Wheatbelt Orchid Rescue Project

Final Report 5

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

Mark Brundrett

Wheatbelt Orchid Rescue

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W.A. Native Orchid Study & Conservation Group

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Wheatbelt Orchid Rescue Project Final Reports

Brundrett M. 2011a. Wheatbelt Orchid Rescue Project. Final Report 1. Objectives, Outcomes and Overall Conclusions. Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 1*

Brundrett M. 2011b. Wheatbelt Orchid Rescue Project Final Report 2. Population Size and Vital Statistics Data for the Granite Spider Orchid (*Caladenia graniticola*). Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 2*

Brundrett M. 2011c. Wheatbelt Orchid Rescue Project Final Report 3. Population Size and Vital Statistics Data for the Ballerina Orchid (*Caladenia melanema*). Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 3*

Brundrett M. 2011d. Wheatbelt Orchid Rescue Project Final Report 4. Population Size and Vital Statistics Data for the William's Spider Orchid (*Caladenia williamsiae*). Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 4*

Brundrett M. 2011e. Wheatbelt Orchid Rescue Project Final Report 5. Population Size and Vital Statistics Data for the lonely Hammer Orchid (*Drakaea isolata*). Wheatbelt Orchid Rescue Project, University of Western Australia. **This Report**

Brundrett M. 2011f. Wheatbelt Orchid Rescue Project Final Report 6. Population Size and Vital Statistics Data for Southern Populations of the Western Underground Orchid (*Rhizanthella gardneri*). Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 6*

Brundrett M and Ager E. 2011. Wheatbelt Orchid Rescue Project Final Report 7. Seed Collecting, Soil Baiting and Propagation of Orchids. Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 7*

Brundrett M. 2011g. Wheatbelt Orchid Rescue Project Final Report 8. Translocation of Orchids in Wheatbelt Nature Reserves. Wheatbelt Orchid Rescue Project, University of Western Australia. *Link 8*

Citation of 2 or more Project Reports
Brundrett M. 2011. *Wheatbelt Orchid Rescue Project: Case Studies of Collaborative Orchid Conservation in Western Australia.* University of Western Australia, Crawley, Western Australia.

Note: Appendix 1 contains location data for Declared Rare Flora that is not included in publicly available versions of this report.

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. Please refer to the first WOR report for further information.

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

Information about the taxonomy, biology and ecology of the lonely hammer orchid *(Drakaea isolata)* is briefly summarised below and additional information is available from the Interim Recovery Plan (IRP) prepared by DEC (Luu and Brown 2004). *Drakaea isolata* is listed as Declared Rare Flora and ranked as Critically Endangered in Western Australia. This species is also ranked as Critically Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (www.environment.gov.au). Only about 300 mature individuals are known in the single known population (Table 1). Threats listed in the IRP include road and track maintenance, airborne dust, changes to hypersaline groundwater hydrology, and inappropriate fire. These factors are discussed further below.

Table 1. Population size estimates for *Drakaea isolata*.

Year	Total Plants	Flowering plants	Source
1989	250	NA	IRP (Luu and Brown 2004)
1999	152	75	IRP
2003	49	4	IRP, Beth Laudon DEC
2006	92	26	Beth Laudon DEC
2007	297	52	WOR survey with WANOSCG

2. Orchid and Habitat Characteristics

Drakaea isolata has a prostrate leaf and a thin flower stalk up to 30 cm high. Its characteristic leaf is single, dull green, heart-shaped, shortly hairy and 1 -2 centimetres in diameter (Fig. 1H). Flowers are single, 2-3 cm long and 3-4 mm wide with a prominent labellum with distinctive warts and trichomes (Fig. 1B). The most similar species 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). Hammer orchids are typically wasp pollinated, but a pollinator has not been observed for *Drakaea isolata* (Hopper and Brown 2007).

This orchid is endemic to Western Australia where it is confined to a location in the vicinity of Pingrup in the southern wheatbelt. It grows with *Paracaleana triens*, *Pyrorchis nigricans*, and *Thelymitra campanulata* 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).

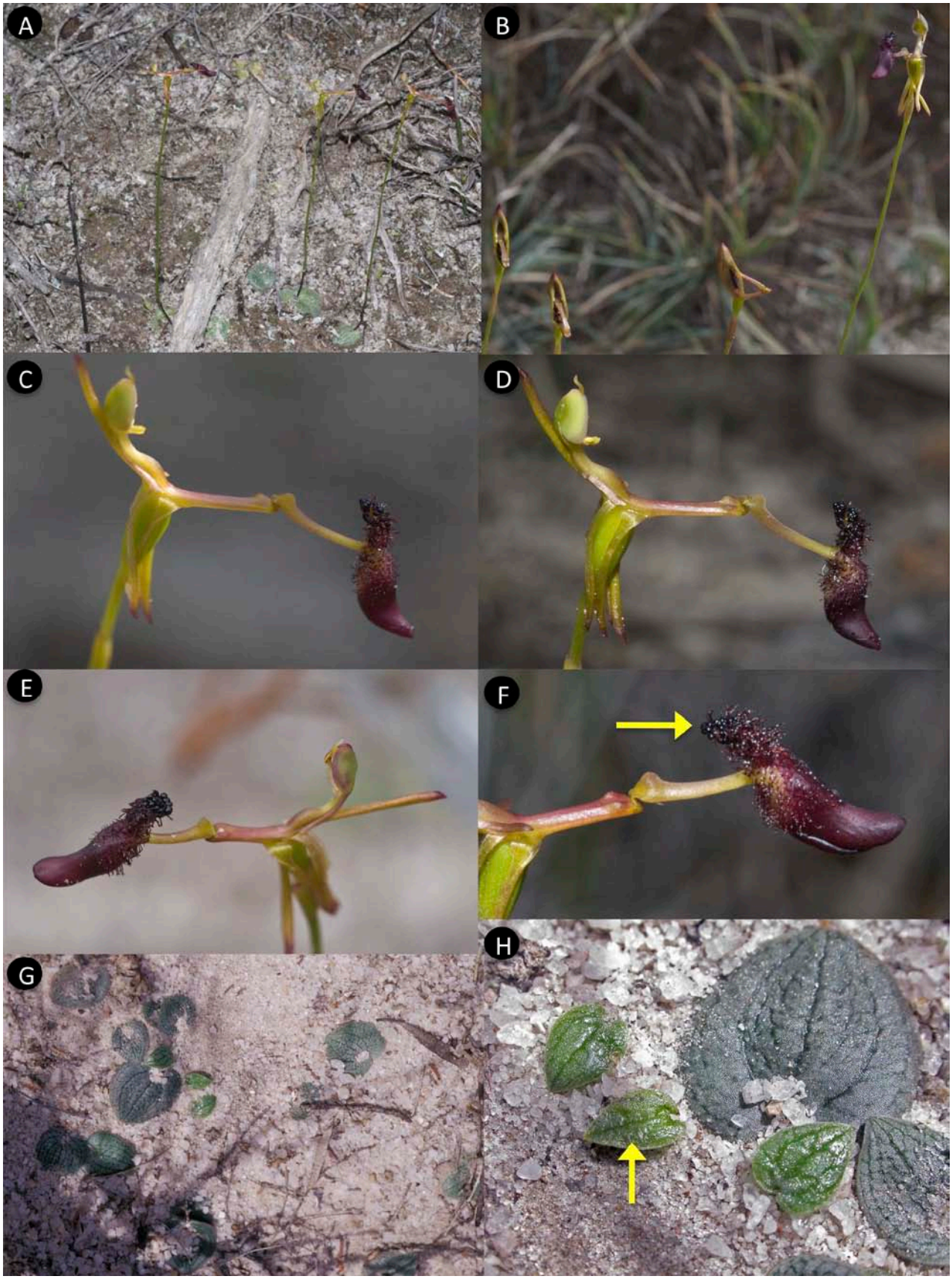

Figure 1. Flowers and leaves of *Drakaea isolata* the lonely hammer orchid. **AB.** Plants in flower and bud. **C-F**. Examples of flowers. **F**. Characteristic hinged lip with gland-like structures and branched hairs (Arrow). **GH.** Leaves have a characteristic grey-green appearance and often occur in groups. **H.** Young leaves (arrow) that emerged close to adults, presumably due to clonal division.

3. Population Surveys

3.1. Survey 2007

Survey data for *D. isolata* are summarised in Table 2. On Saturday Sept 15 2007 WANOSCG volunteers conducted a survey for the lonely hammer orchid near Pingrup, coordinated by WOR and 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 volunteers split into two groups lead by the author (MB) and Andrew Brown (DEC). Despite the cold windy, damp and cloudy conditions they surveyed a large area centred on the known population. This survey revealed almost 300 individuals, of which over 50 were flowering (Table 2). During the survey the teams took GPS coordinates and reference digital photographs for each group of plants to provide the tools for future monitoring (Appendix 1).

3.2 Core and Critical Habitat.

Almost all known plants of *D. isolata* occur in a small square area of approximately 10 ha (Fig. 2). Boundaries of this area are precisely defined in Appendix 1 for inclusion in management plans. Searching outside the Core Habitat 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 within the area outlined in Figure 2 that differ in land tenure. 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.

Table 2. Comparison of 2007 WOR survey data from a larger area 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

Figure 2. Core Habitat for the lonely hammer orchid is 10 ha of low shrubland shown as a yellow square. This area is delimitated by woodland on the left and salt affected habitats on the right (lighter coloured areas). A major track with 2 firebreaks also traverses this area.

4. Population Size and Dynamics

Results of the WOR survey in 2007 are compared to historical data provided by Beth Loudon of DEC in Figure 9 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 and are in agreement that grazing of flowers and stalks is a major concern (Table 2). Ryan Phillips, a former PhD student located at Kings Park has determined that pollination rates are fairly high.

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 (Figs. 6, 7). 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, appear to have recruited since then or were dormant in 2003. There are also 2 individuals present in 2003/4 only that may have died since then (Fig. 7B). 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. 1H). This would also explain the aggregated distribution of individuals in each group (Fig. 5). Leaves often occur in such close proximity that they overlap (Fig. 3).

Figure 3. *Drakaea isolata* leaves in one of the largest groups. This is one example of the 87 geo-referenced photographs taken as a record for future monitoring. This image shows the highly distinctive leaves of a large group of *Drakaea isolata* (with *Paracaleana triens* in bud). Note the overlapping leaves and the coarse white sand in which these species tend to occur.

The plants observed in 2003 were tagged and most were relocated in 2007, expect for 4 of these groups that may no longer exist (Fig. 8). Available data suggest that the main population of *D. iolata* is relatively stable (Fig. 8). As with the other orchids surveyed for this project, the number of plants found is determined to a large extent by the number of people searching for them. There may also be annual fluctuations in numbers of plants that emerge from dormant tubers, 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 and most groups of leaves produce relatively few flowers (Fig. 5). A substantial number of flowers were grazed (i.e. 29% in 2007 Table 2). Additional surveys and photo monitoring are required to resolve the total size of each group of plants, rates of recruitment, the proportion of dormant tubers and the lifespan of individuals.

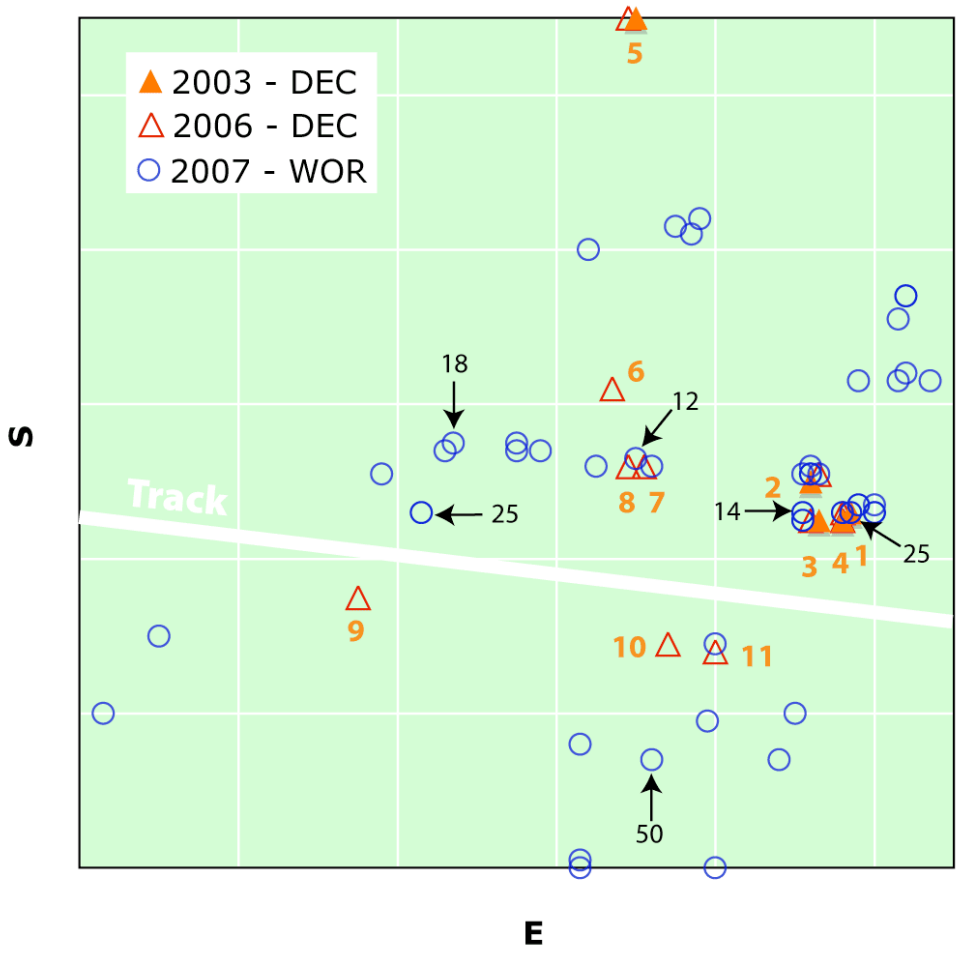

Figure 4. Relative positions of plants observed in the 2007 WOR survey (circles) along with earlier data from 2003 and 2006 (triangles). Arrows show the number of plants in the largest groups. The area illustrated is approx. 300 x 300 m (10 ha).

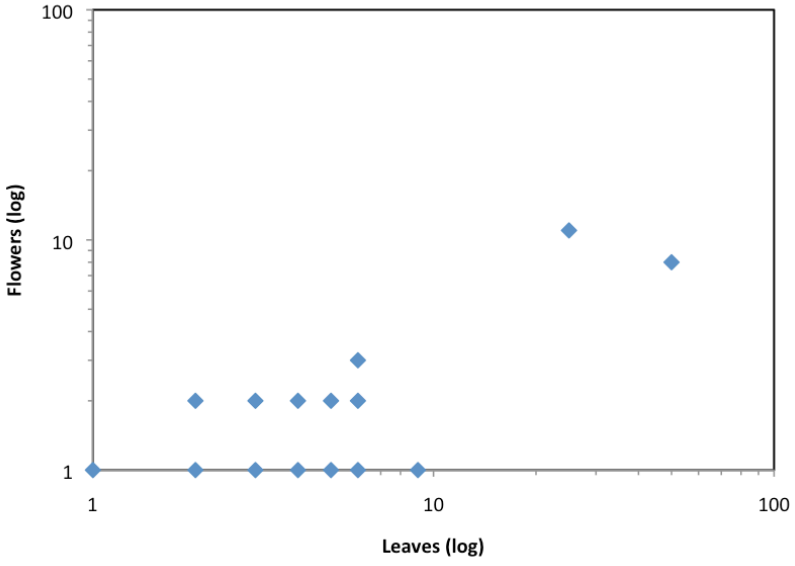

Figure 5. The ratio of leaves and flowers in groups of lonely hammer orchids.

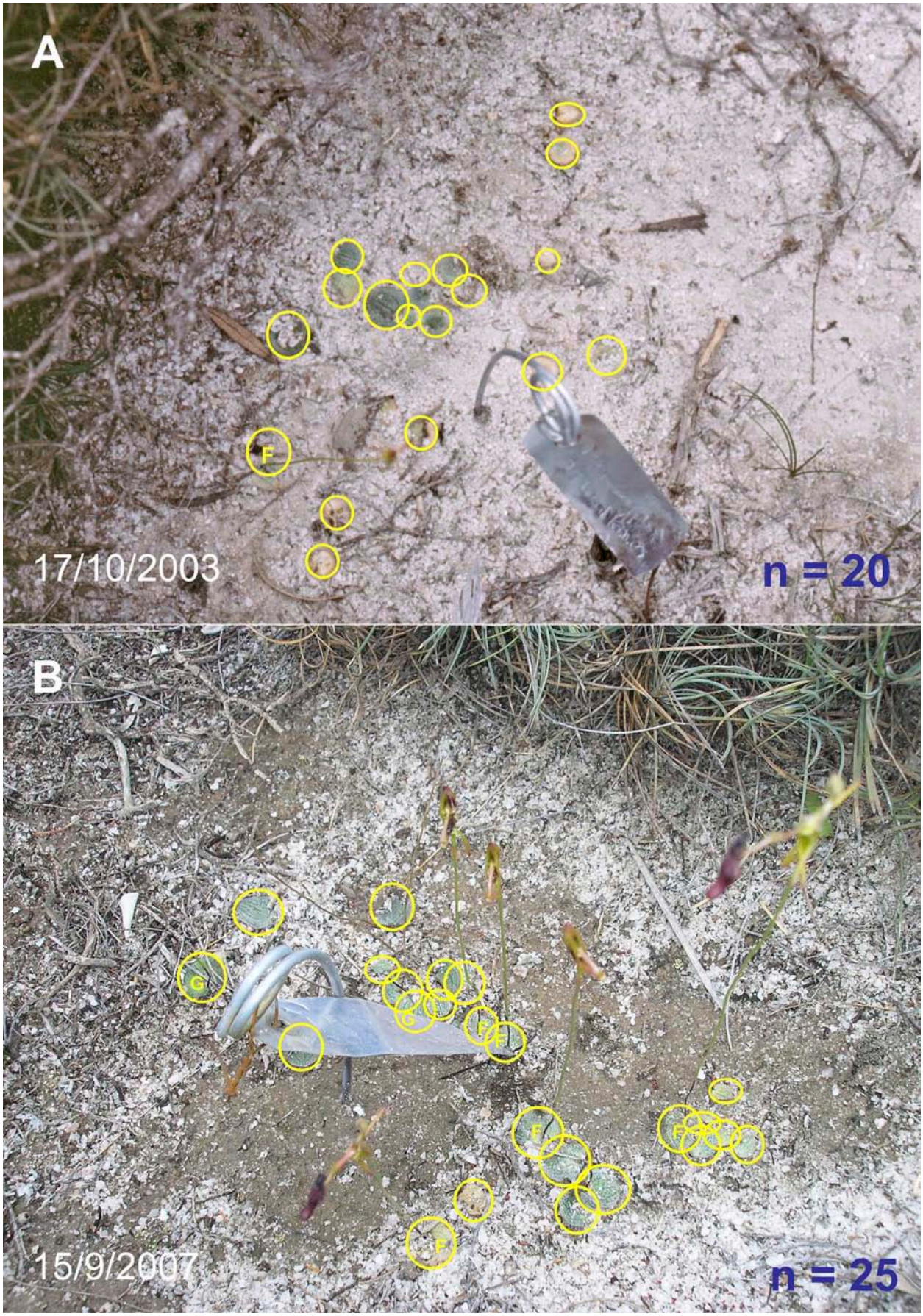

Figure 6AB. Photo-monitoring comparison of plants visible at the same location in 2003 and 2007. Leaves are circled (F= flowering, G = grazed flower). Upper photo by Beth Laudon (DEC).

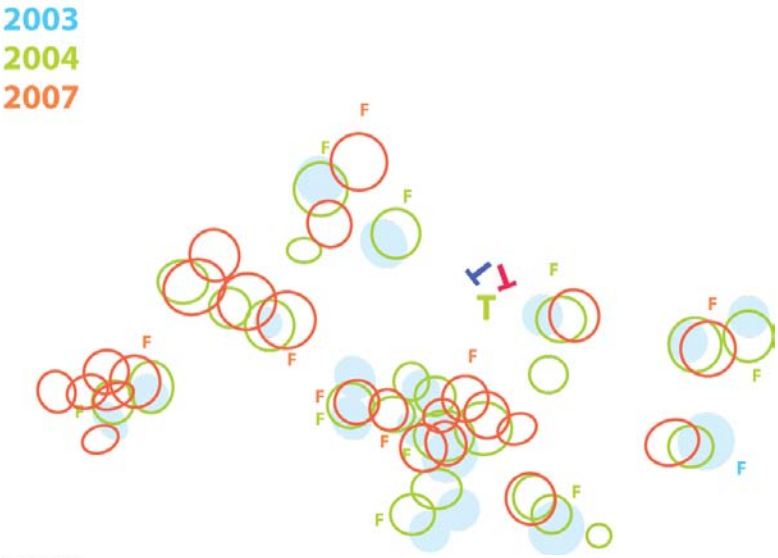

Figure 7A. Comparison of approximate locations of leaves emergent in 2007 overlaid over 2003 and 2004 leaves. Exact comparisons are difficult because each photo provided a different perspective of the colony (T = Tag, F = flowering plant).

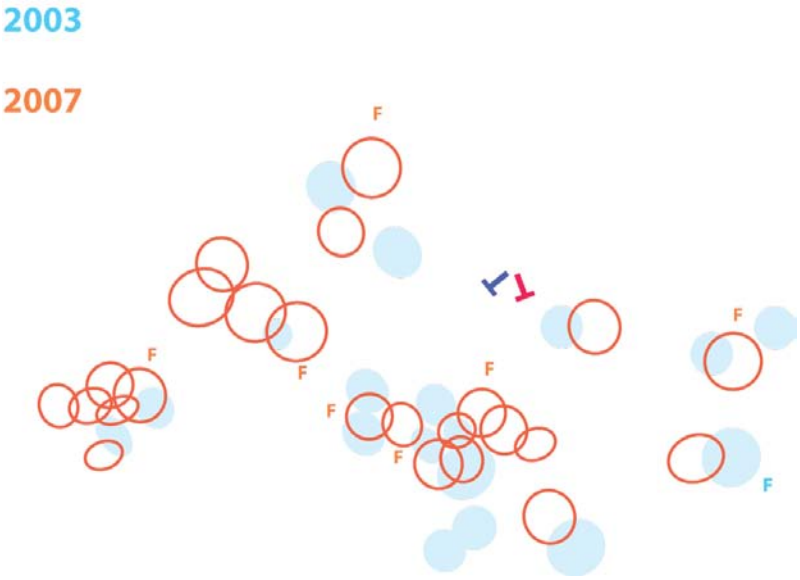

Figure 7B. Comparison of 2003 and 2007 leaves only, to show plants which may have been recruited or lost since 2003 more clearly. It seems that 3 plants were lost and 9 have been recruited since 2003, but some missing plants may have been dormant.

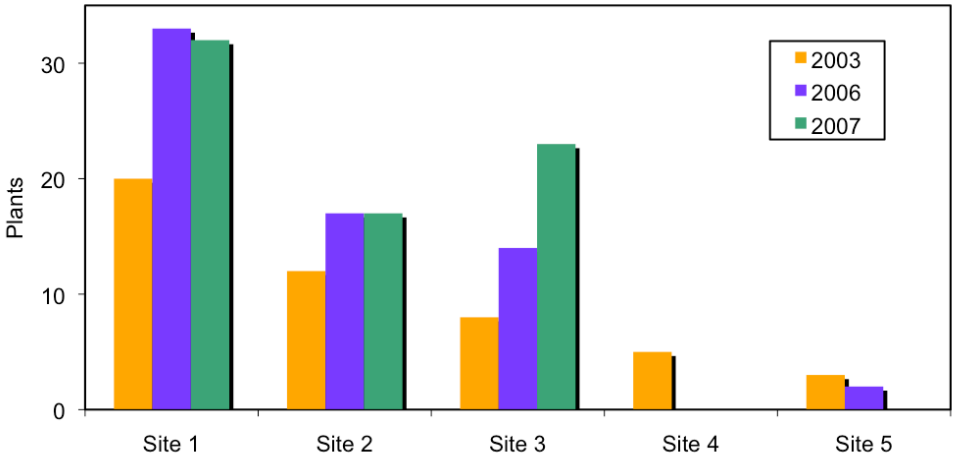

Figure 8. Variations in numbers of *Drakaea isolata* leaf emerging at the same locations on three years. Only group 3 appears to have increasing numbers of plants and 2 groups may have been lost. (Data are from Beth Laudon of DEC in 2006, 2003 and the WOR project in 2007).

5. Adaptations to Survival in a Dry and Exposed Habitat

Anatomical investigation has revealed that the leaves of *Drakaea isolata* are well adapted to grow in harsh environments. These adaptations are illustrated in Figure 9. These adaptations include (i) leaves which are flush with the soil surface and are often partially buried by coarse sand grains, (i) stomata located under the leaf in a humid environment at the soil surface, (iii) a thick waxy covering (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. 9AB).

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. *Fenstraria* 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.

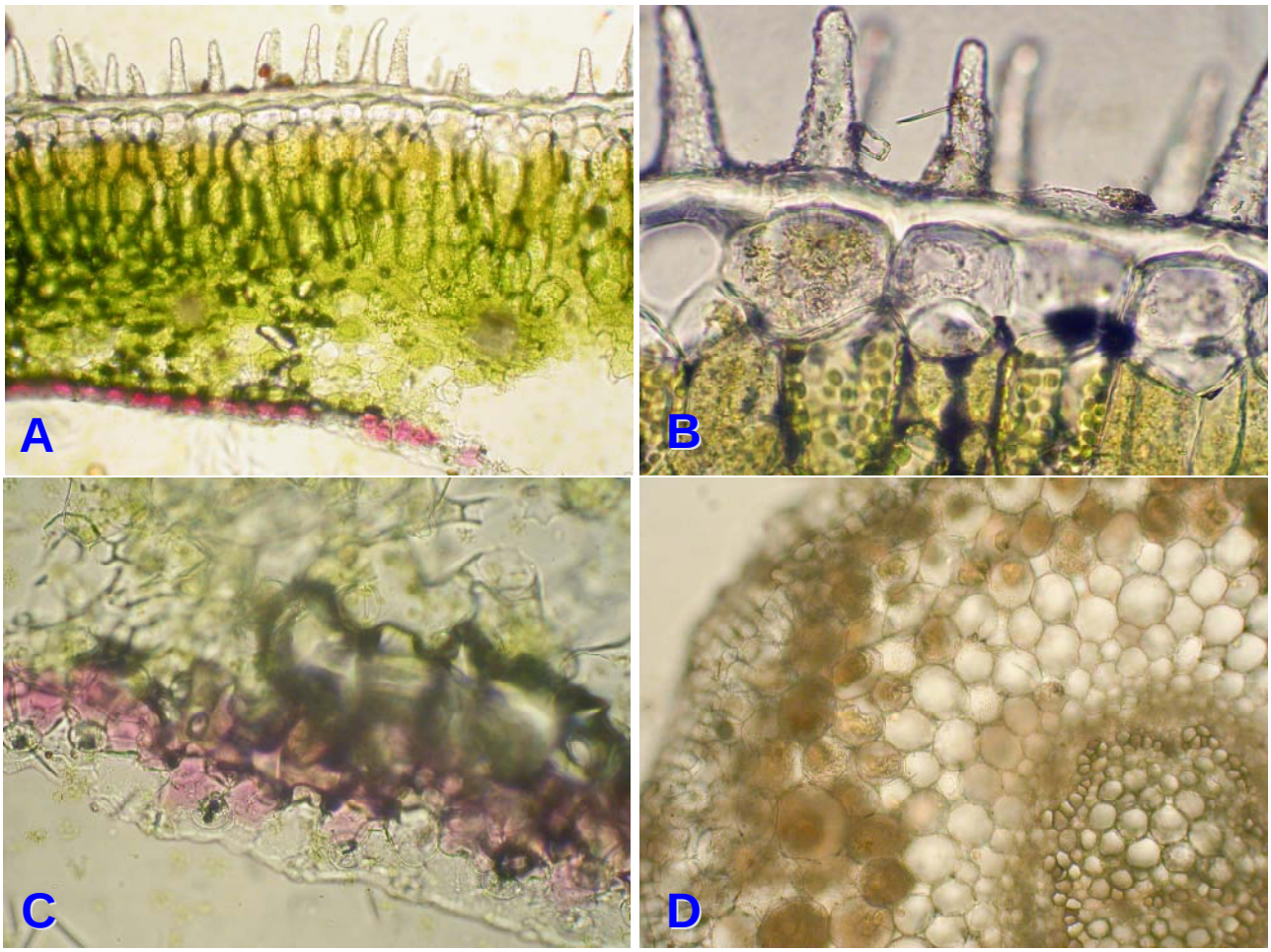

Figure 9. Anatomy of leaves and mycorrhizal associations. **A.** Leaf cross section showing trichomes and chloroplasts. **B.** Close up of conical trichomes with encrustations and the thick epidermal cuticle which protects the leaf surface. **C.** Stomata located under the leaf. **D.** Mycorrhizal association in subterranean stem, consisting of brown balls of hyphae in cells.

6. Long-term Habitat Viability

As Figures 1, 5, 6 and 7 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^2. At least 50% of known individuals occur in these 6 small areas, presumably resulting in increased competition for resources, or pollinators and susceptibility to grazing. These areas are indicated by arrows in Figure 4. Figure 2 shows where disturbance associated with a track bisects the Core Habitat area for this species. This track has been upgraded in recent years and has had heavy vehicle traffic associated with mining.

The encroachment of hyper-saline groundwater has been studied in the catchment were *D. isolata* occurs due to townsite salinity problems at Pingrup townsite (Addison 2001). Monitoring bores have been established in this area but data needs to be assessed (Agriculture Department of WA). As shown in Figure 2, salinity appears to be having an increasing adverse effect on vegetation to the east of the main population, but the impact on the habitat of *D. isolata* requires further investigation. Land Monitor data for this area suggests subsurface soils are already saline (Fig. 10A) and vegetation cover in the area appears to have declined substantially over the past 2 decades (Fig. 10B). Preliminary advice from the Agriculture Department of Western Australia indicates that the local catchment area is at very high risk from rising saline groundwater (see WOR Report 3).

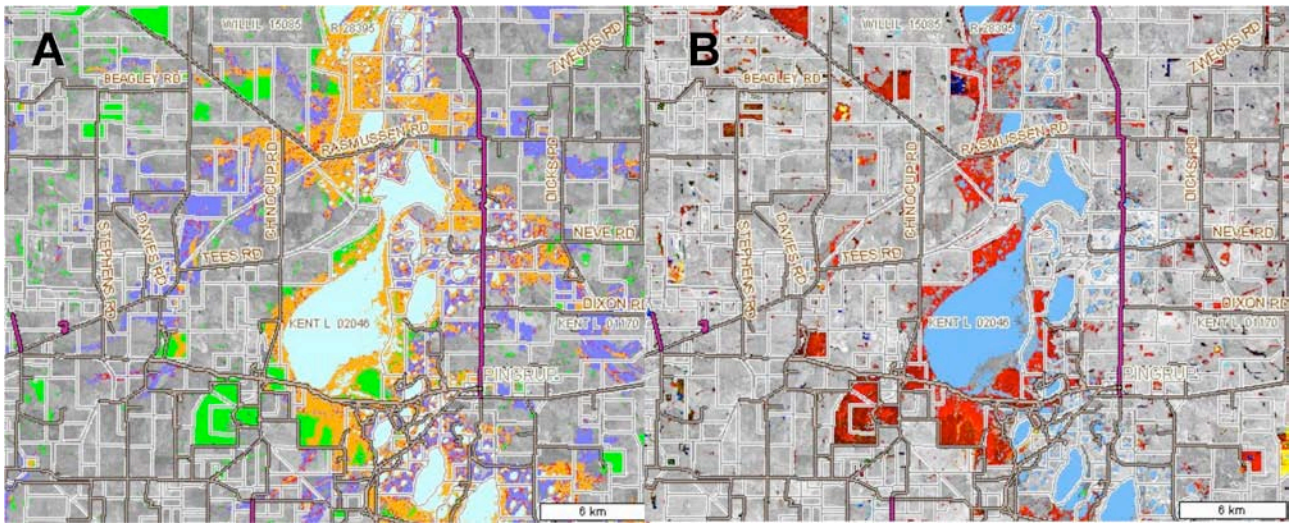

Figure 10. Land Monitor data for areas between Lake Grace and Pingrup (url: landmonitor.landgate.wa.gov.au). **A.** Predictive salinity map for the Chinocup Catchment area (saline areas are orange, predicted salinity blue). **B.** Vegetation trends 1990-2008 (red = general declining tend in vegetation density over 1990-2008 period).

7. Conclusions and Recommendations

1. An intensive survey with the help of WANOSCG volunteers has increased the number of *D. isolata* plants observed in the Core Habitat area in recent years to 300 individuals.
2. In total, 87 photographs were taken and linked to GPS coordinates, representing all plants located in 2007.
3. Existing photo monitoring and population survey data, while limited, was of great value but should be extended to include more groups of plants and photography protocols need to be standardized to allow easier comparison between years (i.e. camera facing straight down and aligned to north in all cases). Tagging of all plants would also be valuable. The data provided in Appendix 1 should be used for future monitoring.

4. Searching effort is a determinant of apparent population size for this species. Consequently, it was not possible to separate seasonal trends in emergence and flowering from searching effort, except for 5 groups of tagged plants monitored since 2003.
5. Data from tagged plants shows that some groups are increasing in numbers while others may be in decline or have been lost. The overall population size estimate has not changed much over 20 years (300 plants). There is currently insufficient data to determine the balance between recruitment and mortality for this species.
6. Either this orchid already occupies most of its available habitat, or recruitment is not frequent enough to result in a substantial population increase.
7. The small size of critical habitat (10 ha) and the fact that ½ of the known plants occur within 6 very small patches (< $1m^2$) within it, confirms that this species should still be considered to be exceptionally vulnerable, on these grounds alone.
8. The primary means of spread appears to be by clonal division resulting in new plants within 1-2 cm of the parent, so the leaves of adjacent plants may overlap. 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 light, water, as well as nutrients provided by mycorrhizal fungi or pollinator visitations is likely to occur in the few square metres where many plants occur.
9. Leaves of this species are very well adapted structurally to survival in a dry and exposed habitat. However, even if adult plants are drought resistant, it is likely that recruitment by seed would be adversely affected by drought.
10. Pollination rates can be relatively high, but only very limited quantities of seed is produced. Further research to identify pollinator(s) and to investigate the possibility of self-pollination is required.
11. Grazing of flower heads, presumably by kangaroos or wallabies, had a substantial impact on flowering, but seems to rarely affect leaves. The erection of additional cages or fences is likely to be beneficial (a few plants are already caged).
12. 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.
13. There is an urgent need to assess the risk of salinity to survival of this species, by assessing the rate of incursion of salinised areas from the east towards the Core Habitat area, which is less than 100 m away. 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 exposed to a high risk of increasing salinisation.
14. Translocation of this species to a new location with a lower risk of salinity impact must be a very high priority. However, it has not yet been possible to identify such an area.
15. As recommended in the IRP (Luu and Brown 2004), a translocation plan should be developed. In addition to augmenting population sixes, this would be an appropriate means of investigating limitations to plant growth and recruitment in areas of currently unoccupied habitat that appear suitable.
16. Coordinates for the Core Habitat area for this species are provided in Appendix 1 that should be included in a fire management plan and any other management plans for the nature reserve.
17. Drakaea isolata *has a single Core Habitat area that contains most plants of this species within a very small area (10 ha).*
18. Critical Habitat areas for *Drakaea isolata* can be defined as all areas of low shrubland and buffer areas within 500 m of within the reserve where it occurs. However, this area may not be much larger than the Core Habitat area.

19. The Core Habitat area, as identified in Appendix 1, should be protected from fire, since the response of *Drakaea isolata* and the associated vegetation to fire is unknown.
20. The WOR project has successfully addressed 7 recommendations in the IRP and suggests 2 important new objectives (Table 3).
21. This report includes data that should be included in future versions of the IRP.

Definitions

Critical habitat is identified as being habitat essential for the survival of a listed threatened species or community. Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism or group of organisms, and into which organisms of that kind have the potential to be reintroduced. (*Environment Protection and Biodiversity Conservation Act 1999*).

Core Habitat, as defined in this report, is the most essential area (s) for survival of the species as it contains the highest concentrations of and/or the majority of currently known individuals. This is the area where the species is most vulnerable to threats such as disturbance causing changes to associated vegetation. This area is the highest priority for protective or remedial actions in the case of fire, weed outbreaks, animal grazing etc. Multiple separate areas, if defined, should be ranked in order of importance.

8. Acknowledgments

The Wheatbelt Orchid Rescue Project was funded primarily by Lotterywest. 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 Roz Hart and 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.

9. References

Addison D. 2001. *Groundwater study of the Pingrup townsite.* Resource Management Technical Report 220. Department of Agriculture, Western Australia

Luu R. and Brown A. 2004. *Interim Recovery Plan No. 81 Lonely Hammer Orchid* (Drakaea isolata ms) *Interim Recovery Plan 2004-2009.* Department of Conservation and Land Management.

Phillimore R, Stack G, Brown A. 2000. *Drakaea isolata* ms Interim Recovery Plan No 81, 2000 – 2003. Department of Conservation and Land Management, Perth.

Hoffman N, Brown A. 1998. *Orchids of South-west Australia*. Revised 2nd edition with supplement. University of Western Australia Press, Nedlands.

Hopper SD, Brown AP. 2007. A revision of Australia s hammer orchids (*Drakaea*: Orchidaceae), with some field data on species-specific sexually deceived wasp pollinators. *Australian Systematic Botany* **20**: 252–285.

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

Recovery Action	WOR Project	Future Objectives
Coordinate recovery actions	Information presented at Recovery Team Meetings	
Map critical habitat	This report (Appendix A)	Prepare or amend Fire Management Plan
Seek a change in purpose from UCL to 'Class A' reserve	Supporting data provided	High priority
Develop and implement a fire management strategy	Critical Habitat identified for inclusion in Fire Management Plan	Prepare or revise plan
Monitor population	Major survey with WANOSCG in 2007 provided population size and grazing data	Long term monitoring required along with additional tagging of plants
Collect seed and fungi		Fungi and limited quantities of seed obtained (BGPA)
Conduct further surveys	Major survey with WANOSCG in 2007 (this report)	Continue regular surveys to monitor population size. Locate potential translocation site(s)
Obtain biological and ecological information	Substantial new data obtained and evaluated in this report	Continue monitoring and photography
Seek improved security for the population	Critical Habitat identified in this report	Long-term security may not be possible due to encroaching salinity
*Grazing control trial by fencing part of area**	*Threat identified*	*Recommended action*
*Monitor habitat decline**	*Preliminary risk assessment provided (this report)*	*Full salinity risk assessment required and remedial actions if possible*
Promote awareness	Presentations and displays for community groups	
Develop and implement a translocation proposal	WOR data shows this species should be a very high priority	
Review the need for a full Recovery Plan		

*New objective for IRP.