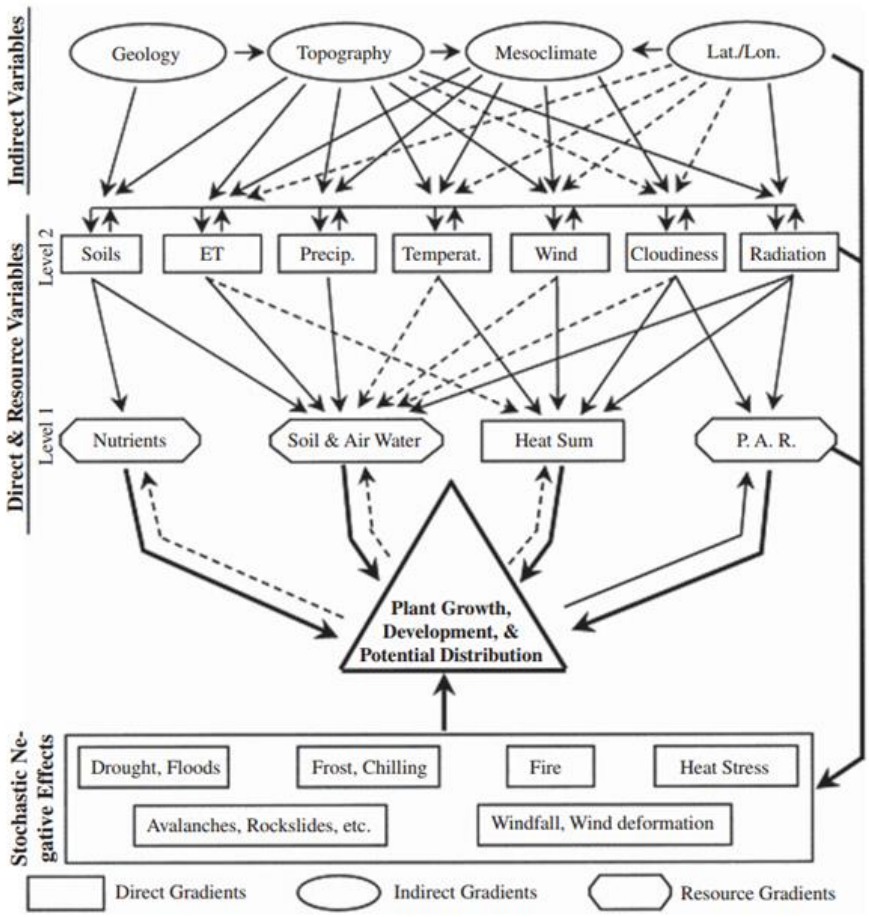
3.6.1 Background

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

Modelling the distribution of a TEC requires the characterisation of 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 narrow set of favourable environmental conditions that are not occupied by other vegetation communities. Nonetheless, without API and associated on-ground validation, it is difficult to determine the extent to which potentially suitable habitat is actually occupied by the TEC.

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). Austin and Smith (1990) differentiate between indirect gradients, which have no physiological effects on plants, and direct or resource gradients, which directly influence plant growth or distribution. Direct or resource gradients mainly concern light, temperature, water and nutrients, whereas the main indirect gradients are altitude, topography and geology (Austin & Van Niel 2011). An environmental variable may act both as a resource that provides building blocks for growth processes and as a condition that fulfils the requirements for physiological processes to function effectively.

Diagram 2 provides a basic conceptual framework for how plant communities are likely to respond to their environment. Arrows in the figure show how particular indirect variables interact to generate more direct environmental drivers through biophysical processes. Stochastic processes such as extreme heat or cold, landslip or erosion, high winds, drought, flood and fire also influence plant distributions. However, in niche modelling, we assume that the composition of vegetation is primarily determined by environment rather than successional status or by time since last disturbance (Franklin 1995). It is also assumed that vegetation is in equilibrium with the environment, or at least a quasi-equilibrium where change is slow relative to the life span of the biota.



<u>Diagram 2</u>: Conceptual model of relationships between resources, direct and indirect environmental gradients and their influence on growth, performance and geographical distribution of plants and vegetation communities in general. Source: Guisan and Zimmermann 2000 (Figure 3).

Diagram 3 provides an overview of the step-by-step modelling process, which involves a 'classification-then-modelling' approach (Ferrier et al. 2002) with two distinct stages. In the first stage, the biological survey data are subjected to a vegetation classification and full-floristic vegetation plots are allocated to presence/absence category for each TEC. This classification is run without any reference to the environmental data. In the second stage, the community-level TEC entities defined by the classification are modelled as a function of environmental predictors. Each of the TEC communities have been modelled separately by relating the observed presence or absence of the community to available environmental predictors. Alternatively, it is possible to fit a model to all communities simultaneously by treating community membership as a multinomial response (e.g. using multinomial boosted regression trees).

The statistical model refers to the choice of (i) a suitable machine-learning algorithm for predicting a presence-absence response variable and its associated theoretical probability distribution, and (ii) choice of an appropriate variable selection procedure that either has the goal of optimising prediction accuracy or interpretability.

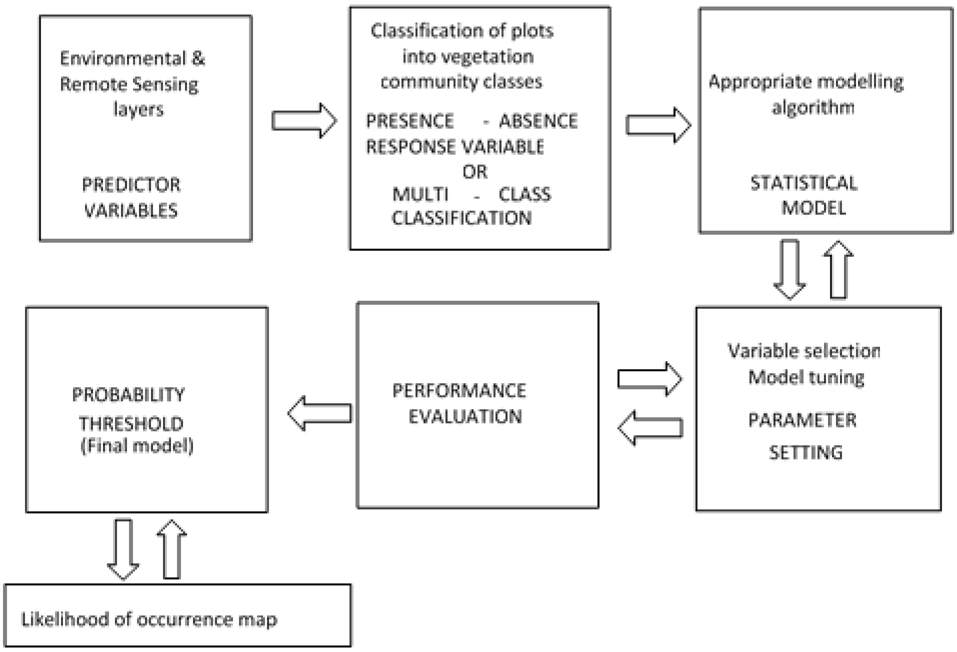


Diagram 3: Process for creating indicative TEC distribution maps

3.6.2 Modelling complex ecological systems

The niche modelling community has made considerable headway in developing machine-learning algorithms to predict the occurrence of species and communities using presence-absence data (Evans & Cushman 2009). The methods model vegetation patterns as continuous measures of site suitability or probability of occupancy. Non-parametric approaches such as Classification and Regression Trees (CART) have gained widespread use in ecological studies (De'ath & Fabricius 2000). However, CART suffers from problems such as over-fitting and difficulty in parameter selection. Solutions to deal with these issues have been proposed that incorporate iterative approaches (Breiman 1996). One approach, Random Forests (Breiman 2001) has risen to prominence due to its ability to handle large numbers of predictors and find signal in noisy data (Cutler et al. 2007). Another advantage of Random Forests is that, by permutation of independent variables, it provides local and global measures of variable importance.

Random Forests is an algorithm that developed out of CART and bagging approaches. By generating a set of weak-learners based on a bootstrap of the data, the algorithm converges on an optimal solution while avoiding issues related to CARTs and parametric statistics (Cutler et al. 2007). Ensemble-based weak learning hinges on diversity and minimal correlation between learners. Diversity in Random Forest is obtained through a Bootstrap of training, randomly drawing selection of *M* (independent variables) at each node (defined as *m*), and retaining the variable that provides the most information content. To calculate variable importance, improvement in the error is calculated at each node for each randomly selected variable and a ratio is calculated across all nodes in the forest.

The algorithm can be explained by:

1. Iteratively construct *N* Bootstraps (with replacement) of size *n* (36%) sampled from *Z*, where *N* is number of Bootstrap replicates (trees to grow) and *Z* is the population to draw a Bootstrap sample from.
2. Grow a random-forest tree T_b at each node randomly select *m* variables from *M* to permute through each node to find best split by using the Gini entropy index to assess information content and purity. Grow each tree to full extent with no pruning (e.g., no complexity parameter).
3. Using withheld data (OOB, out-of-bag) to validate each random tree T_b (for classification OOB Error; for regression pseudo R^2 and mean squared error).
4. Output ensemble of random-forest trees

$$\{T_b\}\frac{B}{1}$$

To make a prediction for a new observation x_i:

Regression:

$$\hat{f}_{\mathrm{rf}}^{B}(x) = \frac{1}{B}\sum_{b=1}^{B} T_b(x)$$

Classification: Let $\hat{C}_b(x)$ be the class prediction of the *B*th random-forests tree then

$$\hat{C}_{rf}^{B}(x) = \text{majorityvote}\left\{\hat{C}_b(x)\right\}\frac{1}{B}$$

Commonly, the optimal *m* is defined for classification problems as sqrt (*M*); and for regression *M*/3, where *M* is a pool of independent variables. It is widely recognised that Random Forest is robust to noise even given a very large number of independent variables (Hastie, Tibshirani & Friedman 2009).

All Random Forest modelling was performed in the statistical software package R version 3.3.0.

3.6.3 Spatial data and the variable selection process

A set of 175 variables were available for modelling. These include a set of

- 130 continuous environmental variables relating to climate, topography and Euclidean distance to features such as the coastline, permanent water bodies and various stream orders,
- 32 variables derived from Landsat and Spot 5 imagery, and

- 13 categorical variables such as great soil group and single dominant lithology type, which were extracted from state-wide corporate GIS layers.

All variables were in the form of gridded Erdas Imagine rasters (*.img), with exactly the same cell size (30 x 30 metre) and extent.

The raster layers were stacked in R using the Raster Package (Hijmans and van Etten 2014). The grid cell values for each of the 175 potential predictor variables were extracted for each site in the allocation file using a customised script in R, and the resulting csv file loaded into R. To improve model fit we tested for multicollinearity between the site values across the predictors using the "multicollinear" function in the rfUtilities library using a significance value of 0.001. To check whether the collinear variables were in fact redundant, we performed a "leave one out" test that identifies whether any variables are forcing other variables to appear multicollinear.

Random Forest models are a good starting point for making inferences about the factors driving the distribution of a plant species or ecological community. However, they are data driven models, whose purpose is to give the best possible predicted extent for the data available and the complexity of spatial pattern. Variable selection is a crucial step in the modelling process. We used a variable selection procedure developed by Murphy, Evans and Storfer (2010) which standardises the relative importance values of predictors to a ratio and iteratively subsets variables within a given ratio, running a new model for each subset of variables. Each resulting model is compared with the original model, which is held fixed. Model selection is achieved by optimising model performance based on a minimisation of both "out-of-bag" error and largest "within-class" error for classification. There is also a penalty for the number of variables selected in a model, resulting in a preference for the lowest number of predictors from closely competing models.

For each model generated, we also checked whether the shape of the fitted functions made sense based on our knowledge of the types of environments that the TECs occupy. When a TEC did not model well into the environments where we expected it to occur, we went back and re-examined the site allocation, and made a decision on whether to split the TEC into different communities or sub-types, that each may respond to different environmental drivers.

We ran preliminary Random Forest models using three types of predictor sets. The first used the full set of continuous environmental variables, with the aim of predicting the potential distribution (realised niche) of the TEC in its broadest sense. The second used a combination of continuous environmental and remote sensing variables. The inclusion of remote sensing variables added information about the spectral characteristics of vegetation at a site and its dynamics through time, giving a better reflection of the actual distribution of the TEC as opposed to the potential distribution of the TEC. Categorical variables were not incorporated into the models directly, but the data were occasionally used to compare frequency histograms across presence and absence sites to see if a distinct preference for a particular soil type or fertility class existed. However, given that the number of absence sites greatly outnumbered the presence sites, there was generally insufficient data to draw conclusions about preferences for one group of soil classes over another.

Through a series of initial trials, we found a third hybrid approach produced the best set of predictors for modelling. Here we used the variable selection process described above to identify a subset of 30 environmental predictors out of the 130 available. We then added the 32 remote sensing variables and reran the same variable selection process, selecting out two subsets, one with 15 and the other with 30 predictors. These numbers were set *a priori* since previous modelling had suggested that a minimum of around 12 predictors (those with the highest relative influence values) was generally needed to get a levelling out of the performance curves (see below). Beyond this stabilisation point, one could double or triple the number of predictors in a model, but this would have little effect on overall performance since the new predictors tended to have a very small influence on the model.

3.6.4 Model performance and TEC-habitat relationships

As a means to assess model performance, we plotted the predicted probability of occurrence (PO) values for all plots allocated to a TEC (in descending order) against the same number of highest ranked absence plots. A good model was defined as having high PO values across the majority of TEC presence sites, dropping sharply at the end for those plots that occupy marginal environmental space (these could potentially be misclassified false positives). If there was no overlap in PO values for the lowest ranked presence sites and the highest ranked absence sites, performing a classification using any number between these two values would result in the correct prediction of 100% of presence and absence sites. In such a case, there was no need to present a confusion matrix describing the percentage of sites correctly classified.

In most cases, environmental variables strongly dominated the set of 15 predictors, although occasionally one or two remote sensing variables were included. However, in the set of 30 predictors, it was common for the number of the original environmental variables to reduce and be replaced with remote sensing variables. We found that models with 15 predictors generally had very good performance with 100% of sites allocated to the TEC and 100% of absence sites correctly classified. However, we also found that doubling the number of predictors generally resulted in a better model. Although a tighter fitting, finer threaded potential distribution map was produced, it was sometimes unclear as to whether the additional variables picked up important variation not captured in the main set of 15 predictors, or whether they simply account for noise in the dataset.

To understand and evaluate the habitat relationships for each TEC, we used a combination of the scaled variable importance values for predictors and shape of the response functions in partial plots as a measure of the strength and nature of interactions.

3.6.5 Spatial interpolation

We used the Random Forest models with 16 and 31 variables to generate two 30x30 metres probability of occurrence maps for each TEC. From the performance plots described above, we selected a threshold just below the maximum PO across all absence sites to represent the cut off above which the TEC has the potential to occur and below which, we assumed the TEC is absent.

3.7 Operational TEC maps

We used the API line work in combination with floristic plot data (both full and partial floristic plots) and our predictive habitat models to identify the locations and extent of BWVF and DYRF.

For LGW we were unable to demonstrate a strong relationship between our mapping and plots assigned to the TEC. We chose to construct an indicative map by combining all our mapped evidence from both API and our predictive model. The final indicative map highlights areas within state forests that represent higher likelihoods of occurrence.

3.8 Validation

We did not conduct any formal validation of our mapping of any of the TECs subject of this assessment because the areas of all three TECs are highly restricted on state forest tenure.

4 Results

4.1 Survey effort

Within our study area there were 8452 standard full-floristic plots in the OEH VIS database, all of which we used for our initial analysis and 812 of which are in state forest. This includes 266 plots that were surveyed specifically for our project. We completed 15 standard full floristic plots in state forests that targeted candidate Lowland Grassy Woodland, seven plots for Brogo Wet Vine Forest and five for Dry Rainforest of the South East Forests. We supplemented these with an additional 312 samples where rapid surveys collected partial floristic data across the project for all TECs and 179 additional observation points targeting *E. tereticornis* stands.

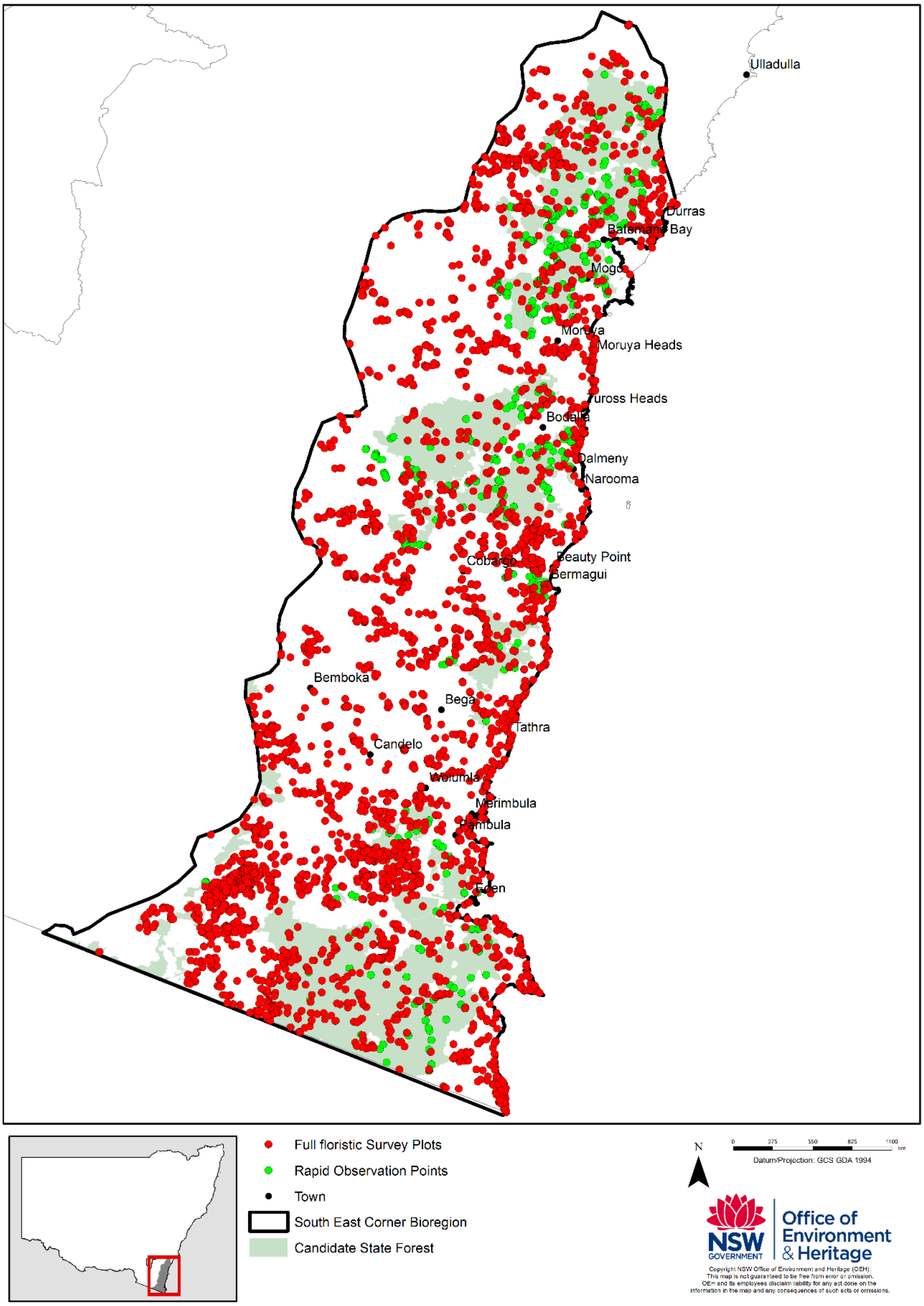
Appendix D identifies the sampling effort against existing mapping of potential LGW found within each state forest.

Table 10 shows the allocation of sampling effort to BWVF and DYRF against referable map units from existing mapping of Tozer et al. (2010). Mapped areas in Mumbulla State Forest were located on a steep precipitous slope that we were unable to access. We did however sample accessible areas adjacent to mapped polygons and extrapolated the results using matching aerial photo patterns.

Table 10: Survey effort against existing map classes and new API relevant to BWVF and DYRF. Number of samples in areas adjacent to mapped polygons are shown in parentheses

TEC	Map Source	State Forest	Hectares	Full Floristic Plots	Rapid partial floristic plots
Brogo Wet Vine Forest	E18 (Tozer et al. 2010)	Mumbulla	91	0(1)	0 (5)
	E18 (Tozer et al. 2010)	Nadgee	39	0	2
	New API	Bodalla	10	4	
	New API	Buckenbowra	2	1	
	New API	Nullica	25	2	3
Dry Rainforest of the south east forests	E1 (Tozer et al. 2010)	Towamba	2	1	
	New API	Towamba	11	2	3

<u>Map 3</u>: **Distribution of new full-floristic and rapid surveys on state forest in the South Coast study area.**



4.2 Classification

4.2.1 Relationships to existing classifications

Of the 8452 plots analysed, 5620 (63%) could be allocated with a high degree of confidence to an existing community described by either Gellie (2005) or Tozer et al. (2010). A further 1436 (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 had been described elsewhere, but which we chose to exclude from our analysis because they were not relevant to any TEC in our study area. In other cases, they may represent previously undescribed communities.

Appendix B summarises the distribution of plots among the existing and new communities relevant to Lowland Grassy Woodland, using plots with membership of at least 0.5 in either Gellie (2005), Keith and Bedward (1999), or Tozer et al. (2010) (SCIVI) communities. The cited communities strongly overlap between SCIVI unit e20p229, Keith and Bedward (1999) E20 and E21, and Thomas, Gellie & Harrison (2000) unit g54. Our analysis also suggests that two cited communities from Thomas, Gellie & Harrison (2000) and Gellie (2005), g50 and g52, overlapped plot membership with two additional SCIVI units e39 and w5(e85) both of which are excluded from the final determination.

Allocations to cited vegetation communities (Keith and Bedward 1999) in the BWVF and DYRF determinations strongly overlapped with the later classification of Tozer et al. (2010). Appendix C provides a comparative table of cited BWVF and DTRF communities.

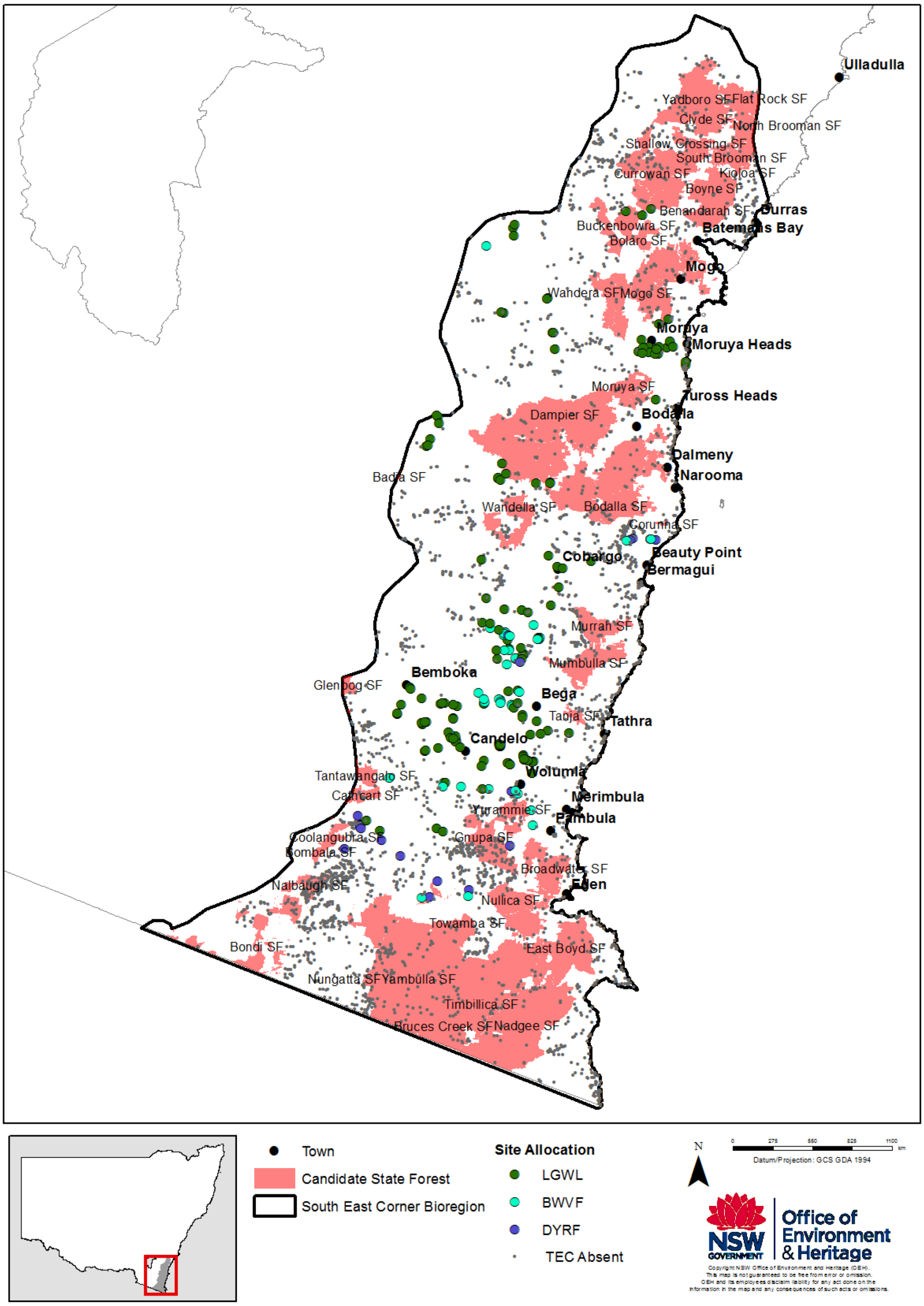
4.2.2 Floristic relationships of communities to LGW assemblage

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 for LGW 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 3.5.3. Appendix B and E shows the results for the communities relevant to our analyses. We used these relationships to put LGW communities (as cited in the determination) and other related communities into context, and in particular to determine whether there are other communities which could be considered to belong to LGW. There is closest relationships between the assemblage list and the cited vegetation communities in the determination with e20/e21 described in Keith and Bedward (1999) and Tindall et al. (2004), (now both included in Tozer et al. (2010) unit e20/p229), and with unit g54 of Gellie (2005) and Thomas, Gellie & Harrison (2000). In comparison, the cited unit g50, from the latter studies, is less strongly related to the assemblage list. We identified an additional community, g171, from those studies that recorded higher mean values than g50, and chose to include this unit as part of LGW even though it has not been explicitly included in the determination.

4.2.3 Assessment of plots and communities as TEC

From our floristic analysis we regard all plots with a membership >=0.5 of any of the communities equivalent to those cited in the final determinations (as described in Section 2.3 and Tables 1, 2 and 3) and which also meet the qualifying criterion as expressions of LGWL, BWVF and DYRF. For management purposes in a precautionary context, we suggest that plots that meet the same membership threshold for unit g171 could also be regarded as LGW, due to its relationship to the determination assemblage. Map 4 and Appendices F-H demonstrate plot allocations for the subject TECs.

Map 4: Site Allocation for Lowland Grassy Woodland, Brogo Wet Vine Forest, Dry Rainforests of the South East Forests TECs



4.3 Occurrence of TECs on state forest

4.3.1 Lowland Grassy Woodland (LGW)

Six plots located on state forest met our prescribed threshold for the TEC. Five of the six plots are included as TEC given the strength of their relationship to Gellie (2005) unit g171. These sites are located on the boundaries of Dampier and Bodalla State Forests in the Tuross Valley and in Buckenbowra and Currowan State Forests in the Clyde Valley. All occur on slopes rising above dry coastal valleys. Only a single plot in western Dampier State Forest met our thresholds for the g50 community cited in the final determination, although this community is the least related to the assemblage list.

We rejected evidence of LGW on state forest from existing mapping sources (Tozer et al. 2010; Gellie 2005 or Thomas, Gellie & Harrison 2000) as our data analysis and new predictive models were unable to provide supporting information. Additional qualitative field based evidence from rapid partial floristic plots also informed our conclusions that the existing mapping captured forests that were clearly unrelated to LGW. None of the 31 sites visited within existing mapped areas on state forest (9 full floristic and 22 partial floristic) supported the assignment of LGW to areas with existing mapping.

Similarly, we were unable to rely on our mapping of *Eucalyptus tereticornis* as a useful indicator of LGW. Our analysis identified five plots that met our prescribed threshold for LGW situated on or within 20 metres of any of our mapped polygons. However, there are 18 plots that are not LGW but are within or adjoining mapped polygons of *E. tereticornis*. Other plots in dry foothills landscapes were more commonly associated with SCIVI unit w5/e85-Wadbilliga Gorge Forest, or, in the case of plots located on alluvium, were aligned with p30-South Coast River Flat Forest, a unit that forms a component of the River Flat Eucalypt Forest on Floodplain TEC.

The location of sites assigned to LGW suggests that LGW is more likely to occur on lower elevation foothills of coastal valleys. These areas are typically associated with state forest boundaries adjoining private lands.

<u>Photo 1:</u> Small areas in the Tuross Valley (CDE07O7L) including Bodalla State Forest supported stands of *Eucalyptus tereticornis* and *Angophora floribunda* with a sparse layer of small trees and clumps of long-leaved wallaby grass (*Rytidosperma longifolium*). We included sites such as these within our interpretation of Lowland Grassy Woodland TEC because they were strongly related to community g171 (Thomas, Gellie & Harrison 2000). We demonstrated that this community is also closely related to the final determination species assemblage, although it has not been explicitly cited.

<u>Photo 2:</u> Site (CDE12O0F) in Dampier State Forest were included as Lowland Grassy Woodland TEC on the basis that it was related to vegetation community g50 from Gellie (2005). The forest at this site is dominated by *Eucalyptus angophoroides* with an open mid stratum of dry shrubs and a sparse ground cover. Comparisons with the alternative classification from Tozer et al. (2010) identified a very strong relationship to Wadbilliga Gorge Forest (W5/e85), a community that is not currently cited.

4.3.2 Brogo Wet Vine Forest

Distribution of candidate areas of BWVF on state forest is small and patchy. Three plots located in Bodalla State Forest met our membership threshold against cited vegetation community e18 (Tozer et al. 2010). All were located within Bodalla State Forest and outside the prescribed Bega Valley Shire boundary in the adjoining Eurobodalla LGA. Two plots are located on the exposed lower slopes of Mt Dromedary. The third plot situated near the banks of the Tuross River also demonstrated strong relationships with the River Flat Eucalypt Forest on Floodplain TEC. It has been included in the operational map for that TEC.

We rejected further evidence of BWVF on state forest from existing map sources on the basis that our field data, predictive models and/or or aerial photograph interpretation were unable to provide supporting evidence.

Photo 3. Small areas of Brogo Wet Vine Forest occur in Bodalla State Forest on the foot slopes of Mt Dromedary. Both *Eucalyptus tereticornis* and *E. bosistoana* are present in the canopy above a smaller tree layer that includes *Ficus rubiginosa* and *Acacia mearnsii*. This stand is located outside of the Bega Valley LGA, but remains within the South East Corner Bioregion.

4.3.3 Dry Rainforest in South-east Forests

We confirmed two plots of DYRF within Towamba State Forest and an additional plot less than 50 metres from the boundary. Assignment of the two plots within the forest used the diagnostic test from Tozer et al. (2010). Both sites are located outside the IFOA operational area (and hence the project's study area) and within the softwoods zone of the Towamba State Forest.

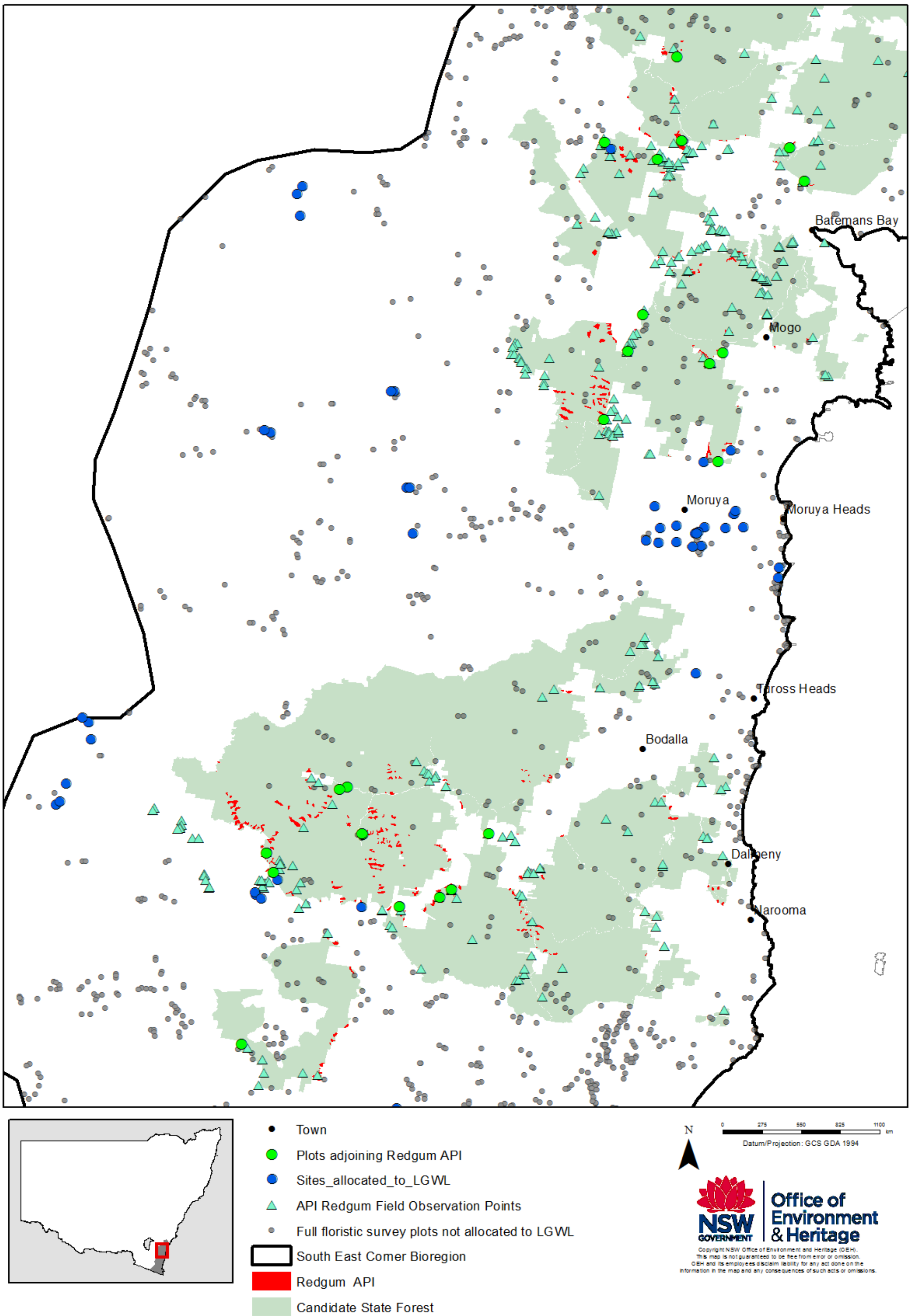
Photo 4. Dry Rainforests of the south east forests was mapped in one patch only in Towamba State Forest near Eden. This sprawling *Ficus rubiginosa* is characteristic of the low dry hinterland rainforest amongst granite outcrops.

4.4 Aerial photograph interpretation

4.4.1 Red Gum dominated forests

We identified a total of 1535 hectares of forest dominated or co-dominated by *Eucalyptus tereticornis*. A smaller area of 1292 hectares (1165 hectares within precise state forest boundaries) was interpreted with a confidence measure of moderate or greater (84%) and formed the basis of our analysis of new mapped data. Just under half (47%) of these *E. tereticornis* polygons were associated with an open understorey with high reflectance (suggesting a grassy ground cover or sparse shrub layer). A similar proportion (44%) were associated with a visibly dry shrubby understorey and only a small proportion (2%) were associated with visible mesic shrubs or rainforest elements. The latter we considered potentially useful for the discrimination of BWVF.

Map 5: **Example areas of *E. tereticornis* (Red gum) API mapping illustrating field survey effort on and adjoining state forests. Plots allocated to Lowland Grassy Woodland TEC are identified.**



4.4.2 Dry Rainforests dominated by fig

We identified 12 hectares of rainforest dominated by low growing stands of *Ficus rubiginosa* in Towamba State Forest. However, only 0.53 hectares fall within our assessable study area, with the remainder in softwood forest management zones.

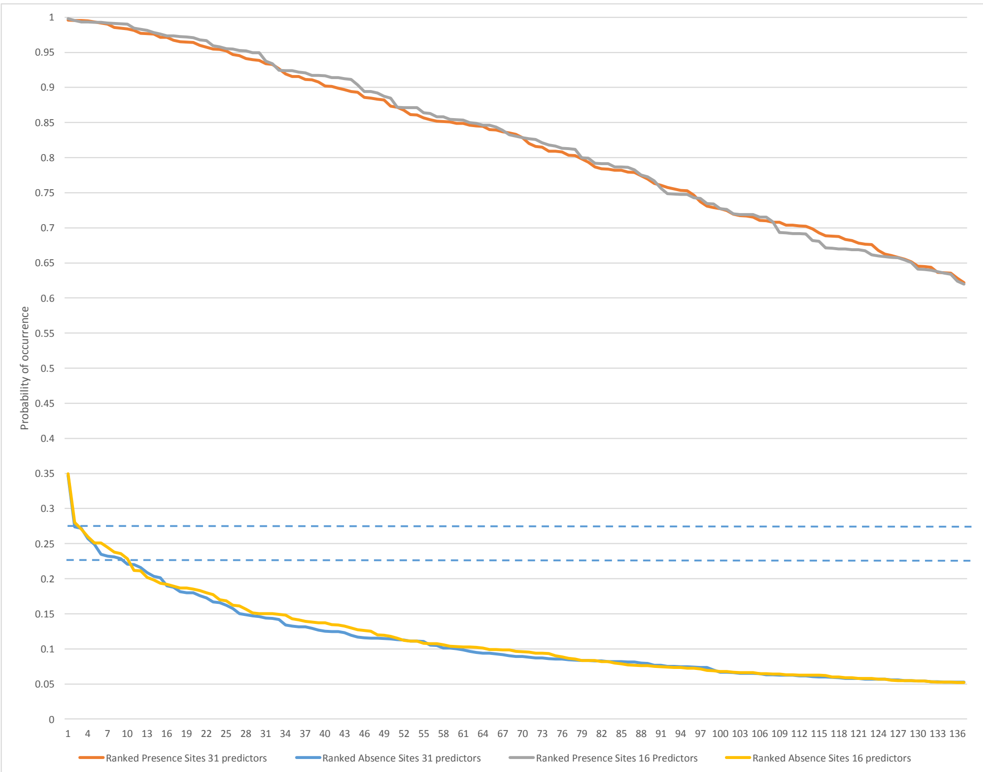
4.5 Indicative maps

4.5.1 Model performance

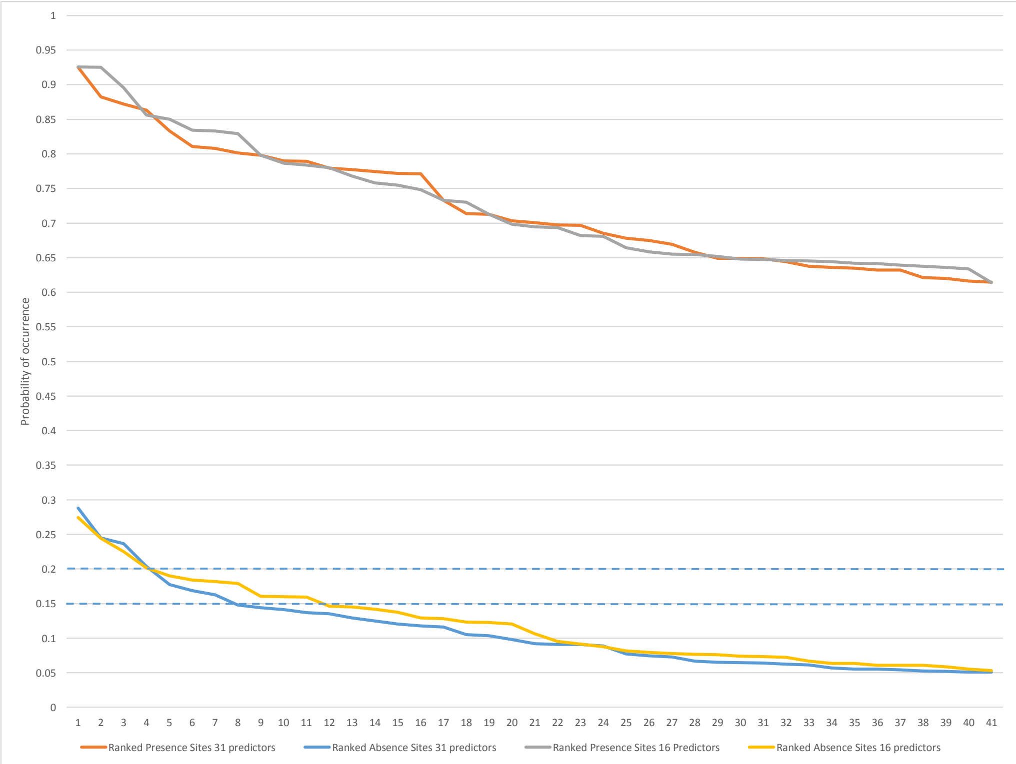
A single set of Random Forest models were constructed for each assessed TEC. Figure 1 shows plots of the predicted probability of occurrence for sites allocated to a TEC (in order of descending probability) plotted against the same number of highest ranked absence plots. Across the ten sets of models (five with 15 predictors and five with 30 predictors), there was no overlap between the lowest probability of occurrence (PO) value for a TEC present site, and the highest probability of occurrence value for a TEC absent site. Thus choosing any threshold between these two PO values results in 100% of all present and absent sites being correctly classified. Each set of plots also shows two thresholds, resulting in two alternate views on where the TEC has the potential to occur, and where it has little to no chance of occurrence (see below).

<u>Figure 1:</u> Predicted probability of occurrence (PO) values for sites allocated to each TEC (in order of descending probability) plotted against the PO values for the same number of highest ranked absence plots. The double lines represent models with 15 and 30 predictors. The order of plots are: a) LGW, b) BWVF, c) DYRF

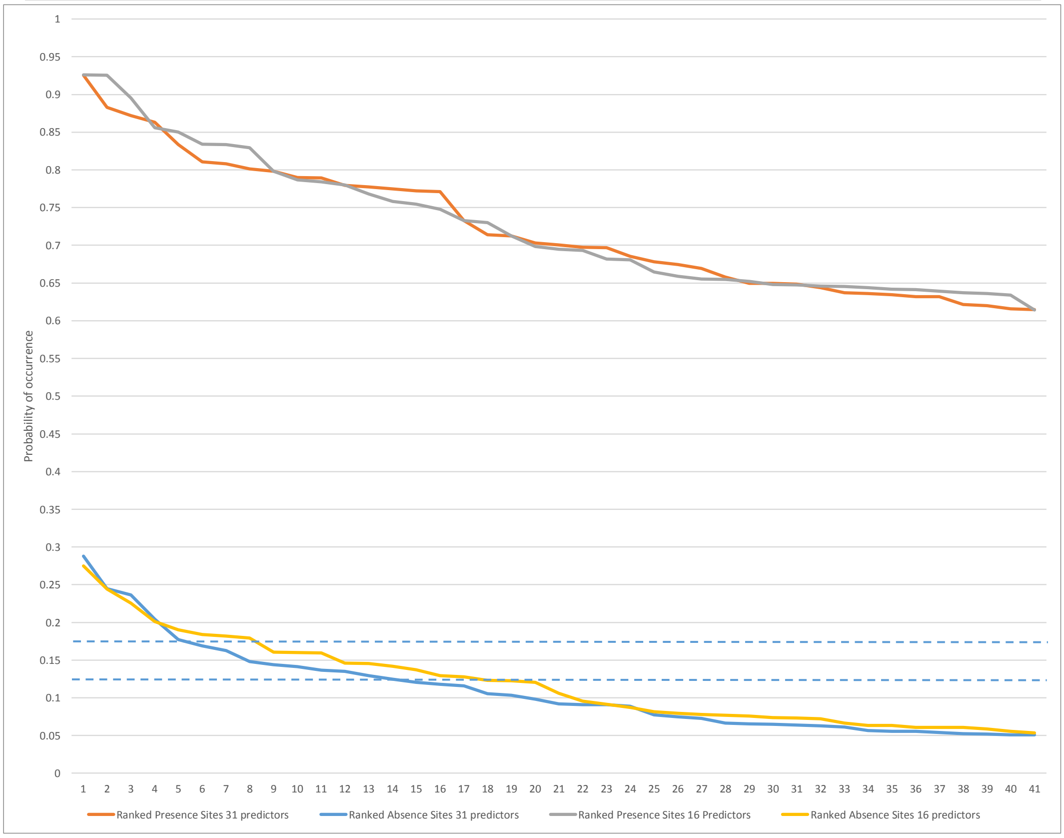
LGWL



BWVF



DYRF



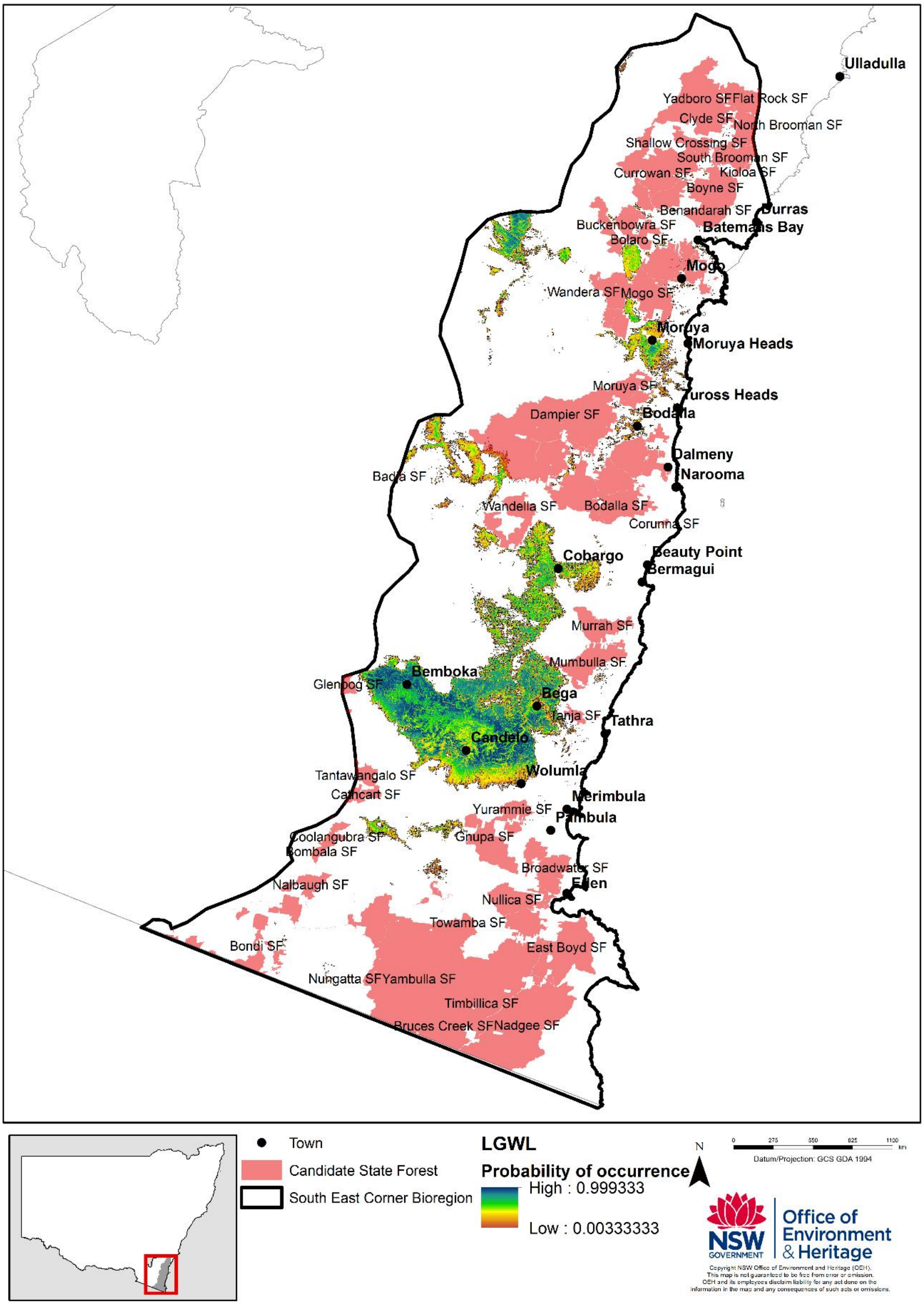
4.5.2 TEC indicative maps

The indicative maps predict the distribution of a TEC based on the probability of occurrence values above a particular threshold. For the two thresholds marked in Figure 1, we accept a very small level of misclassification of absence sites (generally less than 15 out of more than

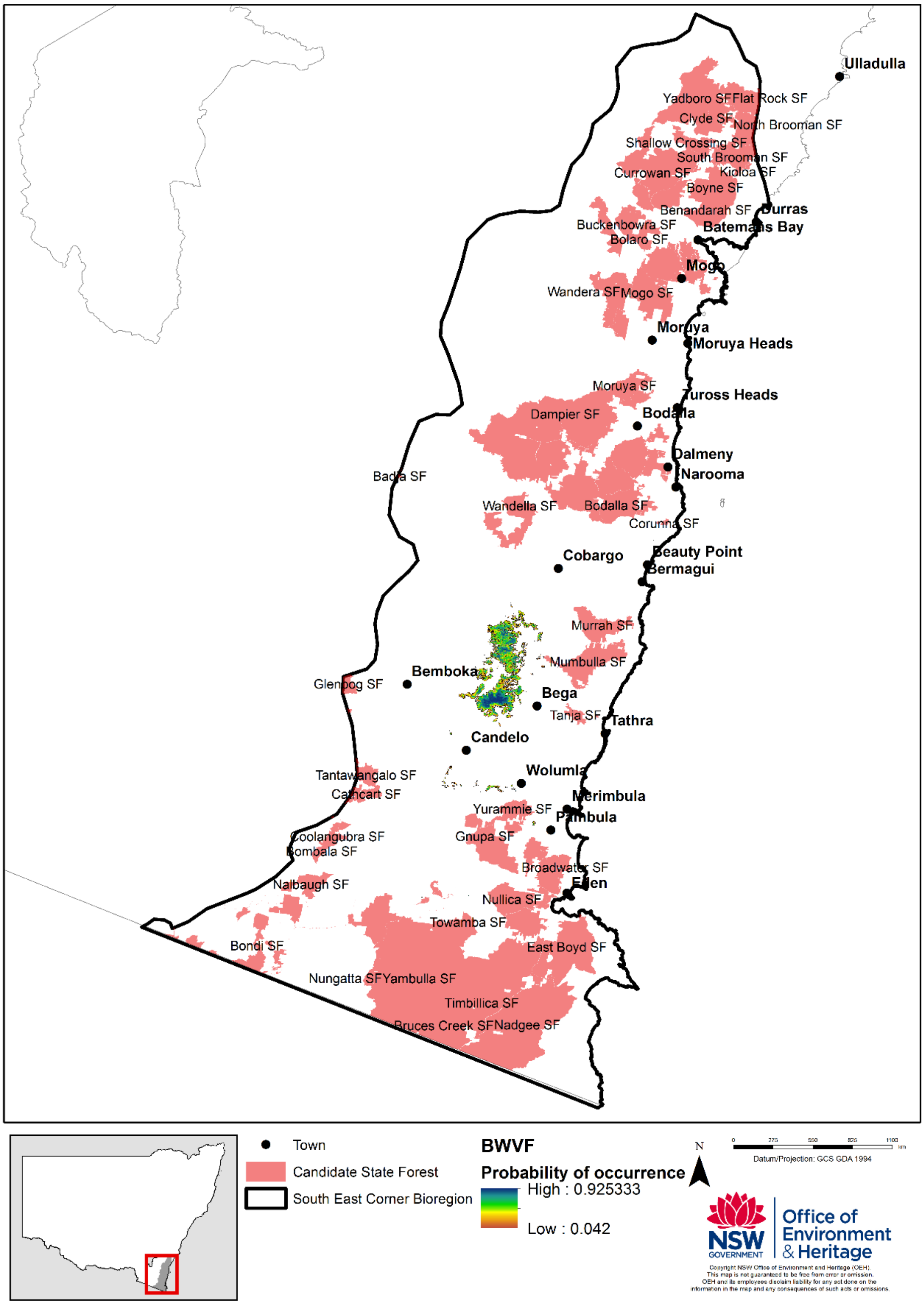
3400 sites). This has the effect of extending the models just enough to account for spatial inaccuracies that may exist in the data.

From the modelling, we have identified four possible indicative maps for each TEC. This included two sets of models (each with 16 and 31 predictors), and two thresholds to predict the potential extent of the TEC. All four sets of predicted occurrence maps were examined in ArcGIS using ADS40 imagery as the backdrop, and an assessment made as to which model/threshold best discriminated the underlying habitat features and our understanding of the vegetation patterns. Our models were examined across all land tenures and compared against any existing vegetation mapping and new API mapping completed during our project. In all cases, the models with 31 predictors and the higher of the two thresholds (narrower distribution) produced the models that best aligned with our knowledge and these formed the basis for new survey and mapping efforts. Maps 6-8 show the predicted distribution of the TECs across all tenure.

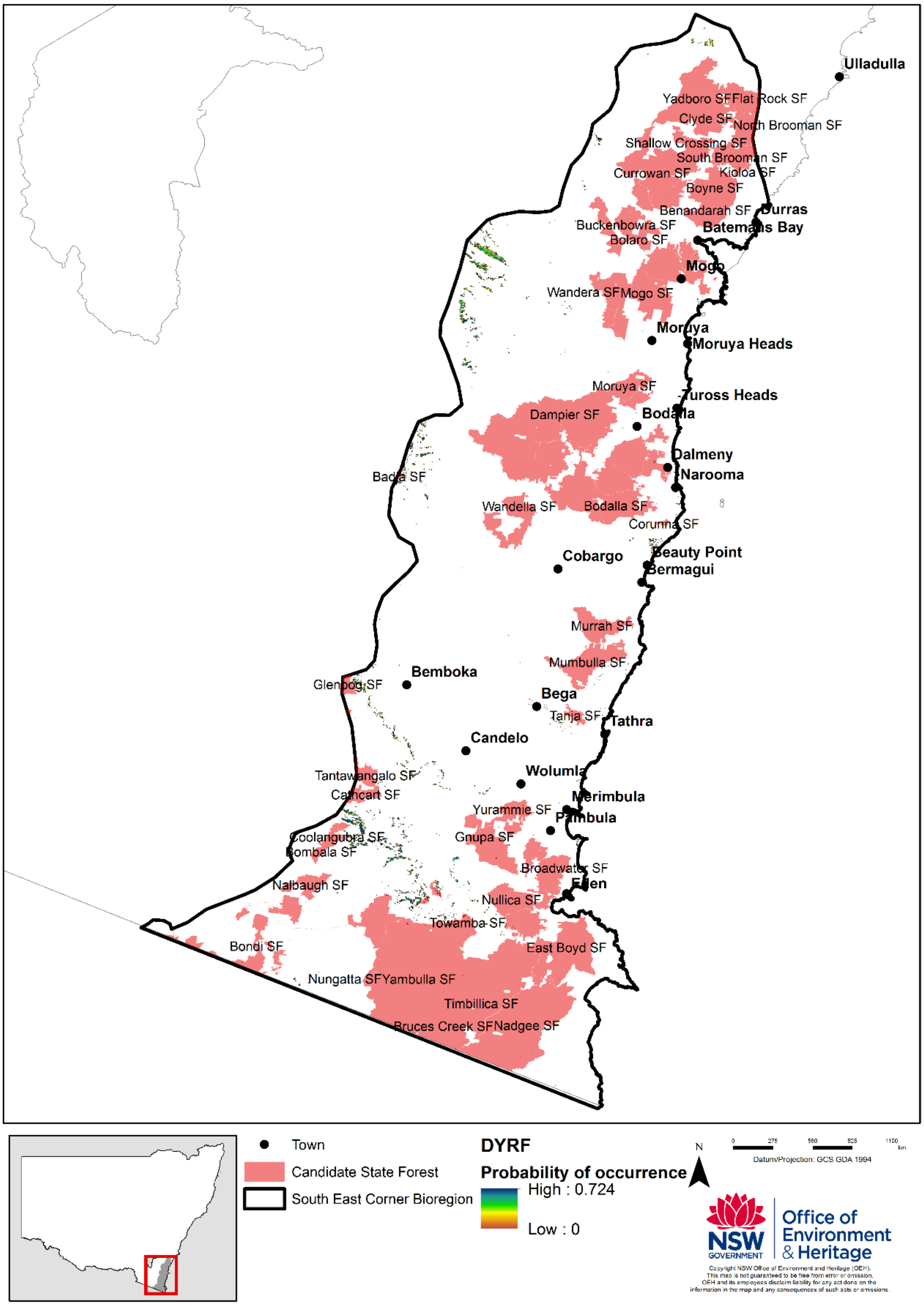
Map 6: Indicative map showing the potential distribution of LGWL



Map 7: Indicative map showing the potential distribution of BWVF



Map 8: **Indicative map showing the potential distribution of DYRF**



4.5.3 Environmental relationships

Individual fitted functions for predictors in the Random Forest models are useful for determining whether the models match what we know about the broad distribution and habitat requirements of a TEC. For example, we know from the final determination that LGWL "*typically occurs in undulating terrain up to 500 metres elevation on granitic substrates (e.g. adamellites, granites, granodiorites, gabbros, etc.) but may also occur on locally steep sites and on acid volcanic, alluvial and fine-grained sedimentary substrates.*"

Table 11 lists the variables selected in p31 and p16 models across the three TECs. The scaled variable importance values for each model are provided in Figure 2. These give a measure of the relative contribution each variable has on the overall model, with low standardised variable importance values having relatively little impact on the probability of occurrence values.

Across the p31 and p16 models, bulk density and soil pH were the two most important predictors for LGWL. Also important at the regional scale were isothermality, precipitation of seasonality, average rainfall - summer winter ratio, mean diurnal range and the prescott index.

For BWVF, soil pH was the most important predictor at the local scale, while at the regional scale a combination of distance from coast, mean diurnal range, temperature annual range and temperature seasonality drive the broad scale distribution of the TEC. Also important are elevation, distance to eighth order streams and above, average areal potential evapotranspiration and neighbourhood topographical roughness using a circular 500 metre neighbourhood.

Cold air drainage, soil pH and neighbourhood topographical roughness with a circular 500 metre neighbourhood were the most important predictors for DYRF, followed by elevation and roughness with a 1000 metre neighbourhood. Other variables of importance included bulk density, annual mean temperature, total phosphorus and distance to both permanent and seasonally flooded water bodies.

The shape of the individual fitted functions for each model are shown in Figure 3. The response functions for variables are generally consistent across the different TEC models, and follow the responses one would expect for the assessed communities.

Table 11: List of variables selected in Random Forest models associated with 31 predictors (p31). Those with asterisks also found in the p16 models

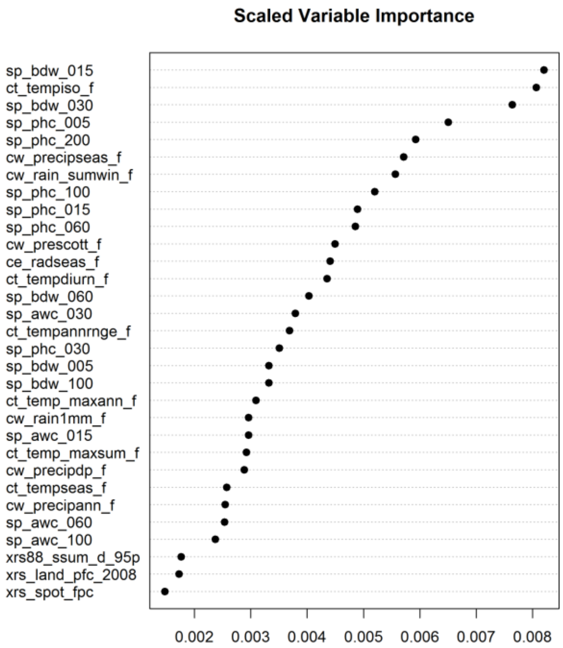
Code	Description	LGWL	BWVF	DYRF
ce_radhp_f	Highest Period Radiation (bio21)		1	
ce_radlp_f	Lowest Period Radiation (bio22)		1	
ce_radseas_f	Radiation of Seasonality: Coefficient of Variation (bio23)	1		
ct_temp_maxann_f	Average daily max temperature - Annual	1		
ct_temp_maxsum_f	Average daily max temperature - Summer	1		
ct_temp_minann_f	Average daily min temperature - Annual		1	
ct_temp_minsum_f	Average daily min temperature - Summer			1
ct_temp_minwin_f	Average daily max temperature - Winter		1	
ct_tempann_f	Annual Mean Temperature (bio1)			1*
ct_tempannrnge_f	Temperature Annual Range: difference between bio5 and bio6 (bio7)	1	1*	
ct_tempdiurn_f	Mean Diurnal Range (Mean(period max-min)) (bio2)	1*	1*	
ct_tempiso_f	Isothermality 2/7 (bio3)	1*	1*	

Code	Description	LGWL	BWVF	DYRF
ct_tempmtcp_f	Min Temperature of Coldest Period (bio6)		1	
ct_tempseas_f	Temperature Seasonality: Coefficient of Variation (bio4)	1	1*	
cw_clim_etaaann_f	Average areal actual evapotranspiration - Annual		1	
cw_clim_etapann_f	Average areal potential evapotranspiration - Annual		1*	
cw_precipann_f	Annual Precipitation (bio12)	1		1
cw_precipdp_f	Precipitation of Driest Period (bio14)	1		
cw_precipseas_f	Precipitation of Seasonality: Coefficient of Variation (bio15)	1*		
cw_precipwp_f	Precipitation of Wettest Period (bio13)			1
cw_prescott_f	Prescott Index	1*		
cw_rain_sumwin_f	Average Rainfall - Summer Winter Ratio	1*		
cw_rain1mm_f	Average Number of days with rainfall greater than 1mm Annual	1	1*	
cw_rainspr_f	Average Rainfall - Spring		1	
d_coast_disa_f	Distance from NSW East Coast (Euclidian)		1*	
d_flooded	Distance (Euclidean) from seasonally flooded water bodies			1*
d_permwater	Distance (Euclidean) from permanent water bodies			1*
d_strahler89	Euclidean distance to 8th order streams and above		1*	
lf_aspect_f	aspect derived from smoothed DEM (DEM-S)			1
lf_aspect_tr_f	Beer's Apsect- transformation of aspect to a continuous scaled variable. Changed for the southern hemisphere by setting maximum value (2) to SE slopes (coolest) and minimum (0) to NW slopes (warmest).			1
lf_dems1s_f	Elevation from 1 sec SRTM smoothed DEM (DEM-S)		1*	1*
lf_logre10_f	Cold air drainage			1*
lf_rough0100_f	Neighbourhood topographical roughness based on the standard deviation of elevation in a circular 100 m neighbourhood. Derived from DEM-S			1
lf_rough0500_f	Neighbourhood topographical roughness based on the standard deviation of elevation in a circular 500 m neighbourhood. Derived from DEM-S		1*	1*
lf_rough1000_f	Neighbourhood topographical roughness based on the standard deviation of elevation in a circular 1000 m neighbourhood. Derived from DEM-S		1	1*
lf_tpi2000_f	Topographic position index using neighbourhood of 2000m radius			1
sp_awc_005	Available water capacity (0 - 5cm)		1	
sp_awc_015	Available water capacity (5 - 15cm)	1*	1	
sp_awc_030	Available water capacity(15 - 30cm)	1*		
sp_awc_060	Available water capacity (30 - 60cm)	1		
sp_awc_100	Available water capacity (60 - 100cm)	1		
sp_bdw_005	Bulk density (0 - 5cm)	1		1*
sp_bdw_015	Bulk density (5 - 15cm)	1*		
sp_bdw_030	Bulk density (15 - 30cm)	1*		1

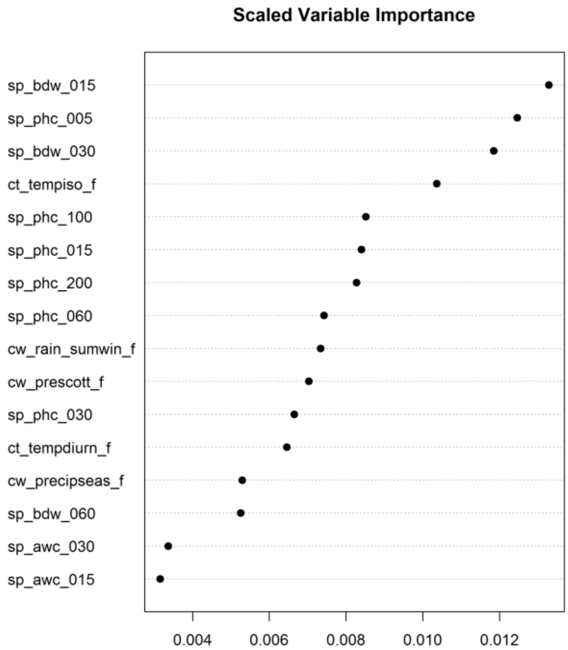
Code	Description	LGWL	BWVF	DYRF
sp_bdw_060	Bulk density (30 - 60cm)	1*		
sp_bdw_100	Bulk density (60 - 100cm)	1		
sp_phc_005	pH (calcium chloride) (0 - 5cm)	1*	1*	1*
sp_phc_015	pH (calcium chloride) (5 - 15cm)	1*	1*	1*
sp_phc_030	pH (calcium chloride) (15 - 30cm)	1*	1*	1*
sp_phc_060	pH (calcium chloride) (30 - 60cm)	1*	1*	1*
sp_phc_100	pH (calcium chloride) (60 - 100cm)	1*	1*	1*
sp_phc_200	pH (calcium chloride) (100 - 200cm)	1*	1*	1*
sp_pto_005	Total phosphorus (%) (0 - 5cm)			1
sp_pto_015	Total phosphorus (%) (5 - 15cm)			1*
sp_pto_030	Total phosphorus (%) (15 - 30cm)			1*
sp_pto_060	Total phosphorus (%) (30 - 60cm)			1
sp_pto_100	Total phosphorus (%) (60 - 100cm)			1
sp_soc_100prop	Soil Organic Carbon proportionally combined depths from 0 to 100 cm			1
xrs_land_pfc_2008	Foliage projective cover or the percentage of ground cover occupied by the vertical projection of foliage. Derived from landsat imagery in 2008	1	1	
xrs_spot_fpc	Foliage projective cover or the percentage of ground cover occupied by the vertical projection of foliage. Predicted using a time series of SPOT images between 2008-2011	1	1	
xrs_spot2011_band3	Individual bands from a 2011 spot image			1
xrs88_sspr_g_05p	Landsat 25-year seasonal greenesss in spring (5th percentile)		1	1
xrs88_sspr_g_50p	Landsat 25-year seasonal greenesss in spring (50th percentile)		1	
xrs88_ssum_d_95p	Landsat 25-year seasonal dry (non-green) vegetation in summer (95th percentile)	1	1	
xrs88_ssum_g_05p	Landsat 25-year seasonal greenesss in summer (5th percentile)			1

<u>Figure 2</u>: Scaled variable importance values in relation to models with 31 and 16 predictors. The order of plots are a) Lowland Grassy Woodland, b) Brogo Wet Vine Forest, c) South East Dry Rainforest.

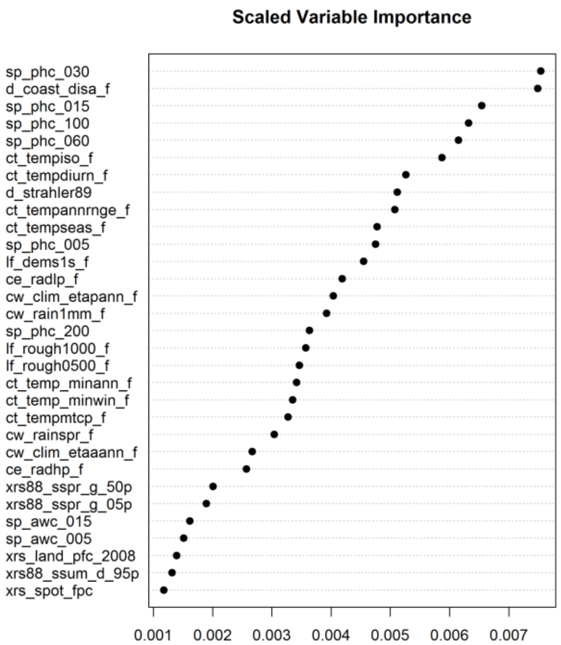
a1)



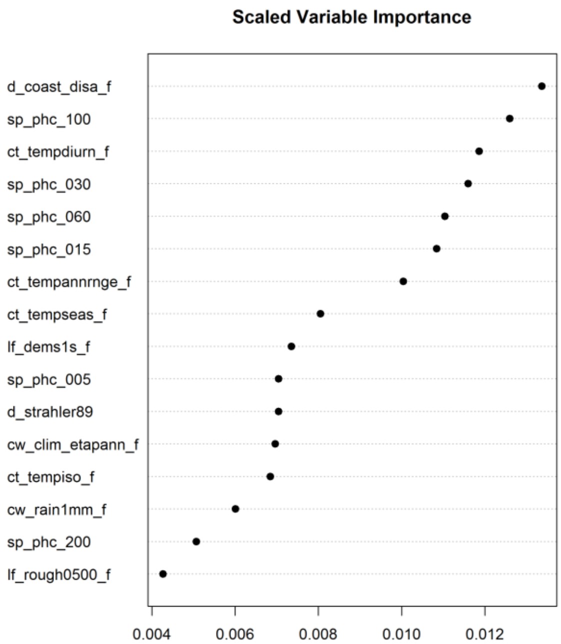
a2)



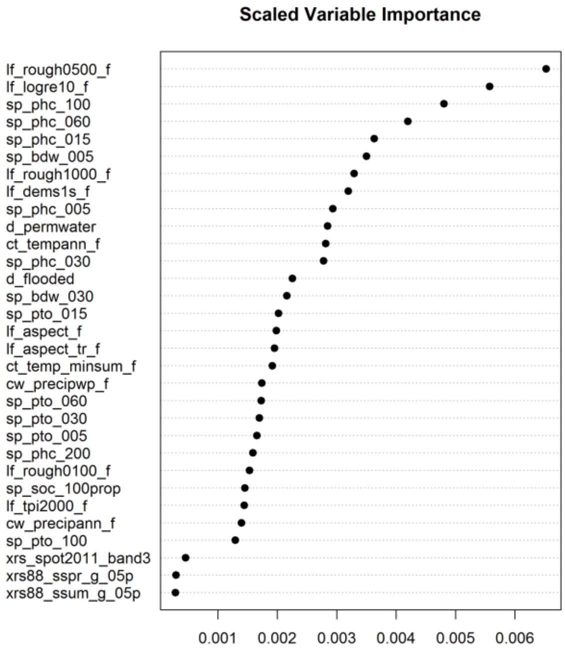
b1)



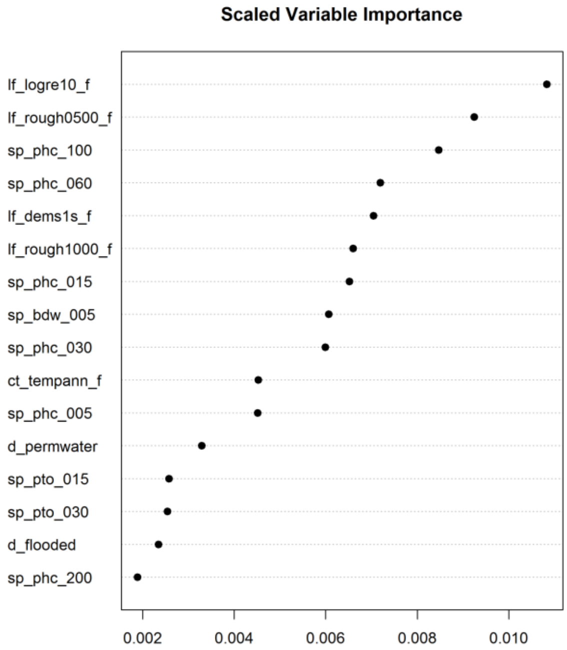
b2)



c1)


Scaled Variable Importance
lf_rough0500_f
lf_logre10_f
sp_phc_100
sp_phc_060
sp_phc_015
sp_bdw_005
lf_rough1000_f
lf_dems1s_f
sp_phc_005
d_permwater
ct_tempann_f
sp_phc_030
d_flooded
sp_bdw_030
sp_pto_015
lf_aspect_f
lf_aspect_tr_f
ct_temp_minsum_f
cw_precipwp_f
sp_pto_060
sp_pto_030
sp_pto_005
sp_phc_200
lf_rough0100_f
sp_soc_100prop
lf_tpi2000_f
cw_precipann_f
sp_pto_100
xrs_spot2011_band3
xrs88_sspr_g_05p
xrs88_ssum_g_05p
0.001
0.002
0.003
0.004
0.005
0.006

c2)


Scaled Variable Importance
lf_logre10_f
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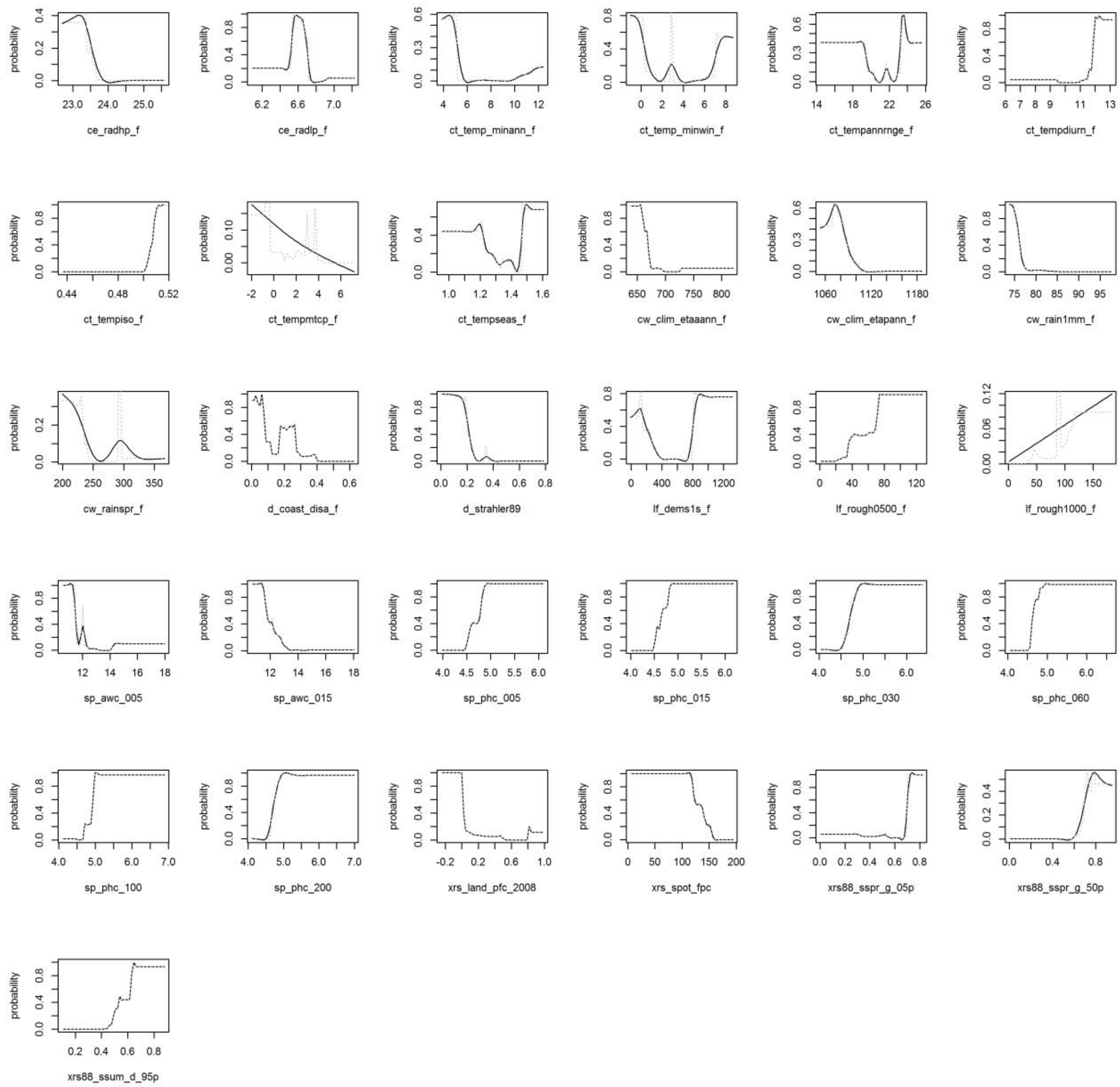
sp_phc_060
lf_dems1s_f
lf_rough1000_f
sp_phc_015
sp_bdw_005
sp_phc_030
ct_tempann_f
sp_phc_005
d_permwater
sp_pto_015
sp_pto_030
d_flooded
sp_phc_200
0.002
0.004
0.006
0.008
0.010

Figure 3: Shape of individual fitted functions in relation to models with 16 predictors. The order of plots are a) Lowland Grassy Woodland, b) Brogo Wet Vine Forest, c) South East Dry Rainforest.

a)

b)


probability
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ct_tempannrnge_f
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ct_tempmtcp_f
ct_tempseas_f
cw_clim_etaaann_f
cw_clim_etapann_f
cw_rain1mm_f
cw_rainspr_f
d_coast_disa_f
d_strahler89
lf_dems1s_f
lf_rough0500_f
lf_rough1000_f
sp_awc_005
sp_awc_015
sp_phc_005
sp_phc_015
sp_phc_030
sp_phc_060
sp_phc_100
sp_phc_200
xrs_land_pfc_2008
xrs_spot_fpc
xrs88_sspr_g_05p
xrs88_sspr_g_50p
xrs88_ssum_d_95p

c)

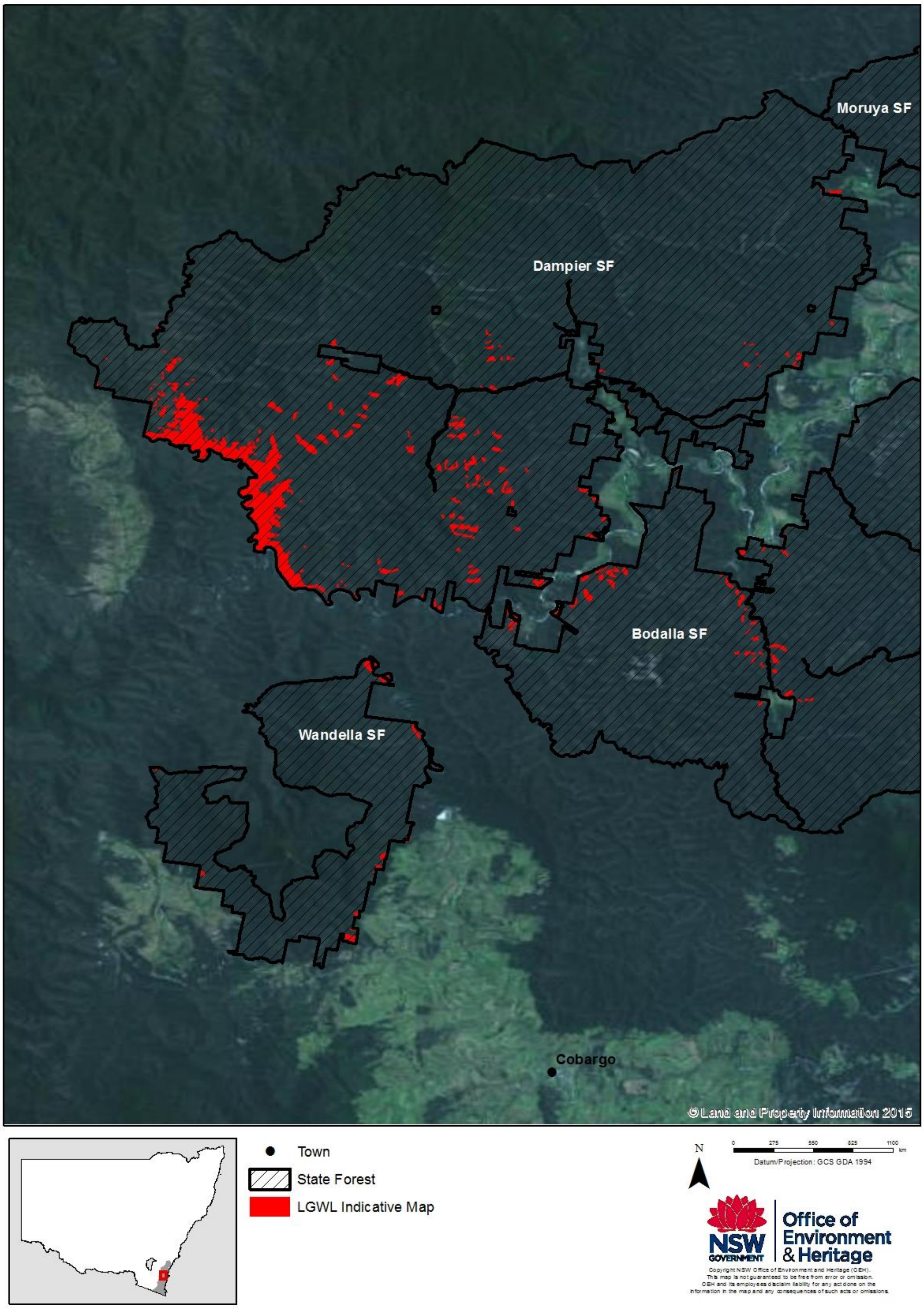
4.6 Operational TEC Mapping

We were unable to construct an operational map for LGW because we found inconsistent evidence that the TEC occurred within state forests. Our results suggest that our mapped extrapolations of LGW include a large proportion of forest that is not the TEC and do not discriminate the TEC at a scale suitable for harvesting operations. We have merged both our predictive and API maps to provide an indication of likely extent of the TEC on state forest. An example area in Dampier State Forest is shown in Map 9.

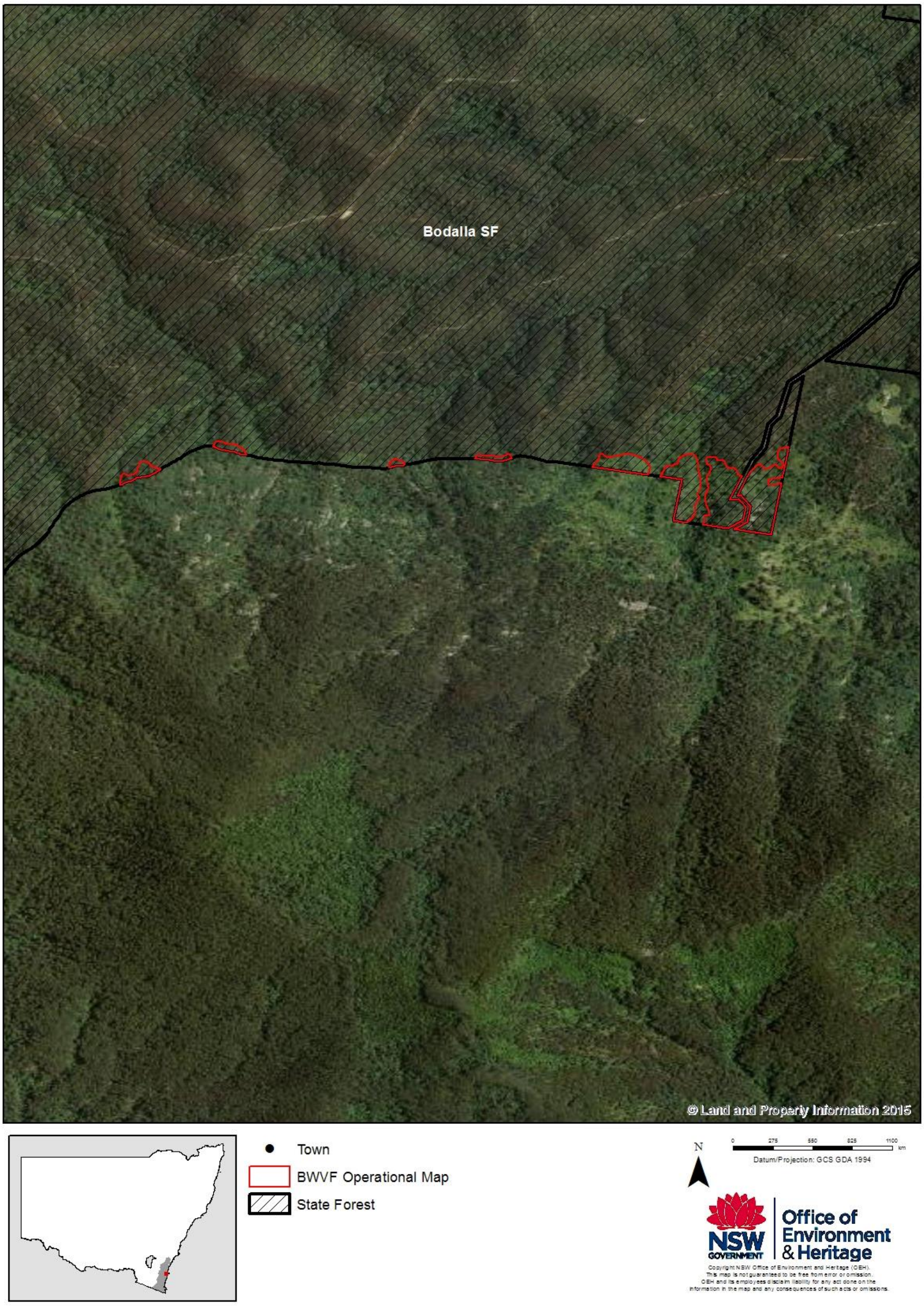
We achieved greater certainty with BWVF as there are very few areas that were assessed with suitable floristic and structural attributes. We identified six small areas within Bodalla State Forest on the exposed lower slopes of Mount Dromedary. Together these total 17.5 hectares. They are presented in Map 10.

Similarly, the results for DYRF highlighted very few areas from either our predictive models or API that suggested the presence of the TEC. We identified six patches of rainforest within Towamba State Forest, although all but one fell outside the IFOA operational area. There is only 0.53 hectares present within our study area in Towamba State Forest (Map 11).

Map 9: Example of final indicative map for LGWL TEC



Map 10: **Final operational map for BWVF TEC**



Map 11: Final operational map for DYRF

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 Brogo Wet Vine Forest and Dry Rainforest in the South East Forests TECs was relatively straightforward, because the final determinations reference single classification units that are supported by traceable plot data.

The interpretation of Lowland Grassy Woodland TEC was more challenging because a range of classifications are cited from overlapping classifications and maps. While we found strong agreement between some of these classifications and the species assemblage in the final determination (e20/p229 from Tozer et al. (2010); e20 and e21 from Keith and Bedward (1999); g54 from Gellie (2005) and Thomas, Gellie & Harrison (2000)), other classification units provided contrasting results. Unit g50 from Gellie (2005) is explicitly included in the determination within the south east corner bioregion. This unit has a relatively weak association with the assemblage list. Community g50 shares many plots assigned to W5/e85 Wadbilliga Gorge Forest in the studies of Keith and Bedward (1999) and Tozer et al. (2010), and this unit is implicitly excluded from LGW as it is not cited in the determination. We also found that unit g171 from Thomas, Gellie & Harrison (2000) shared a higher proportion of species found in the assemblage list than g50, but it was not cited in the LGW determination. This unit was difficult to interpret as it was deleted from the later study of Gellie (2005) and plots allocated to it were assigned to a range of different communities in Tozer et al. (2010). We overcame the ambiguity by including any plot that met the membership of the primary cited units in the determination and those that met g171.

The final determination also implies that *Eucalyptus tereticornis* is a useful diagnostic species for both LGW and BWVF. However, for the former we found it is less likely to be useful in transitional environments such as those that are present within state forests.

5.1.2 Distribution and habitat descriptors

The final determination includes a set of environmental descriptors that assist in locating these three TECs on the South Coast. We achieved agreement with the stated habitat characteristics in the determination for Lowland Grassy Woodland, in particular the elevation, rainfall and substrate characteristics.

The determinations for BWVF and DYRF are unusual as they include explicit statements that the assemblage is known only from Bega Valley (LGA). This conflicted with our evidence that plots that were referable to the cited vegetation communities were located outside the stated LGA. We overcame this uncertainty by constraining the distribution for these TECs to the broader South East Corner Bioregion.

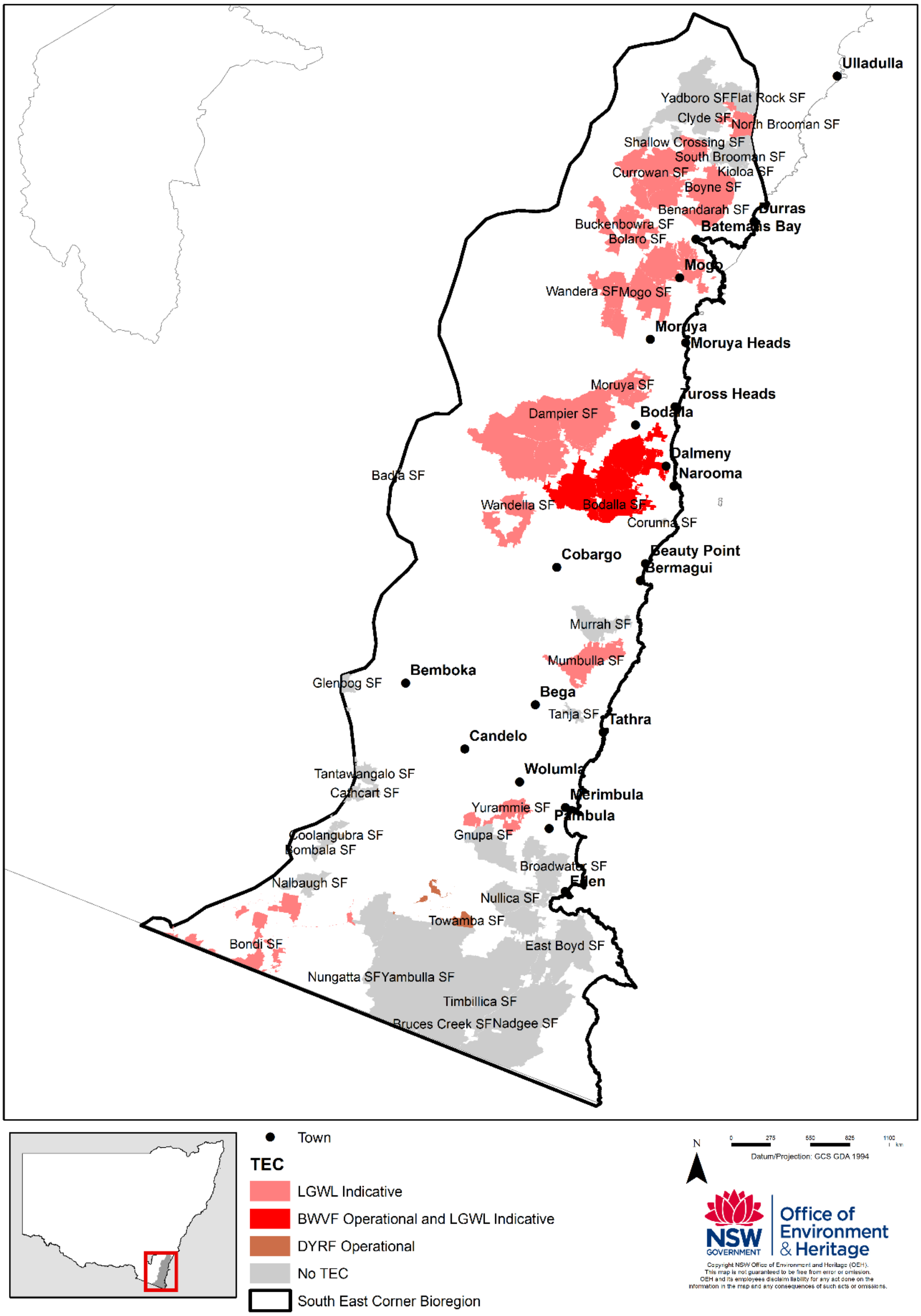
5.2 Final state forest-TEC occurrence matrix

Table 10 presents the total area of Brogo Wet Vine Forest and Dry Rainforest of the South East Forests present within each state forest within the study area. Indicative figures are provided for Lowland Grassy Woodland for guidance purposes only. They do not represent the true extent of LGW. Map 12 shows the state forests containing each of the TECs.

Table 12: Total area of Brogo Wet Vine Forest and Dry Rainforest of the south east forests mapped across all state forests in the South East Corner Bioregion. Lowland Grassy Woodland remains indicative in the state forests shown below.

State Forest	State Forest Area within Bioregion	BWVF (operational)	DYRF (operational)	LGW (indicative)
Benandarah State Forest	1967	0	0	21.76
Bodalla State Forest	24583	17.05	0	206.38
Bolaro State Forest	1475	0	0	15.03
Bondi State Forest	6883	0	0	0.07
Boyne State Forest	6883	0	0	0.14
Buckenbowra State Forest	5408	0	0	126.58
Currowan State Forest	13275	0	0	118.92
Dampier State Forest	33433	0	0	1299.31
Mogo State Forest	14258	0	0	304.38
Moruya State Forest	3933	0	0	2.01
Mumbulla State Forest	5408	0	0	0.29
North Brooman State Forest	2458	0	0	0.26
Shallow Crossing State Forest	3933	0	0	0.36
Towamba State Forest	983	0	0.53	0
Wandella State Forest	4425	0	0	71.57
Wandera State Forest	4425	0	0	160.03
Yurammie State Forest	4425	0	0	0.05
Total		17.05	0.53	2327.13

Map 12: **State forests with mapped (BWVF and DYRF) and indicative (LGWL) occurrences of TECs**



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Appendix A

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

Table A1: Vegetation groups described by Gellie (2005)

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

CODE	VEGETATION COMMUNITY NAME
VG 58	Tableland and Escarpment Wet Layered Shrub Forest
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)

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

CODE	MAPUNIT NAME
e33	Southeast Coastal Range Dry Shrub Forest
e34	Southeast Coastal Gully Shrub Forest
e35	Southeast Escarpment Dry Grass Forest
e37	Southeast Lowland Gully Shrub Forest
e38	Far Southeast Riparian Scrub
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

CODE	MAPUNIT NAME
p33	Cumberland River Flat Forest
p34	South Coast Grassy Woodland
p38	Grey Myrtle Dry Rainforest
p40	Temperate Dry Rainforest
p44	Sydney Swamp Forest
p45	Coastal Sand Swamp Forest
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

Comparison between cited Lowland Grassy Woodland Communities

The number of plots with a membership value greater than 0.5 assigned to a vegetation community cited in the final determination for LGW using Tozer et al. (2010) as rows and Thomas, Gellie & Harrison (2000), Gellie (2005) and Keith and Bedward (1999) units as columns. Cited map units are highlighted in bold. Plot membership of cited vegetation communities strongly overlapped between units e20p229 (Tozer et al. 2010), E20 and E21 of Keith and Bedward (1999) and vegetation group 54 (Thomas, Gellie & Harrison 2000; Gellie 2005).

	Keith and Bedward (1999)/ Thomas, Gellie & Harrison (2000)/Gellie (2005)															
	Keith and Bedward (1999)/ Thomas, Gellie & Harrison (2000)/Gellie (2005)	E18	E20			E21	E35			E39	g171	g50	M11	M14	M17	
Tozer et al. 2010	Thomas and Gellie (2000)	g54	g171	g52	g54	g54	g171	g50	g54	g52	g171	g50	g54	g171	g171	
	SCIVI Code															
	e18	2			1											3
	e20p229		1	1	40	36					2					80
	e35						1	1	2							4
	e39									7						7
	e85		1								1	10				12
	M17												1			1
	M4													1		1
	M7										1					1
	n184											1				1
	p3										5				1	6
	p434										1					1
	p86										1					1

	Grand Total	2	2	1	41	3 6	1	1	2	7	11	1 1	1	1	1	11 8

Appendix C.

Comparison between cited Brogo Wet Vine Forest and Dry Rainforest of the South East communities
The number of plots with a membership value greater than 0.5 assigned to a vegetation community from either Keith and Bedward (1999) or Thomas, Gellie & Harrison (2000) unit. The table shows that there is strong overlap between the units used to define BWVF (e18) and DYRF (e1) in Keith and Bedward (1999) and the corresponding unit in SCIVI (Tozer et al. 2010).

Keith and Bedward (1999)/ Thomas, Gellie & Harrison (2000) code	E1	E18	E19	E2	E20	E3	E34	E35	g171	M12	
SCIVI Code											
e1	10	1		4		1				2	18
e18	1	25	1		1		1	1	1	2	33
Grand Total	11	26	1	4	1	1	1	1	1	4	51

Appendix D

Lowland Grassy Woodland sampling effort by map classes in candidate state forests

State Forest	Tozer et al. (2010)(E20/p229)	Sample Effort		Gellie (2005) (g50,52,54)	Sample Effort		RN17 (93,65)	Sample Effort		New Red Gum API	Sample Effort	
	Hectares	Full Floristic	Rapid	Hectares	Full Floristic	Rapid	Hectares	Full Floristic	Rapid	Hectares	Full Floristic	Rapid
Benandarah State Forest	0	0	0	0	0	0	0	0	0	21	1	0
Bermagui State Forest	0	0	0	0	0	0	0	0	0	0	0	0
Bodalla State Forest	330	3	5	6	0	1	0	0	0	202	3	5
Bolaro State Forest	0	0	0	6	0	3	0	0	0	1	0	1
Boyne State Forest	0	0	0	2	0	0	0	0	0	0	0	0
Buckenbowra State Forest	13	0	2	0	0	0	0	0	0	90	2	10
Currowan State Forest	0	0	0	0	0	0	0	0	0	107	2	4
Dampier State Forest	0	0	0	21	0	0	0	0	0	557	5	21
East Boyd State Forest	63	1	0	0	0	0	0	0	0	0	0	0
Flat Rock State Forest	0	0	0	3	0	1	0	0	0	0	0	0
Mogo State Forest	150	3	2	0	0	0	41	0	2	128	5	10
Mumbulla State Forest	7	0	0	0	0	3	6	0	2	0	0	0
Murrah State Forest	1	0	0	0	0	0	0	0	0	0	0	0
Nadgee State Forest	121	0	0	0	0	0	0	0	1	0	0	0
Nullica State Forest	5	1	0	0	0	0	0	0	0	0	0	0
Tanja State Forest	4	0	0	0	0	0	0	0	0	0	0	0
Timbillica State Forest	12	0	0	0	0	0	0	0	0	0	0	0
Towamba State Forest	170	1	3	0	0	0	0	0	0	0	0	0
Wandella State Forest	0	0	0	45	0	2	0	0	0	68	1	1
Wandera State Forest	0	0	0	0	0	0	0	0	0	13	1	9

Yambulla State Forest	16	0	0	0	0	0	0	0	0	0	0	0
Total	891	9	12	85	0	10	47	0	5	1166	20	23

Appendix E

South coast vegetation communities and TEC status

Median and cumulative proportions of BWVF, LGW or DYRF final determination species in plots of vegetation communities (SCIVI, Tozer et al. 2010) analysed for the study area. Additional communities which we derived from analyses for our project but which do not closely match SCIVI communities have either and ‘xs’ or 'xg' prefix.

Table E1: Classification units from Thomas, Gellie & Harrison (2000) and Gellie (2005)

Thomas, Gellie & Harrison (2000) and Gellie (2005) Unit	Number of Plots	Median Proportion	Cumulative Number of Species	Status
g54	87	0.83	89.68	Included in LGW, cited
g171	27	0.73	75.98	Not cited but included because the community is strongly related to the final determination species list.
g49	97	0.53	70.84	Excluded not cited but considered under assessment of RFEF
g50	17	0.60	63.24	Included in LGW, cited
xg10	227	0.55	61.22	New group against Gellie (2005) classification and weakly related to LGW final determination assemblage list in comparison to primary group g54
xg1	104	0.38	53.1	
g47	43	0.39	52.72	
xg5	154	0.36	48.54	
xg6	116	0.35	47.5	
g9	56	0.34	46.5	
g48	90	0.32	46.22	
g10	19	0.31	43.42	
xg2	177	0.32	43	
g56	28	0.32	42.46	
g13	19	0.44	40.56	
g27	16	0.40	40.52	
g18	88	0.23	40.28	
g53	28	0.39	39.9	
g6	18	0.25	38.74	
g11	13	0.38	37.7	
g55	23	0.17	34.9	
g21	66	0.18	32.88	
g5	17	0.26	31.9	

Thomas, Gellie & Harrison (2000) and Gellie (2005) Unit	Number of Plots	Median Proportion	Cumulative Number of Species	Status
g57	51	0.15	31.34	
g19	41	0.23	31.22	
xg14	195	0.19	31.12	
g7	59	0.29	30.62	
xg13	129	0.14	28.94	
g28	28	0.28	28.92	
g8	49	0.28	28.76	
g1	81	0.11	27.2	
xg12	120	0.15	25.76	
g14	18	0.22	25.32	
g2	97	0.11	23.18	
g58	86	0.11	22.68	
g20	66	0.11	19.28	
g165	74	0.07	18.82	
xg11	153	0.13	17.7	
g25	19	0.13	17.34	
xg9	61	0.04	17.18	
g29	17	0.11	14.9	
xg15	199	0.05	14.74	
xg3	228	0.07	14.5	
g169	45	0.10	12.04	
g170	78	0.14	12.02	
g179	18	0.09	11.88	
g59	16	0.10	11.62	
g167	28	0.11	11.58	
g3	19	0.08	10.72	
g61	17	0.08	9.4	
g24	15	0.07	8.98	
g139	41	0.02	8.72	
g30	20	0.08	8.44	
xg8	122	0.05	8.22	
g141	13	0.00	7.9	
g138	13	0.02	7.32	
g136	23	0.00	7.22	
g166	99	0.04	6.74	
xg4	78	0.00	4.44	
g137	12	0.04	2.8	
g51	6	0.60	NA	
g52	5	0.41	NA	Included in LGW, cited

Thomas, Gellie & Harrison (2000) and Gellie (2005) Unit	Number of Plots	Median Proportion	Cumulative Number of Species	Status
g26	2	0.37	NA	
g33	8	0.29	NA	
g35	7	0.26	NA	
g15	2	0.26	NA	
g168	9	0.20	NA	
g12	8	0.20	NA	
g32	3	0.18	NA	
g92	2	0.17	NA	
g68	4	0.16	NA	
g64	8	0.15	NA	
xg7	4	0.08	NA	
g65	2	0.08	NA	
g62	9	0.06	NA	
g40	4	0.06	NA	
g144	4	0.05	NA	
g140	6	0.00	NA	
g142	4	0.00	NA	
g143	6	0.00	NA	
Other	2173	0.22		

Table C2: Classification units from Tozer et al. (2010)

Tozer et al. (2010)	Number of plots	Median proportion	Cumulative number of species	Status
e20p229	89	0.83	91.54	Included as LGW, cited (includes Keith and Bedward 1999; Tindall et al. 2004)
e18	16	0.63	76.64	Considered under Brogo Wet Vine Forest EEC
e19	66	0.55	69.54	Considered under RFEF EEC
W5/e85	20	0.60	66.18	Excluded not cited
xs17	90	0.55	62.88	
p3	19	0.58	60.3	Excluded part of Illawarra Grassy Woodland EEC
e35	28	0.57	57.16	Excluded, not cited
p34	31	0.48	55.68	Excluded part of Illawarra Grassy Woodland EEC
p33	53	0.46	53.92	Considered under RFEF EEC
xs11	59	0.58	51.42	
e1	19	0.44	51.12	
e34	26	0.34	51.1	

Tozer et al. (2010)	Number of plots	Median proportion	Cumulative number of species	Status
p87	38	0.37	50.66	
xs13	97	0.36	47.48	
n184	22	0.33	46.46	
n185	14	0.35	46.28	
xs20	51	0.37	45.92	
p434	13	0.41	45.18	
p38	40	0.29	44.38	
p30	16	0.44	41.64	
e17	14	0.21	40.74	
p90	55	0.33	40.62	
e13	20	0.26	39.34	
p32	27	0.39	39.12	
e39	12	0.26	38.6	
xs19	31	0.28	38.28	
p86	21	0.34	38.12	
e6e7	36	0.16	38.04	
xs5	47	0.29	36.58	
xs6	69	0.31	36.24	
p99	46	0.24	35.54	
e33	17	0.52	35.08	
e12	48	0.15	33.9	
e29	22	0.27	33.76	
e14	18	0.15	32.72	
e32a	37	0.29	32.54	
e26	18	0.28	32.04	
p146	20	0.21	31.62	
xs9	69	0.21	31.26	
xs1	40	0.18	30.48	
p85	36	0.23	29.88	
p168	18	0.22	29.76	
p91	33	0.24	29.34	
p64	46	0.26	28.16	
e42	42	0.11	28.16	
p104	51	0.17	28.1	
p246	26	0.19	27.22	
e3	17	0.29	27.04	
n183	48	0.17	26.68	
e44	28	0.18	26.66	
xs2	63	0.11	24.72	

Tozer et al. (2010)	Number of plots	Median proportion	Cumulative number of species	Status
xs12	35	0.12	21.6	
p63	35	0.21	21.52	
p100	22	0.16	20.16	
xs7	33	0.26	19.84	
e49	16	0.10	19.14	
p111	67	0.14	18.72	
p142	71	0.09	18.58	
p89	42	0.11	18	
p58	22	0.10	18	
p45	14	0.16	17.42	
e57	23	0.00	17.36	
p40	46	0.15	17.26	
xs18	64	0.09	17	
p103	32	0.09	16.48	
p110	64	0.11	16.4	
p105	35	0.17	15.52	
p98	36	0.08	15.5	
p116	17	0.10	15.36	
p95	46	0.09	15.36	
xs10	12	0.18	15.08	
p102	14	0.10	15	
p107	15	0.08	14.26	
p210	17	0.16	14.1	
xs16	60	0.08	13.44	
e55	47	0.03	12.92	
p109	16	0.00	12.12	
p148	68	0.04	12	
m15	11	0.06	11.34	
xs8	61	0.14	11.02	
p114	34	0.08	10.7	
p516	18	0.15	9.68	
p317	39	0.05	9.52	
p139	17	0.00	9.48	
p140	86	0.05	9.24	
e11	22	0.13	8.96	
p78	16	0.07	8.58	
p131	23	0.03	6.9	
p144	13	0.03	6.76	
p112	59	0.06	6.4	

Tozer et al. (2010)	Number of plots	Median proportion	Cumulative number of species	Status
xs4	95	0.04	6.2	
p113	81	0.04	6.12	
xs3	47	0.02	5.1	
xs14	23	0.00	4.5	
p106	58	0.00	3.1	
e46a	2	0.75	0	
p343	10	0.65	0	
p29	10	0.56	0	
p10	3	0.55	0	
p35	5	0.53	0	
p28	1	0.52	0	
p66	5	0.52	0	
p37	1	0.47	0	
p36	9	0.43	0	
p266	1	0.39	0	
p31	7	0.38	0	
p1	3	0.37	0	
e28	10	0.36	0	
p2	2	0.34	0	
p88	2	0.33	0	
e4	5	0.32	0	
p68	1	0.31	0	
e25	4	0.31	0	
p39	6	0.28	0	
p73	4	0.27	0	
p23	1	0.23	0	
	2477	0.22	0	
p338	4	0.20	0	
e52	8	0.19	0	
p44	5	0.17	0	
p143	6	0.17	0	
e38	2	0.16	0	
e10	8	0.16	0	
p153	4	0.16	0	
p11	1	0.16	0	
p56	2	0.15	0	
p8	2	0.13	0	
p248	3	0.11	0	
e81	8	0.11	0	

Tozer et al. (2010)	Number of plots	Median proportion	Cumulative number of species	Status
e15	7	0.09	0	
p149	7	0.07	0	
p15	1	0.07	0	
p76	1	0.06	0	
e56	10	0.05	0	
p141	6	0.05	0	
e60	9	0.05	0	
p314	2	0.04	0	
p244	1	0.03	0	
p122	9	0.02	0	
p136	2	0.02	0	
p129	3	0.00	0	

Appendix F

Plots assessed as Lowland Grassy Woodland (LGW)

Table F1: Reference plots are those which are strongly matched floristically to a community cited in the final determination. We have a high degree of confidence that these belong to LGW.

Survey ID	Plot Name	Latitude	Longitude	IBRA 4	SCIVI Unit	SCIVI Unit Membership	Gellie (2005)/Keith and Bedward (1999) Units	Gellie (2005)/Keith and Bedward (1999) Membership
SEFCOMB	3BEG01W	-36.691324	149.811705	SEC	e20p229	0.86	E20	0.92
SEFCOMB	3BEG04W	-36.695826	149.811870	SEC	e20p229	0.78	E20	0.92
SEFCOMB	3BEG08S	-36.677313	149.794413	SEC	e20p229	0.91	E21	0.98
SEFCOMB	3BEG09W	-36.667224	149.801879	SEC	e20p229	0.93	E20	0.96
SEFCOMB	3BEG12S	-36.641531	149.783055	SEC	e20p229	0.95	E20	0.94
SEFCOMB	3CAN01N	-36.766251	149.608339	SEC	e20p229	0.65	E21	0.75
SEFCOMB	3CAN02E	-36.765301	149.610547	SEC	e20p229	0.91	E21	0.99
SEFCOMB	3CAN04S	-36.760231	149.636136	SEC	e20p229	0.93	E21	0.94
SEFCOMB	4BEM11N	-36.741472	149.669087	SEC	e20p229	0.97	E20	0.86
SEFCOMB	4BEM13W	-36.744973	149.673688	SEC	e20p229	0.96	E20	0.97
SEFCOMB	4BEM14E	-36.740496	149.672413	SEC	e20p229	0.91	E20	0.95
SEFCOMB	4BEM15W	-36.746799	149.672631	SEC	e20p229	0.93	E20	0.96
SEFCOMB	4BEM17N	-36.735968	149.673375	SEC	e20p229	0.96	E21	0.99
SEFCOMB	4BEM18N	-36.705792	149.611889	SEC	e20p229	0.85	E21	0.97
SEFCOMB	4BEM19W	-36.710466	149.604212	SEC	e20p229	0.99	E21	0.99
SEFCOMB	4BEM1W	-36.672832	149.675663	SEC	e20p229	0.98	E20	0.55
SEFCOMB	4BEM20S	-36.707813	149.601884	SEC	e20p229	0.92	E21	0.89
SEFCOMB	4BEM21W	-36.656433	149.602390	SEC	e20p229	0.98	E21	1.00
SEFCOMB	4BEM22E	-36.705841	149.609652	SEC	e20p229	0.97	E21	1.00
SEFCOMB	4BEM23W	-36.689067	149.552015	SEC	e20p229	0.88	E20	0.36
SEFCOMB	4BEM24W	-36.688166	149.551985	SEC	e20p229	0.99	E21	0.67
SEFCOMB	4BEM25R	-36.669962	149.560333	SEC	e20p229	0.97	E21	1.00
SEFCOMB	4BEM26E	-36.634453	149.577049	SEC	e20p229	0.68	E21	0.95
SEFCOMB	4BEM2S	-36.670307	149.667745	SEC	e20p229	0.90	E20	0.84
SEFCOMB	4BEM4W	-36.734443	149.661006	SEC	e20p229	0.96	E20	0.97
SEFCOMB	4BEM6W	-36.728190	149.658551	SEC	e20p229	0.90	E21	0.98
SEFCOMB	4BEM7N	-36.738921	149.662280	SEC	e20p229	0.97	E20	0.93
SEFCOMB	4BEM9N	-36.740596	149.667937	SEC	e20p229	0.73	E20	0.53
SEFCOMB	4BRO13N	-36.472815	149.810482	SEC	e20p229	0.90	E20	0.90
SEFCOMB	4BRO14E	-36.565082	149.814940	SEC	e20p229	0.94	E20	0.96
SEFCOMB	4BRO18S	-36.575392	149.759448	SEC	e20p229	0.56	E19	0.42

Survey ID	Plot Name	Latitude	Longitude	IBRA 4	SCIVI Unit	SCIVI Unit Member ship	Gellie (2005)/K eith and Bedward (1999) Units	Gellie (2005)/K eith and Bedward (1999) Member ship
SEFCOMB	4BRO3N	-36.575092	149.810834	SEC	e20p229	0.74	E20	0.90
SEFCOMB	4CAN1E	-36.759205	149.682022	SEC	e20p229	0.95	E20	0.71
SEFCOMB	4CAN2S	-36.785998	149.732254	SEC	e20p229	0.53	E19	0.42
SEFCOMB	4CAN3E	-36.797832	149.727072	SEC	e20p229	0.91	E21	0.83
SEFCOMB	4COB1N	-36.477451	149.824040	SEC	e20p229	0.88	E20	0.95
SEFCOMB	4WOL10W	-36.757282	149.765954	SEC	e20p229	0.99	E20	0.90
SEFCOMB	4WOL11E	-36.757308	149.764835	SEC	e20p229	0.99	E20	0.96
SEFCOMB	4WOL3R	-36.775087	149.813644	SEC	e20p229	0.65	E20	0.79
SEFCOMB	4WOL6E	-36.752832	149.763554	SEC	e20p229	0.82	E20	0.94
SEFCOMB	4WOL7S	-36.755507	149.764770	SEC	e20p229	0.74	E20	0.99
SEFCOMB	4WOL8E	-36.753680	149.765825	SEC	e20p229	0.99	E20	0.98
SEFCOMB	4WOL9W	-36.753654	149.766944	SEC	e20p229	0.92	E20	0.83
SEFCOMB	5BEG1N	-36.640185	149.802017	SEC	e20p229	0.90	E20	0.94
SEFCOMB	5BEG3N	-36.704139	149.841271	SEC	e20p229	0.92	E21	0.92
SEFCOMB	5BEM11W	-36.668178	149.641941	SEC	e20p229	0.89	E21	1.00
SEFCOMB	5BEM12E	-36.637107	149.579374	SEC	e20p229	0.97	E21	0.99
SEFCOMB	5BEM1E	-36.698235	149.668150	SEC	e20p229	0.90	E21	1.00
SEFCOMB	5BEM2E	-36.700048	149.667653	SEC	e20p229	0.94	E21	1.00
SEFCOMB	5BEM3N	-36.666253	149.647468	SEC	e20p229	0.66	E20	0.57
SEFCOMB	5BEM4W	-36.667154	149.647499	SEC	e20p229	0.94	E21	0.96
SEFCOMB	5BEM5S	-36.666278	149.646350	SEC	e20p229	0.50	E21	0.79
SEFCOMB	5BEM6E	-36.667104	149.649735	SEC	e20p229	0.64	E21	0.96
SEFCOMB	5BEM9N	-36.667203	149.645263	SEC	e20p229	0.92	E21	1.00
SEFCOMB	5BRO9N	-36.551707	149.808870	SEC	e20p229	0.65	E20	0.69
SEFCOMB	5WOL10E	-36.784939	149.816245	SEC	e20p229	0.94	E20	0.97
SEFCOMB	5WOL13W	-36.784886	149.818484	SEC	e20p229	0.67	E20	0.88
SEFCOMB	5WOL1N	-36.791132	149.782858	SEC	e20p229	0.69	E20	0.94
SEFCOMB	5WOL3W	-36.791158	149.781738	SEC	e20p229	0.76	E20	0.72
SEFCOMB	5WOL4N	-36.787624	149.835950	SEC	e20p229	0.58	E20	0.73
SEFCOMB	5WOL5W	-36.789969	149.832115	SEC	e20p229	0.97	E20	0.99
SEFCOMB	5WOL6W	-36.785680	149.822994	SEC	e20p229	0.88	E20	0.99
SEFCOMB	5WOL9N	-36.783138	149.816179	SEC	e20p229	0.88	E20	0.69
EDENVI	6BEG01E	-36.724311	149.864404	SEC	e20p229	0.99	E20	0.91
P5MA	ARA007G	-35.677249	149.792590	SEC	e20p229	0.56	E21	0.63
P5MA	ARA010	-35.693826	149.794612	SEC	e20p229	0.90	E21	0.71
P_BEGA_FB 4	JMBEG06	-36.728934	149.909715	SEC	e20p229	0.53	E20	0.43

Survey ID	Plot Name	Latitude	Longitude	IBRA 4	SCIVI Unit	SCIVI Unit Membership	Gellie (2005)/Keith and Bedward (1999) Units	Gellie (2005)/Keith and Bedward (1999) Membership
P_BEGA_FB4	JMBEG09	-36.731309	149.849964	SEC	e20p229	0.79	g171	0.57
P_BEGA_FB4	JMBEG10	-36.732877	149.828806	SEC	e20p229	0.89	E20	0.99
P_BEGA_FB4	JMBEM04	-36.669105	149.731067	SEC	e20p229	0.96	E21	0.74
V_BIAMAFB4	JMBIA05	-36.424903	149.887604	SEC	e20p229	0.66	E20	0.55
P_BEGA_FB4	JMBRO01	-36.553709	149.785027	SEC	e20p229	0.94	E21	0.64
P_BEGA_FB4	JMBRO04	-36.557614	149.758581	SEC	e20p229	0.66	g171	0.52
P_BEGA_FB4	JMBRO06	-36.515014	149.762437	SEC	e20p229	0.56	E20	0.34
P_BEGA_FB4	JMBRO08	-36.531775	149.845647	SEC	e20p229	0.83	E20	0.75
P_BEGA_FB4	JMCAN02	-36.845121	149.728886	SEC	e20p229	0.98	E21	0.70
P_BEGA_FB4	JMCOB04	-36.464017	149.870702	SEC	e20p229	0.83	E21	0.54
P_BEGA_FB4	JMCOB06	-36.472079	149.774157	SEC	e20p229	0.88	E21	0.91
P_BEGA_FB4	JMCOB14	-36.382359	149.884937	SEC	e20p229	0.86	E20	0.70
P_BEGA_FB4	JMCOB15	-36.386485	149.895823	SEC	e20p229	0.63	E20	0.34
V_WADBSFB4	JMWAD06	-36.500542	149.744833	SEC	e20p229	0.75	E20	0.51
V_WADBSFB4	JMWAD06	-36.500542	149.744833	SEC	e20p229	0.75	E20	0.51
P5MA	MOR002LG	-35.910533	150.059174	SEC	e20p229	0.70	g171	0.37
P_TOWAMFB4	PMCOOL01	-36.911802	149.487088	SEC	e20p229	0.60	E21	0.61
P_TOWAMFB4	PMWYND06	-36.934462	149.647360	SEC	e20p229	0.76	E21	0.85
P5MA	ARA009	-35.671704	149.796337	SEC	M7	0.64	E21	0.92
NP_DEUA	DEUA0072	-35.896769	149.874145	SEC	p34	0.11	g50	0.93
NP_DEUA	DEUA0073	-35.896716	149.876359	SEC	e19	0.13	g50	0.63
NP_DEUA	DEUA0076	-35.930907	149.878706	SEC	e85	0.46	g50	0.60
NP_DEUA	DEUA0085	-36.071650	149.637377	SEC	e85	0.77	g50	0.98
NP_DEUA	DEUA0086	-36.068145	149.632820	SEC	e85	0.94	g50	0.99
NP_DEUA	DEUA0089	-36.084234	149.638908	SEC	e85	0.96	g50	0.98
V_KOORAFB3	JMKOO02	-36.199950	149.761871	SEC	e85	1.00	g50	0.64

Survey ID	Plot Name	Latitude	Longitude	IBRA 4	SCIVI Unit	SCIVI Unit Membership	Gellie (2005)/Keith and Bedward (1999) Units	Gellie (2005)/Keith and Bedward (1999) Membership
V_KOORAFB3	JMKOO03	-36.198036	149.761236	SEC	e85	0.97	E20	0.70
V_KOORAFB3	JMKOO04	-36.203032	149.766160	SEC	e85	0.95	g50	0.71
V_TANTYFB3	JMTYU28Z	-36.832895	149.651107	SEC	e20p229	0.39	E21	0.53
NP_SCRA	SZ22356M	-35.924775	150.075133	SEC	e20p229	0.92	E21	0.85
V_WADBSFB4	JMWAD15	-36.367646	149.726425	SEC	e85	0.83	g50	0.62
P_TOWAMFB4	PMWYND03	-36.931907	149.515380	SEC	e20p229	0.41	E21	0.74
P_TOWAMFB4	PMWYND05	-36.927524	149.633504	SEC	e20p229	0.33	E21	0.85
NP_SCRA	SZ22357G	-36.359281	149.866558	SEC	e20p229	0.73	E21	0.75
SF_QFS	QFS088	-36.132576	149.612751	SEC	e85	0.54	g50	0.86
SF_QFS	QFS090	-36.117449	149.620358	SEC	e85	0.73	g50	0.97
SF_QFS	QFS111	-36.130792	149.616025	SEC	e85	0.68	g50	0.86
NP_SCRA	SZ22064	-35.824439	149.864893	SEC	n184	0.83	g50	0.59
NP_SCRA	SZ22438M	-36.371542	149.955043	SEC	e20p229	0.91	E21	0.86
NP_SCRA	SZ24057M	-35.855443	149.772736	SEC	e19	0.31	g50	0.66
NP_SCRA	SZ24059R	-35.853744	149.768249	SEC	e85	0.58	g50	0.76
StateFores	CDE12O0F	-36.168578	149.770202	SEC	e85	0.96	g50	0.58
ELA_Moruya	MORZ14P1	-35.929691	150.091601	SEC	M7	1.00	E21	0.65
ELA_Moruya	MORZ5P1	-35.939668	150.093861	SEC	M7	0.99	E21	0.90

Table F2: Reference plots which are strongly matched floristically to the final determination assemblage list because of their relationship with Gellie (2005) unit g171. However, this unit is not cited in the determination. As a result, we have a lower degree of confidence that these belong to LGW.

Survey ID	Plot Name	Latitude	Longitude	IBRA4	SCIVI Unit	SCIVI Unit Membership	Gellie (2005) /Keith and Bedward (1999) Units	Gellie (2005) /Keith and Bedward (1999) Me

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StateForestsEEC	CDE07O7L	-36.208769	149.869025	SEC	e20p229	0.33	g171	0.91
NP_EURO	EP012M	-35.913686	150.119303	SEC	e20p229	0.4	g171	0.99
NP_EURO	EP023M	-35.637842	150.079552	SEC	p3	0.47	g171	0.99
NP_EURO	EP029M	-35.935938	150.052558	SEC	M7	0.33	g171	1
V_KOORAFB3	JMKOO16	-36.209595	149.840656	SEC	e34	0.27	g171	0.76
NP_SCRA	SZ24038	-35.925988	150.124951	SEC	p3	0.45	g171	0.95
StateForestsEEC	NEL14G5L	-35.651472	150.061502	SEC	p3	0.48	g171	0.68
StateForestsEEC	NEL15G7M	-35.643783	150.026595	SEC	p34	0.22	g171	0.51
GAP_EAST	BOD60U0F	-36.035166	150.089888	SEC	M3	0.22	g171	0.5

Appendix G

Plots assessed as Brogo Wet Vine Forest

Reference plots are those that are strongly matched floristically to a community cited in the final determination. We have a high degree of confidence that these belong to BWVF.

Survey ID	Plot Name	Latitude	Longitude	SCIVI Unit	SCIVI Unit Membership	Gellie (2005) /Keith and Bedward (1999) Units	Gellie (2005) /Keith and Bedward (1999) Membership
SEFCOMB	3BEG05S	-36.670240	149.788564	e18	0.73	E18	0.99
SEFCOMB	3BEG06S	-36.673790	149.790929	e18	0.5	E18	0.86
SEFCOMB	3BEG13E	-36.659931	149.766939	e18	0.97	E18	0.99
SEFCOMB	3BEG14N	-36.658234	149.762404	e18	0.99	E18	0.98
SEFCOMB	3BEG15S	-36.663559	149.765950	e1	0.47	E18	0.96
SEFCOMB	3BEG16E	-36.666260	149.766047	e18	1	E18	1
SEFCOMB	3BRO01R	-36.574507	149.797406	e18	0.57	E18	0.35
SEFCOMB	3BRO02N	-36.573607	149.797373	e18	0.57	E20	0.63
SEFCOMB	3BRO06W	-36.586631	149.779963	e18	0.99	E18	1
SEFCOMB	4BEM5S	-36.731742	149.660913	e19	0.49	E18	0.66
SEFCOMB	4BRO12E	-36.519123	149.776428	e18	0.95	E18	1
SEFCOMB	4BRO1N	-36.525504	149.773307	e18	0.99	E18	0.99
SEFCOMB	4BRO2G	-36.521877	149.774294	e18	0.97	E18	0.99
SEFCOMB	5BEG2S	-36.643708	149.805499	e18	0.77	E18	1
SEFCOMB	5BRO4N	-36.527919	149.785676	e18	0.96	E18	0.97
EDENVI	6CAN01N	-36.841174	149.683763	e18	0.69	E1	0.84
EDENVI	6CAN02N	-36.822809	149.535153	e18	0.99	E18	0.99
NP_LOCHIEL	BALDHIL1	-36.920537	149.834011	e18	0.52	E18	0.34
StateForest	CDE06A0F	-36.208147	149.869758	e18	0.36	E18	0.58
NP_ECRA	EDN020AG	-36.890048	149.829977	M11	0.46	E18	0.78
P_BEGA_FB4	JMBEM01	-36.645189	149.719966	e19	0.55	E18	0.56
P_BEGA_FB4	JMBEM03	-36.666316	149.732042	e18	0.88	E18	0.69
P_BEGA_FB4	JMBEM05	-36.665598	149.734254	e18	0.85	E18	0.98
P_BEGA_FB4	JMBEM06	-36.658804	149.731441	e18	0.91	E18	0.93
V_BIAMAFB4	JMBIA12	-36.533292	149.846998	e18	0.68	E18	0.22
V_BIAMAFB4	JMBIA14	-36.530934	149.848005	e18	0.92	E18	0.52
P_BEGA_FB4	JMBRO02	-36.557083	149.784489	e19	0.52	E18	0.4
P_BEGA_FB4	JMBRO03	-36.557494	149.774584	e18	0.9	E19	0.35
P_BEGA_FB4	JMBRO07	-36.531146	149.844797	e18	0.97	E18	0.72
P_BEGA_FB4	JMBRO10	-36.534525	149.843704	e18	0.59	E34	0.25
P_BEGA_FB4	JMBRO12	-36.504757	149.835068	e18	0.87	E18	0.74

Survey ID	Plot Name	Latitude	Longitude	SCIVI Unit	SCIVI Unit Membership	Gellie (2005) /Keith and Bedward (1999) Units	Gellie (2005) /Keith and Bedward (1999) Membership
P_BEGA_FB4	JMCAN01	-36.844877	149.741828	e19	0.46	E18	0.5
V_COOLAFB4	JMCOO24	-37.071862	149.602276	e19	0.81	E18	0.45
V_TANTYFB3	JMTYU26Z	-36.831648	149.648844	e18	0.71	E35	0.31
V_TANTYFB3	JMTYU29Z	-36.840278	149.645767	e18	0.46	E18	0.67
V_TANTYFB3	JMTYU37Z	-36.855805	149.802573	e18	0.95	E18	0.44
V_WADBSFB4	JMWAD03	-36.510989	149.745515	e18	0.99	E18	0.8
P5MA	KAI013G	-35.715711	149.737536	e19	0.71	E18	0.42
P_TOWAMFB4	PMBURR11	-37.068702	149.698837	n185	0.53	E18	0.18
NP_SCRA	SZ22450R	-36.326399	150.080228	e18	0.82	g171	0.47
MILES_06	YUR04	-36.849607	149.797144	e18	0.88	E18	0.81
FSC_Zieria	Zieria_12A	-36.328307	150.028230	e18	0.59	M12	0.5
StateForestsEEC	CTL03G6U	-36.282679	150.040892	E18	Based on spp count in Tozer et al. (2010)		

Appendix H

Plots assessed as Dry rainforest of the South East Forests

Survey ID	Plot Name	Latitude	Longitude	SCIVI Unit	SCIVI Unit Membership	Keith and Bedward (1999) Units	Keith and Bedward (1999) Membership
SEFCOMB	2BUR12N	-37.070625	149.618732	e1	0.9	E1	0.99
SEFCOMB	1COO33	-36.900800	149.469281	e1	0.98	E1	1.00
SEFCOMB	1COO8	-36.970775	149.441215	e1	0.47	E2	0.96
SEFCOMB	1WYN13	-36.952045	149.518097	e1	1	E1	1.00
SEFCOMB	1WYN2	-36.985426	149.558516	e1	1	E1	1.00
SEFCOMB	4BRO5N	-36.581474	149.807714	e1	0.99	E1	1.00
SEFCOMB	5BRO3N	-36.525721	149.783364	e1	0.94	E1	0.90
ENC_KOAL	CEFR22	-36.918961	149.475703	e1	0.61	E2	1.00
ENC_KOAL	CEFR24	-36.925822	149.475140	e1	0.87	E2	1.00
ENC_KOAL	CEFR25	-36.921063	149.474312	e1	0.96	E2	1.00
V_GULAGFB4	JMGUL14	-36.324542	150.041775	e1	0.86	M12	0.40
V_YOWAKFB4	JMYO183	-37.055679	149.700501	e1	0.86	E2	0.75
LITTLEDROM	LDROM03	-36.325919	150.078297	e1	0.6	E1	0.61
NP_LOCHIEL	LOCHIEL2	-36.962867	149.785900	e1	0.98	E1	1.00
P_TOWAMFB4	PMBURR01	-37.037255	149.635830	e1	1	E1	1.00
NP_SCRA	SZ22435G	-36.327507	150.089085	e1	0.74	M12	0.45
NP_SCRA	SZ22439M	-36.328004	150.035619	e1	0.9	E1	0.95
MILES_06	YUR01	-36.851189	149.790036	e1	0.76	E18	0.65
NP_ECRA	ED21037M	-36.926789	149.476293	e1	0.67	E3	0.50
StateForestsEEC	BRT01G8U	-37.038899	149.639031	E1	Based on spp count in Tozer et al. (2010)		
StateForestsEEC	BRT02G3L	-37.074042	149.616418	E1	Based on spp count in Tozer et al. (2010)		

Appendix I: Field key for identification of Lowland Grassy Woodland in the South East Corner Bioregion

This key assumes the vegetation to be assessed is in an area within South East Corner Bioregion (south of latitude 35.4, near North Brooman SF, IBRA version 4) and below 500 m elevation. Lowland Grassy Woodland TEC (LGWL) by definition does not occur outside this Bioregion and there is no indication that it occurs above 500 m. Assessment should be done in 20m x 20m plots or areas of similar size. The more plots assessed, the more reliable the result. Likelihoods given below are mean proportions based on a single plot and have been rounded to the nearest 5%. This key and the likelihoods provided are based on distinguishing LGWL from other vegetation communities including other TECs. Vegetation identified as LGWL by this key may also, or alternatively, belong to other TECs, including River-flat eucalypt forest.

To use this key, count the number of species present which are in the list of positive diagnostic species (Table 1, first column) to use as the row and the number present which are in the list of negative diagnostic species (Table 1, second column) to use as the column. Read the cell in Table 2 corresponding to the row and column counts to obtain an estimate of the likelihood that the vegetation is Lowland Grassy Woodland TEC. Likelihoods for the case where no positive diagnostic species are present use the upper 95% confidence limit. In other cases, mean likelihoods are given and have an uncertainty of approximately +/- 5%.

Table 1 Diagnostic species for Lowland Grassy Woodland

Positive diagnostic	**Negative diagnostic**
Eragrostis leptostachya	Smilax australis
Themeda triandra	Dianella caerulea
Eucalyptus tereticornis	Morinda jasminoides
Dichondra repens	Gonocarpus teucrioides
Hydrocotyle laxiflora	Cissus hypoglauca
Bursaria spinosa	Blechnum cartilagineum
Microlaena stipoides	Elaeocarpus reticulatus
Acacia mearnsii	Platysace lanceolata
Glycine clandestina	Acmena smithii
Angophora floribunda	Tylophora barbata

Table 2 Estimates of likelihood that vegetation is Lowland Grassy Woodland

		Number of negative species					
		0	<=1	<=2	<=3	<=4	<=5
Number of positive species	0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	>=1	0.30	0.20	0.15	0.10	0.10	0.10
	>=2	0.35	0.25	0.15	0.15	0.15	0.10
	>=3	0.45	0.30	0.20	0.20	0.15	0.15
	>=4	0.50	0.35	0.30	0.25	0.25	0.20
	>=5	0.65	0.45	0.40	0.35	0.35	0.30