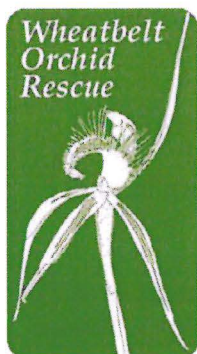


# Wheatbelt Orchid Rescue Project

## Interim Report 5 - March 2009

### Population Size and Vital statistics Data for the Lonely Hammer Orchid (*Drakaea isolata*)

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## 1. Introduction and Objectives

The Wheatbelt Orchid Rescue (WOR) project is a Lotterywest funded collaboration between the Western Australian Native Orchid Study and Conservation Group (WANOSCG), the School of Plant Biology at the University of Western Australia (UWA), the Friends of Kings Park, and the Department of Environment and Conservation (DEC). This project aims to help conserve the rarest orchids in the Western Australian Wheatbelt by obtaining knowledge required for sustainable management and directly contributing to recovery actions.

Information about the taxonomy, biology and ecology of the Critically Endangered Lonely Hammer Orchid (*Drakaea isolata*) is briefly summarised below and additional information is available from the Interim Recovery Plan prepared by DEC (Luu and Brown 2004).

*Drakaea isolata* was discovered in the 1980s by Bob Bates a well respected South Australian orchidologist. The scientific name *isolata* is derived from the Latin 'isolatus', meaning isolated and refers to the inland distribution of the orchid, which is disjunct from all other *Drakaea* species (Hoffman and Brown 1998). It was formerly described by Hopper & Brown in 2007.

*Drakaea isolata* has prostrate leaves and thin flower stalks up to 30 cm high. It has a single, dull green, heart-shaped, shortly hairy leaf that is one to two centimetres in diameter (Fig. 1A). Flowers are single and two to three centimetres long and three to four millimetres wide (Fig. 1B). Its closest relative seems to be the late hammer orchid (*Drakaea confluens*), but *D. isolata* has smaller flowers that are generally more uniform in colour and an earlier flowering period (Hoffman and Brown 1998).

This orchid is endemic to Western Australia where it is confined to the Chinocup area in the southern wheatbelt. It grows with *Paracaleana triens* in patches of bare white, sandy-clay soil among low shrubs and mallee eucalypts, on a slight rise above a large salt lake (Hoffman and Brown 1998).

*Drakaea isolata* is declared Rare Flora in WA (DRF) and ranked as Critically Endangered (CR). Only about 300 mature individuals are known in the single known population (Table 1). Threats include road and track maintenance, airborne dust, changes to hypersaline groundwater hydrology, and inappropriate fire. These factors are discussed further below. The track running next to the population has been upgraded to a road in recent years and has supported heavy vehicle traffic associated with mining.

**Table 1.** Population size estimates for *D. isolata* resulting from site visits and surveys.

Year	Total Plants	Flowering plants	Source
1989	250		IRP
1999	152	75	IRP
2003	49 (47)	4 (3)	IRP 2 (Beth Laudon, DEC)
2006	92	26	Beth Laudon, DEC
2007	297	52	WOR survey with WANOSCG



**Fig. 1** A. (left) *Drakaea isolata* The Lonely Hammer Orchid. B. (right) *Drakaea isolata* leaves in one example of the 87 geo-referenced photographs taken as a record for future monitoring, showing highly distinctive leaves of a large group of *Drakaea isolata* (with *Paraclaeama triens* in bud).

## 2. Detailed observations of the *Drakaea isolata* population

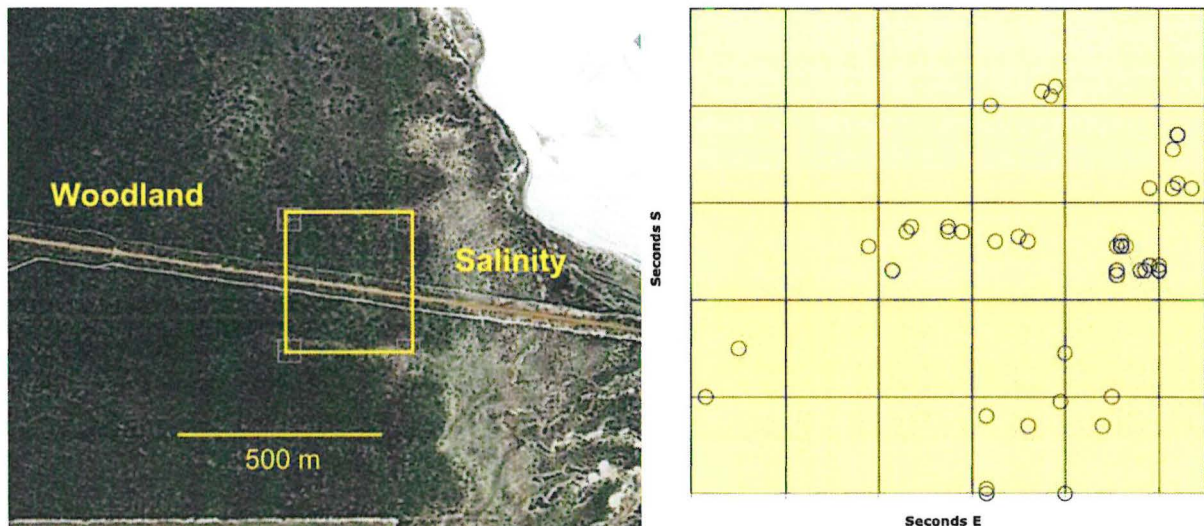
### 2.1. Surveys

Survey data for *D. isolata* are summarised in table 1. On Saturday Sept 15 2007 WANOSCG volunteers conducted an intensive survey for the Critically Endangered Lonely Hammer Orchid (*Drakaea isolata*) near Pingrup, coordinated by the Wheatbelt Orchid Rescue Project (WOR) and Department of Environment and Conservation (DEC). A trip report was produced for the WANOSCG Bulletin (October 2007 pp 6-7). There was a very good turnout for this event with a total of 29 WANOSCG member volunteers. Volunteers were split into two groups lead by Mark Brundrett (WOR) and Andrew Brown (DEC). Despite the cold windy, damp and cloudy conditions there was a successful survey of a large area centred on the known population that revealed almost 300 individuals, of which over 50 were flowering (Table 2). As a consequence of this survey we now have a better idea of the size of the only known population of this rare orchid. A key outcome of the survey was to take GPS coordinates and reference photographs for each group of plants to provide the tools for future monitoring (Appendix 1). It was not possible to cover the entire potential habitat in one morning, so further surveys could be conducted in the future.

### 2.2 Critical habitat.

Almost all known plants of *D. isolata* occur in a small area of approximately 300 m<sup>2</sup> (Figs 3, 4). Boundaries of this area are defined in the Appendix for inclusion in management plans. Searching outside the core area to the east and north was not productive in 2007, but additional surveys to the southwest may expand the habitat area. A few additional plants have been reported to occur in the southwest boundary of the reserve, but coordinates are not provided in IRP. The IRP includes data

on 2 subpopulations, but the 3 coordinates provided all fall within the area outlined in Figure 3A, so should refer to the same subpopulation. Detailed location information for all plants shown in Figures 3 and 4 is provided in Appendix 1.



**Fig. 3. A.** (left) Critical habitat is 10 ha of low shrubland between woodland and salt affected habitats **B.** (right) Approximate relative positions of 56 groups of orchids within the critical habitat area shown as a yellow square in A. Groups of orchids had 1 - 50 leaves and were located on both sides of a track near a salt lake, but greater numbers occur to the north of the track visible in A.

### 2.3. Population size estimates and seasonal variations in abundance

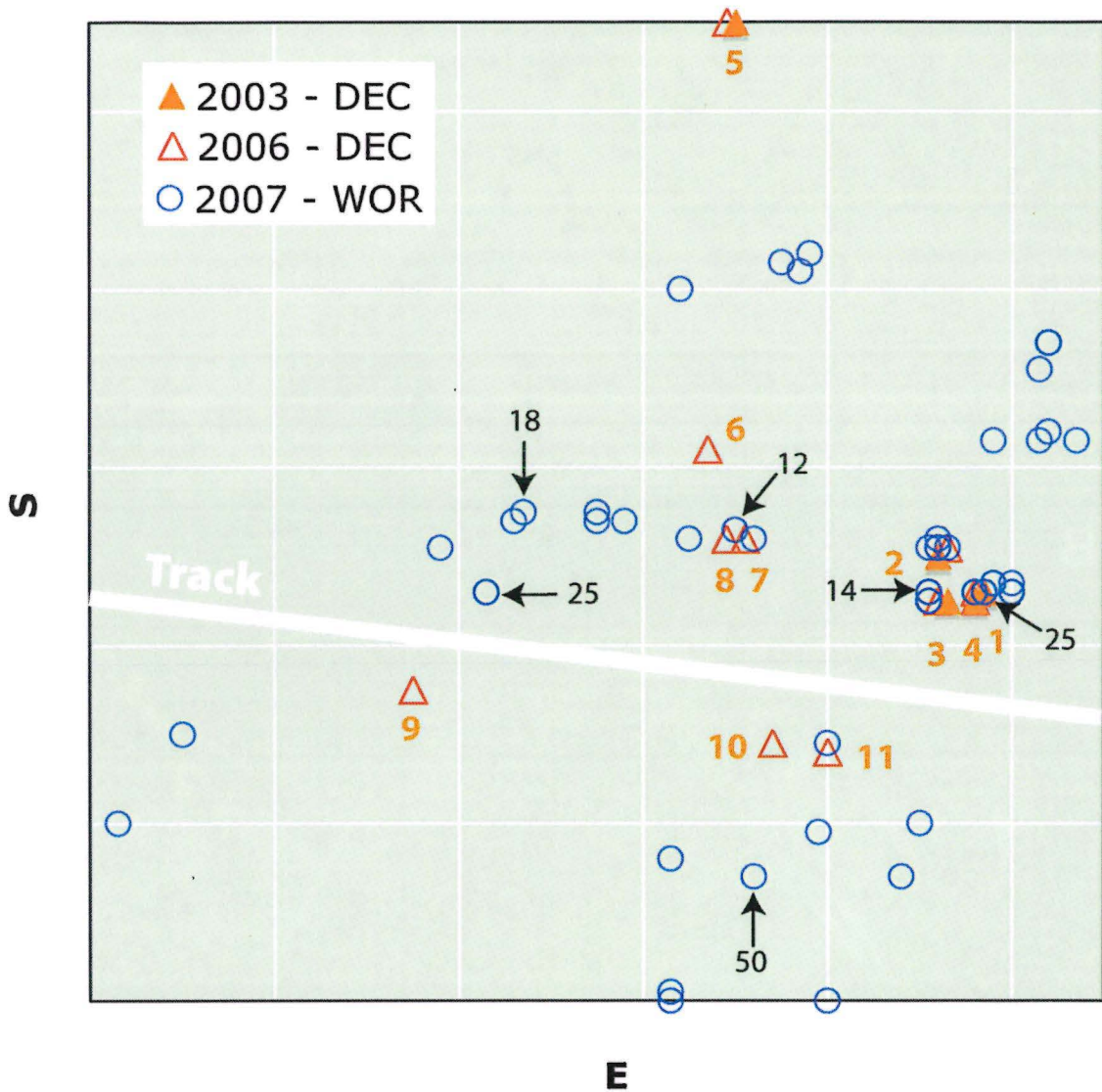
Results of the WOR survey in 2007 are compared to historical data provided by Beth Loudon of DEC in Figure 8 and Table 2. The WOR survey discovered twice as many plants over a much larger area than most earlier surveys, demonstrating the advantage of using a large group of dedicated volunteers. However, all surveys provided valuable data are in agreement that grazing of flowers stalks is a major concern. Ryan Phillips, a PhD student located at Kings Park has determined that pollination rates are fairly high, but has not identified a pollinator.

Photographs taken of a tagged group of plants in by Beth Loudon in 2003 were compared to those taken in 2004 and 2007 at the same coordinates to compare leaf and flower numbers (Fig. 6). Exact comparisons of photos are difficult, due to varying camera positions, but it can be seen that some leaves occupy similar positions while others present in 2007 have recruited since then, or were dormant in 2003. In 2004 8 inflorescences were produced at this spot, but all were grazed. The most likely source of recruitment is vegetative division that results in new leaves and tubers, since new plants were often observed within 1-2 cm of adult leaves (Fig. 7). This would also explain the aggregated distribution of individuals in each group. There are also 2 individuals present in 2003/4 only that may have died since then (Fig. 6B).

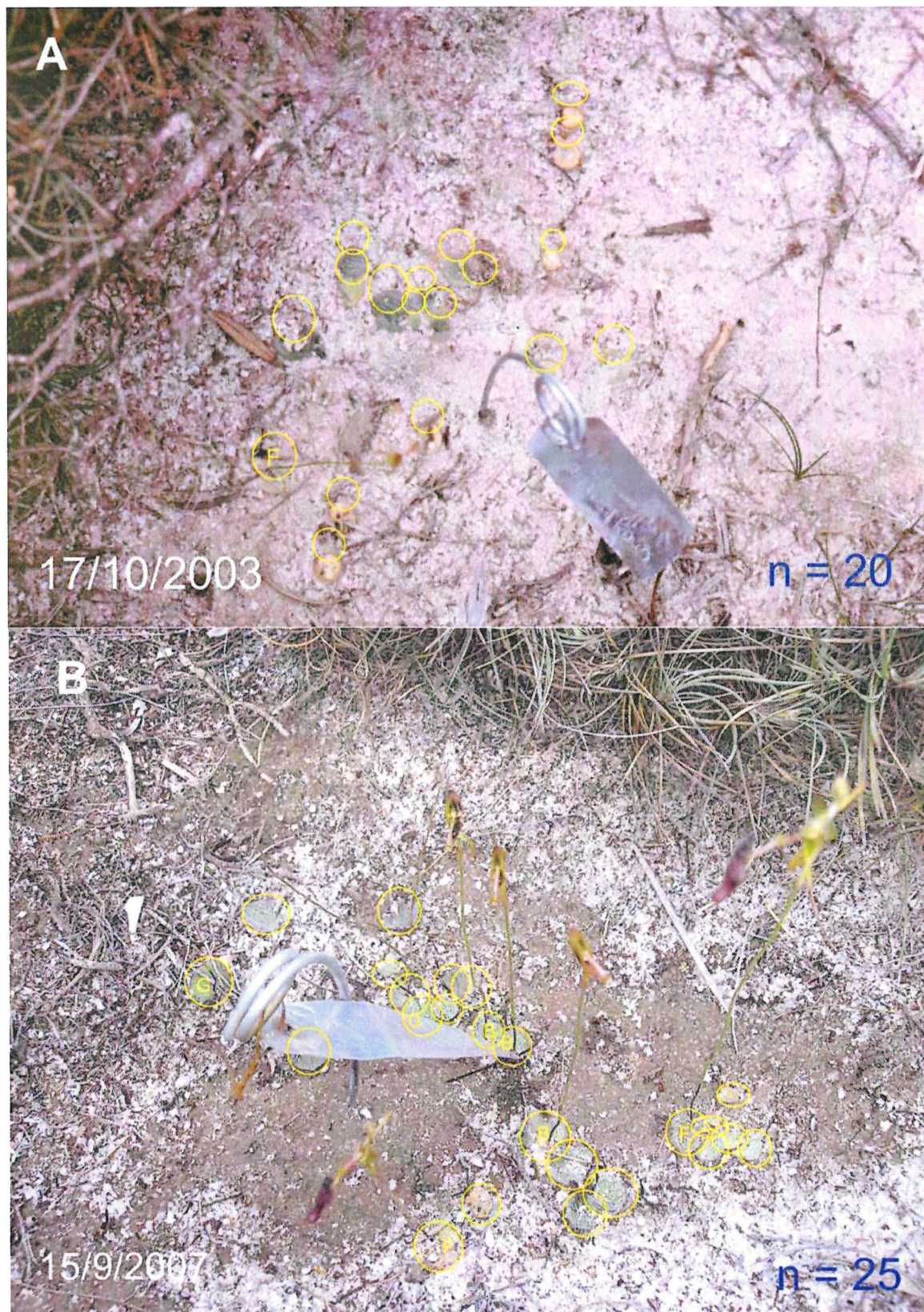
Available data suggest that the main population of *D. iolata* is stable or expanding slowly (Tables 1, 2, Fig 8). As with the other orchids surveyed for this project, the number of orchids found is determined to a large extent by the number of people searching for them. It is probable that there are annual fluctuations in numbers of plants due to annual variations in, as was the case for *Caladenia* species studied for this project. The proportion of leaves that produce flowers varies from 8% to 28% of individuals. However, additional surveys and photo monitoring are required to resolve the total size of each group of plants, rates of recruitment and lifespans of individuals.

**Table 2.** Comparison of 2007 WOR survey data with 2003 and 2006 monitoring data of the core population area by DEC (2003 and 2006 data by Beth Loudon and volunteers).

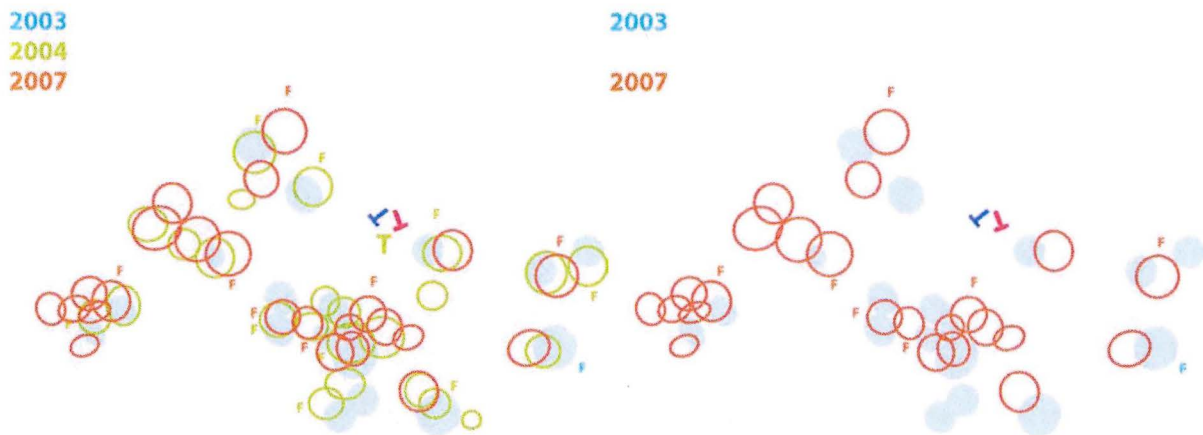
Year	Leaves (n)	Flowers (n)	Flowering (%)	Grazed (%)
2003	49	4	8.2	2.0
2006	92	26	28.3	15.2
2007	297	52	17.5	28.9



**Fig. 4.** Relative positions of plants observed in the 2007 WOR survey (circles) along with earlier data from 2003 and 2006 (Triangles). Most of the plants observed in 2003 have been tagged. Arrows show the number of plants in the largest groups. The area illustrated is approx. 300 m<sup>2</sup>.



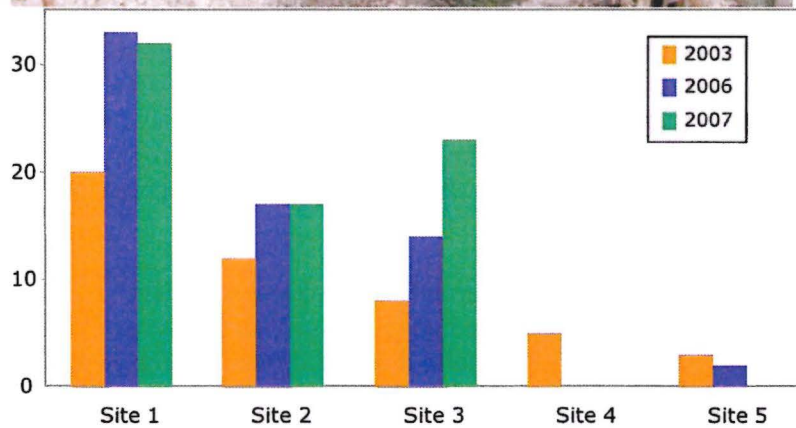
**Fig. 5.** Photo-monitoring comparison of plants visible at the same location in 2003 and 2007. Leaves are circled (F= flowering, G = grazed flower). Upper photo by Beth Laudon.



**Fig. 6.** A. (left) Comparison of approximate locations of leaves emergent in 2007 overlaid over 2003 and 2004 leaves. Exact comparisons are difficult because each photo provided different perspectives of the colony (T = Tag, F = flowering plant). B. (right) comparison 2003 and 2007 leaves only to show plants which may have recruited or lost since 2003 more clearly.



**Fig. 7.** Three young *D. isolata* plants (smaller green leaves) that have emerged next to a parent leaf (larger grey-green leaf). It is presumed that this species reproduces by vegetative division. Leaves often occur in close proximity and may overlap. Note the coarse white sand in which they occur.



**Fig. 8.** Variations in numbers of *Drakaea isolata* leaf emerging at the same locations in three years. Only site 3 appears to support increasing numbers of plants and 2 sites may have been lost. (Data are from Beth Laudon of DEC in 2006, 2003 and the WOR project in 2007).



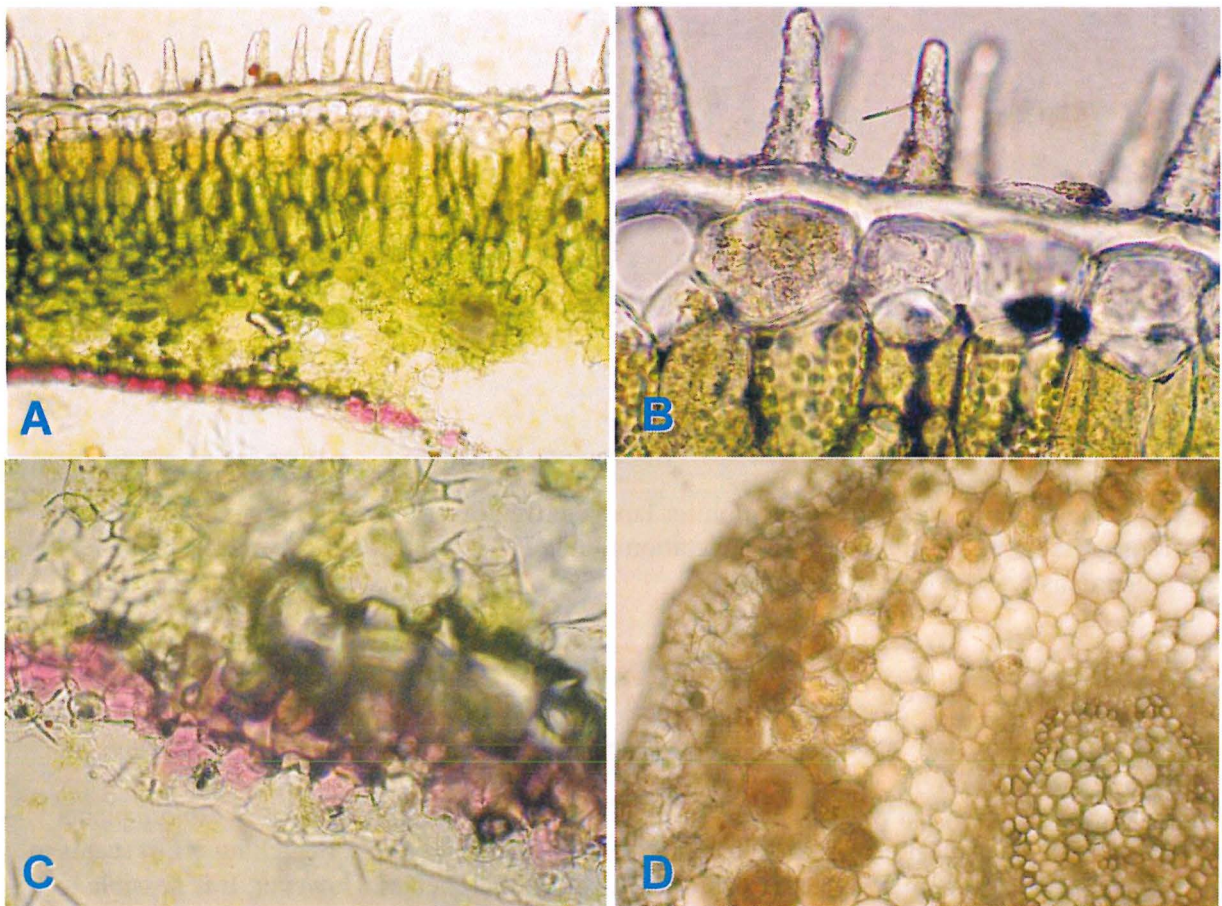
Fig. 9. Flowers and leaves in a group of Lonely Hammer Orchids (*Drakaea isolata*).

As Figures 1B, 5, 7 and 9 illustrate, *Drakaea isolata* flowers and leaves are highly aggregated in 6 locations within the main population area where 10 or more individuals occur within 1 m<sup>2</sup>. At least 50% of known individual occur in these 6 small areas, presumably resulting in increased competition for resources and susceptibility to grazing.

### 3. Adaptations to survival in a dry and exposed habitat

Anatomical investigation has revealed that the laves of *Drakaea isolata* are well adapted to grow in harsh environments. These adaptations are illustrated in Figure 10. These adaptations include (i) leaves which are flush with the soil surface and may be partially buried by coarse sand grains, (i) stomates which located under the leaf in a more humid environment at the soil surface, (iii) a this cuticle and (iv) most impressively a regular array of thick, blunt conical trichomes that have a roughened surface. The latter apparently diffract light to give the leaf its characteristic grey-green banded iridescent appearance, even though the leaf cells below the epidermis are bright green (see Fig. 10).

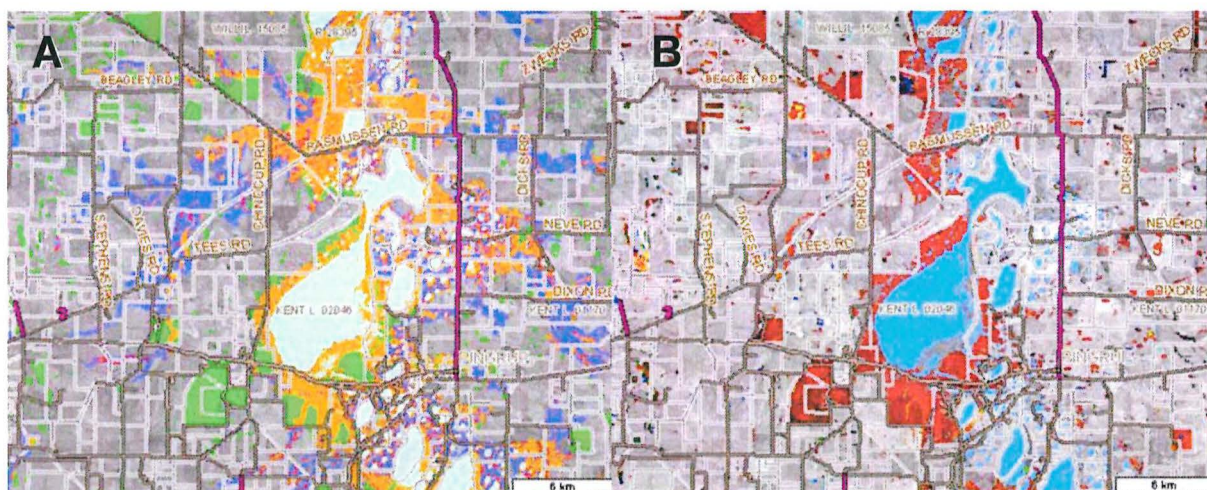
The leaves of *Drakaea isolata* may function in a similar manner to South African succulent “window plants where only the upper leaf surface is exposed to light at the soil surface (e.g. *Fenestraria* sp. ). These adaptations are design tradeoffs that would increase drought tolerance at the expense of rapid photosynthesis, as is typical of the leaves of sclerophyllous woody plants which are common in Western Australia.



**Fig. 10.** Anatomy of leaves and mycorrhizal associations. **A.** A leaf cross section showing trichomes and chloroplasts. **B.** Close up of conical trichomes with encrustations and the thick epidermal cuticle which protects the leaf surface. **C.** Stomates are located under the leaf. **D.** Mycorrhizal association in subterranean stem.

#### 4. Salinity risks in the Lake Chinocup Area

The encroachment of hyper-saline groundwater has been studied in the catchment where *D. isolata* occurs due to townsite salinity problems at Pingrup in the vicinity (Addison 2001). Monitoring bores have been established in this area and data needs to be assessed (Agriculture Department of WA). Salinity appears to be having an increasing adverse effect on vegetation to the east of the main population, but the rate at which shrubland habitat of *D. isolata* is being affected requires further investigation. Land Monitor data in Figure 11 for the habitat of *D. isolata* suggests soils may already be saline (Fig. 11A) and vegetation cover in the area appears to have declined substantially over the past 2 decades (Fig. 11B).



**Fig. 11.** Land Monitor data (<http://landmonitor.landgate.wa.gov.au>). **A.** Salinity map (saline areas are orange, predicted salinity blue). **B.** Vegetation trends 1990-2008 (red = general declining trend in vegetation density over 1990-2008 period).

## 5. Conclusions

The following conclusions are based on an assessment of data summarised in the proceeding sections.

1. An intensive survey by WANOSCG volunteers has increased the number of *D. isolata* plants observed in the critical habitat area in recent years to 300 individuals. Searching effort seems to be a major determinant of apparent population size for this species. However, it is possible to separate seasonal trends in emergence and flowering from searching effort for tagged plants which have been monitored since 2003. These data show that some groups of plants are increasing and others may be in decline or have been lost. The overall population size estimate has not changed much since 1989 (300 plants).
2. Existing photo monitoring and population survey data was of value but should be extended to include more groups of plants and standardized to allow easier comparison between years. The WOR project is developing relevant protocols for population surveys, photo monitoring and tagging of individual plants. The data provided in Appendix 1 should be of great value for future monitoring.
3. In total, 87 photographs were taken and linked to GPS coordinates, representing all plants located in 2007.
4. There is currently insufficient data to determine the balance between recruitment and mortality for this species but long term monitoring data shows that the size of population probably has not increased in the past 20 years. Thus this orchid may already occupy most of its available habitat, or recruitment is not frequent enough to result in population increase.
5. The primary means of spread appears to be by clonal division resulting in new plants that occur within 1-2 cm of the parent plant. Due to the small size of critical habitat (10 ha) and the fact that  $\frac{1}{2}$  of the known plants occur within 6 patches  $< 1\text{m}^2$  within it, confirms that this species should still be considered to be exceptionally vulnerable, on these grounds alone.
6. The highly aggregated distribution of individuals of this orchid suggests that it may already occupy most of its prime habitat. The estimated size of the populations has recently increased but there has been little increase in the known area of occupancy.
7. The concentrated distribution of plants also suggests that competition for resources in these patches may be a major factor limiting the size of populations. Intense competition for resources

such as nutrients provided by mycorrhizal fungi and pollinator visitations is likely to occur in the few square m where most plants occur. Such competition would be less severe in non-productive years where many plants remain dormant.

8. Leaves of this species are very well adapted structurally to survival in a dry habitat. However, even if adult plants are drought resistant, it is likely that recruitment by seed will often be adversely affected by drought.
9. Data obtained by Ryan Phillips, a PhD student located at Kings Park, showed that pollination occurs for a substantial number of flowers at this site, but only very limited quantities of seed were produced.
10. Grazing of flower heads, presumably by kangaroos or wallabies, had a substantial impact on flowering in 2004, 2006 in 2007, but seems to rarely effect leaves. The erection of additional cages or fences is likely to be beneficial (some plants are already caged).
11. Additional research is required to develop an understanding of habitat specificity and why the majority of apparently suitable habitat is unoccupied. The role of mycorrhizal fungi in determining habitat preferences should also be investigated. Ryan Phillips, a PhD student located at Kings Park, is currently undertaking such research.
12. There is an urgent need to assess the risk of salinity to this population, by assessing the rate of spread west towards core area, which is now only 200 m from salt affected areas. Increasing salinity is a well-documented and very substantial problem in the local catchment, but it is not yet clear what impact, if any, this will have on populations of this very rare orchid. However, a precautionary approach is required, as all known individuals of this species are in a location where there is extreme risk of increasing salinisation.
13. Translocation of this species to a new location with a lower risk of salinity impact, if such a habitat is available, must be a very high priority, especially considering the small size of the core habitat area. As recommended in the IRP (Luu and Brown 2004), a translocation plan should be developed. In addition to augmenting population sizes, this would be an appropriate means of investigating plant growth in areas of currently unoccupied habitat that appear suitable.
14. This report identifies coordinates for Critical Habitat for this species that should be included in the fire management plan and any other management plans for the nature reserve.
15. The WOR project research has successfully addressed a number of recommendations in the IRP (Table 3).
16. This report includes data that should be included in future versions of the IRP.

### **Acknowledgments**

On behalf of the WOR Project, DEC and WANOSCG I would like to sincerely thank all the volunteers who attended the major survey. Ryan Phillips provided pollination data. Geo-referencing equipment was provided by the WA Herbarium. Valuable information and assistance was provided by Marie Strelein and Beth Laudon, Flora Conservation Officers in DEC's Great Southern District and Andrew Brown of the DEC Threatened Species and Communities Unit.

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**Table 3.** Recovery actions proposed in the Interim Recovery Plan for *Drakaea isolata* (Luu and Brown 2004) with relevant and planned outcomes of the WOR project.

Recovery Action	WOR Project	Ryan Phillips (BGPA/UWA)
Coordinate recovery actions		
Map critical habitat	This report (Appendix A)	
Seek a change in purpose from UCL to 'Class A' reserve	Supporting data	
Develop and implement a fire management strategy	Critical Habitat identified for inclusion in Fire Management Plan	
Monitor population	Major survey with WANOSCG in 2007 provided population size and grazing data	Pollination (seed set) data obtained
Collect seed and fungi		Fungi and limited quantities of seed obtained
Conduct further surveys	Major survey with WANOSCG in 2007 (this report)	
Obtain biological and ecological information	Substantial new data obtained and evaluated in this report	Pollination and fungal data obtained.
Seek improved security for the population	Critical Habitat identified for inclusion in Fire Management Plan, but long-term security may not be possible as salinity is a major concern	
Promote awareness		
Develop and implement a translocation proposal	Preliminary discussions underway	Preliminary discussions underway
Review the need for a full Recovery Plan		



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Table A2. Locations and geo-referenced photo numbers.

Group #	Total leaves	Total flowers	Side of track	S 00°	00'	00.0"	E 00°	00'	00.0"	Reference photo #s
1	4		N	33	31	55.4	118	23	44.6	14, 15
2	4	2	N	33	31	55.4	118	23	45	16
3	2	2	N	33	31	55.3	118	23	45	19-20
4	5	2	N	33	31	55.3	118	23	44.8	22-24, 10813-10815
5	1		N	33	31	55.3	118	23	44.8	25
6	7		N	33	31	55.5	118	23	44.1	26-27
7	1		N	33	31	55.5	118	23	44.1	27
8	14		N	33	31	55.4	118	23	44.1	28
9	1		N	33	31	55.4	118	23	44.1	
10	3		N	33	31	55.4	118	23	45	29
11	5		N	33	31	55.4	118	23	45	30
12	5	1	N	33	31	55.4	118	23	45	31
13	6	1	N	33	31	55.4	118	23	44.7	32-34
14	3		N	33	31	55.4	118	23	44.7	35
15	23	11	N	33	31	55.4	118	23	44.6	36
16	6	2	N	33	31	54.9	118	23	44.2	37
17	1	1	N	33	31	54.9	118	23	44.2	38
18	5	2	N	33	31	54.9	118	23	44.1	39-41
19	3	2	N	33	31	54.8	118	23	44.2	42
20	2		N	33	31	54.9	118	23	44.3	43
21	3		N	33	31	54.9	118	23	44.2	44
22	1		N	33	31	53.7	118	23	44.8	45
23	1		N	33	31	53.7	118	23	45.3	46
24	1	1	N	33	31	52.9	118	23	45.3	47, 10820-10832
25	1	1	N	33	31	52.6	118	23	45.4	48
26	1		N	33	31	52.6	118	23	45.4	49
27	1		N	33	31	52.6	118	23	45.4	51
28	1	1	N	33	31	52.6	118	23	45.4	50, 10833-10835
29	4	1	N	33	31	53.7	118	23	45.7	52-53
30	1		N	33	31	53.6	118	23	45.4	54
31	12		N	33	31	54.8	118	23	42.2	55-56
32	1		N	33	31	54.7	118	23	42	57
33	5		N	33	31	51.8	118	23	42.7	58
34	2		N	33	31	51.6	118	23	42.8	59
35	1		N	33	31	51.7	118	23	42.5	60
36	1		N	33	31	52	118	23	41.4	61
37	5	2	N	33	31	55.4	118	23	39.3	62-65
38	25		N	33	31	55.4	118	23	39.3	66-67?
39	18		N	33	31	54.5	118	23	39.7	68-71
40	6	3	N	33	31	54.6	118	23	39.6	72-74, 10836-10847
41	2		N	33	31	54.9	118	23	38.8	77
42	3	1	N	33	31	54.6	118	23	40.5	78-79
43	2	1	N	33	31	54.5	118	23	40.5	81
44	1		N	33	31	54.6	118	23	40.8	84
45	8		N	33	31	54.8	118	23	41.5	85-87
46	5		S	33	31	57.1	118	23	43	5,6
47	9	1	S	33	31	58	118	23	44	7,8
48	6		S	33	31	58.1	118	23	42.9	10
49	1		S	33	31	58.4	118	23	41.3	11
50	50	8	S	33	31	58.6	118	23	42.2	12--16
51	6	1	S	33	31	58.6	118	23	43.8	18
52	1	1	S	33	31	60	118	23	43	20--21
53	4	1	S	33	31	59.9	118	23	41.3	22--23
54	3	1	S	33	31	60	118	23	41.3	24--25
55	3	2	S	33	31	57	118	23	36	26
56	1		S	33	31	58	118	23	35.3	27--29
<b>Total %</b>	<b>297</b>	<b>52</b> <b>17.5</b>								