

Assessment of Coastal Saltmarsh TEC on NSW Crown Forest Estate

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

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Published by:

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

Report pollution and environmental incidents

Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
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1 Overview

Coastal Saltmarsh is a threatened ecological community (TEC) associated with the intertidal zone on the shores of estuaries and lagoons along the NSW coast. Our study assesses whether Coastal Saltmarsh is located within the 1.4 million hectares of state forest found within the South, Central and North Coast regions of NSW.

We used an agreed interpretation of the TEC by a project TEC Reference Panel (the Panel), to identify treeless saline and sub saline native vegetation found in the intertidal zone. A fine scale digital elevation model was used to estimate the highest astronomical tide line (HAT) to provide an indicative extent of the intertidal zone in our northern and southern study areas.

Mapping of candidate saltmarsh TEC was undertaken using recent fine scale three-dimensional aerial imagery. Interpreters experienced in mapping native vegetation patterns identified categories of native vegetation that comprised low growing treeless communities within the HAT situated on the landward side of mangroves. Mapping criteria used a tolerance of tree cover of up to 30 percent to include areas that comprise a mixed cover of mangrove, paperbark and casuarina species (or combinations of all three) with a saltmarsh understorey. Exposed mudflats and banks were also mapped where visible.

Our mapping identified 111.9 hectares of Coastal Saltmarsh restricted to 14 state forests along the East Coast. The most extensive areas are located in Bermagui and Mogo State Forests on the South Coast, and Wallaroo State Forest on the North Coast.

We validated our map of Coastal Saltmarsh using an independent map of estuarine habitats produced by Creese et al. (2009). We mapped almost twice as much saltmarsh as Creese et al. (2009), and this was consistent across most state forests, although in Mogo State Forest we mapped significantly more. This is to be expected because the mapping criteria differed between studies, and areas we classified as saltmarsh have in some instances been mapped by Creese et al. (2009) as mangrove or not mapped at all. Conversely, we identified 12.6 hectares of saltmarsh mapped by Creese et al. (2009) in Wallaroo State Forest which we classified as mangrove. We revisited this area and concluded it is likely to be an attribution error in that study.

2 Introduction

2.1 Project Rationale

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

2.2 Final Determination

Coastal Saltmarsh in the North Coast, Sydney Basin and South East Corner bioregions (Coastal Saltmarsh) was first gazetted as an Endangered Ecological Community on 4 June 2004 (NSW Scientific Committee 2004). Minor amendments to the determination were made in 2011.

Paragraphs 1 and 5 of the final determination define the location and habitat of Coastal Saltmarsh as the intertidal zone on the shores of estuaries and lagoons where it is frequently found in a zone landward of mangrove stands.

The species list presented in Paragraph 2 describes a treeless community of salt tolerant sedges, rushes and herbs. Paragraph 5 also describes some additional compositional attributes including occasional scattered mature *Avicennia marina* trees and *Avicennia* (and less frequently *Aegiceras corniculatum*) seedlings may occur throughout saltmarsh. Paragraph 5 also makes reference to a number of tall reed species that are included within Coastal Saltmarsh (*Phragmites australis*, *Bulboschoenus* spp., *Schoenoplectus* spp. and *Typha* spp.) however, these species are not included in the species listed in Paragraph 1. Adam et al. (1988) is referenced as a source of more extensive species lists than those used in Paragraph 1.

Paragraph 7 of the final determination (NSW Scientific Committee 2011) refers to variation in compositional attributes of saltmarsh assemblages along the NSW coast.

2.3 Initial TEC Reference Panel Interpretation

Under the *Threatened Species Conservation Act 1995* (TSC Act), TECs are defined by two characteristics: an assemblage of species and a particular location. The TEC Panel agreed that the occurrence of Coastal Saltmarsh is constrained to the IBRA bioregions stated in the final determination. The Panel considered the characteristic species list but reached agreement that insufficient information was included to diagnose candidate areas at a site scale across the expansive latitudinal gradient circumscribed by the determination. The Panel agreed that the statements used to define the structural characteristics of Coastal Saltmarsh provided a useful diagnostic tool when used in combination with the identified bioregions and habitat characteristics. The Panel considered that the application of precautionary mapping criteria using broad mapping thresholds was likely to result in a more inclusive definition of Coastal Saltmarsh than efforts to assign individual sites to the determination species assemblage list. Table 1 outlines the review of the determination by the Panel.

Table 1: Key features of Coastal Saltmarsh of potential diagnostic value. Numbers in the left-hand column refer to paragraph numbers in the final determination.

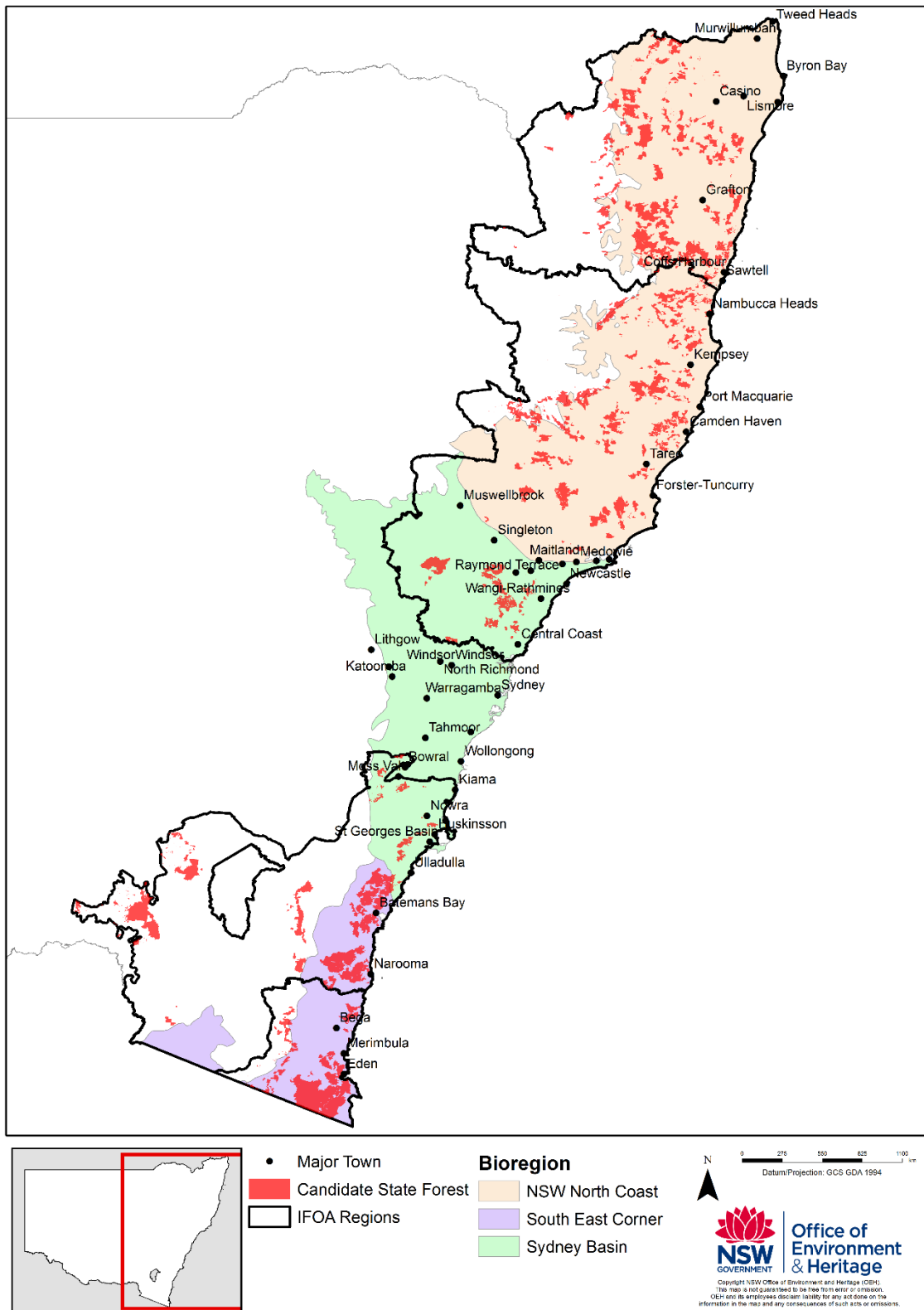
Feature		Diagnostic value and use for this assessment
1	NSW occurrences fall within North Coast, Sydney Basin and South East Corner bioregions	Explicitly diagnostic
1, 5	Occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands	Indicative and used to limit the area of assessment to the intertidal zone
1	Characterised by the listed 10 plant species	Potentially diagnostic
5	Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam et al. 1988). These headland communities and those of inland saline areas are not included within this determination of the Coastal Saltmarsh Ecological Community	Diagnostic. Headlands explicitly excluded from the assessment areas
4	Occasional scattered mature <i>Avicennia marina</i> trees occur through saltmarsh at some sites, and <i>Avicennia</i> (and less frequently <i>Aegiceras corniculatum</i>) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (<i>Phragmites australis</i> , <i>Bulboschoenus</i> spp., <i>Schoenoplectus</i> spp., <i>Typha</i> spp.) may occur as part of the community	Indicative, 'occasional' and 'scattered' not defined for mangrove spp. 'Dense' and 'part' not defined in relation to proportion of additional reed species in a site
7	Description of species compositional attributes in response to environmental gradients	Indicative not used

2.4 Assessment Area

Location and study area boundaries

Our study area is shown in Map 1. This area includes all of the NSW coastline across the North Coast, Sydney Basin and South East Corner bioregions.

Map 1: Assessment area showing study area bioregions.



State forests subject to assessment

The study area includes Crown forest estate situated within Upper North East, Lower North East, Southern and Eden Integrated Forestry Operations Approval (IFOA) regions, (Table 2a and 2b, Map 2). State forests excluded from the assessment include those areas defined as Forest Management Zones 5 (Hardwood Plantations) and Zone 6 (Softwood Plantations). Small areas of native forest wholly enclosed or adjoining Forest Management Zone 6 (Softwoods) are also excluded from assessment as they are considered to be outside of the authority of the IFOA.

Table 2a: List of candidate state forests assessed in the Southern and Eden IFOA regions.

State Forest	Area (Ha)	State Forest	Area (Ha)
Badja State Forest	4839	Moruya State Forest	4059
Bateman State Forest	1	Mumbulla State Forest	6137
Belanglo State Forest	3891	Murrah State Forest	4215
Benandarah State Forest	2761	Nadgee State Forest	20537
Bermagui State Forest	1861	Nalbaugh State Forest	4396
Bodalla State Forest	24079	Newnes State Forest	281
Bolaro State Forest	1779	North Brooman State Forest	3631
Bombala State Forest	620	Nowra State Forest	521
Bondi State Forest	12742	Nullica State Forest	18298
Boyne State Forest	6161	Nungatta State Forest	887
Broadwater State Forest	167	Penrose State Forest	1986
Bruces Creek State Forest	791	Shallow Crossing State Forest	3855
Buckenbowra State Forest	5193	Shoalhaven State Forest	104
Cathcart State Forest	1735	South Brooman State Forest	5587
Clyde State Forest	3587	Tallaganda State Forest	1363
Coolangubra State Forest	8489	Tanja State Forest	867
Corunna State Forest	183	Tantawangalo State Forest	2466
Currumbene State Forest	1695	Termeil State Forest	698
Currowan State Forest	11977	Timbillica State Forest	9144
Dampier State Forest	33746	Tomerong State Forest	212
East Boyd State Forest	21010	Towamba State Forest	5471
Flat Rock State Forest	4896	Wandella State Forest	5492
Glenbog State Forest	4641	Wandera State Forest	5198
Gnupa State Forest	1318	Wingello State Forest	3975
Jellore State Forest	1411	Woodburn State Forest	10
Jerrawangala State Forest	268	Yadboro State Forest	10750
Kioloa State Forest	171	Yambulla State Forest	47108
Mcdonald State Forest	3684	Yarrawa State Forest	179
Meryla State Forest	4554	Yerriyong State Forest	6604
Mogo State Forest	15498	Yurammie State Forest	4050
		Total	352931

Table 2b: List of candidate state forests assessed in the Upper and Lower North East IFOA regions.

Candidate State Forest (SF)	Area (Ha)	Candidate State Forest (SF)	Area (Ha)
Aberdare SF	6	Lansdowne SF	4,118
Avon River SF	5,061	Little Newry SF	189
Awaba SF	1,784	London Bridge SF	118
Bachelor SF	2,642	Lorne SF	3,257
Bagawa SF	5,384	Lower Bucca SF	2,621
Bald Knob SF	1,695	Lower Creek SF	1,270
Ballengarra SF	6,106	Malara SF	3,352
Banyabba SF	2,674	Marara SF	5,351
Barcoongere SF	320	Marengo SF	10,128
Barrington Tops SF	12,588	Maria River SF	1,815
Beaury SF	4,568	Masseys Creek SF	3,127
Bellangry SF	6,411	Mcperson SF	6,488
Ben Halls Gap SF	351	Medowie SF	50
Billilimbra SF	3,853	Mernot SF	4,338
Boambee SF	821	Middle Brother SF	2,131
Bom SF	872	Mistake SF	5,638
Bonalbo SF	1,456	Moogem SF	1,135
Bookookoorara SF	915	Moonpar SF	1,821
Boonanghi SF	3,817	Mororo SF	379
Boonoo SF	3,968	Mount Belmore SF	9,181
Boorabee SF	914	Mount Boss SF	17,165
Boorook SF	2,990	Mount Lindesay SF	3,046
Boundary Creek SF	2,539	Mount Marsh SF	3,636
Bowman SF	3,187	Mount Mitchell SF	2,323
Braemar SF	2,002	Mount Pikapene SF	553
Brassey SF	745	Mount Seaview SF	1
Bril SF	2,333	Muldiva SF	687
Broken Bago SF	3,543	Myall River SF	13,611
Brother SF	6,179	Myrtle SF	4,303
Buckra Bendinni SF	1,766	Nambucca SF	1,510
Bulahdelah SF	7,799	Nana Creek SF	1,793
Bulga SF	14,254	Nerong SF	2,173
Bulls Ground SF	2,010	Never SF	3
Bungabbee SF	1,097	Newfoundland SF	5,939
Bungawalbin SF	1,204	Newry SF	2,841
Burrawan SF	2,040	North Branch SF	796
Cairncross SF	4,487	Nowendoc SF	3,765
Camira SF	4,009	Nulla-five Day SF	3,370

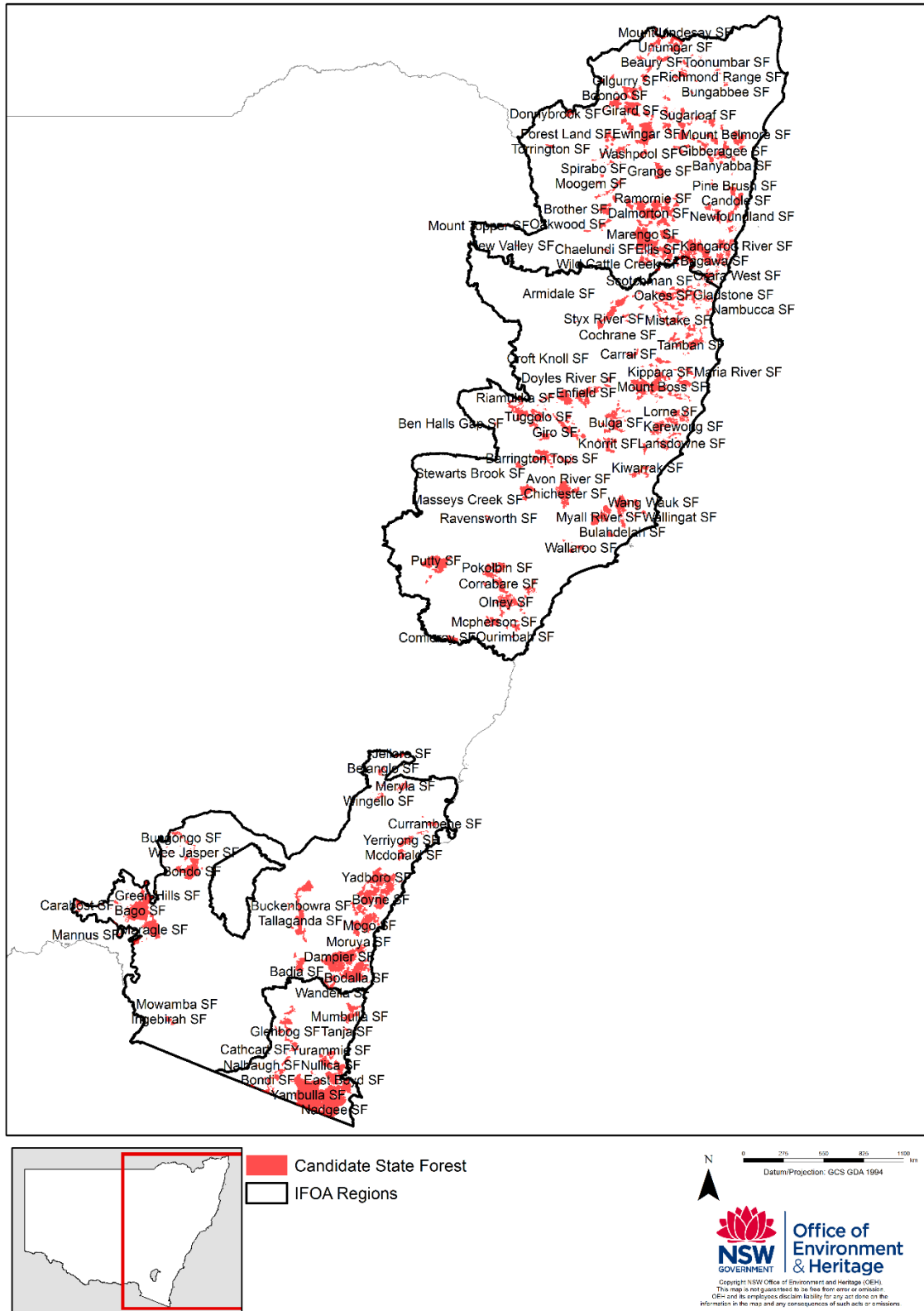
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Candidate State Forest (SF)	Area (Ha)	Candidate State Forest (SF)	Area (Ha)
Candole SF	6,574	Nundle SF	3,279
Carrai SF	3,028	Nymboida SF	6,400
Carwong SF	603	Oakes SF	7,639
Chaelundi SF	18,238	Oakwood SF	2,135
Cherry Tree SF	1,636	Old Station SF	230
Cherry Tree West SF	321	Olney SF	17,795
Chichester SF	20,539	Orara East SF	3,983
Clouds Creek SF	10,241	Orara West SF	4,459
Cochrane SF	231	Ourimbah SF	3,571
Collombatti SF	4,126	Paddys Land SF	907
Comboyne SF	2,576	Pappinbarra SF	1,181
Comleroy SF	2,904	Pee Dee SF	62
Coneac SF	777	Pine Brush SF	3,966
Conglomerate SF	5,162	Pine Creek SF	1,219
Cooperook SF	871	Pokolbin SF	14,030
Corrabare SF	5,197	Putty SF	22,252
Cowarra SF	1,687	Queens Lake SF	576
Curramore SF	84	Ramornie SF	6,175
Dalmorton SF	27,937	Ravensworth SF	901
Devils Pulpit SF	1,484	Riamukka SF	10,029
Diehappy SF	1,275	Richmond Range SF	6,340
Dingo SF	3,555	Roses Creek SF	1,790
Divines SF	1,524	Royal Camp SF	2,203
Donaldson SF	2,331	Scotchman SF	4,158
Doubleduke SF	5,824	Sheas Nob SF	4,333
Doyles River SF	7,744	Skillion Flat SF	5
Dyke SF	6	South Toonumbar SF	410
Eden Creek SF	1,179	Southgate SF	628
Edinburgh Castle SF	949	Spirabo SF	4,138
Ellangowan SF	1,179	Stewarts Brook SF	2,417
Ellis SF	9,736	Strickland SF	485
Enfield SF	12,973	Styx River SF	17,148
Enmore SF	169	Sugarloaf SF	3,151
Ewingar SF	18,433	Tabbimoble SF	2,627
Forest Land SF	6,372	Tamban SF	7,632
Fosterton SF	823	Tarkeeth SF	530
Fullers SF	1,053	Thumb Creek SF	3,944
Gibberagee SF	10,574	Tomalla SF	2,107
Gibraltar Range SF	3,113	Toonumbar SF	1,528
Gilgurry SF	9,531	Tuckers Nob SF	1,885

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Candidate State Forest (SF)	Area (Ha)	Candidate State Forest (SF)	Area (Ha)
Girard SF	18,851	Tuggolo SF	14,004
Giro SF	9,933	Uffington SF	325
Gladstone SF	6,230	Unumgar SF	3,563
Glen Elgin SF	682	Upsalls Creek SF	923
Glenugie SF	4,952	Urbenville SF	3
Grange SF	7,802	Viewmont SF	702
Gundar SF	119	Wallaroo SF	3,487
Hanging Rock SF	38	Wallingat SF	1,240
Heaton SF	2,236	Wang Wauk SF	8,330
Hyland SF	4,577	Washpool SF	2,961
Ingalba SF	6,632	Watagan SF	3,502
Irishman SF	2,733	Way SF	1,268
Johns River SF	725	Wedding Bells SF	4,645
Kalateenee SF	1,344	Whiporie SF	1,109
Kangaroo River SF	11,399	Wild Cattle Creek SF	9,667
Kendall SF	354	Willsons Downfall SF	317
Kerewong SF	3,665	Woodenbong SF	306
Kew SF	897	Woodford North SF	219
Keybarbin SF	3,707	Wyong SF	726
Kippara SF	5,554	Yabbra SF	8,417
Kiwarrak SF	6,535	Yango SF	684
Knorrit SF	5,081	Yarratt SF	2,381
Koreelah SF	708	Yessabah SF	1,887

Map 2: Candidate state forests assessed.



2.5 Project Team

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

The project was managed by Daniel Connolly. Allen McIlwee performed the spatial analysis and broad scale predictive distribution modelling. Owen Maguire, Bob Wilson and Craig Harre undertook API mapping using 3D stereo imagery across the study area.

3 Methodology

3.1 Approach

The Panel concluded that Coastal Saltmarsh occupies a readily identifiable environmental domain known as the intertidal zone. Within this zone in state forest, any treeless native vegetation cover offers a potentially diagnostic indicator of the occurrence of this TEC. The extent to which tree cover, notably mangrove species, but also casuarina or melaleuca species, precludes the identification of the TEC is subject to interpretation. We chose a canopy cover of 30% to define the upper threshold of our interpretation of 'scattered trees'. The choice of threshold was guided by the spatial patterns of Coastal Saltmarsh, which are often small and patchily distributed. Too low a threshold may preclude candidate TEC, as a result of a large overhanging tree.

Candidate areas of Coastal Saltmarsh are readily identifiable in the intertidal zone, both in the field, and in remotely sensed imagery because of their treeless structure. We adopted a broad definition of candidate Coastal Saltmarsh to overcome a number of methodological issues. Firstly, periodic tidal waters can inundate candidate TEC at the time of imagery. There are few state forests dedicated below the mean high tide line and problems are therefore highly localised. Secondly, tidal mudflats apparently devoid of native vegetation can be difficult to assess with certainty, (TEC present or absent), without site visitation. We sought to overcome this problem by including these areas within our treeless vegetation class. Thirdly, Coastal Saltmarsh patches are often small and below tree cover, (Kelleway et al. 2007), although the problem is likely to be most acute in drowned river valleys where valley slopes meet the intertidal zone. Kelleway et al. (2007) also found that 70% of saltmarsh patches were below 100 square metres (0.01 hectares) in size, but the contribution of this size class to the total area was less than 3%. For the purposes of our project, given the extent of the area to be mapped and the scale of available imagery, a mapping area of 0.1 hectare was likely to be the smallest size detectable.

Our project adopted a mapping method that relies on the stereoscopic interpretation of fine scale digital aerial imagery (ADS40). We used a set of mapping rules to identify any candidate native vegetation and within an area defined as the intertidal zone defined by the highest Astronomical Tide (HAT).

3.2 Identifying Intertidal Landforms

Coastal comprehensive assessment floodplain maps

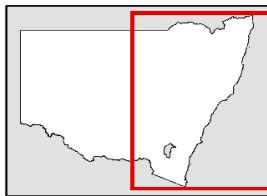
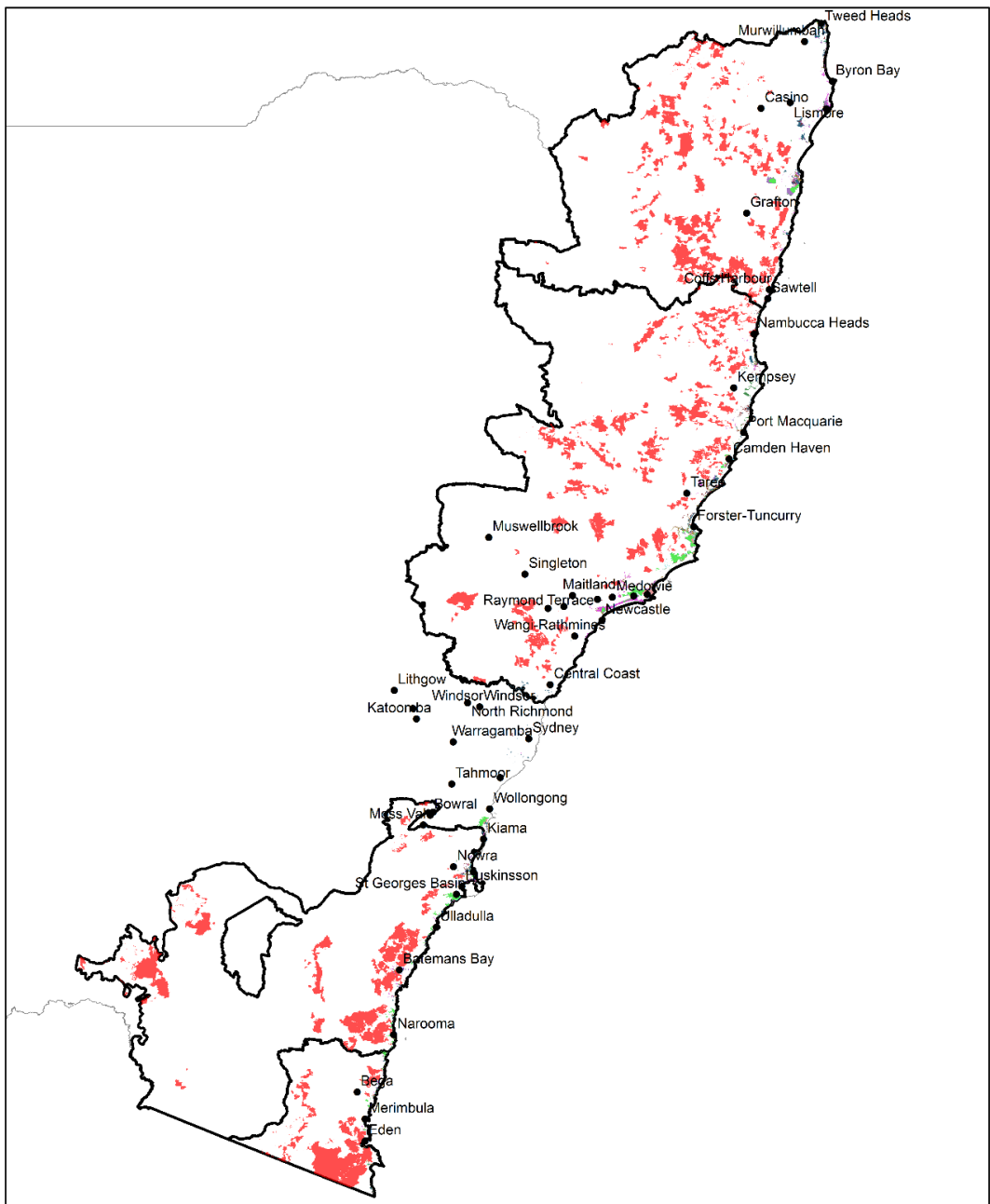
Troedson and Hashimoto (2008) describe a series of maps of Quaternary geology and related features, used for a comprehensive coastal assessment. We assembled all map units within the estuarine plain system and saline lakes as an initial indicative map of intertidal areas that may carry Coastal Saltmarsh assemblages and intersect with state forest boundaries. Map 3 indicates the extent of these mapped systems.

Highest astronomical tideline (HAT)

We estimated the mean astronomical high tide line (HAT) by choosing all elevations less than 1.5 metres above sea level from the 1-metre LIDAR digital elevation model (Map 4).

Map 3: Coastal estuarine plains systems mapped by the comprehensive coastal assessment (CCA).

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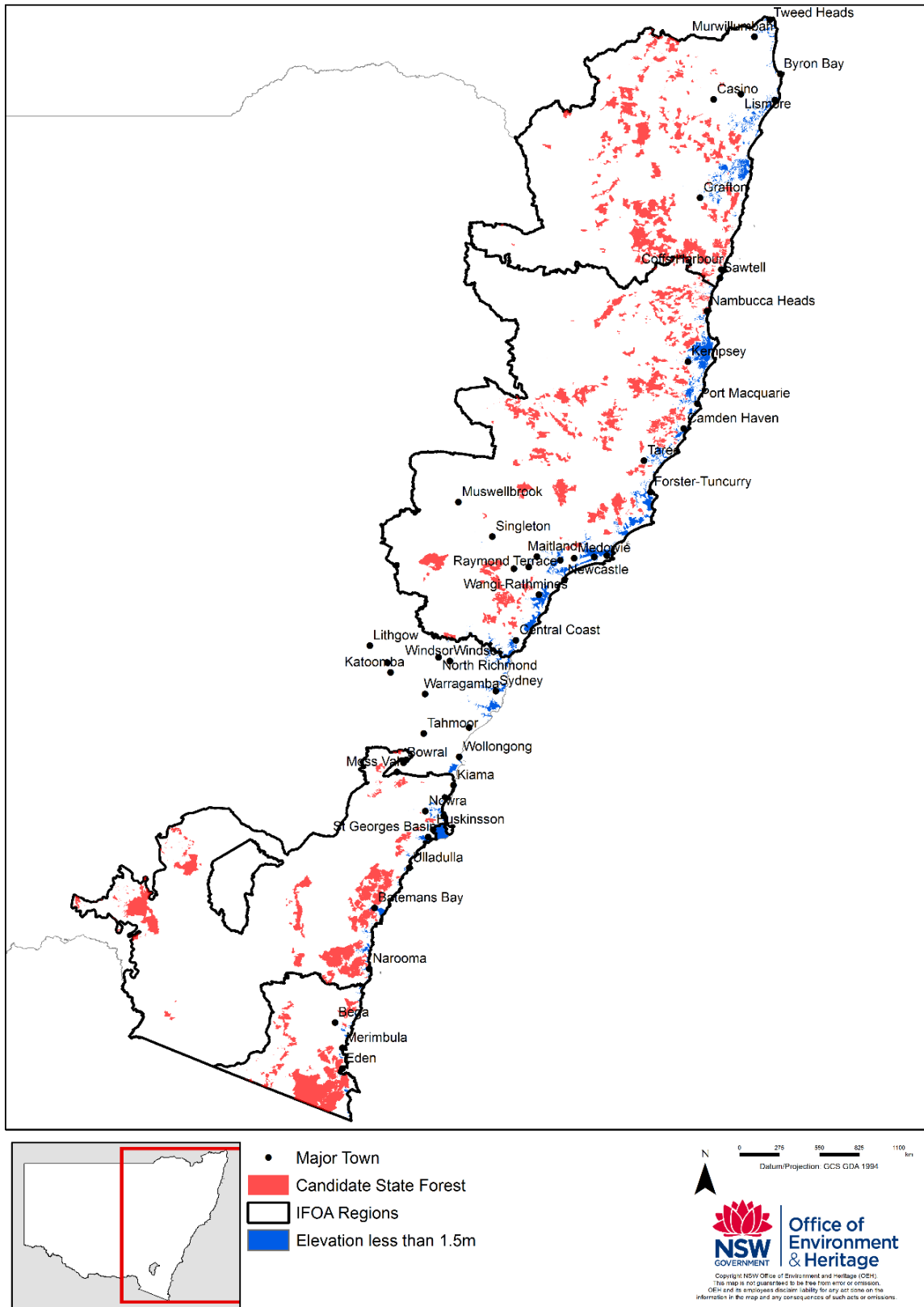


- | | |
|----------------|--|
| ● Major Town | CCA UNIT |
| ■ Candidate SF | ■ Estuarine basin and bay |
| □ IFOA Regions | ■ Estuarine basin and bay (subaqueous) |
| | ■ Estuarine channel (subaqueous) |
| | ■ Estuarine in-channel bar and beach |
| | ■ Estuarine palaeochannel fill |
| | ■ Estuarine shoreline ridge and dune |
| | ■ Saline swamp |
| | ■ Tidal delta (subaqueous) |
| | ■ Tidal-delta flat |



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Map 4: Mean astronomical high tide line map estimated from 1 metre LIDAR DEM.



3.3 Existing Vegetation Data

Maps

A series of maps of estuarine habitats were produced by Creese et al. in 2009. These maps cover 184 estuaries along the East Coast of NSW, and have generally been interpreted using aerial imagery at a scale of 1:1500. These maps were set aside as an independent source of map data and not used in our initial interpretation of the location and extent of the Coastal Saltmarsh TEC.

Field data

Systematic data collected from field surveys are held within OEH Vegetation Information System (VIS) Flora Survey database. These data were extracted, overlaid on state forests and interrogated to identify native vegetation communities present within the intertidal zone. This data was supplemented by additional species locality data, held within the OEH Bionet, that could be used to identify salt tolerant species present within and adjoining state forest boundaries.

3.4 Operational TEC Map

Aerial photograph interpretation

API technicians, experienced in interpretation of NSW forest and vegetation types, used recent high-resolution (50 centimetre GSD) stereo digital imagery, in a digital 3D GIS environment, to delineate observable pattern in vegetation structure. Interpreters adopted a viewing scale between 1:1000 and 1:3000 to mark boundaries to infer changes in canopy and/or understorey

A minimum map polygon size of 0.1 hectares was used to inform the detection and delineation of image patterns. Interpreters were supplied with a range of environmental variables to accompany interpretation including existing vegetation community maps, substrate maps, roads, trails and tenure boundaries.

Interpreters assessed all areas of state forest within our highest astronomic tide line model and our fine scale alluvial model to identify candidate estuarine environments. Treeless vegetation was identified initially with the interpreter assessing the cover thresholds of surrounding tree cover for inclusion within our mapped criteria. Open mudflats were included within our mapped area if there was uncertainty as to whether native vegetation was present.

3.5 Validation

We compared the extent of our Coastal Saltmarsh mapping with Creese et al. (2009) by computing a geometric union between the two coverages in ArcGIS10.1. We retained the original map classes in both coverages for comparison.

4 Results

4.1 Operational TEC Mapping

Aerial photograph interpretation

The results of our mapping of saltmarsh communities as we defined them are shown in Table 3. Consistent with other mapping results of coastal saltmarsh (Kelleway et al. 2007; Creese et al. 2009) our results indicate that patches smaller than 0.5 hectares represent more than half of the total number of patches on state forest. Conversely, almost 50% of the total area of Coastal Saltmarsh present on state forest is found within 23 patches.

Table 3: Coastal Saltmarsh TEC mapped polygons by size class.

Size Class (Ha)	Total Area (Ha)	Number of Polygons	Proportion of Total Area (%)
<0.1	7.1	164	6.40%
0.1-0.5	28.9	131	26.00%
0.5-1	20.3	28	18.30%
1-5	49.1	22	44.20%
>5	5.6	1	5.00%
Grand Total	111	346	100.00%



Photo 1. Wallaroo State Forest includes one of the largest areas of Coastal Saltmarsh TEC within NSW state forests. This area near Lizzies and Limeburners Creek marks the transition from *Casuarina glauca* forest to saltmarsh. Visible here are the taller rush *Juncus kraussii* and the salt tolerant herb *Sarcocornia quinqueflora*.

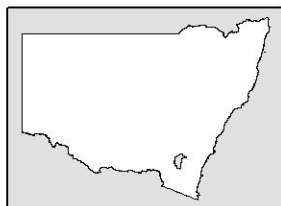
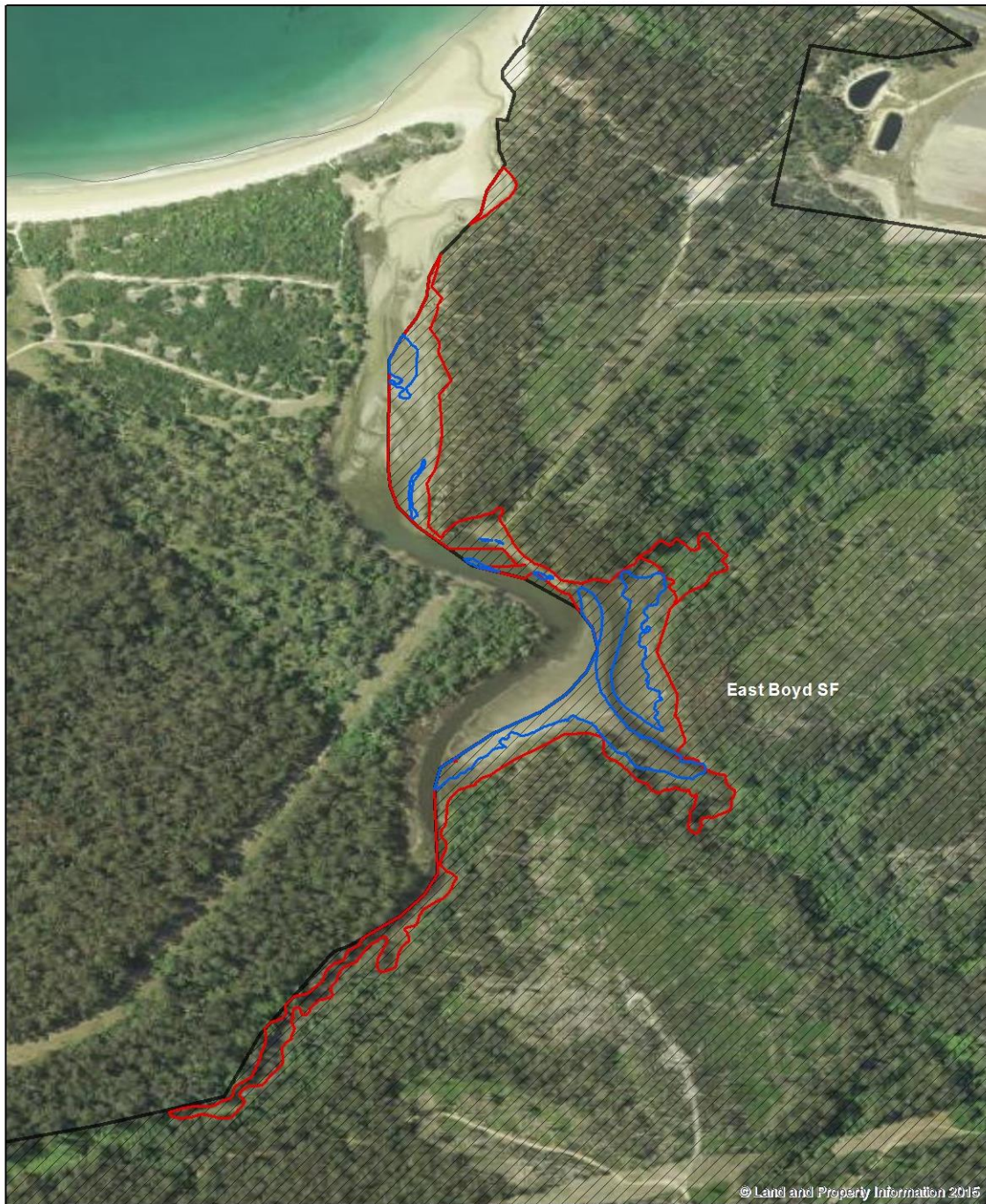
4.2 Validation




We found general high levels of agreement between the total areas and locations of saltmarsh in our operational maps and those of Creese et al. (2009). Table 4 shows the comparative figures between the maps within each state forest. There are two state forests where we mapped saltmarsh, but Creese et al. (2009) did not: Newry State Forest on the North Coast and Nullica State Forest on the South Coast. Overall, we mapped more area than Creese et al. (2009) but these differences are likely to arise from our wider interpretation of candidate saltmarsh using higher mangrove thresholds and open mudflats. There are two state forests where there are significant differences. In Wallaroo State Forest, Creese et al. (2009) have mapped around 16 hectares of saltmarsh that we have identified as mangrove. We reviewed this area and concluded that mangrove was clearly the dominant vegetation present and that the polygons are likely to be an error in Creese et al. (2009). In Mogo and Bermagui State Forests, we identified considerably more saltmarsh likely due to our inclusion of tidal mudflats as candidate saltmarsh. Maps 5-8 show examples of operational maps of coastal saltmarsh in a selection of state forests.

Table 4: Comparison of Coastal Saltmarsh TEC operational map and estuaries saltmarsh maps of Creese et al. 2009.

State Forest (SF)	Total SF Area (Ha)	Coastal Saltmarsh TEC Total Mapped Area (Ha)	Creese Mapped Area Saltmarsh Total (Ha)	Mapped Area in common (Ha)	Mapped TEC only (Ha)	Mapped Creese only (Ha)
Benandarah SF	2,760	1.385	0.489	0.427	0.958	0.062
Bodalla SF	24,060	3.907	0.098	0.096	3.811	0.002
Bermagui SF	1,861	14.075	4.902	2.380	11.696	2.522
Boyne SF	6,160	0.028	0.003	0.003	0.025	0.000
Cairncross SF	4,487	0.172	0.365	0.154	0.018	0.210
East Boyd SF	21,070	9.970	1.616	1.602	8.368	0.014
Medowie SF	50	0.224	0.141	0.125	0.099	0.016
Mogo SF	15,499	39.809	11.585	10.896	28.913	0.689
Murrah SF	4,221	0.944	0.399	0.296	0.648	0.104
Nambucca SF	1,510	3.714	2.021	1.882	1.831	0.138
Newry SF	2,841	1.582	0.000	0.000	1.582	0.000
Nullica SF	18,344	1.153	0.000	0.000	1.153	0.000
Tanja SF	868	0.257	0.032	0.013	0.243	0.018
Wallaroo SF	3,487	34.587	38.376	21.890	12.697	16.486
Total	107,217	111.808	69.025	39.764	72.043	20.261

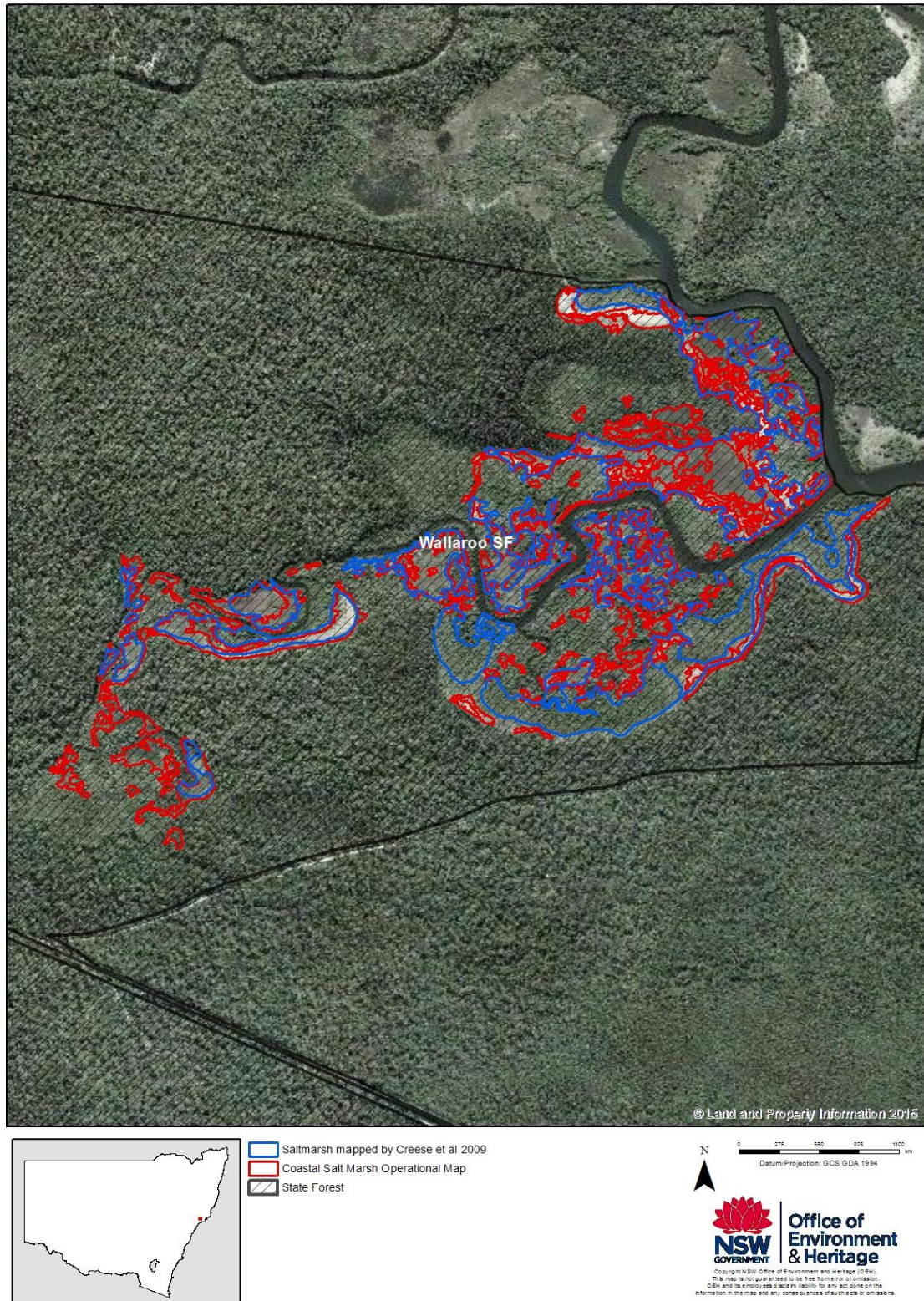
Map 5: Example of operational mapping of Coastal Saltmarsh in East Boyd State Forest.



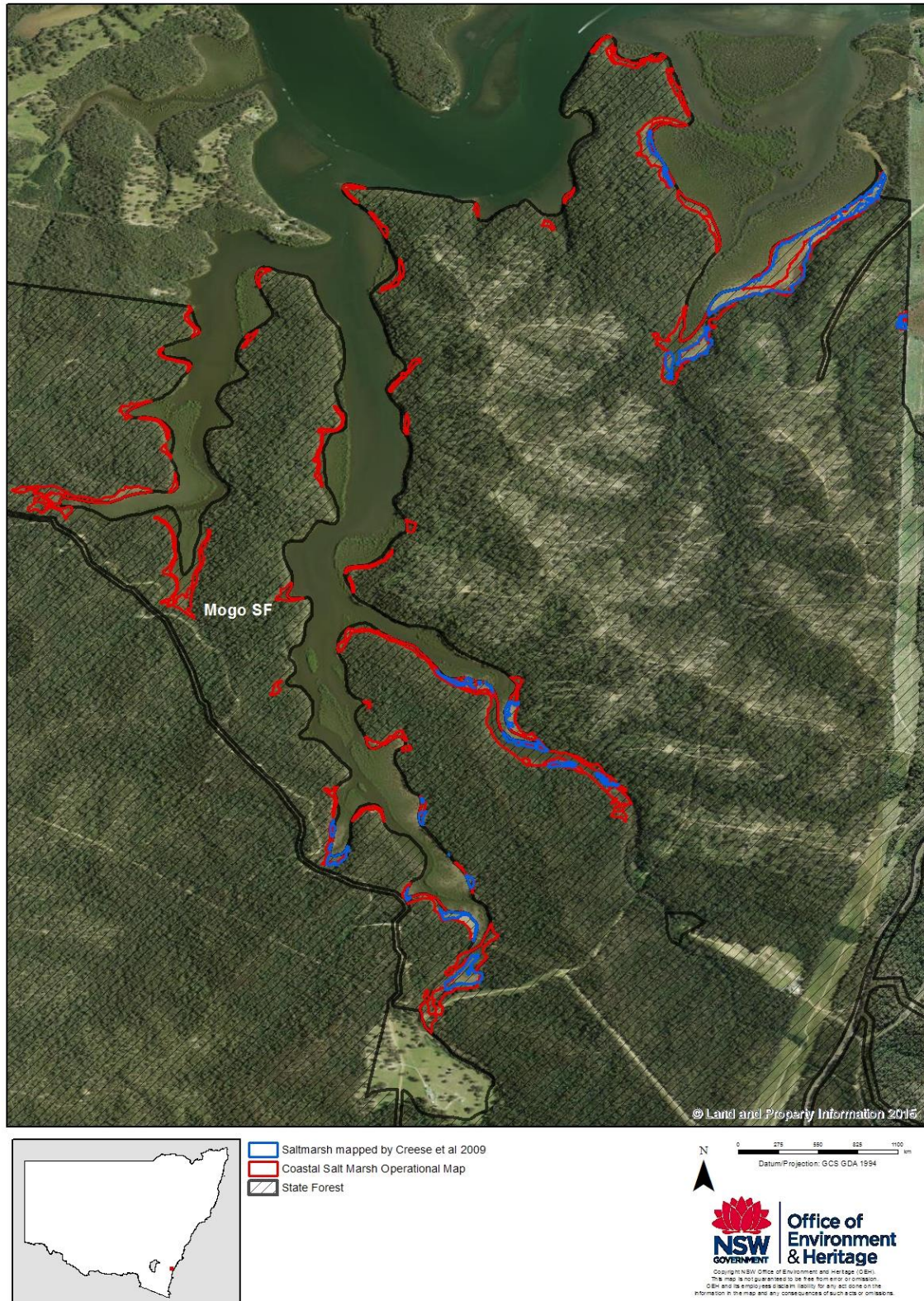
-  Saltmarsh mapped by Creese et al 2009
-  Coastal Salt Marsh Operational Map
-  State Forest



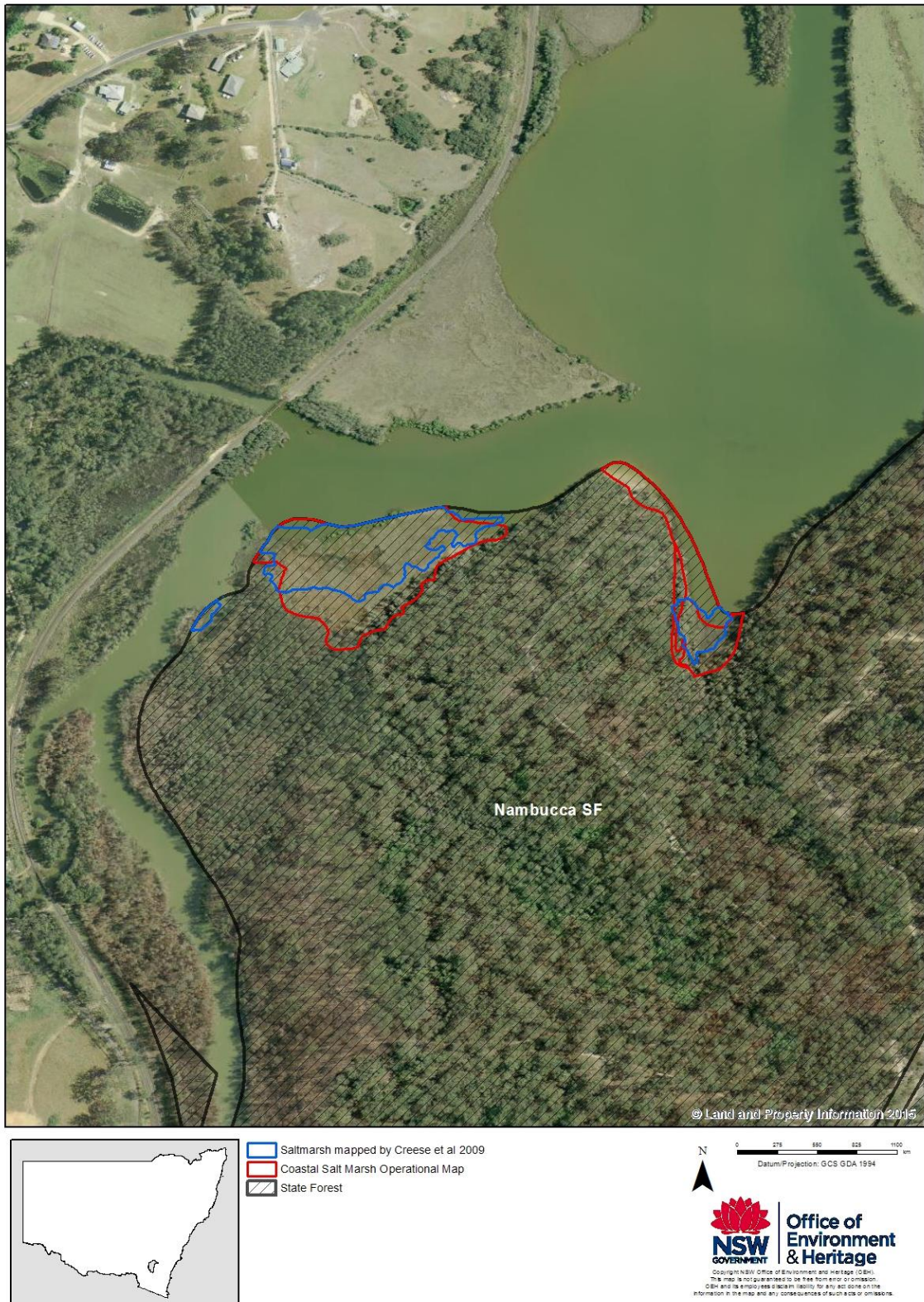
Map 6: Example of operational mapping of Coastal Saltmarsh in Wallaroo State Forest.



Map 7: Example of operational mapping of Coastal Saltmarsh in Mogo State Forest.



Map 8: Example of operational mapping of Coastal Saltmarsh in Nambucca State Forest.



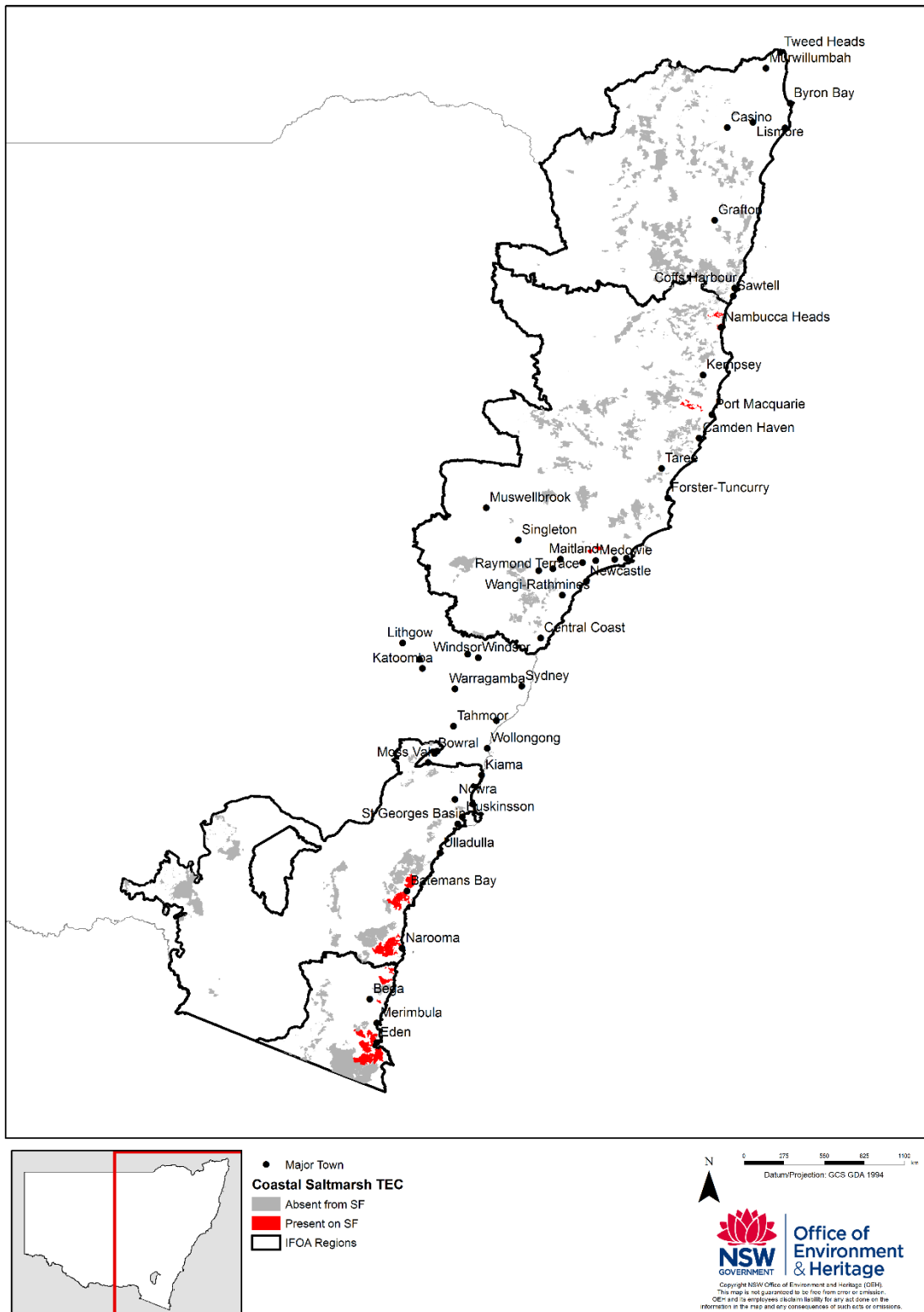
4.3 Final State Forest-TEC Occurrence Matrix

Table 9 presents the total area of Coastal Saltmarsh present within each state forest within the study area. We mapped the TEC within 14 state forests.

Table 9: Total area of Coastal Saltmarsh TEC mapped across all state forests in the study area.

State Forest	Area Hectares	Number of Polygons	Proportion of Total Saltmarsh Area
Benandarah State Forest	1.4	6	1.20%
Bermagui State Forest	14.1	28	12.70%
Bodalla State Forest	3.9	2	3.50%
Boyne State Forest	0	1	0.00%
Cairncross State Forest	0.2	1	0.20%
East Boyd State Forest	10	19	9.00%
Medowie State Forest	0.2	1	0.20%
Mogo State Forest	39.8	68	35.90%
Murrah State Forest	0.9	5	0.80%
Nambucca State Forest	3.7	4	3.30%
Newry State Forest	1.6	1	1.40%
Nullica State Forest	1.2	6	1.00%
Tanja State Forest	0.3	2	0.20%
Wallaroo State Forest	34.6	209	30.40%
Grand Total	111.9	355	100.00%

Map 9: State forests with mapped occurrences of Coastal Salt Marsh.



References

- Adam, P., Wilson, N.C. & Huntley, B. (1988). The phytosociology of coastal saltmarsh vegetation in New South Wales. *Wetlands (Australia)*, 7, pp. 35-85.
- Creese, R.G., Glasby, T.M., West, G. & Gallen, C. (2009). Mapping the habitats of NSW estuaries. Industry & Investment NSW Fisheries Final Report Series 113, pp. 95. Port Stephens.
- Kelleway, J., Williams, R.J. & Allen, C.M. (2007). An Assessment of the Saltmarsh of the Parramatta River and Sydney Harbour. Cronulla: NSW Department of Primary Industries.
- NSW Scientific Committee (2004). Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing. Hurstville.
- Troedson, A.L. & Hashimoto, T.R. (2008). Coastal Quaternary Geology - north and south coast of NSW. *Bulletin 34*. Sydney: Geological Survey of New South Wales.