POPULATION CHARACTERISTICS OF *ROYCEA PYCNOPHYLLOIDES* (SALTMAT)

A framework for monitoring change

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Conserving the nature of WA

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1.0 INTRODUCTION

There are three described taxa of *Roycea* found in Western Australia (Paczkowska and Chapman 2000). This study focuses on *Roycea pycnophylloides,* identified as being seriously threatened by salinity and waterlogging. Funds made available through the State Salinity Strategy have enabled this study, which aims to increase the understanding of the species biology and ecology.

Roycea pycnophylloides occurs in seasonal wetlands within the wheatbelt of Western Australia. Such wetlands have suffered marked changes due to clearing for agriculture and associated land management practices.

Populations of *R. pycnophylloides* in all study sites are located along drainage lines that flow through agricultural areas used for grazing or cropping. Extensive clearing for agriculture since European settlement has resulted in the fragmentation of ecosystems (Muir 1977). Remaining native vegetation exists as reserves, or is found on private land, much of which is unmanaged and unfenced (Weaving 1999). Reserves were set aside for many purposes including, townsites, recreation, timber, gravel, water catchments and roads as well as flora and fauna conservation. Road reserves and wetlands form important biological corridors often containing rare and endangered flora and are frequently the only remaining examples of original vegetation within cleared areas. Wetland corridors can be more complex to manage because the interaction between the vegetation and hydrology is dynamic (Mattiske 1995).

Salinization of inland wetlands in south-west Western Australia has caused both a decline in species richness and a marked change in species composition, particularly in saline and hypersaline sites. Many species occur only within a restricted salinity range (Halse *et al.* 1993; Sanders 1991). In addition to clearing, climatic change may also influence the hydrology and salinity of lake chains and this also needs to be factored into conservation consideration (Hobbs and Hopkins 1991).

1.1 History and conservation status

Charles Gardner first collected *Roycea pycnophylloides* in 1945 from an area just east of Meckering in the central wheatbelt of south-west Western Australia. Further populations were located in:

- 1985 by Steve Hopper[1]
- 1995 by employees of Mattiske Consulting during surveys for 'A review of botanical values on a range of Gypsum Dunes in the Wheatbelt of Western Australia' (Mattiske 1995)
- 1999-2002 by Mike Lyons[2] while establishing floristic survey quadrats as part of a 'Biological Survey of the Wheatbelt' under the Salinity Action Plan (Lyons *et al.* in press); and in
- 2003 by Diana Papenfus[3] during surveys for Critically Endangered Plants (Papenfus 2004).

The species was declared as Rare Flora in October 1996, ranked as Critically Endangered (CR) in December 1997, was downlisted to Endangered (EN) in September 1999 and is currently listed as Vulnerable under World Conservation Union (IUCN) Red List Criteria 2ab(iii) (IUCN 2000). Sixteen populations totalling over 1.5 million plants have been located, many of which are in the conservation estate.

1.2 Plant description

Roycea pycnophylloides can differ in its growth habit. It has been described as; a perennial herb that forms densely branched, silvery mats to 1m wide (Paczkowska and Chapman 2000) and a mat-like subshrub (Brown *et al.* 1998). It has many hairy branchlets covered with dense silvery sessile leaves that overlap tightly. The leaves are about 2 mm long, more of less concave, have membranous edges and minute hairs. The taxa are predominantly dioecious, although male and female flowers have been observed to occur on a single plant. Male flowers have 4 or 5 orange-red stamens opposite the

[1] Steve Hopper, Former Senior Research Scientist, CALM Science Division
[2] Mike Lyons, Research Scientist, CALM Science Division
[3] Diana Papenfus, former Project Officer, CALM

perianth segments with yellow pollen and female flowers have long maroon styles divided into 2 or 3 parts. Flowering occurs from October to April. The fruit is fleshy, 1-2 mm long hidden in the leaf axils and contains a single fleshy seed less than 1 mm in length (Figure 6).

1.3 Distribution and habitat

Populations of *Roycea pycnophylloides* are found in the Avon, Yilgarn and Lockhart catchments of the central and southern Wheatbelt region of south-west Western Australia, growing along shorelines or on open saline flats of major drainage channels.

The preferred habitat for *Roycea pycnophylloides* is from just below the low watermark to around the highwater mark of lake shorelines where populations occur in white to pale brown sand over sandy clay both independently of or within nearby fringing vegetation. Associated plants include *Frankenia* spp. *Halosarcia* spp. *Atriplex hymenotheca, Melaleuca halmaturorum, M. thymoides* and ephemeral species. (See Site and quadrat descriptions, pages 28-32).

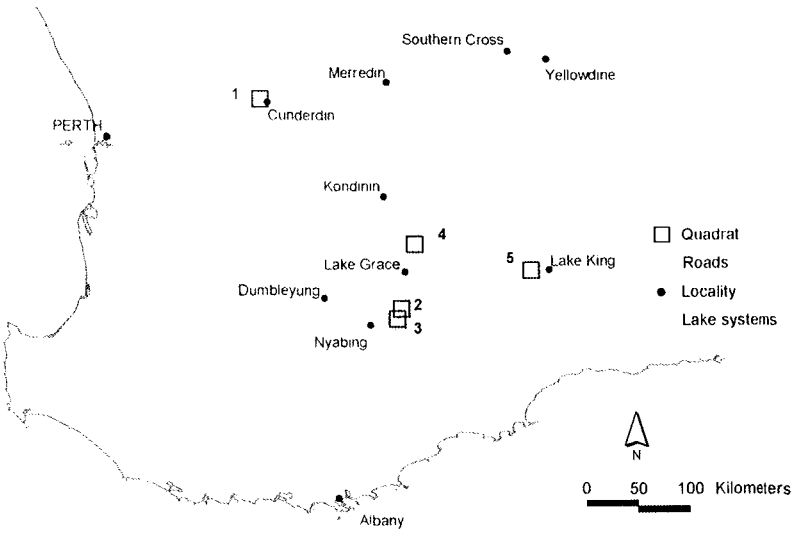
Of the nine populations known prior to 2003, five were selected for long-term monitoring and collection of reproductive data. They are located within the Department of Conservation and Land Management's (CALM's) Merredin and Katanning districts over an area of 290 km (Figure 1).

Population 7 at Cunderdin, occurs within a threatened ecological community (TEC) known as the 'Salt Flats Plant Assemblages of the Mortlock River (East Branch)' (English and Blyth 1999). Located on private property, the area was cleared for agriculture but is now fenced from grazing stock.

Populations 2, 4 and 5 occur along drainage channels running into Lake Chinocup and Lake King. Both lake areas were found by Mattiske *et al.* (1995) to be of particular importance because they have a high degree of uniqueness and several threatened, restricted or poorly collected plant species. Population 2 is made up of three subpopulations in Chinocup Nature Reserve (NR), an A class reserve (No. 28395) covering 19,825 hectares. This is an extensive population that grows on a number of clay flats interspersed with sandy rises. Population 5 occurs on the western edge of Lake Chinocup ~12 km south of Population 2. Population 4 is located on the southern edge of a drainage line entering Lake King from the west.

Population 9 occurs in the Mordetta NR, a C class reserve (No. 27887) ~50 km north of Chinocup NR. This is a smaller reserve covering just 374.3 hectares. The population occurs on the northern shoreline of a drainage channel that flows through cleared agricultural land.

Figure 1. Location of selected Roycea pycnophylloides populations with established quadrats.



The Wheatbelt region has a Mediterranean climate with cool wet winters and hot dry summers. Weather data recorded at the nearest centres to monitored *Roycea pycnophylloides* populations were collated and are shown in the table below.

Table 1. Weather data recorded from the nearest centres to *Roycea pycnophylloides* study sites.

Nearest weather centre	Long-term mean rainfall	5 year trend for total annual rainfall	Long-term mean temperatures	
Lake Grace	353.3	1999-428.8 2000-325.6 2001-312.6 2002-196.4 2003-343.8	Warmest month January Max – 31.5°C Min – 14.8°C	Coolest month July Max – 15.3°C Min – 5.7°C
Lake King	342.1	1999-404.1 2000-321.2 2001-387.6 2002-193.2 2003-360	No temperature data available	
Cunderdin	368.6	1999-526.4 2000-351.6 2001-300 2002-268 2003-380.2	January Max – 34.1°C Min – 17.4°C	July Max – 16.6°C Min – 6.2°C

Well above average rainfall was recorded at all centres in 1999. This increase was reflected throughout the mid-Wheatbelt and into the Midwest region. Although rainfall is predominantly between May and September at all centres, summer rainfall events are also recorded.

The fire histories of habitat in which *Roycea pycnophylloides* occurs are not known. However fires have not occurred on the Jasper property, where Population 7 occurs, for over 40 years (D. Jasper[4] *pers. comm.*). Satellite imagery available since 1985 does not show burns within locations of *R. pycnophylloides*.

2.0 REPORT OBJECTIVE AND OUTLINE

The *in-situ* conservation of rare and threatened plant species is contingent upon firstly, detecting changes in population size or condition, secondly, determining the causes of changes and thirdly, in the case of population decline implementing actions that will reverse the trend.

The aims of this project were to establish for *Roycea pycnophylloides* a quantitative monitoring framework and data baseline to obtain information on populations and species growth characteristics and for detecting changes in population abundance, health, life stage structure and reproductive potential.

This report presents data on the characteristics of *R. pycnophylloides* populations that will serve as a baseline for detecting change and determine if the management of populations is meeting conservation objectives.

3.0 METHODS

[4] Darren and Donna Jasper, property owners, Cunderdin, Western Australia.

Known populations of *Roycea pycnophylloides* that were accessible and those at geographical extremities were selected for long-term monitoring. Time constraints for the project did not enable the assessment of all populations prior to selection; therefore study sites were established as each population was visited.

3.1 Population details

The project involved:

1. Establishing permanently marked quadrats of 25 m^2 (12.5 x 2.5 m) within five separate populations.
2. Permanently identifying at least 100 *Roycea pycnophylloides* plants for long-term monitoring.
3. Assessing canopy dimensions of identified plants by measuring width at the widest diameter and at 90° to the widest diameter.
4. Assessing the health and vigour of identified plants by estimating the percentage of live canopy.
5. Counting the total number of inflorescences on each *R. pycnophylloides* plant identified.
6. Recording sexual status of each plant.
7. Recording life-stage classification of each plant assessed, ie. mature or juvenile (juveniles were identified as non-flowering plants with smaller growth measurements than flowering plants in the same quadrat).
8. Recording other ecological and biological observations relevant to *F. conferta* populations that will assist in management of the species.

A subset of 375 plants throughout the five study sites were permanently identified for monitoring. Establishment of all quadrats was undertaken in October 2003 when flowers were emerging. Quadrat 1 is located just west of Cunderdin within Population 7. Quadrat 2 is established within Subpopulation 2a west of Lake Altham. Quadrat 3 is established within Population 5 on the western edge of Lake Chinocup. Quadrat 4 is located in Population 9 in the Mordetta NR and Quadrat 5 has been established within Population 4 on the western edge of Lake King.

All 25m^2 quadrats have five 1m^2 subquadrats permanently marked within them to monitor a random subsample of the population. As it was impractical to permanently label the plants due to their small size and fine stems, the area and location of the first 10 male and 10 female plants within the subquadrats (where possible) were graphed for future reference. The graphs are held in CALM files at WATSCU. Plant characteristics were assessed at the time of quadrat establishment (Table 10).

Characteristics of each quadrat were also recorded at the time of establishment and are detailed in Appendix 1. Characteristics include: soil descriptions, plant community classification according to Muir (1977), estimation of percentage cover of each strata including bare ground (Table 9) and location descriptions. The method of percentage cover estimation uses that of Keighery (1994). Associated species in all quadrats and occasional plants common to each site were also noted. Samples of unknown species were collected and identified at the Western Australian Herbarium.

Photographs (transparencies are lodged with WATSCU) were taken of all study sites to monitor change (Figures 7-11). GPS readings were also taken at all populations and quadrats and at all landmarks considered relevant for the relocation of the populations for long-term monitoring (Table 11).

3.2 Plant size and vigour

Measurements taken to assess the size and vigour of the 375 identified plants were:

1. Height.
2. Width of the canopy at the widest point and the width at 90° to the widest point.
3. Percentage of live canopy.

Canopy area for each plant was calculated using the equation for an ellipse (long axis x short axis x 0.7854). Results were graphed using canopy area size classes of 0-1, 1.1-10, 10.1-50, 50.1-100, 101.1-500 and >500 cm^2, which allows for adequate viewing of the size distribution over all study sites

(Figure 2). Then the number of plants within each of the size classes that had 0, 1-25, 26-50, 51-75, 76-99 and 100% live canopy were calculated (Figure 3).

Plants that exhibited signs of stress were recorded on the field data forms and numbers detailed in results under 4.3. Signs of stress include:
1. Partial canopy death (plants within the 51-75% live canopy or less)
2. Obvious damage to plant from eg. animals or insects
3. Vegetation colour changes eg. Chlorosis

The growth habit of *Roycea pycnophylloides* is mostly mat-forming and at times definitive boundaries of individual plants were unclear. Separation of plants was undertaken by identifying male and female flowers within plant canopies.

Photographs were taken showing growth habit, male and female flowers, root structure and also of stressed and healthy plants for future comparison (Figures 4, 5 and 6).

3.3 Reproductive characteristics

Reproductive characteristics were investigated over a single flowering season from late spring 2003 to autumn 2004. It was impractical and damaging to permanently label stems or inflorescences on each plant due to their small size, fine multiple stems and, in most populations, mat-forming growth habit. Therefore, reproductive potential of *Roycea pycnophylloides* plants was assessed by:
1. Selecting the first 4 female plants (where possible) within each subquadrat for flower and fruit monitoring.
2. Counting the total number of flowers on each plant.
3. Counting the total number of fruits on each plant.
4. Collecting fruits for assessment of seed production.

Flowers were counted at quadrat establishment between the 15th and 29th of October 2003. Fruits were counted and collected on the 21st of January and the 31st of March 2004. Mature fruits were difficult to determine, therefore stems that were viewed under a hand lens as having swollen leaf axils were collected. Collections from each plant were stored separately and the seeds counted under a stereomicroscope. An assessment of viable seeds per fruit was made (Table 7). Seed viability was assessed by their size, form and fleshiness.

Whilst digging shallow excavations to determine plant boundaries within Population 4, it was noted that plants have a swollen tuberous-like taproot. Further investigation included excavations of one plant each at Populations 4 and 2a to determine whether *Roycea pycnophylloides* plants have storage capabilities.

The mean and total number of flowers and fruits for male and female plants were then calculated for each site (Table 4).

3.4 Soil characteristics

Descriptions of surface and shallow depth soils were recorded at the time of quadrat establishment. Soil samples were taken for salinity and pH testing on the 26th and 27th of November 2003. Samples were taken at 10 cm intervals to a depth of 30 cm (determined to be the furthest depth at which the *Roycea pycnophylloides* roots grow) from each corner and in the centre of all quadrats using a 5 cm diameter augur.

Soil from each hole was placed in labelled press lock plastic bags for transport and then stored in open bags under cover to air dry. Testing was undertaken at the Department of Conservation and Land Management research laboratory in Como.

Electrical conductivity (EC) and pH tests were undertaken after the samples were amalgamated for each site and then oven dried at 40°C for 3 days. Dried soil aggregates were broken down and

passed through a 2 mm sieve then particles 2 mm or less was reduced in volume to approximately 250 ml by repeated cone and quarter method (Table 8).

4.0 RESULTS AND DISCUSSION

4.1 Population Size

Surveys undertaken from 1985 to 2003 have located 16 populations of *Roycea pycnophylloides*. Accurate counts of plant numbers were difficult to assess because of the large numbers of plants in some populations and their mat-forming growth habit.

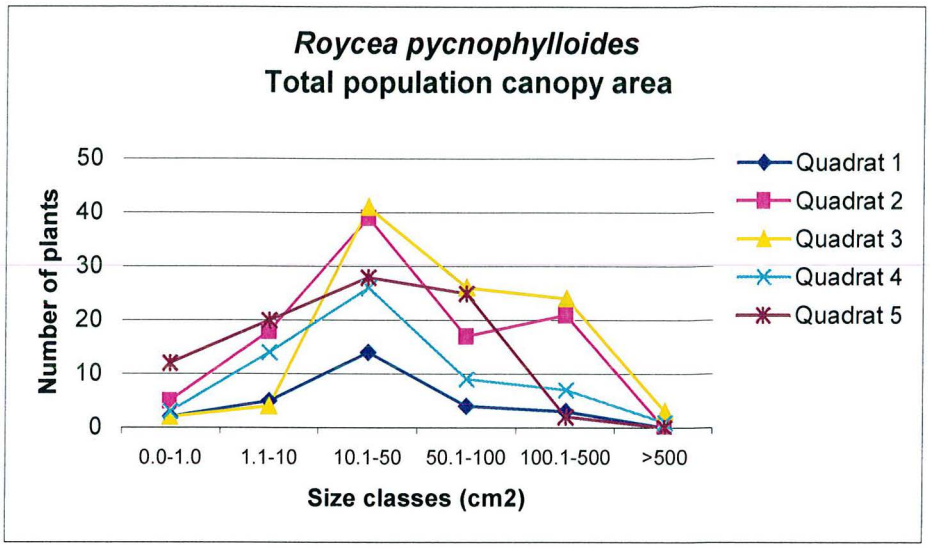
Table 2. Population details for *Roycea pycnophylloides* – December 2003.

Population No. & Location	Year found	Number of plants to date	Population condition
1. East of Meckering	1988	12	Poor
2 (a, b & c). Chinocup Nature Reserve	1985 (a) 2000 (b & c)	~1,500,000	Healthy/Moderate
3. Kondinin Salt Marsh	1999	29,720	Healthy
4. Lake King	2000	100+	Healthy
5. Lake Chinocup	2000	100+	Healthy
6. North-east of Lake Grace	2000	20+	Healthy
7. Cunderdin (East of Mortlock River)	2000	30+	Moderate
8. West of Pingaring	2001	37,800	Healthy/Moderate
9. North-west of Pingaring	2001	11,050	Healthy/Moderate
10 & 11. Glenluce Nature	2003	260	Poor
Reserve	2003	49	Healthy
12 (a & b). Lake Gounter	2003	3000	Healthy
Nature Reserve	2003	3000	Healthy
13. Kwolyin Nature Reserve	2003	300	Moderate/Poor
14. East of Mt. Caroline	2003	900	Healthy/Moderate
15. Kondinin	2003	700+	Healthy
16 (a & b). South of Mt.	2003	23	Moderate
Caroline.	2003	31	Moderate

4.2 Size class structure and individual health

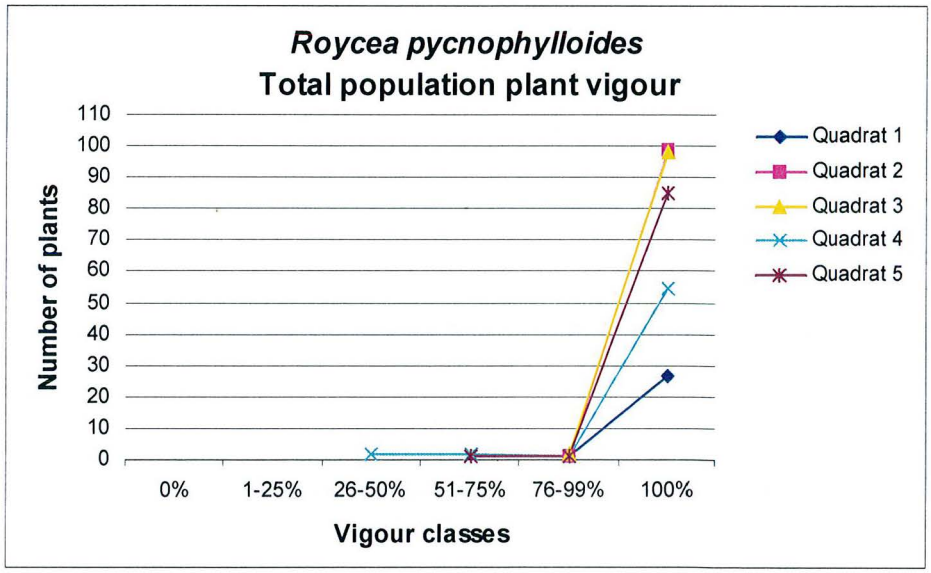
The distribution of *Roycea pycnophylloides* plants varied throughout all canopy area size classes, although only 1% of plants measured >500 cm^2 (Figure 2). Sixty-one percent of plants fell into the middle size classes of 10.1-50 and 50.1-100 cm^2. Heights ranged from 1-4.5 cm with the average height being 1.6 cm over all study sites.

Figure 2. The distribution of *Roycea pycnophylloides* plants across canopy area size classes for each study site.



The vigour of plants was skewed with 97% of plants falling into the 100% live canopy class (Figure 3). The reason for the low incidence of plant stress is unknown, however evidence of re-sprouting and storage of reserves within taproots may indicate that *Roycea pycnophylloides* plants die back annually, with new growth forming when conditions are favourable. Further studies are necessary to confirm this hypothesis.

Figure 3. Vigour of *Roycea pycnophylloides* plants across all study sites.



Total canopy area varied in the quadrats with higher numbers of plants (Table 3). Although Quadrat 2 shared the highest number of plants at 100, the total canopy area was less than that recorded for the 87 plants within Quadrat 5. The mean canopy area for all sites was 72.73 cm^2 ± 32.53 SE with a range of 41.59 - 104.81 cm^2.

Table 3. Mean and total canopy area (cm^2) for *Roycea pycnophylloides* plants within subquadrats for the five study sites – October 2003.

Quadrat/Location	Number of plants	Mean canopy area (cm^2) ± SE	Total canopy area (cm^2)
1/Cunderdin	28	41.59 ± 8.80	1164.55
2/Lake Altham	100	60.65 ± 6.91	6065.45
3/Chinocup Lake	100	103.09 ± 13.03	10,309.16
4/Mordetta NR	60	53.51 ± 11.03	3210.32
5/Lake King	87	104.81 ± 14.00	9118.49

Only 2 juvenile plants were recorded throughout all study sites with both occurring in Quadrat 1 at Cunderdin. However, seedlings were recorded for Populations 2a, 7 and 9. They were identified by their bright red fleshy cotyledons observed to be growing amongst the canopies of the *Roycea pycnophylloides* plants.

4.3 Population dynamics

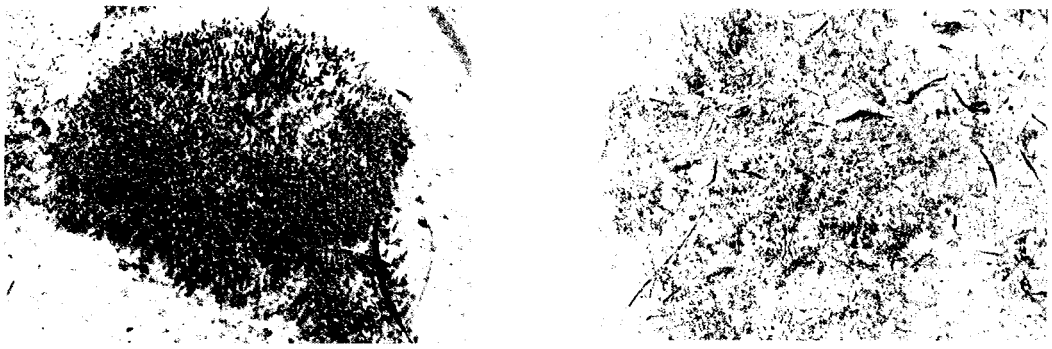
Plant community structure in the habitat of *Roycea pycnophylloides* ranges from Open Dwarf Scrub D to Very Open Mat Plants (Muir 1977).

An adjacent landowner to the Jasper property, Mr. J. Stokes, noticed that some parts of the samphire community associated with the *Roycea pycnophylloides*, are drying out and dying. He has observed drought conditions over the past 2-3 years and has noted less or no flushing of the drainage channels within the area. The drainage flat on Department of Agriculture land adjacent to his property has not had sheep grazing on it for about 15 years and the samphires are still dying, therefore he thinks the vegetation stress is not caused by grazing pressure (J. Stokes[5] 2004 *pers. comm.*).

Large patches of dead *Melaleuca* spp. occur near both Populations 2 and 5, although no stressed or dead *R. pycnophylloides* plants were recorded within the quadrats. Lake Grace weather centre has recorded below average rainfall for the past four years with 2002 falls recorded at 156.9 mm, nearly half the annual average.

Differences in growth form of *Roycea pycnophylloides* plants, was observed between and within populations. Both clumping and mat-forming growth habits were recorded at Populations 4 and 9 (Figure 4) and only mat-forming plants were recorded at Populations 2a, 5 and 7.

Figure 4. Clump and mat-forming *Roycea pycnophylloides* plants from Population 9 (Mordetta).



Excavations of one plant each from Populations 2a and 4 were undertaken to determine the reason for differences in growth form. A thickened taproot was found to be a common feature of both plants (Figure 5a) with the thickest taproot occurring on clumping plants. Differences in growth habits may be related to the age differences of plants, ie. clumping plants that have thicker taproots may be older.

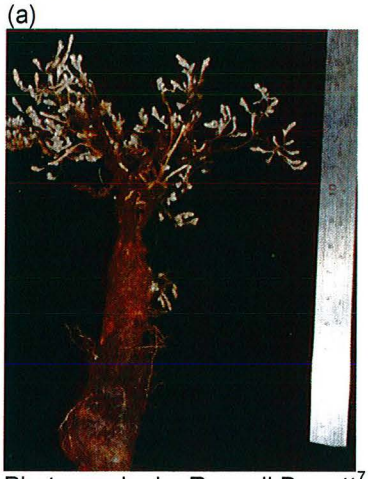
[5] Mr. John Stokes, property owner, Cunderdin WA.

Sections of the taproot stained with iodine solution by Mark Brundrett[6] at the Botanical Gardens and Parks Authority Plant Science Laboratory, confirmed that the roots were capable of storing reserves.

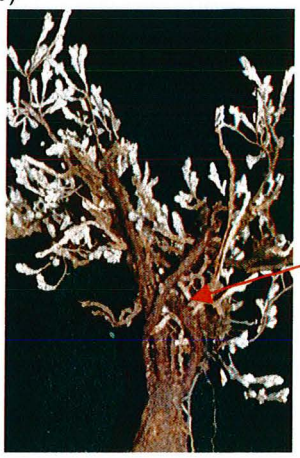
Observations of plants within all study sites also showed the presence of new shoots from old stems and from the thickened taproot. Figure 5 below shows both new shoots and a thickened taproot from a plant excavated from Population 4 at Lake King.

Figure 5. (a) *Roycea pycnophylloides* plant from Population 4 at Lake King showing the thickened taproot and (b) re-sprouting stems.

(a)



(b)



Photographs by Russell Barrett[7]

Re-sprouting from underground stems or roots as a response to pressures such as grazing, fire and inundation has been well documented and is recognized as one approach used to classify species for comparisons of fire response on a regional, national and international basis (Pate & McComb, 1981).

Although *Roycea pycnophylloides* plants re-sprout and produce storage roots, the response to frequent or hot fires and prolonged inundation is unknown. There are no past records of fires in the areas or reserves where *R. pycnophylloides* populations are located and it is unlikely that hot or frequent fires would occur within the plants habitat.

4.4 Inflorescence, fruit and seed production

Roycea pycnophylloides plants are dioecious, however both male and female flowers were observed to occur on the same plant in Quadrats 2a and 5. Inflorescences were produced from October 2003 through to April 2004 with fruits maturing in late March.

The total number of inflorescences counted for the 375 plants identified throughout all study sites was 21,528. The number of male and female flowers for each site is detailed in Table 4 below.

Table 4. The total and mean numbers of female and male flowers and the number of plants assessed for *Roycea pycnophylloides* study sites – October 2003.

Quadrat-Location	No. of female plants assessed	No. of male plants assessed	No. of female flowers	Mean no. of female flowers ± SE	No. of male flowers	Mean no. of male flowers ± SE
1-Cunderdin	10	13	917	61.13 ± 18.67	268	20.62 ± 4.03
2-Lake Altham	50	50	5321	106.42 ± 17.53	2415	48.30 ± 5.51

[6] Mark Brundrett, Research Scientist, (Plant Science) Kings Park, Botanical Gardens and Parks Authority.
[7] Russell Barrett, Research Scientist (Plant Science) Kings Park, Botanical Gardens and Parks Authority.

3-Chinocup Lk	50	50	4138	82.76 ± 24.52	1364	27.28 ± 4.02
4-Mordetta Res.	28	32	1300	46.43 ± 12.54	3726	116.44 ± 93.23
5-Lake King	39	48	792	20.31 ± 3.05	1287	26.81 ± 4.83

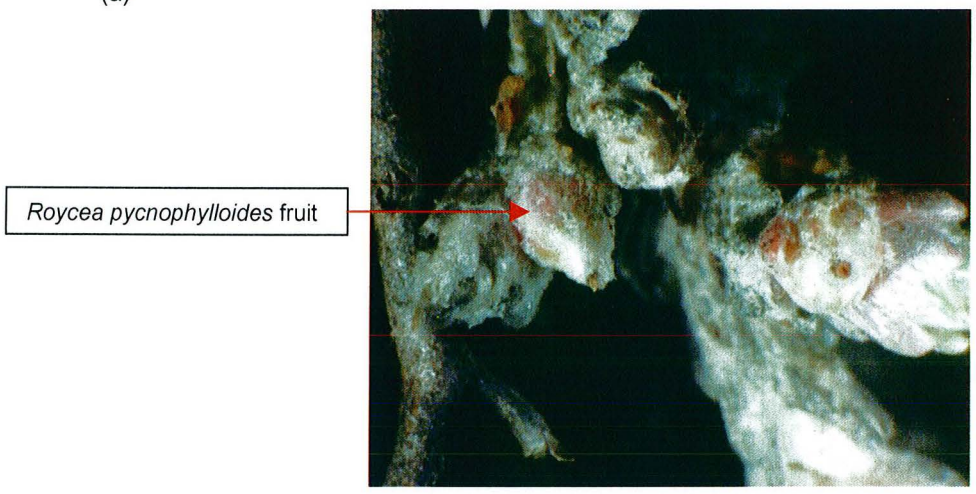
Results showed a variable relationship between inflorescence numbers and plant canopy area for each monitoring site. The number of female flowers produced per canopy area was markedly higher for plants in Quadrat 5, although the average canopy area recorded was only marginally higher (Table 5).

Table 5. The average canopy area and the number of female and male flowers per cm^2 for *Roycea pycnophylloides* plants across all study sites – October 2003.

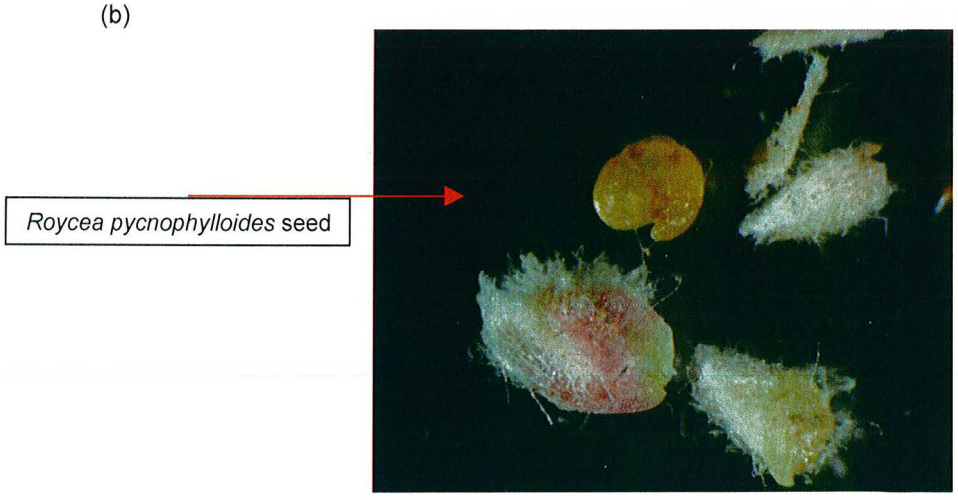
Quadrat-Location	Average canopy area (cm^2)	Number of female flowers per cm^2	Number of male flowers per cm^2
1-Cunderdin	41.59	1.26	4.34
2-Lake Altham	60.65	1.13	2.51
3-Chinocup Lk	103.09	2.49	7.55
4-Mordetta Res.	53.51	2.46	0.86
5-Lake King	104.81	11.5	7.08

Figure 6. Photograph showing (a) fruit and (b) seed of *Roycea pycnophylloides* viewed through a stereo microscope at the Botanical Gardens and Parks Authority Plant Science Laboratory.

(a)



(b)



Each *Roycea pycnophylloides* female flower may form one fruit that produces one seed. Plants in Quadrats 1 and 5 produced a higher number of fruits per plant with a corresponding higher fruit/flower ratio (Table 6). Although the mean number of female flowers was highest for plants in Quadrat 2 and mature fruit was collected, none contained viable seeds. The reason for this is unknown. This study site is part of the largest population found (Table 2) with over a million plants estimated.

Table 6. The mean number of *Roycea pycnophylloides* flowers and fruits and the fruit/flower ratio.

Quadrat-Location	Mean no. of female flowers ± SE	Mean no. of fruits per plant ± SE	Mean fruit/flower ratio ± SE
1-Cunderdin	61.13 ± 22.40	9.7 ± 2.07	0.31 ± 0.109
2-Lake Altham	106.42 ± 15.65	2.55 ± 0.73	0
3-Chinocup Lk	82.76 ± 35.38	0.45 ± 0.23	0.01 ± 0.003
4-Mordetta Res.	46.43 ± 10.52	0.87 ± 0.42	0.01 ± 0.005
5-Lake King	20.31 ± 3.71	4.29 ± 1.31	0.24 ± 0.075

Fruit set was low with only 5.2% production over all study sites. The lowest results were produced from Quadrats 2, 3 and 4 (Table 7). These quadrats are all located within the Lake Grace region where lower than average rainfall for the last four years and only just over half the average rainfall for 2002 was recorded. Along with possible reduction of resource availability, freshwater flushing of drainage areas is reduced and may result in salinity level rises.

Table 7. Total number of *Roycea pycnophylloides* female flowers and the fruits and viable seeds produced for all study sites.

Quadrat-Location	No. of female plants assessed	Total no. of flowers/plant	No. of fruits collected	No. of viable seeds
1-Cunderdin	10	917	97	30
2-Lake Altham	20	1221	51	0
3-Chinocup Lk	20	1523	9	2
4-Mordetta Res.	15	662	13	12
5-Lake King	17	352	73	65

The proportion of *Roycea pycnophylloides* fruits that produced viable seed over the five monitoring sites was 44.8% with a range of 0 to 92.3%.

Crawling insects and ants were observed as plentiful within populations of *Roycea pycnophylloides* however specific pollinators were not recorded.

Investigations of soil stored seed was not possible within the time frame for this project, however observations of seedlings growing in amongst the canopies of *Roycea pycnophylloides* plants suggest that seeds may be held within fruits until conditions for germination are favourable or that seeds may not disperse from the parent plant and are trapped. The period of time needed for germination and the conditions favourable for their germination is not known and requires further research.

4.5 Soil structure

Soil at Quadrats 1, 3, 4 and 5, where populations occur on shorelines, is white sand over sandy clay and pale clay at Quadrat 2 (Site and quadrat descriptions, pages 28-32).

Table 8 below shows the results of electrical conductivity and pH analysis of soil samples taken at all *Roycea pycnophylloides* quadrats.

Table 8. Results of soil analysis for salinity and pH for five *Roycea pycnophylloides* sites –November 2003.

Quadrat-Location	Depth (cm)	pH (H_20)	pH (CaC_{12})	E.C. (mS/m) 11/2003

1-Cunderdin	0-10	5.70	5.48	379
	10-20	5.58	5.24	308
	20-30	5.07	4.88	387
2-Lake Altham	0-10	5.91	5.84	378
	10-20	6.03	5.97	489
	20-30	6.06	6.04	525
3-Chinocup Lk	0-10	5.69	5.47	325
	10-20	5.31	5.00	403
	20-30	5.05	4.85	430
4-Mordetta Res.	0-10	5.06	4.90	342
	10-20	4.82	4.47	288
	20-30	4.62	4.33	364
5-Lake King	0-10	5.51	5.04	205
	10-20	5.41	5.05	326
	20-30	5.10	4.85	395

All samples were taken in late November 2003. It is probable that the salinity readings will increase before the next winter rainfall occurs. The relationship between salinity, pH and plant health is unknown. Results presented above serve as a baseline for comparison against any further research. Research on salinity levels of agricultural soils and water bodies utilised by livestock is available, however information on inland salt lakes and halophytic plants is limited.

4.6 Relocation information

Table 11 details all GPS readings taken in and around the *Roycea pycnophylloides* populations. Waypoints in decimal minutes using WGS 84 datum were recorded from all quadrats and at road intersections where necessary, to relocate sites.

4.7 Associated vegetation

Associated species growing within all Quadrats were recorded. Samples of unknown species were collected and identified using voucher specimens held at the West Australian Herbarium and by enlisting the aid of Paul Wilson[8] for Chenopodiaceae and Asteraceae specimens, Frank Obbens[9] for *Calandrinia* sp. and Rob Davis[10] and Mike Hislop[11] for confirmation of preliminary identifications.

One species of priority flora, *Drosera salina* (P2) was identified growing within Quadrat 5 at Lake King. Priority flora are those, which may be rare or threatened but have insufficient survey data to accurately determine their status. They are grouped and ordered according to the perceived urgency for further survey as follows (Atkins 2003).

Priority 1 - Poorly Known Taxa.
Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2 – Poorly Known Taxa.
Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
Priority 3 – Poorly Known Taxa.
Taxa which are known from several populations, and the taxa are not believed to be under immediate threat.
Priority 4 – Rare Taxa.
Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.

[8] Paul Wilson, Contract Consultant, West Australian Herbarium
[9] Frank Obbens, Consultant and Volunteer, West Australian Herbarium
[10] Rob Davis, Technical Officer, West Australian Herbarium
[11] Mike Hislop, Contract Consultant, West Australian Herbarium

Species collected for each location are provided in Appendix 1 under Site and Quadrat Descriptions. A total of 28 taxa from 12 families and 21 genera were recorded for all five-study sites. The most species diverse families were Chenopodiaceae (8 taxa) and Asteraceae (6 taxa).
Roycea pycnophylloides grows within vegetation communities of Open Dwarf Scrub D to Very Open Mat Plants (Muir 1977) in association with halophytes, predominantly *Halosarcia* spp., and few perennial or ephemeral species. At the time of establishment some annual species had senesced and were therefore unable to be identified. These were recorded under dead shrubs/litter in cover percentages, which are detailed in Table 9 below.

Three weed species were recorded from the families Poaceae, Aizoaceae and Caryophyllaceae and are identified within the species lists with an asterisk. All of these occurred in low numbers and are therefore not considered to be a threat to the *Roycea pycnophylloides* populations.

Table 9. Percentage cover of *Roycea pycnophylloides,* native plants, weeds, dead shrubs/litter and bare ground within all quadrats – October 2003.

Quadrat-Location	COVER %				
	R. pycnophylloides	Native plants	Weeds	Dead shrubs/litter	Bare ground
1-Cunderdin	1.5	50	0	0	48.5
2-Lake Altham	30	2	0.5	0	67.5
3-Chinocup Lk	36	2	0	0	62
4-Mordetta Res.	8	4	0	3	85
5-Lake King	6	2.5	0.5	0	91

5.0 CONCLUSIONS

This project established a fixed-point monitoring framework for *Roycea pycnophylloides.*

1. Recent surveys have significantly increased the number of *Roycea pycnophylloides* populations.
2. Although *Roycea pycnophylloides* numbers have increased significantly through the surveys, the plants occupy a highly specialised habitat that is restricted within largely cleared agricultural areas.
3. Regular monitoring using the framework established by this project is necessary to quantify future population trends.
4. Roots of *Roycea pycnophylloides* plants are capable of storing reserves and evidence of re-sprouting was observed. These characteristics enable the recovery of *R. pycnophylloides* plants from disturbance events and also to endure periods of unfavourable growing conditions, which although advantageous, the effects of prolonged inundation, rising salinity levels, fire damage and drought are unknown.
5. *Roycea pycnophylloides* plants throughout the five study sites were healthy with 92 to 99% of plants having 100% live canopies. Further research is necessary to determine whether this level of health is due to annual re-growth.
6. Fruit production was low throughout all study sites, however the proportion of viable seed produced was 44.8%. Reasons for the low fruit set are unknown and as a consequence the reproductive potential of the population cannot be assessed without further monitoring and comparison with a common and close relative.
7. Soil analysis undertaken within this project to provide a baseline needs to be repeated during differing seasons to more adequately assess the affect of salinity and pH on population condition.

REFERENCES

Atkins, K.J. (2003) *Declared Rare and Priority Flora List for Western Australia.* Department of Conservation and Land Management.

Brown, A., Thomson-Dans, C. and Marchant, N. (1998) *Western Australia's Threatened Flora.* Department of Conservation and Land Management, Perth Western Australia.

English, V., and Blythe, J. (1999) *Development and application of procedures to identify and conserve Threatened Ecological Communities in the South-west Botanical Province of Western Australia.* Pacific Conservation Biology 5:124-138.

Halse, S.A., Pearson, G.B., and Patrick, S. (1993) *Vegetation of depth-gauged wetlands in nature reserves of south-west Western Australia.* Department of Conservation and Land Management. Perth, Western Australia.

Hobbs, R.J. and Hopkins, A.J.M. (1991) *The role of conservation corridors in a changing climate.* In : Saunders, D.A. and Hobbs, R.J. (eds.) *Nature Conservation 2 : The Role of Corridors.* pp. 281-290. Surrey Beatty & Sons Pty Ltd, Chipping Norton, N.S.W.

IUCN (2000) IUCN *Red List Categories* prepared by the IUCN Species Survival Commission, as approved by the 51st meeting of the IUCN. Gland, Switzerland.

Keighery, B. (1994) *Bushland Plant Survey.* A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc.)

Lyons, M., Gibson, N., Keighery, G. and Lyons, S.D. (In press) *Wetland flora and vegetation of the Wheatbelt of southwestern Australia.* Records of the Western Australian Museum.

Mattiske Consulting Pty. Ltd. (1995) *A Review of Botanical Values on a Range of Gypsum Dunes in the Wheatbelt of Western Australia.* Final Report for Australian Nature Conservation Agency Save the Bush Program 1993/94 Project SS6007. Parts A and D. Unpublished report for the Department of Conservation and Land Management. Perth, Western Australia.

Muir, B.G. (1977) *Vegetation and habitat of Bendering Nature Reserves. Part 2 of the Biological Survey of the Western Australian Wheatbelt.* Rec. Western Australian Museum Supplement No. 3.

Paczkowska, G., and Chapman, A. R., (2000) *The Western Australian Flora. A Descriptive Catalogue.* Wildflower Society of Western Australia (Inc.), Western Australian Herbarium, (Department of Conservation and Land Management), Botanic Gardens and Parks Authority, Perth. Western Australia.

Papenfus, D. (2004) *Report on Western Australian Threatened Species and Communities Unit Flora Survey October – November 2003.* Unpublished report for the Department of Conservation and Land Management, Threatened Species and Communities Unit, Woodvale, Western Australia.

Pate, J.S. and McComb, A.J. (eds) (1981) *The Biology of Australian Plants.* University of Western Australia Press, Nedlands.

Weaving, S. (1999). *Avon and Upper Hotham Region. Natural Resource Atlas.* Agriculture Western Australia.

Sanders, A. (1991) *Oral histories documenting changes in wheatbelt wetlands.* Occasional Paper 2/91. Department of Conservation and Land Management. Perth, Western Australia.

Weaving, S. (1999) *Avon and Upper Hotham Region Natural Resource Atlas.* Spatial Resource Information Group, Agriculture Western Australia.

APPENDIX 1

Table 10. Plant dimensions (height, width at widest point and at 90°), percentage of live canopy, number of inflorescences per plant and life stage classification for *Roycea pycnophylloides* as at October 2003.

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
7/1	1	1	3.5	11	10	99	182	f	M
		2	3	7	7	100	10	m	M
		3	4	8	6	100	132	f	M
		4	2.5	7	5	100	34	m	M
		5	4	12	13	100	138	f	M
		6	2	5	2	100	1	m	M
		7	1	2	1	100	4	f	M
		8	3	7.5	6	100	28	m	M
	2	1	4.5	4	4	100	4	m	M
		2	2	3	3	100	15	f	M
		3	3	5.5	5.5	100	30	m	M
		4	3	17	15	100	213	f	M
	3	1	3	4	4	100	34	m	M
		2	2	3	3	100	48	f	M
		3	4	3	3	100	0	nf	M
		4	3	8	5	100	48	f	M
		5	2	5.5	5	100	51	m	M
	4	0	0	0	0	0			
	5	1	2.5	7	5	100	0	nf	M
		2	3	7	6	100	12	m	M
		3	2	6	6	100	11	m	M
		4	2.5	5	3	100	0	nf	M
		5	3	14	8	100	18	m	M
		6	2	11	6	100	74	f	M
		7	2.5	9	7	100	9	m	M
		8	2	13	13	100	63	f	M
		9	2.5	1	0.5	100	0	nf	J
		10	2	1	0.5	100	0	nf	J
		11	1.5	11	7	100	26	m	M
2a/2	1	1	2	7.5	3	100	9	m	M
		2	1	10	9	100	81	f	M
		3	1.5	8	8	100	80	f	M
		4	1.5	9	8	100	41	m	M
		5	2	6	5	100	18	f	M
		6	1	2	2	100	12	f	M
		7	1	3	3	100	7	f	M
		8	1	5	3	100	23	f	M
		9	2	8	7	100	41	f	M
		10	2	12	11	100	66	m	M
		11	1	6	3	100	24	m	M
		12	1.5	4	4	100	25	m	M
		13	2	12	8	100	125	f	M
		14	1.5	5	4	100	32	m	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		15	1.5	3	3	100	23	m	M
		16	1.5	3	3	100	26	f	M
		17	1.5	12	9	100	220	f	M
		18	1.5	15	10	100	125	m	M
		19	2	3	3	100	3	m	M
		20	2	8	5	100	60	m	M
	2	1	1.5	1	1	100	3	f	M
		2	1.5	9	7	100	50	m	M
		3	2	10	5	100	125	f	M
		4	2	10	3	100	36	m	M
		5	2	13	10	100	284	f	M
		6	2.5	8	7	100	56	f	M
		7	1.5	10	10	100	120	m	M
		8	1	8	5	100	35	m	M
		9	1.5	3	3	90	7	m	M
		10	1.5	1	1	100	3	f	M
		11	2	20	8	100	174	f	M
		12	2	14	12	100	81	m	M
		13	2	25	10	100	69	m	M
		14	1.5	13	5	100	145	f	M
		15	2	9	9	100	102	m	M
		16	3	10	10	100	182	f	M
		17	2	8	3	100	48	m	M
		18	2	6	5	100	27	m	M
		19	2.5	28	15	100	350	f	M
		20	2	12	12	100	93	f	M
	3	1	2.5	10	8	100	58	m	M
		2	2	3	3	100	25	f	M
		3	2	10	6	100	90	f	M
		4	2.5	16	16	100	135	m	M
		5	1.5	1	1	100	10	f	M
		6	1.5	4	4	100	12	f	M
		7	2	9	9	100	138	f	M
		8	1.5	3	2	100	17	m	M
		9	1.5	5	5	100	6	f	M
		10	1	2	2	100	13	m	M
		11	1	7	6	100	17	m	M
		12	2	5	4	100	21	m	M
		13	2.5	19	10	100	98	f	M
		14	3	2	2	100	3	m	M
		15	2	1	1	100	3	m	M
		16	2	34	7	100	700	f	M
		17	1.5	7	7	100	43	m	M
		18	2.5	4	4	100	28	m	M
		19	2	16	12	100	220	f	M
		20	1.5	9	6	100	200	f	M
	4	1	1.5	14	10	100	64	m	M
		2	2	2	1.5	100	18	f	M
		3	1.5	11	9	100	165	f	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		4	2	25	10	100	140	m	M
		5	2	24	16	100	98	m	M
		6	1.5	3	2	100	20	f	M
		7	2	18	11	100	55	m	M
		8	2	10	9	100	64	m	M
		9	1.5	11	10	100	28	f	M
		10	2	7	6	100	25	m	M
		11	2.5	21	16	100	106	m	M
		12	1.5	7	4	100	76	f	M
		13	2	10	9	100	93	m	M
		14	1.5	10	3	100	40	f	M
		15	2	6	5	100	21	m	M
		16	2	8	6	100	120	f	M
		17	2.5	12	11	100	134	m	M
		18	2	10	8	100	170	f	M
		19	1.5	9	6	100	164	f	M
		20	2	6	4	100	28	f	M
	5	1	2	9	7	100	17	m	M
		2	2	1	1	100	5	f	M
		3	2	6	5	100	70	f	M
		4	2.5	3.5	3.5	100	8	m	M
		5	2.5	7	7	100	42	m	M
		6	2	7.5	7	100	110	f	M
		7	2.5	6	6	100	21	m	M
		8	2	3	2	100	9	f	M
		9	2	10	6	100	31	m	M
		10	3	17	14	100	380	f	M
		11	1.5	10	8	80	25	m	M
		12	2	5	4	100	28	m	M
		13	2	3	3	100	15	m	M
		14	2	3	3	100	15	m	M
		15	2	15	13	100	92	m	M
		16	2	3.5	3	100	34	f	M
		17	2	7	4	100	58	f	M
		18	2	6	5	100	35	f	M
		19	2	10	6	100	80	f	M
		20	2	18	18	100	164	f	M
5/3	1	1	2	20	20	100	92	m	M
		2	1.5	18	10	100	35	f	M
		3	1.5	35	20	100	120	m	M
		4	1.5	10	4	100	18	f	M
		5	1.5	6	3	100	10	f	M
		6	1.5	6	2.5	100	6	m	M
		7	1	12	8	100	20	f	M
		8	1	9	7	100	18	m	M
		9	1	5	4	100	15	f	M
		10	1	25	20	100	25	m	M
		11	2	24	14	100	42	f	M
		12	1	6	3	100	25	f	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		13	1	1	1	100	1	m	M
		14	1	12	11	100	17	m	M
		15	1	3	2	100	6	f	M
		16	1	6	6	100	5	f	M
		17	1	18	15	100	65	m	M
		18	1.5	11	10	100	43	m	M
		19	1.5	22	19	100	54	f	M
		20	1.5	6	3	100	7	m	M
	2	1	1.5	20	10	100	35	m	M
		2	1	5	3	100	3	m	M
		3	1	9	7	100	7	m	M
		4	1	8	4	100	10	f	M
		5	1	9	8	100	52	f	M
		6	1	9	7	100	48	f	M
		7	1	8	5	100	12	m	M
		8	1	11	6	100	23	m	M
		9	1	6	6	100	3	m	M
		10	1	6	5	100	2	f	M
		11	1	19	12	100	27	m	M
		12	1	9	8	100	10	f	M
		13	1	5	5	100	17	f	M
		14	1	22	19	100	78	m	M
		15	1	6	5	100	27	f	M
		16	2	17	13	100	48	m	M
		17	1.5	9	5	100	28	f	M
		18	2	8	5	100	27	f	M
		19	2	10	10	100	25	m	M
		20	1.5	9	9	100	29	f	M
	3	1	1.5	26	15	100	38	m	M
		2	1	13	12	100	42	f	M
		3	1	8	7	100	5	f	M
		4	1	12	10	100	66	m	M
		5	1	9	9	100	68	f	M
		6	1.5	7	7	100	11	m	M
		7	1.5	15	7	100	17	f	M
		8	2	10	8	100	36	f	M
		9	2	20	12	100	65	m	M
		10	1	24	18	100	165	f	M
		11	1.5	12	10	100	25	m	M
		12	1	13	10	100	42	m	M
		13	1.5	18	10	100	22	m	M
		14	1	10	3	100	42	f	M
		15	1.5	10	8	100	65	f	M
		16	1	4	4	100	42	f	M
		17	1.5	7	6	100	15	m	M
		18	2	10	9	100	108	f	M
		19	2	8	7	100	12	m	M
		20	1.5	6	6	100	15	m	M
	4	1	1	12	4	100	98	f	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		2	1	25	17	100	650	f	M
		3	1	9	7	100	48	m	M
		4	1	16	13	100	380	f	M
		5	2	12	10	100	15	m	M
		6	1.5	23	18	100	350	f	M
		7	1.5	11	10	100	28	m	M
		8	1.5	7	5	100	3	m	M
		9	1.5	4	3	100	5	m	M
		10	1.5	26	13	100	73	m	M
		11	1	3	3	100	24	f	M
		12	1.5	6	6	100	42	f	M
		13	1.5	4	4	100	30	f	M
		14	1.5	6	6	100	11	m	M
		15	1.5	7	6	100	48	f	M
		16	1.5	6	6	100	8	m	M
		17	1.5	10	8	100	72	f	M
		18	1	36	26	100	1000	f	M
		19	1	30	25	100	103	m	M
		20	1	21	12	100	32	m	M
	5	1	1	12	10	95	25	f	M
		2	1	12	8	100	3	m	M
		3	1	12	10	100	15	f	M
		4	1	10	7	100	5	f	M
		5	1	6	4	100	5	f	M
		6	1	10	7	100	10	m	M
		7	1	10	7	100	5	f	M
		8	1	10	6	100	43	f	M
		9	1	7	3	100	8	m	M
		10	1	11	9	100	68	f	M
		11	1	13	10	100	14	m	M
		12	1	6	4	100	2	m	M
		13	1.5	9	3	100	3	m	M
		14	1.5	14	10	100	6	m	M
		15	1	10	10	100	160	f	M
		16	1.5	15	8	100	8	m	M
		17	1	1	1	100	3	f	M
		18	1	7	7	95	45	f	M
		19	1	8	6	100	13	m	M
		20	1	7	4	100	5	m	M
9/4	1	0	0	0	0				
	2	1	1.5	13	6	100	65	f	M
		2	1	6	6	50	4	m	M
		3	1.5	7	4	100	25	f	M
		4	1	4	3	60	5	m	M
		5	2	10	10	30	44	f	M
		6	1.5	26	26	90	3000	m	M
	3	1	2	15	13	100	120	f	M
		2	2	11	7	100	35	m	M
		3	1	11	4	100	146	f	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		4	1	7	6	100	25	m	M
		5	1	8	4	100	2	m	M
		6	1	5	4	100	13	f	M
		7	1	8	7	100	32	m	M
		8	1	3	2	100	6	f	M
		9	1.5	13	11	100	300	f	M
		10	1	1	1	100	2	m	M
		11	1.5	7	6	100	32	f	M
		12	1	17	7	100	163	m	M
		13	2	29	9	100	180	f	M
		14	1.5	16	7	100	120	m	M
	4	1	1	6	4	100	13	m	M
		2	1.5	6	5	100	12	m	M
		3	1	5	5	100	12	f	M
		4	1	3	3	100	7	m	M
		5	1	4	3	100	12	m	M
		6	1.5	4	3	100	15	f	M
		7	1.5	25	15	100	68	m	M
		8	1.5	15	6	100	56	f	M
		9	1.5	16	9	100	45	f	M
		10	1.5	9	7	100	11	m	M
		11	1	1	1	100	4	f	M
		12	1	6	5	100	18	f	M
		13	1	4	2	100	3	f	M
		14	1	7	7	100	15	m	M
		15	1	1	1	100	3	f	M
		16	1.5	23	14	100	76	m	M
		17	1	10	6	100	10	f	M
		18	1	4	4	100	12	f	M
		19	1	5	3	100	14	m	M
		20	1.5	4	3	100	11	m	M
	5	1	1.5	4	3	100	2	m	M
		2	1.5	6	6	100	12	m	M
		3	2	10	9	100	36	f	M
		4	1	5	4	100	5	m	M
		5	2	4	3	100	1	m	M
		6	1.5	5	2	100	5	f	M
		7	2	5	4	100	11	m	M
		8	2	11	11	100	46	f	M
		9	2	2	1	100	6	m	M
		10	2	7	4	70	6	m	M
		11	1.5	5	4	100	28	f	M
		12	1	3	2	100	5	m	M
		13	1.5	5	3	100	6	m	M
		14	1.5	10	6	100	51	f	M
		15	1	8	7	100	10	f	M
		16	1	8	7	100	23	m	M
		17	2	9	8	100	10	f	M
		18	1	3	1.5	100	5	f	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
		19	1.5	10	6	100	18	m	M
		20	1.5	3	3	100	4	m	M
4/5	1	1	1.5	10	8	60	25	m	M
		2	1.5	5	10	100	19	m	M
		3	1.5	10	10	100	36	f	M
		4	1.5	12	10	100	39	m	M
		5	1.5	4	4	100	16	m	M
		6	2	12	12	100	45	f	M
		7	2	23	12	100	82	m	M
		8	3	17	14	95	49	m	M
		9	3	20	20	100	42	m	M
		10	1.5	4	2	100	15	f	M
		11	1.5	9	8	100	1	f	M
		12	2	13	13	100	15	m	M
		13	2.5	18	17	100	4	f	M
		14	2.5	24	21	100	15	m	M
		15	2	9	7	100	10	f	M
		16	2	8	7	100	7	f	M
		17	2	13	9	100	2	m	M
		18	3	8	5	100	5	f	M
		19	1.5	2	2	100	3	f	M
		20	2.5	10	10	100	7	f	M
	2	1	1.5	6	4	100	4	m	M
		2	2.5	12	8	100	2	m	M
		3	2	9	4	100	2	m	M
		4	1.5	4	3	100	2	m	M
		5	1.5	20	10	100	15	m	M
		6	1	10	10	100	28	f	M
		7	1	3	3	100	2	m	M
		8	1.5	12	10	100	8	m	M
		9	1.5	12	10	100	5	m	M
		10	1	12	12	100	8	m	M
	3	1	1	20	10	100	9	m	M
		2	1	14	5	100	2	m	M
		3	1	5	4	100	8	f	M
		4	1.5	38	26	100	110	m	M
		5	1.5	10	8	100	47	m	M
		6	2	14	14	100	7	m	M
		7	2	25	13	100	35	f	M
		8	1	9	4	100	5	f	M
		9	1.5	6	6	100	10	f	M
		10	2.5	37	25	100	120	m	M
		11	1.5	13	9	100	5	m	M
		12	1.5	13	9	100	15	f	M
		13	1.5	35	13	100	60	f	M
		14	1	10	7	100	14	f	M
		15	1	8	8	100	7	m	M
		16	1	7	6	100	90	f	M
		17	2	12	8	100	25	m	M

Population/ Quadrat number	Sub-quadrat number	Plant number	Height (cm)	Width @ widest point (cm)	Width @ 90deg (cm)	% Live canopy	Number of flowers	Female (f) Male (m) or non-flowering (nf)	Mature (M) Juvenile (J) or Dead (D) plants
	4	1	1.5	15	12	100	25	m	M
		2	1	3	2	100	10	f	M
		3	1.5	10	8	100	25	f	M
		4	1.5	5	5	100	13	f	M
		5	2	3	2	100	10	f	M
		6	1	4	3	100	20	f	M
		7	1	10	7	100	5	m	M
		8	1	10	9	100	5	m	M
		9	2.5	3	3	100	4	m	M
		10	1.5	22	10	100	6	m	M
		11	1.5	4	3	100	25	f	M
		12	2.5	10	5	100	20	m	M
		13	1.5	6	4	100	10	m	M
		14	2	3	2	100	15	f	M
		15	1.5	23	10	100	57	m	M
		16	1	23	10	100	28	m	M
		17	1	8	6	100	24	f	M
		18	1	20	20	100	170	m	M
		19	1	17	10	100	5	f	M
		20	1	5	4	100	8	f	M
	5	1	1	3	2	100	5	f	M
		2	1.5	10	8	100	7	m	M
		3	2.5	30	10	100	30	m	M
		4	1.5	10	10	100	15	m	M
		5	1.5	10	7	100	20	m	M
		6	1.5	27	10	100	48	m	M
		7	1	9	8	100	50	f	M
		8	1.5	15	10	100	27	m	M
		9	1	5	4	100	18	f	M
		10	1.5	10	10	100	20	m	M
		11	1	10	10	100	38	f	M
		12	1.5	23	10	100	45	m	M
		13	2	20	10	100	32	m	M
		14	1.5	9	5	100	54	f	M
		15	1	10	6	100	20	f	M
		16	1	6	6	100	15	f	M
		17	1	4	2	100	3	f	M
		18	1	15	10	100	32	f	M
		19	1	8	8	100	29	m	M
		20	1	10	10	100	4	f	M

SITE AND QUADRAT DESCRIPTIONS

POPULATION 7
NB-LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

QUADRAT 1-CUNDERDIN GPS: 31° 37 '54.6"S
117° 11' 21.1"E

QUADRAT AREA: 25 m^2 (12.5 X 2 m)
SUBQUADRAT AREA: 5 m^2 (5 x 1 m)

DATE ESTABLISHED: 15/10/2003

LOCATION: In private property, on western shoreline of sandy rise ~150m west of Stokes Rd, 7 km west of Cunderdin.

SOIL: Coarse white sand over grey/brown sandy clay.

COVER: *Roycea pycnophylloides* – 2.5%
Native plants - 50%
Weeds – 0%
Bare ground – 48.5%
Dead shrubs/litter - 0%

PLANT COMMUNITY CLASSIFICATION (Muir 1977): Open Dwarf Scrub D.

NUMBER OF *ROYCEA PYCNOPHYLLOIDES* PLANTS IN SUBQUADRATS : 28

CONDITION: Healthy

ASSOCIATED SPECIES IN QUADRAT:
Atriplex hymenotheca
Angianthus micropodioides
Halosarcia sp. (Lyons & Lyons 2760)
Halosarcia indica ssp. bidens
Halosarcia halocnemoides
Crassula exserta

Figure 7. Quadrat 1 established within Population 7 at Cunderdin. Photograph taken from northwest corner of quadrat – December 2003.

POPULATION 2a
NB-LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

QUADRAT 2 – LAKE ALTHAM (CHINOCUP NATURE RESERVE) GPS: 33° 24' 53"S 118° 25' 31"E

QUADRAT AREA: 25 m^2 (12.5 X 2 m)
SUBQUADRAT AREA: 5 m^2 (5 x 1 m)

DATE ESTABLISHED: 20/10/2003

LOCATION: On claypan floor of drainage flats ~30 m north of Rasmussen Rd, 8.2 km west of Lake Grace/Pingrup Rd.

SOIL: Thin layer of white sand over pale clay .

COVER: *Roycea pycnophylloides* – 30%
Native plants – 2%
Weeds –0.5%
Bare ground – 67.5%
Dead shrubs/litter – 0%

PLANT COMMUNITY CLASSIFICATION (Muir 1977): Open Mat Plants.

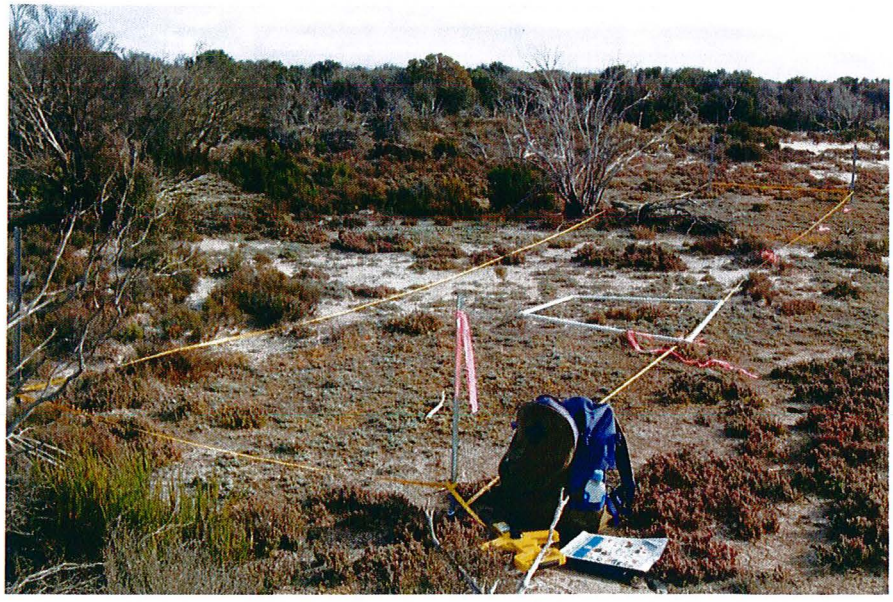
NUMBER OF *ROYCEA PYCNOPHYLLOIDES* PLANTS IN SUBQUADRATS : 100.

CONDITION: Healthy

ASSOCIATED SPECIES IN QUADRAT:
Halosarcia sp. *'central wheatbelt Lyons & Lyons 2760*
**Parapholis incurva*
**Spergularia marina*
Gnephosis acicularis
Angianthus microcephalus
Senecio glossanthus

COMMON SPECIES IN AREA:
Frankenia ?tetrapetala/drummondii
Melaleuca halmaturorum

Figure 8. Quadrat 2 established within Population 2a at Lake Altham (Chinocup Nature Reserve). Photograph taken from southeast corner of quadrat – 20/10/2003.



POPULATION 5
NB-LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

QUADRAT 3 – CHINOCUP LAKE (CHINOCUP NATURE RESERVE)

GPS: 33° 29' 54"S
118° 23' 24"E

QUADRAT AREA: 25 m^2 (12.5 X 2 m)
SUBQUADRAT AREA: 5 m^2 (5 X 1 m)

DATE ESTABLISHED: 21/10/2003

LOCATION: On shoreline of low rise within drainage flats ~60 m east of Chinocup Rd, 3.4 km south of Grey and Chinocup Roads intersection.

SOIL: White coarse sand and quartz over sandy clay.

COVER: *Roycea pycnophylloides* - 36%
Native plants - 2%
Weeds – 0%
Bare ground – 62%
Dead shrubs/litter – 0%

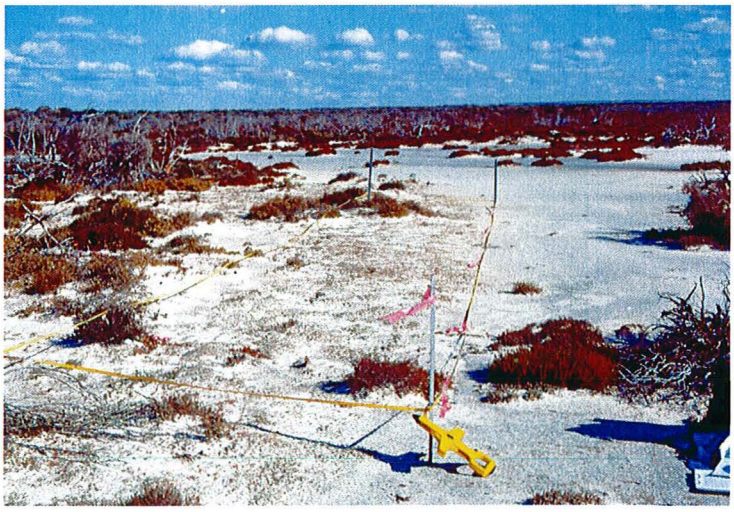
PLANT COMMUNITY CLASSIFICATION (Muir 1977): Open Mat Plants.

NUMBER OF *ROYCEA PYCNOPHYLLOIDES* PLANTS IN SUBQUADRATS : 100

CONDITION: Healthy.

ASSOCIATED SPECIES IN QUADRAT:
Atriplex hymenotheca
Calandrinia granulifera
Cotula cotuloides
Frankenia cinerea/punctata
Frankenia setosa
Halosarcia sp.
Halosarcia syncarpa
Hypoxis salina ms (Cugley 89)
Tribonanthes minuta (M.N. Lyons 2730)

Figure 9. Quadrat 3 established within Population 5 at Chinocup Lake (Chinocup Nature Reserve). Photograph taken from northwest corner of quadrat – 20/10/2003.



POPULATION 9
NB-LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

QUADRAT 4 – MORDETTA (MORDETTA NATURE RESERVE) GPS: 32° 51' 57"S 118° 32' 23"E

QUADRAT AREA: 25 m^2 (12.5 X 2 m)
SUBQUADRAT AREA: 5 m^2 (5 X 1 m)

DATE ESTABLISHED: 22/10/2003

LOCATION: On north shoreline of drainage channel ~220 m northeast of Mordetta Rd, 2.1 km west of Lake Grace/Kalgarin Rd intersection.

SOIL: White sand over sandy clay.

COVER: *Roycea pycnophylloides* – 8%
Native plants - 4%
Weeds – 0%
Bare ground – 85%
Dead shrubs/litter – 3%

PLANT COMMUNITY CLASSIFICATION (Muir1977): Very Open Mat Plants.

NUMBER OF *ROYCEA PYCNOPHYLLOIDES* PLANTS IN SUBQUADRATS : 60.

CONDITION: Healthy.

ASSOCIATED SPECIES IN QUADRAT:

**Mesembryanthemum nodiflorum*
Angianthus micropodioides
Atriplex hymenotheca
Austrostipa pyanostachya
Calandrinia granulifera
Disphyma crassifolium ssp. *clavellatum*
Frankenia ?cinerea
Frankenia setosa
Podolepis capillaris
Sclerostegia moniliformis

Figure 10. Quadrat 4 established within Population 9 at Mordetta Nature Reserve. Photograph taken from northwest corner of quadrat – 22/10/2003.

POPULATION 4
NB-LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

QUADRAT 5 – LAKE KING GPS: 33° 05' 06.5"S
119° 32' 58.5"E

QUADRAT AREA: 25 m^2 (12.5 X 2 m)
SUBQUADRAT AREA: 5 m^2 (5 X 1 m)

DATE ESTABLISHED: 29/10/2003

LOCATION: On south shoreline of drainage line that runs into Lake King from the west. ~500 m north along track from Lake King/Newdegate Rd.

SOIL: Coarse white sand over sandy clay.

COVER: *Roycea pycnophylloides* – 6%
Native plants – 2.5%
Weeds –0.5%
Bare ground – 91%
Dead shrubs/litter – 0%

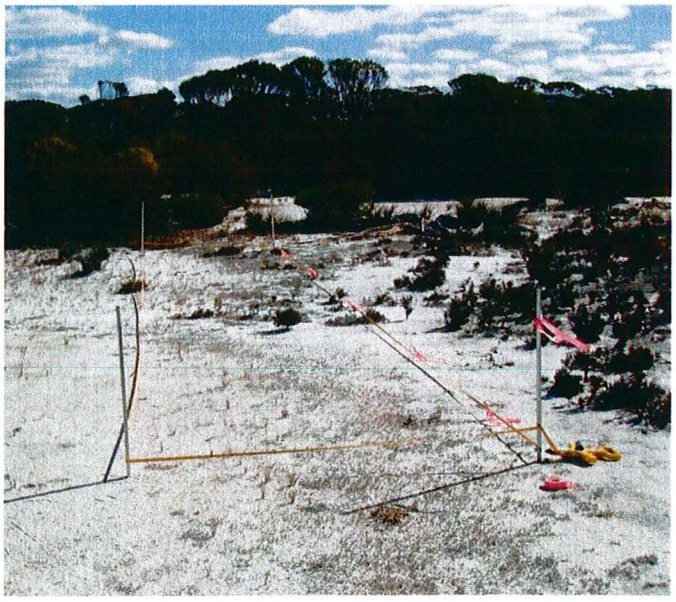
PLANT COMMUNITY CLASSIFICATION (Muir 1977): Very Open Mat Plants.

NUMBER OF *ROYCEA PYCNOPHYLLOIDES* PLANTS IN SUBQUADRATS : 87.

CONDITION: Healthy

ASSOCIATED SPECIES IN QUADRAT:
Atriplex hymenotheca
Austrostipa pyanostachya
Disphyma crassifolium ssp. *clavellatum*
Drosera salina Priority 2
Frankenia cinerea/punctata
Gnephosis acicularis
Halosarcia undulata
Isotoma scapigera

Figure 11. Quadrat 5 established within Population 4 at Lake King. Photograph taken from south side of quadrat 29/10/2003.



APPENDIX 2

4.5 RELOCATION INFORMATION

NB: LOCATIONAL INFORMATION IS CONFIDENTIAL – NOT FOR PUBLICATION

Table 11 below, details all GPS readings taken within the *Roycea pycnophylloides* populations. Waypoints in degrees, minutes and seconds using WGS 84 datum were recorded at all quadrats and landmarks where necessary, to relocate sites.

Table 11. GPS waypoints for *Roycea pycnophylloides* populations.

Population/Quadrat (Location)	Landmark	GPS reading (Garmin 12 channel)	GPS reading (Magellan 8 channel)
7/1 (Cunderdin)	Northwest corner of quadrat	31° 37' 54.6"S 117° 11' 21.1"E *	
2a/2 (Lake Altham)	Southeast corner of quadrat		33° 24' 53"S 118° 25' 31"E
5/3 (Chinocup Lake)	Southwest corner of quadrat		33° 29' 54"S 118° 23' 24"E
9/4 (Mordetta)	Southwest corner of quadrat		32° 51' 57"S 118° 32' 23"E
4/5 (Lake King)	Northeast corner of quadrat	33° 05' 06.5"S 119° 32' 58.5"E	
Waypoints from Ben Bayliss			
7/1 (Cunderdin)	Park point	31° 37' 45.34"S 117° 11' 35.56"E	Note this is ~ 150m to NE of * above
2a/2 (Lake Altham)	Quadrat site	33° 24' 52.99"S 118° 25' 30.83"E	
2a/2 (Lake Altham)	Chinocup Rd - "local traffic Rd" intersection	33° 25' 48.07"S 118° 23' 21.52"E	
5/3 (Chinocup Lake)	Park point	33° 29' 54.89"S 118° 23' 21.26"E	
5/3 (Chinocup Lake)	Grey Rd - Chinocup Rd intersection	33° 28' 26.40"S 118° 23' 21.01"E	
9/4 (Mordetta)	Park point	32° 52' 09.84"S 118° 32' 15.58"E	
9/4 (Mordetta)	Quadrat site south-west corner	32° 51' 56.99"S 118° 32' 22.67"E	
4/5 (Lake King)	Quadrat site south-west corner	33° 05' 06.9"S 119° 32' 58.24"E	