Targeted Rare and Priority Flora Survey: La Grange Project Area

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In partnership with:

KARA JARRI RANGERS

NYANGUMARTA WARRARN • DESERT TO THE SEA •

YAWURU

Final Report

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GOVERNMENT OF WESTERN AUSTRALIA

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Executive Summary

The primary purpose of this survey is to provide information to stakeholders on the distribution and status of conservation-listed flora within the western half of the La Grange Project Area being investigated by the Western Australian Department of Primary Industries and Regional Development (DPIRD). This area lies between Broome and Mandora in the West Kimberley, and encompasses of a range of vegetation communities on Pindan sandplain, palaeodrainage systems and coastal saline plains. The tenure of most of this area is Crown Land held under pastoral leases, and DPIRD has identified areas which have potential for irrigated agriculture to serve the horticultural and pastoral industries. To facilitate the environmental approvals process, and to assess risks to species and identify issues of conservation concern, the Department of Biodiversity and Attractions (DBCA) undertook a targeted survey for conservation-listed flora in the project area. The project involved Traditional Owner Ranger Group collaboration with Yawuru Country Managers, Karajarri Rangers and Nyangumarta Rangers, who accompanied field surveys, shared traditional flora knowledge and provided logistical support and access guidance.

The survey commenced with a desktop study that identified 28 conservation-listed taxa present or potentially present in the region, which was increased to 30 species once work proceeded. Field survey focused primarily on areas identified as preferred for irrigated agriculture. The majority of the survey area was on pastoral lease, but also included unallocated crown land and conservation estate. Fieldwork was undertaken between June and September 2017, during a good flowering season. A total area of 9270 km^2 was accessed by vehicle and foot traverses. A range of habitats and vegetation types were surveyed, with the majority occurring in Pindan sandplain vegetation.

Of the 30 species surveyed, 19 conservation-listed species were located, three of these found at locations that were range extensions > 15 km from nearest previously known locations. Of note, a new population was located of the threatened species, *Seringia exastia*. Eleven species were not located, primarily because suitable habitats were rare or absent in the La Grange Survey Area and / or it was too late in the dry season for these particular species to be present or visible. This project found taxonomic or identification issues arising with nine conservation-listed taxa, and this was addressed to varying degrees using information from field collections, herbarium records, taxonomic literature and type specimens.

Twelve species have part or all of their known range within the La Grange Survey Area within areas indicated as preferred for irrigated agriculture, which places these species at risk from clearing. The greatest flora conservation implications from agricultural development are exist for the one Threatened species (*Seringia*

exastia), and the La Grange endemic (*Tephrosia andrewii*). Potential flora conservation impacts are progressively lower for species which are more widespread but have limited ranges within the La Grange region (*Croton aridus, Dasymalla chorisepala* and *Indigofera ammobia*) and lowest for species which are common and widespread within the La Grange region but whose distribution outside of the La Grange region is unknown or limited. Seven species are unlikely to be impacted as they occur on substrates and in areas not suitable for irrigated agriculture.

This investigation generated sufficient information to assess and where appropriate amend the conservation status of 21 species. Two species were upgraded, four species were downgraded, four species were removed from the state conservation list, two species are pending further inquiry, and ten species had no change to their status.

This report details the results of the first attempt to provide a regional perspective of the distribution and status of conservation-listed flora in the La Grange region. This is an advance on previous surveys that have been restricted to small areas proposed for development and which assumed regional species distributions based on a limited amount of on-ground survey, herbarium records and extent of potential habitat. This report will assist in assessing the flora conservation implications of development for irrigated agriculture at a regional scale and will inform assessments of individual land parcels and projects, and work demonstrates the value of undertaking regional assessments for conservation-listed flora where major regional scale developments are proposed.

Further work is recommended following on from this report. A good proportion of the eastern half of the La Grange Project Area remains to be surveyed for its flora, and extending survey into these eastern regions and further southwest into the north-eastern Pilbara (which is a region of rapidly expanding development) would be the next desirable step. Given that the distribution of the target species outside of the La Grange region remains unknown or limited, it is recommended that cumulative impacts are taken into account when assessing developments over the La Grange region, and further surveys discover the extent of the range of La Grange conservation-listed and endemic species into the Dampier peninsula, Great Sandy Desert and north-eastern Pilbara.

This survey found significant issues with the taxonomic definition or species identification for several of the species, and this emphasises that conservation-listed taxa are often poorly known. Further taxonomic investigations into Kimberley conservation-listed species and the La Grange and western Kimberley flora are recommended.

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Acknowledgments

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1 Introduction

The La Grange region of the south-west Kimberley, Western Australia, has been investigated as an area for development of irrigated agriculture for pastoralists and horticulturalists by the Department of Primary Industries and Regional Development (DPIRD – formerly Department of Agriculture and Food Western Australia (DAFWA)). Through funding from Royalties for Regions, the La Grange Agriculture Opportunities project was established in 2012 as part of the Regional Economic Development Water Opportunities Project, and has assessed the potential for expanding irrigated agriculture in the region, including studies on soil, groundwater from the Broome Sandstone aquifer, land tenure, markets and investment opportunities. Through soil and hydrological studies, DPIRD has identified areas in the La Grange Project Area which are preferred for irrigated agriculture (DAFWA 2016a, DAFWA 2016b).

The La Grange region encompasses a long, linear area extending along the coastline between Broome and Sandfire and inland into the Great Sandy Desert (Figure 1). Land tenure in the La Grange region is mostly pastoral on Crown Land, and includes Roebuck Plains, Thangoo, Frazier Downs, Nita Downs, Anna Plains, Wallal and Mandora stations. Horticultural production is conducted on the Shelamar lease. Tenure for an area around Walyarta / Mandora Marsh and the Salt Creek wetlands was transferred to conservation estate in 2015 to become the Walyarta Conservation Park (DPaW 2016a). A substantial part of the eastern half of the project area is Unallocated Crown Land.

Although both flora and fauna of conservation significance are known to occur in the La Grange region, recent detailed flora surveys have been mostly localised (e.g. Markey 2017) and a regional perspective on rare and poorly known flora is lacking. This project undertook a targeted survey for conservation-listed flora (Threatened and Priority) to provide an update on knowledge of these species that will assist on species conservation and assessing development proposals for the region. Rare flora are categorised as Threatened and listed as Specially Protected under the state *Wildlife Conservation Act 1950* and can also be listed under the federal *Environmental Protection and Biodiversity Conservation Act 1999*. Priority flora are assessed by the Department of Biodiversity, Conservation and Attractions (DBCA), and are defined as possibly threatened but haven't met the criteria, or are otherwise data deficient (DPaW 2017)[1]. Priority flora are not protected by State legislation but are considered protected under Principle (a) guidelines to the assessment of clearing applications under the *Environmental Protection Action 1986* by the Department of Water and Environmental Regulation (formerly the Department of Environmental Regulation) (DER 2014). This survey aimed to update information on the distribution and conservation status of conservation listed flora in the region through desktop and

[1] Priority Flora are ranked in numerical order of priority for survey and assessment of conservation status, where Priority One – Three are poorly-known, with the exception of Priority Four taxa which are rare, near-threatened or have been recently removed from the Threatened list (DPaW 2017)

field surveys, with a focus on areas identified by DPIRD as Preferred Areas for irrigated agriculture.

This survey project was initiated as a partnership between the Department of Biodiversity, Conservation and Attractions (DBCA) and Traditional Owner ranger groups. Traditional owner ranger groups operating within the La Grange flora survey area include Karajarri Rangers, Nyangumarta Rangers and Yawuru Country Managers. Head agreements and supporting Fee-for-Service Schedules were developed with these Traditional Owners and their representative bodies.

1.1 The La Grange Region

Most of the La Grange region occurs in the south-western extent of the Dampierland biogeographic region (the Pindanland subregion), extending inland into the Great Sandy Desert bioregion along its eastern margin (Department of the Environment 2013). The climate of the study area is described as semi-arid monsoonal, where c. ≥80% of rainfall falls in the wet season between December and April (Cotching 2005). Mean annual rainfall ranges from 605 to 370 mm (Broome and Mandora recording stations respectively) (Paul *et al*. 2013).

The overall physiography of the La Grange is of a subdued, flat landscape. In the west are flat coastal plains, which transition to gently undulating aeolian sandplains in the east and to longitudinal dunefields in the far southeast (Paul *et al.* 2013). There are minor occurrences of hills, mesas, lateritic rises and seasonally inundated claypans within the region, while the extensive coastline is marked by extensive tidal mudflats, white sandy beaches and dunes and ridges, inlets, bays and some areas of coastal cliffs. There are few significant drainage features, apart from three major palaeodrainage features which filled with sediments following the onset of greater aridity in the region over the Quaternary (V & C Semeniuk Research Group 2000). These form chains of saline wetlands, with freshwater mound springs and intermittently inundated salt lakes and river channels, bordered by plains of saline light grey silty clays. The northernmost palaeodrainage feature is associated with the Roebuck Plains, which are intermittently inundated with freshwater following cyclonic rainfall events.

The La Grange region lies within the Canning Basin, a large sedimentary basin of Palaeozoic sedimentary rocks overlain with comparatively thin strata of Mesozoic and Cainozoic sediments (Paul *et al.* 2013). Much of these surface sediments form red aeolian sandplains and dunes overlying sedimentary rocks, with soils of deep red sands and loamy sands. Coastal plain surface sediments are marine (estuarine mud) and aeolian (sand) deposits, and coastal plain soils are saline and largely grey to black surface silty clays or sandy loams overlying light grey silty clays. A small proportion of the area has skeletal lateritic soils and gravelly soils with stony mantle (Cotching 2005).

1.2 Vegetation of the La Grange Region

Land systems of the La Grange region have been mapped and described as part of regional rangelands surveys by Cotching (2005) and compiled by Schoknect & Payne (2011). Seventeen land systems occur within the La Grange Project Area, the main ones being the Anna, the Great Sandy, Mannerie, Mandora, Nita, Roebuck and Yeeda land systems. The Nita and Yeeda land systems occur on sandplains of Quaternary aeolian deposits and harbour characteristic Pindan vegetation communities. The Yeeda land system covers the northern extent of Pindan vegetation and associated landforms in the La Grange region, while the Nita land system covers the southern half of Pindan vegetation and landforms in the region.

The La Grange region is located in the Dampierland bioregion (Department of the Environment and Energy 2018). Pindan vegetation consists of a mosaic of open low woodlands to scattered, isolated trees of *Corymbia greeniana*, *Corymbia zygophylla*, *Corymbia flavescens*, *Erythrophleum chlorostachys* and/or *Bauhinia cunninghamii,* or tall shrublands dominated by *Acacia eriopoda*, *Acacia monticola* and/or *Acacia colei*, over hummock grasslands dominated by *Triodia* spp. and *Chrysopogon pallidus*. Other common taxa included *Grevillea pyramidalis*, *Persoonia falcata*, *Carissa lanceolata* and *Acacia drepanocarpa*. The sandy gravels of more upland sites are dominated by a mixed shrubland/grassland of *Triodia* spp., *Acacia hilliana* and *Acacia adoxa*. In the eastern extent of the survey area, dunefields are dominated by scattered tall shrubs / trees of *E. chlorostachys*, *Owenia reticulata* and *Terminalia kumpaja* over a mixed shrubland/grassland of *Acacia stellaticeps* and *Triodia* spp., with *Grevillea stenobotrya* occurring on dune crests.

Associated with the major saline plains and palaeodrainage channels dissecting the survey area are *Melaleuca alsophila* shrublands over halophytes and samphires. Samphire shrublands (*Tecticornia indica* subsp. *bidens*, *Tecticornia auriculata*, *Tecticornia halocnemoides*) and *Xerochloa barbata* and *Sporobolus virginicus* grasslands dominate the saline floodplains and salt lakes. The Anna land system encompasses these communities on the coastal plains of the southern half of the La Grange region, while other halophytic, grassland and *Melaleuca* shrubland communities on the palaeodrainage features are included within the Mannerie and Mandora land systems.

There are seven ecological communities within the La Grange region that are listed as Priority Ecological Communities (DBCA 2017), and the assemblages of springs in the Walyarta / Mandora Marsh wetland complex are listed as a Threatened Ecological Community (DPaW 2016b). Threats to these Ecological Communities are noted as general, extensive processes (altered fire regimes, over-grazing and weed invasion). These Priority Ecological Communities are:

Priority One

- Inland Mangrove (*Avicennia marina*) community of Salt Creek
-

Priority Three (iii)

- ***Parda Land System****: Conical hills, stony ring plains, alluvial plains and shallow valleys supporting spinifex grasslands with sparse shrubs and trees*
- ***Vegetation Association 37****: Shrublands; teatree thicket.*
- ***Gourdon Land System:*** *Sandplain and undulating lateritic country with steep coastal gullies supporting spinifex grasslands with scattered trees.*
- ***Vegetation Association 67****: Grasslands, tall bunch grass savanna, sparse low tree; ribbon grass & paperbarks.*
- ***Vegetation Association 73:*** *Grasslands, short bunch grass savanna, grass; salt water grassland (Sporobolus virginicus)*
- ***Eighty Mile Land System****: Beach foredunes, longitudinal coastal dunes and sandy plains with tussock grasslands and spinifex grasslands*

1.3 Hydrology and Potential Irrigated Agricultural Development in the La Grange Project Area

The La Grange region has been under consideration for irrigation projects since the late 1990s, which has triggered a planning process and investigations to assess the soils and hydrogeology of the region, allocations for water extraction, land tenure status, and environmental, heritage and cultural values (DoW 2010). The area under investigation has been designated as the La Grange Project Area (DAFWA 2016a, DAFWA 2016b, DoW 2010), and is subdivided into north and south subareas, a coastal management zone and a Mandora management zone (Figure 1). The coastal management zone is of high priority for management to maintain the saltwater interface in this part of the project area (DoW 2010). The La Grange groundwater subareas consist of a hydrogeological system with two main aquifers: the Broome Sandstone and Wallal Sandstone aquifers. The Broome Sandstone aquifer is a superficial, fresh and accessible groundwater resource while the Wallal Sandstone aquifer is unsuitable for extraction as it is saline, located at depth, and underlies the impermeable Jarlemai Siltstone (Paul *et al.* 2013, DoW 2010). There are numerous environmentally sensitive sites within the project area, including wetland zones of significance, and three Ramsar listed wetlands (Eighty Mile Beach wetland system, Walyarta / Mandora Marsh wetland system, Roebuck Bay wetland system) (DoW 2010, Paul *et al*. 2013, Wright *et al.* 2016, V & C Semeniuk Research Group 2000). The Mandora management zone has been established to protect the environmentally and culturally significant Walyarta / Mandora Marsh wetlands (Figure 1, DAFWA 2016b, DoW 2010).

Excluding these management zones, the DPIRD La Grange project assessment optimised areas and identified potentially suitable land for irrigation development. Designated as Preferred Areas for irrigated agriculture (Figure 1), these were divided into three zones and given a preference rating (Preferred, Possible and Least preferred) based on depth to the water table and soil quality (DAFWA 2016b). The most preferred zones are those with shallowest water table depths (3–20m) and high quality Pindan soils, while least preferred have only medium-high quality Pindan soils and water table depths of 40-60m. Using these zones as a guide, pastoralists and horticulturalists in the region are already taking up diversification on their leases.

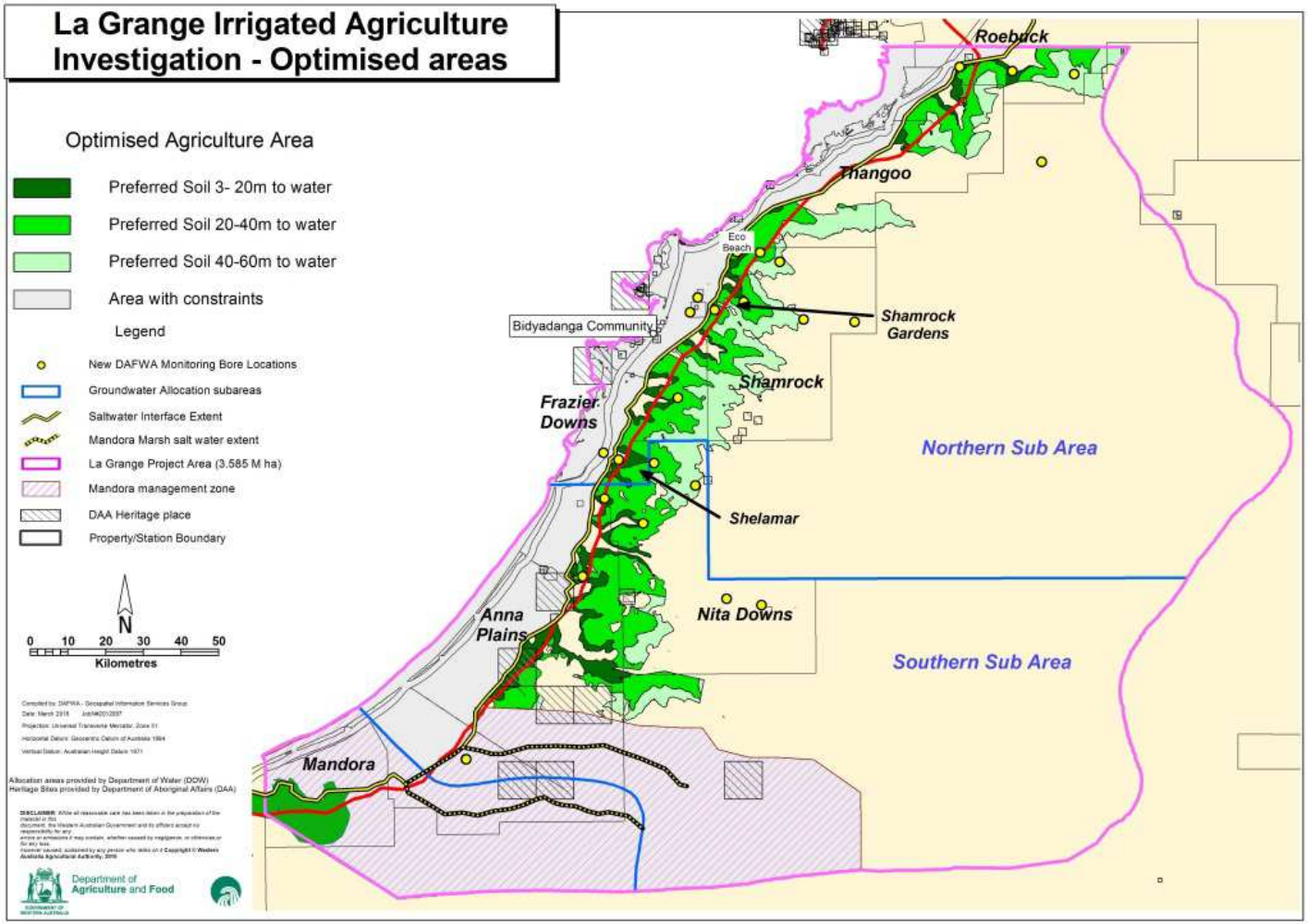

Figure 1: The La Grange Project Optimised Irrigation Areas, as identified by the DPIRD in the La Grange Agriculture Opportunities Project (DAFWA 2016a), showing division into subareas, two management zones and areas preferred for irrigated agriculture.

2 Methods

2.1 Desktop Flora Survey

Prior to field survey, a desktop survey was undertaken to identify species of conservation significance and determine their known locations and identify suitable potential habitats for field survey. Conservation listed flora were initially identified from within the La Grange Project Area from departmental spatial data, with additional taxa of interest that may potentially occur in the area suggested by regional DBCA staff. Locality information for species was obtained from records compiled by the Western Australian Herbarium, and DBCA's Threatened and Priority Flora (TPFL) databases (Figure 2). From these records and from both taxonomic publications and rangeland surveys (Cotching 2005), information has been compiled on habitats and landforms associated with these species. Using the broad La Grange DPIRD project area, an initial 31 taxa (species, informally-named taxa and hybrid taxa) of conservation significance were identified. This number was revised down to 28 taxa which were likely to be within the DPIRD Preferred Areas for irrigated agriculture (Table 1) when taxa from the periphery of the survey area and on unusual substrates were excluded (e.g.: the rock outcrop specialist, *Pandanus spiralis* var. *flammeus*).

This desktop flora survey was compiled into a document of species information sheets summarising current known distribution, diagnostic characters, and habitat associations. These were distributed to Ranger groups and some pastoralists with the aim to guide flora surveys and inform on Threatened and Priority flora in the La Grange Project Area. It is anticipated that this document will be made into a more formal document to assist Ranger groups when information and images are updated following the field survey.

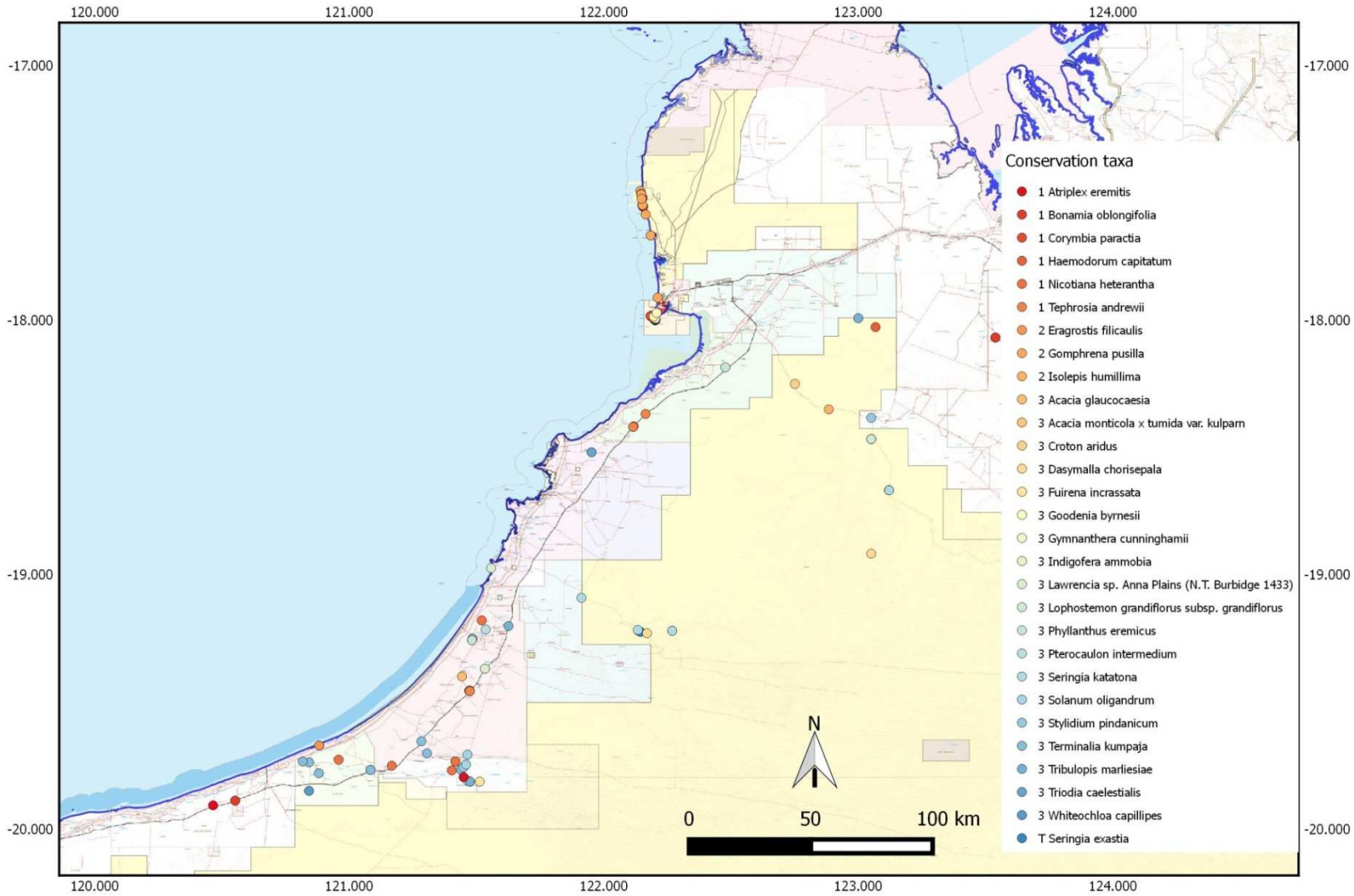

Figure 2: Records of Rare and Priority flora in the La Grange Project Area, from the Western Australian Herbarium (1998-) and Threatened and Priority Flora databases. Conservation listings current at April 2017, which was the time of the desktop survey.

Table 1: Rare and Priority flora in the La Grange Project Area, with State conservation codes (Smith 2017), known distribution and recorded habitat type. Table information is based on voucher collections held at the Western Australian Herbarium (accessed January 2017). Conservation codes refer to the definitions available at https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf.

Taxon	Conservation Code	Location	Habitat	No. of locations
Seringia exastia	T	Great Sandy Desert, Broome	Red sandplain and dunes	7
Atriplex eremitis	P1	Mandora Marsh	Salt marshes	1
Bonamia oblongifolia	P1	La Grange	Pindan	6
Haemodorum capitatum	P1	E of Broome, Dampier Peninsular	Pindan	1
Nicotiana heterantha	P1	Mandora Marsh, Anna Plains	Marshes	5
Tephrosia andrewii	P1	Scattered Thangoo - Sandfire	Red sandplain	7
Eragrostis filicaulis	P2	Mandora Station, Drysdale River	Coastal grassland	1
Gomphrena pusilla	P2	Disjunct North of Broome and near Port Hedland	Coastal sand dunes	1
Isolepis humillima	P2	East of Broome - north Kimberley	Seepage areas	1
Acacia glaucocaesia	P3	Anna Plains, Mandora Marsh, Pilbara	Clayey soils, colluvium	1
Acacia monticola x *tumida* var. *kulparn*	P3	Broome, Dampier Peninsular	Coastal headland, Pindan	2
Croton aridus	P3	South-east Broome, Pilbara	Pindan plain	2
Dasymalla chorisepala	P3	East of Broome, Great Sandy (Nita Downs)	Sandplains	2
Fuirena incrassata	P3	Mandora Marsh	Marshes	2

Taxon	Conservation Code	Location	Habitat	No. of locations
Goodenia byrnesii	P3	Southern limit north of Broome, co-occurring with *Seringia exastia*	Rocky slopes, black soil plains, creeklines, ephemeral pools, Pindan	2
Gymnanthera cunninghamii	P3	Mandora Marsh	Margins of seasonal watercourses and wetlandS	1
Indigofera ammobia	P3	Mandora Marsh	Pindan	1
Lawrencia sp. Anna Plains (N.T. Burbidge 1433)	P3	La Grange, Anna Plains	Seasonal watercourses	4
Lophostemon grandiflorus subsp. *grandiflorus*	P3	South-east Broome, Dampier Peninsular	Claypans, seepages	1
Phyllanthus eremicus	P3	Thangoo, Anna Plains	Pindan plain	2
Pterocaulon intermedium	P3	Anna Plains, Pilbara, north Kimberley	Sandplain	1
Seringia katatona	P3	Nita Downs, Great Sandy, Edgar Ranges	Red sandplain	5
Solanum oligandrum	P3	Mandora Marsh, Anna Plains	Saline flats, calcrete	3
Stylidium pindanicum	P3	South-east Broome, Dampier Peninsular	Claypans	1
Terminalia kumpaja	P3	Anna Plains, Mandora Marsh, Broome	Red sandplain and dunes	10
Tribulopis marliesiae	P3	Mandora Marsh, Port Smith	Red sandplain.	4
Triodia caelestialis	P3	Port Smith, Central Kimberley	Red sandplain	1
Whiteochloa capillipes	P3	Mandora, north Kimberley, Pilbara	Pindan	1

2.2 Targeted Field Survey

Field surveys aimed to locate additional populations of Threatened and Priority flora in the survey area. Previously recorded populations were also revisited to determine their persistence and habitat associations, but the primary focus was to access a significant part of the La Grange Project Area concentrating on the areas in the west identified by DPIRD as preferred areas for irrigation (Figures 1, 3). This reduced area was selected primarily as it was not feasible to cover the entire La Grange Project Area (time constraints and inaccessibility prevented survey of the far eastern part of the La Grange Project Area and the Unallocated Crown Land south east of Broome), and the intention was to provide a regional coverage for an area most likely to be targeted for development. This area selected specifically for rare and priority flora survey is referred to in this report as the La Grange Survey Area.

Field survey for targeted species was undertaken between June and September 2017 and comprised three, three-week long fieldtrips (19th June – 6th July, 17th July – 4th August and 11th August – 1st September). Accessible parts of the La Grange Project Area were traversed by vehicle (Figure 3). The methods of survey involved slow driving down tracks observing for targeted flora, stopping every 2 - 4 km to have two people walk two separate 100m transects - usually on either side of the vehicle track. Additional stops were made for further collections and photo points. This was the most practical method for both covering long distances in such a large survey area and still completing on ground searches for target species. An absence of passable tracks prevented vehicle access to the far eastern parts of Anna Plains, Thangoo and Nita Downs Stations.

When located, an attempt was made to define the area of the population by walking around the margins, but for many species the large sizes of populations meant this was not possible. Either counts of individuals or stems, estimates of density or percentage cover were made for estimating abundance.

Field Season.

Fieldwork was conducted during the dry season (May – November). While typically late July – August can be too late in the season for optimal flowering, fortunately, the 2016–2017 wet season was a particularly good season for rainfall (BoM 2017), and flowering of shrubs and trees occurred well into late August. Monthly rainfall totals for Bidyadanga indicate that summer rainfall, particularly for December 2016, were above average (Figure 3).

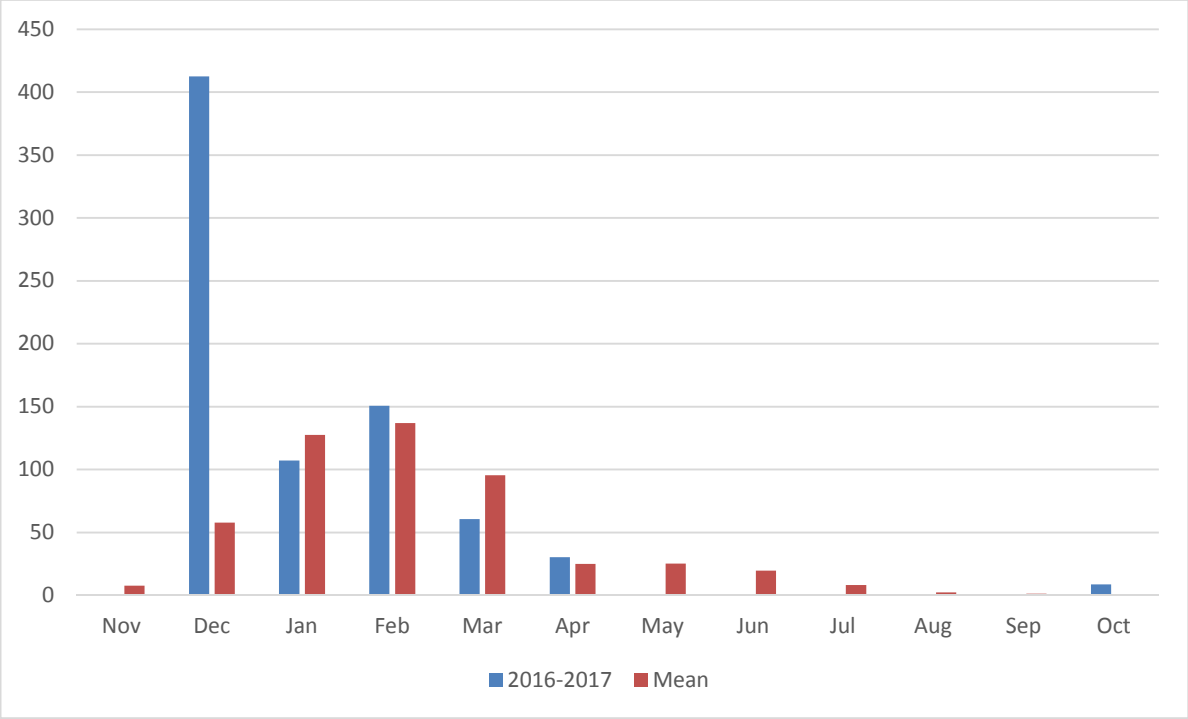

Figure 3: Monthly total rainfall (mm) data from Bidyadanga for the period between November and October for 2016-2017 compared to the recording station average (BoM 2017).

Survey Effort Summary Statistics.

- *Person days in the field* — *124*
- *Total area covered* — *9270 km^2*
- *Number of 200m transects walked* — *443*
- *Total length of tracks driven* — *1423 km*
- *Number of plant collections* — *c. 1400.*

Locations of survey transects and waypoints are given in Appendix 1. Most sites were established in Pindan Sandplain vegetation, which is the dominant vegetation complex in the region. Closer to the coastline, searches were made in samphire and halophyte shrublands, saltmarshes and tall saltwater paperbark (*Melaleuca alsophila*) shrublands (Figure 4). Dunefields and sandplains were surveyed in the eastern extent of the survey area. Only very recently burnt sites (< 3 months) were not surveyed.

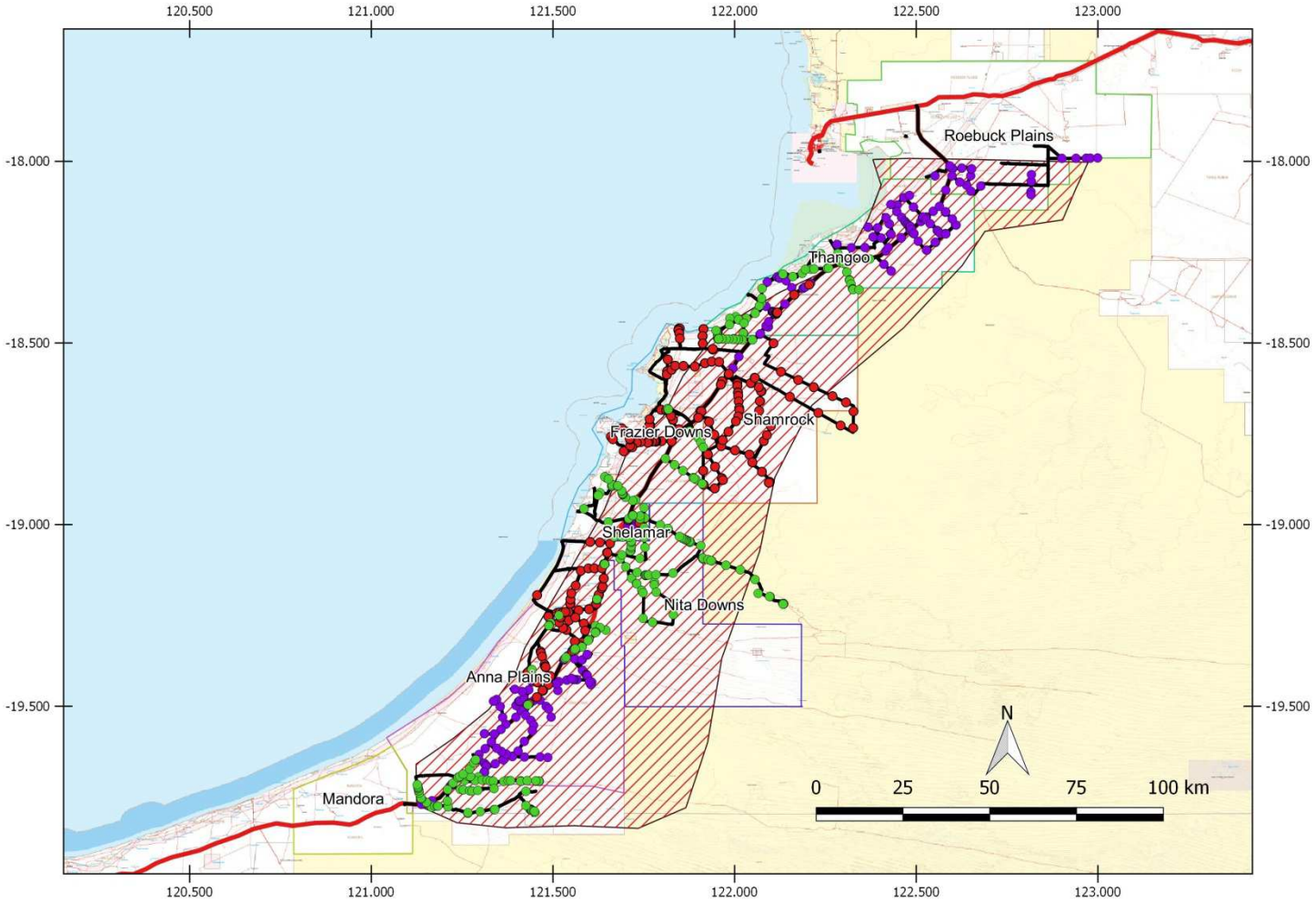

Figure 4: Hatched area on map indicates broad area in which the La Grange Flora Survey is focused based on DPIRD preferred areas for irrigation (cf. Figure 1). Exploration tracks (black) and collection site or search transect waypoints are indicated by points. Waypoints are colour-coded according to fieldtrip date: red dots (●) mark the June-early July fieldtrip sites, purple dots (●) mark the July-early August fieldtrip sites, green dots (●) mark sites assessed mid-August to early September. Waypoint data are given in Appendix 1

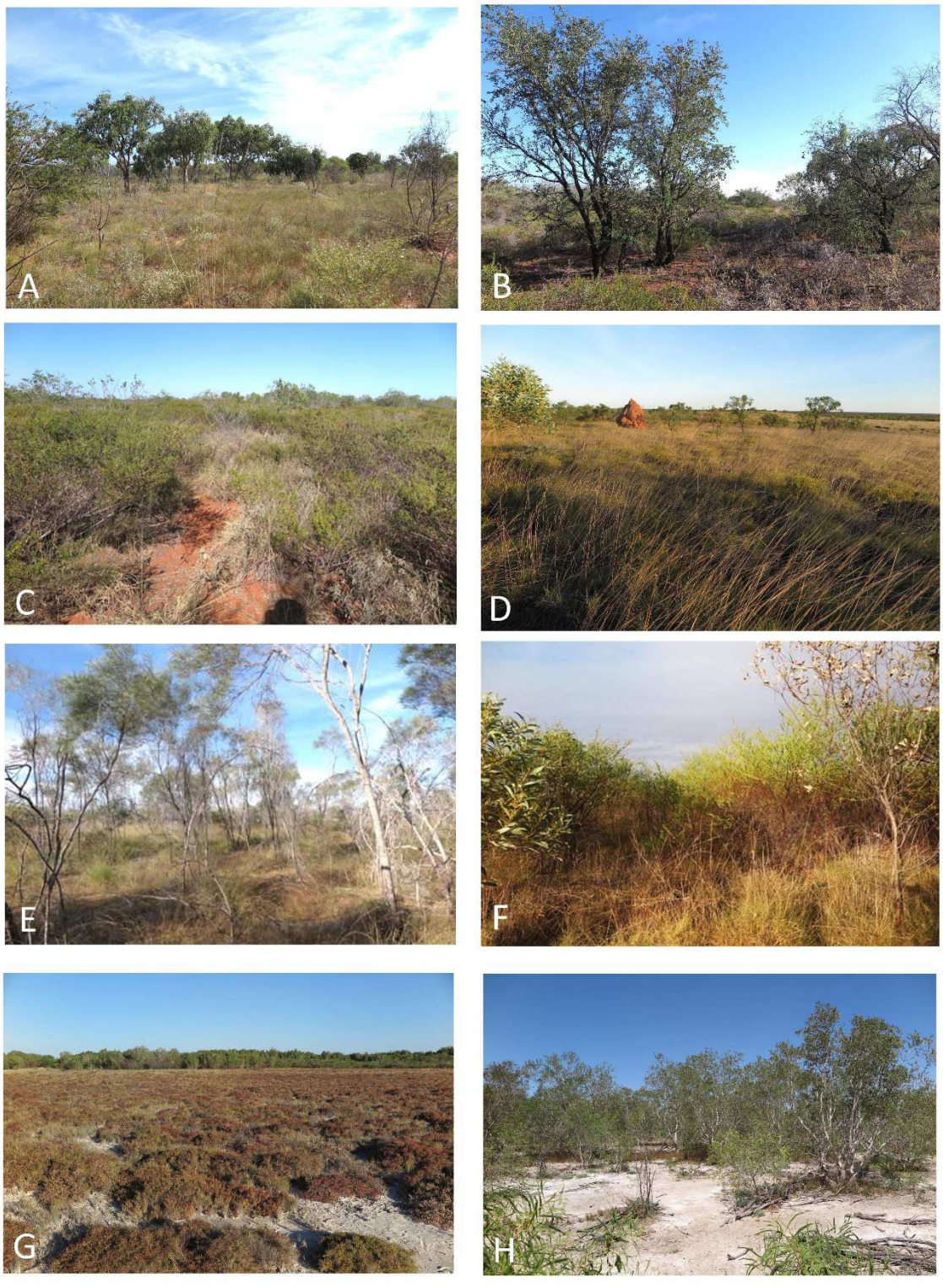

Figure 5: Examples of habitats surveyed in the La Grange Project Area. A-F: Pindan habitats. A: open *Corymbia* woodland, B: *Bauhinia cunninghamii* shrubland, C: *Acacia stellaticeps* shrubland/grassland D: *Triodia* hummock grassland, E: *Acacia eriopoda* tall shrubland, F: *Acacia monticola* thicket; G-H: Saline plain habitats: G: samphire shrubland, H: *Melaleuca alsophila* shrubland.

2.3 Traditional Owner Ranger Group Engagement

Three Traditional Owner Ranger groups (Nyangumarta Rangers, Karajarri Rangers and Yawuru Country Managers) were consulted with for the La Grange survey, and three rangers from Karajarri Rangers were able to accompany field surveys over a period of two days. This short period of time was a consequence of many competing work commitments of the three Ranger groups, and the logistics of coordinating a tight and inflexible fieldwork schedule around station access and ranger availability. However, Yawuru Country Managers and the Karajarri Rangers were able to share traditional flora knowledge and provide invaluable logistical support and guidance for fieldwork. Time and schedule constraints mean that the flora survey team was not able to meet up with the Nyangumarta Rangers.

Figure 6: Karajarri rangers and DBCA staff on Frazier Downs Station looking for *Tephrosia andrewii* (top image) and a successful find of *Pterocaulon intermedium* (bottom image) by Karajarri Ranger Jackie Shovellor.

2.4 Methods of species identifications, distributions and assessment of conservation status

Species identifications were determined from material collected from across the La Grange survey region and examined at the Western Australian Herbarium. Additional flora survey data has been included from the recent 2015 survey at Walyarta / Mandora Marsh (Markey 2017) to complement this study. Both the herbarium collection and online scans of type sheets held at other herbaria (*plants.jstor.org*), were referenced to confirm identifications and species distributions. Taxonomic expertise was sought for problematic groups.

Advice has been provided regarding changes in status of Priority flora based on spatial distribution and abundance information from both this survey and from herbarium collections. This has been done in consultation with Species and Communities Branch (DBCA). Representative specimens will be lodged at the Western Australian Herbarium (PERTH). New records and updated population information for existing records will be compiled and added to the departmental Threatened and Priority Flora (TPFL) database.

3 Results and Discussion

3.1 Species identifications, distributions, and taxonomic status updates.

Results from these investigations are summarised in Table 2 and Table 3, and further detailed discussion is made in Appendix 2. Two additional species (*Polymeria* sp. Broome (K.F. Kenneally 9759) and *Polymeria distigma*) were added to the list when the former taxon was located during fieldwork and confirmed from collections. Of the 30 species (including the original 28) targeted for survey, eleven were not located, mostly because suitable habitats were rare or absent in the La Grange Survey Area and / or it was too late in the dry season for the species to be present or visible (Table 2). The search for *Acacia monticola* x *tumida* var. *kulparn* was abandoned after it was determined that it would have taken an unreasonably large effort to locate, collect and identify a hybrid taxon known from an area north of the La Grange Survey Area. It was also determined that *Whiteochloa capillipes* was absent from the La Grange Survey Area, and *Polymeria distigma* had complex taxonomic issues (Table 2, Appendix 2). Nine of these eleven species are not considered any further in this section, and the following results section will focus on findings from field and herbarium investigations.

Sixteen species were found in new and/or previously known locations, and a further three species were recorded at new locations that were a range extension of > 15 km from the nearest previously known location. In the case of *Dasymalla chorisepala*, this was an 83km range extension (Table 2). One new population of the Threatened species, *Seringia exastia* was located.

This project found issues with the taxonomic status or identification of nine conservation-listed taxa in the La Grange region which were redressed to some degree in this study (see Table 2 and Appendix 2). The greatest issues were found with species of *Seringia*, where intermediate forms and intergrades between three species (*S. katatona*, *S. nephrosperma* and *S. exastia*) were found with intensive sampling over the survey area (Table 2, Appendix 2). Genetic analysis is underway which is resolving and redefining the concepts of these species. Other species, such as *B. oblongifolia* and the two species of *Polymeria*, required further taxonomic investigation to determine if these names were being applied correctly (see Table 2 and Appendix 2). In the case of *W. capillipes*, there were simple errors in identification of herbarium collections and these were quickly resolved. While the degree to which this project became redirected to resolving or clarifying some taxonomic problems was initially unexpected, it highlights the poorly known nature of a significant component of the Kimberley flora. By their nature; (data deficient, with few records and sometimes not formally described), conservation-listed taxa often present taxonomic difficulties. Resolution of some of the

Table 2: Summary of Results of the Targeted Taxa Searches in the La Grange Flora Survey. State conservation codes are from Smith (2017).

Species	2017 DBCA conservation code	Comments
Not present in La Grange region		
Acacia monticola x tumida var. *kulparn*	P3	Some collections were made, but searches and identifications were abandoned after the effort required exceeded the time allocated to this project. Appears to occur outside of the La Grange Project Area
Polymeria distigma	P3	Taxonomic investigation found species to have taxonomic issues. Entity matching type not located during survey.
Whiteochloa capillipes	P3	*Whiteochloa capillipes* does not occur in the La Grange region. Herbarium collections were misidentified and have been re-identified as *W. cymbiformis*.
Not seen / relocated during current survey		
Eragrostis filicaulis	P2	Was not located during this survey, and the two herbarium collections from Mandora Station require further examination to verify their identity (Steven Dillon, pers. comm.). This is a small and inconspicuous species growing in dune swales in coastal grasslands which can be easily overlooked.
Fuirena incrassata	P3	This diminutive sedge was not located during the current survey.
Gomphrena pusilla	P2	Not located at the suitable foredune locations surveyed during the current survey.
Goodenia byrnesii	P3	Not located in this survey. Suitable habitats (damp creeklines and freshwater claypans) were rarely encountered.
Haemodorum capitatum	P1	Suitable damp habitat was rarely encountered in the La Grange Survey Area. Was not located at one wet seep. This is a geophyte which dies back after flowering, so may have been too late in season.
Isolepis humillima	P2	Suitable damp habitat was rarely encountered in the La Grange Survey Area. Not observed when suitable habitats were encountered.
Lophostemon grandiflorus subsp. *grandiflorus*	P3	This distinctive shrub/tree species was not seen. Appears to occur outside of the La Grange Project Area.
Tribulopis marliesiae	P3	One collection of the morphologically similar *T. angustifolia* was made, providing some confidence that *T. marliesiae* may also have been flowering. However, there was no sign of this species at two known collection locations.
Previously known and new locations		
Acacia glaucocaesia	P3	Located at Walyarta Conservation Park. Known population on Anna Plains Station was not relocated.
Atriplex eremitis	P1	Several populations were located on Anna Plains Station and Walyarta Conservation Park.
Bonamia oblongifolia	P1	Found to be widespread and common throughout La Grange Survey Area.
Gymnanthera cunninghamii	P3	Was located in the Walyarta / Mandora Marsh 2015 survey. Not located during the 2017 La Grange Survey.

Indigofera ammobia	P3	One population located in the La Grange Survey Area on Frazier Downs Station.
Lawrencia sp. Anna Plains (N.T. Burbidge 1433)	P3	Large populations located in several saline palaeodrainage systems across the La Grange Survey Area, where it is locally abundant following a good wet season. Seed characters show taxonomic utility to distinguish this entity from *L. glomerata.*
Nicotiana heterantha	P1	Located at several locations on Anna Plains and Walyarta Conservation Park, where it is locally abundant following a good wet Season.
Phyllanthus eremicus	P3	Found as common and widespread across the survey area where population densities range from scattered and infrequent to abundant and common.
Polymeria sp. Broome (K.F. Kenneally 9759)	P1	Found to be widespread in the La Grange Survey Area. Was added to list after taxonomic investigation.
Pterocaulon intermedium	P3	Populations were located on Frazier Downs Station and Roebuck Plains Station.
Seringia exastia	T	One known population was relocated, and one new population was found on Nita Downs Station. High levels of morphological variability found which required expert taxonomic investigation. Collections were made at regional and population-level for further taxonomic investigation and genetics study.
Seringia katatona	P3	Found to be widespread and abundant. High levels of morphological variability found which required expert taxonomic investigation. Collections were made at regional and population-level for further taxonomic investigation and genetics study.
Solanum oligandrum	P3	Suitable habitat was searched across La Grange Survey Area, but this species is largely restricted to Walyarta Conservation Park with one occurrence on Anna Plains Station. Near endemic to the La Grange region.
Tephrosia andrewii	P1	Large and extensive populations were located on Thangoo, Frazier Downs and Anna Plains Stations.
Terminalia kumpaja	P3	Extensive stands of this tree were located in a region between Emu Bore (Anna Plains Station), Sandfire roadhouse and Walyarta Conservation Park, with scattered occurrences c. 40km north of Emu Bore.
Triodia caelestialis	P3	New populations were located, and this species was found in the northern half of the La Grange Survey Area. Despite fieldwork being delayed to late in the dry season, there was sufficient material from *Triodia* spp. to be able to identify and map this species.
New populations and range extensions		
Croton aridus	P3	A large population of *C. aridus* has been located on Thangoo Station, spanning approximately 15 km x 20 km in extent. This is a new record and minor range extension at least 15 km west of the closest previously recorded location.
Dasymalla chorisepala	P3	A large (>1000 plants) population has been located along the boundary of Frazier Downs Station and Thangoo Station. This is a range extension of c. 83 km west of the closest previously known population.
Stylidium pindanicum	P3	One small population was found on Roebuck Plains Station in a wet seepage area near an ephemeral creek line. This is a minor range extension of c. 33 km west from nearest previously known location.

taxonomic issues with the targeted conservation-listed taxa became a necessary and major first step in assessing their distributions and conservation status. The results of the process are presented in Appendix 1, and Table 3 summarises the main findings for the 21 species.

3.2 Implications and recommendations for irrigated agriculture

Findings for 21 species and their implications for the assessment of irrigated agriculture projects and species conservation are summarised in Table 3 and presented in Appendix 2. Based on their presence within areas indicated by DPIRD as preferred for irrigated agriculture (DAFWA 2016a), twelve species have part or all of their range within the La Grange Survey Area and are at risk of being affected by proposed clearing for irrigated agriculture.

Ratings for individual species of the conservation implications and their importance in assessing development proposals are based on the species presence in areas preferred for irrigation, its conservation listing, its distribution across the survey area and its total distribution. The Threatened species, *Seringia exastia* presents the greatest implications (**high** rating in Table 3) for conservation and any proposed developments owing to its status and extremely small range that coincides with a preferred area.

Based on their restricted distribution within the La Grange region, both the conservation implications and importance in assessing proposed developments are rated **medium-high** for *Croton aridus, Dasymalla chorisepala, Indigofera ammobia* and *Tephrosia andrewii*. In particular, while locally abundant *Tephrosia andrewii* is endemic to the La Grange region, so caution must be exercised when assessing successive clearing applications that may cumulatively impact this species.

The conservation implications of agricultural developments are rated **low-medium** for species that are widespread across the survey region. These species are often locally abundant or common, but their total distribution is still centred in the La Grange Region, often intersecting areas with potential for irrigated agriculture. This **low-medium** level was determined for *Bonamia oblongifolia*, *Phyllanthus eremicus*, *Polymeria* sp. Broome (K.F. Kenneally 9759) and *Seringia katatona* (see section 3.4 for updated conservation

listings). Current knowledge suggests that the bulk of these species' distributions are in the La Grange region, so cumulative impacts of clearing should be assessed unless further survey determines their range extends beyond the region.

The presence of *Terminalia kumpaja* is considered to pose **low** implications for proposed developments, as the southern edge of the La Grange Project Area intersects with the northern edge of the range of this species, and part of this range occurs within the Walyarta Conservation Park.

While *Pterocaulon intermedium* and *Triodia caelestialis* occur in areas with potential for development, this has no implications for irrigated agriculture proposals as these two species are widely distributed outside of the La Grange region and have been recently removed from the conservation list (see Section 3.4). Seven species (*Stylidium pindanicum*, *Solanum oligandrum*, *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433), *Nicotiana heterantha, Atriplex eremitis, Acacia glaucocaesia* and *Gymnanthera cunninghamii*) are under no direct threat from clearing for irrigated agriculture as they occur on substrates and in areas not suitable for such development.

It is noted that this ranking of species (low to high conservation concern / implications for development) only applies to the La Grange Project Area and does not take into account developments or threats outside of the project area nor any potential indirect effects of groundwater extraction.

Table 3: Summary of main findings of the La Grange Rare and Priority Flora Survey for 21 species, and their implications for Irrigated Agriculture in the La Grange Project Area. Tenure abbreviations are as follows: AP: Anna Plains, WCP: Walyarta Conservation Park, FD: Frazier Downs, RP: Roebuck Plains, ND: Nita Downs, TG: Thangoo, SHK: Shamrock, SLM: Shelamar, UCL: Unallocated Crown Land.

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Acacia glaucocaesia	Collections from the Walyarta Conservation Park were confirmed as *Acacia glaucocaesia.* This species is restricted to the several locations in the La Grange region, almost all of these within the Walyarta Conservation Park, where it is a dominant and widespread shrub on grey 'black soil' flats on plains dissected by saline river systems. One outlying stand recorded on Anna Plains Station was not relocated in 2017. *Acacia glaucocaesia* is easily confused with *Acacia synchronicia*, which itself is restricted to several locations on gravelly upland plains in the La Grange region	**No implications** *Acacia glaucocaesia* occurs outside of the Preferred Irrigation Areas, and development will not impact or affect populations. *Acacia glaucocaesia* does not grow on sandy pindan soils suitable for irrigated agriculture. **Tenure: AP, WCP**
Atriplex eremitis	Eight new populations have been located on Anna Plains Station and Walyarta Conservation Park. Prior to the La Grange survey, known from only six herbarium collections, and no collections had been made since 1987. Four of these six herbarium collections were previously misidentified as *Atriplex elachophylla*, but have been determined to be *Atriplex eremitis*.	**No implications** *Atriplex eremitis* occurs outside of the Preferred Irrigation Areas, in the La Grange Project Area. *Atriplex eremitis* does not grow on sandy pindan soils suitable for irrigated agriculture. Not under immediate threat from proposed irrigated agricultural developments. **Tenure: AP, WCP**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Bonamia oblongifolia	*Bonamia oblongifolia* is widespread across the La Grange region, which appears to be the core of its range between Port Hedland and Broome. It is found on all pastoral leases and on UCL in the La Grange Survey Area. Not located in Walyarta Conservation Park. It is often locally common and abundant across the La Grange region, growing in Pindan soils and vegetation. Further taxonomic and fieldwork is required to update the current understanding of *B. oblongifolia* and allied species.	**Low-medium implications** Most of the distribution of *Bonamia oblongifolia* in the La Grange survey area coincides with Preferred Areas for Irrigation (Preference ratings: Preferred, Possible and Least). Despite being widespread, *Bonamia oblongifolia* is likely to be impacted by clearing for irrigated agriculture given its habitat preferences. Cumulative impacts should be considered over the La Grange region. **Tenure: AP, FD, ND, TG, RP, SHK, SLM, UCL**
Croton aridus	Two new large populations of *Croton aridus* (> c. 1400 plants and possibly up to 42000 individuals in, total area estimated to be 70.4 $km^{2)}$, were located on Thangoo Station, in the northern part of the La Grange Survey Area. These findings extend the known range of this species 17 - 50 km west and south of previous known locations.	**Medium-high implications** Most of the distribution of *Croton aridus* in the La Grange survey area coincides with Preferred Areas for Irrigated Agriculture (Preference ratings: Preferred, Possible and Least). *Croton aridus* has the potential to be impacted by clearing for irrigated agriculture, and its limited distribution within the survey area should be taken into consideration **Tenure: TG, UCL**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Dasymalla chorisepala	A single, large population (> 500 plants, area estimated to cover 10.3 km^2) of *Dasymalla chorisepala* was located at the boundary of Frazier Downs and Thangoo Roebuck Plains Stations in the northern part of the La Grange survey region. These findings extend the range of this species 83 km NNW of the closest previously known location.	**Medium-high implications** The entire population of *Dasymalla chorisepala* within the La Grange survey area is located within a Preferred Area for Irrigated Agriculture (Preference ratings: Preferred and Possible). *Dasymalla chorisepala* has the potential to be impacted by clearing for irrigated agriculture, and its highly limited distribution within the survey area should be taken into consideration. **Tenure: FD, TG**
Gymnanthera cunninghamii	*Gymnanthera cunninghamii* was not located during the 2017 La Grange survey. A single sterile plant was tentatively identified as *G. cunninghamii* from the 2015 survey of Walyarta / Mandora Marsh. The northern limit of this species appears to be at Walyarta Conservation Park, where *Gymnanthera cunninghamii* grows in *Melaleuca alsophila* woodlands and shrublands on the calcareous plains and those surrounding mound springs.	**No implications** *Gymnanthera cunninghamii* occurs outside of the Preferred Irrigation Areas, and occurs on substrates unsuitable for irrigated agriculture. Development is unlikely to impact or affect populations. **Tenure: WCP**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Indigofera ammobia	A single, very small population (c. several plants within a 10000 m^2 area) of *Indigofera ammobia* was located on Frazier Downs Station. *Indigofera ammobia* was found as infrequently occurring, scattered individuals on a recently burnt area (c. 1 year post burn). *Indigofera ammobia* is concluded to be highly uncommon in the La Grange area.	**Medium-high implications** The one known location of *Indigofera ammobia* occurs just outside (550 m) of the Preferred Areas for Irrigated Agriculture, but a form of *Indigofera haplophylla* with affinities to *Indigofera ammobia* has been previously recorded on Shamrock Station. *Indigofera ammobia* occurs on suitable Pindan substrates and may be located within areas proposed for development for irrigated agriculture. **Tenure: FD, SHK**
Lawrencia sp. Anna Plains (N.T. Burbidge 1433)	*Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) was found at several locations in the La Grange survey, being closely associated with saline palaeodrainage channels and salt lake margins. *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) responds well to a good wet season with high summer rainfall, forming dense stands in the following dry season.	**No implications** *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) does not grow on Pindan substrates and does not occur within the Preferred Areas for Irrigated Agriculture. *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) will not be directly affected by proposed developments for irrigated agriculture. **Tenure: AP, WCP**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Nicotiana heterantha	*Nicotiana heterantha* was found at several locations in the La Grange survey, being closely associated with saline palaeodrainage channels, salt lake margins and saline plains It is found under *Melaleuca alsophila* shrublands or in samphire shrublands. *Nicotiana heterantha* responds well to a good wet season with high summer rainfall and a prolonged salt marsh inundation event, and was found to be highly abundant on these landforms during the 2017 survey.	**No implications** *Nicotiana heterantha* does not grow on Pindan substrates and does not occur within the Preferred Areas for Irrigated Agriculture. *Nicotiana heterantha* will not be directly affected by proposed developments for irrigated agriculture. **Tenure: AP, WCP**
Phyllanthus eremicus	*Phyllanthus eremicus* is locally abundant at sites that are distributed widely occurs across the La Grange survey area. *Phyllanthus eremicus* is found in Pindan soils and vegetation, from Pardoo to Broome, and was found by this survey to range eastwards into the Great Sandy Desert.	**Low - medium implications** Most of the distribution of *Phyllanthus eremicus* in the La Grange survey area coincides with Preferred Areas for Irrigation (Preference ratings: Preferred, Possible and Least). Despite being widespread, *Phyllanthus eremicus* is likely to be impacted by clearing for irrigated agriculture given its habitat preferences. Cumulative impacts should be considered over the La Grange region. **Tenure: AP, ND, TG, FD, RP, SHK, SLM, UCL**
Polymeria distigma	The name *P. distigma* Benth. is to be transferred to the genus *Jaquemontia* (see *Polymeria* sp. Broome (K.F. Kenneally 9759))	Nothing matching type found La Grange Survey Area

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Polymeria sp. Broome (K.F. Kenneally 9759)	*Polymeria* sp. Broome (K.F. Kenneally 9759) is widespread across the La Grange region, in Pindan habitats. *Polymeria* sp. Broome (K.F. Kenneally 9759) is restricted to the La Grange and Broome regions. Has been previously been referenced as *Polymeria distigma sensu* Wheeler & Marchant 1992, Kennelly *et al.* 1996, which is in error. The name *P. distigma* Benth. is to be transferred to *Jaquemontia*.	**Low - medium implications** Despite being widespread, most of the distribution of *Polymeria* sp. Broome (K.F. Kenneally 9759) in the La Grange survey area coincides with Optimal Areas for Irrigated Agriculture (Preference ratings: Preferred, Possible and Least). *Polymeria* sp. Broome (K.F. Kenneally 9759) is likely to be impacted by clearing for irrigated agriculture given its occurrence in Pindan habitats and distribution within optimal areas for agricultural development. Cumulative impacts should be considered over the La Grange region. **Tenure: AP, FD, ND, SHK, SLM, RP, TG**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Pterocaulon intermedium	*Pterocaulon intermedium* is found in several locations in the northern half of the La Grange Survey Area, on two pastoral leases. *Pterocaulon intermedium* occurs in two different habitats*:* • on saline floodplains at the boundary of samphire grasslands and *Melaleuca alsophila* shrublands. • in *Acacia eriopoda shrublands / Corymbia* open woodlands on pindan sandplains in the far north of the study area. *Pterocaulon intermedium* is not widespread in the La Grange region, and usually uncommon or infrequent when present. However, there were some sites where >200 individuals were counted.	**No implications** Inland populations are located within areas identified as preferred for irrigated agriculture (Preference rating: Possible). Coastal populations occur outside of preferred areas and are at no risk from proposed development. *Pterocaulon intermedium* is widely distributed in northern Australia, and the recent removal of conservation status reflects this. **Tenure: FD, RP**
Seringia spp. (including intergrades)	Three species *of Seringia* (*S. exastia, S. katatona* and *S. nephrosperma*) co-occur in the La Grange region, some co-occurring within the same immediate area. These species can be difficult to distinguish in the La Grange region, and forms with intermediate floral characters are present. Population-level sampling found mixed stands where the species and intermediates co-occur. A genetic study is underway on populations sampled in the La Grange region to inform on species boundaries and concepts.	Recommendations pending results of genetic study **Tenure: AP, FD, ND, SHK, SLM, TG, UCL**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Seringia exastia	*Seringia exastia* is restricted to several populations, one at Broome, one on the eastern edge of Nita Downs and several populations in the Great Sandy Desert.	**High implications** One population is located within a Preferred Area for Irrigated Agriculture (Preference rating: Possible) and would be at risk from clearing. Great Sandy Desert occurrences are outside of areas with potential for irrigated agriculture. **Tenure: ND, UCL**
Seringia katatona	*Seringia katatona* is more widespread and variable than previously understood.	**Low-medium implications – pending genetics study results** Much of the distribution of *Seringia katatona* and intermediate forms in the La Grange survey area coincide with Preferred Areas for Irrigation (Preference ratings: Preferred, Possible and Least). Cumulative impacts should be considered over the La Grange region. **Tenure: AP, FD, ND, SHK, SLM, TG, UCL**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Solanum oligandrum	In the La Grange Survey Area, *Solanum oligandrum* is restricted to Walyarta Conservation Park, with one occurrence immediately adjacent to the reserve on Anna Plains Station. Counts of individuals at some sites can number into the hundreds. The entire known range of *S. oligandrum* is restricted to two main, disjunct areas: one in the Walyarta Conservation Park and a second in the Great Sandy Desert.	**No implications** *Solanum oligandrum* does not grow on Pindan substrates and does not occur within the Preferred Areas for Irrigated Agriculture. *Solanum oligandrum* will not be directly affected by proposed developments for irrigated agriculture. **Tenure: AP, WCP**
Stylidium pindanicum	*Stylidium pindanicum* was located at one small site in the La Grange area, and has not been found south of Roebuck Plains Station. *Stylidium pindanicum* is restricted to wet seepages associated with the inland drainage into the Roebuck Plains, which are not common habitats in the wider La Grange region.	**No implications** *Stylidium pindanicum* does not occur within the Preferred Areas for Irrigated Agriculture. *Stylidium pindanicum* will not be directly affected by proposed developments for irrigated agriculture. **Tenure: RP**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Tephrosia andrewii	*Tephrosia andrewii* has a distribution restricted to the central La Grange region, and is not found east of Nita Downs. It was found to be a locally abundant in two disjunct areas; one on Anna Plains Station and another area extending from Frazier Downs Station to southern Thangoo Station. *Tephrosia andrewii* was found in 11 populations, where over 3800 plants were counted in a total walked area of 2.4 km^2. When extrapolated to cover the possible total area of populations in the La Grange region, it is estimated that some 44000 individual plants may occur in an area of 27.4 km^2	**Medium-high implications** Much of the entire species' range occurs within or immediately adjacent to the preferred areas for irrigated agriculture (Preference ratings: Preferred, Possible and Least). There is potential for *T. andrewii* to be impacted by proposed developments. Cumulative impacts should be considered over the La Grange region, especially due to restricted range of this species. **Tenure: AP, FD, ND, TG**
Terminalia kumpaja	*Terminalia kumpaja* is found in the southern third of the La Grange survey area, with the exception of an outlying cluster of several plants in the north of the survey area. *Terminalia kumpaja* is widespread, common and locally abundant where does it occur, forming large and extensive stands of trees and tall shrubs.	**Low implications** Much of the range of *Terminalia kumpaja* in the La Grange Project Area occurs outside of Preferred Areas, and will not be impacted by proposed developments for irrigated agriculture. Some stands which occur in face a potential risk of being cleared. **Tenure: AP, RP, TG, WCP**

Taxon	Main Findings	Implications / recommendations for irrigated agriculture in the La Grange Project Area
Triodia caelestialis	*Triodia caelestialis* is found in the northern half of the La Grange survey area. *Triodia caelestialis* can co-occur with *Triodia schinzii* at a site, and the ranges of the two species overlap over the La Grange region. *Triodia caelestialis* and *T. schinzii* may not be readily distinguished without examination of seeds and leaves - a good flowering season is important for survey. *Triodia caelestialis* is locally abundant when present, often being one of the dominant species in the grass stratum, and has a widespread distribution across the west Kimberley.	**No implications** Much of the range of *Triodia caelestialis* in the La Grange Project Area occur within Preferred Areas for Irrigated Agriculture (Preference ratings: Preferred, Possible and Least), However, *Triodia caelestialis* is widespread and abundant in both the northern La Grange region and western Kimberley, and the recent removal of conservation status reflects this. **Tenure: FD, ND, RP, TG**
Whiteochloa capillipes	*Whiteochloa capillipes* does not occur in the Pilbara and south-west Kimberley. Specimens from the Pilbara and south-west Kimberley in both the Western Australian Herbarium and collected from the La Grange survey were found to be either *Whiteochloa cymbiformis* or *W. airoides*.	Not present in La Grange Survey Area

3.3 Assessment of species conservation status

From a combination of field survey, examination of herbarium collections and herbarium records, the conservation statuses of 21 species (Smith 2017) were reassessed and changes made where appropriate (Table 4). These changes were made in consultation with DBCA, and have been updated by the department (Smith 2018). On the basis of species abundance, distribution and potential or current threats to populations, two species were upgraded in status, four species were downgraded in status, four species were downgraded to Not Threatened and removed from the state conservation list, two species had no change but are pending further information, and ten species had no change to their status. Further details for each species are provided in Appendix 2. These changes reflect improvements in the understanding of these poorly known species gained from locating populations and surveying potential habitats, and from new investigations on the available taxonomic information and herbarium collections.

Table 4: Summary of conservation-listed taxa recorded from the La Grange region, for which changes in status were recommended (current as of November 2018). Changes have been made following liaison within DBCA. Conservation Codes are from Smith (2017, 2018).

Taxon	2017 DBCA Conservation Code	Changed (Yes / No)	2018 DBCA Conservation Code or suggested change	Reason
Acacia glaucocaesia	P3	Y	Downgraded to Not Threatened removed from list	Widespread. Not considered to be threatened, naturally uncommon or rare.
Atriplex eremitis	P1	N	P1	Despite finding new populations, still a poorly known species with scattered distribution restricted to area between Anna Plains and Port Hedland.
Bonamia oblongifolia	P1	Y	Downgraded to P3	Common and widespread in La Grange region.
Croton aridus	P3	N	P3	Has restricted distribution in Western Australia.
Dasymalla chorisepala	P3	N	P3	Has restricted distribution in Western Australia.
Gymnanthera cunninghamii	P3	N	P3	Known from wide area but infrequent. No new major finds from La Grange Survey Area.
Indigofera ammobia	P3	N	P3	Known from wide area but uncommon and infrequently encountered.

Taxon	2017 DBCA Conservation Code	Changed (Yes / No)	2018 DBCA Conservation Code or suggested change	Reason
Lawrencia sp. Anna Plains (N.T. Burbidge 1433)	P3	N	P3	Poorly known taxon more-or-less restricted to the southern La Grange region. Locally abundant during good seasons.
Nicotiana heterantha	P1	Y	Downgraded to P3	Known from six main locations, including within conservation reserves. Locally highly abundant within these sites.
Phyllanthus eremicus	P3	Y	Downgraded to Not Threatened removed from list	Common and widespread in La Grange region, but has restricted distribution in Western Australia.
Polymeria distigma	P3	?	Pending	Recommendation regarding change in status pending nomenclatural resolution.
Polymeria sp. Broome (K.F. Kenneally 9759)	P1	Y	Downgraded to P3	Widespread in La Grange region, but still geographically restricted to the La Grange area.
Pterocaulon intermedium	P3	Y	Downgraded to Not Threatened removed from list	Widespread. Not considered to be threatened, naturally uncommon or rare.
Seringia exastia	T	N	T	Known from three populations.
Seringia katatona	P3	Y?	Pending	Widespread in Dampierland. Species concept could be expanded to include more forms. Recommendation regarding change in status pending results of genetics study.
Solanum oligandrum	P3	Y	Upgraded to P2	Known from only one conservation reserve. Restricted to two core areas. Distribution poorly known.
Stylidium pindanicum	P3	N	P3	No evidence from this survey to change status. Widespread distribution in West Kimberley but restricted to specific habitats.
Tephrosia andrewii	P1	Y	Downgraded to P3	Narrow geographic range and restricted to central La Grange region, but has large populations. Could face future threats from land clearing.
Terminalia kumpaja	P3	N	P3	Locally common, but restricted to southern half of the La Grange region. No evidence from this survey to suggest change to status.
Triodia caelestialis	P3	Y	Downgraded to Not Threatened removed from list	Appears to be widespread and abundant in the La Grange and western Kimberley.
Whiteochloa capillipes	P3	Y	Upgraded to P1	Less common and geographically restricted than previously thought. Not on conservation estate in Western Australia.

4 Conclusions

This targeted survey for rare and priority flora has been the first attempt to provide a regional perspective of the distribution and status of conservation-listed flora in the La Grange region. It provides an advance on prior targeted flora surveys that have been restricted to collecting data from small, discrete areas marked for proposed development, and which have only been able to assume the wider distribution of species based on a relatively small number of herbarium records or extrapolate from the area of presumed potential habitat occurring in the wider region. Not only were the distributions and site abundances of species clarified, but this survey generated sufficient information to assess and, where appropriate, amend the conservation status of 21 species. Two species were upgraded, four species were downgraded, four species were removed from the state conservation list, two species are pending further inquiry, and ten species had no change to their status. This will assist in assessing the flora conservation implications of development for irrigated agriculture at a regional scale and will inform assessments of individual land parcels and projects. This work demonstrates the value of undertaking regional assessments for conservation-listed flora where major regional-scale developments are proposed.

Approximately 63% of targeted species were located in this regional survey. Some of the species not located were determined to be either absent or infrequent, or restricted to habitats uncommon or not present in the La Grange region. One of the limitations of this survey was the timing of survey, and starting investigations sooner after the wet season may have enabled more species to be found and identified (especially geophytes, herbaceous annuals and grasses) and more locations of species found (such as with *Triodia caelestialis*, which had dropped its seed early in the season). Fortunately, a good wet season resulted in a good flowering and fruiting season which persisted into September and provided good material for identifications. Another limitation of the survey was accessibility, and a good proportion of the eastern half of the La Grange Project Area remains to be surveyed for both conservation-listed species (such as further searches for *Seringia exastia*) and for general flora survey. Extending survey into these eastern regions and further southwest into the north-eastern Pilbara (which is a region of rapidly expanding development) would be the next desirable step following this current survey.

This survey ranked species in order of conservation concern / implications for development based on distribution in the La Grange region, conservation status and occurrence on preferred areas for irrigated agriculture. *Seringia exastia* has the highest priority for conservation concern when considering developments. Four species (*Croton aridus, Dasymalla chorisepala, Indigofera ammobia* and *Tephrosia andrewii*.) are ranked medium-high, owing to their restricted distributions in the La Grange region. This applies particularly to *Tephrosia andrewii*, which may be locally abundant but it is

endemic to the La Grange region. Four species were ranked low-medium, and while these may be common and widespread within the La Grange region, their distribution outside of the La Grange region is unknown or limited. It is recommended that caution is exercised when assessing successive clearing applications that may cumulatively impact these species. It is also recommended that there is further survey for *Bonamia oblongifolia*, *Phyllanthus eremicus*, *Polymeria* sp. Broome (K.F. Kenneally 9759) and *Seringia katatona* outside of the La Grange region into the Dampier peninsula, Great Sandy Desert and north-eastern Pilbara.

This survey found significant issues with the taxonomic definition or species identification for several of the species, and this emphasises that conservation-listed taxa are often poorly known. Further taxonomic investigations into Kimberley conservation-listed species and the La Grange and western Kimberley flora are recommended.

5 Appendix 1: Survey Transect and Non-transect Waypoint locations from the La Grange Flora Survey

Transect / Waypoint Code	Latitude (dd WGS84)	Longitude (dd WGS84)	Date
T1	-17.990615	122.999499	21/07/2017
T2	-17.991217	122.979235	21/07/2017
T3	-17.991314	122.968149	21/07/2017
T4	-17.99155	122.939968	21/07/2017
T5	-17.991778	122.90116	20/07/2017
T6	-18.010472	122.863021	19/07/2017
T7	-18.009119	122.828897	19/07/2017
T8	-18.008113	122.80459	19/07/2017
T9	-18.006917	122.77658	19/07/2017
T10	-18.005737	122.747491	19/07/2017
T11	-18.005364	122.73646	19/07/2017
T12	-18.040259	122.862987	19/07/2017
T13	-18.066177	122.862737	19/07/2017
T14	-18.065259	122.827316	19/07/2017
T15	-18.036545	122.817273	21/07/2017
T16	-18.083724	122.815936	20/07/2017
T17	-18.091808	122.816103	20/07/2017
T18	-18.064558	122.796379	19/07/2017
T19	-18.063608	122.757437	19/07/2017
T20	-18.062677	122.719086	19/07/2017
T21	-18.062017	122.690473	19/07/2017
T22	-18.067946	122.677758	20/07/2017
T23	-18.082241	122.650773	20/07/2017
T24	-18.065685	122.638885	19/07/2017
T25	-18.039865	122.650121	20/07/2017
T26	-18.021174	122.651493	20/07/2017
T27	-18.018491	122.625697	20/07/2017
T28	-18.020184	122.599933	20/07/2017
T29	-18.057246	122.620054	20/07/2017
T30	-18.039815	122.598616	20/07/2017
T31	-18.040153	122.551791	21/07/2017
T32	-18.079215	122.581398	18/07/2017

T33	-18.123935	122.563993	26/07/2017
T34	-18.140065	122.580395	26/07/2017
T35	-18.158637	122.599362	26/07/2017
T36	-18.174628	122.608121	26/07/2017
T37	-18.198756	122.580914	26/07/2017
T38	-18.190259	122.557767	26/07/2017
T39	-18.171399	122.538406	25/07/2017
T40	-18.153255	122.527452	18/07/2017
T41	-18.153949	122.519786	25/07/2017
T42	-18.223145	122.553284	26/07/2017
T43	-18.244233	122.529468	26/07/2017
T44	-18.219939	122.505751	26/07/2017
T45	-18.198961	122.492699	26/07/2017
T46	-18.189484	122.483422	18/07/2017
T47	-18.180685	122.481727	25/07/2017
T48	-18.172511	122.474894	25/07/2017
T49	-18.168241	122.471356	25/07/2017
T50	-18.164847	122.46855	25/07/2017
T51	-18.154295	122.459854	25/07/2017
T52	-18.138298	122.446591	25/07/2017
T53	-18.118586	122.430315	25/07/2017
T54	-18.120071	122.44803	25/07/2017
T55	-18.099813	122.466014	25/07/2017
T56	-18.093945	122.481502	25/07/2017
T57	-18.125877	122.492593	25/07/2017
T58	-18.137124	122.547085	18/07/2017
T59	-18.165456	122.512784	18/07/2017
T60	-18.2109	122.458755	18/07/2017
T61	-18.237496	122.422904	24/07/2017
T62	-18.246871	122.416631	18/07/2017
T63	-18.20044	122.429567	24/07/2017
T64	-18.172064	122.42598	24/07/2017
T65	-18.155123	122.417088	24/07/2017
T66	-18.182828	122.393887	24/07/2017
T67	-18.18134	122.367634	24/07/2017
T68	-18.210868	122.403714	24/07/2017
T69	-18.208207	122.381249	24/07/2017
T70	-18.237197	122.358783	24/07/2017
T71	-18.237775	122.321477	24/07/2017

T72	-18.228605	122.282208	24/07/2017
T73	-18.253263	122.284356	18/08/2017
T74	-18.27813	122.291473	18/08/2017
T75	-18.266125	122.264501	18/08/2017
T76	-18.254108	122.236841	18/08/2017
T77	-18.297587	122.195027	18/08/2017
T78	-18.296872	122.209426	18/08/2017
T79	-18.296345	122.218866	18/08/2017
T80	-18.294277	122.255184	18/08/2017
T81	-18.308264	122.186275	18/08/2017
T82	-18.317316	122.160162	18/08/2017
T83	-18.310676	122.133156	18/08/2017
T84	-18.318441	122.117206	27/07/2017
T85	-18.321003	122.122588	27/07/2017
T86	-18.32863	122.14191	27/07/2017
T87	-18.347588	122.157355	27/07/2017
T88	-18.367457	122.164378	5/07/2017
T89	-18.349482	122.188535	27/07/2017
T90	-18.335224	122.209274	27/07/2017
T91	-18.392825	122.138954	27/07/2017
T92	-18.417998	122.115423	5/07/2017
T93	-18.420543	122.113267	23/07/2017
T94	-18.419076	122.112204	22/07/2017
T95	-18.414887	122.106722	22/07/2017
T96	-18.413533	122.104856	22/07/2017
T97	-18.399566	122.086842	22/07/2017
T98	-18.397585	122.068207	19/08/2017
T99	-18.37717	122.074444	19/08/2017
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T101	-18.331772	122.090392	27/07/2017
T102	-18.441396	122.093798	23/07/2017
T103	-18.452781	122.086879	23/07/2017
T104	-18.456287	122.092268	23/07/2017
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T107	-18.490419	122.021011	19/08/2017
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T110	-18.432214	122.032142	19/08/2017

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T114	-18.432362	121.987248	19/08/2017
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T116	-18.465687	121.949331	20/08/2017
T117	-18.468227	121.953978	19/08/2017
T118	-18.488219	121.954644	19/08/2017
T119	-18.488656	121.966263	19/08/2017
T120	-18.489074	121.976526	20/08/2017
T121	-18.489579	121.996616	19/08/2017
T122	-18.490214	122.01059	20/08/2017
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T125	-18.601967	122.175182	20/06/2017
T126	-18.621914	122.218081	20/06/2017
T127	-18.646255	122.269628	20/06/2017
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T129	-18.688625	122.32756	20/06/2017
T130	-18.733958	122.326612	20/06/2017
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T134	-18.610875	122.045232	28/06/2017
T135	-18.621628	122.066639	28/06/2017
T136	-18.632966	122.073159	28/06/2017
T137	-18.660538	122.070353	28/06/2017
T138	-18.686688	122.067677	28/06/2017
T139	-18.709535	122.065269	28/06/2017
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T149	-18.702279	122.00994	28/06/2017

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T152	-18.660957	122.01135	28/06/2017
T153	-18.64567	122.010182	28/06/2017
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T155	-18.618397	122.007825	28/06/2017
T156	-18.610203	122.007231	28/06/2017
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T159	-18.51759	121.939725	25/06/2017
T160	-18.50147	121.91238	24/06/2017
T161	-18.481244	121.912387	24/06/2017
T162	-18.461658	121.91435	24/06/2017
T163	-18.487515	121.849315	24/06/2017
T164	-18.463853	121.845302	24/06/2017
T165	-18.460206	121.84654	24/06/2017
T166	-18.45978	121.849136	24/06/2017
T167	-18.545638	121.81624	23/06/2017
T168	-18.578045	121.814293	23/06/2017
T169	-18.587403	121.813688	23/06/2017
T170	-18.573876	121.826792	23/06/2017
T171	-18.562713	121.836246	23/06/2017
T172			
T173	-18.563316	121.859382	23/06/2017
T174	-18.564908	121.89082	23/06/2017
T175	-18.555681	121.91857	23/06/2017
T176	-18.551391	121.937089	23/06/2017
T177	-18.552224	121.957488	23/06/2017
T178	-18.605132	121.965578	25/06/2017
T179	-18.614451	121.962325	21/06/2017
T180	-18.688109	121.908684	25/06/2017
T181	-18.717057	121.930112	21/06/2017
T182	-18.752918	121.944061	21/06/2017
T183	-18.806884	121.926441	22/06/2017
T184	-18.840827	121.946333	22/06/2017
T185	-18.872265	121.964973	22/06/2017
T186	-18.900327	121.945416	22/06/2017
T187	-18.890179	121.914834	22/06/2017
T188	-18.851565	121.913705	22/06/2017

T189	-18.787189	121.913726	30/08/2017
T190	-18.773663	121.907043	30/08/2017
T191	-18.752356	121.894694	30/08/2017
T192	-18.741552	121.876261	30/08/2017
T193	-18.73726	121.846686	27/06/2017
T194	-18.711762	121.830051	27/06/2017
T195	-18.701179	121.824986	27/06/2017
T196	-18.688444	121.818578	24/05/2017
T197	-18.682978	121.817207	27/06/2017
T198	-18.685705	121.811639	24/05/2017
T199	-18.683748	121.797596	24/05/2017
T200	-18.884803	122.094596	21/06/2017
T201	-18.854621	122.075357	21/06/2017
T202	-18.828529	122.048974	21/06/2017
T203	-18.887614	121.911062	30/08/2017
T204	-18.870763	121.886228	30/08/2017
T205	-18.851505	121.858025	30/08/2017
T206	-18.835492	121.83478	30/08/2017
T207	-18.81807	121.809737	30/08/2017
T208	-18.771007	121.826631	25/06/2017
T210	-18.769677	121.784758	25/06/2017
T211	-18.77337	121.761656	27/06/2017
T212	-18.772765	121.76416	25/06/2017
T213	-18.75949	121.765852	25/06/2017
T214	-18.740032	121.765769	25/06/2017
T215	-18.726961	121.765664	25/06/2017
T216	-18.709827	121.766244	27/06/2017
T217	-18.773004	121.741562	27/06/2017
T218	-18.787364	121.718418	27/06/2017
T219	-18.783014	121.712662	27/06/2017
T220	-18.766232	121.712256	27/06/2017
T221	-18.764021	121.711367	27/06/2017
T222	-18.743741	121.701214	27/06/2017
T223	-18.734871	121.689226	27/06/2017
T224	-18.757813	121.659531	27/06/2017
T225	-18.765147	121.665123	27/06/2017
T226	-18.798153	121.694705	27/06/2017
T227	-18.871133	121.646701	29/08/2017
T228	-18.893296	121.677776	29/08/2017

T229	-18.917071	121.691802	29/08/2017
T230	-18.924468	121.699663	29/08/2017
T231	-18.932283	121.727885	29/08/2017
T232	-18.894002	121.661849	28/08/2017
T233	-18.912485	121.629625	28/08/2017
T234	-18.956668	121.585511	28/08/2017
T235	-18.993313	121.652353	28/08/2017
T236	-18.987029	121.707473	25/05/2017
T237	-19.001861	121.706825	26/06/2017
T238	-19.007573	121.706668	26/06/2017
T239	-19.008357	121.725538	26/06/2017
T240	-19.008869	121.739154	26/06/2017
T241	-18.994874	121.737921	25/05/2017
T242	-18.981525	121.739891	26/06/2017
T243	-18.98119	121.75336	17/08/2017
T244	-18.973967	121.720167	28/08/2017
T245	-18.953512	121.750836	17/08/2017
T247	-19.035969	121.751133	17/08/2017
T248	-19.062762	121.753324	17/08/2017
T249	-19.093106	121.739509	15/08/2017
T250	-19.072175	121.714696	15/08/2017
T251	-19.06352	121.715241	15/08/2017
T252	-19.048858	121.715944	15/08/2017
T253	-19.034448	121.691683	15/08/2017
T254	-19.034143	121.668615	15/08/2017
T255	-19.083571	121.689799	15/08/2017
T256	-19.094061	121.685065	14/08/2017
T257	-19.116418	121.700445	14/08/2017
T258	-19.131837	121.731603	14/08/2017
T259	-19.138942	121.753956	14/08/2017
T260	-19.138069	121.78354	17/08/2017
T261	-19.133675	121.830449	17/08/2017
T262	-19.092019	121.912904	16/08/2017
T263	-19.099215	121.93553	16/08/2017
T264	-19.112086	121.976354	16/08/2017
T265	-19.151367	122.056383	16/08/2017
T266	-19.189377	122.06497	16/08/2017
T267	-19.217954	122.133397	16/08/2017
T268	-19.198421	122.097814	16/08/2017

T269	-19.057996	121.90696	15/08/2017
T270	-19.047539	121.878186	15/08/2017
T271	-19.03284	121.848255	15/08/2017
T272	-19.011423	121.817225	15/08/2017
T273	-19.000814	121.795674	15/08/2017
T274	-19.158757	121.779428	14/08/2017
T275	-19.185983	121.784331	14/08/2017
T276	-19.225276	121.837794	14/08/2017
T277	-19.247955	121.831544	14/08/2017
T278	-19.269058	121.774224	14/08/2017
T279	-19.258167	121.748099	14/08/2017
T280	-19.197738	121.750499	14/08/2017
T281	-19.187932	121.748057	14/08/2017
T282	-19.181193	121.744542	14/08/2017
T283	-19.162663	121.730078	14/08/2017
T284	-19.147717	121.716404	14/08/2017
T285	-19.052084	121.657379	3/07/2017
T286	-19.077981	121.650059	3/07/2017
T287	-19.049247	121.629351	3/07/2017
T288	-19.047903	121.602503	3/07/2017
T289	-19.127332	121.57681	2/07/2017
T290	-19.120796	121.597819	2/07/2017
T291	-19.120566	121.613927	2/07/2017
T292	-19.120242	121.634571	2/07/2017
T293	-19.108521	121.641143	3/07/2017
T294	-19.148222	121.640046	2/07/2017
T295	-19.170795	121.636998	3/07/2017
T296	-19.175799	121.634332	3/07/2017
T297	-19.192961	121.627016	3/07/2017
T298	-19.206058	121.621197	3/07/2017
T299	-19.218593	121.619145	3/07/2017
T300	-19.2324	121.599418	3/07/2017
T301	-19.236014	121.570866	3/07/2017
T302	-19.240215	121.542157	3/07/2017
T303	-19.240622	121.534116	2/07/2017
T304	-19.24239	121.518098	2/07/2017
T305	-19.243109	121.511481	2/07/2017
T306	-19.255531	121.520283	3/07/2017
T307	-19.269266	121.516426	3/07/2017

T308	-19.263937	121.543998	3/07/2017
T309	-19.255916	121.561696	3/07/2017
T310	-19.272252	121.584979	4/07/2017
T311	-19.292065	121.588876	4/07/2017
T312	-19.324759	121.579594	4/07/2017
T313	-19.339608	121.564433	4/07/2017
T314	-19.344418	121.558273	4/07/2017
T315	-19.321609	121.560074	4/07/2017
T317	-19.284874	121.527796	4/07/2017
T318	-19.27653	121.489437	27/08/2017
T319	-19.337075	121.580025	26/08/2017
T320	-19.319326	121.596627	26/08/2017
T321	-19.316394	121.599276	26/08/2017
T322	-19.295944	121.618238	26/08/2017
T323	-19.27887	121.617022	26/08/2017
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T327	-19.358812	121.594257	31/07/2017
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T329	-19.412589	121.591901	31/07/2017
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T331	-19.440816	121.604615	31/07/2017
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T333	-19.426543	121.557934	31/07/2017
T334	-19.426498	121.556587	31/07/2017
T335	-19.428231	121.538274	31/07/2017
T336	-19.432801	121.51591	31/07/2017
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T348	-19.434175	121.456736	4/07/2017
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T365	-19.530058	121.494972	1/08/2017
T366	-19.524563	121.424318	30/07/2017
T367	-19.539174	121.439261	30/07/2017
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W19	-18.012312	122.592538	21/07/2017
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W73	-19.656042	121.281592	27/08/2017
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W75	-19.496382	121.431231	27/08/2017
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W98	-18.053764	122.863051	19/07/2017
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W103	-19.575443	121.347949	30/07/2017
W104	-19.55134	121.373893	30/07/2017
W105	-19.473492	121.458319	30/07/2017
W106	-19.329197	121.578829	30/07/2017
W107	-19.136713	121.639327	3/07/2017

6 Appendix 2: Detailed Findings and Discussion on 21 Species from the La Grange Flora Survey

The following section describes findings and taxonomic investigations for 20 species of conservation significance. A brief outline of their taxonomy and a description of are given, along with comparisons to closely related or morphologically similar taxa. Their distribution within the La Grange region is described from herbarium records and the findings of the current study. Distributions of the species are based on both field survey and herbarium records, and these are mapped onto pastoral leases and the Preferred Irrigation Areas of DPIRD (DAFWA 2016a).

1: Acacia glaucocaesia

Taxonomy

Acacia glaucocaesia Domin (Fabaceae) was redescribed in detail by Maslin (1992) as part of a revision of the *Acacia victoriae* group.

Description

From Maslin (1992), *A. glaucocaesia* is a densely branched shrub 2–6 m high, with conspicuously pruinose terete branches and spines on young plants but only minute, blunt bases persisting on older plants and growth. The phyllodes are elliptic to obovate to oblong-oblanceolate, rounded to obtuse, 1.5–2.5 cm long and 7–13 mm wide, with a leaf:width ratio of 1.5–3. The surface is glaucous, lacking a prominent midrib, the gland on upper margin of phyllodes, not overly prominent and c. 0.5 mm long. Flower counts are 30–50 per inflorescence. Inflorescences are arranged most commonly in a raceme, with some peduncles subtended by secondary phyllodes, or sometimes with a few simple inflorescences on new shoots as in *Acacia synchronicia* Maslin. Both inflorescence types may be present on the same plant (Maslin 1992, B. Maslin pers. comm.) (Figure 7).

Similar species

As part of the *Acacia victoriae* group (Maslin 1992), *A. glaucocaesia* can be confused with the closely allied and morphologically similar *Acacia victoriae* Benth. and *A. synchronicia*. *Acacia synchronicia* occurs in the La Grange area, primarily on gravelly rises in the Pindan, and it does not co-occur with *A. glaucocaesia*. It has narrower, longer leaves, prominent phyllode glands, branches are not pruinose, phyllodes are not glaucous, and inflorescences are axillary as opposed to being predominantly racemose.

However, Maslin (1992, pers. comm.) notes that inflorescence structure (notably heads held in racemes versus axillary heads) in the *A. victoriae group* (including *A. victoriae*, *A. synchronicia* and *A. glaucocaesia*) is a variable and labile character, and species identity should not be unduly weighted by inflorescence type but determined from the combination of all morphological characters.

Distribution and abundance

Acacia glaucocaesia is endemic to Western Australia, with most populations occurring in the northern and western part of the Pilbara region but several locations are scattered into the Dampierland bioregion (Western Australian Herbarium 1998–). Prior to the 2015 Walyarta / Mandora Marsh (Markey 2017) and 2017 La Grange flora surveys, there were only two herbarium records for *A. glaucocaesia* in the La Grange region. One of these, a collection from Salt Creek, Walyarta / Mandora Marsh (BR Maslin 4874) has been only tentatively referred to as this species (see Maslin 1992 for discussion) and its

persistent spines and relatively narrow leaves were assumed to be related to regrowth (Maslin 1992). The 2017 survey relocated *A. glaucocaesia* at Walyarta Conservation Park, including at Salt Creek (Figure 7). However, this species was not relocated at the location of the second herbarium record, on Anna Plains Station (G. Byrne 1241).

Collections from a 1999 survey of the Walyarta Conservation Park were identified as *A. synchronicia,* but these were not lodged at PERTH so were unavailable for confirmation. More flowering material from the same area in Walyarta Conservation Park was collected in 2015 and 2017, from stands in long-unburnt vegetation. The 2015 collections were originally identified as *A. synchronicia* (see Markey 2017) because of their persistent spines on stems and the predominance of axillary heads. Despite the near absence of racemose inflorescences on these collections, these Salt Creek populations have all the other characters consistent for *A. glaucocaesia* (pruinose branchlets, glaucous leaves, comparatively less prominent leaf glands, and glaucous, obovate leaves with an obovate -obtuse apex) (B. Maslin pers. comm.).

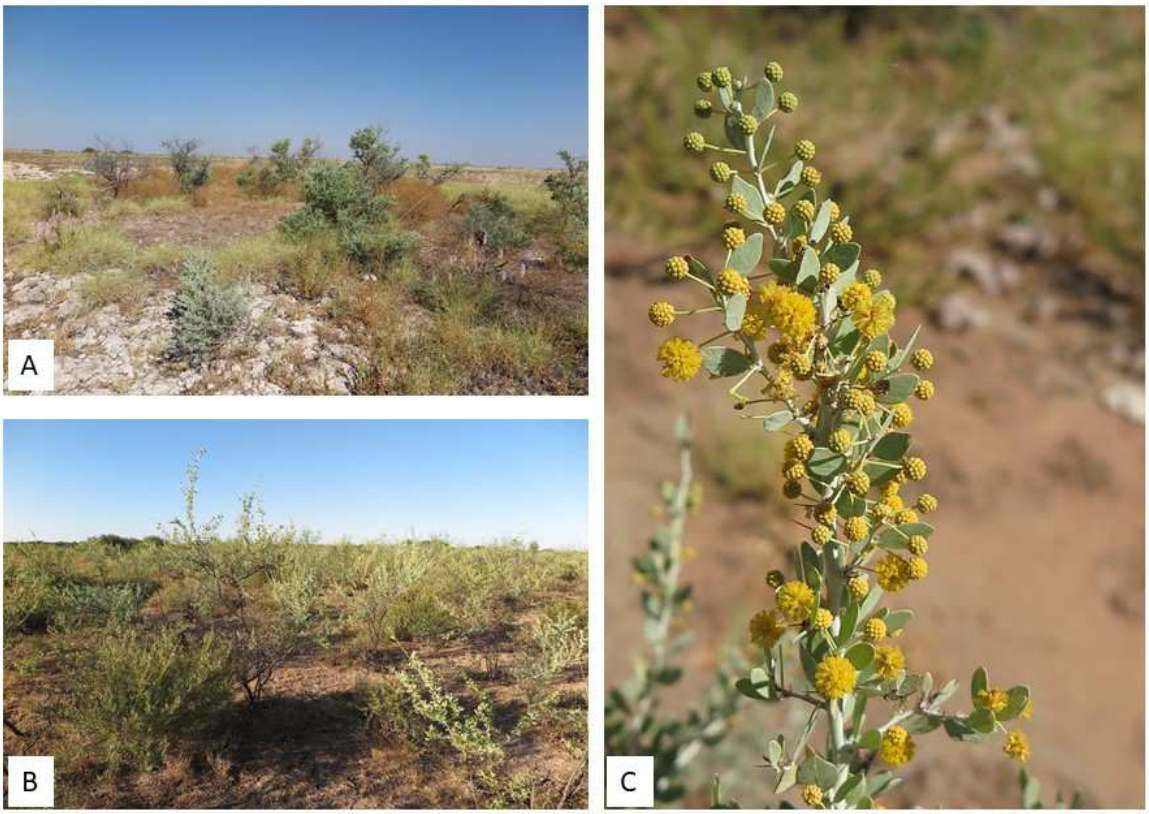

Figure 7: *Acacia glaucocaesia* at Walyarta Conservation Park, **A:** growing on small calcrete outcrops, **B:** forming mid-dense shrublands on the saline terraces on the margins of Salt Creek, **C:** detail of mostly axillary inflorescences and glaucous leaves.

Acacia glaucocaesia has an extensive distribution at Walyarta Conservation Park on the expanses of terraces and plains surrounding Salt Creek, and on extensive loamy flats on the margins of mound springs. This species was located at several sampling sites in the 2015 and 2017 surveys, where its abundance was estimated to range from isolated plants (<1% cover) on the loamy flats, to patches of several shrubs on calcrete rises to a mid-dense cover (35%) as a dominant species of the shrublands on the saline plains (Figure 7). These findings confirm that the Walyarta Conservation Park indeed holds substantial stands of *A. glaucocaesia*, and is the largest occurrence of this species in the La Grange region.

Field observations of Acacia glaucocaesia in the La Grange Region

Habit:

Acacia glaucocaesia grows as straggly, intricately branched shrubs 1.5-2 m tall, which persist for at least several years after fire. While flowering in abundance during the current survey (late August-September), it was too early for mature pods and seed, which would have been available from October to November.

Habitat:

Acacia glaucocaesia grows on a range of calcareous and saline soils, from the calcareous saline soils on the terraces adjacent to the palaeochannels, skeletal soils on low calcrete outcrops and pavements, and loamy calcareous soils on calcrete plains and around mound springs (Figure 7).

Acacia glaucocaesia is associated with *Melaleuca alsophila* / *Acacia ampliceps* open shrublands on calcareous plains over *Triodia epactia* and with halophyte *Trianthema turgidifolium* and *Tecticornia indica* subsp. *leiostachya*. On the calcareous plains adjacent Salt Water Creek, *Acacia glaucocaesia* grows as a dominant shrub over shrubs of *Scaevola spinescens*, *Tecticornia indica* subsp *leiostachya*, *Frankenia ambita* and *Neobassia asterocarpa*, *Trianthema turgidifolium* and low tussocks of *Eragrostis falcata*.

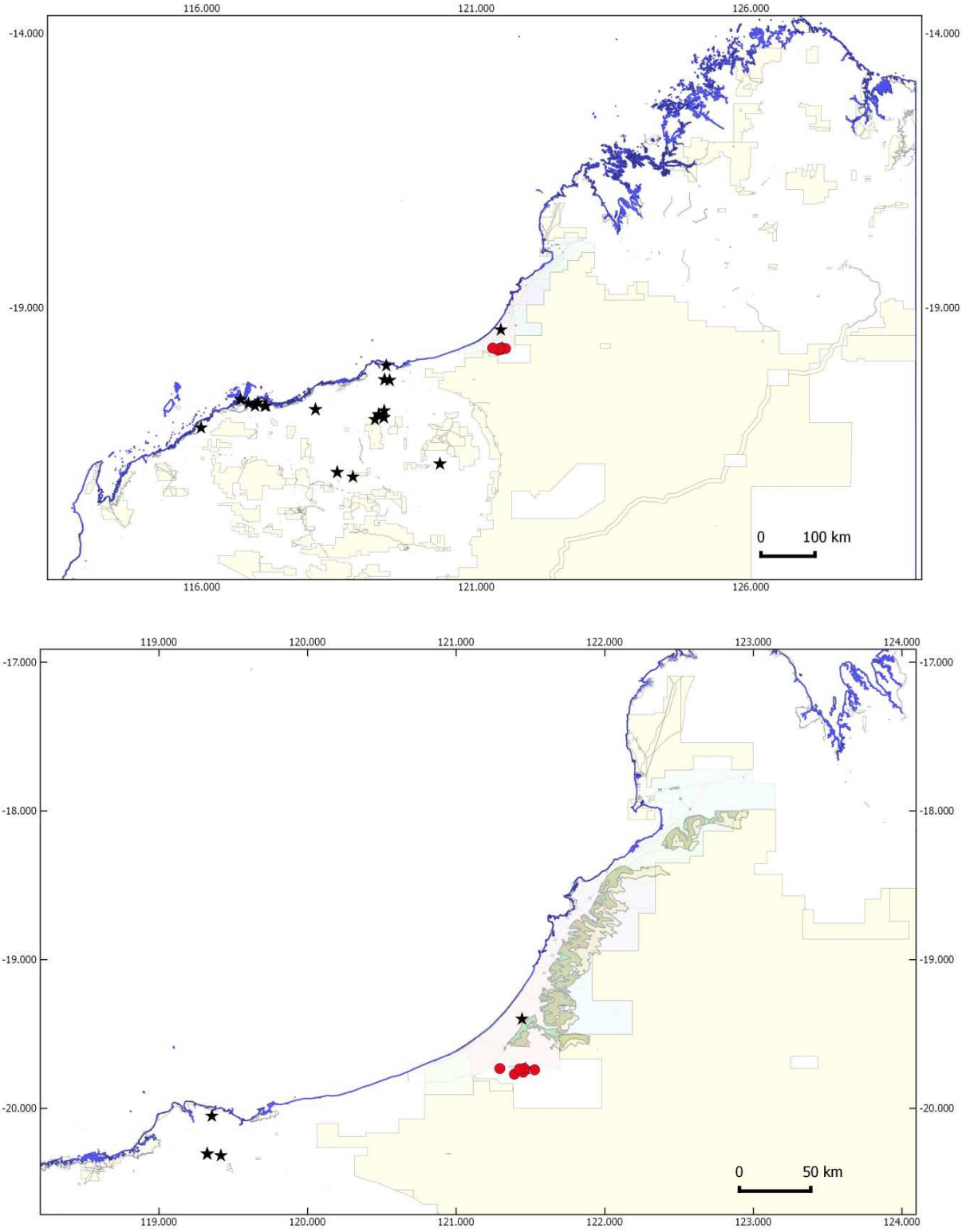

Figure 8: Distribution of *Acacia glaucocaesia* in northern Western Australia (**Top**)_and within the La Grange region (**Bottom**), based on locations found during the 2017 La Grange survey and 2015 Mandora Marsh survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars).

Recommendations

As a result of this study, *A. glaucocaesia* has been removed from conservation listing and downgraded to Not Threatened (Table 4) (Smith 2018). Although listed of conservation concern at time of description (Maslin 1992), it is not considered to be threatened or naturally uncommon or rare. *Acacia glaucocaesia* forms large stands, particularly along drainage features in the Pilbara and into the southern edge of the Kimberley (B. Maslin pers. comm., Figure 8).

Acacia glaucocaesia is not considered to be at direct risk from proposed irrigation projects in the La Grange as a consequence of its distribution to the south of the region and distribution on calcareous, saline soils in palaeodrainage systems that are unsuitable for irrigated agriculture.

2: Atriplex eremitis

Taxonomy

Initially informally phrase-named as *Atriplex* sp. De Grey (A.A. Mitchell PRP1940), *Atriplex eremitis* Cranfield (Chenopodiaceae) was formally described by Cranfield (2008) based on collections from De Grey Station in the north-east Pilbara. When described, Cranfield (2008) placed this species in section Dialysex Moq., which are predominately dioecious perennial herbs or shrubs with spicate or paniculate glomerules of male flowers (Wilson 1984). Cranfield (2008) referenced its close relationship to *Atriplex cinerea* and *Atriplex amnicola*, using an amended couplet from the key of Wilson (1984) to distinguish it from *A. amnicola* based on bracteole and leaf size.

Description

Cranfield (2008) described *A. eremitis* as an erect, open subshrub to 30cm tall. Leaves are thin, narrowly elliptic to oblong, obtuse leaves 4–16 mm long and 2–6 mm wide, vesiculate and scurfy on both surfaces, and attenuate at the base. Plants are either monoicous or dioecious, with male flowers in glomerules 2 mm forming a short panicle. Female flowers are arranged in axillary clusters lacking male glomerules or occasionally at the base of a spike subtending male glomerules. Fruiting bracteoles are rhomboid to deltoid, 1.5–2 mm long and 1.5–2 mm wide with 3 obtuse lobes, sessile and fused in the lower third. Cranfield (2008) made no mention of appendages on the bracteoles.

Similar species, taxonomic Issues and the La Grange collections

Prior to the 2017 La Grange survey and taxonomic investigation, *A. eremitis* was only known from two collections, one from the type locality in the Pilbara and a second collection made in 1999 from Walyarta Conservation Park / Mandora Marsh. This latter specimen was held in a regional herbarium until 2015, when it was transferred to the Western Australian Herbarium (PERTH) and had its identity confirmed following examination. Because this species had been originally allied to *A. cinerea* and *A. amnicola*, its relationship to other species in the genus had not undergone scrutiny.

During the 2017 La Grange survey, collections of *Atriplex* were made which appeared to be *A. eremitis* but also resembled *Acacia elachophylla* F. Muell. Further examination of the collections of *A. elachophylla* at the Western Australian Herbarium found five other accessions, all from the La Grange region, which closely matched the both type for *A. eremitis* and the collections from the 2017 La Grange survey. One of these (Beauglehole ACB 11280) was cited in Wilson's (1984) treatment with the note on his determinavit stating it was only a "broad match with type [*A. elachnophylla*]". The Western Australian Herbarium holds a good selection of collections of *A. elachophylla* from interstate and central Western Australia as well as from the La Grange region, and these inland collections were found to not closely match those from the La Grange

region. These La Grange collections were therefore re-identified with confidence as *A. eremitis* based on being closely morphologically matched leaf shape and size (small and entire) and fruit size and shape.

Similar species

Atriplex elachophylla

Wilson (1984) based is his description of *A. elachophylla* F.Muell. using material from across Australia, including from the La Grange region but with some reservations about these specimens strictly matching the type. From Wilson (1984), *A. elachophylla* is an erect, perennial shrub to 50 cm tall, with narrowly elliptic to elliptic, subsessile leaves 2.5–5 mm long in the northern part of its range, to obovate and 10–40 mm long in the southern part of its range (This northern range of leaf lengths includes measurements made on some of the La Grange collections which were re-identified as *A. eremitis* in this current study). Leaf margins range from entire to strongly sinuate-dentate, with glabrescent adaxial and scurfy to scaly abaxial leaf surfaces. Male flowers are in 2–3 mm wide glomerules arranged on terminal axils, while female flowers in scattered axillary clusters. Fruiting bracteoles are sessile, fused into swollen campanulate tubes 1.5–2.5 mm long, with truncate or rounded, entire or 3-toothed apices. There may be 1–4 small and tooth-like appendages on bracteole faces, or these may be absent.

The core distribution of *A. elachophylla* is central Australia, from South Australia and the Northern Territory into Queensland and central Western Australia (Figure 9). Wilson (1984) notes that at their extremes, northern and southern variants differ in leaf and fruit size, but these species intergrade into one another. The La Grange collections, which have been subsequently re-identified as *A. eremitis*, are greatly disjunct from this main distribution.

Atriplex flabelliformis

Another species Wilson (1984) notes is similar to *A. eremitis*, *Atriplex flabelliformis* Paul G. Wilson is a Priority Three listed species (Smith 2018) occurring in several disjunct locations from the eastern Pilbara into the Great Sandy and Tanami Deserts. *Atriplex flabelliformis* is another erect, short-lived perennial shrub to 35 cm tall, but differs from both *A. elachophylla* and *A. eremitis* by having numerous, verrucose, papillose or spiny appendages on the bracteoles (Wilson (1984), and from *A. eremitis* by its larger, dentate leaves and smaller, straggly stature (A. Markey pers. obs). *Atriplex flabelliformis* possibly intergrades with *A. elachophylla* (Wilson (1984), but it is unknown if it also intergrades with *A. eremitis* without further examination of a large number of herbarium collections. However, no specimens of *A. eremitis* were found in the Western Australian Herbarium's collections of *A. flabelliformis*.

Distribution and abundance

No plants were relocated at the 1999 collection site at Walyarta / Mandora Marsh, and relocating the former '*A. elachophylla*' locations was not possible due to errors with old locality information or a need to search a wider area to relocate populations. However, eight new populations of *A. eremitis* were found in the La Grange survey area, on Anna Plains Station and within the Walyarta Conservation Park (Figure 9). *Atriplex eremitis* is restricted to the southern third of the La Grange survey area, all locations being associated with the saline flood plains of the two palaeodrainage systems in the La Grange survey area. Suitable habitats were searched further north in the survey area, but no plants were found. There is a herbarium record dating from 1965 (A.C. Beauglehole ACB 11280) for a location "40 miles S of Broome" which corresponds to Shamrock Station, but this record lacks precise locality information and could not be relocated.

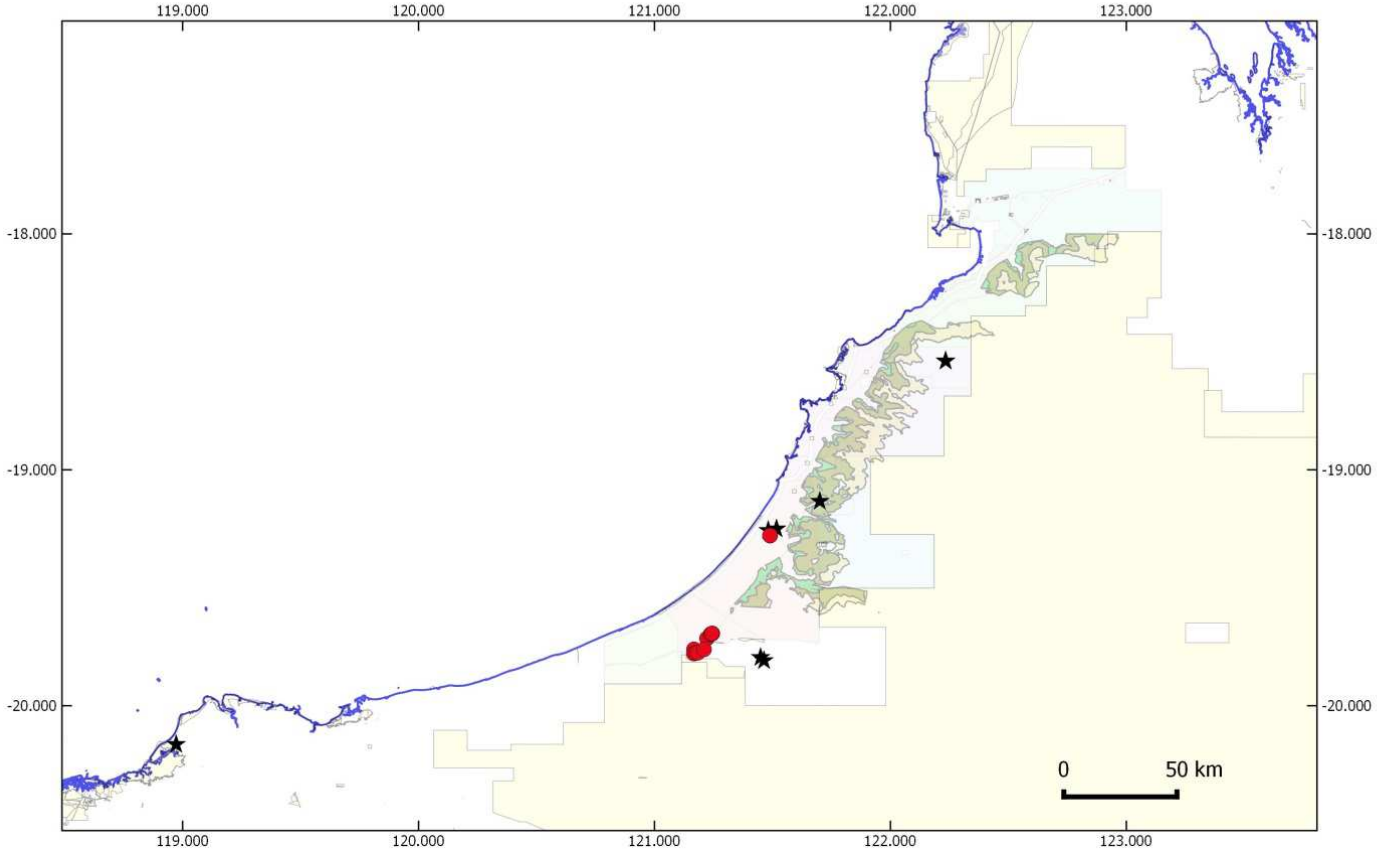

Figure 9: Distribution of *Atriplex eremitis* based on locations found during the 2017 La Grange survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars) (including collections initially misidentified as *Atriplex elachophylla*).

Field observations of Atriplex eremitis in the La Grange Survey Area

Habit:

Plants form a distinctive erect, compact, rounded shrub formed by densely interlacing, divaricate branches, of the dimensions of 0.3–1.0 1 m x 0.3–1 m wide high (Figure 10). After a good wet season and in microsites that retain soil moisture, plants can be particularly robust and compact. The foliage is characteristically small (c. 3–5 mm long) but larger leaves (10–20 mm long) can be found deeper within the canopy. The scurfy leaves and stems give the plants an overall silvery-white appearance, which is a good spotting feature for field survey.

Plants were found to be both in flower and fruit from July to late August, with plants both in late fruiting stages and starting to dry off in late August (especially those plants in drier microsites).

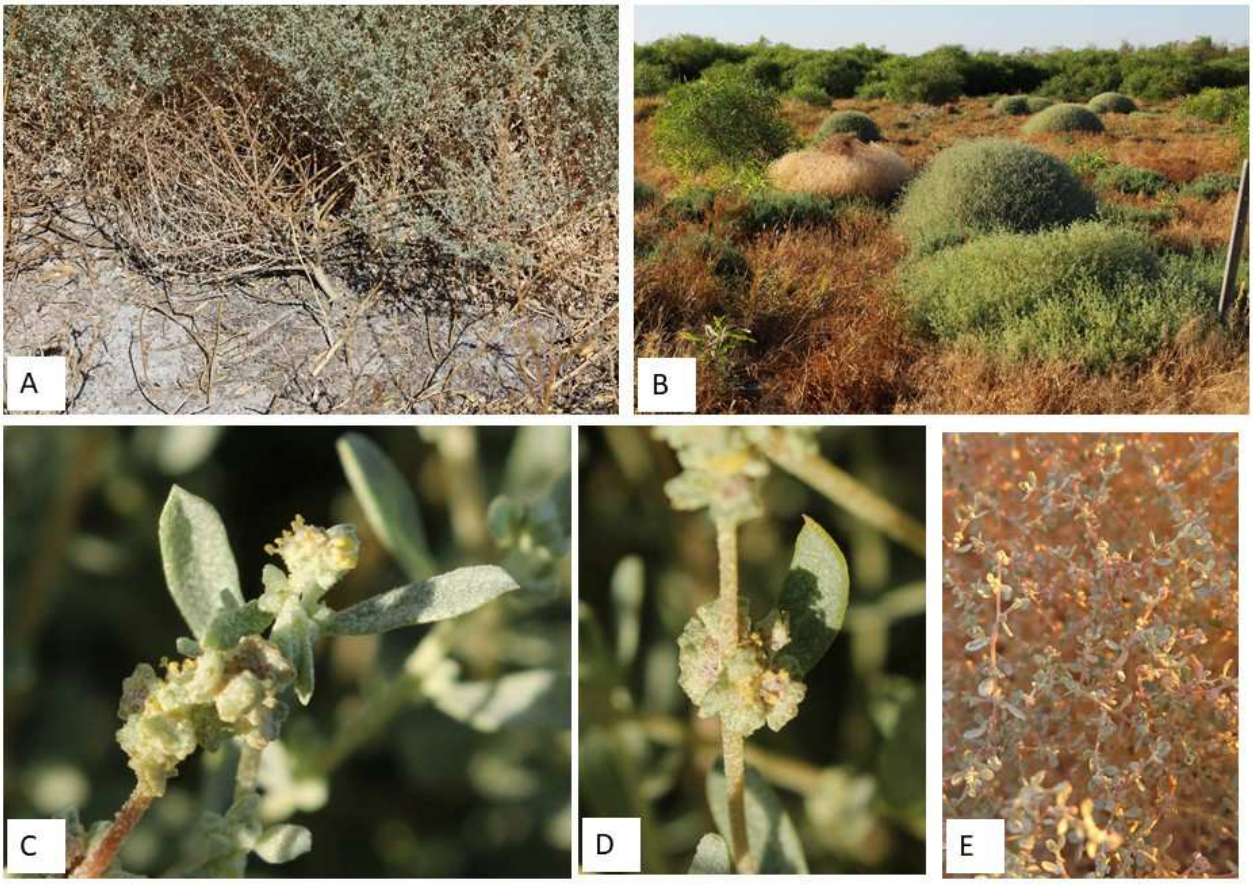

Figure 10: *Atriplex eremitis* **A:** detail of habit, including intricate branching arising from a single stem, **B:** rounded shrubs growing in samphire and halophyte shrubland, **C:** detail of male flowers (top) and female flowers and fruits (basal) on inflorescence, **D:** detail of fruits, **E:** detail of small, silvery-white leaves and inflorescences within the shrub.

Atriplex eremitis appears to be short-lived perennial, as some of the plants were observed to be starting to senesce, some of these breaking off at their bases and forming tumbleweeds like *Salsola australis* (Figure 10).

Habitat:

Atriplex eremitis grows on the edges of saline salt marshes, in low samphire shrublands dominated by *Tecticornia* spp., and in association with *Trianthema turgidifolium, Trianthema triquetrum, Neobassia astrocarpus, Panicum decompositum, Nicotiana heterantha, Pterocaulon sphacelatum, Flaveria trinervia* and *Salsola australis*. This species appears on road and track edges, possibly in response to disturbance and often in shallow depressions which retain moisture. *Atriplex eremitis* does not occur in heavily grazed areas, as observed for populations bisected by fence lines.

Recommendations

More taxonomic study is recommended to define the characters of *A. eremitis* that distinguish it from *A. elachophylla* and the two species (*A. flabelliformis and the* Queensland species *Atriplex cornigera* Domin) which Wilson (1984) noted had close affinities to *A. elachophylla*. Molecular phylogenetic analyses investigating the genus are currently underway (K. Shepherd, pers. comm.) which will complement any morphological studies undertaken on this group.

More information of species biology is required to see how it responds to rainfall, grazing, flooding and mechanical disturbance, and if fire is a threat. Samphires usually do not carry fire to a great extent, but the October 2017 fires that burnt into Walyarta Conservation Park may have encroached on areas where *A. eremitis* is located. Given that this species appears to respond well to rainfall, it may decline or become absent during poor seasons. This must be taken into consideration for future surveys for this species.

Following recommendations from this survey, the conservation status of this species remains at Priority One (Table 4) (Smith 2018), given that it has a restricted distribution between Port Hedland and and the main current threat appears to be from grazing. However, it is not under immediate threat from proposed irrigated agricultural developments given that it does not grow on Pindan soils in the La Grange Project Area.

3: *Bonamia oblongifolia*

Taxonomy

Bonamia oblongifolia Myint (Convolvulaceae) was described by Myint (1968), based on a single type specimen from Broome township.

Description

As described by Myint (1968), *B. oblongifolia* is a herbaceous perennial with stems arising from a woody base, densely ferruginous (rust coloured) plants. Stems are erect or suberect, 15–20 cm tall, with dense, villous, brown hairs. The leaves are shortly petiolate (1–2 mm) or subsessile (with indistinct petioles), and densely sericeous or villous with ferruginous hairs on upper and lower leaf surfaces. Leaf blades are oblong or less commonly oblong-elliptic, 10–20 mm long, 3–4 mm wide, and rounded at the base and apex. Flowers have a blue, campanulate–funnelform corolla, 6–8 mm long and 5–10 mm wide. Sepals are 3–4 mm long, densely ferruginous or sericeous with brownish hairs, ovate, oblong ovate or ovate–acute. The seed is entire, trigonal and lacking a wing on the margin.

Similar species

Bonamia oblongifolia is similar to *B. linearis* (R.Br.) Hallier, *B. media* (R.Br.) Hallier, and *B. deserticola* R.W. Johnson. The key characters which distinguish these taxa are leaf shape, width and length:width ratio, followed by stem node lengths, leaf petiole length and flower colour. *Bonamia oblongifolia* is distinguished from these three species primarily by its distinctly oblong leaves which are rounded at both ends, c. 5 mm wide and with length to width ratio of > 2.5 (Myint 1968).

Bonamia oblongifolia differs to *B. linearis* by its broader, oblong leaves with rounded ends and blunt apices, as opposed to narrower leaves with acute, pointed apices in *B. linearis* (Myint 1968). From an examination of the collections of *B. linearis* at the Western Australian Herbarium (PERTH), this species tends have narrow, sparsely hairy leaves, relatively long pedicels, the flower colour ranges from white to pale blue.

There are close similarities between *B. oblongifolia* and some forms of *B. media*, but the decision to distinguish these taxa relies heavily on leaf shape and flower colour. Of importance, Myint (1968) used sessile to subsessile leaves to differentiate *B. oblongifolia* from *B. media*. However, some recent collections of *B. oblongifolia* have leaves that both have petioles and a leaf shape that starts to resemble that seen in some specimens of *B. media*.

Bonamia deserticola is closely allied to *B. oblongifolia*, having been referred to as *B*. aff. *oblongifolia* prior to being formally named. The main differences come down to flower colour and pedicel lengths (white versus blue flowers and pedicels 1.5–2 vs 3–4 mm) (Johnson 1987). *Bonamia deserticola* is greatly disjunct from *B. oblongifolia*, with its western limit at the Northern Territory - Western Australian border.

References to Kimberley Bonamia

There are difficulties using publications which address *Bonamia* in the Kimberley region to identify *B. oblongifolia*. Both Wheeler & Marchant (1992) and Kenneally *et al*. (1996) exclude *B. oblongifolia* as a main species in the Kimberley region, but refer to this species in notes under *Bonamia linearis* (R.Br.) Hallier f. and (in Wheeler & Marchant 1992) *B. media*. Kenneally *et al*. (1996) even uses an image of *B. oblongifolia* which is labelled as *B. linearis*. Despite this, both their notes accord with Myint (1968) in stating that *B. oblongifolia* differs from *B. linearis* by its subsessile, slightly broader oblong, obtuse leaves and blue flowers with acute to obtuse sepals. Reference is also made about the large-flowered forms of *B. oblongifolia* from near Port Hedland, and both texts also concede that further studies are required to determine the relationship between these two taxa. Wheeler & Marchant (1992) also notes that *B. media* was previously often misidentified as *B. oblongifolia*.

Taxonomic Issues and the La Grange collections

Bonamia oblongifolia was described from a single collection made in 1905 and which is held overseas in the Geneva Herbarium. At the time of description and for a long period thereafter, it was only known from this type collection. Since 2007, seven collections have been made in the south-western Kimberley, six of which are held at the Western Australian Herbarium (PERTH), which have been identified as this species presumably based on the description but possibly without reference to the type. These collections all have the characteristic oblong leaves matching the description, but the older leaves are distinctly petiolate, with petioles 1–3 (–6) mm long. The indumentum on the leaves and stem is distinctly white and not brown. This same petiolate, white-haired variant of *B. oblongifolia* is the form collected during the 2017 La Grange survey (Figure 11).

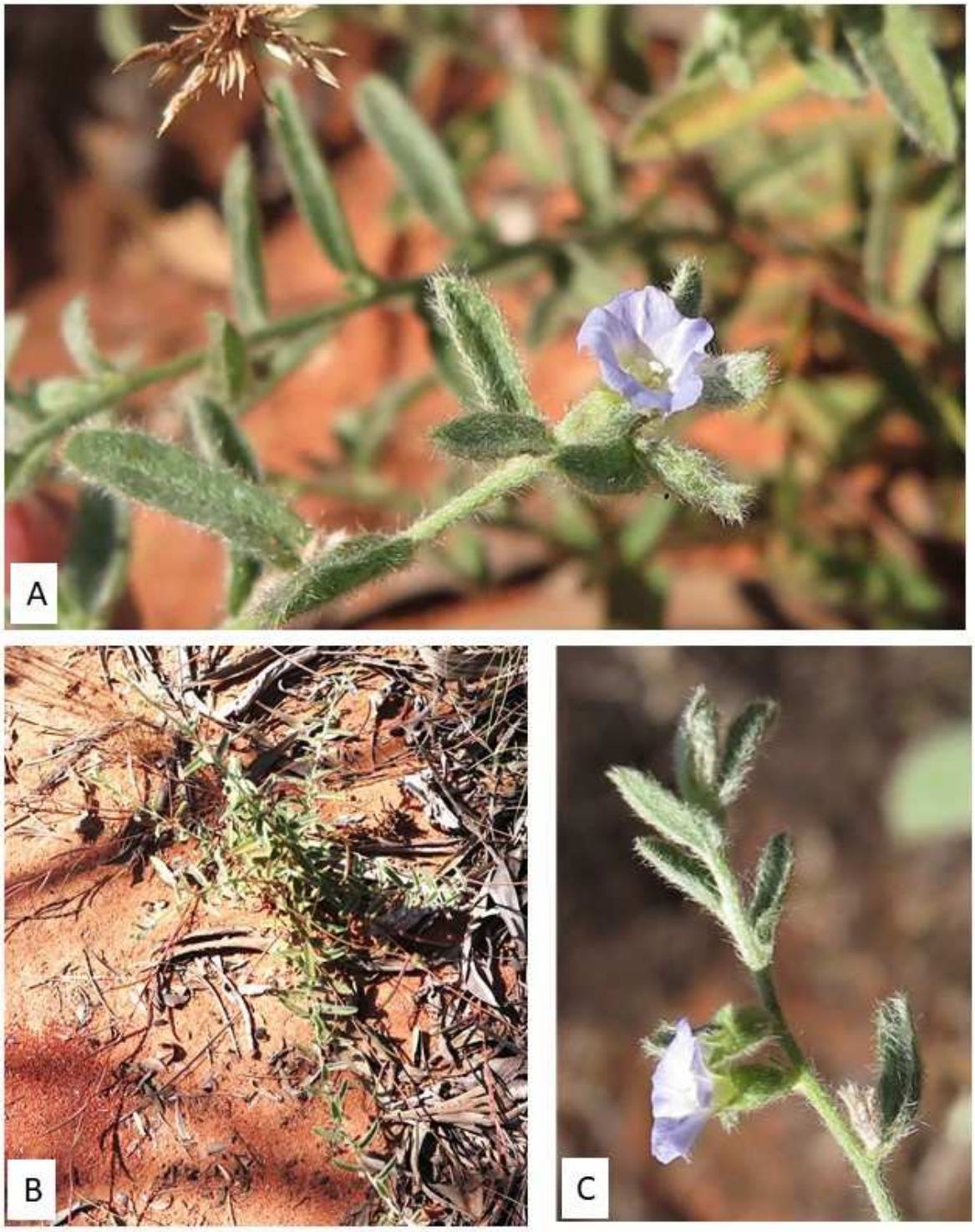

Figure 11: *Bonamia oblongifolia* **A:** detail of flowers and petiolate leaves, **B:** detail of habit, including trailing and erect stems, **C:** side view of flower and sessile leaves near stem tips.

Differences between these La Grange and herbarium collections and Myint's (1968) description are given in Table 5. The main discrepancies are petiole length, indumentum colour, habit and stem length. As the type collection was already c. 60 years old when seen for the description, it is possible that it may have discoloured with age. La Grange specimens possessed erect stems, sometimes associated with recent

new growth after fire or grazing. Like the type, the La Grange plants have small, blue corollas, which are considerably smaller than those found in the Port Hedland plants.

Despite the differences, these recent collections are consistent with *B. oblongifolia* and future descriptions should be expanded to include this range of morphological variation (D. Halford, pers. comm.).

Table 5: Comparison of distinguishing features of the La Grange and Port Hedland collections of *Bonamia oblongifolia sen. lat.*(including from the 2017 La Grange survey) and Myint's (1968) description based on the Broome type**.**

Distinguishing features of recent collections of *Bonamia oblongifolia*	**Distinguishing features of type, from Myint (1968)**
Both long (30-50 cm), trailing, decumbent stems as well as erect stems to 20 cm.	Erect or suberect habit, short stems and branches.
Indumentum is white not ferruginous	Indumentum of dense brown hairs
Older leaves are usually petiolate, petiole length usually 1-3 mm but not unusual to be 4-5 (6) mm in length	Sessile to subsessile leaves

Distribution and abundance

Bonamia oblongifolia has been found by this study to be widespread across the La Grange survey area (Figure 12). Although detailed population counts were not attempted during the survey due to identification uncertainties, estimates of abundance ranged from scattered and infrequent to relatively common and, at some sites, reaching an estimated cover of 1–2%.

Field observations of *Bonamia oblongifolia* in the La Grange Survey Area

Habit:

Plant habit has already been addressed, but plants were observed to be both in good condition and actively growing during the 2017 field survey. Flowering was observed in most of the populations from late May to Late August.

Habitat:

Bonamia oblongifolia grows on deep sands in a wide range of pindan vegetation types, including the widespread *Acacia monticola* / *Acacia eriopoda* shrublands, sparse open *Corymbia* woodlands over *Acacia* shrubland and *Triodia* / *Chrysopogon* grasslands.

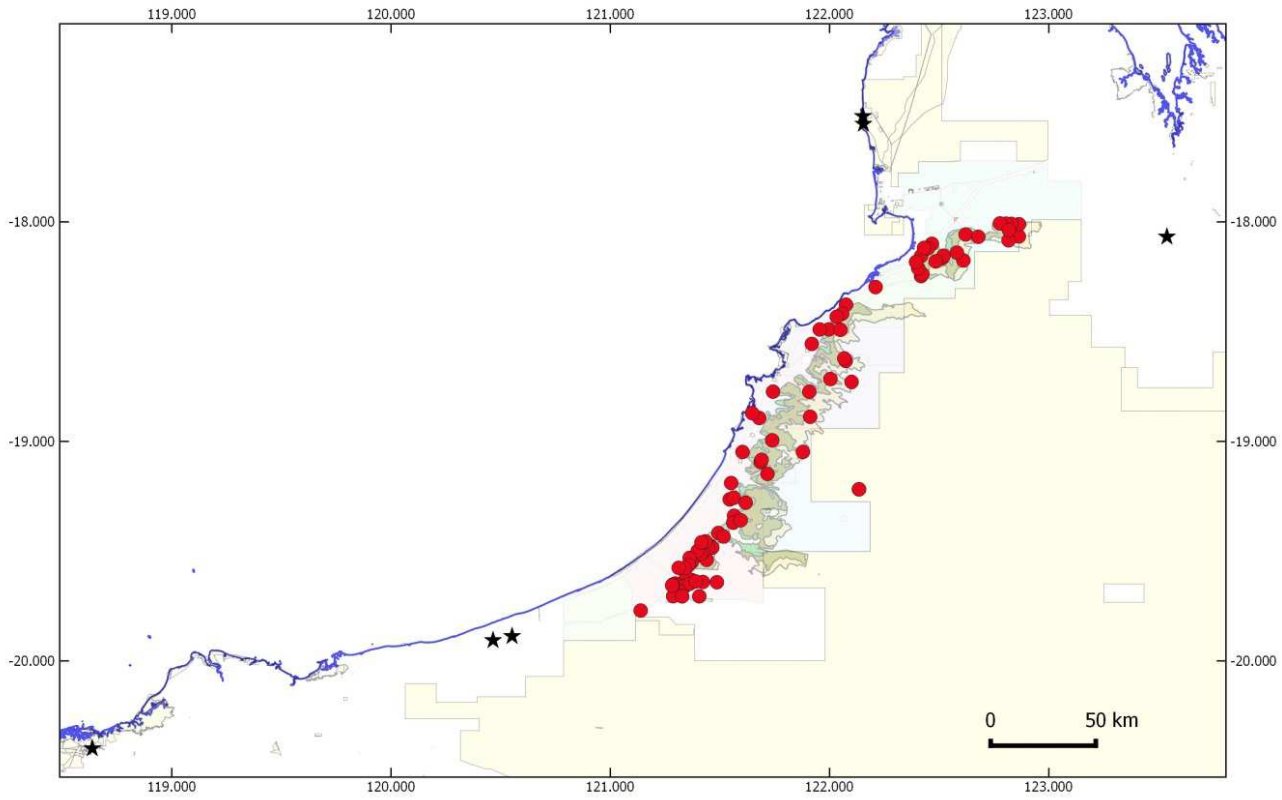

Figure 12: Distribution of *Bonamia oblongifolia* based on locations found during the 2017 La Grange survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars). This map covers the entire known range of this species.

Recommendations

Originally described from very limited material, there are now more collections available to better assess *B. oblongifolia*. Further taxonomic work should both address differences among *B. oblongifolia*, *B. media*, *B. linearis* and *B. deserticola*, and expand the species description to incorporate information from recent collections.

The conservation status of *B. oblongifolia* has been revised and downgraded from Priority One to Priority Three, as the findings from the La Grange flora survey indicate that it is both widespread and locally common across the survey area (Table 4) (Smith 2017, Smith 2018).

Despite being widespread, *B. oblongifolia* is likely to be impacted by clearing for irrigated agriculture given its habitat preferences for Pindan soils and vegetation and occurrences within areas preferred for irrigated agriculture (Figure 12).

4: *Croton aridus*

Taxonomy

Described as a new speciesby Forster (2003) as part of a taxonomic revision of Australian species of *Croton*, *C. aridus* P.I.Forst. (Euphorbiaceae) was segregated from *C. arnhemicus* Müll.Arg..

Description

From Forster (2003) *C. aridus* is a monecious, multistemmed shrub or tree to 1.5–2.0 m high, with large (15–80 mm long and 10–80 mm wide), palminerved ovate to broadly ovate leaves with 10–18 teeth along dentate to crenate margins. Foliage is green, discolorous, and covered in an indumentum of dense white trichomes and conspicuous reticulate venation on lower leaf surfaces. Inflorescences are short (up to 40 mm long), androgynous, with male flowers clustered at the top and female flowers at base of reduced to single flower. Both flowers have greenish-yellow perianth, male flowers are small (petals 4–4.5 mm long) with yellow anthers. Fruits are oblong – ovoid 3–17 mm long, and seeds are 8.5-10.5 mm long (Figure 13).

Similar species

There are four other species of *Croton* in the Kimberley region, all distributed north of the range of *C. aridus*. *Croton arnhemicus* is closely allied to *C. aridus*, and is distinguished by having considerably larger leaves with 60-100 marginal teeth, smaller globose fruit and smaller seeds (Forster 2003). Among the characters detailed in Forster (2003), both *Croton tomentellus* F.Muell. and *C. schultzii* Benth. have distinctive discolorous foliage with silver-white on the lower leaf lamina, and *C. habrophyllus* Airy Shaw has pennenervate leaves with 70-122 teeth.

Distribution and abundance

Croton aridus is widespread in arid central Australia, occurring in Western Australia the Northern Territory and in the Burke district in Queensland (Forster 2003, CHAH 2011–). The Western Australian populations are greatly disjunct from the main distribution (Forster 2003, CHAH 2011–). Given its wide distribution over areas that may have little botanical survey, Forster (2003) speculated that many more populations would be found. In Western Australia, *C. aridus* is restricted to two areas, with three locations scattered in Dampierland and two sites in the Great Sandy Desert near the border with the east Pilbara (Figure 14).

Figure 13: *Croton aridus* **A:** habit and habitat shot of a large shrub of *Croton aridus* (foreground) in relatively long unburnt tall *Acacia eriopoda* shrubland (10 years since last fire), **B:** maturing fruit on inflorescence, **C:** inflorescence showing developing and mature male flowers.

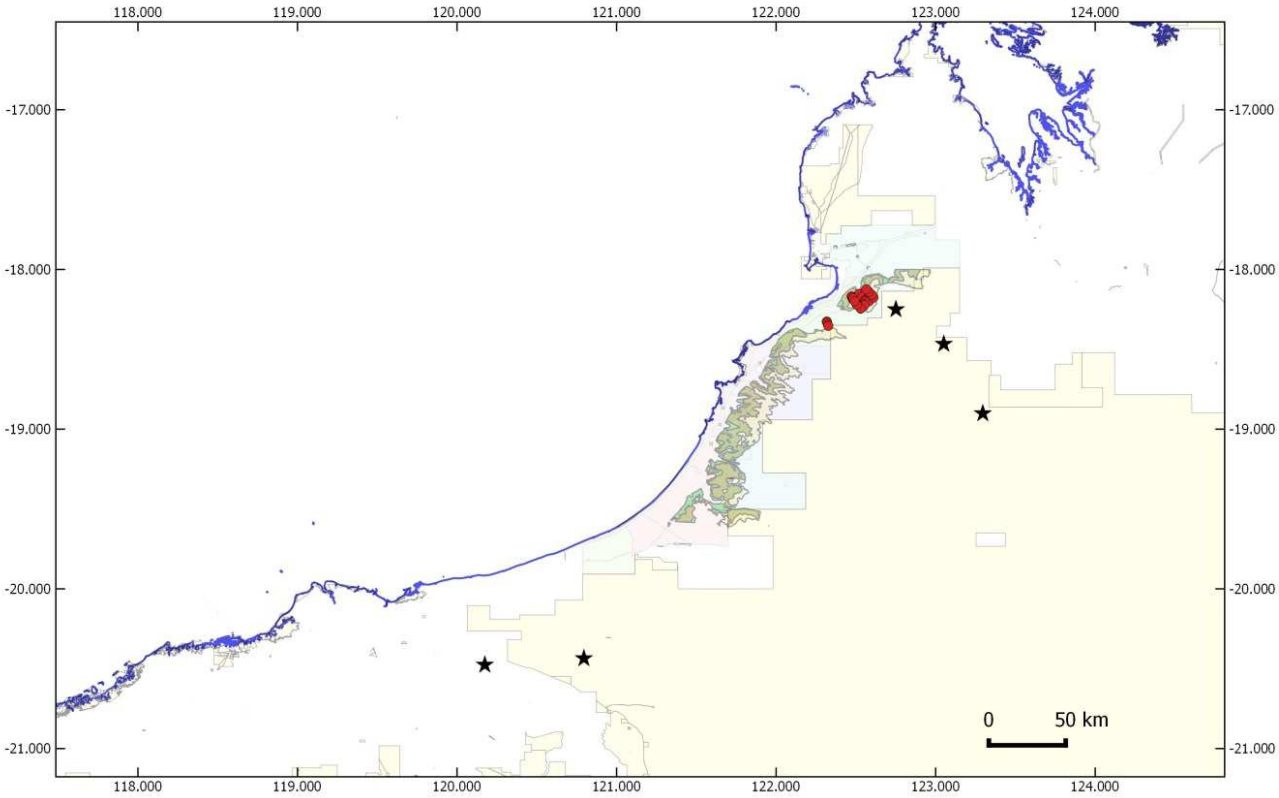

Figure 14**:** Distribution of *Croton aridus* based on locations found during the 2017 La Grange survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars). This map covers the entire known extent of this species within Western Australia.

Within the La Grange Survey Area, *C. aridus* was found to be restricted to the north-eastern region, on Thangoo Station (Figure 14). From field survey there appears to be two main patches of *C. aridus*, but the distribution and extent of this species away from the surveyed tracks is unknown. These newly discovered stands are at least 17.3 km at their closest and up to 50 km at their farthest from the nearest previously known location (Figure 14). These two populations are estimated to cover 63.1 km^2 and 8.0 km^2 in area. It is unknown if these two areas are the edges of a more continuous distribution that extends eastwards, as the central Dampierland east of the La Grange survey region is largely unexplored and inaccessible (only Dampier Downs Road provides some access into the interior).

Croton aridus is locally abundant at these new sites, with densities ranging from a few isolated plants to counts exceeding 100 individuals and a survey total of > 1384 plants. Densities were estimated to range from (<1) 3 to 15 shrubs per 20 x 20m^2. Cover estimates ranged from < 1% to 2-5%, and, at peak densities, 10% where it is dominant species. Counts of individuals are higher in recently burnt shrubland (3-4 years post fire) than long unburnt shrubland / woodland (7–10 years since last burn), while estimates of cover are higher in the long unburnt shrublands / woodlands. Given the total area that this species potentially covers in the study area, it raises the possibility of thousands to tens of thousands of plants in this area. When observed densities are extrapolated to the estimated total area, there could be some c. 42000 individual plants over this 70.4 km^2 as a rough estimate. Despite being locally abundant, *C. aridus* has a restricted distribution within the La Grange Survey Region.

Field observations of Croton aridus in the La Grange Survey Area

Habit:

In the La Grange Survey Region, *C. aridus* can form impressive, leafy shrubs up to 3 m tall and 2-3 m wide in long unburnt vegetation (7–10 years since last fire) (Figure 13), but has a shorter stature (1–1.5 m) in more recently burnt shrubland (3–5 years after fire). Flowers and fruits were observed between July to August, with estimates from few to up to 20% of individuals within a stand in fruit and flower.

Habitat:

Forster (2003) noted that *C. aridus* occurs on sandplains or ridges, in *Triodia* hummock grassland, mulga shrublands and *Ventilago viminalis*-dominated woodland. Within the La Grange Survey Area, *C. aridus* is primarily located in *Acacia eriopoda* tall shrublands/woodland on flat - gently sloping deep red Pindan sands (Figure 13). Associated species include *Corymbia* sp., *Bauhinia cunninghamii*, *Grevillea refracta*, *Dolichandrone occidentalis*, *Grevillea wickhamii* and *Gyrocarpus americanus*, over smaller shrubs of *Corchorus sidoides*, *Hibiscus leptocladus* and *Dodonaea hispidula*, over grasses of *Triodia caelestialis*, *Triodia schinzii*, *Aristida holathera*, *Sorghum* sp. and *Chrysopogon pallidus*.

Responses to Fire, Disturbance and Grazing

Croton aridus was located in both long-unburnt and recently burnt (3–5 years post fire) *Acacia* shrublands. Post-fire recovery is unknown but 1–1.5 m tall shrubs occur in recently burnt area (3–4 years) suggesting rapid recovery. According to Crowley *et al*. (2007), *C. aridus* resprouts after fire and shrubs have lifespans of 6–10 years, although the plants were in good condition and showed no signs of senescence in long-unburnt *A. eriopoda* shrubland/ woodland (c.10 years). *Croton aridus* does not appear in recently disturbed areas such as road or trackside gradings, edges or culverts.

Croton aridus appears to tolerate low intensity grazing and persists in grazed but not heavily stocked areas.

Recommendations

At a national level, Forster (2003) noted that this species was widespread and common within its known range.

At a state level, this survey has found that the range of *C. aridus* has been extended westwards, with a large new population discovered on Thangoo Station. Despite this minor (< 50 km) range extension, *C. aridus* is not widespread across the La Grange survey area and has a restricted distribution within Western Australia (Figure 14). The conservation status has been retained at Priority Three (Table 4) (Smith 2018).

Given its distribution and habitat and occurrence predominantly in preferred areas for potential development (Figure 14) stands of *C. aridus* may be affected by clearing for irrigated agriculture.

5: *Dasymalla chorisepala*

Taxonomy

Western Australian members of this species were originally described by Munir (1979) under the name *Pityrodia ovata* Munir (Lamiaceae), which was closely allied to the Northern Territory endemic, *Pityrodia chorisepala* Munir (Lamiaceae). With an increase in the availability of material to compare these two taxa, these two species were found to be indistinguishable and were reduced to synonymy by Rye & Trudgen (1998). *Pityrodia chorisepala* was incorporated into the new genus *Dasymalla* by Conn *et al*. (2011) as the new nomenclatural combination *Dasymalla. chorisepala* (Munir) B.J.Conn. & M.J.Henwood (Lamiaceae).

Description

Dasymalla chorisepala is an aromatic, compact to spreading perennial shrub 0.5–1.5 m tall and 1–1.5 m wide, with stems and branches covered in white dendritic hairs, leaves very shortly petiolate-sessile, opposite, ovate, 5–15 mm long and 3–6 mm wide and entire, flat to recurved leaf margins. Leaves are smooth adaxially, honeycombed underneath, are densely covered in glandular hairs and have non-glandular dendritic hairs on the veins and margins Flowers are produced at the tips of young branches, usually grouped in threes in the axils of upper leaves. Flowers are sessile to near sessile, with hairy, green sepals 3.5–5 mm long and a white corolla 5–7 mm long with a hairy throat and four exserted stamens (Figure 15).

Distribution and abundance

Western Australian populations of *D. chorisepala* are greatly disjunct from those in the Northern Territory, and have been recorded at two locations at the Edgar Ranges and three locations in the Great Sandy Desert, including along the McLarty Track near the eastern boundary of Nita Downs (Figure 16), (CHAH 2011–,Western Australian Herbarium 1998–).

A new, large population of *D. chorisepala* was discovered during the 2017 La Grange survey on the boundary of Frazier Downs and Thangoo Station, only 6 km from the coast and 83 km NNW from the nearest known population on the McLarty Track (Figure 16). The western edge of the population is only a few hundred metres from where the sandplain commences to slope down to the coast.

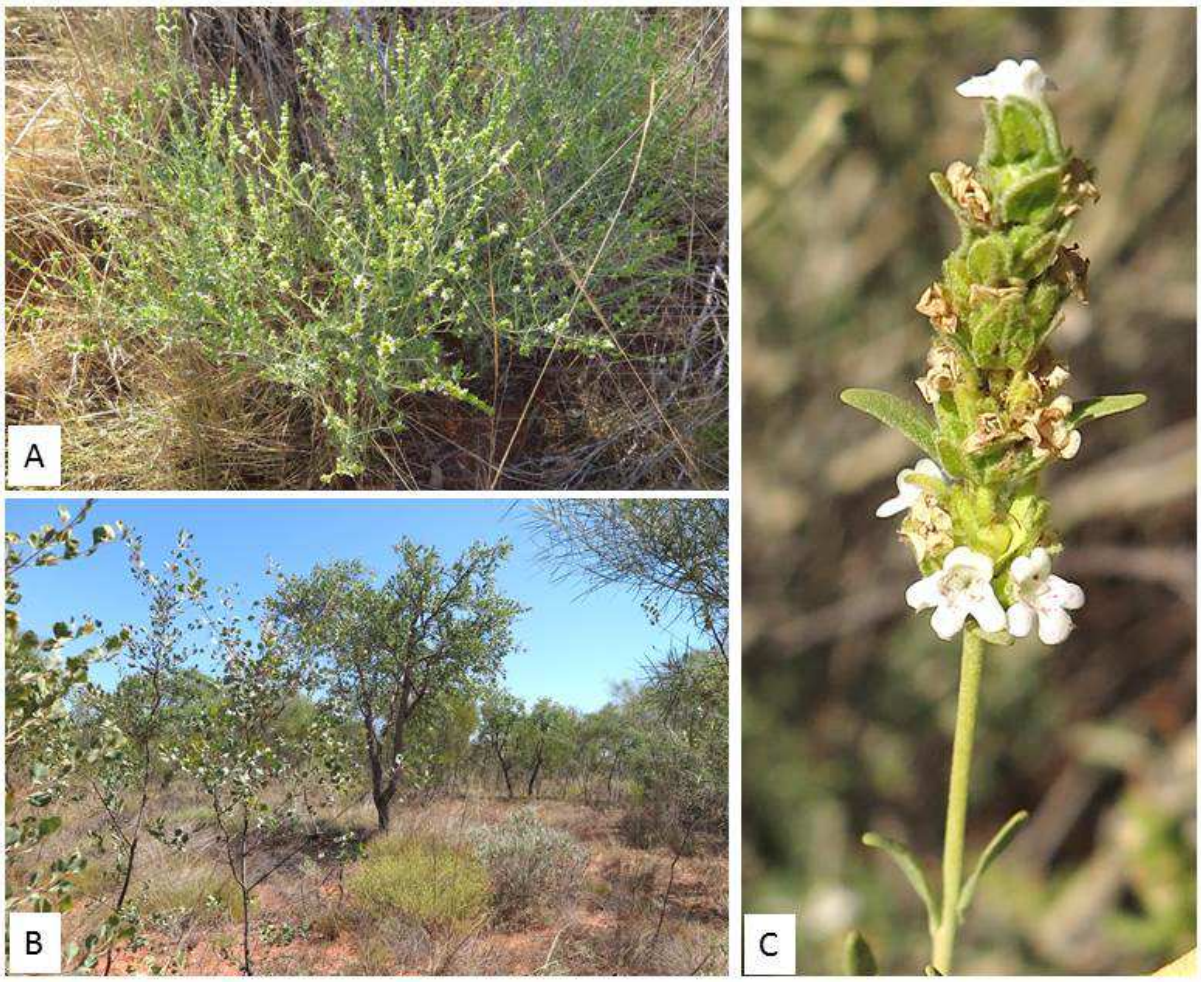

Figure 15: A: Low, many-branched, erect shrubby habit of *Dasymalla chorisepala*, **B:** *Corymbia* open woodland / *Acacia eriopoda* shrubland habitat on boundary of Frazier Downs and Thangoo Station, with *Dasymalla chorisepala* in foreground (round, light green shrub), **C:** Terminal shoots of *Dasymalla chorisepala* with clusters of flowers in the leaf axils.

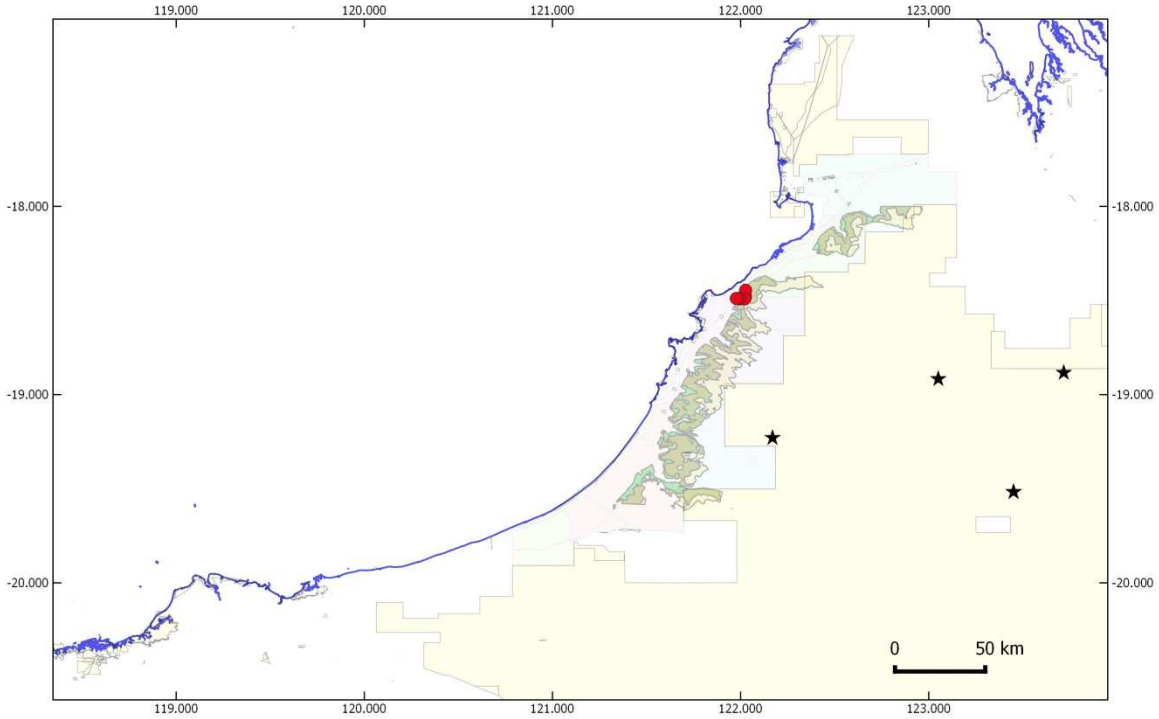

Figure 16: Distribution of *Dasymalla chorisepala* based on locations found during the 2017 La Grange survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars).

This population is estimated to occupy an area of at least 10.3 km² although the actual extent of this population is unknown as surveying was restricted to vehicle tracks, but this area is bounded by other tracks that were also driven and *D. chorisepala* was not located along these nor elsewhere in the La Grange survey. Numbers of plants within the area were estimated to exceed 500 individuals, plant density estimates range from (1–) 2–8 plants per 20 x 20 m, plant cover is estimated to be scattered to very sparse (< 1% - 1% cover), and this species is a common component in the shrub stratum.

Field observations of Dasymalla chorisepala in the La Grange Region

Habit:

At the time of survey in mid-August, plants all appeared to be in good condition, with new growth, profuse flowering and nearly all individuals in flower (Figure 15). Plants were robust, leafy, green and many-branched shrubs c. 1 m tall and 1 m wide, growing in vegetation last burnt 5–6 years ago.

Habitat:

This new population of *D. chorisepala* is located in open *Corymbia* spp. woodland (5% cover) over sparse (30% cover) tall *Acacia eriopoda* shrubland, over a mid-dense cover of shrubs of *Jacksonia aculeata*, *Gompholobium simplicifolium*, *Calytrix carinata, Newcastelia cladotricha*, and tussocks of *Triodia* spp. and *Chrysopogon pallidus*. Associated species include *Bauhinia cunninghamii, Dolichandrone occidentalis, Cyanostegia cyanocalyx, Erythrophleum chlorostachys* and *Acacia colei*. Soils are deep red Pindan sands on flat terrain.

Recommendations

Prior to the La Grange survey, *D. chorisepala* had a Priority Three conservation listing (Smith 2017). The discovery of a new population of *D. chorisepala* on Thangoo Station was unexpected, particularly for such an inland desert species occurring so close to the coast, but this does not change the overall conservation status of the species (Table 4) (Smith 2018). This conclusion is based on the restricted distribution of this species in the La Grange region, and the small number of sites this species is known from in the Great Sandy Desert. It is expected that more surveys in the remote desert country east of the La Grange region may find more populations of *D. chorisepala.*

This new population of *D. chorisepala* is located entirely within Preferred Areas for Irrigated Agriculture (Zones 20 and 40) (Figure 16), and as such is at risk of clearing for agricultural development.

6: *Gymnanthera cunninghamii*

Taxonomy

Gymnanthera cunninghamii (Benth.) P.I.Forst. (Apocynaceae) was first described by Bentham (1867) as a species of *Wrightia*, before Forster (1991) transferred the species to *Gymnanthera* in his revision of this genus in Australia.

Description

From Forster (1991), *G. cunninghamii* is an erect, woody, multistemmed shrub to 1.5m tall with smooth to conspicuously tuberculate stems, all parts exuding white latex sap when damaged. The leaves are distinctly pendulous and the plant itself can take on a weeping habit. The leaves are simple, lanceolate to elliptic, concolorous, glabrous, up to 115 mm long and 20–30 mm wide. Leaves have 8–10 prominent secondary veins per side, distinctly reticulate venation, acute apices and petioles up to 30 mm long. The inflorescence is a cyme up to 30 mm long with 1–3 clusters of flowers on 12 mm long peduncles, each cluster being comprised of one to four flowers. Flowers are small (9–15mm long), with five ovate, glabrous green sepals, five fleshy transverse segments on the corona, and a cream to green-yellow, glabrous corolla with tube 4–9 x 3–4 mm, and glabrous lanceolate-ovate to ovate corolla lobes, *c.* 6–8 x 4–5.5 mm. Fruits are dehiscent follicles *c.* 60–90 x 5–7 mm, that split along one side to release small (5 mm long) seed with a long (15–20 mm), white, filamentous coma.

Similar species

Gymnanthera cunninghamii is distinguished from the closely related *Gymnanthera oblonga* (Burm.f.) P.S.Green by habit and leaf colouration, the latter species being a scrambler or vine with discolorous leaves (Forster 1991). This species can be easily overlooked where there are superficially similar sterile species such as *Ehretia saligna* and juvenile supplejack (*Ventilago viminalis*).

Distribution and abundance

Gymnanthera cunninghamii has two disjunct distributions in northern Australia; one in central Australia (Northern Territory–Queensland) and in north-western Western Australia, where it has been recorded sporadically and mostly in the Pilbara, with outliers to West Kimberley and Carnarvon regions (CHAH 2011–) (Figure 17). *Gymnanthera cunninghamii* was not located during the La Grange 2017 survey but was collected during the Walyarta 2015 flora survey. Including this recent record, *G. cunninghamii* has only been located on three occasions in the La Grange Region, all of these at or near the Walyarta Conservation Park / Mandora Marsh.

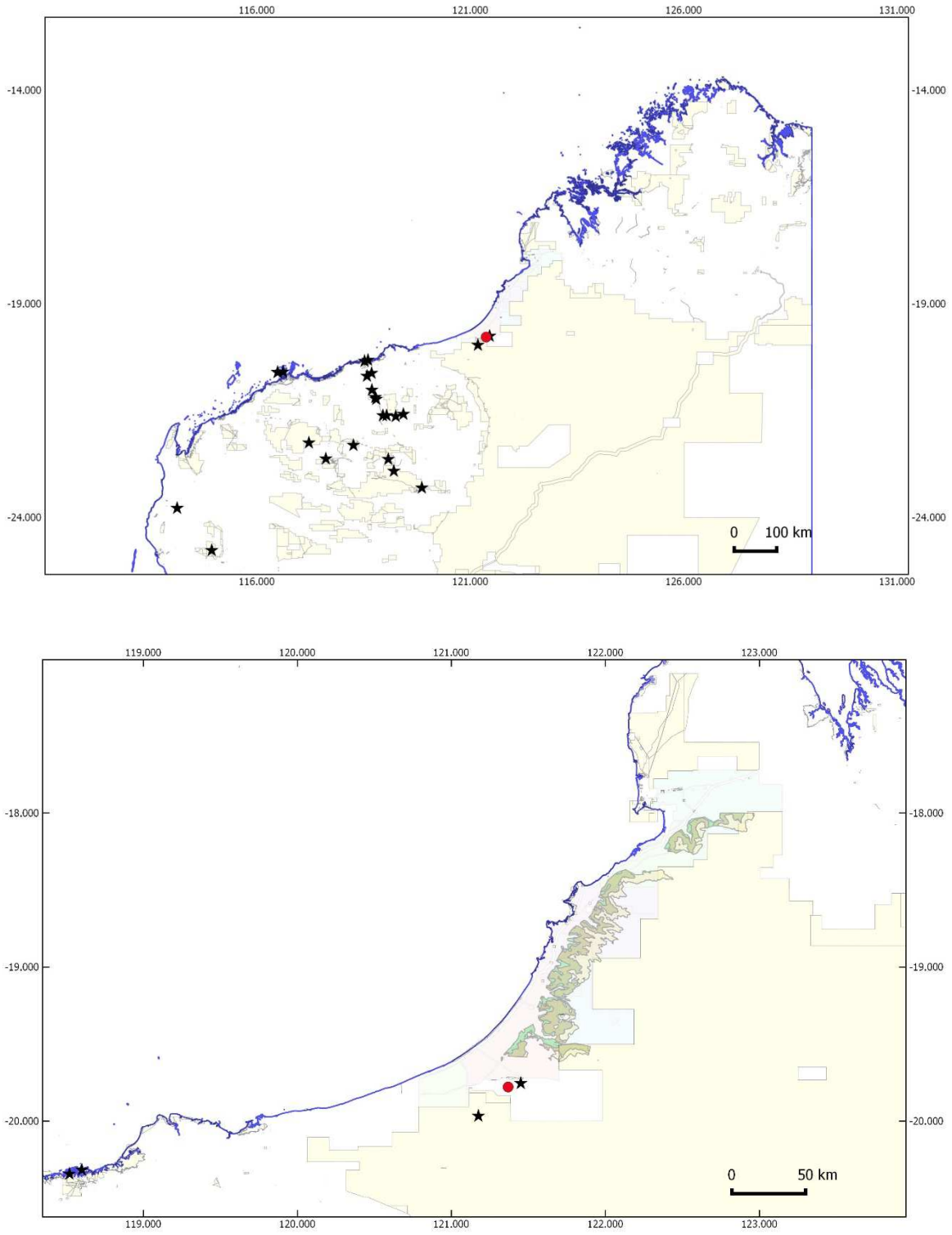

Figure 17: Top: Total extent of the distribution of *Gymnanthera cunninghamii* in Western Australia, **Bottom**: distribution of *Gymnanthera cunninghamii* in the La Grange Survey Area. Both maps are based on locations found during the 2015 Walyarta / Mandora Marsh survey (● red circles) and from herbarium records (★ black stars) (Western Australian Herbarium 1998–).

Field observations of Gymnanthera cunninghamii in the La Grange Survey Area

Habitat:

Herbarium records in Western Australia indicate that *G. cunninghamii* grows in sandy soils on margins of permanent and ephemeral creek lines and riverbeds, floodplains and rocky drainage lines and even among rockpiles and scree (Western Australian Herbarium 1998–). At Walyarta Conservation Park, *G. cunninghamii* has been found in *Melaleuca alsophila* tall shrubland on the sandy-loam flats on the margins of mound springs (Figure 18), and in *M. alsophila* and *Acacia ampliceps* shrubland over *Triodia epactia* hummock grassland on saline silty clays over calcrete.

Gymnanthera cunninghamii was not relocated in 2017 as there was insufficient time for an exhaustive search, but it is possible that more individuals may be located in this reserve, and perhaps also in the wider La Grange region around mound springs and *M. alsophila* shrublands on the margins of palaeodrainage channels. The other possibility is that Walyarta Conservation Park may be the northern limit for this species. In either circumstance, *G. cunninghamii* is unlikely to be widespread within La Grange Survey Area as the region largely lacks the drainage features and rocky terrain that this species is associated with.

Figure 18: *Melaleuca alsophila* shrubland - one of the habitats that *Gymnanthera cunninghamii* has been found in at Walyarta Conservation Park.

Recommendations

This survey found no evidence to change the conservation listing of this species (Table 4). No significant stands were located in the La Grange Survey Area, nor were the records from Walyarta Conservation Park a notable range extension.

Given the substrate and habitats *G. cunninghamii* occupies, it is highly unlikely to be found in areas of the La Grange Project Area proposed for irrigated agriculture (Figure 17).

Future surveys for this species in the La Grange region should focus on the areas around mound springs and associated flats in palaeodrainage areas, and any rocky landforms with associated drainage features.

7: *Indigofera ammobia*

Taxonomy

Indigofera ammobia Maconochie (Fabaceae) was described as a new species by Maconochie (1980) based on collections from the Great Sandy Desert, and further descriptions are available in Wilson & Rowe (2004).

Description

Indigofera ammobia is an erect, wiry, multi-stemmed annual or short-lived perennial subshrub or herb 0.5-0.7 m high with a stout taproot. Stems are dull green to brown green, with a sparse to moderately dense indumentum of adpressed biramous hairs. Leaves are few (may be absent or inconspicuous), simple, petiolate, green, linear and narrow (120–45 mm long and 0.3–1.0 mm wide). Leaves are sparsely hairy, channelled adaxially, with inrolled margins and with an acute apex. Stipules are small (≤ 1 mm long), scarious and not persistent. Inflorescences are axillary racemes of 4–6 flowers, *c.* 5–55 mm long. Flowers are small (4 mm long), pink to purple with green sepals. Pods are glabrous, brown, linear terete and 15–30 mm long, with a shortly pointed apex, containing 5–10 cuboid seeds 1–1.5 mm in diameter.

Similar species

Indigofera ammobia is allied to *Indigofera ixocarpa* Peter G. Wilson & Rowe, which is found in the Fortescue district of the Pilbara region and differs by fruit and leaf characters (see Wilson & Rowe 2004). *Indigofera haplophylla* F.Muell. differs from *I. ammobia* by its wider (3 mm), linear oblong leaves (Wilson & Rowe 2004). Wilson & Rowe (2004) note that a “a specimen collected from near Shamrock Station (*Mitchell* 2757) shows some features intermediate between this species and *I. ammobia*, particularly the narrow leaves”. While the main range of *I. haplophylla* tends to be to the north of *I. ammobia*, this particular location (central La Grange region) lies in the area where the main ranges of *I. haplophylla* and *I. ammobia* overlap in Western Australia (Western Australian Herbarium 1998–).

Indigofera linifolia is a very common species in the La Grange region which has been allied to *I. ammobia* (Maconochie 1980), but this species is a leafy subshrub with broader, shorter leaves and inflated, short, spherical pods, and is unlikely to be mistaken for *I. ammobia*.

Distribution and abundance

Indigofera ammobia is scattered from the Pilbara into the Kimberley and eastwards across the Great Sandy Desert into the Northern Territory. It was located during the 2017 La Grange survey on Frazier Downs Station, 5 km west from the *I. haplophylla* collection on Shamrock Station and 135 km north from the nearest known *I. ammobia* population.

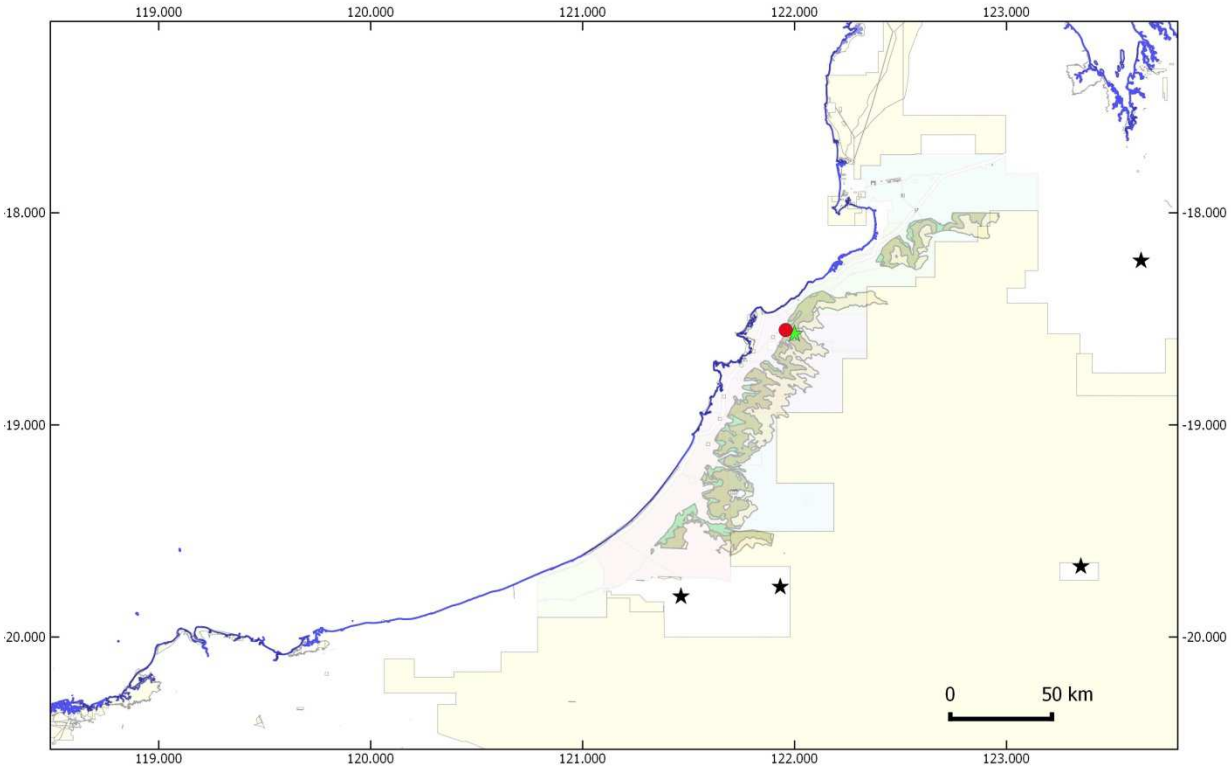

Figure 19: Distribution of *Indigofera ammobia* within the La Grange Survey Area, based on locations found during the 2017 La Grange Flora Survey (● red circles) and from herbarium records (★ black stars) (Western Australian Herbarium 1998–). The location of the unusual *Indigofera haplophylla* collection from Shamrock Station is indicated by a green star (★).

Field observations of Indigofera ammobia in the La Grange Survey Area

Habitat:

*Indigofera amm*obia typically grows on sandy substrates (Wilson & Rowe 2004), and collections are not associated with any single vegetation community type but a range of general sand plain and sand dune communities (Western Australian Herbarium 1998–). The 2017 La Grange Flora Survey located *I. ammobia* on recently burnt (≤ 1 year previously) very sparse open *Melaleuca alsophila* shrubland over a regrowth of shrubs of *Senna notabilis, Acacia colei*, *Indigofera monophylla*, *Acacia adoxa*, *Sida* sp. Pindan (B.G. Thomson 3398) and *Crotalaria ramosissima*, over a mid-dense *Triodia* sp. grassland.

The vegetation recorded at the two locations closest to this La Grange survey record are *Acacia ancistrocarpa / Acacia drepanocarpa / Acacia monticola* shrublands over

Sorghum plumosum and *Triodia epactia* grassland (Western Australian Herbarium 1998–) and mixed *Acacia stellaticeps* and *Triodia epactia* shrubland and grassland (Markey 2017).

Recommendations

The one known location of *Indigofera ammobia* in the La Grange Survey Area occurs just outside (550 m) of the Preferred Irrigation Areas, but the unusual form of the closely allied *I. halophylla* has been recorded from areas under development for irrigated agriculture. *Indigofera ammobia* occurs on Pindan substrates suitable for irrigated agriculture and more populations may be located within areas identified with high potential for development

Given the abundance of suitable habitat in the La Grange Survey Area, it is surprising that *I. ammobia* was so infrequently encountered. Even when care was taken to not confuse it with the superficially similar and very common *Tephrosia leptoclada,* this survey found that *I. ammobia* was only encountered once and is therefore uncommon. Because of this, no changes are recommended to the Priority Three conservation status of *Indigofera ammobia* (Table 4) (Smith 2018).

In the Northern Territory, *I. ammobia* is listed as data deficient (http://eflora.nt.gov.au/threatenedspecies), a status which has been retained since Albrecht *et al*. (1997) and White *et al*. (2000) (in Wilson & Rowe 2004). Wilson & Rowe (2004) note that although collected infrequently, *I. ammobia* is probably not at risk and this also may be the case in Western Australia. Further survey should focus on very recently burnt sites (1–3 years post burn) in case this is an important habitat requirement.

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8: *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433)

Taxonomy

Lawrencia sp. Anna Plains (N.T. Burbidge 1433) (Malvaceae) is an informally phrase-named taxon raised in c. 1993 by W.R. Barker (State Herbarium of South Australia). It is currently undescribed and there is very little information available for this taxon.

Description

Based on both field and herbarium observations and collections, *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) is an erect annual or perennial herb with a robust taproot, 0.3–0.8 m high and 0.2–0.3 m wide. Leaves are glabrous, semi-succulent, green, narrow, oblong-elliptic, with denticulate-serrate margins, 15–25 mm long and 5–15 mm wide, petiolate on lower leaves, becoming sessile on flowering stems. Leaves and green stems with a scurfy, waxy surface. Plants may be monoecious with protandrous bisexual flowers, or polygamodioecious or dioecious with functionally male or female flowers (where the respective gynoecium or androecium is vestigial). Axillary clusters of 5–7 sessile flowers are crowed in leaf axils on the erect stems. Flowers are regular, with green, turbinate calyces and yellow-green, semi-transparent corolla lobes reflexed onto adpressed to the open, spreading calyx lobes. The calyces are mostly glabrous, with short hairs on the lobe margins and pedicel. Fruits are schizocarps which dehisce into 5 oblate to ovoid mericarps, of which only 2–3 mature. The pericarp is white, translucent, membranous, and reticulate-alveolate to fenestrate on lateral and basal surfaces. Each mericarp is single-seeded, and seeds are brown, reniform and minutely papillate (Figure 20, Figure 21).

Similar species

Lawrencia sp. Anna Plains (NT Burbidge 1433) is closely allied to *L. glomerata* Hook., from which it has been segregated. It has been distinguished from the latter species by having a more oblong-elliptic leaf lamina with evenly many-toothed (8-10) margins (W. Barker, pers. comm.). Examination of recently collected fruiting material and herbarium specimens of both *Lawrencia* species has found reliable and consistent differences in fruits between these taxa. For *Lawrencia* sp Anna Plains (NT Burbidge 1433), only two or three of the five mericarps reach maturity, and the pericarp is noticeably inflated, translucent, chartaceous, and reticulate-alveolate to fenestrate. In *L. glomerata* the mericarps are more rigid and bony, uninflated, with angled edges, opaque, prominently reticulate on the lateral and basal walls, sculptured on the mericarp outer face, and with all five mericarps developing (Figure 21). The calyces of *L. glomerata* appear to be covered in a sparse-dense indumentum of short hairs as opposed to the less hirsute calyces on the flowers of *Lawrencia* sp. Anna Plains (NT Burbidge 1433).

Lawrencia glomerata does not occur in northern Western Australia, including the La Grange region, but is widespread across mainland Australia south of the tropics and inland from the Great Dividing Range (CHAH 2011–). It therefore does not co-occur with *Lawrencia* sp. Anna Plains (NT Burbidge 1433), which is almost entirely restricted to the La Grange region except for a Herbarium of South Australia (AD) record 300 km east in the Great Sandy Desert (Fatchen 933) (W. Barker, pers. comm.), and one outlying occurrence on Wanna Station in the Gascoyne region of Western Australia (Western Australia Herbarium 1998–).

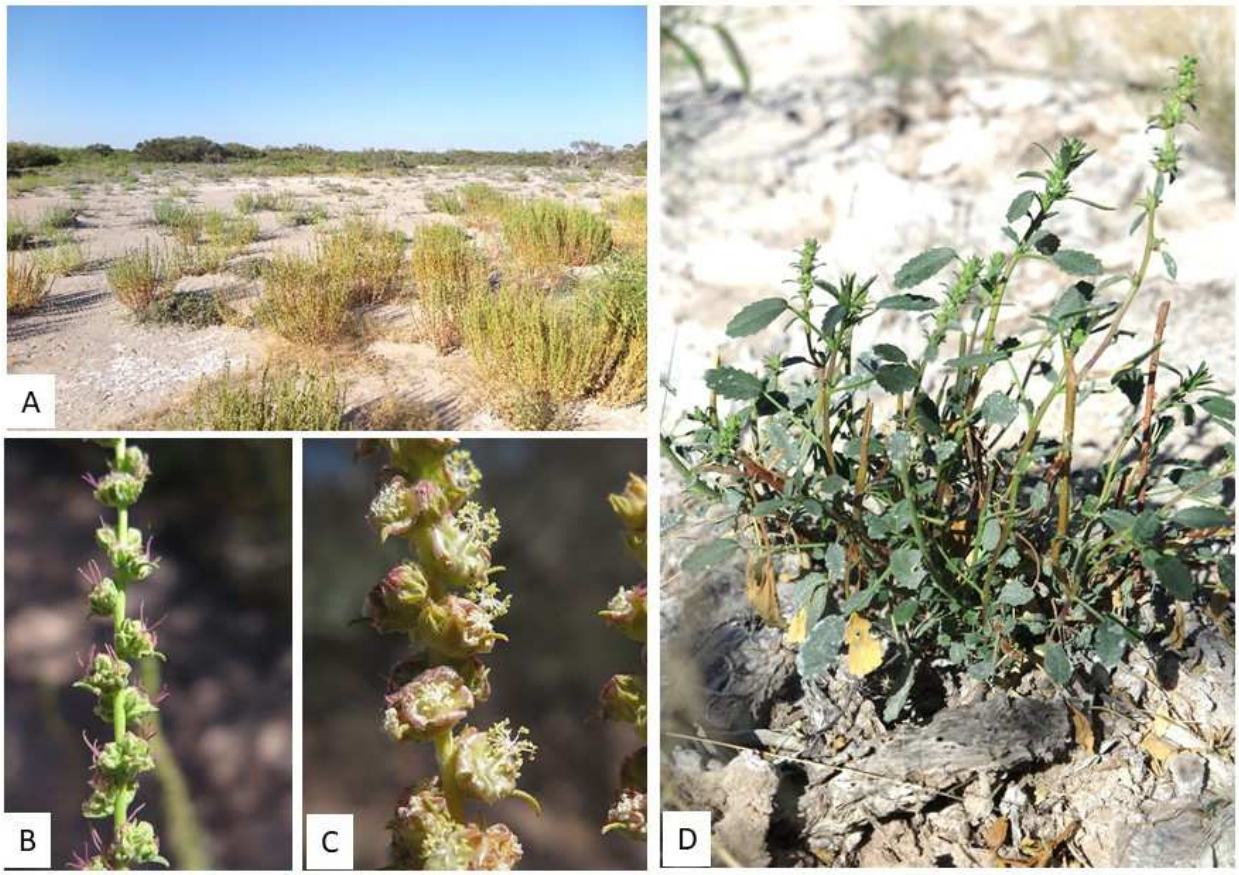

Figure 20: A: A stand of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) on saline flood plain, **B:** Detail of female flowers on erect stem, **C**: detail of male flowers, **D:** a small subshrub of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) recovering from grazing, showing the distinctive elongate, toothed leaves.

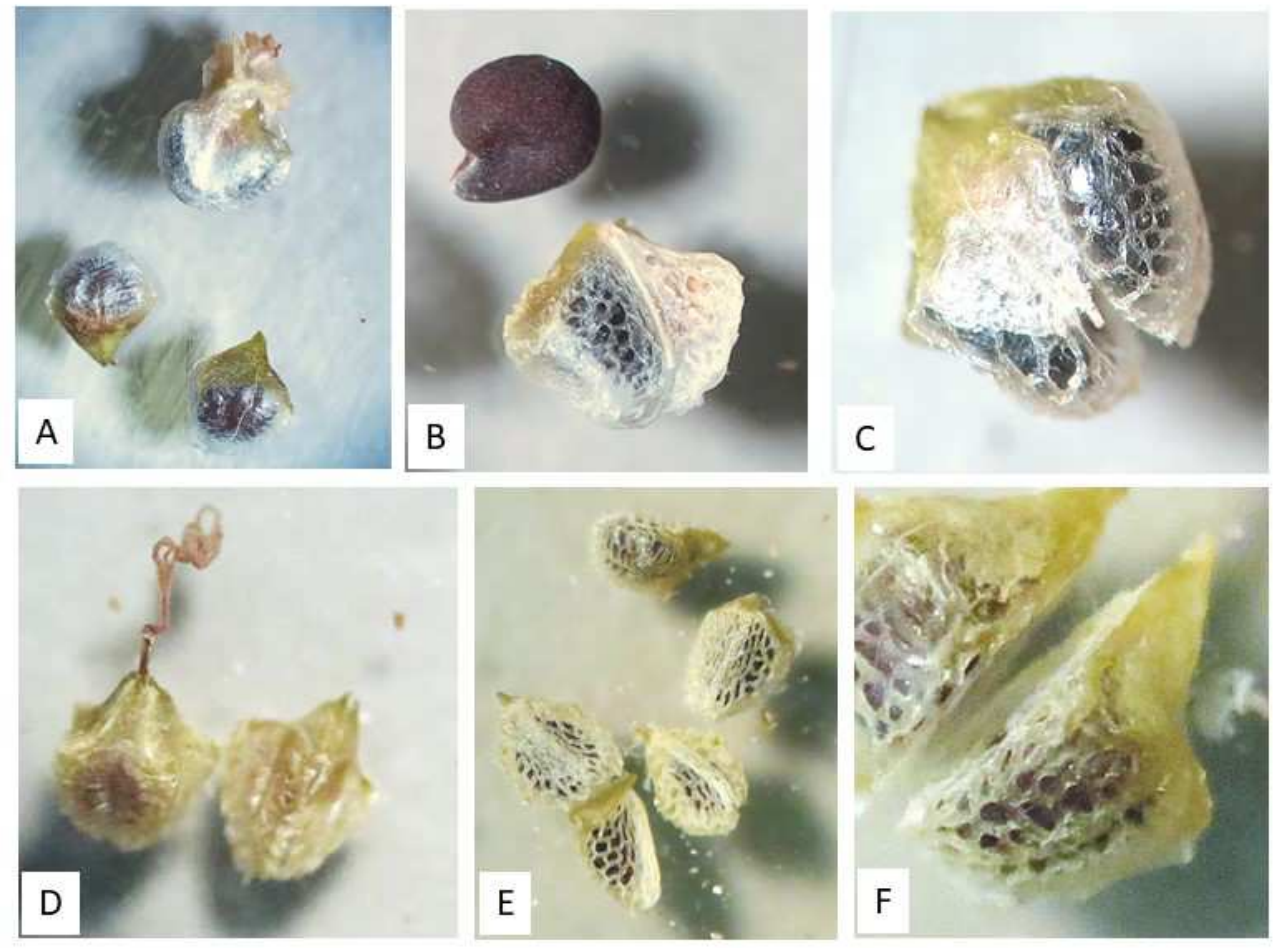

Figure 21: A-C: Mature fruits of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433), **A:** intact, entire schizocarp showing the 2-3 mature, inflated, translucent mericarps, **B:** partially separated mature mericarps and seed, **C:** detail of schizocarp showing two filled and one aborted mericarp, **D-F**: Mature fruits of *Lawrencia glomerata*, **D:** A: intact, entire schizocarp showing the five robust, reticulate, opaque mericarps **E:** separated mericarps showing reticulate lateral walls, **F:** detail of mericarp walls

Lawrencia viridigrisea is another species of this genus which does occur in the La Grange region on saline soils in samphire shrublands and *Melaleuca alsophila* shrublands over halophytes. This species is not closely allied to *Lawrencia* sp. Anna Plains (NT Burbidge 1433), but has a similar habit to *Lawrencia* sp. Anna Plains (NT Burbidge 1433). It can be readily distinguished by the densely stellate-hairy indumentum on leaves and stems which makes the plants appear silvery-grey (Lander 1984).

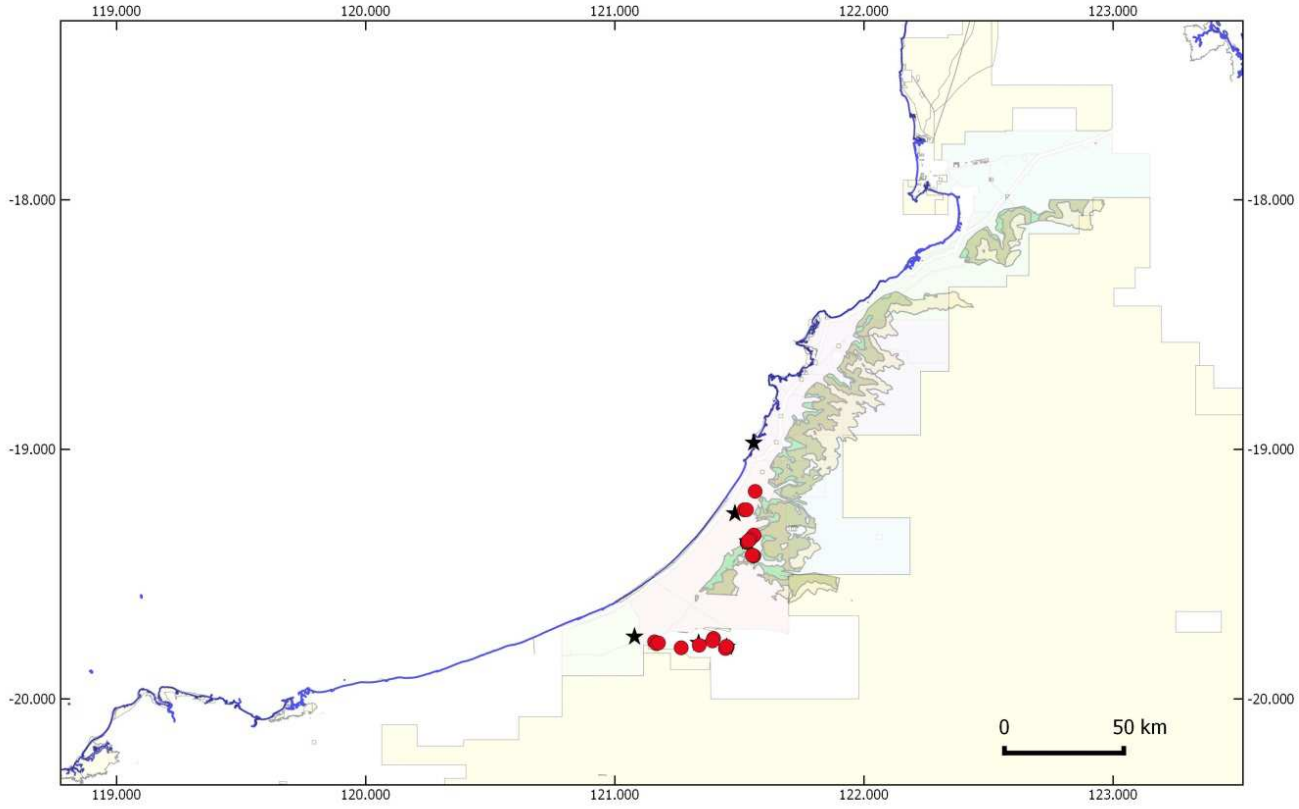

Figure 22: Distribution of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) in the La Grange Survey Area based on locations found during the 2017 La Grange survey and 2015 Mandora Marsh survey (● red circles) and herbarium records (Western Australian Herbarium 1998–) (★ black stars).

Distribution and abundance

Extensive stands of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) were located in the southern half of the La Grange Survey Area (Figure 22), in association with the saline flood plains and river channels of the two major saline river systems. It was found to be a highly abundant species in 2017, with estimates of numbers ranging from a few, scattered individuals around the edges of tall shrublands to 100s or even 1000s on wide, open floodplains and channels. It is assumed that such high numbers are a consequence of the above average rainfall the previous summer leading to flooding and filling of the channels, plains and lakes of these saline drainage systems. In a season following a relatively dry summer, *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) was found to be less common and abundant in the 2015 survey of Walyarta / Mandora Marsh (Markey 2017).

Field observations of Lawrencia sp. Anna Plains (N.T. Burbidge 1433) in the La Grange Survey Area

Habitat:

Lawrencia sp. Anna Plains (N.T. Burbidge 1433) grows on saline flood plains, on the margins of salt lakes and wide saline river beds and channels. It can be found growing under or around the edges of *M. alsophila* / *A. ampliceps* shrublands which line the margins of the saline flood plains and channels, in associated with *Zygophyllum compressum* and *Pterocaulon sphacelatum*. Large stands can occupy the open saline flats, where *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) grows in low halophytic shrublands dominated by *Trianthema turgidifolium*, *Surryea diandra*, *T. triquetrum, Neobassia asterocarpa*, *Sporobolus virginicus* and *Ptilotus nobilis.* The third major vegetation community where low numbers of *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) can be found is in *Tecticornia* samphire shrublands, co-occuring with *L. viridigrisea, Flaveria trinervis, T. auriculata, T. indica* and *T. halocnemoides*.

Recommendations

Lawrencia sp. Anna Plains (N.T. Burbidge 1433) is a poorly understood taxon which has a distribution more-or-less restricted to the southern half of the La Grange region. There is little known on its biology, taxonomic status and geographical distribution. It is currently listed as having Priority Three conservation status (Smith 2018) and no change is advised until more is known about this taxon (Table 4).

Formally describing *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) would be a priority for this taxon, as this would confirm the distinctiveness of this species from other members of the genus, provide some definite characters for recognising this species in the field, and start the collation of information its distribution and biology.

The main threat to *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) appears to be grazing, as this species is palatable, and its habitat is vulnerable to trampling. *Lawrencia* sp. Anna Plains (N.T. Burbidge 1433) does not grow in the pindan habitats and does not occur in Preferred Areas for irrigated agriculture (Figure 22), so it will not be directly affected by any of these proposed developments.

9: *Nicotiana heterantha*

Taxonomy

Nicotiana heterantha Symon & Kenneally (Solanaceae) was described from collections of a distinct new entity from the Broome region (Symon & Kenneally 1994). Further information on *N. heterantha* is available in an earlier revision of the genus *Nicotiana*, published by Horton (1981).

Description

From Symon & Kenneally (1994), *N. heterantha* is an annual or short-lived perennial herb with leafy basal rosette, branching near base and with tufts of cauline leaves on the lower parts of slender, decumbent to erect stems (Figure 24). Leaves are petiolate, elliptic to obovate, 2–10 cm long, 1–4.5 cm wide, with entire margins and a sparsely glandular-pubescent to glabrescent indumentum. Stems and inflorescences axes are wiry and decumbent but are often held upright by supporting vegetation when growing through shrubs. Flowers are arranged on simple or few-branched, long (up to 1 m), wiry racemes. Flowers have white, tubular corollas 28–42 mm long with blue-purple stripes. Calyces are 7–9 mm long, puberulent, lobes are broad, free at top 2 mm, joined by membrane 2–3 mm below this, green with distinctive blue-purple stripes running down length of calyx. Inflorescences can also have diagnostic cryptic short (5 mm long) flowers which do not open (cleistogamous) on lower parts of inflorescences. Flowers possess four upper anthers and a lower fifth anther, with the style just exceeding the upper four. Fruits are capsules 8–10 mm long which split by 4 valves, and seeds are brown, 1 mm long, triangular to reniform in shape, with a reticulate surface.

Similar species

Nicotiana rosulata (S.Moore) Domin occurs through much of the Eremaean phytogeographic region of Western Australia except the Great Sandy Desert overlapping with *N. heterantha* in the Pilbara and with nearest occurrences to the La Grange region recorded from Mandora and Pardoo (Western Australian Herbarium 1998–). *Nicotiana rosulata* is typically an erect, rosetted herb with stouter inflorescences which are held on erect racemes that are branched more towards the apex, hence flowers are concentrated in the top third of the inflorescences and cleistogamous flowers are absent (Symon & Kenneally 1994). Flowers are a distinctly longitudinally ribbed and shortly hispid calyx with more narrowly triangular or linear-subulate lobes free for considerably more of their length than *N. heterantha*.

Nicotiana occidentalis H.-M.Wheeler has a similar geographical distribution to *N. rosulata*, but differs in that often the plants sticky or distinctly glandular, glandular hairs are present on the leaves and/or stems and ellipsoid headed glands are present (Horton 1981).

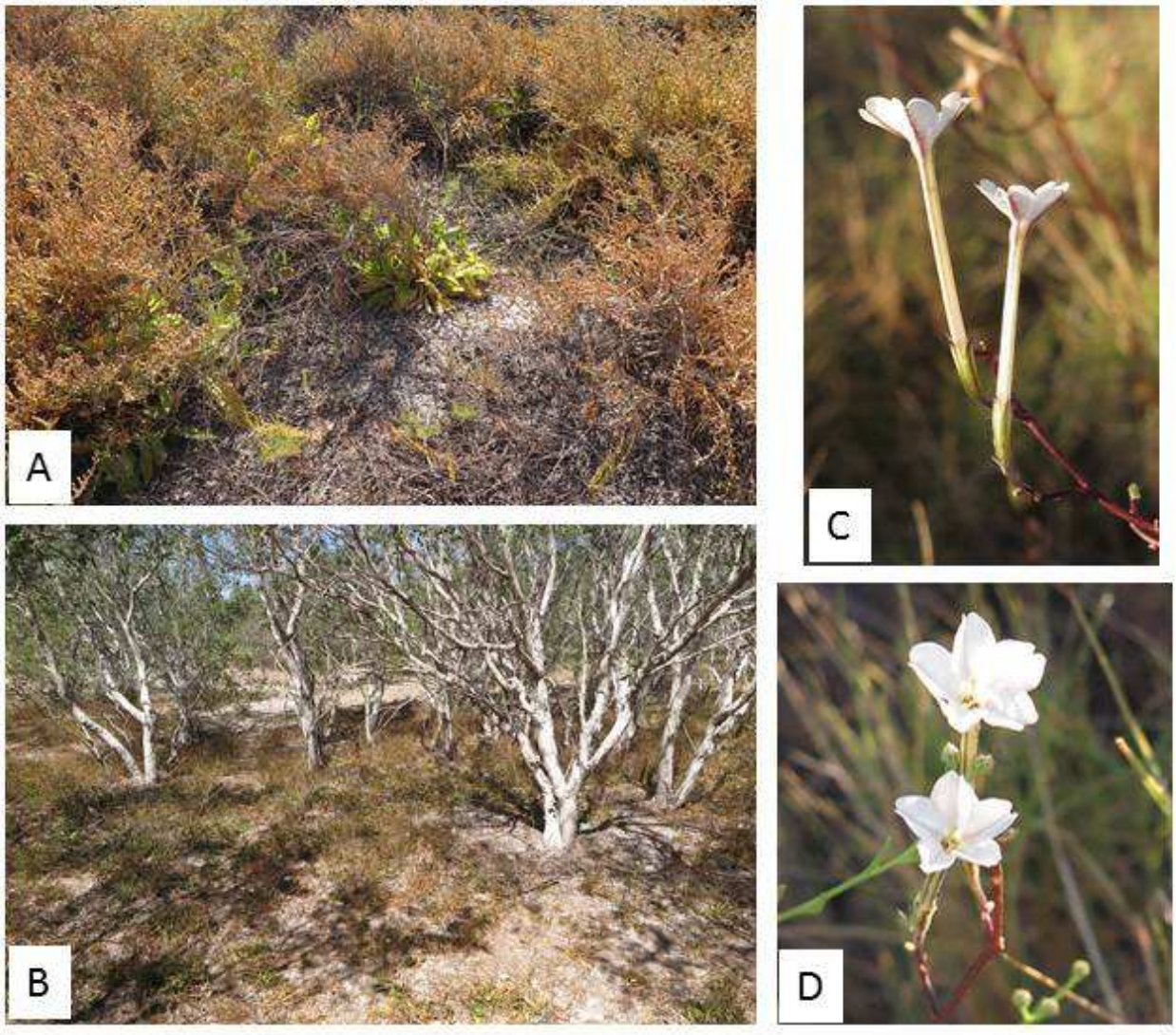

Figure 23: A: Green leafy rosettes of *Nicotiana heterantha* growing in *Tecticornia* samphire shrubland**, B**: A dense herb layer of *Nicotiana heterantha* growing under *Melaleuca alsophila*, **C:** side view of flowers, showing purple-blue stripes on corolla and calyces, **D:** top view of flower, showing corolla lobes and anthers.

Distribution and abundance

At the time of its description, *N. heterantha* was only known from north of Broome, but surveys of saline wetlands and saline flats have located more populations in the Pilbara and Kimberley (Western Australian Herbarium 1998–). The main centres of abundance are near-coastal locations north of Broome, from the Anna Plains-Walyarta / Mandora Marsh area, and the Fortescue Marsh in the Pilbara, with minor occurrences scattered across the Pilbara and Gascoyne (Figure 25).

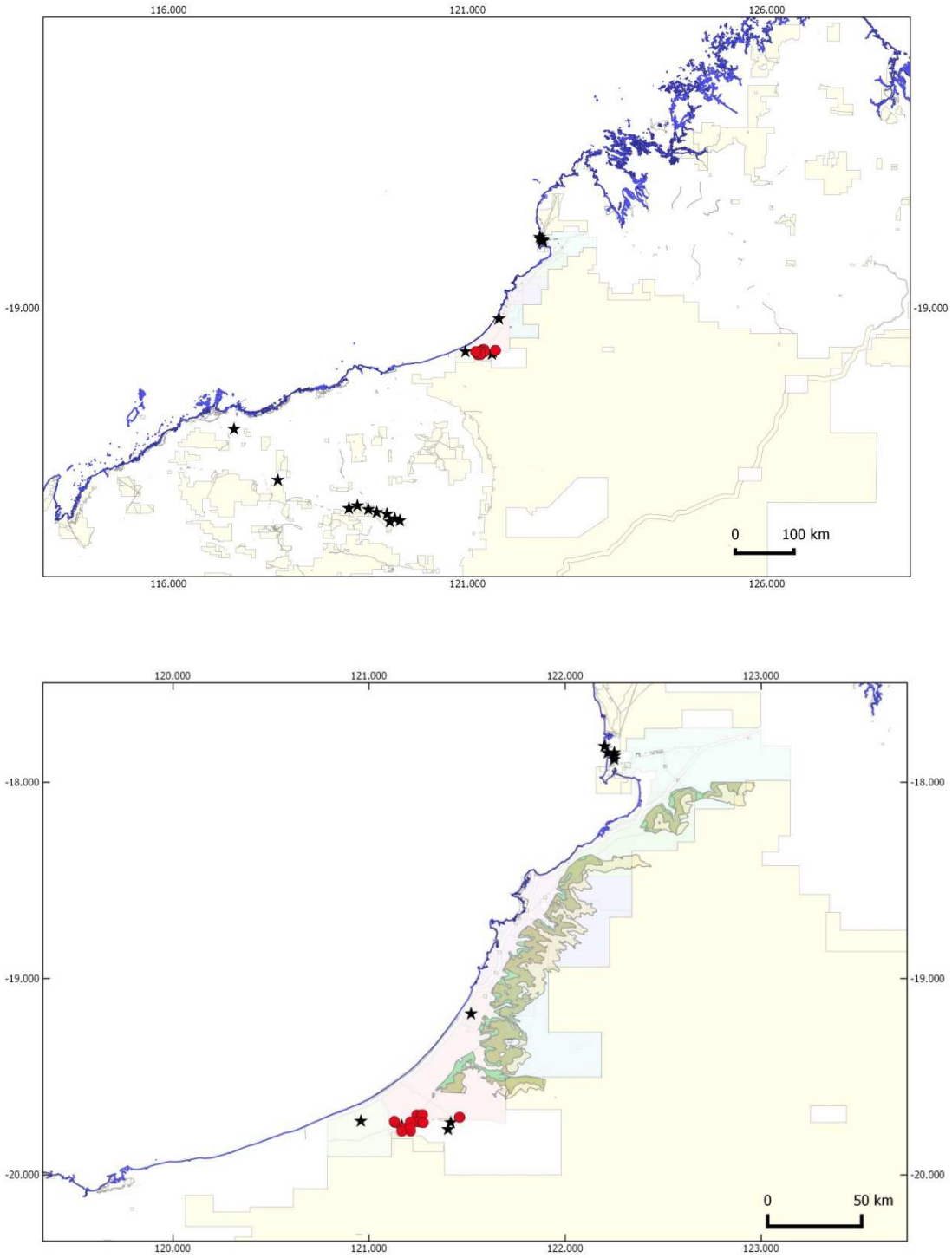

Figure 24: Top: Distribution of *Nicotiana heterantha* in northern Western Australia based on records from the La Grange 2017 survey (● red circles) and Western Australian Herbarium records (★ black stars), **Bottom**: Distribution of *Nicotiana heterantha* in the La Grange Survey Area based on locations found during the 2017 La Grange survey (● red circles) and herbarium records (Western Australian Herbarium 1998–) (★ black stars).

Populations of *N. heterantha* were located during the 2017 La Grange Flora Survey in the southern third of the La Grange Survey Area (Figure 24). These populations were entirely associated with the two major palaeochannels that bisect the southern half of the La Grange region. The 2017 survey provided an opportunity to revisit areas of Walyarta Conservation Park that had been surveyed in late August–September 2015. While there was no sign of *N. heterantha* in the area in 2015 (Markey 2017), it was found to be common in the *Tecticornia* spp. shrublands that grow in the western half of the reserve, extending west and north into the samphire shrublands in the adjacent Anna Plains Station.

Nicotiana heterantha was found to be growing in abundance, particularly in seasonally damp sites that retain moisture for longer periods. At Lingette Bore on Anna Plains, plants were so abundant that they formed a dense herbfield under the *Melaleuca alsophila* shrubland (Figure 23). At other sites, estimates of plant cover and abundance ranged from < 1% and scattered individual plants to patches reaching 2-5% cover.

Field observations of Nicotiana heterantha in the La Grange Survey Area

Habitat:

In the La Grange Flora Survey Area, *N. heterantha* grows on seasonally inundated saline flood plains and saline claypans that are associated with the two large palaeodrainage systems in the south of the region. Soils are typically saline, clayey and seasonally wet. This species grows in *Tecticornia* dominated samphire shrublands in association with *Tecticornia auriculata*, *Tecticornia indica* subsp. *bidens*, *Eragrostis falcata, Ptilotus exaltatus* and *Pterocaulon sphacelatum*. It also grows in *Melaleuca alsophila / Acacia ampliceps* shrublands, and in halophyte shrublands dominated by *Atriplex eremitis, Flaveria trinervis, Trianthema turgidifolium and Neobassia asterocarpa*.

Symon & Kenneally (1994) note that *N. heterantha* can be a short-lived perennial but field observations from Walyarta Conservation Park and Fortescue Marsh over consecutive years finds that they tend to be annual and start to senesce at the end of the dry season (A. Markey, pers. obs.). The abundance of *N. heterantha* observed in 2017 can be attributed to the preceding good wet season which lead to an extensive and prolonged filling of the Walyarta salt marshes and palaeochannels. Increases in the abundance of this species were documented following a similar inundation event on the Fortescue Marsh (A. Markey, unpublished data). This emphasises the importance of searching for this species after rainfall events which fill seasonal wetlands.

Recommendations

When originally described, *N. heterantha* was known from two populations from a single general location, which were threatened by grazing (Symon & Kenneally 1994). It is now

known that *N. heterantha* has populations located within a conservation reserve (Walyarta Conservation Park) and a proposed conservation reserve (Fortescue Marsh). In light of this, the conservation status of *N. hetera*ntha as a Priority One species has been reassessed and downgraded to Priority Three to reflect these findings (Table 4) (Smith 2018).

Threats to *N. heterantha* include grazing, development and weed invasion, which are in the process of being managed in both Walyarta Conservation Park and the Fortescue Marsh. *Nicotiana heterantha* does not grow on deep red sands and is absent from areas indicated as preferred for irrigated agriculture (Figure 24), so will not be directly affected by proposed developments for irrigated agriculture in the La Grange Project Area.

10: *Phyllanthus eremicus*

Taxonomy

Phyllanthus eremicus R.L.Barrett & I.Telford (Phyllanthaceae) was formerly described by Barrett & Telford (2015) after being informally phrase-named as *Phyllanthus* sp. C Kimberley Flora (N.T. Burbidge 1400) (Western Australian Herbarium 1998–) from a description in Wheeler (1992a) and referenced in Kenneally *et al*. (1996).

Description

From Barrett & Telford (2015), *Phyllanthus eremicus* is an erect, single-stemmed subshrub 30–50 (100) cm high, to 50 cm wide, with a distinctive fissured, woody main stem to 3.5 mm diameter. Branches are covered in an abundance of shortly petiolate (0.5–1.1 mm) oblong to obovate, leaves 4–13 mm long and 2-5 mm wide. Leaves are light green, slightly paler abaxially and glabrous. Shrubs are monoecious, producing unisexual flowers with six pale green to yellow green tepals. Male flowers are usually solitary or sometimes arranged in groups of two to three, on short pedicels 0.5–1.5 mm long. Female flowers usually solitary or sometimes in pairs, on 4.5–7.0 mm long, pendulous pedicels. The fruit is a six-segmented capsule 4.2–6.2 mm wide containing six light-brown seeds (Figure 25).

Similar species

Initially included in the broader concept of *P. aridus* Benth., *P. eremicus* was distinguished from the former taxon by larger leaves, pedicellate male flowers and larger fruiting sepals. In *P. eremicus*, seeds are transversely striate (Figure 25) and smoother in surface texture than *P. aridus*. *Phyllanthus aridus* is distributed in the North Kimberley, and doesn't co-occur with *P. eremicus*.

Distribution and abundance

Barrett & Telford (2015) considered *P. eremicus* to be of conservation concern as it was known from few collections scattered between Shay Gap & Pardoo (northern edge of Pilbara) to north of Broome (Figure 26) (Western Australian Herbarium 1998–, CHAH 2011–). In the La Grange region, *P. eremicus* has been found to be widely and evenly distributed across the survey region (Figure 26). This survey has both filled in distribution gaps between Anna Plains and Roebuck Plains, and extended the known range east into the Great Sandy Desert. Further surveys outside of the La Grange region into Dampierland, the Great Sandy Desert and eastern Pilbara may extend the range further into these regions.

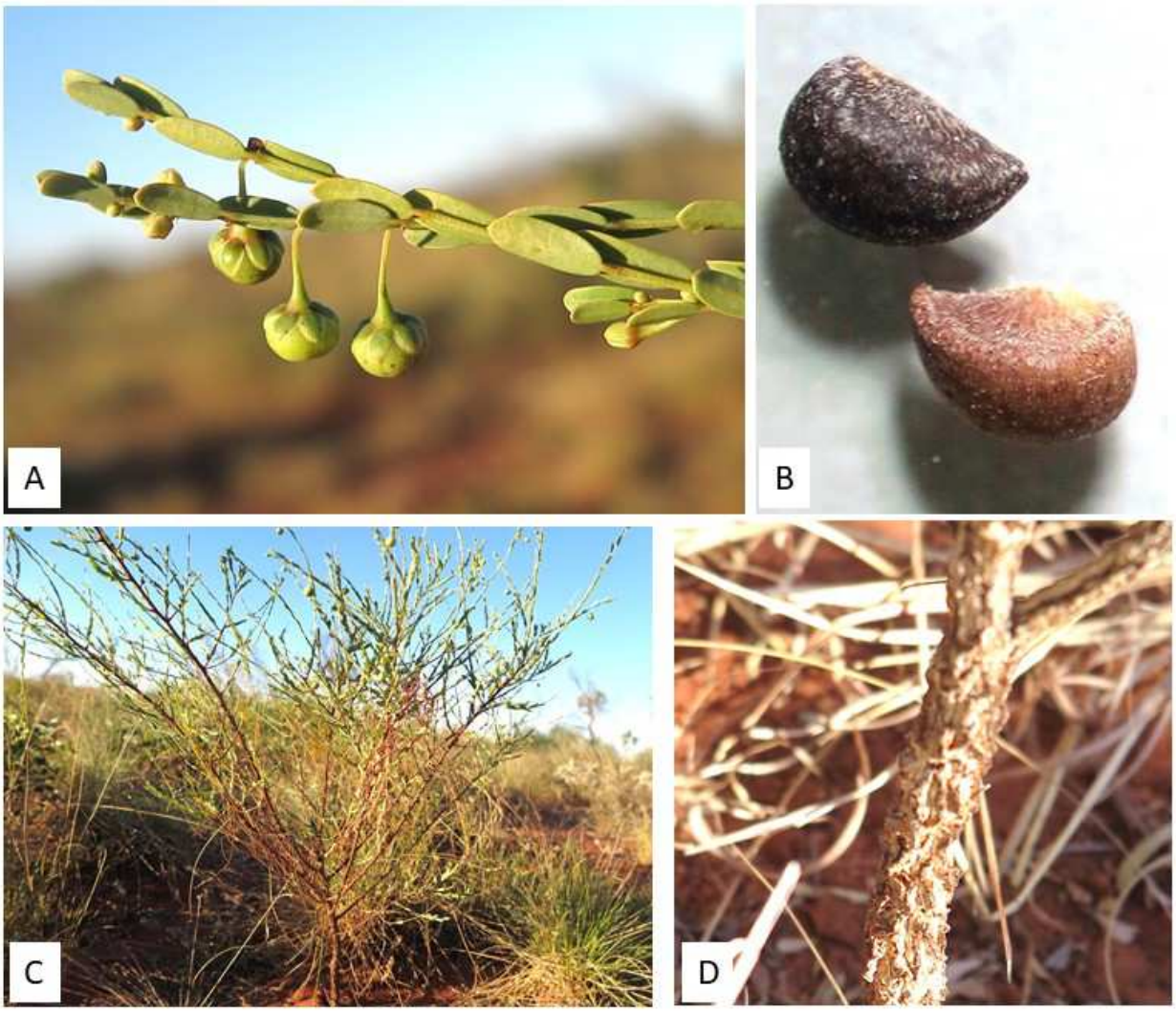

Figure 25: *Phyllanthus eremicus* **A:** terminal branches with small male flowers and large mature fruits developing from female flowers, **B**: details of mature seeds showing striations **C:** entire plant showing erect, shrub habit, **D:** detail of fissured bark on older plant

Estimates of abundance ranges from few, isolated, scattered plants (1–several per transect), to clusters of plants (10–30 in a small 10x10m patch), to a more continuous distribution with counts numbering from counts of 50–200 plants per 100–150 m transect or up to >500 plants per sampling site. In these instances, *P. eremicus* was observed to be an abundant and common component of the understory, with densities estimated at (2–) 5–10 plants in a 5 x 5 m area.

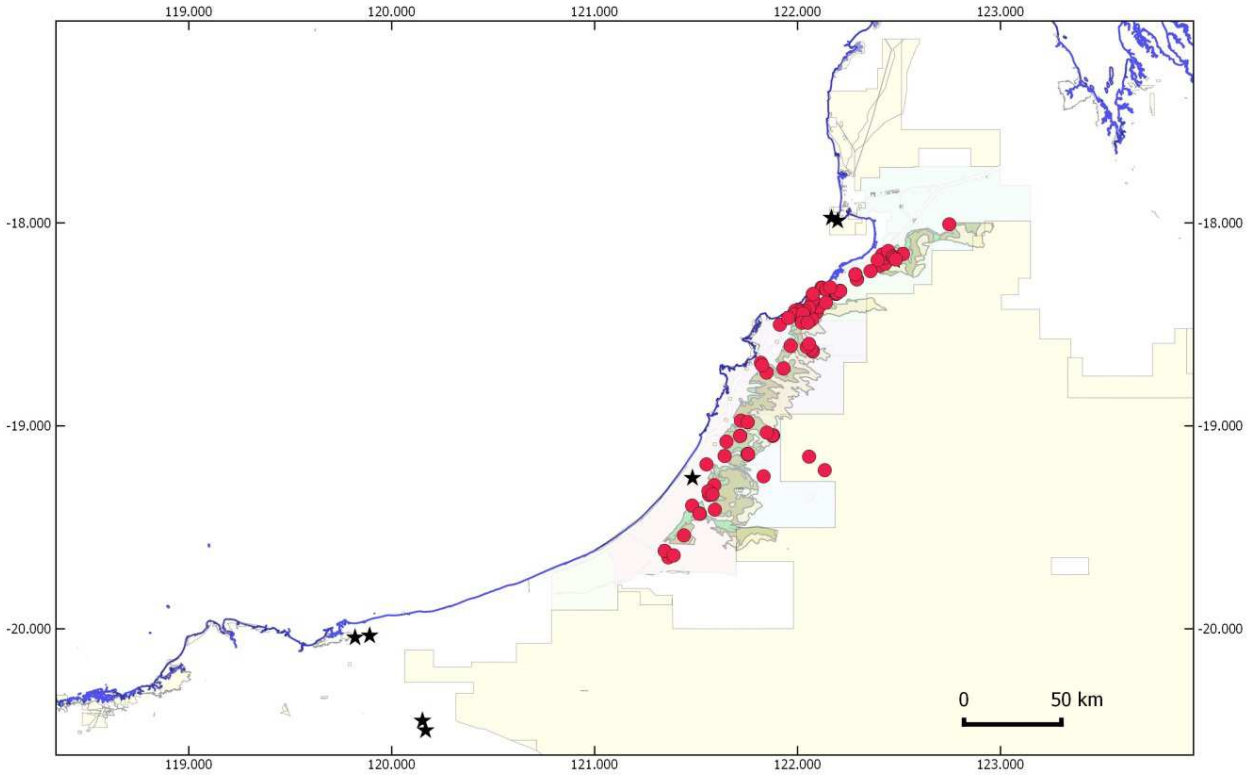

Figure 26: Distribution of *Phyllanthus eremicus* based on locations found during the 2017 La Grange survey (● red circles) and Western Australian Herbarium (1998–) records (★ black stars).

Field observations of Phyllanthus eremicus in the La Grange Survey Area

Habit:

Phyllanthus eremicus was easily located in the field as an erect shrub 30-60 cm tall. Most (nearly all) plants were found to be in fruit and flower which enabled clear, unambiguous identification of this species. Plants were in good condition, with only few instances of apparent drought death. They did not appear to generally suffer from heavy grazing, and were not observed to preferentially grow in disturbed areas such as road gradings. Plants were found in intact vegetation with a range of fire histories, from as recently as 3-5 years post-fire to as much as +10 years since the last fire.

Habitat:

Phyllanthus eremicus is found in a wide range of Pindan vegetation communities on red sandplains, growing in open *Corymbia* spp. woodland or tall shrublands dominated varyingly by *A. eriopoda*, *A. monticola, A. colei* and *A. ancistrocarpa* shrublands over *T. epactia* and *C. pallidus* grassland. *Phyllanthus eremicus* appears to be particularly common in tall, old stands of *A. monticola*.

Recommendations

Phyllanthus eremicus is widespread over the La Grange Survey Area, where it has been found to be common and numerous on the Pindan. However, herbarium records show this species is largely restricted to the La Grange region (Western Australian Herbarium 1998–).

Phyllanthus eremicus was listed as a Priority Three species (Smith 2017), but was removed from this list in 2018 following a review of its priority status (Table 4) (Smith 2018). Because of its restricted range and occurrence on areas suitable for irrigated agriculture, there remains the potential for cumulative impacts on this species in the La Grange region. It is still recommended that future surveys determine the range and abundance of *P. eremicus* in the Great Sandy Desert and Pilbara to allay concerns about risks to this possible La Grange endemic.

11: *Polymeria sp. Broome (K.F. Kenneally 9759)*

Taxonomy

Polymeria sp. Broome (K.F. Kenneally 9759) (Convolvulaceae) is an informal phrase-name taxon raised by R.W. Johnson. There is no published description available, so it is currently a source of great confusion. This entity has been previously recognised as *P. distigma* Benth. by Wheeler & Marchant (1992) in the Flora of the Kimberley, and again in Kenneally *et al*. (1996). These two publications define this Kimberley entity by the style have two terminal lobes, which distinguishes this species from other Kimberley species (notably *Polymera ambigua* R.Br., *Polymeria calycina* R.Br. and *Polymeria lanata* R.Br.). The type for this Western Australian concept of *P. distigma* is a collection from Broome (Kenneally 9759).

In 2012, this Kimberley entity was phrase-named *Polymeria* sp. Broome (K.F. Kenneally 9759). However, as it was not formally described and because Wheeler & Marchant (1992) is still the most current treatment for Convolvulaceae available for the region, collections from northern Western Australia are still being identified as *P. distigma sensu* Wheeler & Marchant 1992, Kenneally *et al.* 1996. An examination of all the collections of *P. distigma* Benth. in the Western Australian Herbarium finds that their identification has followed the concepts of Wheeler & Marchant (1992) and Kenneally *et al*. (1996) and not that of the original author, Bentham (1863).

In order to resolve this issue, a scan of the type (J. Martin 87) for *P. distigma* Benth. was accessed online (*plants.jstor*.org). This collection was found to be not only entirely unlike the north-west Western Australian collections being identified as *P. distigma,* but it is fact a species of *Jacquemontia*. *Polymeria distigma sensu* Benth. will ultimately be transferred to *Jacquemontia,* with the remaining issue being whether this entity will become *J. distigma,* be synonymised with *J. browniana* or all three entities reduced to synonymy with *J. pannosa* (D. Halford, pers. comm.).

While this naming issue cannot be resolved easily, the entity that is being called *P. distigma sensu* Wheeler & Marchant 1992, Kennelly *et al.* 1996 in northern Western Australia is *Polymeria.* sp. Broome (K.F. Kenneally 9759). After examination, all Western Australian Herbarium Kimberley collections previously named as *P. distigma* were re-identified as *Polymeria* sp. Broome (K.F. Kenneally 9759). The remaining two collections from the west Pilbara appear to be another, potentially new taxon of *Polymeria* (S. Dillon, pers. comm.)

Description

From the concept of Wheeler & Marchant (1992), *Polymeria* sp. Broome (K.F. Kenneally 9759) is a perennial herb or subshrub with both erect stems 10-15 cm and long, trailing,

prostrate stems 30-50 cm long. Flowers have a pale pink corolla 2 cm long, with a style divided into 2-3 stigmatic lobes. Seeds are black and shortly hirsute (Figure 27).

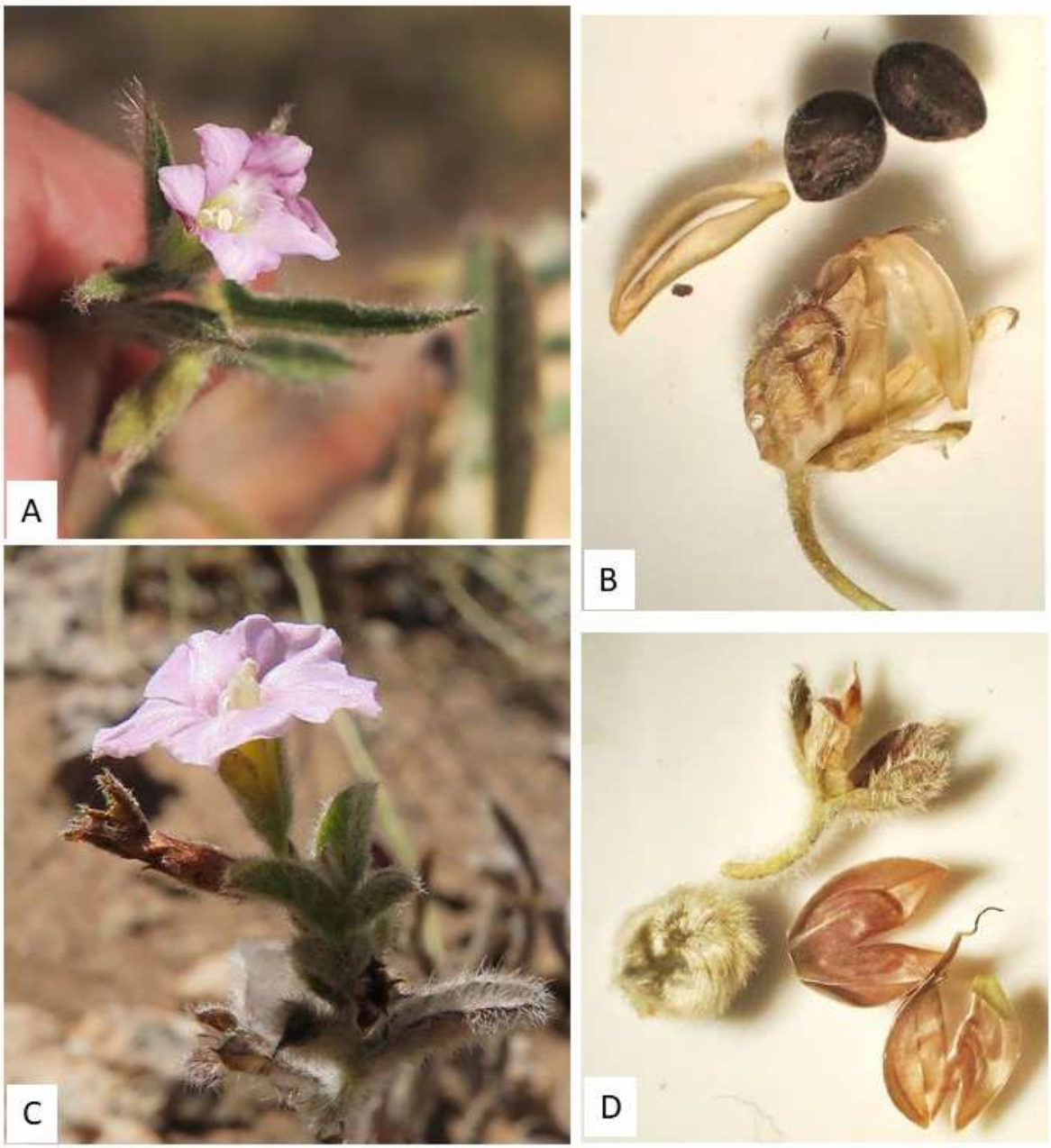

Figure 27**: A:** Flower of *Polymeria* sp. Broome (K.F. Kenneally 9759) with two fine style lobes exserted beyond the anthers, **B:** fruit and seed of *Polymeria* sp. Broome (K.F. Kenneally 9759) showing the black, shortly hirsute seeds **C:** Flower of *Polymeria* ambigua showing anthers concealing style lobes, **D:** fruit and seed of *Polymeria ambigua* showing the densely tomentose seed with long, white hairs.

Similar species

Polymeria ambigua is a very similar species also found in the La Grange region and can be distinguished from *Polymeria* sp. Broome (K.F. Kenneally 9759) by broader sepals, narrower leaves with acute apices, styles with several lobes that are not exserted beyond the anthers, and seed that are densely tomentose with long, white hairs (Figure 27). *Polymeria lanata* is very similar to *P. ambigua* Bentham (1863), but differs from *Polymeria* sp. Broome (K.F. Kenneally 9759) by a similar suite of characters.

It must be emphasised that the Convolvulaceae was being revised by the late R.W. Johnson, but this was not completed. Therefore there remains uncertainty regarding the taxonomy and identity of species in *Polymeria* until this work is finalised and published.

Distribution and abundance

Using the updated herbarium records for *Polymeria* sp. Broome (K.F. Kenneally 9759), most collections come from the Dampier Peninsula, with one outlier to the south in the Walyarta Conservation Park (Figure 28). The collections from the La Grange Flora Survey have greatly increased both the number of records for this species and filled in the massive distribution gap between Mandora Station and Broome (Figure 28). Although counts and estimates were not conducted in the field because of uncertainty about this species, it was noted to be scattered and infrequent at sites.

The common species, *P. ambigua* was also found in the La Grange Survey Area at two locations. Because it can be confused with *Polymeria* sp. Broome (K.F. Kenneally 9759), it is considered here. *P. ambigua* is uncommon within the La Grange survey area, and tends to occur more on gravelly substrates than sand. Outside of the La Grange region, it is common and widespread (Figure 28). It appears that *Polymeria* sp. Broome (K.F. Kenneally 9759) replaces *P. ambigua* in the La Grange and Broome region.

Field observations of Polymeria sp. Broome (K.F. Kenneally 9759) in the La Grange Survey Area

Habit:

Polymeria sp. Broome (K.F. Kenneally 9759) is a sprawling, low subshrub with long, trailing stems with a similar habit to *B. oblongifolia*, but with brownish-green leaves that have a distinct apical mucro. Plants were both flowering and fruiting between June – late August, and plants appeared to be in good condition and actively growing. Plants did not appear to be affected by grazing, and were present in sites with a range of different fire histories.

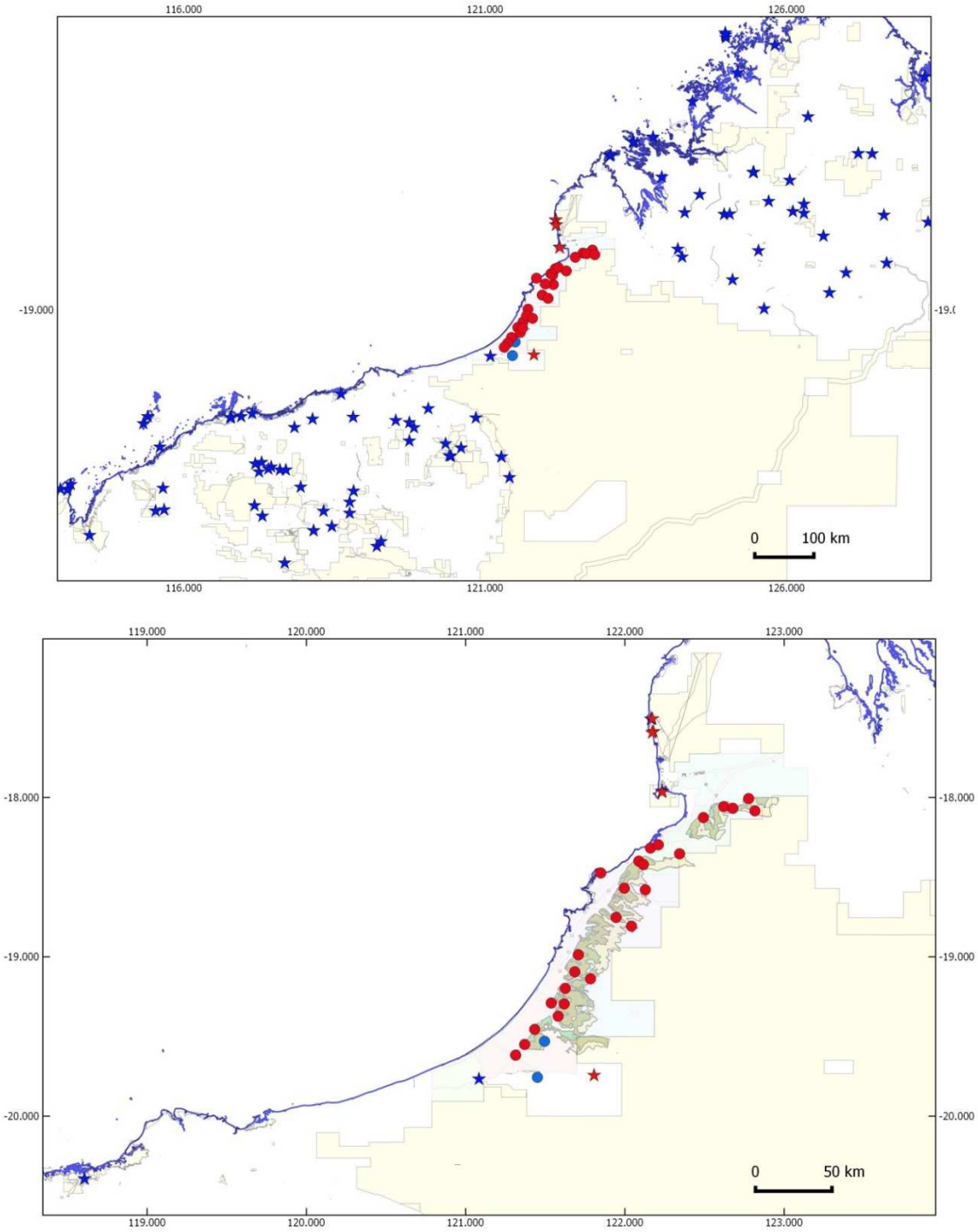

Figure 28: Distributions in northern Western Australia **(Top)** and within the La Grange region **(Bottom)** of *Polymeria* sp. Broome from La Grange 2017 survey records (● red circles) and herbarium (Western Australian Herbarium 1998–) records (★ red stars), and *Polymeria ambigua* from field records (● blue circles) and herbarium (PERTH) records (★ blue stars).

Habitat:

Polymeria sp. Broome (K.F. Kenneally 9759) is found on deep red soils on pindan sandplains, in a range of typical pindan vegetation communities that include sparse open *Corymbia* woodlands over *Acacia* and *Triodia* / *Chrysopogon* grasslands and *A. monticola* / *A. eriopoda* shrublands.

Recommendations

This study has gone some way in clarifying taxonomic issues, but *Polymeria* sp. Broome (K.F. Kenneally 9759) will be formally named as part of the larger flora treatment of Convolvulaceae (D. Halford, pers. comm.). However, further curation of *Polymeria* collections at the Western Australian Herbarium (PERTH) is required.

Polymeria sp. Broome (K.F. Kenneally 9759) appears to be restricted to the La Grange region and southern coastal part of the Dampier peninsula (Figure 28). It is recommended that more surveys are undertaken to determine the distribution limits and abundance of this taxon in northern Western Australia.

The conservation status of *Polymeria* sp. Broome (K.F. Kenneally 9759) has been revised and downgraded from Priority One to Priority Three following the findings from the La Grange flora survey (Table 4) (Smith 2017, Smith 2018).

Despite being widespread, *Polymeria* sp. Broome (K.F. Kenneally 9759) is likely to be impacted by clearing for irrigated agriculture given its habitat preferences and distribution within Preferred Areas for agricultural development (Figure 28).

12: *Pterocaulon intermedium*

Taxonomy

In his revision of the genus, Bean (2001) described *P. intermedium* (DC) A.R. Bean (Asteraceae), which was previously recognised by the informal name *Pterocaulon* sp. A. Kimberley Flora (B.J. Carter 599), and which had been referred to as *Pterocaulon* sp. A in Wilson (1992b) and as *Pterocaulon* sp. A Kimb. Flora in Kenneally *et al*. (1996).

Description

From Bean (2001), *Pterocaulon intermedium* is a resinous, aromatic perennial, subshrub 20–60 cm high with multiple, leafy, winged stems arising from a woody rootstock. Stems wings are entire and narrow (0.2–2 mm wide). Stems and leaves are sparsely to (very) densely hairy and with short glandular hairs. Leaves are pale-green, decurrent, elliptic to lanceolate, 15–50 mm long × 4–20 mm wide and broadest at their midpoint. Leaf margins are entire or denticulate, not recurved, and the adaxial leaf surface is not bullate. Inflorescences are a globose, terminal head 10–14 (20) mm diameter and on long peduncles 7–25 mm long. The outer involucral bracts are cream coloured and densely lanate while the inner bracts are pink to violet. Florets are a mix of female and bisexual, with pink–purple corollas. Female florets number 8-17 per head. Achenes are narrowly ellipsoidal, longitudinally ribbed, dark brown, with few hairs, with a pappus of barbellate bristles 2.5–3 mm long.

Similar species

In addition to *P. intermedium,* there are three other *Pterocaulon* species in the La Grange region. *Pterocaulon serrulatum* (Montrouz.) Guillaumin can be distinguished from *P. intermedium* by ovoid to cylindrical heads, broad, serrated stem wings, serrulate leaves and sessile glands on adaxial leaf surface. *Pterocaulon paradoxum* A.R.Bean can be recognised by its distinctly erect habit, a densely hairy indumentum, ovoid heads with 16-44 female florets, broad (1.5-4.5 mm) winged stems, elliptical to oblanceolate leaves which are widest above the midpoint and with obtuse apex, and with denticulate, recurved margins. *Pterocaulon sphacelatum* (Labill.) F.Muell. can be confused with *P. intermedium* as it also has globular heads, but is distinguished by its narrow (4–15 mm), oblanceolate–spathulate leaves which are often adaxially bullate and with recurved margins, and heads on shorter peduncles and with numerous (30–50) female florets per head. More distinguishing features for species of *Pterocaulon* are given in Bean (2011).

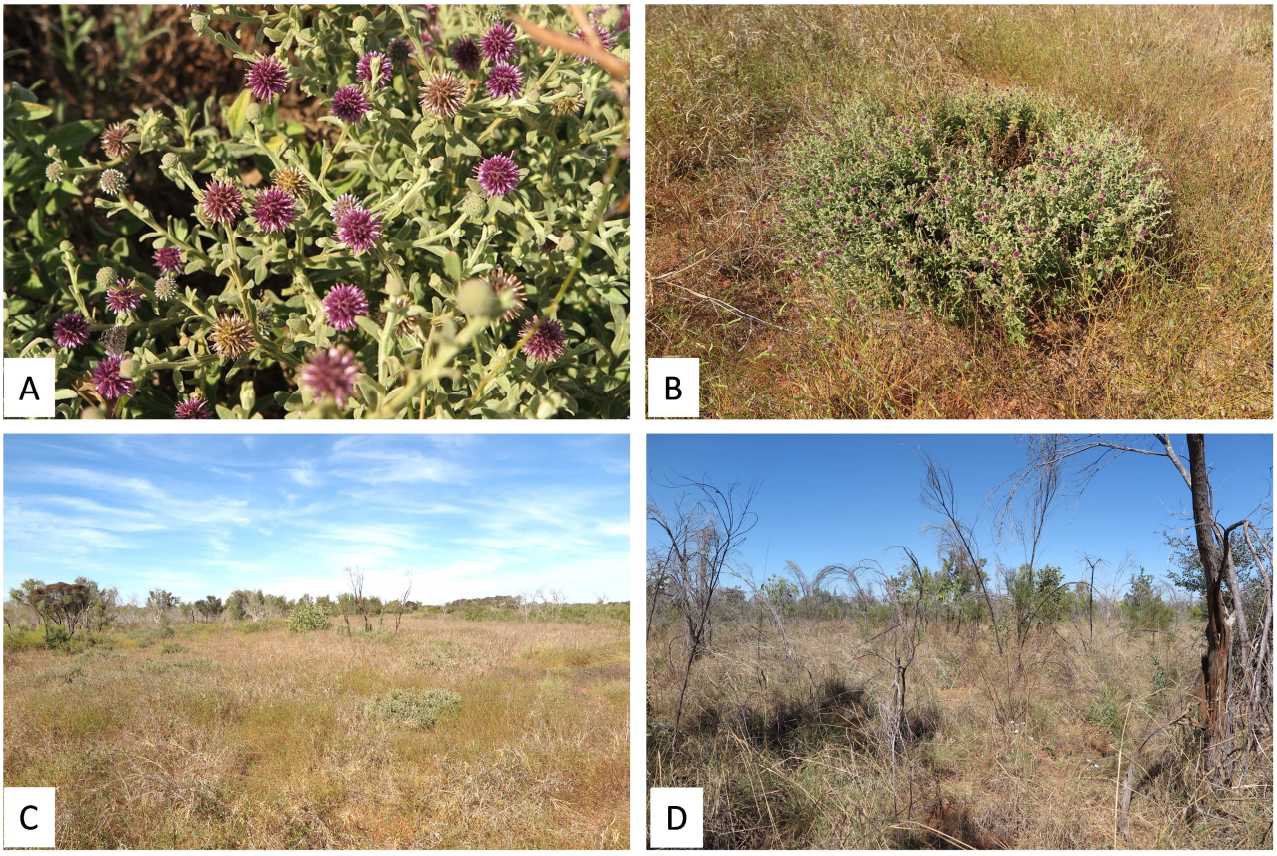

Figure 29: *Pterocaulon intermedium* **A:** details of flower heads (capitula) and leaves, **B:** example of the low, compact, leafy shrub habit**, C:** coastal grassland habitat on saline flood plain, **D:** inland *Acacia eriopoda* / *Bauhinia cunninghamii* shrubland habitat on pindan sandplain.

Distribution and abundance

Pterocaulon intermedium has a distribution that extends from northern Western Australia, across northern Australia through to south-east Queensland, and ranges into Kisar (Indonesia) and a single location in Papua New Guinea (Bean 2011). In Western Australia, populations are scattered from near Port Hedland northwards and across the Kimberley into the northern Kimberley (Figure 30).

All four species of *Pterocaulon* were found in the La Grange Survey Area, with *P. sphacelatum* and *P. serrulatum* being the most widespread and common species. *Pterocaulon intermedium* was found at only eight survey sites, three of which were in coastal areas on Frazier Downs Station and five located 40-70 km inland on Roebuck Plains station (Figure 30). Further survey may locate more coastal sites on Frazier Downs as well as inland of Roebuck Plains Station.

Pterocaulon intermedium is common and abundant in the coastal sites, with estimates of plant density ranging from c. 5–15 plants per 10 x 10 m, and counts of over 200 individual plants at each location. At the inland sites, *P. intermedium* was uncommon and only a few (1–3), scattered plants were found per site.

Field observations of Pterocaulon intermedium in the La Grange Survey Area

Habit:

It was found that species of *Pterocaulon* can be difficult to distinguish in the field (particularly between *P. sphacelatum* and *P. intermedium)*, so identifications were primarily determined from collections. In the La Grange Survey Area, *P. intermedium* is a rounded, squat, densely branched shrub 0.5–0.7 cm tall and 1.0 m wide, with distinctly flat, elliptic, pale green leaves. There was no noticeable difference in morphology between shrubs growing in the two different areas. All mature plants were in flower and producing an abundance of flowering heads at the time of survey (Figure 29).

Habitat:

Pterocaulon intermedium occurs in two very different habitat types in the La Grange region. Plants at the coastal sites grow on saline floodplains, at the boundary where *Melaleuca* (*M. alsophila / M. nervosa / M. viridiflorus / M. glomerata*) shrublands transition into open buffel grass (*Cenchrus* spp.) and salt water couch (*Sporobolus virginicus*) grassland (Figure 29). Associated plants include herbs (*Buchnera ramosissima, Swainsona* sp.), and the shrubs *Cullen martinii* and *Crotalaria medicaginea*. Soils at these sites are grey, hard-setting saline clays.

The inland sites of *P. intermedium* are located on deep red pindan sandplains, which support very open woodlands or isolated trees of *Corymbia* sp., *Bauhinia cunninghamii*, *Ventilago viminalis* and/or *Gyrocarpus americanum,* over tall shrublands of *B. cunninghamii* and *A. eriopoda,* over a mid-dense grass layer that includes *Triodia, Sorghum plumosum* and *Chrysopogon pallidus*. Associated species includes *Ehretia saligna*, *A. platycarpa, Waltheria indica*, *Dodonaea hispidula* and *Dolichandrone occidentalis* (Figure 29).

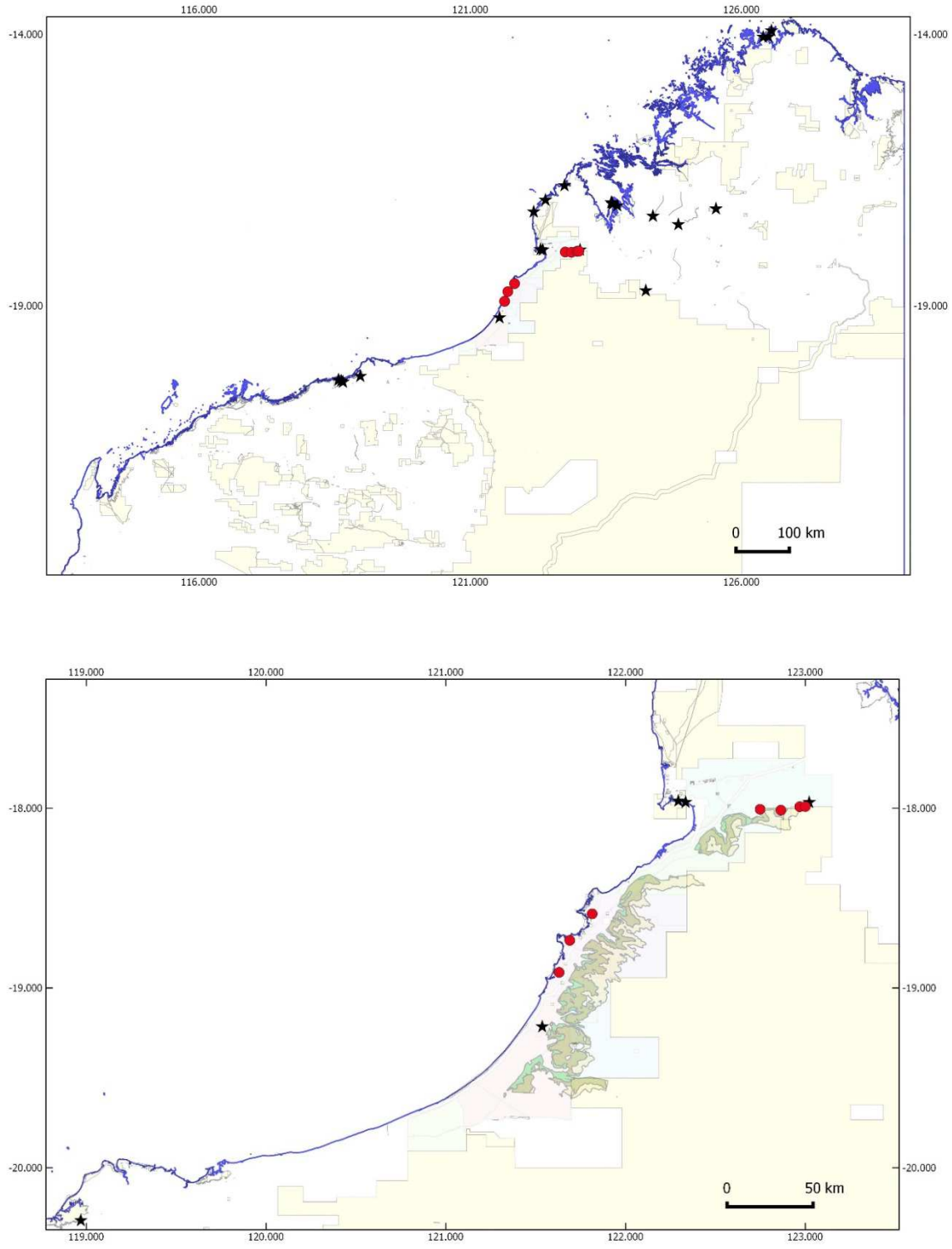

Figure 30: Distributions in northern Western Australia **(Top)** and within the La Grange region **(Bottom)** of *Pterocaulon intermedium* from La Grange 2017 survey records (● red circles) and herbarium (Western Australian Herbarium 1998–) records (★ black stars).

Recommendations

Given its wide distribution in northern Australia and into Papua New Guinea and Indonesia, *P. intermedium* is not considered threatened at a national level.

Pterocaulon intermedium is an infrequently encountered species restricted to two disjunct areas within the La Grange region. Several coastal sites support large populations, but this species occurs at low densities at inland sites. There a further two records for this species on the north side of Roebuck Bay, and one at Barn Hill (Thangoo Station). The state conservation listing of this species was Priority Three (Smith 2017) but revised and removed from the Priority Flora (Smith 2018) (Table 4).

Only the inland populations of *P. intermedium* are located within areas identified as with potential for irrigated agriculture (Figure 30), while the coastal populations are at no risk from proposed development. Risks that these coastal populations do face may be overly frequent, hot fires. It is interesting to note that *P. intermedium* persists in buffel grass dominated grasslands, while other native species can be readily displaced.

13: *Seringia spp.*

Taxonomy

Prior to this survey, three species of *Seringia* were known from the La Grange region: *Seringia. nephrosperma* F.Muell., *Seringia katatona* (C.F.Wilkins) C.F.Wilkins & Whitlock and *S. exastia* (C.F.Wilkins) C.F.Wilkins & Whitlock. *Seringia nephrosperma* is a widespread species ranging across the northern half of Australia from coastal Western Australia (Figure 31) to just east of the Great Diving Range in Queensland and northern New South Wales (CHAH 2011-). The latter two species were described as new species by Wilkins (1999) prior to the generic revision by Wilkins & Whitlock (2015).

Description

Species of *Seringia* are known as 'fire bushes', as they are typically leafy, clonal shrubs to 1 m tall which resprout and flower profusely after fire. A similar response is seen after physical disturbance such as track grading (A. Markey. pers. obs.). *Seringia* is here defined by having prominent yellow filaments with the outer surface convex and covered with minute, yellow, simple hairs; the calyx is petaloid and purple (rarely white or pink); the petals are absent or much reduced and scale-like; the inner surface of the calyx has a single prominent rib; anthers have extrorse, longitudinal slit dehiscence and the ovary has 3–5 styles that are coherent only at sub capitate stigmas.

Seringia nephrosperma, *S. katatona* and *S. exastia* all share some characters or affinities. *Seringia exastia* is listed as Threatened at the state and federal level (Smith 2018), being known from only two locations (Broome and near Nita Downs-Great Sandy Desert) (Figure 31). The main distinguishing character of *S. exa*stia is the calyx lobe apical margin having fine denticulations, and the calyx apex acuminate to filiform. Calyx lobes of *S. exastia* are also characteristically longer than wide. Like *S. katatona*, *S. exastia* has carpels fused in the basal third (Wilkins & Whitlock 2015).

Prior to this study, the only taxonomic issues for *S. exastia* concerned the Nita Downs/Great Sandy Desert populations that required confirmation. Recent collections from the McLarty Track in the Great Sandy Desert have been identified as *S. exastia* because of their prominently fringed calyx lobes with an acuminate apex (Addison 2012, Wilkins & Whitlock 2015). However, these collections differ from the Broome population in having longer pedicels and anthers, and leaves that are discolorous, rather than the greyish-green and almost concolorous leaves of the Broome population (Wilkins & Whitlock 2015).

Seringia katatona is listed with Priority 3 conservation status (Smith 2018) and is restricted to the West Kimberley, with most herbarium records from the Great Sandy

Desert region centred on the Edgar Ranges, one record from near Broome townsite and one record from within the central La Grange Survey Area (Figure 31). The specific epithet (Gk: *katatonus*) refers to its calyx lobes being distinctively broader than long. It has morphological similarities in the seed to *S. exastia*, but differ in calyx lobe characters (Wilkins & Whitlock 2015). *Seringia katatona* and *S. nephrosperma* both have reniform seed and calyx lobes that are broader than long and with reticulate venation, but *S. katatona* differs by having staminodes with recurved thickened apices as opposed to the erect, acute staminode apices found in *S. nephrosperma* (Wilkins & Whitlock 2015). *Seringia elliptica* C.F.Wilkins is a species from outside of the study area (Figure 31) but is allied to *S. nephrosperma* and *S. katatona* (Wilson & Whitlock 2015).

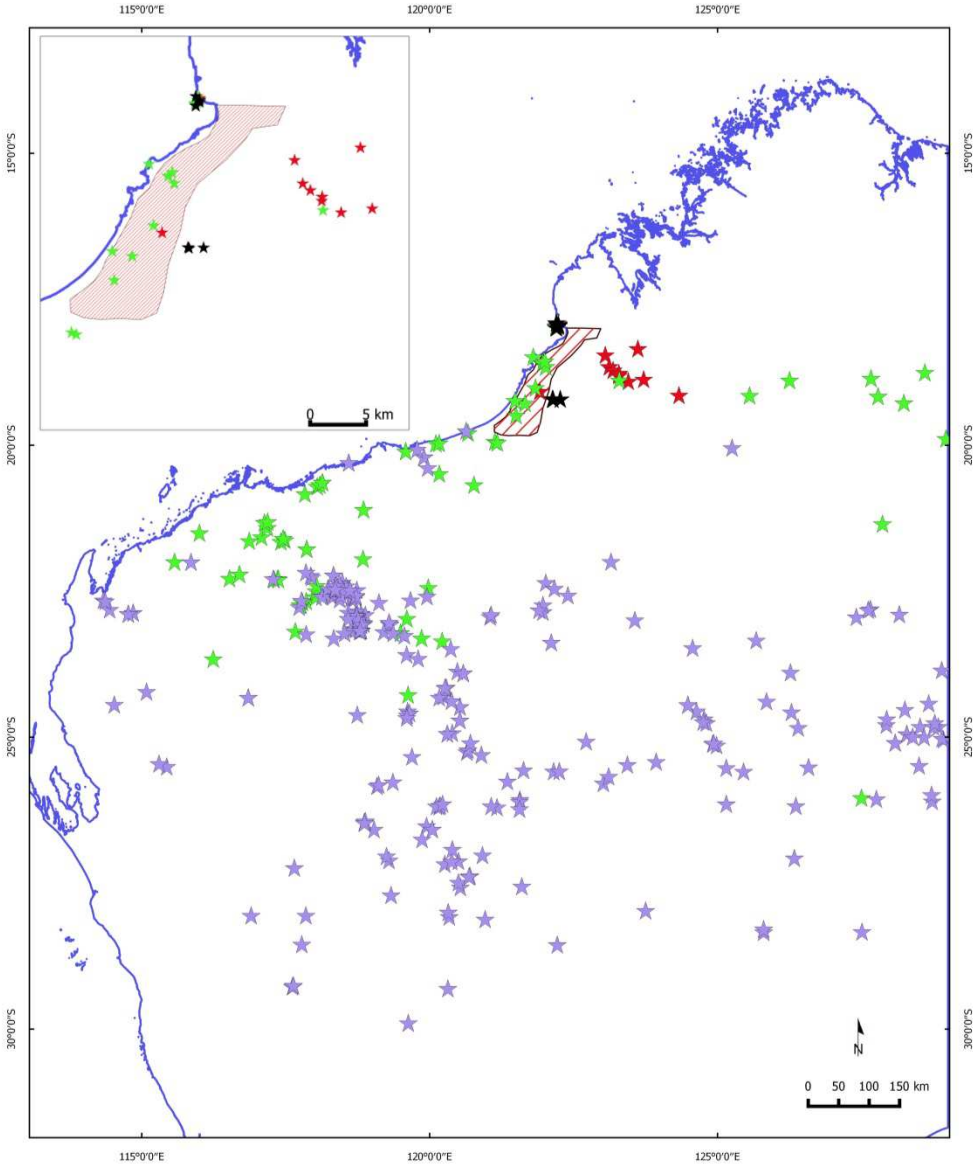

Figure 31: Distributions of *Seringia elliptica* (☆), *Seringia exastia* (★) *Seringia katatona* (★), and *Seringia nephrosperma* (★) in Western Australia, based on records from the Western Australian Herbarium (1998–). The La Grange Survey Area (inset) is indicated by the shaded area (.).

Methods

Collection methods:

As fieldwork proceeded, it was evident that the different species were difficult to identify in the field, confirmed when preliminary collections were examined by C. Wilkins. Collections displayed features intermediate between the three species and the different taxa co-occurred. It was decided to sample intensively within populations, with preference for populations in flower. In total, 26 populations of *Seringia* were sampled, with a population defined as a stand of individual stems or clumps within a 300 m radius. Knowing that *Seringia* is highly clonal, effort was made to sample discrete clumps 5 – 20 m apart.

Both leaf samples and a corresponding voucher specimen from up to 25 individuals were collected per population. Leaf samples were stored in silica gel desiccant for future genetic analysis, and vouchers were pressed for later identification. Since leaves and vegetative characters of all *Seringia* species in the survey are similar and cannot be used reliably for identification, sterile collections were not able to be identified. The flowers of *Seringia* are difficult to study as they have mucilage glands within the petaloid calyx and the flowers close when picked. Flowers were soaked for five minutes in boiling water and detergent to open the calyx. This was required for the identification characters of whether the ovary carpels were free or fused centrally and the lobe shape. All flowers were glued to card for future reference.

Results

La Grange survey: identification of Seringia species

This survey collated hundreds of records of *Seringia* in the La Grange Survey Area, which filled a previous distribution gap for these species (Figure 31). The *c.* 400 specimens of species of *Seringia* in the La Grange survey were resolved into five entities using the characters described in Table 6. The major division is based on the presence of free (*S. nephrosperma*) and fused carpels (*S. katatona, S. exastia* and taxa with affinities to these two species). Given its relatedness to *S. nephrosperma* and *S. katatona* (Wilkins & Whitlock 2015), characters of *Seringia elliptica* are given for comparison. Descriptions of the *Seringia* taxa identified in the La Grange survey are given below:

Seringia nephrosperma

Seringia nephrosperma collections were readily identified by possessing an ovary of free carpels and calyx lobes with a rounded apex (Figure 32A). The lobes are much broader than long and, with age, have a reticulate venation. Inflorescences are

compact, and fruits are free enlarged carpels (Figure 32A). The ovary carpel indumentum ranges from glabrous, to glabrous with a fringe at the dehiscence line, to stellate hairs all over carpels that may or may not have a fringe of hairs on the dehiscence line. The presence of a fringe only on the carpel dehiscence line of *S. nephrosperma* was considered as *Keraudrenia* sp A. Kimberley Flora (T.E.H. Aplin *et al.* 333) by Wilson (1992a) (Figure 32A). At generic revision, Wilkins & Whitlock (2015) included all these carpel forms in *S. nephrosperma.* The current study with many replicates at one location has confirmed this decision with many forms at one survey site.

The remaining species in question have ovaries with carpels that while all are free centrally they all have the basal third laterally fused. Fruits of these remaining species were not available for comparison at time of survey. The inflorescences of all the remaining species are similar (Figure 32B, 32E) and less compact than *S. nephrosperma.*

S. exastia and S. aff. exastia

From observation of many collections of *S. exastia* from Broome and the La Grange area it appears this species is now identifiable from a combination of the calyx lobes always being much longer than wide and the apex of the calyx lobes always acuminate with the apical margin with a fringe of irregular denticulations and hairs (Figure 32C.).

Seringia aff. *exastia* from the survey area was confused with this species due to the acuminate apex of the calyx and the similar fringe on the margin. The calyx lobes are however, broader than or as broad as long (Figure 32D). With the benefit of many collections at each location, lobe margins of *S.* aff. *exastia* are seen to range from strongly fringed to scarcely fringed, and in shape and size the lobe resembles *S. katatona*.

Table 6: Characters used to identify *Seringia* taxa from La Grange survey, with reference to *Seringia elliptica* as the putative outgroup to the La Grange taxa.

***Seringia* species**	**Carpels laterally free/ laterally fused basally c. 1/3**	**Calyx lobes broader than long / longer than broad**	**Apex calyx lobe acute to acuminate / rounded**	**Calyx apical margin fringed / not fringed**	**No. of ovules per carpel 2 / 4/ 6**	**Sterile anthers on staminodes**	**Inflorescence compact or spreading**
S. nephrosperma	Free	Broader	Rounded	Not fringed mainly/ rarely slight fringe	2 or 4	Absent and rarely present	Compact
S. exastia	Base fused	Longer	Acute to acuminate	Fringed	4-6	Absent	Spreading
S. aff. *exastia*	Base fused	Broader	Acute to acuminate	Fringed	4	Absent and rarely present	Spreading
S. katatona	Base fused	Broader	Acute	Not fringed	4	Absent or present	Spreading
S. aff *exastia/ katatona*	Base fused	Broader	Acute to acuminate	Scarcely fringed	4	Absent and rarely present	Spreading
S. elliptica (similar Pilbara species not in survey)	Base fused	Mainly longer or broader	Acute to acuminate	Not fringed	4-6	Absent	Spreading
S. katatona / nephrosperma	Free – scarcely fused	Broad	Rounded – more acute than usual for *S. nephrosperma*	Not fringed	4	Absent or present	Compact

Seringia katatona and S. aff. exastia / *S. katatona*.

Seringia katatona was listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian flora (Table 4) (Smith 2017) but this survey has found that it is more widespread than previously considered. This species has been differentiated in the past (Wilkins & Whitlock 2015) as having calyx lobes with an entire margin and acute apex (Figure 32E), and small sterile anthers or thickening on the apex of the staminodes. In this survey both presence and absence of sterile anthers on staminodes was observed occasionally on *S. nephrosperma*, *S. katatona* and *S.* aff*. exastia* and as such is not a good character to identify *S. katatona*.

Flowers resembling *S. katatona* with slight fringing of the calyx lobes and with or without an acuminate lobe apex were identified as *S.* aff*. exastia* / *S. katatona*.

Status of S. exastia., S. aff. exastia and S. katatona

It is now considered possible that, with the flower similarity of *S.* aff*. exastia* and *S. katatona*, *S. katatona* may range from having a calyx fringe present to having entire calyx lobe margins. Therefore these two entities should be combined as *S. katatona*. Analysis of DNA sequences is however required to verify both this and their difference from the threatened species *S. exastia*. It would be of interest to include in this molecular analysis *S. elliptica* that occurs in the Pilbara region. It has the same leaf shape and indumentum as the studied species and resembles *S. katatona* with entire calyx lobe margins and acute apex but has lobes mainly longer than broad and a larger flower (Figure 32F). *Seringia katatona* was considered to be closely allied to *S. nephrosperma* but with features of both *S. nephrosperma* and *S. elliptica* (Wilkins and Whitlock 2015). This study may indicate that *S. katatona* has more affinity to combined characters of *S. exastia* and *S. nephrosperma*.

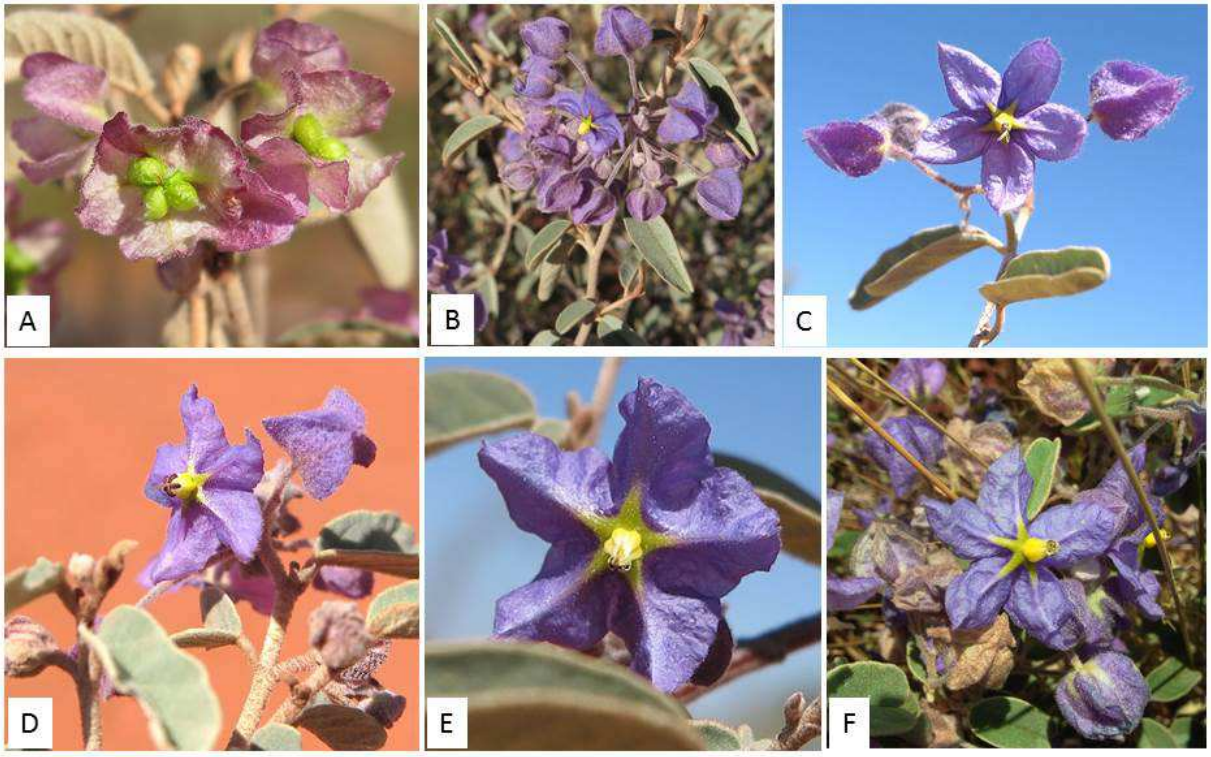

Figure 32: A: *Seringia nephrosperma* showing, compact inflorescence, broad calyx lobes with entire margins and rounded apex, and fruits of free carpels**, B:** Less compact inflorescence of *Seringia katatona*, **C:** Flower of *Seringia exastia* with longer than broad calyx lobes, fringed margin and acuminate apex of calyx lobes, **D:** Flower of *Seringia* aff. *exastia*, with broader than long calyx lobes and acute apex, **E**: Flower of *Seringia katatona* with broader than long calyx lobes with entire margin and acute apex, **F:** Large flower of *Seringia elliptica* with longer than broad calyx lobes and entire margin with acute apex.

Distribution:

Population-level Regional Distribution and Diversity

Results of the population level sampling are given in Figure 33, and summarised in Table 7. It is important to note that identifications were only able to be based on flowering material, and there were sites where some or all individuals were sterile and therefore omitted from this survey. At the time of collection it was also assumed that all plants within a site were part of the same population and that term is used here, although it became obvious during the identification phase of the work that some of these sites were stands of mixed taxa. Of the 26 populations, 13 are "pure" or monospecific for a particular taxon, and 13 have a mixture of co-occurring *Seringia* taxa. Three *S. exastia* populations are monospecific (including the species type locality at Broome), although other taxa were collected c. 330 m away from the Nita Downs stand of *S. exastia*.

Table 7: Summary table of results from population-level sampling of *Seringia* in the La Grange Survey Area. The status of the population refers to presence of one or multiple *Seringia* taxa and intermediate forms within a site.

Population Status	No. populations
Pure *S. exastia*	**3**
Pure *S. nephrosperma*	**7**
Pure *S. katatona*	**1**
Pure *S.* aff. *exastia* / *katatona*	**1**
Pure *S.* aff. *exastia*	**1**
Mixed *S. katatona*, aff. *exastia* and *S. nephrosperma*	**6**
Mixed *S. katatona* and *S. nephrosperma*	**1**
Mixed *S. katatona* and *S.* aff. *exastia*	**1**
Mixed *S. katatona* and *S.* aff. *exastia* / *katatona*	**1**
Mixed *S.* aff. *exastia*, *S. katatona* and *S.* aff. *exastia* / *katatona*	**2**
Mixed *S.* aff. *exastia* and *S. nephrosperma*	**2**

One general trend is noted: there is a shift from *S. nephrosperma*-dominated sites to mixed stands of *S.* aff. *exastia* / *S. katatona* / intermediates heading from the coast on Pindan soils inland into the Great Sandy Desert (Figure 33). The two 'pure'

populations of *S. exastia* are located on this track, one within Nita Downs Station boundary and a second along the McLarty Track, in the Great Sandy Desert.

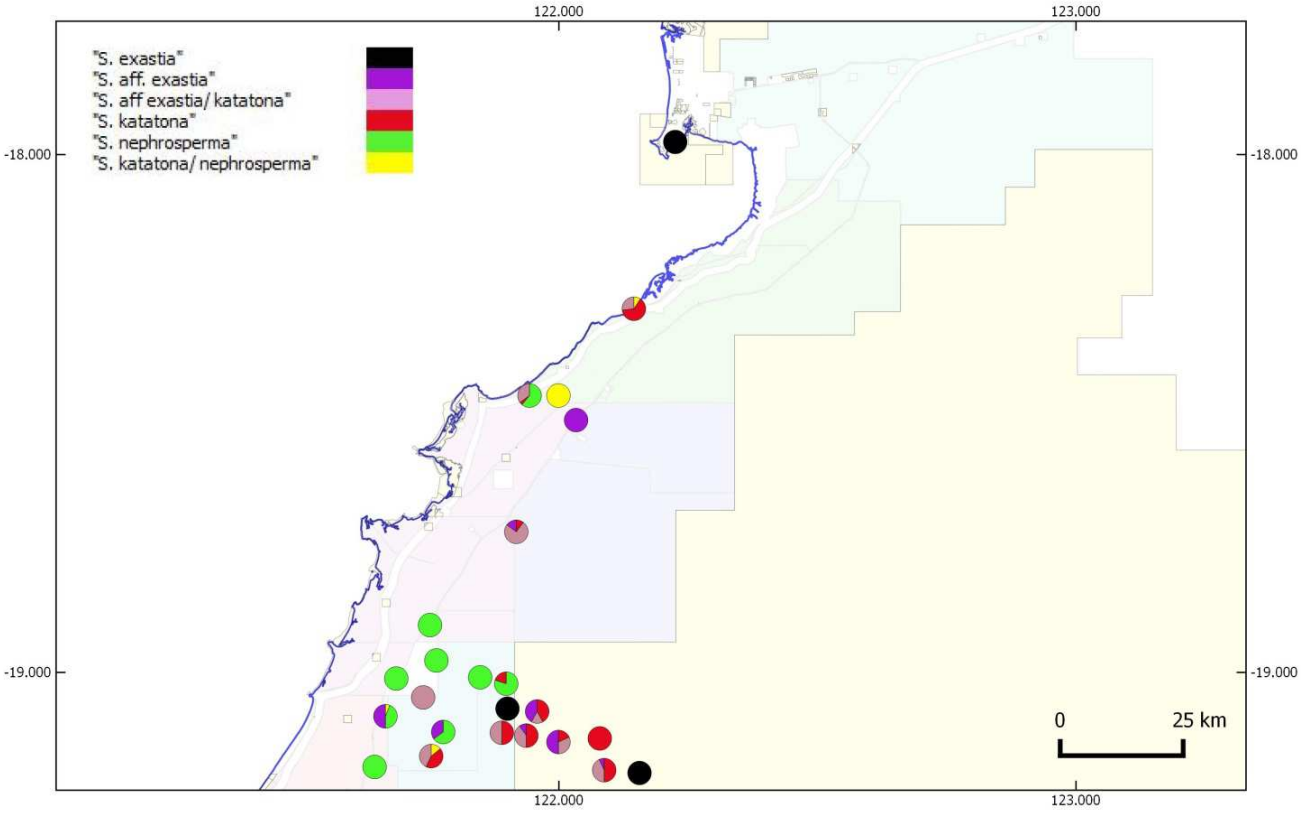

Figure 33: Results from identifications of individuals within 26 populations of *Seringia* in the La Grange Region. Proportions of the different *Seringia* taxa and intermediate forms within a population are displayed as a pie chart.

La Grange Regional Distributions

Figure 34 illustrates the distributions of 596 individual identified collections of *Seringia* over the La Grange Survey Area, which shows that (with the exception of *S. exastia*) five of the six taxa are widely distributed over the survey area. The ranges of all six taxa more-or-less overlap and there is no regional segregation among taxa. *Seringia* aff *exastia* occurs in a distribution gap between the two disjunct areas occupied by *S. exastia*,

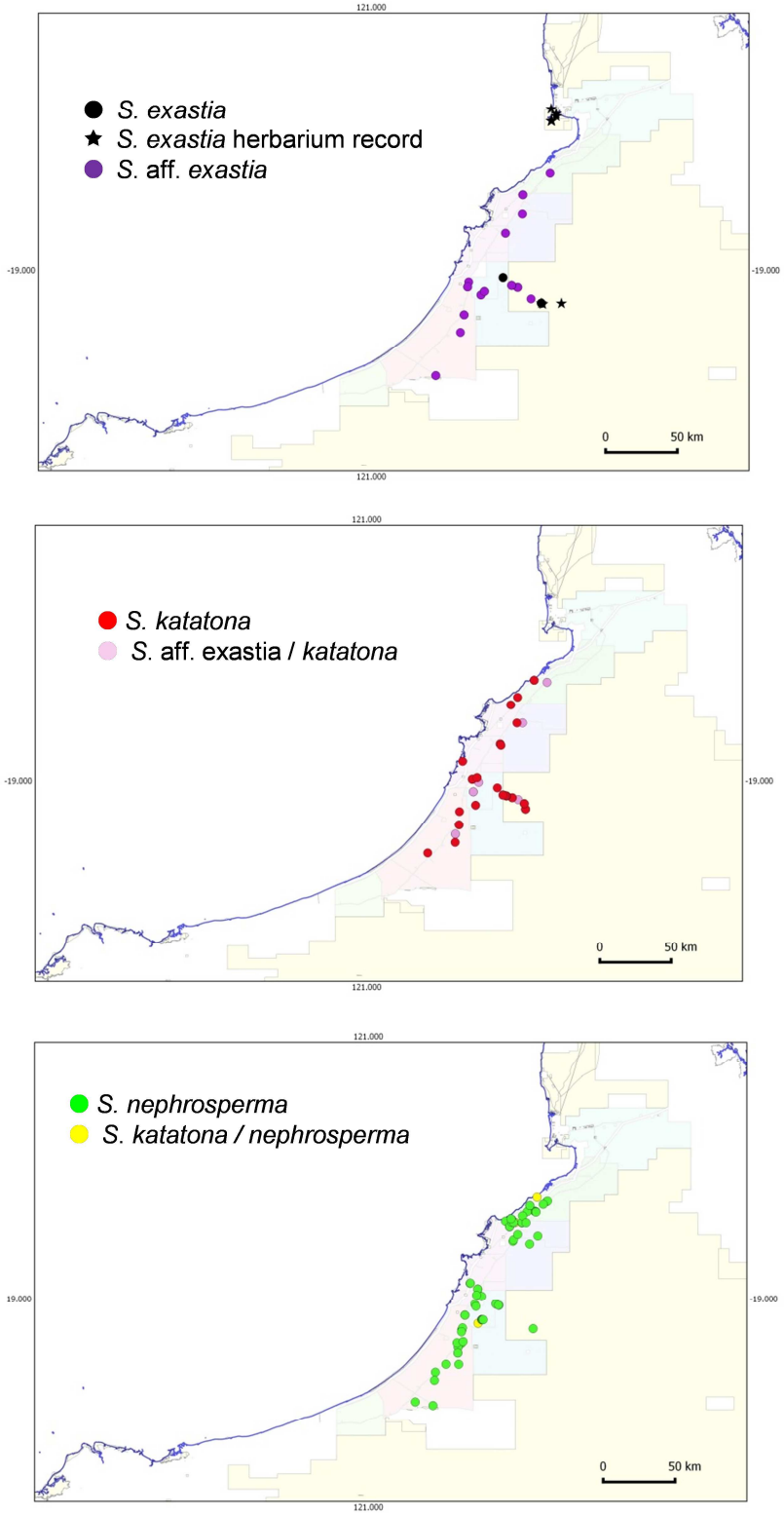

Figure 34: Distributions of the six taxa or intermediate taxa of *Seringia* with the La Grange Region, as determined from sampling of individual plants over the La Grange Survey Area (herbarium records for *S. exastia* populations are given in top figure). .

Abundance:

All three species of *Seringia* were found to be highly clonal and forming large clumps of stems from presumably the same individual, which made counts of individuals difficult for some sites. *Seringia nephrosperma* was observed to occur in small clumps of plants numbering from one to several stems per clump, although some sites had more extensive stands with evident clonality, counts of stems exceeding 120 and with canopy cover estimates of 1-5%. Both *S. exastia* and *S. katatona* and the intermediate taxa were found to occur in highly clonal and sometimes dense stands, particularly along tracksides. The Great Sandy Desert survey site of *S. exastia* was a large population whose boundary could not be walked, where plants were a dominant in the middle shrub stratum at 10-15% cover and counts exceeding 1000 stems. The Nita Downs population of *S. exastia* was estimated to have 10% canopy cover and counts of > 500 stems, although only 1-5% of plants/clumps were in flower so identification was based only on a few plants. Similarly, stands of *S. katatona* and mixed stands could be found at sites in numbers from 200 to > 1000 stems, being a dominant species in the shrub stratum and with a canopy cover of 10-15%. At other sites, these populations were considerably smaller and limited to a narrow zone of 10-50m from the edge of a track.

Habitat

All species and intermediate forms of *Seringia* were found within a wide range of Pindan vegetation communities on sandplains, growing in open *Corymbia* spp. woodlands over *Acacia* and *Triodia* / *Chrysopogon* grasslands, or tall shrublands dominated varyingly by *Acacia eriopoda*, *Acacia monticola, Acacia colei* and *Acacia ancistrocarpa* shrublands over *Triodia epactia* and *Chrysopogon pallidus* grasslands. There were no obvious differences in associated substrate or vegetation between the taxa or within stands of mixed taxa.

Conclusions and recommendations

Seringia exastia is restricted to four populations, three within the La Grange region and one near Broome townsite. No populations are located with a conservation reserve. Therefore, it is recommended that the conservation status as Threatened is retained. The Great Sandy Desert has more populations of *S. exastia*, but locating the number and extent of these requires further survey into a region that is very difficult to access.

One new population was located on Nita Downs Station by this survey, which is located within an area identified as preferred for irrigated agriculture. It is recommended that the extent of this population is determined and this population is protected from risk of future clearing.

Seringia katatona is a relatively widespread and abundant species within the La Grange Survey Area, and most of these sites lie within areas indicated as preferred for irrigated agriculture. However, if the circumscription of *S. katatona* is expanded to include the variants identified in this study, then this will warrant the downgrading of its conservation status to Not Threatened. Any changes to the conservation status of *S. katatona* will be decided after the genetic analysis has been completed.

There are limitations to this survey, but it has provided more detailed information in an otherwise poorly sampled region, and has shown that there is a greater level of complexity than had been determined from a limited number of herbarium collections.

14: *Solanum oligandrum*

Taxonomy

Solanum oligandrum Symon (Solanaceae) was described by Symon (2001) from several collections made from 1984 to 1999 which had affinities to *Solanum pugiunculiferum* C.T. White but were recognised as a new and distinct species.

Description

From Symon (2001), *Solanum oligandrum* is an open, sparsely-branched multi-stemmed annual or perennial shrub to 1 m tall. Both stems and leaves are covered in long (2–20 mm) straw-coloured prickles. Leaves are glabrous, glossy, bright green, up to 7 cm long and 4 mm wide, and deeply pinnately divided with 1–3 pairs of lobes. Flowers are held in an extremely shortened cyme c. 3 mm long bearing several male flowers above 1(–2) bisexual flowers. Calyces are green, sparsely-prickly, with lobes 6-8 mm long, and the corolla is lilac-purple, glabrous inside and densely stellate-hairy outside. Anthers are c. 6.5 mm long, bright yellow, arranged tightly around a sigmoidal style c. 1 1 mm long in bisexual flowers, which is absent in male flowers. The fruit is a greenish-brown berry at maturity, c. 10 mm diameter, semi-succulent, turning black and drying on the plant. Seeds are 2–2.5 mm long, dark brown to black (Figure 35).

Similar species

Solanum oligandrum is has close affinities to *S. pugiunculiferum*, which occurs in the Northern Territory and whose differences are discussed in Symon (2001). Within the La Grange region, *S. oligandrum* co-occurs with the unrelated *Solanum diversiflorum* F.Muell. and *Solanum esuriale* Lindl. *Solanum diversiflorum* has larger, fleshy fruit and stellate hairy, dull leaves with rounded lobes, while *S. esuriale* is a small, few-branched subshrub (20–30 cm) which lacks prickles and has pale green, entire, stellate-hairy leaves.

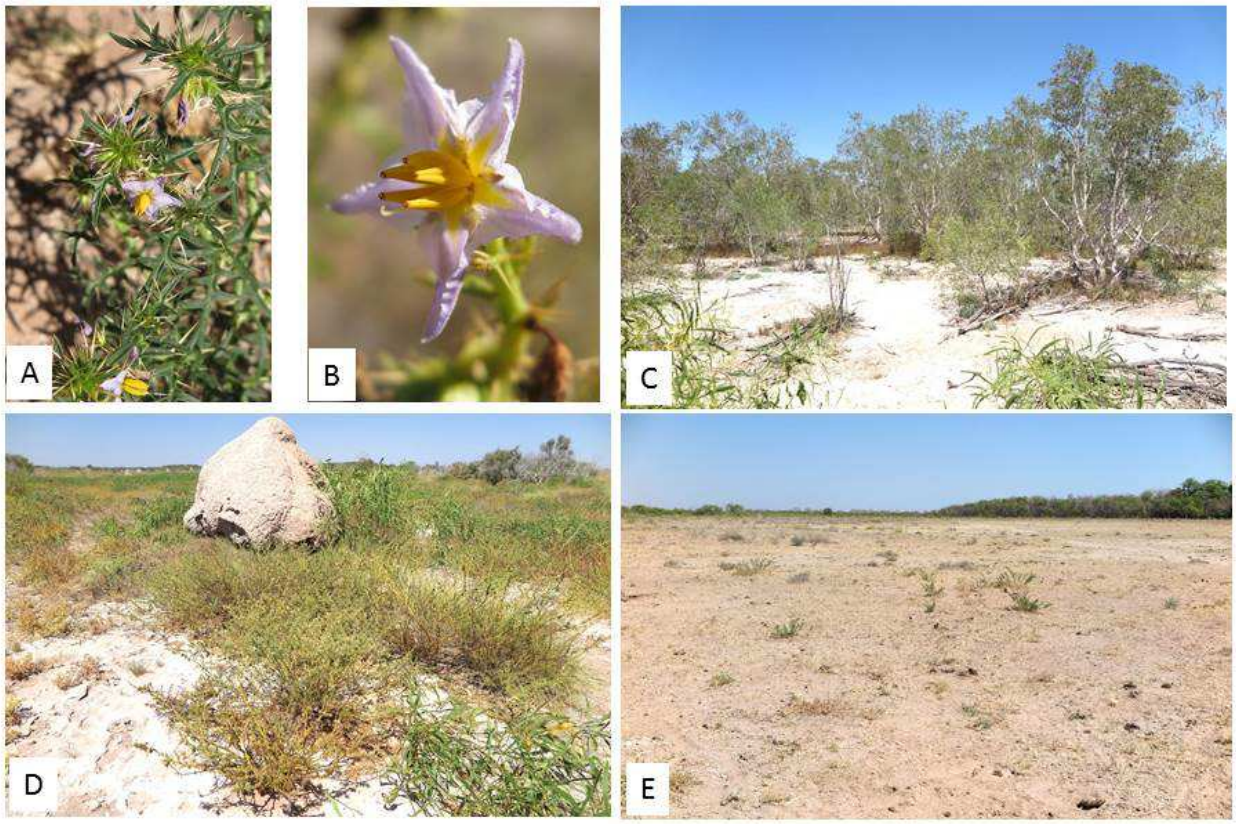

Figure 35: *Solanum oligandrum* **A**: showing stems, leaves and flowers, all covered in an abundance of prickles, **B**: detail of bisexual flower, **C:** example of *Melaleuca alsophila* / *Acacia ampliceps* shrubland habitat in seasonally inundated saline claypan, **D:** example of calcareous plains supporting shrublands of *Acacia ampliceps*, *Solanum oligandrum* and *Trianthema turgidifolium***, E:** heavily grazed calcareous flats adjacent to Saunders Spring with stunted, trampled plants of *Solanum oligandrum.*

Distribution and abundance

The distribution of *S. oligandrum* is restricted to two disjunct areas, one in the Great Sandy Desert and the second c. 400 km west in the Walyarta Conservation Park (Figure 36). Despite searching in suitable habitat in the La Grange Survey Area, no other new populations of *S. oligandrum* were found outside of the Walyarta / Mandora Marsh area. The bulk of the known occurrences of *S. oligandrum* are within the boundary of the Walyarta Conservation Park, except for a small, isolated population immediately north of the reserve at Lingette Well, on Anna Plains Station.

While frequently found as scattered plants on the edges of *Melaleuca alsophila* thickets surrounding mound springs and seasonally wet saline claypans, *S. oligandrum* is also common and abundant on adjoining calcareous plains. Cover values estimates at these sites ranged from 5-10% to 20-30%. Counts of plants exceed 500 individuals.

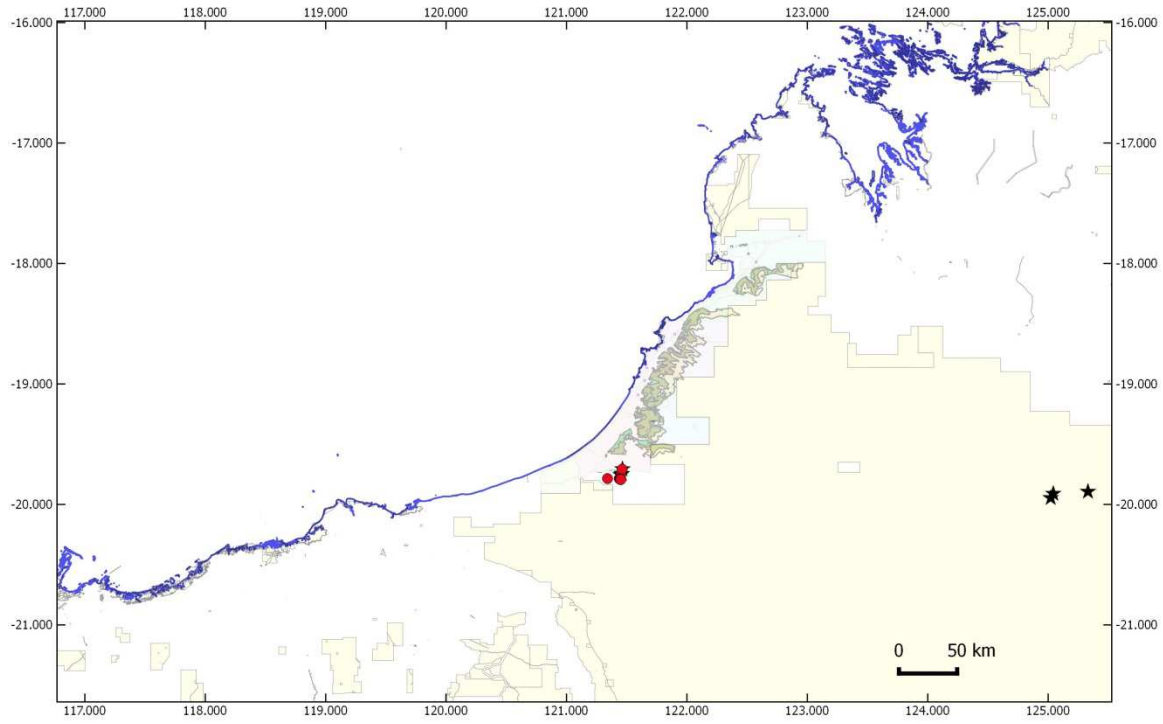

Figure 36: Distribution of *Solanum oligandrum* based on the 2017 La Grange and 2015 Mandora Marsh survey records (● red circles) and herbarium (Western Australian Herbarium 1998–) records (★ black stars).

Field observations of Solanum oligandrum in the La Grange Survey Area

Habit:

Solanum oligandrum is a low, multistemmed shrub from 0.3 to 1 m, which is easily recognised by its immensely prickly stems, leaves and flowers, and by its glossy, bright green leaves. At the time of survey, all mature plants were heavily in flower and fruit and, by late August, some 5% of plants were turning yellow and starting to senesce (Figure 35). *Solanum oligandrum* was still present in sites where it had been recorded in the 2015 Walyarta survey.

Habitat:

Solanum oligandrum is found on saline calcareous substrates, these being clayey flats on the margins of mound springs, seasonally wet calcareous depressions between longitudinal dunes, or calcareous silty-clays overlying a calcrete plain. These latter landforms are distinctive in that they often carry large numbers of termite mounds.

On the margins of inundated areas, *S. oligandrum* grows in tall, dense *Melaleuca alsophila* / *Acacia ampliceps* shrublands over the low halophytes, *Neobassia astrocarpus*, *Sporobolus virginicus* and *Zygophyllum compressum*. On the calcareous-loam flats around the mound springs, *S. oligandrum* is a dominant shrub species in sparse tall *M. alsophila* shrubland over *A. ampliceps* and *Triodia epactia* hummocks. The vegetation is similar on calcareous plains, which are (2–5 years after fire), shrublands of *A. ampliceps, S. oligandrum, Heliotropium glanduliferum, Trianthema turgidifolium* and *Eragrostis falcata.* Associated species can include *Grevillea wickhamii*, *Pluchea ferdinandi-muelleri*, *Heliotropium pachyphyllum, Solanum diversiflorum* and *Corchorus sidoides*.

Responses to Fire, Disturbance and Grazing

Solanum oligandrum persists at Lingett's Well and Saunders Spring despite the grazing pressure at these water sources, probably because cattle are eating other more palatable and less prickly species. However, heavy trampling and browsing appears to have reduced the stature and density of *S. oligandrum* at Saunders Spring (Figure 35).

Solanum oligandrum recovers well in recently burnt areas after good summer rainfall. It mostly likely establishes from seed after fire, as mature stands are present within 2–3 years after fire and up to 1 m tall c. 5 years post-burn. However, possible threats to *Solanum oligandrum* could be very hot, too frequent fires. The fire responses of *Solanum oligandrum* may need further investigation to inform appropriate fire management plans.

Recommendations

Since it was first described, there have been no new records that have extended the known range of *S. oligandrum*. Following recommendations from this survey, the current priority conservation status has been revised upwards to Priority Two since it is known from few locations and only one conservation reserve (Table 4) (Smith 2018).

In addition to the Walyarta / Mandora Marsh area, *S. oligandrum* is known from three widely-spaced locations in the Great Sandy Desert (Symon 2001). Given that there are saline palaeodrainage channels extending from Walyarta Conservation Park to well east of Dragon Tree Soak Reserve, it is possible that more populations could be found in this area, but this is a remote and mostly inaccessible region and survey would be exceedingly difficult.

Solanum oligandrum does not grow on soils or landforms suitable for irrigated agriculture, and is outside of the areas identified as having potential for irrigated agriculture in the La Grange Project Area (Figure 36).

15: *Stylidium pindanicum*

Taxonomy and Description

Stylidium pindanicum R.L. Barrett (Stylidiaceae), recently described in 2015 (Barrett *et al.* 2015), is a small (12–32 cm tall) herbaceous annual triggerplant with flowers on 1– or unbranched stems 13–30 mm long, and leaves arranged in a terminal rosette of 14–49 sparsely-glandular leaves. There are 1–15 scapes arising from the stem, 7–33 cm long which are sparsely glandular hairy. Flowers are on monochasial or dichasial cymes, flowers with glandular hairy sepals, corolla is pink with a distinctive paracorolla (Figure 37).

Similar species

Stylidium pindanicum was separated from *Stylidium semipartitum* F.Muell. based on its considerably shorter stem (13–30 mm vs 23–64 mm), such that the rosette is held close to the ground like a basal rosette (Barrett *et al.* 2015). *Stylidium semipartitum* has only 10–20 leaves clustered at stem apex as opposed to the leafier S. *pindanicum*. Barret *et al*. (2015) note that the inflorescences of *S. semipartitum* are few-branched and sparser in appearance in comparison to the more-branched, denser inflorescences of *S. pindanicum*, and leaves have a more ovate apex and a distinctly petiolate leaf base as opposed to the slender leaves with an acute-attenuate apex in *S. pindanicum*. The corolla face of *S. semipartitum* is of a darker pink with pale pink on the reverse side, versus the paler pink corolla face with mottled dark red reserve face in S. *pindanicum*. The paracorolla appendages differ in shape and count (2–4 corolla appendages in *S. semipartitum* and four in S. *pindanicum*).

Stylidium pindanicum has been illustrated in Kenneally *et al.* (1996) under the name *Stylidium leptorrhizum* F.Muell., which had been misapplied to *S. semipartitum* (Barrett *et al*. 2015). *Stylidium leptorrhizum* occurs east and north of the La Grange region (mostly in the North Kimberley) (Western Australian Herbarium 1998–), and differs from *S. pindanicum* by its very short stems (2–6mm), entirely basal leaves, glabrous leaves and having only two paracorolla appendages (Barrett *et al*. 2015). Morphological differences between *S. pindanicum*, *S. semipartitum* and *S. leptorrhizum* are given in detail in Barrett *et al*. (2015).

Distribution and abundance

Stylidium pindanicum is endemic to the Kimberley, where it has a western Kimberley distribution that mostly does not overlap with the more northerly and eastern distribution of *S. semipartitum* (Western Australian Herbarium 1998–). It grows in seasonally damp areas over pindan sands (Barrett *et al*. 2015). These habitats were rarely encountered during the 2017 La Grange survey, and *S. pindanicum* was found in only a single location in the far northern edge of the survey region on Roebuck

Plains Station (Figure 37). It is a new location for the species, 33 km southwest of the nearest known location.

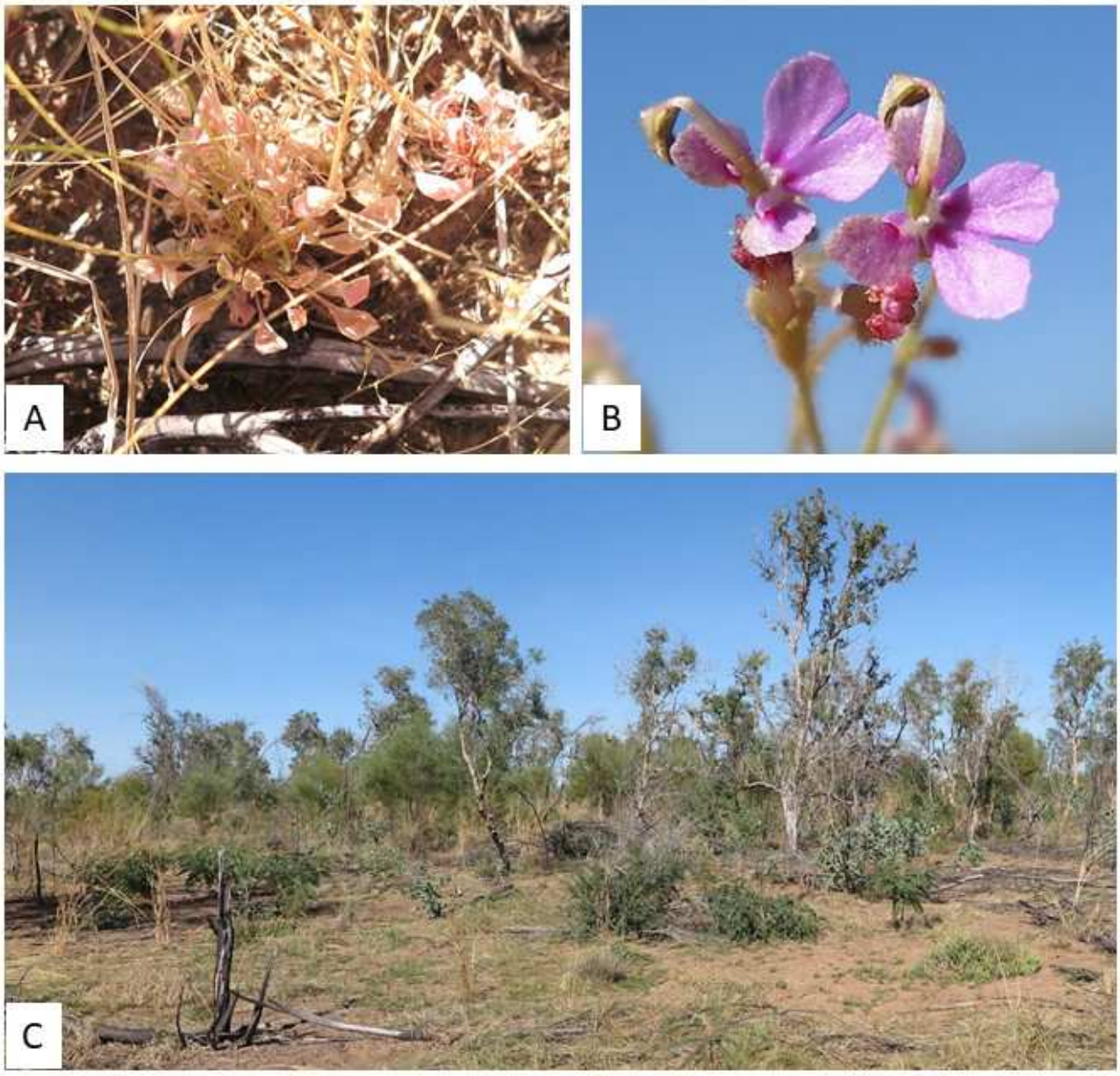

Figure 37: *Stylidium pindanicum*, **A:** terminal rosette of leaves on short stem, **B:** detail of flowers, **C:** *Melaleuca nervosa* open woodland over *Chrysopogon pallidus* grassland. Note that some trampling and grazing damage is evident which has affected the habitat of *Stylidium pindanicum*.

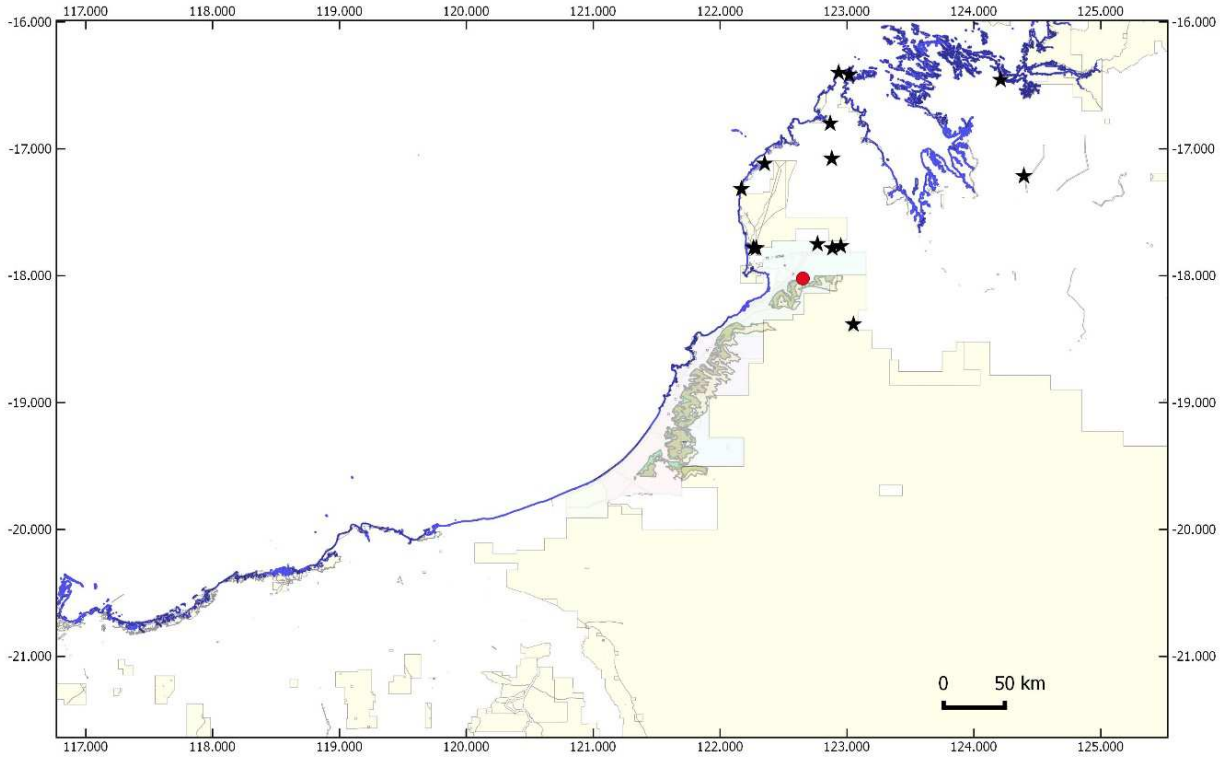

Figure 38: Distribution of *Stylidium pindanicum* based on the 2017 La Grange survey records (● red circles) and herbarium (Western Australian Herbarium 1998–) records (★ black stars).

Field observations of Stylidium pindanicum in the La Grange Survey Area

Habit:

This annual herb was in the late stages of flowering and starting to senesce in August 2017. Future survey for this species would have to focus on the small areas of seasonally damp habitats soon after the wet season.

Habitat:

The single survey record is located at the southern boundary of the pindan sandplain and the drainage system on the southern margin of the main broad valley that leads into Roebuck Plains. Plants were found growing in a damp seep on the sides of a shallow valley incised into the adjacent pindan and at whose base is an ephemeral creek line which drains into the Roebuck Plains floodplain. The vegetation in this seep is dense *Chrysopogon pallidum* and *Sorghum plumosum* grassland under *Melaleuca nervosa* open woodland and co-occurring with other herbs such a *Byblis rorida*, *Drosera* sp. and *Mitrasacme exserta*. While these plants were locally very

common and numbered >200, they were confined to a small 30 x 5 m patch of damp soil.

This area of incised valleys and channels extends for >30 km inland, and other populations have been recorded further inland on this same landform (Figure 37), so it is expected that even more patches of *S. pindanicum* will be found on Roebuck Plains Station. However, on a regional scale, these habitats are uncommon features of the La Grange Survey Area, so *S. pindanicum* is not expected to be common or frequently encountered elsewhere in the study area.

Responses to Fire, Disturbance and Grazing

Damage from grazing and trampling was evident at the site, and if animal damage becomes worse, this species and any herbs in these fragile sites would not be expected to survive. The site had been burnt three years previously, so *S. pindanicum* does reappear after fire. Another potential threat to this species is weed invasion. Buffel grass wasn't present at the time of survey, but it has the potential to invade these habitats and displace this species.

Recommendations

This site and other potential populations of *S. pindanicum* are located just outside the Preferred Areas for irrigated agriculture, so this species and its habitat are unlikely to be directly impacted by clearing for irrigated agriculture.

This survey did not find enough evidence to warrant any changes to the conservation status of this species (Table 4).

16: *Tephrosia andrewii*

Taxonomy

Tephrosia andrewii Cowie (Fabaceae) was described by Cowie (2004) based on collections from the La Grange region which were found to be of a new species.

Description

From Cowie (2004), *T. andrewii* is an erect, multi-stemmed perennial shrub to 0.8 m tall and to 1 m wide. Lower stems are thick, woody and with furrowed and corky bark. Branchlets and leaves appear silvery as they are covered in a dense indumentum of adpressed silky, white hairs. Leaves are compound, with persistent stipules and 1–5 leaflets. Leaflets are discolorous, obovate to broadly cuneate, 15–31 mm long and 12–20 mm wide, on a rachis 0–22 mm long to lower leaflets, 13 mm long between leaflets and 3-12 mm to the terminal leaflet. Flowers are arranged in pairs along a 15 mm long axillary inflorescence. The corolla is bright orange, with standard and wings 11–13 mm long and keel 10–11 mm long. The calyces are densely covered in white hairs and have long (6–8 mm) linear lobes. Pods are narrowly oblong 30–40 mm long, 6–7 mm wide, and with a dense indumentum of white hairs (Figure 39).

Similar species

Tephrosia andrewii is a distinctive and easily recognisable shrub in the La Grange region. It is most closely related to *Tephrosia uniovulata* F.Muell, but differs by its higher ovule and seed count of 4–5 per ovule/pod versus 1–2 in in *T. uniovulata*, has distinctly larger flowers and more equal leaflet lengths per leaf Cowie (2004). *Tephrosia uniovulata* does not occur in the Kimberley, but is distributed in the west Pilbara and Gascoyne (Western Australian Herbarium 1998–). *Tephrosia andrewii* is also closely allied to *Tephrosia lasiochlaena* Cowie, which does occur in the La Grange region on Parda Hill (Western Australian Herbarium 1998–), the latter species differing by 1 ovule per ovary and narrower leaflets and more compact inflorescences (Cowie 2004).

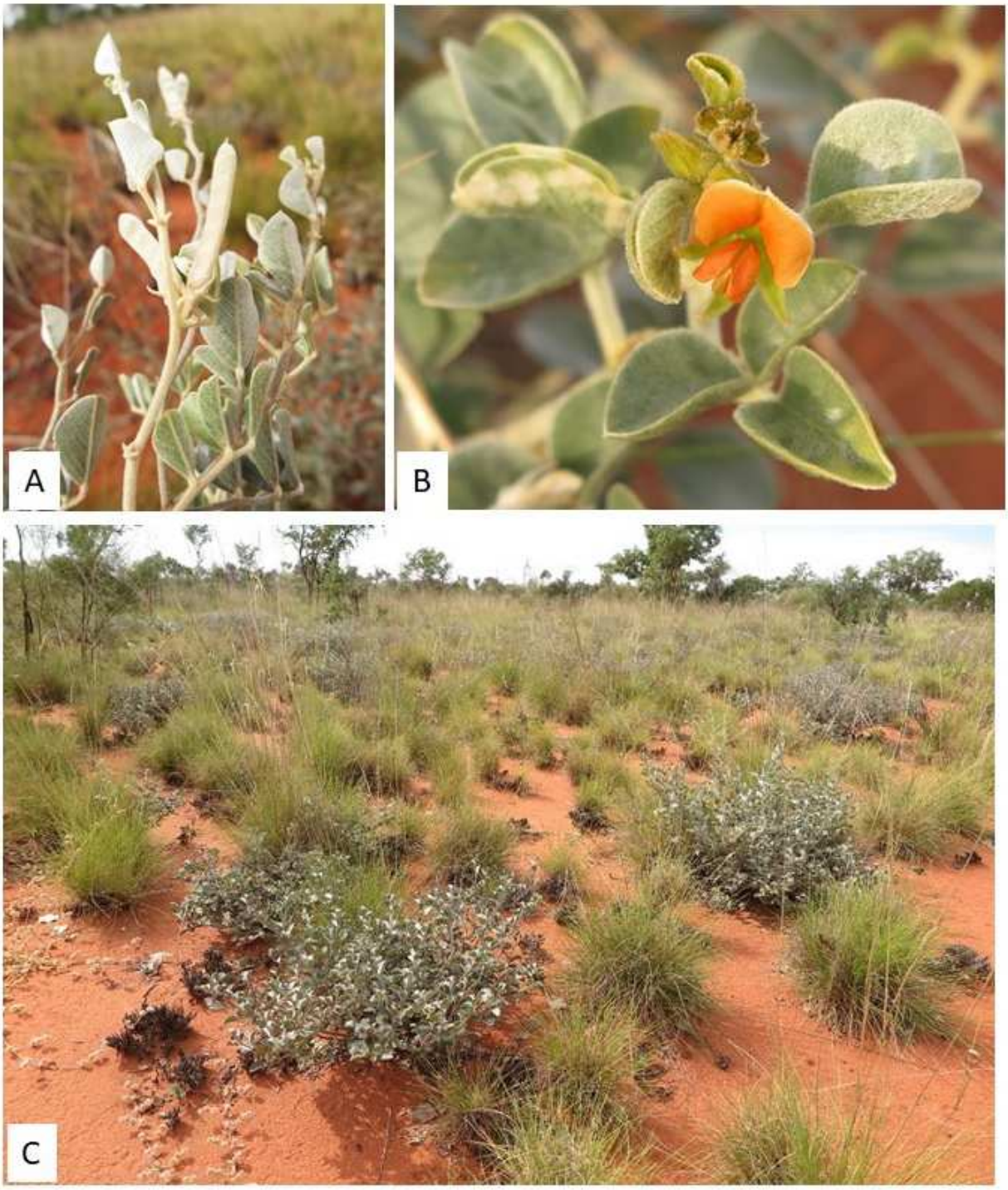

Figure 39: *Tephrosia andrewii* **A:** fruits and leaves, **B:** detail of flower**, C:** example of habit and typical habitat of *Tephrosia andrewii*. This is recently burnt open *Corymbia* woodland over *Triodia* grassland where *Tephrosia andrewii* is a dominant in the shrub stratum.

Distribution and abundance

Prior to this survey, *T. andrewii* was known from eight herbarium collections from a single location on Anna Plains and two locations on Thangoo. This distribution gap was filled as more locations and large populations were found on Anna Plains, Thangoo and Frazier Downs Stations (Figure 40). An outlying stand of a few plants was found on the north-east border of Nita Downs, but was not found east of Nita Downs. The abundance of *T. andrewii* at these sites can ranges from several scattered individuals to being a common component of the shrub stratum and with numbers exceeding >100 or >500 plants at a survey site. Estimates of density range from 7–25 plants per 10 x 10m.

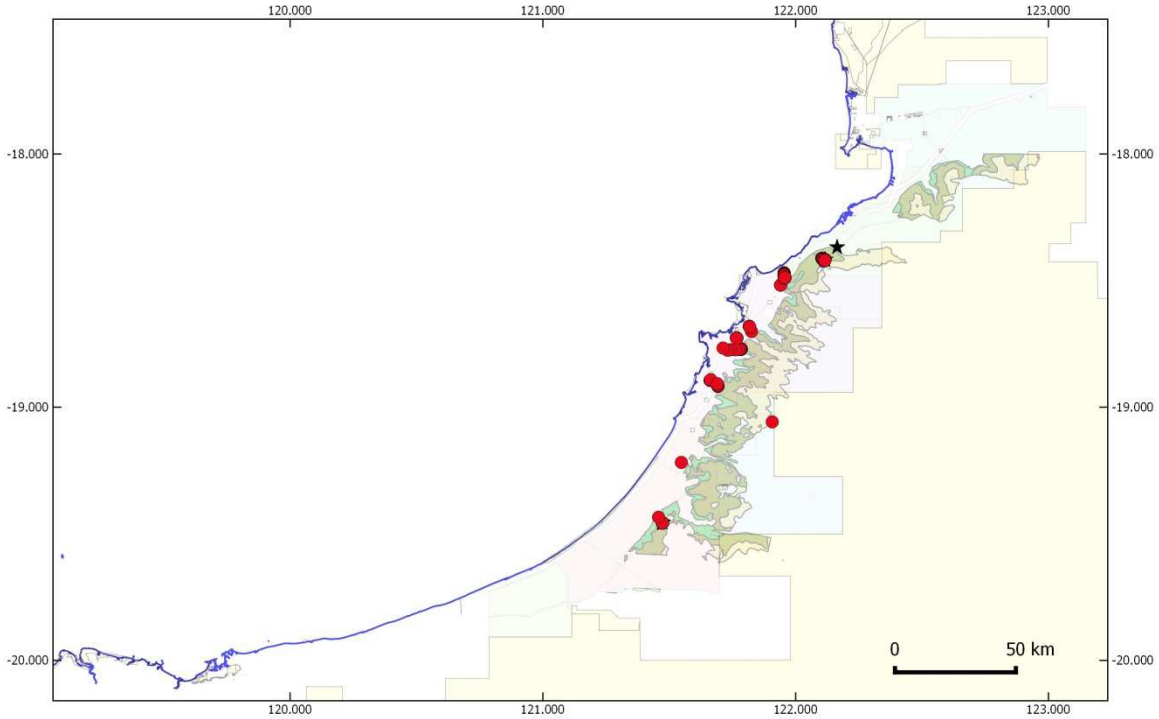

Figure 40: Distribution of *Tephrosia andrewii* based on La Grange 2017 survey records (● red circles) and herbarium (Western Australian Herbarium 1998–) records (★ black stars).

Field observations of Tephrosia andrewii in the La Grange Survey Area

Habit:

Tephrosia andrewii is a distinctive and easily recognisable shrub to 1 m with silvery compound foliage. At the time of survey from June to late August 2017, only a few individuals were in found to be fruit (<2%) and even fewer were found in flower (Figure 37).

Habitat:

Tephrosia andrewii grows on the deep red soils of the Pindan sandplain, in *Corymbia* spp. open savanna woodland, tall shrublands of *Bauhinia cunninghamii, Erythrophleum chlorostachys* or tall shrublands of *Acacia eriopoda*, *Acacia colei,* and/or *Acacia drepanocarpa*, over *Triodia/Chrysopogon* grassland. Associated species include the trees/shrubs *Grevillea wickhamii*, *Grevillea pyramidalis* and *Persoonia falcata*, low shrubs of *Corchorus incanus*, *Corchorus sidoides*, *Halgania solanacea* and *Triumfetta johnstonii*. It is not as abundant or common, and can even be absent, in dense *Acacia monticola* shrublands.

Responses to Fire, Disturbance and Grazing

Tephrosia andrewii recovers well after mechanical disturbance and fire. Not only is it very abundant in recently burnt sites (3–5 years post burn), it reaches high densities along road edges and plants resprout vigorously after road verge grading (Figure 41). *Tephrosia andrewii* appears to tolerate grazing.

Recommendations

Tephrosia andrewii has a narrow geographic range that is restricted to the central part of the La Grange region. Although locally abundant, it still is restricted to and an endemic of the La Grange region. Following suggestions, the conservation status of *Tephrosia andrewii* has been a downgraded to Priority Three (Table 4) (Smith 2018).

Much of the species' range and known sites occur in or immediately adjacent to the Preferred Areas for irrigated agriculture (Figure 40), so there is potential for *T. andrewii* to be impacted by proposed developments and cumulative impacts must be taken into account with future proposals.

Figure 41: *Tephrosia andrewii* growing along road edges (**Top**) and resprouting after mechanical disturbance from roadside mowing (**Bottom**).

17: *Terminalia kumpaja*

Taxonomy

Terminalia kumpaja R.L. Barrett (Combretaceae) was described recently by Barrett (2015) as part of a revision of species complexes in *Terminalia*, having been split from *Terminalia cunninghamii* C.A.Gardner to accommodate the morphologically distinct, disjunct southern populations of the latter species.

Description

From Barrett (2015), *T. kumpaja* is a leafy shrub or small spreading tree, 2–6 m high, with deeply fissured bark on the trunk and branches (Figure 42). The ultimate flowering branches are typically slender, and juvenile growth on seedlings and saplings is distinctively divaricately branched. Leaves are 18–85 mm long, 7–28 mm wide, light to dark green, shiny, glabrous, coriaceous, concolorous, lanceolate, narrowly-oblanceolate or narrowly-obovate, and crowded on long branchlets. Flowers are arranged on spikes 43–73 mm long, with a few bisexual flowers at the base and numerous male flowers along most of the spike. Both flower types are 2.3–2.8 mm in diameter and 2.8–4.4 mm long, white to cream in colour. The mature fruit is a glabrous, globular, dark purple to burgundy coloured drupe which is succulent when fresh, 43–53 mm long, 43–62 mm in diameter and usually with a short, distinct beak.

Similar species

Among the several species of *Terminalia* in the La Grange region and wider Kimberley, only two are likely to be confused with *T. kumpaja,* and diagnostic characters and keys are available in Wheeler (1992b), Kenneally *et al.* (1996) and Barrett (2015). As a closely related species, *T. cunninghamii* differs from *T. kumpaja* by being a taller shrub or tree (5-10 m), with longer, broader leaves (64–105 mm long and 19-43 mm wide), lacking dense divaricate branches on young plants, having thickened ultimate flowering branchlets, having larger flowers (2.7–4.5 mm diameter), and larger calyx lobes (c.1.5 mm wide × c.1.5 mm long) (Barrett 2015). *Terminalia cunninghamii* is located in the far north of the Kimberley, greatly disjunct from *T. kumpaja.*

Terminalia grandiflora is another species which has been occasionally confused with T*. kumpaja,* but this species is located north of Broome and is distinguished by its large (1.5-2 cm long) flowers (Barrett 2015)..

Figure 42: *Terminalia kumpaja* **A:** adult tree with several juvenile saplings at the base exhibiting a divaricate growth form, **B:** detail of flowers, **C:** example of massed flowering in *Terminalia kumpaja*

Distribution and abundance

Terminalia kumpaja is restricted to the Dampierland bioregion, with most populations located between Wallal Downs and Anna Plains Stations and a few more isolated occurrences scattered on the Dampier Peninsula (Figure 43). This species was found to be a common and abundant species in the southern third of the La Grange Survey Area, but this declines to occasional, isolated, scattered trees c. 50 km north-east of Sandfire Roadhouse (near Wild Dog Bore on Anna Plains Station). North of this point, *T. kumpaja* was only encountered on two occasions: as a single tree c. 7km north of the turnoff to Anna Plains Homestead, and a solitary cluster of several plants on Thangoo Station (Figure 43). No other plants were encountered beyond this stand, which suggests that these may have been an accidental or deliberate introduction.

Within its main distribution, *T. kumpaja* ranges in abundance from isolated, scattered trees to being locally common, forming extensive stands of 10 -15% cover or estimates densities of 2-5 trees per 20 x 20m. Counts were not attempted as aerial imagery would be the preferable option for population counts rather than counts from ground transects.

Field observations of Terminalia kumpaja in the La Grange Survey Area

Habit:

Terminalia kumpaja forms large shrubs to small trees to 4 m, plants appeared to be in good-excellent condition, with new growth and flowering was estimated to be 10-40% of individuals within a site. By late August, fruiting had still not commenced. The distinctive divaricate growth form and small leaves was commonly observed in juvenile forms of *T. kumpaja* (Figure 42). Seedlings were not observed, but it is suspected that the saplings clustered around adult trees may be growing from root suckers.

Habitat:

Terminalia kumpaja grows in deep red sands, on expansive sandplains and swales between longitudinal sand dunes. Together with *Owenia reticulata*, and *Bauhinia cunninghamii*, *T. kumpaja* is one of the dominant trees in the region where they form the upper stratum of a very sparse open woodland or isolated trees over shrublands varyingly dominated by *Acacia colei*, *B. cunninghamii, Acacia coriacea, Acacia bivenosa* and *Erythrophleum chlorostachys*, over shrublands and grasslands of *Acacia. stellaticeps*, *Corchorus incanus, Crotalaria cunninghamii*, *Triodia schinzii* and *Triodia epactia*.

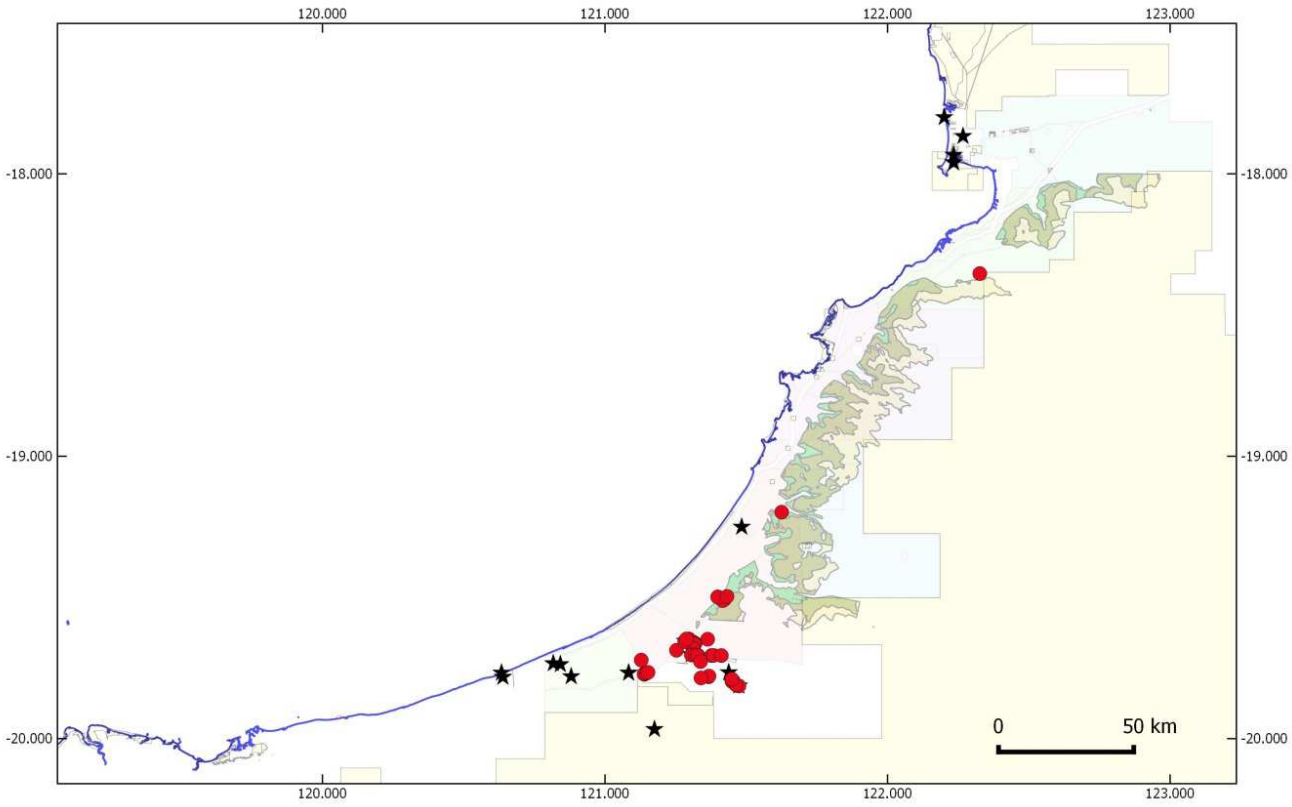

Figure 43: Distribution of *Terminalia kumpaja* based on La Grange 2017 survey records (● red circles) and herbarium (Western Australian Herbarium 1998–)) records (★ black stars).

Responses to Fire, Disturbance and Grazing

Terminalia kumpaja appears to recover from fire by resprouting and possibly from suckering, and appears to tolerate grazing, with tall, healthy plants observed around cattle yards. The effects of grazing and weed invasion on seedling recruit are unknown. It is not considered likely that *T. kumpaja* can tolerate mechanical disturbance.

Recommendations

Terminalia kumpaja is largely absent from the La Grange Project Area (Figure 43), so much of the range of this species will not be impacted by the proposed developments for irrigated agriculture.

This species is largely restricted to a narrow geographic range in the south of the La Grange region, and while locally abundant, it is recommended that no changes are made to its current conservation listing.

18: *Triodia caelestialis*

Taxonomy

Triodia caelestialis G. Armstrong is one of the 'soft' spinifex grasses described in 2008 (Armstrong 2008), and is named for the distinctive star-shaped cluster of sterile florets at the top half of the spikelet.

Description

As described by Armstrong (2008), it is a non-stoloniferous, non-resinous perennial tussock-forming grass 40 cm tall x 60 cm wide. Non-reproductive culms are up to 4 cm long, leaf blades to 30 cm long and 2 mm wide. Reproductive culms are 160–200 cm tall, and 4–5 mm wide, with 3–5 prominent nodes. Panicles are 18–40 cm long, with 11–26 primary branches and secondary branching of basal branches. Spikelets number up to 14 per branch, have a distinctive campanulate apex and coalesce into a tangled ball when dry. Spikelets have 6–10 florets, the basal 1–3 being fertile and the apical 5–7 infertile and consisting only of lemma lobes. The middle 2–3 of the infertile florets have characteristic wider lemma lobes than surrounding florets, which are compact and flaring out in a star-shape. Lemmas are bitextured, and lobes range in colour from purple to straw, with a central green nerve. Uppermost florets are reduced to awns. Glumes are linear-lanceolate, 15–24 mm long, exceeding the spikelet (but not awns), and upper and lower glumes are of equal length.

Similar species

Triodia caelestialis was separated from its sister taxon *T. acutispicula* Lazarides by Armstrong (2008) based on differences in inflorescence morphology and reproductive output. Unlike *T. caelestialis*, *T. acutispicula* has elongate (> 4 cm) non-reproductive culms, produces stolons and has only a fifth of the seed output. The glumes of *T. acutispicula* are shorter on average (9–18 mm), with fewer florets (3–7) per spikelet. In *T. caelestialis*, the indurated lower part of the lemma has two parallel rows of hairs running up the centre of the lower half while *T. acutispicul*a has a glabrous lemma (Armstrong 2008).

While *T. acutispicula* is located north of the La Grange region (Western Australian Herbarium 1998–), *Triodia schinzii* (Henrard) M. Lazarides is the only other species within the survey area which has similarly long glumes. *Triodia schinzii* is easily distinguished from *T. caelestialis* by appressed hairs covering the lemma, awns on the floret do not expand, resinous foliage, leaf blades are straight, pungent and arising at wide angle from the culm (Lazarides *et al*. 2005). *Triodia caelestialis* has flexuose, spiralling, slightly pungent leaf blades (Armstrong 2008) which arise at a more acute angle to the culm axis.

Distribution and abundance

The La Grange Survey Area is at the south-western edge of the range of *T. caelestialis,* which has a wider regional distribution in the west Kimberley (Figure 44). *Triodia caelestialis* was only found in northern half of the La Grange survey area, on Shamrock, Thangoo, Frazier Downs and Roebuck Plains Stations. Conversely, *T. schinzii* was found across the survey region, including some co-occurrences with *T. caelestialis* (Figure 44).

Triodia caelestialis is often dominant or co-dominant in the lower stratum, with cover estimates ranging from 10–40% (and up to 65%) and extending for kilometres down a track. In other locations, times *T. caelestialis* can be very sparse (2–8%) and scattered among more dominant grass species.

The distribution and abundance of *T. caelestialis* is likely to have been underestimated during this survey as sampling was not as exhaustive as had there been younger, fertile material available. Although a good wet season resulted in copious flowering among the Triodia species in the La Grange region, by the time fieldwork commenced the grasses had shed almost all of their seed and only weathered, frayed glumes remained on panicles. Often spikelets were only available when they had been trapped in spider webs on panicles, so usually only that material was collected. In hindsight, more material could have been collected for identification purposes, as *T. schinzii* can be differentiated from *T. caelestialis* (with some practice) from leaf and tussock morphology and from old disarticulated spikelets trapped in glume remnants (using lower indurated lemma hair characters), but this was only discovered after fieldwork.

Field observations of Triodia caelestialis in the La Grange Survey Area

Habitat:

Triodia caelestialis was found in this survey in open woodlands of *Corymbia* spp. over *Acacia eriopoda*, or *Acacia eriopoda* and / or *Acacia monticola* woodland or tall shrublands on Pindan soils, where it usually forms a mid-dense tussock grassland in association with *Chrysopogon pallidus* and *Aristida inaequiglumis*. It has been found to co-occur with *T. schinzii* (this extent of this co-occurrence needs further survey to determine extent of this). Other commonly associated species are *Gyrocarpus americanus, Grevillea refracta, Corchorus sidoides*, *Dolichandrone occidentalis, Bauhinia cunninghamii, Eriachne obtusa, A. monticola*. *Waltheria indica, Melhania oblongifolia, Sida* sp. Pindan (B.G. Thomson 3398) and *Sorghum* sp..

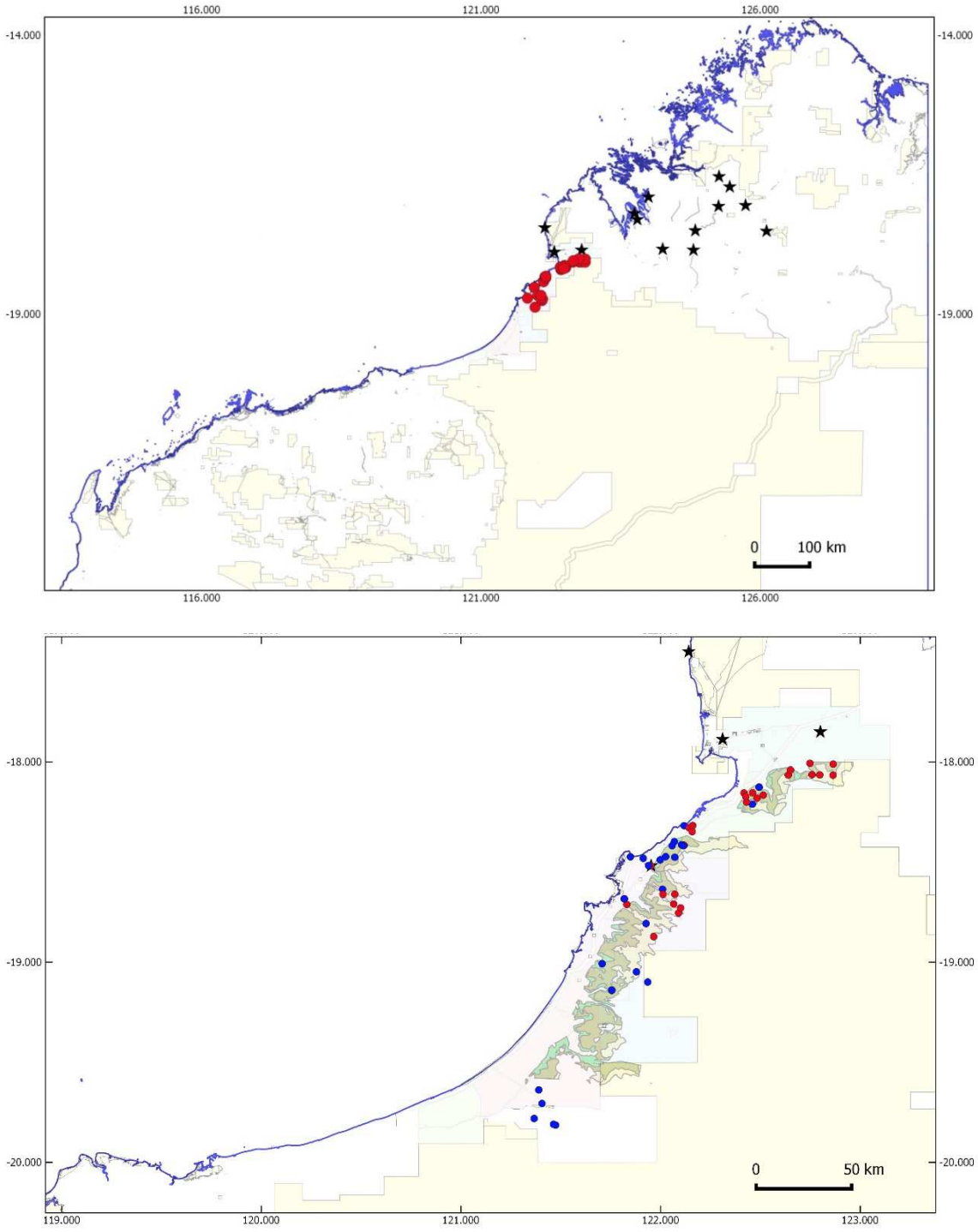

Figure 44: Top: Distribution of *Triodia caelestialis* in northern Western Australia based on records from the La Grange 2017 survey based on *Triodia caelestialis* (● red circles) and Western Australian Herbarium (1998–) records (★ black stars), **Bottom:** distribution of *Triodia caelestialis* (● red circles) and *Triodia schinzii* (● blue circles) within the La Grange Survey Area based on identified collections from the La Grange 2017 survey.

Recommendations

Triodia caelestialis is widespread and abundant in both the northern La Grange region and western Kimberley, which warranted the removal of its conservation status and downgrading to Not Threatened (Table 4).

For future surveys, sampling in the months immediately after a good wet season is recommended for good, identifiable material for species of *Triodia*.

19: *Whiteochloa capillipes*

Taxonomy

Whiteochloa capillipes (Benth.) Lazarides was formally described by Bentham (1878) under the name *Panicum capillipes*, included in the treatment of *Panicum* by Hughes (1923), and was later being transferred with four other *Panicum* species (including *P. airoides*) to the genus, *Whiteochloa* (Hubbard 1952, Lazarides 1978). *Panicum cymbiformis* was later transferred to *Whiteochloa* by Simon (1981) after Lazarides (1978) found it to have characters intermediate between the two genera.

Description

Whiteochloa capillipes is distinguished by its lax, loose to open, slender, decompound panicle 16(–25) cm long and 5–6 cm wide, which is erect or sometimes drooping. Bristles are consistently absent at the end of panicle branches. Primary panicle branches up to 14 cm long, divided from base. Secondary branchlets are spreading and long, and spikelets are borne on long, thread-like, fine, spreading pedicels. Pedicels 6–15 mm on lateral branches, and 11–30 mm long on terminals. Spikelets are slender and glabrous. Plants are annual or short-lived perennials, 60–105 cm tall, loosely tufted tussocks. More diagnostic leaf, spikelet, glume characters are detailed in Lazarides (1978).

Similar species

Two species in the La Grange region are similar to *W. capillipes. Whiteochloa cymbiformis* (Hughes) B.K.Simon is distinguished by filiform bristles at the end of panicle branches, which are usually (but not always) present. Like *W. capillipes*, the panicles of *W. cymbiformis* are tall, lax-branched and decompound. Panicles are 12–70 cm long and 4–15 cm wide, lanceolate–elliptic, and contracted around primary branches. Other salient characters are spikelets subsessile or on short pedicels, set obliquely and crowded on short, secondary branchlets of the panicle. Plants are annual or short-lived perennials forming loosely tufted tussocks 50–200 cm tall. Diagnostic leaf, spikelet, glume characters are detailed in Lazarides (1978) under *P. cymbiformis*. In the La Grange region, panicles are ≥40cm and plants appear to be annuals (possibly short-lived perennials), loose, weak tussocks 1m tall.

Whiteochloa airoides is distinguished by shorter, narrow, racemose panicles, 10–25 cm long, loosely contracted and 1–2 cm wide, or sometimes open and up to 10 cm wide. Spikelets are characteristically plump, strongly convex and with a prominently ribbed upper glume, and clustered on crowded short, stout panicle branches. Plants are perennials, 45–105 cm tall and forming compact tussocks. In the La Grange region, *W. airoides* has the compact panicle and compact, perennial growth habit.

Herbarium collections of Whiteochloa capillipes from the Pilbara - Kimberley

Collections of *Whiteochloa* held at the Western Australian Herbarium were examined with reference to both species descriptions (Lazarides 1978, Hughes 1923), and an online image of the type (A.C. Hull, s.n.). Four specimens of *W. capillipes* were re-identified as other species. Two of these collections (C. Parker 1592 – CWP-330.1, A.A. Mitchell, PRP 192) were found to be species of *Panicum* (*P. decompositum* and tentatively *P. laevinode*). The seed, panicle shape, pedicel length and habit of these *Panicum* species are distinctively different to that of *Whiteochloa*.

The remaining two specimens (A.A. Mitchell 4568 and A.A. Mitchell PRP 336) were re-identified to *W. cymbiformis* as these had spikelets on short pedicels (subsessile) and bristles on end of secondary branches.

Distribution and abundance

Re-identifications of the four collections in the Western Australian Herbarium (PERTH) effectively removed *W. capillipes* from the Pilbara and western Kimberley, although there is a remaining record for *W. capillipes* in the Australian National Herbarium (CANB) as an outlier in Exmouth which will need to be examined. The remaining *W. capillipes* collections at PERTH were found to accord with characters given in Lazarides (1978) and Hughes (1923), and were good match for the type (A. Cunningham #341). Therefore, in Western Australia *W. capillipes* is restricted to the far northern Kimberley, extending across the Northern Territory and into northern Queensland (Figure 45) (CHAH 2011–, Lazarides 1978).

Field observations of Whiteochloa cymbiformis and W. airoides in the La Grange Survey Area

Habitat:

Whiteochloa cymbiformis is widespread in La Grange region, where it occurs in open *Corymbia* spp. / *Bauhinia cunninghamii* woodlands or tall *A. eriopoda* shrublands, over *Triodia* grassland on pindan soils. It is usually infrequent and restricted to growing under taller shrubs, but it can occur as the dominant grass layer (Figure 46). Within the state, *W. cymbiformis* occurs across the Pilbara coast and into and across the Kimberley (Figure 46). Within Australia, *W. cymbiformis* extends across the Northern Territory into scattered locations in Queensland (CHAH 2011–).

Whiteochloa airoides has been recorded from a across wide range of sandy, alluvial or lateritic habitats (Lazarides 1978), but along the south-western Kimberly coastline it is as a dominant, perennial tussock grass on stabilised coastal sand dunes. On the

Dampier Peninsula, it occurs on the edges of mobile sand dunes outside vine thickets (Kenneally *et al*. 1996). In the La Grange region, a robust, perennial form is seen along 80 Mile Beach on Anna Plains Station (Figure 46). Within Australia, *W. airoides* occurs across northern Australia, ranging from Western Australia and the Northern Territory into Queensland (CHAH 2011-, Lazarides 1978)

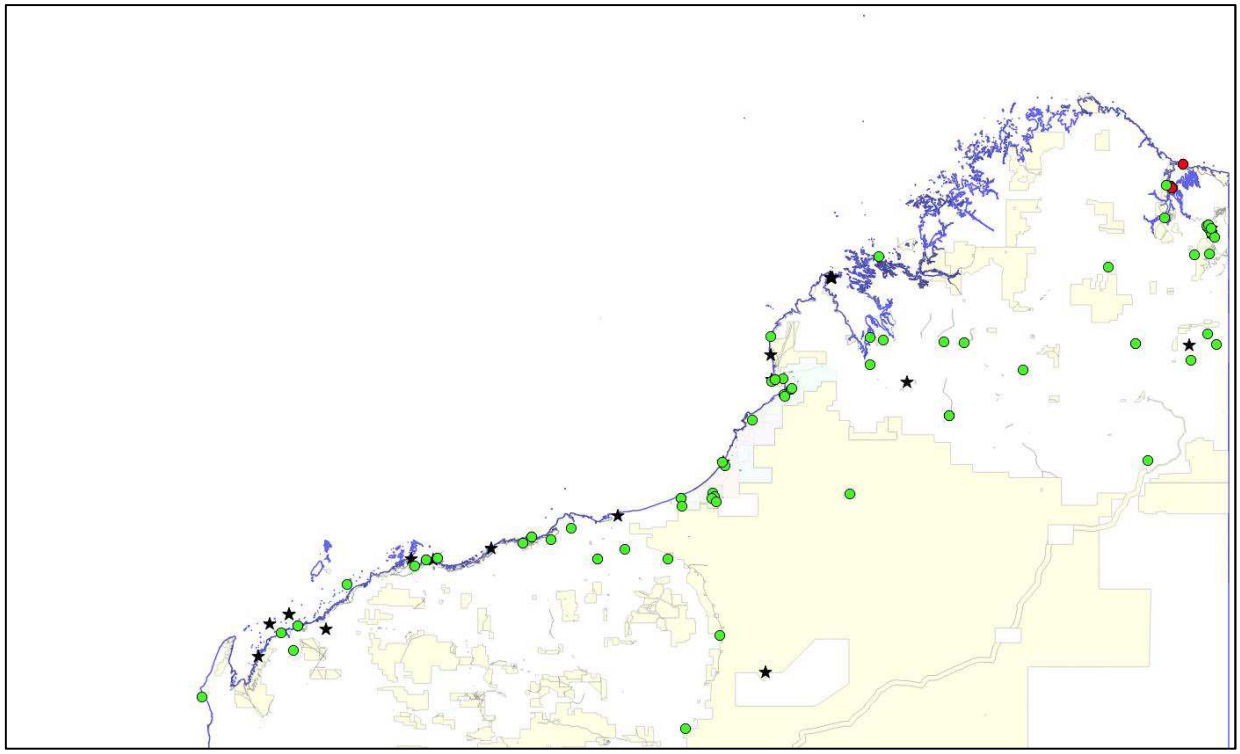

Figure 45: Distribution of *Whiteochloa capillipes* (● red circles), *Whiteochloa cymbiformis* (● green circles) and *Whiteochloa airoides* (★ black stars) based on the Western Australian Herbarium (1998–) collections and findings from the La Grange survey. Collections in other Australian herbaria have not been included as their identities cannot be confirmed. Note that *Whiteochloa capillipes* is restricted to the far northern Kimberley region, close to the border with the Northern Territory.

Figure 46: Top: *Whiteochloa airoides* on stabilised fore-dunes on Eighty Mile Beach, Anna Plains Station. **Bottom:** *Whiteochloa cymbiformis* as a dominant grass layer in open *Corymbia / Eucalyptus* woodland on Pindan soils on Thangoo Station.

Recommendations

Collections of these three similar *Whiteochloa* species held in Australian herbaria require further curation to confirm or correct species identifications.

Whiteochloa capillipes does not occur within the La Grange Project Area and will therefore not be impacted by proposed agricultural development associated with the La Grange project.

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