



SCIENCE AND CONSERVATION DIVISION

**MANDORA MARSH / WALYARTA FLORA AND
FLORISTIC VEGETATION SURVEY: 2015**

Progress Report

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Introduction and Methods

Between 1st and 10th September 2015, a floristic survey was undertaken for Mandora Marsh / Walyarta, as part of a larger biodiversity and hydrological survey being coordinated by the Department of Parks and Wildlife Kimberley Region. The aim of the survey was to revisit sites established in 1999 (see Graham 1999) and then sample additional sites within the survey area. These original sites included 100 x 100 m flora quadrats, which were not permanently marked. Although georeferenced at the time by GPS, selective availability (US degradation of public GPS positions for national security purposes) and a less accurate GPS meant that site coordinates could be inaccurate by a distance of up to 200m. Therefore, the Mandora Marsh / Walyarta 2015 survey endeavoured to establish permanent plots at the approximate position of these original sites, using departmental floristic survey standards. Plot dimensions were 50 x 50 m for extensive vegetation communities or 5 x 40 m for smaller, more restricted vegetation communities on mound spring edges. In the 10 days of flora survey, 22 50 x 50 m and four 4 x 50 m plots were established across the survey area (Figure 1, Table 1). Plots were marked with plastic posts at three corners and a steel star-picket at the tag corner, and all four corners georeferenced by GPS. Each plot corner photographed across the quadrat diagonal. Visual cover estimates for all vascular plant species were recorded, as well as vegetation structure and other attributes (disturbance, signs of recent fire, weed invasion), and collections made of all vascular flora for identification and vouchering purposes. Other site physical parameters for plots (field litter and bare ground cover, exposed bedrock and surficial rock cover, surficial rock size, soil colour) were noted in the field using the methods of McDonald *et al.* (1998).

For each plot, soils were collected evenly over the plot area from the top 10-15 cm layer, and bulked to a 1-2 kg sample. These were dried at 60° C and the ≤ 2 mm soil fraction retained after sieving. This fraction was analysed at the Chemistry Centre of Western Australia using methods detailed in (Markey & Dillon 2009), to determine following parameters: concentrations (mg/kg) of 19 elements (Al, As, B, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, NP, Pb, S, Se, Zn), total N and P (%), organic C, pH, soil texture particle fractions and electrical conductivity (EC_{1:5}).

Multivariate Analyses

Vegetation cover-abundance for all species was recorded in the field as a visual estimate of % cover on a modified Braun-Blanquet / Domin scale in McDonald *et al.* (1998). All species were included in analysis and converted to presence / absence data as floristic composition was considered the most important attribute over cover values, and previous analyses (Graham 1999) had also analysed presence / absence data. Two smaller linear plots set at right angles were combined for analysis (MAND22). MAND21 was nested within MAND20 (so only MAND20 was analysed as MAND21 was a subset). Therefore a total of 25 plots were analysed as presence/absence data.

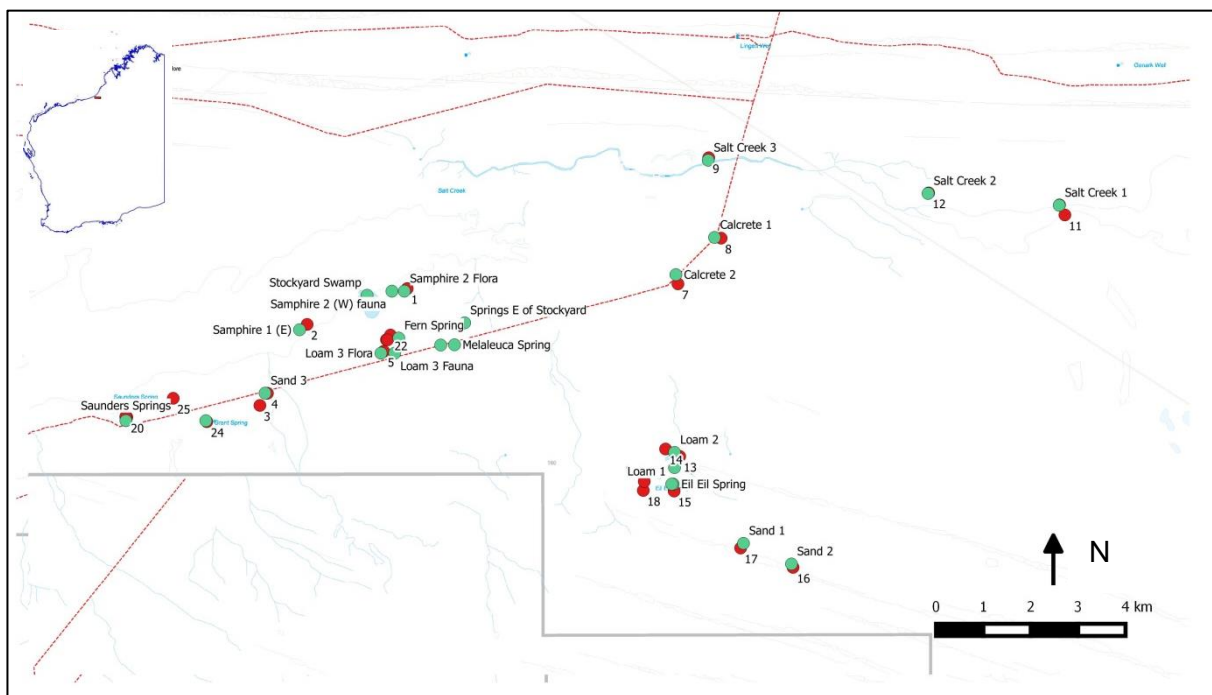


Figure 1: Location of flora survey plots across the Mandora Marsh / Walyarta Survey Area. Plots are labelled according to their number (red circles) and survey areas (green circles) labelled according to names given in Graham (1999).

Multivariate analyses was executed using PRIMER-E & PERMANOVA+ version 7 (Clarke & Warwick 2001). The dataset was reduced to a Site by Species resemblance matrix using the Bray & Curtis dissimilarity measure (Bray & Curtis 1958). Cluster Analysis was used to classify vegetation communities among sites (site groups), using flexible beta ($\beta = -0.1$) method of agglomerative hierarchical fusion for cluster analysis (Lance and Williams (1967)). A similarity profile permutation test (SIMPROF) was implemented on site classification to

test statistical support of branches and test for groupings in the classification (Clarke & Warwick 2001, Clarke *et al.* 2008). The SIMPER routine was used to find discriminating species contributing to community type, limited to 70% cumulative similarity (Clarke & Warwick 2001). Both site and species classifications used the same resemblance matrices and classification parameters, and were combined to produce a two way table of the Site x Species data matrix, where sites and species were ordered according to their group associations. Floristic similarity among the sites was visualised using nonmetric multidimensional scaling (nMDS) ordination of the same Site x Species dataset.

Soil variables were checked for heteroscedasticity and intercorrelation before analysis. A single variable was retained for soil variables ((K, Ca, Na and S), (Org C and N total)) with high levels of intercorrelation ($p > 0.9$). Highly skewed variables were transformed either by square root- or log-transformation and the resulting variable matrix normalised. The BEST (Bio-Env + Stepwise) procedure in PRIMER was used to find the best subset of environmental variables with highest correlation to the site vegetation compositional similarity (Clarke and Ainsworth 1993, Clark & Gorley 2015). This analysis searches for maximum rank correlations (Spearman's) between the Bray-Curtis similarity matrix of species presence/absence for the sites and subsets of the Euclidean distance matrix of site environmental variables.

Results

Flora

2015 survey records

A total of 143 taxa were identified for the Mandora Marsh / Walyarta 2015 survey from the 25 plots and adjacent collections, of which 22 were new records (Appendix 1), which adds new taxa to the list of species compiled from previous collections and survey from the survey area (Appendix 2). Conversely, not all previously recorded taxa were relocated in 2015. This may be due to actual absence of these taxa in 2015, or taxonomic inconsistencies between surveys (i.e. a different name has been applied to the same taxonomic entity between years). For example, previously unidentified *Heliotropium* collections in the Ovalifolium subgroup are likely to be *Heliotropium pachyphyllum* following the collection of fertile material in 2015. *Xerochloa barbata* has been previously called *Xerochloa imberbis*, as found from a re-examination of WAH material (S. Dillon, pers. comm). *Lawrencia densiflora* is absent from the Kimberley region (Florabase 1998-) yet was recorded in the 1999 survey (Graham 1999). This absence of *Lawrencia densiflora* in 2016 may be actual but requires collections to confirm. Or it may be a misidentification of *Lawrencia glomerata* (with one herbarium record collected 1997) or *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433). The latter taxon is an informally (phrase) named entity raised by W. Barker (AD) which appears close to *Lawrencia viridigrisea*.

Previous records

Herbarium records (AVH) from a polygon encompassing the Mandora Marsh / Walyarta survey area (see Figure 2) indicate that 221 taxa (species, subspecies, varieties and hybrids) are known from this survey area (Appendix 2), although the site descriptions and previous plot species indicate that more species were present but were not lodged at the WA Herbarium.



Figure 2: Polygon encompassing area from which records from the Western Australian Herbarium were retrieved (Image: Landsat/Copernicus, Data: Google, Google Earth).

Taxa of conservation significance

Six taxa of state conservation significance are from the Mandora Marsh / Walyarta area (Jones 2015, Appendix 1 and Appendix 2). Four species, *Gymnanthera cunninghamii* (**P3**), *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) (**P3**), *Solanum oligandrum* (**P3**) (Figure 3A) and *Terminalia kumpaja* (**P3**), were located during this survey (Appendix 1). One of these (*Lawrencia* sp. Anna Plains (N.T. Burbidge 1433)), was not recorded in the 1999 survey (Graham 1999). *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) is an informally named taxon with no published description available to assist identification. Identification in this survey was reliant on comparison with herbarium vouchers. Furthermore, despite being recorded frequently in the 1999 survey there are no WAH records of *L. densiflora* north of the Pilbara region (Florabase 1998-). It is likely that *L. densiflora* is being confused with other species identified from the survey area (*L. glomerata*, *L. viridigrisea* or *L. sp. Anna Plains* (N.T. Burbidge 1433)), given that they are often misidentified in the WAH herbarium collections and there has been no taxonomic treatment of *Lawrencia* since 1984 (Lander 1984)

Three other priority species previously known from Mandora Marsh / Walyarta survey area (Appendix 2) were not located in this brief, current survey: It may have been too dry for the annual herb, *Nicotiana heterantha* (**P1**) or the annual sedge, *Fuirena incrassata* (**P3**) to be present, or the latter diminutive species may have been present but overlooked. Future surveys would require a favourable season following appropriate rainfall (flowering

collections in WAH occur from June - October). No new collections of the De Grey Saltbush (*Atriplex eremitis*) (**P1**), have been made since 1999 (Florabase 1998-), despite being formally described in 2008 (Cranfield 2008). It would be prudent to search for new populations and relocate and assess the Eil Eil Springs population of this species in the Mandora Marsh / Walyarta conservation area.

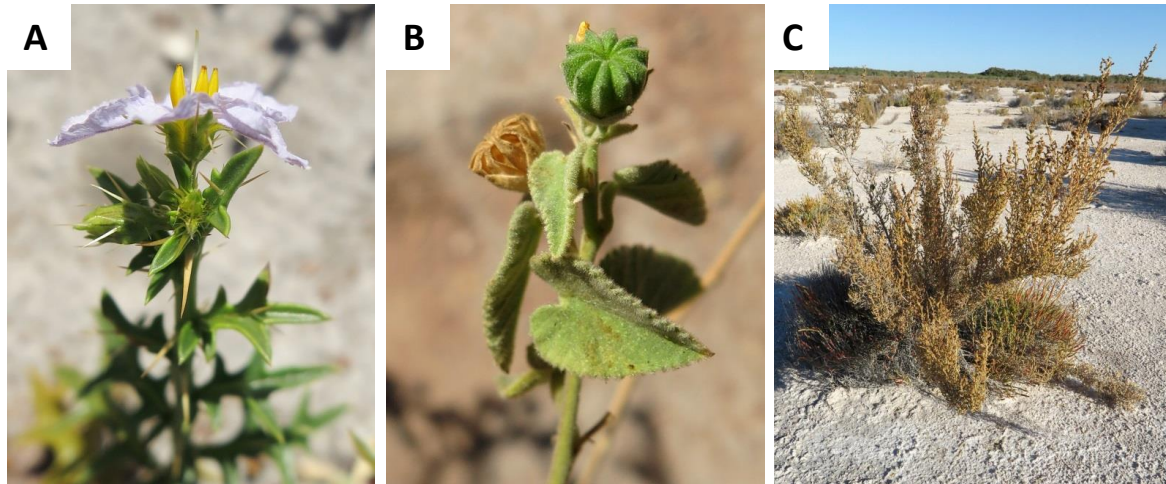


Figure 3: Notable taxa on Mandora Marsh / Walyarta: A: *Solanum oligandrum*. B: *Abutilon* aff *hannii*. C: *Tecticornia* sp. "tall, robust".

Putative new taxa and problematic taxonomic groups

Two putative new taxa were identified which may, with further work and collections, prove to be new taxa.

- *Euphorbia* aff. *hassallii* -most similar to and with affinities to *Euphorbia hassallii* but seeds are notably different (see Halford & Harris 2012). Material has been lodged in the WA Herbarium and duplicates would need to be forwarded to David Halford (Queensland Herbarium) for confirmation.
- *Abutilon* aff. *hannii* (Figure 3B). There is a previous WAH collection of *Abutilon macrum* from Mandora Marsh / Walyarta, as identified by Malvaceae expert, Robyn Barker (Herbarium of South Australia) which was on loan at time of this survey so was not seen. Material collected during this survey was identified as being close to *Abutilon hannii* using the key in Barker (1998). Recent investigations into recent collections of both *Abutilon macrum* and *Abutilon hannii* at the Western Australian Herbarium and a review of older published descriptions suggest that there are several entities under these names and that further taxonomic work is required on this species group (Dillon, pers. comm). At this stage, such a major undertaking is not currently possible.

Tecticornia halocnemoides specimens were briefly examined by Kelly Shepherd (Western Australian Herbarium), who advised that there were several entities tentatively identified to or affiliated with *Tecticornia halocnemoides* (Appendix 1). There were three collections of a putative new taxon which was only identified as *Tecticornia* sp. 'tall, robust'. This is a problematic species complex, especially around the Mandora Marsh / Walyarta area, and many more fruiting collections are required to make more definitive identifications on these taxa. Although an unverified record of *Tecticornia ? pergranulata* was made during the 1999 survey, (without herbarium voucher) this species was not located during the 2015 survey and further suggests that *Tecticornia* is a genus which requires further detailed survey and study in the Mandora Marsh / Walyarta area.

Non-native taxa

Five non-native weed species were recorded (Appendix 1), the two more notable species being the invasive Bush Kapok (*Aerva javanica*) and Buffel Grass (*Cenchrus ciliaris*). None of the sites appeared to be heavily invaded by weeds, although Grant Springs did have some kapok bush and buffel grass infestation along the fenceline. The other three weed species were *Cynodon dactylon*, *Flaveria trinervia* and *Setaria verticillata*. Australian collections of *Flaveria trinervia* were, until recently, considered to be a native species, *Flaveria australasica*, until the treatment of Bean (2009).

Salt Water Couch (*Paspalum vaginatum*) was recorded around the mound springs, and while often being recorded as an introduced species over much of Australia (Simon & Alfonso 2011, Western Australian Herbarium 1998-), it also has been noted as native to the Australian tropics (Bennett 1987, Short *et al.* 2011), and Keighery (Department of Parks and Wildlife) has suggested that it may be a rare native of Kimberley mound springs (Keighery, pers. comm.).

It is noted that this survey was not an extensive weed survey, which would require a separate effort covering the area during the appropriate season and conditions.

General Vegetation Associations

Nine general vegetation associations were observed in the course of fieldwork. Plots were established in most, but not all, of these broad vegetation associations (Appendix 3).

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1. *Triodia* hummock grasslands / *Acacia stellaticeps* shrublands on red aeolian sand dunes (longitudinal dunefields and sand plains). **4 plots**
 2. *Tecticornia halocnemoides* subsp. *longispicata*, *Tecticornia halocnemoides* subsp. *tenuis* and *Tecticornia indica* subsp. *leiostachya* samphire shrublands on salt lakes **3 plots**
 3. *Avicennia marina* mangroves fringing saline creeks **0 plots**

4. *Melaleuca alsophila* tall shrublands / woodlands on sandy-loam flats in wider area surrounding mound springs. **4 plots**
 5. Mound Spring *Melaleuca leucadendra* / *Sesbania formosa* woodlands **5 plots**
 6. *Acacia ampliceps*, *Muellerolimon salicorniaceum*, *Frankenia ambita* and samphire low saline shrublands on sandy-loam flats in wider area around mound springs and *Melaleuca* tall shrublands
4 plots
 7. Mound Spring sedgelands **2 plots**
 8. *Triodia epactia* hummock grasslands on paleoriver and estuary plains **1 plot**
 9. *Triodia epactia* hummock grasslands on calcrete plain **2 plots**
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Floristic Communities

Results:

Seven floristic community units were identified from the classification (Figure 4), of which one, heterogeneous group (Type G: Mound Springs) was further subdivided into two subunits. Although there was no statistical support for this subdivision, it was retained to recognise two subunits: the *Sesbania formosa* / Mangrove Fern-dominated springs and the tall *Melaleuca* woodland / sedgeland dominated springs. It is noted that the analyses in Graham (1999), where the Fern Spring site was classified into a different group (Group 8) from other mound springs sites (Group 7). This is preliminary work and it is anticipated that more plots are going to be established in an upcoming field season.

The first major split in the dendrogram separates *Triodia* grasslands and *Acacia* shrublands (Groups A, B, C and D) on sands, loam and calcretes from the mound spring associated communities - namely the samphires, shrublands and mound spring woodlands (Groups E, F and G). There was low stress for the nMDS ordination (0.08), indicating that floristic similarities were well resolved in a 2D solution. Groups are reasonably resolved, with a floristic gradient evident from sand dunes across to salt lakes, and another from *Melaleuca alsophila* loam communities to the species-poor mound spring communities (Figure 5). The Two Way Table (Table 1) presents the floristic data grouped according to the site and species classifications.

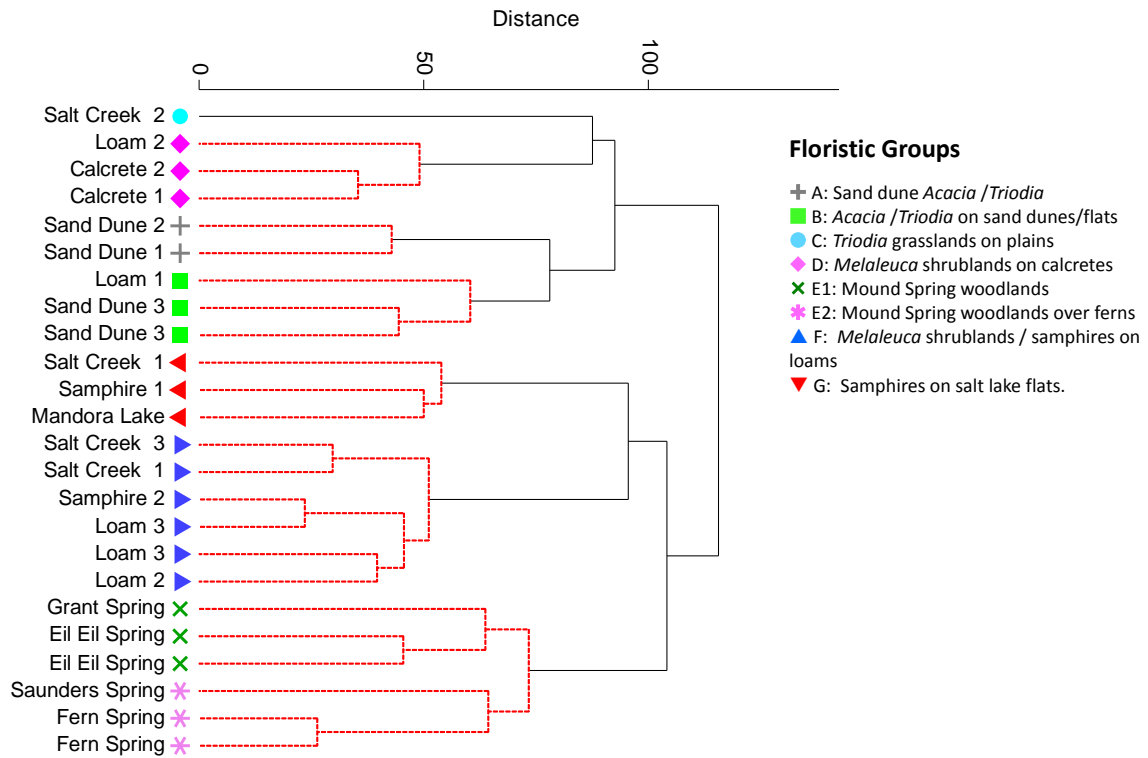


Figure 4: Dendrogram of flexible UPGMA Classification of 25 plots from Mandora Marsh / Walyarta 2015 Survey. SIMPROF supported lines in bold, dotted red lines without SIMPROF support. Plots are labelled by their general site rescore location (Grant 1999) and symbols and legend indicate floristic community unit.

Species	Floristic Community Type							
	A	B	C	D	E1	E2	F	G
<i>Abutilon aff. hannii</i>								
<i>Calandrinia quadrivalvis</i>								
<i>Carissa lanceolata</i>								
<i>Cleome viscosa</i>								
<i>Corchorus sidoides</i> subsp. <i>vermicularis</i>								
<i>Dysphania plantaginella</i>								
<i>Eriachne obtusa</i>								
<i>Gossypium australe</i>								
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>								
<i>Grevillea wickhamii</i>								
<i>Hakea chortophylla</i>								
<i>Heliotropium pachyphyllum</i>								
<i>Hibiscus apodus</i>								
<i>Phyllanthus maderaspatensis</i>								
<i>Plucheia rubelliflora</i>								
<i>Polymeria ambigua</i>								
<i>Portulaca intraterreanea</i>								
<i>Ptilotus axillaris</i>								
<i>Senna ferraria</i>								
<i>Senna noliabilis</i>								
<i>Sida fibulifera</i>								
<i>Solanum diversiflorum</i>								
<i>Solanum oligandrum</i>								
<i>Sternodia grossa</i>								
<i>Streptoglossa odora</i>								
<i>Tephrosia supina</i>								
<i>Acacia anatifolia</i>								
<i>Acacia melioidora</i>								
<i>Acacia tumida</i> var. <i>tumida</i>								
<i>Aenictophyton reconditum</i> subsp. <i>reconditum</i>								
<i>Chamaecrista symonii</i>								
<i>Cleome uncinata</i> subsp. <i>uncinata</i>								
<i>Corynoloba micrantha</i> var. <i>gracilis</i>								
<i>Cyanostegia cyanocalyx</i>								
<i>Cyperus conicus</i>								
<i>Dampiera cinerea</i>								
<i>Dodonaea coriacea</i>								
<i>Erythrophleum chlorostachys</i>								
<i>Gompholobium simplicifolium</i>								
<i>Grevillea refracta</i> subsp. <i>refracta</i>								
<i>Grevillea stenobotrya</i>								
<i>Heliotropium transforme</i>								
<i>Jacksonia aculeata</i>								
<i>Newcastelia cladotricha</i>								
<i>Ptilotus anthousus</i>								
<i>Spermacoce occidentalis</i>								
<i>Triodia schinzii</i>								
<i>Veilleia panduriformis</i>								
<i>Amaranthus undulatus</i>								
<i>Salaria verticillata</i>								
<i>Abutilon otocarpum</i>								
<i>Acacia colei</i> var. <i>colei</i>								
<i>Achyranthes aspera</i>								
<i>Aerva javanica</i>								
<i>Aristida contorta</i>								
<i>Bauhinia cunninghamii</i>								
<i>Boerhavia burbridgeana</i>								
<i>Cenchrus ciliaris</i>								
<i>Cucumis variabilis</i>								
<i>Dolichandrone heterophylla</i>								
<i>Gymnanthera cunninghamii</i>								
<i>Melaleuca lasiantha</i>								
<i>Tinospora smilacina</i>								
<i>Acacia stellaticeps</i>								
<i>Aristida holathera</i> var. <i>holathera</i>								
<i>Bulbostylis barbata</i>								
<i>Cassylia filiformis</i>								
<i>Eragrostis eriopoda</i>								
<i>Plucheia ferdinand-muelleri</i>								
<i>Terminalia kumpaja</i>								
<i>Trianthema pilosum</i>								
<i>Triodia epactia</i>								
<i>Codonocarpus cotinifolius</i>								
<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i>								
<i>Eriachne aristida</i>								
<i>Euphorbia aff. hassellii</i>								
<i>Euphorbia myrsoides</i>								
<i>Heliotropium glanduliferum</i>								
<i>Trianthema triquetrum</i>								
<i>Zygophyllum compressum</i>								
<i>Cassylia capillaris</i>								
<i>Pterocaulon serrulatum</i> var. <i>veitlinum</i>								
<i>Acacia synchronica</i>								
<i>Dactyloctenium radulans</i>								
<i>Erneapogon purpurascens</i>								
<i>Scaevola spinescens</i>								
<i>Cyperus bulbosus</i>								
<i>Lawrenzia viridigrisea</i>								
<i>Melaleuca glomerata</i>								
<i>Panicum decompositum</i>								
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>								
<i>Streptoglossa bubaki</i>								
<i>Threikeldia diffusa</i>								
<i>Schoenus falcatus</i>								
<i>Xerochloa barbata</i>								
<i>Acacia amplicox</i>								
<i>Cynanchum carnosum</i>								
<i>Eragrostis falcata</i>								
<i>Flaveria trinervia</i>								
<i>Frankenia ambia</i>								
<i>Lawrenzia</i> sp. Anna Plains (N.T. Burbridge 1433)								
<i>Melaleuca alsophila</i>								
<i>Neobassia astrocarpa</i>								
<i>Plucheia longica</i>								
<i>Solanum esuriale</i>								
<i>Sporobolus australasicus</i>								
<i>Sporobolus virginicus</i>								
<i>Sureya diandra</i>								
<i>Tecticornia halocnemoides</i> subsp. <i>tenuis</i>								
<i>Tecticornia indica</i> subsp. <i>leiochacha</i>								
<i>Trianthema turgidifolium</i>								
<i>Avicennia marina</i>								
<i>Muelleroiimon saltcorniaceum</i>								
<i>Tecticornia auriculata</i>								
<i>Tecticornia halocnemoides</i> aff. <i>tenuis</i>								
<i>Tecticornia halocnemoides</i> not subsp. <i>tenuis</i>								
<i>Tecticornia halocnemoides</i> subsp. <i>longispicata</i>								
<i>Tecticornia</i> sp. "Big robust"								
<i>Acrostichum speciosum</i>								
<i>Fimbristylis ferruginea</i>								
<i>Heliotropium curassavicum</i>								
<i>Lemna aequinoctialis</i>								
<i>Melaleuca leucadendra</i>								
<i>Paspalum vaginatum</i>								
<i>Samolus</i> sp. Millstream (M.I.H. Brooker 2076)								
<i>Schoenoplectus subulatus</i>								
<i>Sesbania formosa</i>								
<i>Sesuvium portulacastrum</i>								
<i>Typha domingensis</i>								

Floristic Groups

- A: Sand dune *Acacia / Triodia*
- B: *Acacia / Triodia* on sand dunes/flats
- C: *Triodia* grasslands on plains
- D: *Melaleuca* shrublands on calcretes
- E1: Mound Spring woodlands
- E2: Mound Spring woodlands over ferns
- F: *Melaleuca* shrublands / samphires on loams
- G: Samphires on salt lake flats.

Table 1: Two Way Table of sites by species from 25 plots from the Mandora Marsh / Walyarta 2015 Survey, sorted and grouped by their respective classifications. Species presence indicated by filled square.

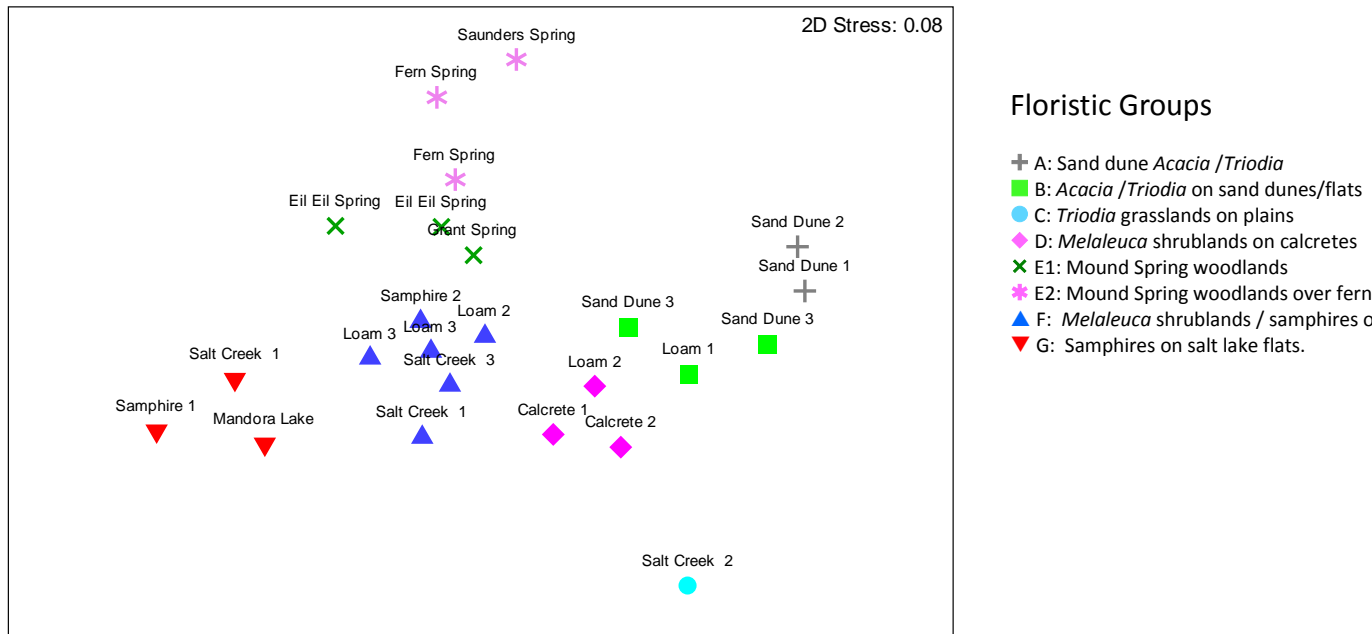


Figure 5: Two dimensional Nonmetric MDS ordination of floristics data from 25 plots from Mandora Marsh / Walyarta 2015 Survey. Plots are labelled by their general site rescore location (Graham 1999) and both symbols and legend indicate floristic community unit.

Soil variables

An overlay of vectors of soil variables shows some correlation of these environmental variables to floristic composition and an increasing gradient from in soil nutrients / elements from sand plain to mound spring and samphire communities (Figure 6). There is a general trend for low elemental concentrations, low organic carbon, low total nitrogen, low phosphorous and high soil sand content in the sites with sand plain and sand dune communities (Floristic groups A, B). Correspondingly, high phosphorous and organic carbon and nitrogen is associated with soils in the mound spring communities (floristic groups E1 and E2). Soil clay, soil pH and calcium are higher in the salt lake samphire communities, which is associated with saline, lake beds deposits.

The BEST procedure is an explorative method to identify set of environmental variables correlated with and possibly driving community composition. When all variables were included in the BEST procedure, the Rho statistic was 0.785 and the top five environmental attributes identified as significantly correlated with the similarity matrix were electrical conductivity (EC mS/m) , soil pH, soil clay % fraction , total % phosphorous (P tot) and calcium (Ca, mg.kg).

Bubbleplots illustrate the association of these soil variables with site floristic composition (Figure 7). As a measure of salinity, electrical conductivity (EC) grades from barely discernible in the sand dunes sites (Floristic Group A) and calcrete sites (Floristic Group D) to highest values in the samphire/loamy flats and salt lake flats, corresponding with Floristic groups G and F. Total phosphorous (P tot) is highest in the mound spring communities (Groups E1 and E2), which produce deep, peaty soils. Soil carbon (Figure 6) and nitrogen are also highest in these communities (soil N were organic C are highly correlated $p > 0.9$, so only organic C is shown). Soil clay content tends to be lower in floristic groups (Groups A, B, C and D) associated with sand plains, dunes and calcrete plains, while low soil calcium is associated with only sand plains and dunes (Groups A, B and C)

(probably reflecting calcareous inputs from ground water and calcrete plain). On the whole, soils are neutral to alkaline, with more acidic soils associated with sand dune communities and for Fern Spring (which could reflect acidic peaty substrate). It is emphasised that these findings are only based on 25 plots.

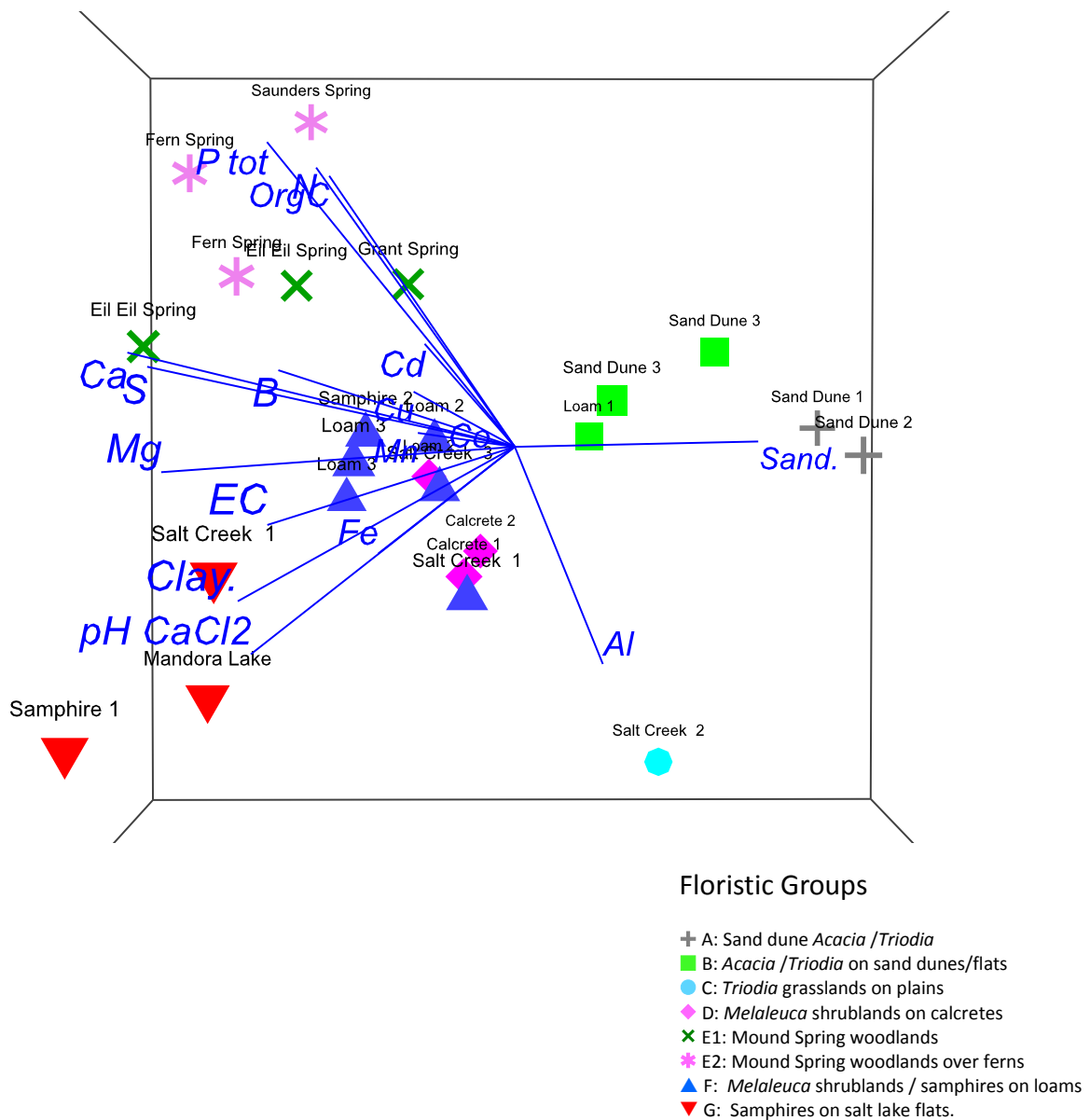
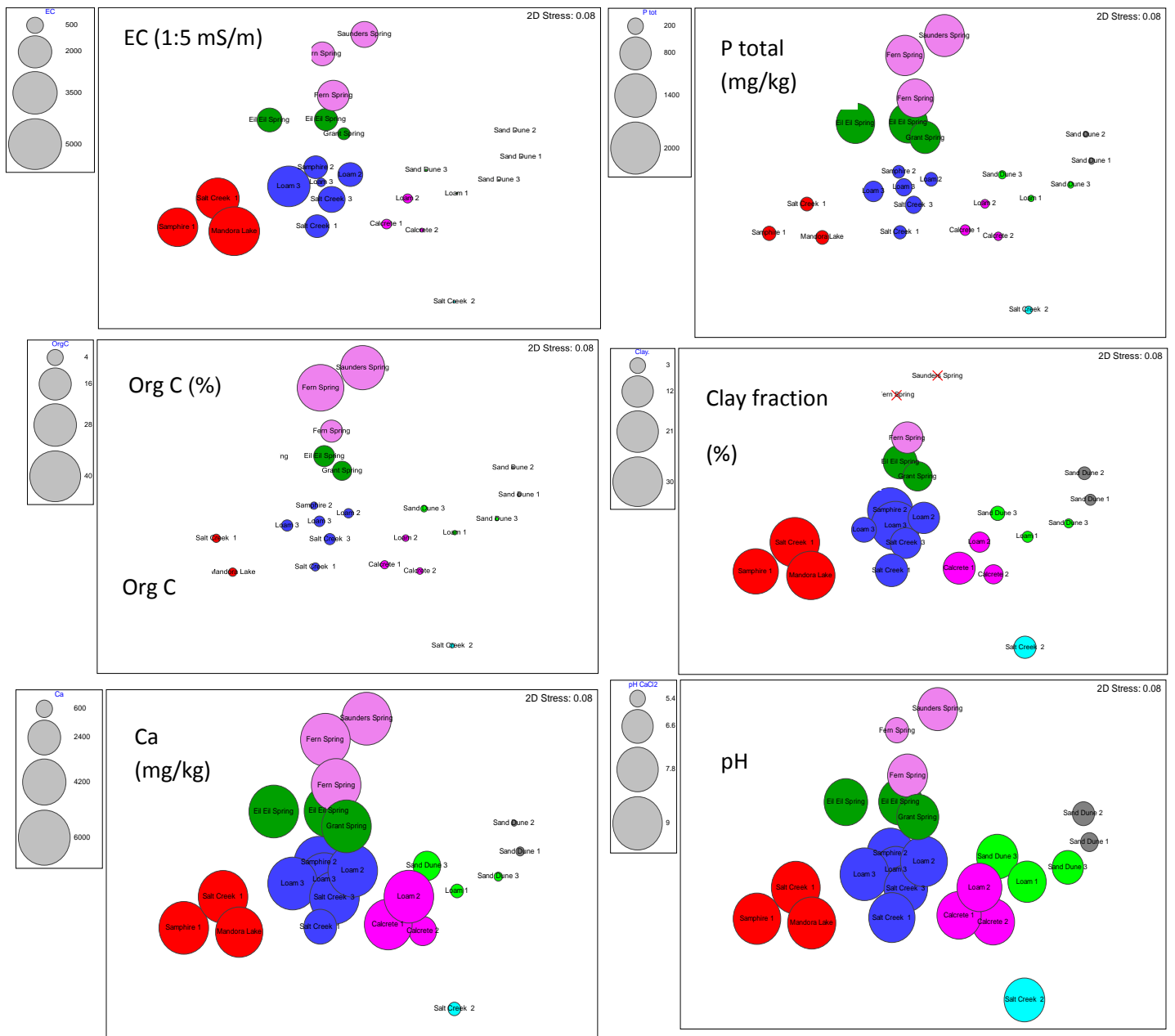


Figure 6: 3D nonmetric MDS ordination of floristics data from 25 plots from Mandora Marsh / Walyarta 2015 Survey with an overlay of vectors of soil variables (Pearson correlation). Plots are labelled by their general site rescore location (Graham 1999) and both symbols and legend indicate floristic community unit.



- A: Sand dune *Acacia* and *Triodia* shrublands/grasslands
- B: *Acacia* and *Triodia* shrublands/grasslands on sand dunes/flats
- C: *Triodia* hummock grasslands on plains

- D: *Melaleuca alsophila* shrublands on calcretes
- E1: Mound Spring woodlands
- E2: Mound Spring woodlands over ferns
- F: *Melaleuca* shrublands / samphires on loamy flats
- G: Samphires on salt lake flats.

Figure 7: Bubbleplots of five soil variables superimposed on the 2D nmMDS ordination of the Mandora Marsh / Walyarta floristic data from the 2015 Survey. Floristic Groups coded by colour in legend (note that clay values were unavailable for two mound spring sites so are rendered as crosses in the plot).

Floristic Community Types

The following section summarises the Floristic Communities of the Mandora Marsh / Walyarta 2015 Survey

Red Sand dunes and plains

A: Acacia and Grevillea shrublands over *Triodia* hummock grasslands on sand dunes

Mallee and shrubs of *Acacia tumida*, *Grevillea stenobotrya*, *Grevillea wickhamii*, *Erythrophleum chlorostachys*, *Gardenia pyriformis* and *Terminalia kumpaja*, over - dense hummock grassland of *Triodia schinzii* and *Triodia epactia* and mid-dense shrubland of *Acacia stellaticeps* on mid- lower slopes and flats. Scattered common low shrubs of *Dampiera candidans*, *Jacksonia aculeata* and *Gompholobium simplicifolium* on dune crests and mid-slopes.

Location on landform: Crests and slopes of aeolian red sand dunes on edge of Great Sandy Desert.

Plots: MAND16, MAND17

Species of Conservation Significance: *Terminalia kumpaja*

SIMPER Species: *Acacia anaticeps*, *Cassytha filiformis*, *Cleome uncifera* subsp. *uncifera*, *Cyanostegia cyanocalyx*, *Dampiera cinerea*, *Gompholobium simplicifolium*, *Grevillea stenobotrya*, *Heliotropium transforme*, *Jacksonia aculeata*

B: *Acacia* / *Melaleuca* shrublands and *Triodia* hummock grasslands on sand dunes/flats

Tall shrublands and hummock grasslands. Isolated *Bauhinia cunninghamii* trees among sparse tall shrublands of *Terminalia kumpaja*, *Grevillea stenobotrya*, *Acacia colei*, *Melaleuca alsophila* and *Melaleuca lasiandra* over mosaic of sparse shrublands of *Acacia stellaticeps* and *Pluchea ferdinandi-muelleri*, and hummock grasslands of *Triodia schinzii* and *Triodia epactia*, over scattered low herbs and tussocks of *Euphorbia myrtoides*, *Trianthema pilosum* and *Eragrostis eriopoda*.

Location on landform: Interface between red aeolian sand plains and dunes and loam soils on margins of mound springs or paleo-estuarine soils. Sandy loam soils on red sandy plains and low dunes between mound springs and salt lakes. Gently undulating sandy flats on margin of dunefield and loamy flats surrounding a mound spring.

Plots: MAND03, MAND04, MAND15

Species of Conservation Significance: *Terminalia kumpaja*, *Gymnanthera cunninghamii*

SIMPER Species: *Acacia stellaticeps*, *Aristida holathera* var. *holathera*, *Eragrostis eriopoda*, *Pluchea ferdinandi-muelleri*, *Terminalia kumpaja*, *Trianthema pilosum*, *Triodia epactia*, *Grevillea stenobotrya*, *Bulbostylis barbata*, *Corchorus sidoides* subsp. *vermicularis*

Calcretes and calcareous clay plains

C: *Triodia* hummock grassland on palaeoestuarine plains

Extensive hummock grassland plain with isolated tall shrubs of *Acacia synchronicia* over dense *Triodia epactia* hummock grassland. Isolated subshrubs of *Stemodia grossa*.

Plots: MAND12

Location on landform: Silty clay plain of old riverine/estuarine sediments abutting saline creek. Areas of partially exposed calcrete and scattered tall termite mounds.

Species of Conservation Significance: None

No SIMPER Species analysis possible for one plot:

D: *Melaleuca alsophila* / *Acacia ampliceps* shrublands on calcretes

Sparse tall shrublands of *Melaleuca alsophila* and *Acacia ampliceps* over sparse shrublands of *Acacia stellaticeps*, *Pluchea ferdinandi-muelleri* and/or mid-dense hummock grasslands of *Triodia epactia*. Scattered low shrubs and herbs of *Solanum oligandrum*, *Heliotropium glanduliferum*, *Trianthema turgidifolia*, *Ptilotus axillaris*, *Corchorus sidoides* and *Calandrinia quadrivalvis*.

Plots: MAND07, MAND08, MAND13

Location on landform: Extensive, gently-undulating plains of shallow-skeletal sandy loams over calcrete.

Species of Conservation Significance: *Solanum oligandrum*, *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433)

SIMPER Species: *Acacia ampliceps*, *Acacia stellaticeps*, *Cleome viscosa*, *Heliotropium pachyphyllum*, *Melaleuca alsophila*, *Pluchea ferdinandi-muelleri*, *Pluchea rubelliflora*, *Ptilotus axillaris*, *Senna notabilis*, *Solanum diversiflorum*, *Stemodia grossa*, *Streptoglossa odora*, *Triodia epactia*.

E: MOUND SPRING WOODLANDS

E1: Tall Mound Spring *Melaleuca* woodlands

Dense woodland of *Melaleuca leucadendra* or *Melaleuca alsophila* over very sparse shrubs of *Acacia ampliceps*, over very sparse sedges of *Fimbristylis ferruginea* which form mid-dense sedgeland on the margins of permanent freshwater pools.

Plots: MAND18, MAND19, MAND24

Location on landform: Large peaty freshwater mound springs on saline clay-loam flats.

Species of Conservation Significance: *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433)

SIMPER Species: *Acacia ampliceps*, *Cynanchum carnosum*, *Eragrostis falcata*, *Fimbristylis ferruginea*, *Melaleuca leucadendra*

E2: *Sesbania formosa* / *Melaleuca alsophila* tall woodlands and fernland on Mound Springs

Tall mid-dense woodland of *Sesbania formosa*, *Acacia ampliceps* *Melaleuca alsophila*, over dense fern layer of *Acrostichum speciosum*, with of *Typha domingensis*, *Schoenoplectus subulatus*, and *Samolus* sp. Millstream (M.I.H. Brooker 2076) fringing the margins of the mound spring woodland.

Plots: MAND20, MAND22, MAND23

Location on landform: Large peaty mound springs on saline clay-loam flats.

Species of Conservation Significance: None

SIMPER Species: *Acrostichum speciosum*, *Sesbania formosa*, *Typha domingensis*, *Melaleuca alsophila*, *Acacia ampliceps*

Samphire shrublands

F: *Melaleuca alsophila* shrublands over samphires on loamy flats

Very sparse shrubs of *Acacia ampliceps* or mid-dense tall shrublands of *Melaleuca alsophila* among sparse samphire shrublands of *Tecticornia indica* subsp. *leiostachya*, *Muellerolimon salicorniaceum*, *Tecticornia halocnemoides* subsp. *tenuis*, *Trianthema turgidifolium*, *Tecticornia halocnemoides* subsp. *longispicata*, *Neobassia asterocarpa* and *Frankenia ambita*, over clumps of *Sporobolus virginicus*.

Plots: MAND01, MAND05, MAND06, MAND09, MAND10, MAND14

Location on landform: Plain between dunefield and saline creek, on margins of saline creek, and extensive, loamy flats on outer margins of mound spring. Very fine grained clay-loam overlying calcrete.

Species of Conservation Significance: *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433),

SIMPER Species: *Eragrostis falcata*, *Frankenia ambita*, *Neobassia astrocarpa*, *Sporobolus virginicus*, *Tecticornia indica* subsp. *leiostachya*, *Trianthema turgidifolium*, *Sporobolus australasicus*, *Acacia ampliceps*, *Flaveria trinervia*, *Pluchea longiseta*.

G: Samphire shrublands on salt lake flats

Low halophyte-dominated samphire shrublands dominated varyingly by *Tecticornia halocnemoides* subsp. *longispicata*, *Tecticornia auriculata*, *Tecticornia halocnemoides*, *Tecticornia* sp. "tall, robust" and *Tecticornia indica* subsp. *leiostachya* chenopod shrubland.

Plots: MAND02, MAND11, MAND25

Location on landform: Inland salt lake flats and in a dry channel of a wide, ephemeral saline creek.

Species of Conservation Significance: None.

SIMPER Species: *Tecticornia halocnemoides* subsp. *longispicata*, *Tecticornia indica* subsp. *leiostachya*, *Tecticornia* sp. "tall, robust"

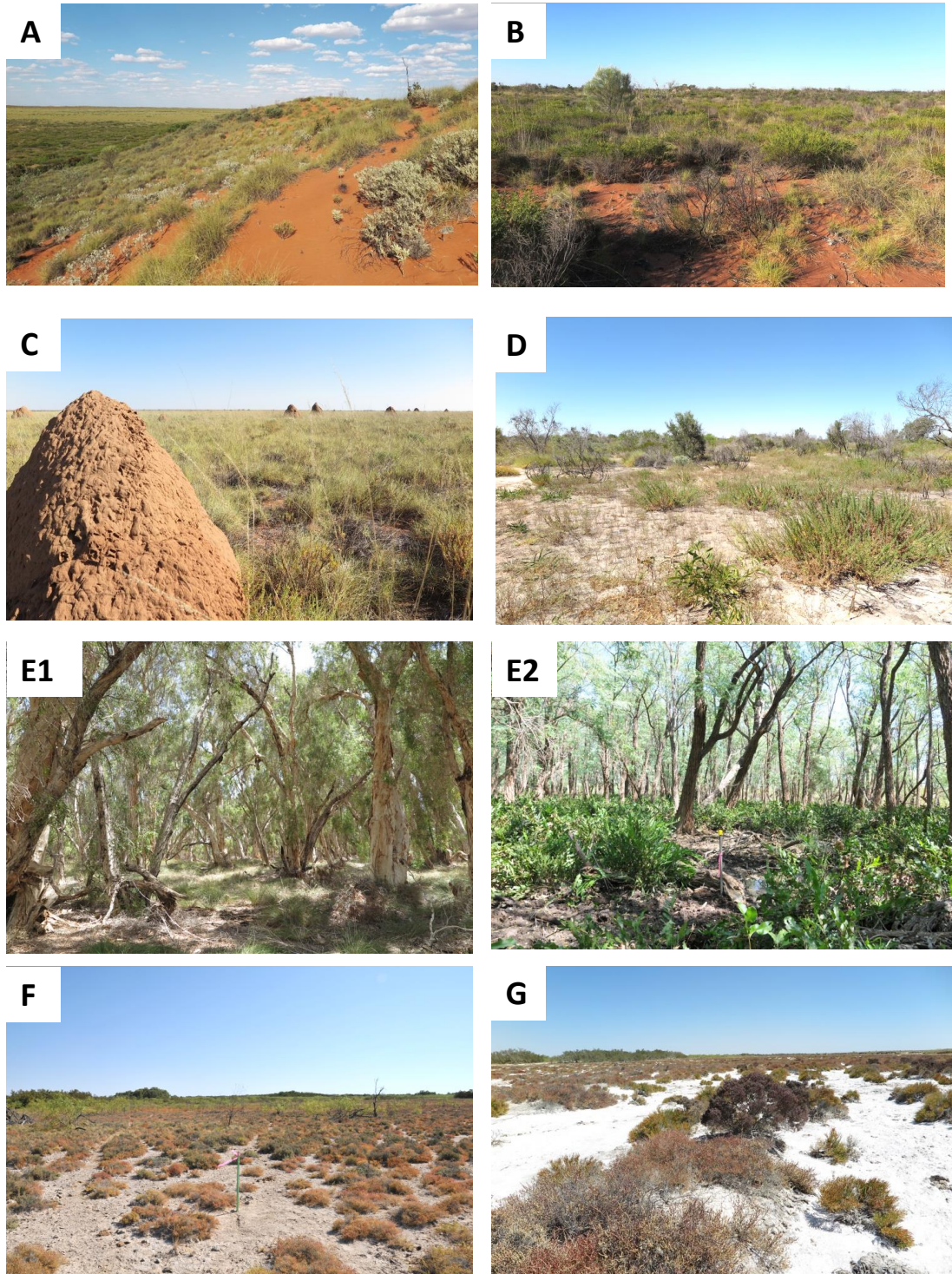


Figure 5: Vegetation Communities of the Mandora Marsh / Walyarta Survey 2015 Area labelled by floristic community group code: Group A: Sand dune *Acacia* shrublands and *Triodia* grasslands, Group B: *Acacia* shrublands and *Triodia* grasslands on sand dunes/flats, Group C: *Triodia* hummock grasslands on plains, Group D: *Melaleuca alsophila* shrublands on calcretes, Group E1: Tall Mound Spring *Melaleuca* woodlands, Group E2: Tall *Sesbania* / *Melaleuca* Mound Spring woodlands over ferns, Group F: *Melaleuca alsophila* shrublands over samphires on loamy flats Group G: Samphires on salt lake flats.

Appendix 1: Species list for the Mandora Marsh / Walyarta survey area, grouped by family, compiled only from records in and adjacent to all 26 survey plots established in 2015. (red text indicates species identified in 2015 survey which were not recorded in the previous survey (Graham 1999) or are absent from herbarium (KNR, WAH) records, see Appendix 2). Conservation priority listing in parentheses and introduced species indicated by asterisk. Family taxonomy follows the APG III system (Angiosperm Phylogeny Group 2009), which was current at time of flora list compilation (Florabase 1998-)

Acanthaceae

Avicennia marina

Aizoaceae

Sesuvium portulacastrum

Trianthema pilosum

Trianthema triquetrum

Trianthema turgidifolium

Amaranthaceae

Achyranthes aspera

***Aerva javanica* ***

Amaranthus undulatus

Ptilotus arthrolasius

Ptilotus axillaris

Ptilotus nobilis subsp. *nobilis*

Surreya diandra

Apocynaceae

Carissa lanceolata

Cynanchum carnosum

***Gymnanthera cunninghamii* P3**

Araceae

Lemna aequinoctialis

Asteraceae

***Flaveria trinervia* ***

Pluchea ferdinandi-muelleri

Pluchea longiseta

Pluchea rubelliflora

Pterocaulon serrulatum var. *velutinum*

Streptoglossa bubakii

Streptoglossa odora

Bignoniaceae

Dolichandrone heterophylla

Boraginaceae

Heliotropium curassavicum

Heliotropium glanduliferum

Heliotropium pachyphyllum

Heliotropium transforme

Capparaceae

Capparis spinosa var. *nummularia*

Chenopodiaceae

Dysphania plantaginella

Neobassia astrocarpa

Tecticornia auriculata

Tecticornia halocnemoides* aff. *tenuis

***Tecticornia halocnemoides* (not subsp. *tenuis*)**

Tecticornia halocnemoides subsp. *longispicata*

Tecticornia halocnemoides subsp. *tenuis*

Tecticornia indica subsp. *leiostachya*

***Tecticornia* sp. "tall robust"**

Threlkeldia diffusa

Cleomaceae

Cleome uncifera subsp. *uncifera*

Cleome viscosa

Combretaceae

***Terminalia kumpaja* P3**

Convolvulaceae

Polymeria ambigua

Cucurbitaceae

Cucumis cf. *variabilis*

Cyperaceae

Bulbostylis barbata

Cyperus bulbosus

Cyperus conicus

Fimbristylis ferruginea

Schoenoplectus subulatus

Schoenus falcatus

Euphorbiaceae

Adriana tomentosa var. *tomentosa*

Euphorbia* aff. *hassallii

Euphorbia myrtoides

Fabaceae

Acacia ampliceps

<i>Acacia anaticeps</i>	<i>Sida</i> sp. Pindan (B.G. Thomson 3398)
<i>Acacia colei</i> var. <i>colei</i>	
<i>Acacia melleodora</i>	
<i>Acacia monticola</i>	
<i>Acacia stellaticeps</i>	
<i>Acacia synchronicia</i>	
<i>Acacia tumida</i> var. <i>kulparn</i>	
<i>Aenictophyton reconditum</i> subsp. <i>reconditum</i>	
<i>Bauhinia cunninghamii</i>	
<i>Chamaecrista symonii</i>	
<i>Crotalaria cunninghamii</i> subsp. <i>cunninghamii</i>	
<i>Erythrophleum chlorostachys</i>	
<i>Gompholobium simplicifolium</i>	
<i>Jacksonia aculeata</i>	
<i>Senna ferraria</i>	
<i>Senna notabilis</i>	
<i>Sesbania formosa</i>	
<i>Tephrosia</i> sp. B Kimberley Flora (C.A. Gardner 7300)	
<i>Tephrosia supina</i>	
Frankeniaceae	
<i>Frankenia ambita</i>	
Goodeniaceae	
<i>Dampiera cinerea</i>	
<i>Scaevola parvifolia</i>	
<i>Scaevola spinescens</i>	
<i>Velleia panduriformis</i>	
Gyrostemonaceae	
<i>Codonocarpus cotinifolius</i>	
Hemerocallidaceae	
<i>Corynotheca micrantha</i> var. <i>gracilis</i>	
Lamiaceae	
<i>Cyanostegia cyanocalyx</i>	
<i>Newcastelia cladotricha</i>	
Lauraceae	
<i>Cassytha</i> cf. <i>capillaris</i>	
<i>Cassytha filiformis</i>	
Malvaceae	
<i>Abutilon</i> aff. <i>hannii</i>	
<i>Abutilon otocarpum</i>	
<i>Corchorus sidoides</i> subsp. <i>vermicularis</i>	
<i>Gossypium australe</i>	
<i>Hibiscus apodus</i>	
<i>Lawrencia</i> sp. Anna Plains (N.T. Burbidge 1433) P3	
<i>Lawrencia viridigrisea</i>	
<i>Sida fibulifera</i>	
Menispermaceae	
<i>Tinospora smilacina</i>	
Myrtaceae	
<i>Calytrix carinata</i>	
<i>Corymbia zygophylla</i>	
<i>Melaleuca alsophila</i>	
<i>Melaleuca glomerata</i>	
<i>Melaleuca lasiandra</i>	
<i>Melaleuca leucadendra</i>	
Nyctaginaceae	
<i>Boerhavia</i> cf. <i>burbidgeana</i>	
Phyllanthaceae	
<i>Phyllanthus maderaspatensis</i>	
Plantaginaceae	
<i>Stemodia grossa</i>	
Plumbaginaceae	
Muellerolimon salicorniaceum	
Poaceae	
<i>Aristida contorta</i>	
<i>Aristida holathera</i> var. <i>holathera</i>	
<i>Cenchrus ciliaris</i> *	
<i>Chrysopogon pallidus</i>	
<i>Cynodon dactylon</i> *	
<i>Dactyloctenium radulans</i>	
<i>Enneapogon purpurascens</i>	
<i>Eragrostis eriopoda</i>	
<i>Eragrostis falcata</i>	
<i>Eriachne aristidea</i>	
<i>Eriachne obtusa</i>	
<i>Panicum decompositum</i>	
<i>Paspalum vaginatum</i>	
<i>Setaria verticillata</i> *	
<i>Sporobolus australasicus</i>	
<i>Sporobolus virginicus</i>	
<i>Triodia epactia</i>	
<i>Triodia schinzii</i>	
<i>Whiteochloa cymbiformis</i>	
<i>Xerochloa barbata</i>	
Portulacaceae	
<i>Calandrinia quadrivalvis</i>	
<i>Portulaca intraterranea</i> 3	
Primulaceae	

Samolus sp. Millstream (M.I.H. Brooker 2076)

Dodonaea coriacea

Proteaceae

Grevillea pyramidalis subsp. *leucadendron*

Grevillea pyramidalis subsp. *pyramidalis*

Grevillea refracta subsp. *refracta*

Grevillea stenobotrya

Grevillea wickhamii subsp. *macrodonta*

Hakea chordophylla

Solanaceae

Solanum diversiflorum

Solanum esuriale

Solanum oligandrum 3

Thymelaeaceae

Pimelea ammocharis

Pteridaceae

Acrostichum speciosum

Typhaceae

Typha domingensis

Rubiaceae

Gardenia pyriformis subsp. *keartlandii*

Spermacoce occidentalis

Zygophyllaceae

Zygophyllum compressum

Sapindaceae

Appendix 2: Previous species records for the Mandora Marsh / Walyarta survey area (excluding the 2015 survey), grouped by family, compiled from herbarium records and previous flora survey data (Graham 1999) and updated to 2016 nomenclature. Red text indicates species from 1999 datasets but not in Western Australian herbarium records. Conservation priority listing in parentheses and introduced species indicated by asterisk. Family taxonomy follows the APG III system (Angiosperm Phylogeny Group 2009), which was current at time of flora list compilation (Florabase 1998-)

Acanthaceae

Avicennia marina

Aizoaceae

Sesuvium portulacastrum
Trianthema pilosum
Trianthema triquetrum
Trianthema turgidifolium

Amaranthaceae

Achyranthes aspera
Aerva javanica *
Ptilotus arthrolasius
Ptilotus astrolasius
Ptilotus axillaris
Ptilotus calostachyus
Ptilotus lanatus
Ptilotus nobilis subsp. nobilis
Ptilotus polystachyus
Surreya diandra

Apocynaceae

Cynanchum carnosum
Gymnanthera cunninghamii

Asteraceae

Flaveria trinervia *
Minuria integerrima
Pluchea ferdinandi-muelleri
Pluchea longiseta
Pluchea rubelliflora
Pluchea tetranthera
Pterocaulon serrulatum
Streptoglossa bubakii
Streptoglossa odora

Bignoniaceae

Dolichandrone heterophylla

Boraginaceae

Ehretia saligna
Halgania solanacea var. *solanacea*
Heliotropium curassavicum
Heliotropium glanduliferum
Heliotropium ovalifolium
Heliotropium transforme
Trichodesma zeylanicum

Byblidaceae

Byblis rorida

Chenopodiaceae

Atriplex eremitis (P1)
Neobassia astrocarpa
Salsola australis
Tecticornia ? pergranulata
Tecticornia auriculata
Tecticornia halocnemoides subsp. *longispicata*
Tecticornia halocnemoides subsp. *tenuis*
Tecticornia indica subsp. *leiostachya*

Cleomaceae

Cleome uncifera subsp. *uncifera*
Cleome viscosa

Combretaceae

Terminalia kumpaja

Convolvulaceae

Bonamia alatisemina
Bonamia pannosa
Cressa australis
Polymeria ambigua

Cucurbitaceae

Cucumis variabilis

Cyperaceae

Bulbostylis barbata
Cyperus bulbosus
Cyperus conicus
Cyperus squarrosus
Cyperus vaginatus
Fimbristylis ammobia
Fimbristylis caespitosa
Fimbristylis ferruginea
Fimbristylis rara
Fimbristylis tristachya
Fuirena incrassata P3
Schoenoplectus subulatus
Schoenus falcatus

Droseraceae

Drosera finlaysoniana
Drosera indica
Drosera petiolaris

Elatinaceae

Bergia ammannioides

Euphorbiaceae

Adriana tomentosa
Euphorbia coghlanii
Euphorbia drummondii
Euphorbia myrtilloides
Euphorbia vaccaria var. *vaccaria*

Fabaceae

Acacia adoxa var. *adoxoidea*
Acacia ampliceps
Acacia ampliceps x *bivenosa*
Acacia anaticeps
Acacia ancistrocarpa
Acacia ancistrocarpa x *drepanocarpa*
Acacia colei var. *colei*
Acacia coriacea
Acacia drepanocarpa subsp. *drepanocarpa*
Acacia glaucocaesia
Acacia melleodora
Acacia monticola
Acacia sabulosa
Acacia sp. Ripon Hills (B.R. Maslin 8460)
Acacia stellaticeps
Acacia synchronica
Acacia tumida var. *kulparn*
Aenictophyton reconditum subsp. *reconditum*
Chamaecrista symonii
Crotalaria cunninghamii
Crotalaria medicaginea
Crotalaria ramosissima
Cullen martinii
Cullen pustulatum
Erythrophleum chlorostachys
Gompholobium simplicifolium
Indigofera ammobia P3
Indigofera colutea
Indigofera linifolia
Indigofera linnaei
Indigofera monophylla
Jacksonia aculeata
Leptosema anomalum
Senna ferraria
Senna glutinosa
Senna notabilis
Sesbania cannabina
Sesbania formosa
Tephrosia brachyodon
Tephrosia rosea var. *clementii*
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)
Tephrosia sp. D Kimberley Flora (R.D. Royce 1848)

Frankeniaceae

Frankenia ambita

Gentianaceae

Schenkia australis

Goodeniaceae

Dampiera cinerea
Goodenia armitiana
Scaevola amblyanthera
Scaevola parvifolia
Scaevola spinescens
Velleia panduriformis

Gyrostemonaceae

Codonocarpus cotinifolius
Gyrostemon tepperi

Hemerocallidaceae

Corynotheca micrantha

Lamiaceae

Cyanostegia cyanocalyx
Newcastelia cladotricha

Lauraceae

Cassytha filiformis

Lythraceae

Ammannia baccifera

Malvaceae

Abutilon lepidum
Abutilon macrum
Abutilon otocarpum
Androcalva loxophylla
Corchorus incanus subsp. *incanus*
Corchorus sidoides subsp. *vermicularis*
Gossypium australe
Hibiscus apodus
Hibiscus leptocladus
Hibiscus pentaphyllus
Lawrencia densiflora
Lawrencia viridigrisea
Melhantha oblongifolia
Sida arenicola
Sida fibulifera
Sida sp. B Kimberley Flora (A.A. Mitchell 2745)

Meliaceae

Owenia reticulata

Menispermaceae

Tinospora smilacina

Molluginaceae

Glinus oppositifolius
Mollugo molluginea

Muntingiaceae

Muntingia calabura *

Myrtaceae

Calytrix carinata
Corymbia zygomphylla
Eucalyptus victrix
Melaleuca alsophila
Melaleuca argentea
Melaleuca glomerata
Melaleuca lasiandra
Melaleuca leucadendra
Melaleuca nervosa subsp. *crosslandiana*
Melaleuca viridiflora

Phrymaceae

Mimulus uvedaliae

Plantaginaceae

Stemodia grossa

Plumbaginaceae

Muellerolimon salicorniaceum

Poaceae

Aristida contorta
Aristida holathera
Cenchrus ciliaris *
Cenchrus setiger *
Chrysopogon fallax
Dactyloctenium radulans
Digitaria brownii
Enneapogon purpurascens
Enneapogon robustissimus
Eragrostis cumingii
Eragrostis eriopoda
Eragrostis falcata
Eragrostis fallax
Eragrostis speciosa
Eriachne aristidea
Eriachne obtusa
Panicum decompositum
Paractaenum refractum
Paspalum vaginatum
Setaria apiculata
Setaria verticillata *
Sorghum stipoideum
Sporobolus virginicus
Triodia epactia
Triraphis mollis
Xerochloa imberbis
Yakirra australiensis

Primulaceae

Samolus sp. Millstream (M.I.H. Brooker 2076)

Portulacaceae

Calandrinia quadrivalvis
Calandrinia uniflora

Potamogetonaceae

Stuckenia pectinata

Proteaceae

Grevillea pyramidalis subsp. *pyramidalis*
Grevillea stenobotrya
Grevillea wickhamii subsp. *macrodonta*
Grevillea wickhamii subsp. *wickhamii*
Hakea chordophylla
Hakea lorea

Pteridaceae

Acrostichum speciosum

Rubiaceae

Gardenia pyriformis subsp. *keartlandii*
Spermacoce occidentalis
Timonius timon

Santalaceae

Santalum lanceolatum

Sapindaceae

Dodonaea coriacea

Solanaceae

Duboisia hopwoodii
Nicotiana benthamiana
Nicotiana heterantha P1
Solanum diversiflorum
Solanum esuriale
Solanum oligandrum P3

Stylidiaceae

Stylidium desertorum

Thymelaeaceae

Pimelea ammocharis

Typhaceae

Typha domingensis

Verbenaceae

Phyla nodiflora *

Zygophyllaceae

Tribulopsis angustifolia
Tribulopsis marliesiae
Zygophyllum compressum

Appendix 3: Quadrat geographic locations (WGS 84) and vegetation description of plots established on Mandora Marsh / Walyarta. Site/location refers to sampling locations surveyed by Graham (1999). Rescore in parenthesis refers to the site being a rescore of general plot location from Graham 1999. Floristic communities refer to those identified in this report (from the 2015 survey).

Plot code	site /location	Lat (dd)	Long (dd)	Vegetation	Floristic Community Group	Site Description
MAND01	Samphire 2 (rescore)	-19.7570°	121.3958°	Isolated plants of <i>Acacia ampliceps</i> over sparse samphire shrubland of <i>Tecticornia indica</i> subsp. <i>leiostachya</i> and <i>Tecticornia halocnemoides</i> subsp. <i>longispicata</i> and <i>Frankenia ambita</i> , over isolated clumps of <i>Sporobolus virginicus</i>	F: <i>Melaleuca alsophila</i> shrublands over samphires on loamy flats	Extensive, loamy flats on outer margins of mound spring and near inland saline salt lake flats.
MAND02	Samphire 1 (rescore)	-19.7642°	121.3756°	Sparse <i>Tecticornia halocnemoides</i> subsp. <i>longispicata</i> , <i>Tecticornia halocnemoides</i> , <i>Tecticornia</i> sp. and <i>Tecticornia indica</i> subsp. <i>leiostachya</i> chenopod shrubland.	G: Samphire shrublands on salt lake flats	Inland saline salt lake margin.
MAND03	Sand Dune 3 (rescore)	-19.7806°	121.3661°	Sparse tall shrubs of <i>Terminalia kumpaja</i> , <i>Grevillea stenobotrya</i> , <i>Acacia colei</i> and <i>Melaleuca lasiandra</i> over sparse shrubland and grasses of <i>Crotalaria cunninghamii</i> , <i>Triodia schinzii</i> , <i>Euphorbia myrtilodes</i> , <i>Trianthema pilosum</i> and <i>Eragrostis eriopoda</i> .	B: <i>Acacia</i> / <i>Melaleuca</i> shrublands and <i>Triodia</i> hummock grasslands on sand dunes/flats	Red aeolian sand dune crest.
MAND04	Sand Dune 3 (rescore)	-19.7781°	121.3676°	Isolated <i>Bauhinia cunninghamii</i> trees over mid-dense <i>Melaleuca alsophila</i> shrubland with over sparse shrubland of <i>Acacia stellaticeps</i> , <i>Acacia colei</i> and <i>Pluchea ferdinandi-muelleri</i> , over various isolated grass species.	B: <i>Acacia</i> / <i>Melaleuca</i> shrublands and <i>Triodia</i> hummock grasslands on sand dunes/flats	Interface between red aeolian sand plains and dunes and loam soils on margins of mound springs. Sandy loam soils.
MAND05	Loam 3 (rescore)	-19.7697°	121.3911°	Mid-dense <i>Melaleuca alsophila</i> tall shrubland, over very sparse shrubs of <i>Acacia ampliceps</i> , over sparse succulent shrubs of <i>Trianthema turgidifolium</i> , <i>Tecticornia indica</i> subsp. <i>leiostachya</i> and <i>Sporobolus virginicus</i> .	F: <i>Melaleuca alsophila</i> shrublands over samphires on loamy flats	Extensive, loamy flats on outer margins of mound spring.

MAND06	Loam 3 (rescore)	-19.7673°	121.3916°	Very sparse shrubs of <i>Acacia ampliceps</i> , over mid-dense shrubland of <i>Muellerolimon salicorniaceum</i> , <i>Tecticornia halocnemoides</i> subsp.? <i>tenuis</i> and <i>Frankenia ambita</i> .	F: <i>Melaleuca alsophila</i> shrublands over samphires on loamy flats	Extensive, loamy flats on outer margins of mound spring.
MAND07	Calcrete 2 (rescore)	-19.7561°	121.4504°	Very sparse tall shrubland <i>Melaleuca alsophila</i> and <i>Hakea chordophylla</i> over very sparse shrubs of <i>Grevillea wickhamii</i> , <i>Pluchea ferdinandi-muelleri</i> and <i>Grevillea pyramidalis</i> , over mid-dense hummock grassland, herb and shrub mosaic of <i>Triodia epactia</i> , <i>Heliotropium pachyphyllum</i> , <i>Acacia stellaticeps</i> , <i>Corchorus sidoides</i> and <i>Ptilotus axillaris</i> .	D: <i>Melaleuca alsophila</i> / <i>Acacia ampliceps</i> shrublands on calcretes	Extensive, recently-burnt, gently-undulating calcrete plain.
MAND08	Calcrete 1 (rescore)	-19.7468°	121.4591°	Very sparse shrubland of <i>Melaleuca alsophila</i> and <i>Acacia ampliceps</i> over sparse shrubland of <i>Acacia stellaticeps</i> , <i>Grevillea wickhamii</i> , <i>Stemodia grossa</i> and <i>Triodia epactia</i> , over sparse herbs and subshrubs of <i>Corchorus sidoides</i> , <i>Trianthema turgidifolia</i> , <i>Lawrencia viridigrisea</i> and <i>Neobassia asterocarpa</i> .	D: <i>Melaleuca alsophila</i> / <i>Acacia ampliceps</i> shrublands on calcretes	Extensive, recently-burnt, gently-undulating calcrete plain.
MAND09	Salt Creek 3 (rescore)	-19.7306°	121.4566°	Mid-dense shrubland of <i>Acacia synchronicia</i> , over mid-dense shrubland and grasses of <i>Eragrostis falcata</i> , <i>Scaevola spinescens</i> and <i>Tecticornia indica</i> subsp. <i>leiostachya</i> , over very sparse plants of <i>Solanum esuriale</i> , <i>Cenchrus ciliaris</i> , <i>Dactyloctenium radulans</i> and <i>Sporobolus australasicus</i> .	F: <i>Melaleuca alsophila</i> shrublands over samphires on loamy flats	Plain between dunefield and saline creek, on margins of saline creek. Very fine grained clay-loam overlying calcrete.
MAND10	Salt Creek 1	-19.7401°	121.5272°	Isolated plants of <i>Triodia epactia</i> and <i>Acacia synchronicia</i> , over mid-dense shrubland of <i>Tecticornia indica</i> subsp. <i>leiostachya</i> , <i>Trianthema turgidifolium</i> , <i>Frankenia ambita</i> and <i>Neobassia asterocarpa</i> , over very sparse sedges of <i>Cyperus bulbosus</i>	F: <i>Melaleuca alsophila</i> shrublands over samphires on loamy flats	Extensive, clayey, plain abutting saline creek. Very fine grained clay-loam overlying calcrete.

MAND11	Salt Creek 1 (rescore)	-19.7422°	121.5283°	Mid-dense shrubland of <i>Tecticornia auriculata</i> , <i>Tecticornia halocnemoides</i> subsp. <i>longispicata</i> , <i>Tecticornia halocnemoides</i> subsp. aff. <i>tenuis</i> and <i>Tecticornia indica</i> subsp. <i>leiostachya</i>	G: Sapphire shrublands on salt lake flats	Dry bed of wide, ephemeral saline creek.
MAND12	Salt Creek 2	-19.7377°	121.5009°	Isolated tall shrubs of <i>Acacia synchronicia</i> over dense <i>Triodia epactia</i> hummock grassland	C: <i>Triodia</i> hummock grassland on palaeoesturine plain	Plain abutting saline creek. Areas of partially exposed calcrete.
MAND13	Loam 2	-19.7908°	121.4507°	Sparse tall shrubland of <i>Melaleuca alsophila</i> and <i>Acacia ampliceps</i> over mid-dense hummock grassland and shrubs of <i>Triodia epactia</i> , <i>Solanum oligandrum</i> , <i>Heliotropium glanduliferum</i> over isolated herbs of <i>Calandrinia quadrivalvis</i> .	D: <i>Melaleuca alsophila</i> / <i>Acacia ampliceps</i> shrublands on calcretes	Extensive plain of pink-grey sandy loam - loam (breaking into with occasional termite mounds to 1.5m)
MAND14	Loam 2 (rescore)	-19.7893°	121.4479°	Mid-dense woodland of <i>Melaleuca alsophila</i> over sparse lower stratum of <i>Sporobolus virginicus</i> , <i>Tecticornia halocnemoides</i> subsp. ? <i>tenuis</i> , <i>Neobassia asterocarpa</i> , <i>Lawrenzia</i> sp. Anna Plains (N.T. Burbidge 1433) and <i>Pluchea longiseta</i> .	F: <i>Melaleuca alsophila</i> shrublands over sapphires on loamy flats	Flats on margins of mound spring, with sandy loam - loam soils.
MAND15	Loam 1 (rescore)	-19.7978°	121.4496°	Very sparse tall shrubs of <i>Grevillea stenobotrya</i> , <i>Terminalia kumpaja</i> and <i>Melaleuca alsophila</i> over mid-dense shrubland and hummock grassland of <i>Acacia stellaticeps</i> and <i>Triodia epactia</i> .	B: <i>Acacia</i> / <i>Melaleuca</i> shrublands and <i>Triodia</i> hummock grasslands on sand dunes/flats	Gently undulating sandy flats on margin of dunefield and loamy flats surrounding a mound spring. Interface of sand plain and paleo-esturine soils. Infrequent termite mound to 1.5m.
MAND16	Sand Dune 2	-19.8132°	121.4735°	Very sparse tree-mallee and shrubland of <i>Acacia tumida</i> , <i>Erythrophleum chlorostachys</i> and isolated trees of <i>Gardenia pyriformis</i> and <i>Terminalia kumpaja</i> , over mid-dense hummock grassland and shrubs of <i>Triodia schinzii</i> , <i>Triodia epactia</i> , <i>Dampiera candicans</i> , <i>Jacksonia aculeata</i> and <i>Gompholobium simplicifolium</i> .	A: <i>Acacia</i> and <i>Grevillea</i> shrublands over <i>Triodia</i> hummock grasslands on sand dunes	Crest of tall red sand dune in dunefield.

MAND17	Sand Dune 1	-19.8093°	121.4630°	Isolated tall shrubs of <i>Grevillea stenobotrya</i> , <i>Terminalia kumpaja</i> and <i>Grevillea wickhamii</i> , over mid-dense shrubland and hummock grassland of <i>Acacia stellaticeps</i> and <i>Triodia epactia</i> .	A: Acacia and Grevillea shrublands over Triodia hummock grasslands on sand dunes	Mid slopes - lower slopes of tall aeolian red sand dune in dunefield.
MAND18	Eil Eil Spring	-19.7977°	121.4434°	Dense woodland of <i>Melaleuca leucadendra</i> over very sparse shrubs of <i>Acacia ampliceps</i> , over sparse clumps of <i>Fimbristylis ferruginea</i>	E1: Tall Mound Spring Melaleuca woodlands	Large peaty mound spring on saline clay-loam flat.
MAND19	Eil Eil Spring	-19.7959°	121.4436°	Very sparse trees of <i>Melaleuca leucadendra</i> , over very sparse tall shrubs of <i>Acacia ampliceps</i> , over mid-dense sedgeland of <i>Fimbristylis ferruginea</i>	E1: Tall Mound Spring Melaleuca woodlands	Large peaty mound spring on saline clay-loam flat.
MAND20	Saunders Spring	-19.7829°	121.3393°	Mid-dense woodland of <i>Sesbania formosa</i> over <i>Acrostichum speciosum</i>	E2: Sesbania formosa / Melaleuca alsophila tall woodlands and fernland on Mound Springs	Large peaty mound spring on saline clay-loam flat.
MAND21	Saunders Spring	-19.7828°	121.3391°	Mid-dense woodland of <i>Sesbania formosa</i> and <i>Acacia ampliceps</i> over dense stand of <i>Acrostichum speciosum</i>	E2: Sesbania formosa / Melaleuca alsophila tall woodlands and fernland on Mound Springs	Large peaty mound spring on saline clay-loam flat. 5 x 40m plot nested in MAND20 (E2). Analysed as part of MAND20.
MAND22	Fern Spring	-19.7664°	121.3924°	Mid-dense woodland of <i>Sesbania formosa</i> and <i>Acacia ampliceps</i> over dense stand of <i>Acrostichum speciosum</i>	E2: Sesbania formosa / Melaleuca alsophila tall woodlands and fernland on Mound Springs	Large peaty mound spring on saline clay-loam flat. Two 5 x 40m plots. Combined for analysis.
MAND23	Fern Spring	-19.7673°	121.3918°	Sparse <i>Acacia ampliceps</i> , <i>Melaleuca alsophila</i> and <i>Sesbania formosa</i> , over <i>Schoenoplectus subulatus</i> , <i>Samolus</i> sp. Millstream (M.I.H. Brooker 2076) and <i>Sporobolus virginicus</i> .	E2: Sesbania formosa / Melaleuca alsophila tall woodlands and fernland on Mound Springs	Large peaty mound spring on saline clay-loam flat. 5 x 40m plot

MAND24	Grant Spring	-19.7838°	121.3554°	Dense woodland of <i>Melaleuca alsophila</i> , over isolated subshrubs of <i>Solanum esuriale</i> .	E1: Tall Mound Spring <i>Melaleuca</i> woodlands	Large peaty mound spring on saline clay-loam flat.
MAND25	Mandora Lake	-19.7791°	121.3487°	Sparse chenopod shrubland of <i>Tecticornia auriculata</i> , <i>Tecticornia</i> sp. and <i>Tecticornia indica</i> subsp. <i>leiostachya</i> .	G: Samphire shrublands on salt lake flats	Dry (periodically inundated) salt lake flats.

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References

- Clarke KR, Warwick RM (2001) *Change in marine communities: an approach to statistical analyses and interpretation*, 2nd edn. PRIMER-E, Plymouth
- Barker, R.M. (1998). A revised key to *Sida* section *Sida* in Australia, including a newly introduced species and name changes for *Sida rohlena* var. *mutica* (Benth.) Fryxell and *S. magnifica* Domin. *Journal of the Adelaide Botanic Garden* 18: 33–41.
- Bean, A. R. (2009) The Australian *Flaveria* (Asteraceae): its correct name and origin status. *Newsletter of the Australian Systematic Botanical Society* 140:2-3.
- Bray, J. R. and J. T. Curtis (1957). An ordination of upland forest communities of southern Wisconsin. *Ecological Monographs* 27:325-349.
- Clarke, K. R., & M. Ainsworth (1993). A method of linking multivariate community structure to environmental variables. *Marine Ecology Progress Series* 92: 205-219
- Clarke, K.R. & R. N. Gorley (2015). *PRIMER v7: User Manual/Tutorial*. PRIMER-E, Plymouth, 296pp.
- Clarke, K. R., P. J. Somerfield, & R. N. Gorley (2008). Testing null hypotheses in exploratory community analyses: similarity profiles and biota-environmental linkage. *Journal of Experimental Marine Biology and Ecology* 366: 56-69.
- Cranfield R.J. (2008). *Atriplex eremitis* (Chenopodiaceae), a new species from northern Western Australia. *Nuytsia* 18: 49–52
- Graham G (1999) *A Land Management Assessment of Mandora Marsh / Walyarta and Its Immediate Surrounds*. Department of Conservation and Land Management, Unpublished report, 91 pps
- Halford D. A. and Harris, W. K. (2012) A taxonomic revision of *Euphorbia* section *Anisophyllum* Roesler (Euphorbiaceae) in Australia. *Austrobaileya* 8, 441–600.
- Jones A. (2014). *Threatened and Priority Flora list for Western Australia*. Department of Parks and Wildlife: Kensington, Western Australia. 11th November 2015.
- Lance, G.N., Williams, W.T. (1967). A general theory of classificatory sorting strategies. I. Hierarchical Systems. *The Computer Journal* 9:373–380.

Lander N.S. (1984). Revision of the Australian genus *Lawrencia* Hook. (Malvaceae: Malveae) *Nuytsia* 5:249-252

Markey A.S, and Dillon S.J (2009). Flora and vegetation of the banded iron formations of the Yilgarn Craton: Herbert Lukin Ridge (Wiluna). *Conservation Science Western Australia* 7, pp. 391–412

McDonald R.C., Isbell R.F., Speight J.G, Walker J., Hopkins M.S. (1998) *Australian Soil and Land Survey: Field Handbook*. 2nd ed. Australian Collaborative Land Evaluation Program, Canberra, Australia.

Short P.S., Albrecht D.E., Cowie I.D., Lewis D.L. and Stuckey, B. (eds) (2011). *Checklist of the Vascular Plants of the Northern Territory*. Northern Territory Herbarium, Department of Natural Resources, Environment, The Arts and Sport, Palmerston, Northern Territory.

Simon, B.K. & Alfonso, Y. (2011). AusGrass2, <http://ausgrass2.myspecies.info/> accessed on [last accessed 15th May 2016].

Sneath PHA, Sokal RR (1973) *Numerical Taxonomy: The Principles and Practice of Numerical Classification*. Freeman, San Francisco.

Western Australian Herbarium (1998–) *Florabase–The Western Australian Flora*. Department of Parks and Wildlife. <http://florabase.dpaw.wa.gov.au> [last accessed 17th May 2016].