SUBTROPICAL AND TEMPERATE COASTAL SALTMARSH IN WESTERN AUSTRALIA, A REPORT TO ENVIRONMENT AUSTRALIA

Greg Keighery
Science Division
Department of Environment and Conservation
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INTRODUCTION

This report provides a brief overview of the Subtropical and Temperate Coastal Saltmarsh ecological community (Coastal Saltmarsh) in Western Australia, which is proposed for listing under the EPBC Act. Topics covered include: where it occurs; what vegetation types are normally listed as Coastal Saltmarsh; listing of some component species, including weeds; what level of mapping exists; what degree of loss may have occurred; and other relevant issues for listing of Coastal Saltmarsh under the EPBC Act. It is not designed to be completely comprehensive or a bibliography on Coastal Saltmarsh literature for Western Australia. A number of issues are highlighted (Issues 1 to 5) as these raise significant matters in relation to defining and describing Coastal Saltmarsh in WA.

DEFINING THE GEOGRAPHICAL EXTENT OF COASTAL SALTMARSHES IN WESTERN AUSTRALIA.

According to the EPBC draft nomination WA supports the largest area of Coastal Saltmarsh in Australia (c. 200,000 ha). Two issues are associated with this distribution being: the use of the 23^0 latitude as the northern limit; and the inclusion of coastal and island lagoon saltmarsh. Both issues relate to Western Australia, especially north of Perth, being more arid than the east coast.

Issue 1: Northern Extent of Coastal Saltmarsh in Western Australia
Temperate and tropical saltmarshes merge over a broad geographic range in Western Australia. There are two possible breaks in Coastal Saltmarsh and tropical saltmarsh systems, either at North West Cape or Shark Bay.

North West Cape (c. 23^0S)
The eastern side of North West Cape supports the most southern large tidal, mud flat systems dominated by tropical Mangroves, tropical Chenopods or tropical grasses. *Avicennia* is the only Mangrove found south of North West Cape at Turquoise Bay, although as yet unverified records are from Lake MacLeod. Saintilan (2009) in a biogeographical analysis of saltmarsh species has a SW division from NW Cape (c. 23^0S) to Cape Arid. He noted that less than 25% of the coastal marsh flora is shared between these regions.

Shark Bay (c. 26^0S)
At Shark Bay *Avicennia* concludes as a mainland component (island populations in the Abrolhos and a disjunct population at Bunbury) of Coastal Saltmarsh and many component species, also end their ranges. For example many tropical species of Samphire change over in this area, such as *Tecticornia dissarticulata, T. doleiformis, T. halocnemoides* subsp. *tenuis, T. indica* subsp. *leiostachya, T. pergranulata* subsp.

elongata, *T. pteryosperma* subsp. *denticulata* and *T. pruinosa*. These taxa largely occur north of here in tropical saltmarshes and salt lakes, but extend south to Shark Bay along the coast. Also a number of South Western species end at Shark Bay including *Samolus repens* var *pauciflorus* and *Samolus junceus*.

Several other studies support Shark Bay as the limit. Bridgewater and Creswell (2003) identified 5 coastal/inland saltmarsh phytogeographic groups, which support the division at Shark Bay and the NW Cape, with the latter as the strongest. Saenger *et al.* (1977) delimit a Salt Marsh Biogeographic Zone (SW1), which stretches from Shark Bay to Cape Arid.

Northern Boundary

Shark Bay is probably the logical northern limit for Coastal Saltmarsh in Western Australia. If 23^0 S is chosen it should terminate at the tip of NW Cape and not include any of the eastern side of the Cape.

Issue 2: Coastal and Island Lagoons?

In WAs arid environment there is apparently less distinction between the flora of Coastal Saltmarsh and that of the inland salt lakes (Bridgewater and Creswell 2003). These extensive and ancient saline habitats in Western Australia support the world centre of diversity for several halophytic groups, many of which also occur sporadically in Coastal saltmarsh especially in the drier areas.

Unlike eastern Australia, Western Australian coastal areas support an entire series of saline coastal wetlands that abut typical coastal saltmarshes. These include: saline lakes, such as Lake Macleod; permanent lakes on Rottnest Island and Middle Island-east of Esperance; coastal lagoons such as Hutt Lagoon or little lagoon near Denham; and the birridas of Shark Bay such as on Dirk Hartog Island, Peron Peninsular or Faure Island. These wetlands are all connected to the sea in various ways, and contain typical saltmarsh vegetation (Keighery and Keighery, 2013a). Similar wetlands that have lost their connection to the sea are the lagoon saline lakes of the Swan Coastal Plain (Keighery and Keighery 2013b): Leeman Lagoons; and lakes Walyungup, Coolongup and the Yalgorup Lakes. The loss of connection to the sea will probably happen to all the other wetland lagoons.

If Coastal Saltmarsh nomination includes WA it may be necessary to amend the Description to only cover estuarine associations, excluding “closed lagoons”. Setting the northern boundary near 26^0 S would also exclude Lake McLeod.

GEOGRAPHIC SPREAD AND DOCUMENTATION OF SALT MARSH COMMUNITIES

The extent and nature of Coastal Saltmarsh is described in the IBRA Regions grouped into WA’s west and south coasts. Any known mapping is referenced.

West Coast

1. Carnarvon Bio-Geographic Region: North West Cape to Shark Bay.

North West Cape

There is an area of Samphire Marsh around Tower Zero on North West Cape, unsure if this area is at or below sea level or tidally influenced. Not mapped.

Lake Mcleod
The Lake Macleod System includes: distinct inner wetlands sinkholes, channels, lakes and marshes to the west; flood-out marshes at the river mouths in the northeast; and an inner lake bed. On its western margins seawater enters the lake through a series of vents in the surrounding limestone known as the blue holes. Vegetation at one such "blue hole" (Jacks Vent) has been documented in Department of Environment and Conservation (2009), where *Avicennia marina* sparse low mangrove shrubland is present over the more widespread low closed succulent shrubland of *Tecticornia peltata, T. pruinosa, T. pergranulata* and *Muellerolimon salicorniaceum*. Because of the sea connection large parts of the western side of the lake has permanent water with a Mangrove fringe. No mapping is available for this area.

Carnarvon-Gascoyne River
The delta of the Gascoyne River and especially around Babbage Island has diverse series of salt marshes. This vegetation extends in a narrow band south to Shark Bay and is included in the Shark Bay World Heritage Area. Habitat mapping of Mangroves has been undertaken by DEC for the World Heritage property.

Shark Bay
There are two distinctive marsh communities in the Bay, one at the ends of inlets on the peninsulas (Edel Land, Peron Peninsular and Carrang Peninsular) and the other around the birridas. These are gypsophilus wetlands that are tidally connected to the sea via the limestone bedrock, normally without an obvious flow line except for Little Lagoon near Denham. Studies by Claymore and Markey, (1999) have shown that the floristics of these two areas is virtually identical. For example the birrida on Edel Land have *Avicennia marina* low woodland or forest over *Tecticornia halocnemioides* and *Sarcocornia quinqueflora* (quadrat bora3). In large inlets are areas of *Avicennia marina* low woodland or forest, or *Sporobolus virginicus* grassland with *Tecticornia* (pern05) or *Tecticornia halocnemiodes*, *Sarcocornia quinqueflora* and *Muellerolimon salicorniaceum* (stp03).

Shark Bay Islands
Birridas are present on Faure and Dirk Hartog Island. Mangroves and Salt Marshes are present and mapped on Faure (Keighery and Muir, 2008).

2. Geraldton Sandplain Bio-Geographic Region

Kalbarri to Jurien Bay.
The Murchison River mouth (Wittecarra Gully) has a small area of salt marsh, probably not mapped. Hutt Lagoon at Port Gregory has substantial areas of Samphire shrubland dominated by *Tecticornia, Wilsonia humilis*/*W. backhousei* with *Frankenia* spp and *Juncus kraussii* sedgeland (Keighery unpub. obs.). The small estuaries of the Bowes, Oakabella, Oakajee, Chapman and Buller Rivers are briefly discussed by Brearley (2005), but there is no mention of salt marshes.

Greenough and Irwin Rivers

There are small areas of salt marsh at the mouth of both rivers. Photographs of the Irwin River Estuary (Brearley, 2005, p. 288) show massive loss of saltmarsh due to erosion and re-distribution of sediments. Similar events appear to have occurred in all these rivers. Of interest is the occurrence of Mangle and Salt marsh around lagoons on the Abrolhos Islands. Harvey et al. (2001, table 20) mapped *Avicennia marina* woodlands on 33 islands. There are salt lake and low saltbush flats on North and West Wallabi Island and a tall *Tecticornia* shrubland on Leo Island.

3. Swan Coastal Plain Bio-Geographic Region

This area contains the largest areas of salt marsh vegetation in Western Australia, around the Swan, Peel-Harvey, Leschenault and Vasse-Wonnerup Estuaries.

Hill River

This river was probably fresh before clearing for agriculture, currently no salt marsh vegetation is mapped at the mouth.

Moore River

Again the mouth has been considerably altered by sediment accumulation; there are currently small areas of salt marsh at the mouth and some fringing *Juncus kraussii* sedgelands.

Swan River Estuary

The Estuary has been Described and mapped by Penn (1983) and Brock and Penn (1984). It contains a diverse range of Salt Marsh Communities, including: *Sarcocornia quiqueflora*/ *Suaeda australis*/ *Samolus repens* heath (4 types); *Juncus* sedgeland complex (2 types); Shrubby Samphires (*Tecticornia*) (3 types); *Sarcocornia blackiana* complex; and *Bolboschoenus caldwellii* sedgeland. Penn (1987) noted that salt marshes had declined in area by over 50%. No further estimates.

Rottnest Island

Halophytic communities are present around brackish swamps and saline temporary to permanent salt lakes (McArthur, 1957) have bands of *Wilsonia humilis*/*Sarcocornia blackiana*, then *Tecticornia indica* subsp. *bidens* with *Apium annuum*, *Suadea australis* and *Atriplex paludosa*). These unique lakes are all below sea level are permanent and uniquely stratified (Bunn and Edwards, 1984).

Peel Harvey Estuary

This Ramsar Wetland has been subject to a series of studies starting with Backshall (1977) who listed *Sarcornia* marsh (with *Tecticornia halocnemoides*, *Atriplex paludosa* and *Suaeda australis*), *Juncus kraussiii* sedgeland, *and Boloboschoenus caldwelli* sedgeland which appears to be replacing *Juncus kraussii* at the southern end. Backshall (1977) and Rose and McComb (1980) have maps of these communities combined as marsh vegetation.

Semeniuk and Semeniuk (1990) mapped Tidal Shoals (Salt marsh - *Tecticornia halocnemoides*, *T. indica* subsp. *bidens*, *Suaeda australis*, *Frankenia pauciflora* and *Muellerolimon salicorniaceum* with scattered *Casuarina obsesa*); Tidal Deltas; relict Tidal deltas and Fluvial Delta Complexes. These geomorphologies had Salt Marsh as above, often with a *Casuarina obesa* overstory.

There has been considerable loss due to urban development, weed invasion (**Watsonia meriana* var *bulbillifera*) following drainage, freshwater drains (*Bolboschoenus*), nutrient enrichment (Rose and McComb 1980) and the erosion occurring around the wetland after establishment of the Dawesville Channel (Gibson, 2001 and Calvert *et al.* 2002) which was partly to alleviate the nutrient problems.

Mapping is available to calculate loss, but this is not current.

Leschenault Inlet
Salt marsh vegetation of the inlet has been mapped by, Penn (1992) and Penn *et al.* (2000). Penn *et al*., (2000) lists this system as the premier area of salt marsh in Western Australia. Detailed descriptions of the following saltmarsh communities are listed:

- *Juncus kraussiii* closed rushland;
- *Sarcocornia quinqueflora* saltmarsh complex (5 assemblages- *Sarcocornia quinqueflora* closed herbfield; *Suaeda australis - Sarcocornia quinqueflora* closed herbfield, *Samolus repens- Sarcocornia quinqueflora* closed herbfield; *Sarcocornia quinqueflora-Bolboschoenus caldwellii* closed herbland, *Wilsonia humilis* low open to closed herbfield);
- *Frankenia pauciflora- Sarcocornia quinqueflora-Suaeda australis* low closed heath;
- *Triglochin striata* closed herb land;
- *Samolus repens* closed herb land;
- *Sporobolus virginicus* grassland;
- *Tecticornia halocnemoides* low open heath;
- *Tecticornia indica* subp. *bidens* low open heath;
- *Gahnia trifida* open sedgeland;
- *Bolobschoenus caldwellii* closed sedgeland; and
- a number of emergent fringing communities *Schoenoplectus validus* low closed sedgeland, *Paspalum vaginatum* low closed grassland, *Paspalum vaginatum-Bolboschoenus caldwellii* closed grass and sedgeland).

These are all mapped in the paper, as are the changes in cover, since 1941. An initial area of 700 ha is mapped, declining to c.350 ha in 1989. Loss has continued since this period.

Broadwater System and Vasse-Wonnerup System
These systems stretch from Toby's Inlet near Dunsborough north and east to near Capel. The Vasse is approximately 9 kilometres long, and the Wonnerup 5 kilometres long, covering about 900 hectares of core wetlands and up to 1500 ha in flood (Webb *et al.* 2009).

Toby's Inlet has a line of Samphire shrublands, but has also been much modified by drainage and urbanization (Corner and Clay 1999, Webb *et al.* 2009).

The Vasse-Wonnerup System has been mapped in detail by Tingay and Tingay (1980). In a large series of small scale maps they map Taylors Swamp (*Melaleuca hamulosa* over *Tecticornia pergranulata, Sarcornia quinqueflora* or mixed Samphire open heath), Broadwater river (Melaleucas over Samphire), Broadwater Swamp

(*Juncus kraussii* sedgeland, a narrow band of mixed *Sarcornia blackiana* with *Suaeda* and *Melaleuca hamulosa*/*M. cuticularis* over Samphires); Long Swamp (largely cleared), New River (*Melaeuca cuticularis*, *Juncus* sedgeland, *Sarcornia* heath); Vasse Estuary (complex combinations of **Carex divisa* sedgeland, *Tecticornia pergranulata* heath, bands of *Sarcocornia blackiana*, *T. pergranulata* and **Carx divisa* sedgelands [often cleared for pasture grasses]).

The system is now highly modified by drainage, trapping of fresh water, increasing nutrients, invasion by **Carex divisa* and urban development (Webb *et al.* 2009).

4. Jarrah Forest and part Warren Biogeographic Region: Granite Coast Dunsborough to Augusta.

There is a small estuary at the mouth of the Margaret River but there would only be a very small amount of salt marsh vegetation, if present. Not mapped.

Hardy Inlet-Blackwood River Estuary
Congdon and McComb (1976) map the Blackwood River Estuary salt marshes, however, their map amalgamates *Sarcornia* (*S. blackiana*/*Samolus repens*) shrublands with *Juncus kraussiii* (with *Baumea juncea* and *Ficinia nodosa*) sedgeland. Alteration and loss has occurred but not quantified.

South Coast

5. Warren Biogeographic Region

Augusta to Denmark
A series of reports following document the estuaries between Augusta to Esperance, vegetation data in these reports was undertaken by Jane Chambers. Hodgkin and Clark (1989a) document the small estuaries at the mouths of the Donnelly (here Samphire on bar at mouth, *Juncus kraussii*/*Ficinia nodosa* form a wide band for the first kilometre from the mouth), Gardner (small Samphire marsh 250 m north of mouth, Beach at mouth Warren (largely fresh but with Samphire on the river bar). Hodgkin and Clark (1989b) describe the Broke inlet as fringed by a narrow band of *Juncus kraussii* and *Melaleuca cuticularis* with *Gahnia trifida*, but association too small to map at scale of maps. Hodgkin and Clark (1988, a) mapped the Walpole – Nornalup Estuaries with a narrow fringe of *Juncus kraussii* sedgeland especially at the mouths of the Deep, Frankland and Walpole Rivers).

Semeniuk *et al*., (2012) have undertaken a major study of the Walpole-Nornalup Estuary and note that the Estuary is rather fresh and contains no real Samphires or Salt marsh. There are fringes of *Melaleuca cuticularis* over *Juncus kraussii*/Gahnia trifida over freshwater sedges and herbs or *Juncus kraussi* dense sedges (with *Atriplex hypoleuca*/*Hemiarthria uncinata*/ *Sarcocornia quinqueflora*/*Sporobolus virginicus*) as the common fringing vegetation.

Hodgkin and Clark (1988, b) show the Wilson Inlet at Denmark has small areas of salt marsh near the mouth of the Estuary. Penn (1996) has quantified change at the Wilson River mouth. Another small area is shown at the mouth of Irwin Inlet, with none shown at Parry Inlet.

6. part Jarrah Forest and Esperance Sandplain Bio-Geographic Regions

Albany to Bremer Bay
Hodgkin and Clarke (1990, b) note extensive Salt marsh vegetation occurs in Oyster Harbour (*Sarcornia*/*Suaeda*/*Tecticornia lepidosperma*) backed by *Melaleuca cuticularis* over *Juncus kraussii*. Not mapped, but Penn (unpub,) has mapped and these are held by the Department of Water. Same vegetation also recorded for Normans Inlet (*Melaleuca cuticularis*/*Juncus krausssi* around edges), Torbay, Taylor Inlet and Cheyne Inlet. Cordinup River has a delta with Samphire flats edges with MC/JC and similar for Eyre River. Penn (1995) has also mapped fringing vegetation in Princess Royal Harbour at Albany. Hodgkin and Clarke (1987) map Wellstead Estuary with a fringing area of Mellaeuca/Samphire/Rush-*Juncus kraussii-Gahnia trifida* association all around. Well developed associations of *Sarcocornia blackiana-Suaeda-Samolus repens*; *Juncus kraussii*/*Gahnia trifida* sedgeland and flats with *Wilsonia humilis*/*Disphania clavellatum*/*Tecticornia halocnemoides* shrublands.

Bremer Bay to Esperance
Hodgkin and Clarke (1990a) only map Hamersley Inlet, where small areas of Samphires occur in the upper section. Described with small areas are Dempster Inlet, Gordon Inlet, Saint Marys Inlet, Fitzgerald Inlet and Culham Inlet. The Jerdacuttup Lakes have areas of *Melaleuca cuticularis* over Samphires, but this may not be an estuarine site.

The Beaufort and Gordon Inlets are mapped showing extensive areas of Salt marsh. The Beaufort often has *Casuarina obesa* as an overstory with *Gahnia trifida*/*Ficinia nodosa*/*Juncus kraussii*/ *Atriplex cinerea*/*Tecticornia halocnemoides*/*Tecticornia indica* subsp. *bidens*, *Tecticornia pergranulata*/*Rhagodia crassifolia*/ *Sarcocornia quiqueflora*/*Suaeda*/ *Carpobrotus modestus*/*Disphyma clavellatum*/*Samolus repens*/ *Wilsonia backhousei* and *Wilsonia humils*).

Hodgkin and Clark (1989c) Described and map salt marsh around Stokes Inlet (*Sarcocornia quiqueflora*, *Melaleuca cuticularis* woodland over *Ficinia nodosa*); Oldfield River Inlet (*Melaleuca cuticularis* over *Baumea juncea* and *Casuarina obesa*); Torradup (*Melaleuca cuticularis* over *Juncus krausssii* and sandy flats with *Wilsonia*/*Juncus*/*Ficinia* and *Sarcocornia*); Barker Inlet (*Melaleuca cuticularis* over *Gahnia trifida*, the western shore with Salt Marsh of *Tecticornia pergranulata*, *Suaeda*/*Melaleuca cuticularis* and *Juncus kraussii*).

East of Esperance
Hodgkin and Clark (1989c) show the following: *Juncus kraussii* sedgeland at the Dailey River mouth; and *Suaeda*/*Juncus kraussii*/ Samphires at mouth of Munglinup Creek, Alexander River, Blackboy Creek, Thomas River and at Cape arid –Jonadee Creek and Poison Creek. There is a saline lagoon on Middle Island (off Cape Arid) in the Recherche Archipelago.

Mapping Issues
Issue 3: Data on occurrence and loss
The most significant areas of Coastal Saltmarsh in Western Australia are along the Estuaries of the Swan Coastal Plain (Swan, Peel-Harvey, Leschenault and Vasse-Wonnerup). All of these estuaries are mapped to some extent and show considerable

loss of this vegetation. Luke Penn mapped many of these areas and his published and unpublished maps are held by the Department of Water. However the data sets are not readily available, incomplete (especially small areas), not amalgamated or standardised.

The Western Australian Department of Water has mapped most rivers in southern WA for condition of fringing vegetation, and most are available as Pdf files (www.water.wa.gov.au/Publications/default.aspx), but I have not attempted to compile these reports.

VASCULAR FLORA OF WESTERN AUSTRALIAN COASTAL SALTMARSH

A preliminary list of 95 species recorded in Western Australian Coastal Saltmarsh is given in Table 1. Many of these taxa are not listed as components of Coastal Saltmarsh in Saintilan (2009), suggesting that there is considerable floristic differences in this species poor community between east and west (viz *Gahnia filum* replaced by *G. trifida* in Western Australia).

Again because of along history of naturally occurring salinity in WA, the south-west is the world centre of many groups that grow under such conditions, including the Samphires (*Tecticornia)* and *Triglochin*. There is also a high diversity in *Samolus* species (Keighery, unpub. obs.) and *Puccinellia*, including a local Saltmarsh endemic, *P. vassica* (Williams 2007). Current taxonomic studies are delimiting many new taxa in WA's saline habitats.

Issue 4: Does WA have the most diverse Coastal Saltmarsh flora?
This brief examination of species lists for reserves with Coastal Saltmarsh species listed suggests that WA's flora is richer than currently considered in Coastal Saltmarsh species, including a few local endemics such as *Puccinellia vassica*. This questions whether the South Australian Bioregions listed as most diverse are perhaps a product of sampling effort.

COASTAL SALTMARSH CONDITION

Issue 5: Many major weeds of Coastal Saltmarsh are different in WA.
There are some similar weeds in Western Australian Coastal Saltmarsh to those listed for eastern Australia. These include *Juncus acutus* (Keighery & Keighery 2006). However there are some Coastal Saltmarsh weeds that do not appear to be listed in eastern Australia. Examples are listed below.

- *Atriplex prostrata* (Chenopodiaceae) is a major weed of estuarine edges from Perth to Albany. It is common in most Coastal Saltmarsh of the Swan (Keighery and Keighery, 2013).
- *Limonium hyloblaeum* (Plumbaginaceae) has invaded Coastal Saltmarsh on coastal salt lakes at Hutt Lagoon. A similar species *L. campanyonis* is doing the same from Perth south and I have seen it invading intact salt marsh vegetation in the Coorong.
- *Puccinella cilata* (Poaceae), commonly used as salt-land reclamation species in Western Australia and is invading grazed Coastal Saltmarsh in the Vasse - Wonnerup system near Capel (Keighery, unpub. obs.).

- *Carex divisa* (Cyperaceae) is a major invader of saline communities around the Vasse-Wonnerup Wetlands.
- *Paspalum vaginatum*/*Boloboschoenus caldwellii* ?native invaders of hydrologically altered marshes in Perth, Peel, Leschenault and Vasse-Wonnerup Estuaries.
- Less common invaders are Iridaceous Cormous weeds such as *Watsonia* species (Peel-Harvey), *Gladiolus undulatus* and *Moraea setifolia*.

Control measures for these weeds present on the Swan Coastal Plain, are described, by Brown and Bettink (2009-).

ISSUES IN EASTERN AUSTRALIA ARE NOT MAJOR CONCERNS IN WESTERN AUSTRALIA

Salt ponds

The continuing removal of Coastal Saltmarsh to develop salt ponds is not a major issue in Western Australia south of NW Cape. However there are major proposals by Yannarie Salt for the Exmouth Gulf from the Bay of Rest to near Onslow. The only developed salt ponds are already established at Lake MacLeod and at Useless Loop in Shark Bay.

Mangrove Invasion

Unlike in eastern Australia there appears to be no evidence of Mangrove encroachment into Coastal Saltmarshes, probably partly because there are no Mangroves in most sites. Unlike Eastern Australia two trees (*Casuarina obesa* and *Melaleuca cuticularis*) are frequent over storey species as are the woody shrubs (*Melaleuca hamulosa* and *M. viminea*).

SUMMARY

Northern limit of Sub-tropical Salt Marshes needs to be set, either at Shark Bay or North West Cape.

Inclusion of or, exclusion of coastal lagoonal salt marshes and Island lagoonal marshes needs clarification.

Data compilation:
This is an obvious need, the figure of c. 200, 000 hectares of salt marsh in Western Australia given in the nomination [?derived from OZ coasts (www.ozcoasts.gov.au)] seems to be much larger than my reading of all reports for southern Western Australia, which add up to nearer 2-3,000 hectares. Even if my guestimates are factor too low, i.e. 20,000 ha not 2,000, the figure needs substantiation.

There are numerous maps of Coastal Salt marsh, largely not digitised or standardised including community descriptions. These need to be collated, archived, digitised to enable accurate estimates of extent and loss.

Substantial loss of salt marsh vegetation has and is continuing to occurred in those areas considered to contain the largest and most diverse examples (Swan, Peel-Harvey Leschenault and Vasse-Wonnerup), but this is data at least a decade old at best.

Floristic diversity and richness of Western Australian Coastal Saltmarshes may have been under estimated. A comprehensive list of the flora of WA Coastal Saltmarshes has yet to be undertaken.

Weeds of Western Australian Salt Marshes appear substantially different from Eastern Australia. Replacement of marsh vegetation by invasive weedy natives due to hydrological change has and is occurring, but remains largely un-documented.

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Table One: Southern Western Australian Salt Marsh Species

This list has been compiled from the literature read for this report, the authors flora lists for appropriate reserves, e.g. : Keighery and Keighery, (2013), Webb et al., (2009), EA Griffins Quindalup quadrat data, Swan Coastal Plain quadrat data, Cate Tauss's coastal monitoring data, Geraldton and Albany flora survey data and data on specimens in Florabase(http://florabase.dec.wa.gov.au/).
Species only recorded from Birridas, Lake Macleod etc are not included.

Aizoaceae
Carpobrotus modestus
Disphyma clavellatum

Amaranthaceae
Hemichroa diandra
Hemichroa pentandra

Apiaceae
Apium annuum
Apium prostratum subsp. prostratum

Asteraceae
Angianthus preissianus
Angianthus micropodioides
Cotula coronopifolia
Cotula cotuloides
Senecio pinnatifolius
Sonchus hydrophilus

Caryophyllaceae
*Sagina maritima
*Spergularia marina
*Spergularia rubra

Casuarinaceae
Casuarina obesa

Chenopodiaceae
Atriplex cinerea
Atriplex hypoleuca
Atriplex paludosa subsp. baudinii
*Atriplex prostrata
Chenopodium glaucum subsp. ambiguum
Rhagodia baccata
Rhagodia crassifolia
Sarcocornia blackiana
Sarcocornia quinqueflora
Tecticornia dissarticulata
Tecticornia doleiformis

Tecticornia halocnemoides subsp. halocnemoides
Tecticornia halocnemoides subsp. tenuis
Tecticornia indica subsp. bidens
Tecticornia indica subsp. leiostachya
Tecticornia lepidosperma
Tecticirnia leiostachyum
Tecticornia leptoclada subsp. inclusa
Tecticornia moniliformis
Tecticornia pergranulata subsp. pergranulata
Tecticornia pergranulata subsp. elongata
Tecticornia pterygosperma subsp. denticulata
Tecticornia pruinosa
Tecticornia syncarpa
Suaeda australis
Threlkeldia diffusa

Convolvulaceae
Wilsonia backhousei
Wilsonia humilis
Wilsonia rotundifolia

Cyperaceae
Baumea juncea
Bolboschoenus caldwellii
*Carex divisa
Cyperus gymnocaulis
*Cyperus laevigatus
Ficinia nodosa
Gahnia trifida
Isolepis cernuua var cernuua
Schoenoplectus pungens
Schoenoplectus validus
Schoenus nitens

Frankeniaceae
Frankenia pauciflora
Frankenia tetrapetala

Gentianaceae
*Centaurium erythraea
Centaurium spicatum

Goodeniaceae
Selleria radicans

Haemodoraceae
Tribonanthes ?violacea

Juncaceae
*Juncus acutus

Juncus bufonius
Juncus kraussii subsp. australiensis

Juncaginaceae
Triglochin mucronata
Triglochin minutissima
Triglochin striata

Lamiaceae
Avicennia marina

Malvaceae
*Hibiscus diversifolius
Lawrencia spicata
Lawrencia glomerata
Lawrencia squamata
Lawrencia viridigrisea

Myrtaceae
Melaleuca cuticularis
Melaleuca hamulosa
Melaleuca pauciflora
Melaleuca viminea

Plumbaginaceae
*Limonium campanyonis
Muellerolimon salicorniaceum

Poaceae
Distichlis distichophylla
*Hainardia cylindrica
*Hordeum marinum
Hemiarthria uncinata
* Lolium loliaceum
*Paraphlois incurva
?*Paspalum vaginatum
*Pucinella ciliata
Puccinella stricta
Puccinella vassica
Sporobolus virginicus
*Stenotraphum secundatum

Primulaceae
Samolus repens var repens
Samolus repens var floribundus
Samolus repens var pauciflorus
Samolus junceus