INTERIM RECOVERY PLAN NO. 272

GRAND SPIDER ORCHID

(*CALADENIA HUEGELII*)

INTERIM RECOVERY PLAN

2008-2013

April 2008

Department of Environment and Conservation
Kensington

Australian Government

Government of Western Australia

Department of Environment and Conservation
Our environment, our future

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50. CALM formally became the Department of Environment and Conservation (DEC) in July 2006. DEC will continue to adhere to these Policy Statements until they are revised and reissued.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

DEC is committed to ensuring that threatened taxa and threatened ecological communities are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible and, in the case of Critically Endangered (CR) taxa and communities, always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan will operate from April 2008 to March 2013 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Critically Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan assessed.

This IRP was approved by the Director of Nature Conservation on the 30 April 2008. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

Information in this IRP was accurate in April 2008.

This IRP was prepared with financial support from the Australian Government to be adopted as a National Recovery Plan under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

ACKNOWLEDGMENTS

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Thanks also to the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and DEC's Species and Communities Branch for assistance.

Cover photograph by Andrew Brown.

CITATION

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SUMMARY

Scientific Name:	*Caladenia huegelii*	**Common Name:**	Grand Spider Orchid, King Spider Orchid
Family:	Orchidaceae	**Flowering Period:**	Late September to early November
DEC Regions:	Swan, South West	**DEC Districts:**	Swan Coastal, Wellington, Blackwood
Local Government Authorities:	Armadale, Busselton, Canning, Capel, Cockburn, Gosnells, Harvey, Kwinana, Mandurah, Melville, Murray, Serpentine-Jarrahdale, Swan, Toodyay, Wanneroo, Waroona	**Recovery Teams:**	Swan Region Threatened Flora and Ecological Communities Recovery Team; South West Region Threatened Flora and Communities Recovery Team

Illustrations and/or further information: Atkins, K. (2008) *Declared Rare and Priority Flora List for Western Australia.* Department of Environment and Conservation, Western Australia; Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) *Western Australia's Threatened Flora*, Department of Conservation and Land Management, Western Australia; Hoffman, N. and Brown, A. (1998) *Orchids of South-west Australia*, Revised 2nd edition with supplement, University of Western Australia Press, Nedlands; Hopper, S.D. and Brown, A.P. (2001) Contributions to Western Australian orchidology: 2. New taxa and circumscriptions in Caladenia (Spider, Fairy and Dragon Orchids of Western Australia), *Nuytsia* 14(1/2), 27-307; Evans, R., Willers, N. and Mitchell, D. (2003) Threatened Flora of Swan Region. Unpublished report to the Department of Conservation and Land Management, and Environment Australia; Western Australian Herbarium (1998-) *FloraBase – The Western Australian Flora*, Department of Environment and Conservation, Western Australia, http://florabase.calm.wa.gov.au/.

Current status: *Caladenia huegelii* was declared as Rare Flora as *Caladenia* sp. (Coastal Plain) SD Hopper 3400 in September 1987 and as *Caladenia huegelii* in November 1990, under the Western Australian *Wildlife Conservation Act 1950*. It is ranked as Critically Endangered (CR) under World Conservation Union (IUCN 2001) criterion B2ab(i,ii,iii,iv) due to the severe fragmentation of populations and the continuing decline in the extent of occurrence, area of occupancy, quality of habitat and number of locations. *C. huegelii* is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Caladenia huegelii is currently known from 33 extant populations with surveys conducted over the last decade recording 1,614 mature plants. At the time of most recent survey, 17 of the 33 extant populations contained less than five flowering plants each, and in many cases no plants were recorded. However, as habitat appears intact in these areas some populations may still be extant. Three hundred and sixty three plants (22%) occurred within Nature Reserves. An additional 196 plants (12%) occurred on land that has been or is currently in the process of becoming reserved for conservation, largely as a result of negotiations with developers (Population 44 and Subpopulations 28b and 42a). If improved tenure or conservation management is negotiated for Populations 6 and 56 (which are in fact a single large population split over two adjoining properties), a further 805 plants or 50% of the total number of known plants and their extensive supporting habitat would be protected.

Although it appears that there are a high number of populations of this species, most are very small and occur in small disjunct remnants of natural vegetation on the Swan Coastal Plain, and many are subject to development pressures. Threats include urban development, degraded habitat, poor recruitment, weed invasion, roadworks, firebreak maintenance, inappropriate fire regimes, recreational activities and dumping of rubbish.

Description: *Caladenia huegelii* grows up to 60 cm tall with a single erect, pale green, hairy leaf and one or two (rarely three) predominantly pale greenish-cream flowers 7–10 cm across, with variable suffusions, lines and spots of red-maroon. Floral odour is absent. The sepals end in slender light brown to yellow clubs. The large labellum is prominently two-coloured with a pale greenish-cream base and a uniformly dark maroon recurved apex (Hopper and Brown 2001). Distinctively, the labellum contains particularly long, fine, sometimes split fringes, which extend well above the column (Brown *et al*. 1998).

Habitat requirements: *Caladenia huegelii* occurs in areas of mixed woodland of jarrah (*Eucalyptus marginata*), candlestick banksia (*Banksia attenuata*), holly banksia (*B. ilicifolia*) and firewood banksia (*B. menziesii*) with scattered sheoak (*Allocasuarina fraseriana*) and marri (*Corymbia calophylla*) over dense shrubs of blueboy (*Stirlingia latifolia*), Swan River myrtle (*Hypocalymma robustum*), yellow buttercups (*Hibbertia hypericoides*), buttercups (*H. subvaginata*), balga (*Xanthorrhoea preissii*), coastal jugflower (*Adenanthos cuneatus*) and *Conostylis* species, from just north of Perth to the Busselton area, usually within 20 km of the coast. Throughout its range the species tends to favour areas of dense undergrowth. Soil is usually deep grey-white sand usually associated with the Bassendean sand-dune system. However, rare plants have been known to extend into the Spearwood system (in which calcareous yellow sands dominate) in some areas.

Habitat critical to the survival of the species, and important populations: Habitat critical to the survival of *C. huegelii* includes the area of occupancy of important populations; areas of similar habitat surrounding important populations (i.e. jarrah/banksia woodland on Bassendean sands), as these areas provide potential habitat for natural range extension and are

necessary to support viable populations of the associated mycorrhizal fungus and the pollinating wasp species crucial to the orchid's survival, and to allow pollinators to move between populations; and additional occurrences of similar habitat that may contain important populations of the species or be suitable sites for future translocations or other recovery actions intended to create important populations.

Given that this species is listed as Critically Endangered, it is considered that all known habitat for wild and translocated populations is habitat critical to its survival, and that all wild and translocated populations are important populations. However, it is acknowledged that some of the smaller populations and populations in highly degraded or small areas of remaining habitat have lower potential for long-term survival and therefore resources will be focussed towards populations with greater potential for long-term survival.

Benefits to other species or ecological communities: A number of flora and fauna species of conservation significance occur in association with *Caladenia huegelii*, as detailed in the body of this IRP. Recovery actions for *C. huegelii*, such as protection of habitat from clearing and the management of fire, disease and weeds, will protect these species and the ecological community in which populations are located. Population 38 occurs within 200 m of the boundary of a Threatened Ecological Community (TEC), and is within contiguous bushland. This TEC is identified as 'Herb rich saline shrublands in clay pans' as defined in the Gibson *et al.* (1994) report 'A floristic survey of the southern Swan Coastal Plain'. It is ranked as Vulnerable on the list of TECs in Western Australia. Recovery actions such as management of fire, disease and weeds will help to protect this TEC as well as *C. huegelii*.

International obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. *Caladenia huegelii* is listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), ratified by Australia in July 1976, under 'Orchidaceae'. The aim of that convention is to ensure that international trade in listed species does not threaten their survival (UNEP-WCMC 2007). This plan is in full accord with that aim.

Indigenous consultation: Involvement of the Indigenous community is being sought through the indigenous reference groups for the Swan Catchment Council and South West Catchment Council to determine whether there are any issues or interests identified in the plan. A search of the Department of Indigenous Affairs' Aboriginal Heritage Sites Register has identified a number of sites in the area of *Caladenia huegelii* populations, as detailed in the body of this IRP. Where registered sites co-occur with *Caladenia huegelii*, specific advice will be sought from the relevant indigenous community or advisory bodies.

Social and economic impact: The habitat type that *Caladenia huegelii* occupies is widespread, but is in high demand for housing, commerce, industry and agriculture. Conflict between the protection and recovery of this species and the development of land for human use is particularly high in the Perth metropolitan area. Negotiations between DEC, land developers and other stakeholders are ongoing in an effort to seek a mutually acceptable outcome which takes the conservation of this species into consideration. (Further details of these are provided in Section 1 – History). Protection of populations of this species has the potential for both social and economic impact, and individual situations must be resolved on a case-by-case basis.

Affected interests: Stakeholders potentially affected by the implementation of this plan include land managers and landowners on whose property *Caladenia huegelii* occurs. Other potential stakeholders include infrastructure providers and developers of land containing *C. huegelii* who need to plan their development and maintenance to protect *C. huegelii*.

Evaluation of the plan's performance: The Department of Environment and Conservation will evaluate the performance of this IRP in conjunction with the Swan Region and South West Region Threatened Flora and Communities Recovery Teams. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

Completed recovery actions

1. Relevant land managers have been notified of the location and threatened status of the species.
2. A heavy gate was installed in 2007 to restrict access to Population 42.
3. DEC staff, consultants, members of the Western Australian Native Orchid Study and Conservation Group and other volunteers have undertaken many surveys for the species.
4. An information sheet that describes and illustrates the species has been prepared, printed and distributed.
5. Research has been conducted into the biology and ecology of this species, examining genetic variability patterns, pollination rate (one site only), development of symbiotic germination methods, and experimental translocation attempts.

Ongoing and future recovery actions

1. Staff from DEC's Swan and South West Regions and Blackwood, Wellington and Swan Coastal Districts are liaising with relevant land managers over actions to conserve the species.
2. Staff from DEC's Swan Region have assessed development applications for bushland containing *C. huegelii* and sought good conservation outcomes. This action is ongoing as required.
3. Staff from DEC's Swan and South West Regions and Blackwood, Wellington and Swan Coastal Districts regularly monitor known populations of the species.
4. The Swan Region and South West Region Threatened Flora and Communities Recovery Teams are overseeing the implementation of this IRP and will include information on progress in their annual reports to DEC's Corporate Executive and funding bodies.

IRP Objective

The objective of this IRP is, during the five year term of this plan, to maintain or improve the conservation status of this species, by ensuring the continued survival of known populations, abating identified threats to populations, and supporting future increases in area of occupancy and numbers of mature plants through translocations once successful techniques are established. However, it is acknowledged that some smaller populations and populations in highly degraded or small areas of remaining habitat have lower potential for long-term survival and resources will be focussed towards populations with greater potential for long-term survival.

Criteria for success

The IRP will be considered to have succeeded if any two of A, B or C are met:

A. The area of occupancy is maintained or increased over the term of the plan.

B. There is an increase of 10% or more in the total number of mature plants and/or area of occupancy under secure conservation tenure.

C. Results of research conducted as per recommendations in this IRP (eg appropriate fire regimes, pollinator habitat, recruitment requirements, survey, monitoring etc) is applied in habitat management over 20% or more of the known area of occupancy of the species.

Criteria for failure

The IRP will be considered to have failed if either of A or B are met:

A. The area of occupancy has decreased by ten percent or more over the term of the plan.

B. There has otherwise been a decline in the species, or worsening of the nature of threatening processes, leading to increased concern over the long term survival of the species.

Recovery actions

1. Coordinate recovery actions
2. Liaise with land managers
3. Carry out appropriate management of bushland that contains *C. huegelii*
4. Carry out environmental assessment of developments or actions that have the potential to damage *C. huegelii* plants or habitat
5. Seek positive conservation outcomes for future development proposals for lands containing *C. huegelii*
6. Monitor populations
7. Increase area of *C. huegelii* habitat on secure tenure
8. Manage access
9. Assess and install Declared Rare Flora markers
10. Undertake weed control
11. Conduct further surveys
12. Clarify identification of unconfirmed populations
13. Develop and implement a fire management strategy
14. Develop and implement a grazing control strategy
15. Collect and store seed and fungal material
16. Promote awareness
17. Manage small populations to increase numbers of individuals and area of occupancy
18. Research and develop best practice protocols for translocations
19. Plan conservation translocations
20. Obtain biological and ecological information
21. Map habitat critical to survival
22. Review the need for further recovery actions

1. BACKGROUND

History

Caladenia huegelii was described by H.G. Reichenbach in 1871 from specimens collected by Baron von Huegel. However, as the type sheet contains three distinct taxa (*C. ensata*, *C. paludosa* and *C. huegelii*), and it is only recently that the latter two have been regarded as distinct, a good deal of confusion has surrounded the correct identity of the species. It has been regarded by most recent authors as a widespread, variable species and as such has embraced a number of related but nevertheless distinct taxa including *C. pectinata* and *C. ferruginea* and the recently named *C. arenicola*, *C. georgei*, *C. applanata* and *C. thinicola*. *C. huegelii* is now known to be a restricted species confined to the Swan Coastal Plain between Perth and Capel (Hopper and Brown 2001). A full description of this species is included in Section 6 of this Plan.

David Jones and Mark Clements created the segregate genus *Arachnorchis* for a group of *Caladenia* species including *Caladenia huegelii* (Jones *et al*. 2001). Steve Hopper and Andrew Brown argued against this (Hopper and Brown 2004), and the split has not been generally accepted in Australian or international herbaria.

Caladenia huegelii was probably once more common on the Swan Coastal Plain. However, the distribution of the species overlaps with large areas of urban development between Perth and Bunbury. Clearing of native vegetation for these purposes has led to the increasing fragmentation of habitat with most populations now confined to small areas of remnant bushland.

There is increasing clearing pressure on remnants of uncleared bushland that contain *Caladenia huegelii*. In 2005, proposed developments threatened all five larger populations. Details of these are provided below as they would impact significantly on the conservation of the species. In light of this development pressure, extensive surveys for new populations were undertaken in September 2005, and two additional large populations were found; one in a nature reserve, and the other in an area proposed to be cleared for light industrial purposes. Additional surveys of appropriate habitat was undertaken in 2006 and 2007, locating a population of 19 plants on a small urban bush remnant.

Synopses of key developments
Development proposals that threatened Populations 6, 28, 42, 44, 48, 54 and 56 are described, including details of outcomes that are relevant to the ongoing conservation and management of *Caladenia huegelii*.

Population 6 - Ken Hurst Park
Also relevant to Populations 20, 55, 56 and 57 and Subpopulations 21a&b.

Population 6 includes plants in Ken Hurst Park, plus the Roe Highway road reserve, and the rail reserve, that passes through Ken Hurst Park. Population 20 and Subpopulation 21a are also within Ken Hurst Park and are contiguous with Population 6. Populations 55, 56 and 57 and Subpopulation 21b,are contiguous with Population 6 but on different tenure.

Ken Hurst Park and the Roe Highway alignment were identified in the State government's Bush Forever program as a regionally significant bushland to be protected.

The extension of Roe Highway has been included in urban planning for several decades. Part of the land area reserved for Stage 7 of this extension passed through Ken Hurst Park, impacting on a known population of *C. huegelii*. This project was subject to a Public Environmental Review, assessed by the Environmental Protection Authority (EPA) and under the Commonwealth EPBC Act.

Flora surveys carried out for the environmental impact assessment process discovered that the population of *Caladenia huegelii* on Ken Hurst Park (including the road reserve) was larger and covered a greater area than previously known.

A wide range of stakeholders were involved in extensive discussions about how best to minimise the environmental impacts of this project, including impacts on *Caladenia huegelii*. These included the then Department of Conservation and Land Management and the Department of Environment (now combined to

form Department of Environment and Conservation), Botanic Gardens and Parks Authority (BGPA), and non-government groups including Friends of Ken Hurst Park, WA Native Orchid Study and Conservation Group, Wildflower Society of WA, Conservation Council, Melville Preservation Group, Melville Watchdog group, Wetlands Conservation Society and Beeliar Wetlands Group. The original proposal would have resulted in the loss of up to 63 hectares of habitat and a significant number of *C. huegelii* plants in Ken Hurst Park.

A Western Power above ground transmission line was also proposed to be constructed along this alignment in association with the Highway extension. Design of the transmission line and environmental assessment was carried out in conjunction with the Roe 7 processes.

Initial planning designs minimised the overall impact on the *Caladenia huegelii* population, and fragmentation of the contiguous bushland associated with Ken Hurst Park. Further construction design modifications incorporated to minimise impacts on *Caladenia huegelii* included "reduction of the highway median width; realignment of the Principle Shared Path in the vicinity of orchid locations; placement of kerbing near orchid locations downslope from hydrological catchments; relocation of drainage sumps to maximise separation from orchid locations; realignment of the road carriageway partly outside the road reserve to avoid orchid locations; and modification of vertical alignment to minimise cut and fill batters to reduce the clearing footprint" (Honczar 2005).

Mitigation of unavoidable residual impacts on *Caladenia huegelii* included land purchase at two metropolitan sites known to support significant populations of the orchid (Populations 42 and 44) and also the proposal to transfer uncleared parts of the road reserve and other adjacent land parcels surrounding the Roe 7 alignment to Ken Hurst Park. Where possible, land offsets were to be placed into the conservation estate to ensure their long-term viability and provision of secure habitat for the species.

A research program was developed to gather information that will assist future conservation and management of this species on the Ken Hurst Park and Roe 7 area and elsewhere. This research includes translocation of orchids within the final construction envelope to the habitat area preserved. This was undertaken by a PhD student working through both University of Western Australia's School of Earth and Geographical Sciences and BGPA's Science section. Plants were translocated in summer 2004 according to a plan approved by DEC's Director of Nature Conservation, and have been monitored since. The BGPA research program funded by Roe 7 also includes a study of the wasp pollinator, mycorrhizal fungus, genetics of *Caladenia huegelii* and *in-vitro* and *in-situ* propagation of *C. huegelii*. More detail about this research is included in the Existing Recovery Actions section of this IRP. DEC is continuing to liaise with the Roe 7 project team, and BGPA continues their involvement with the translocation of orchids affected by construction of this Highway.

Population 28 – Murdoch Train Station

One plant of *Caladenia huegelii* was observed at this site in 1988, but no more plants were recorded until 2003. The 2003 surveys that located new *C. huegelii* plants were required as part of the environmental assessment process for the construction of extensions and redevelopment of the Murdoch bus and train transit station as part of the Perth to Mandurah Railway.

The 2003 survey identified twenty two *Caladenia huegelii* plants in approximately four hectares of bushland at this location. This area was scheduled to be cleared as part of the extensions and redevelopment of the Murdoch Transit Station, and associated car parking facility. After negotiations between then-CALM, New MetroRail (part of Public Transport Authority), Department for Planning and Infrastructure and EPA Service Unit, the design was modified to allow retention of 0.8 hectares of bushland which incorporated twenty of the twenty two *C. huegelii* individuals found during the previous spring survey. The remaining plants were to be translocated into the retained area. The Public Transport Authority has proposed to transfer management of this area to the City of Melville for conservation of *C. huegelii*.

The car park and roadworks were completed, the translocation and other works on the retained bushland were carried out and this remaining 0.8ha of bushland is now referred to as Population 28b (Population 28a being the area of habitat and plants cleared in construction).

Mitigation for the residual impact to the habitat of this species involved contributing to the purchase of land supporting Population 44, to secure *C. huegelii* present at that site against clearing for housing.

Population 42 - Banjup

Population 42 of *Caladenia huegelii* occurs on private property and road reserve in bushland in Banjup. Individual lots were owned by the Western Australian State Housing Commission (SHC) (and leased for sand extraction), and a range of private property owners. The road reserve is vested in City of Cockburn.

This bushland was identified in the State government's Bush Forever program (BF site 390) as a regionally significant bushland to be protected.

Prior to 2003 the numbers and area of occupancy of *Caladenia huegelii* in Population 42 was thought to be small. Additional surveys in conjunction with the Bush Forever program, and prompted by proposals by a sand mining company to clear and mine new areas of the bushland, and by Western Power to clear adjacent areas of bushland for above ground powerlines, found that the bushland contained hundreds of plants occupying a larger area than previously thought. These surveys in 2003-2005 also located subpopulations on adjoining lots.

In May 2005, the sand mining company applied to the Minister for the Environment for permission to take and translocate 59 *Caladenia huegelii* plants into the adjacent Bush Forever bushland so they could continue to extract sand. Permission to take was not granted on the basis that translocations were an experimental, unproved action, (success or failure will not be known for many years) and it was the intention of the State government to acquire this land and reserve it for the conservation of *C. huegelii*.

The WA Planning Commission (WAPC) has negotiated the purchase of the location supporting most plants, and has determined a process to protect the majority of the area across the remaining lots through statutory land use planning processes. The purchased land will be formally reserved for conservation.

Population 44 - Huntingdale

A small number of plants of *Caladenia huegelii* were first observed at this site in 1996 and 1997, but no further surveys were carried out until 2003. The 2003 surveys that located *C. huegelii* plants was required as part of the local government statutory land use planning process for an urban subdivision proposed for the site.

The surveys in 2003 covered 14 hectares of bushland on four Lots, and located 21 plants on three of the Lots and the adjacent road reserve. These locations contained contiguous vegetation that constituted an area of viable habitat unusually large for the metropolitan area, and *C. huegelii* was scattered widely across much of it.

The entire area was proposed for urban subdivision and development, and options to purchase housing blocks had been sold to individual consumers prior to obtaining subdivision approval or approval to clear. However taking of listed threatened flora would have required State and Commonwealth ministerial approval.

Extended discussions were had between then-CALM, the developer, EPA, State Appeals Convenor and then-Commonwealth Department of Environment and Heritage. Final resolution saw the sale of two Lots to the State government for a conservation reserve, and permission for the developer to translocate seven plants from the third Lot into that proposed reserve. This made the development of the third Lot possible, and individuals who had bought parcels of the first two Lots were offered building blocks on this adjacent third Lot. The 2003 surveys did not locate any *Caladenia huegelii* on the fourth lot, and this area was subsequently cleared and developed for housing.

The area sold to the State government was purchased through WAPC for formal reservation, and is now vested in the Conservation Commission of Western Australia and managed by DEC as a nature reserve. This conserves approximately 5.5 hectare of the original 8.8 hectare area of *C. huegelii* habitat on site, and 12 known plants. This acquisition was part of a conservation offset for the developments affecting Population 6 and 28, as detailed above.

Population 48 - Forrestdale

Also relevant to Population 51, which is now considered part of Population 48.

The land supporting Population 48 had planning approval as a commercial zoning and an application was submitted to clear this land for construction of a commercial precinct in accordance with strategic planning for the district.

After extensive discussions, it was agreed that the long-term viability of this population was low once existing links to nearby bushland were severed through development. It was also noted that the bushland on the site was heavily affected by *Phytophthora* dieback. Ministerial approval to take the plants was granted in September 2003. The developers offset the impact of clearing on the conservation of this species by funding a survey of appropriate habitat in the broader area. This information was used in later surveys for the species by then-CALM in 2003. The developers also provided $62,500 for conservation measures.

The bushland on this location has now been cleared. No translocation of the existing plants was required or attempted and Populations 48 and 51 are now considered extinct.

Population 54 - Dawesville

Two *Caladenia huegelii* plants were discovered on this site in October 2002 as a result of survey required by the local government as part of its statutory land use planning process for an urban subdivision proposed for the site. This is seen as an important population because it occurs in slightly atypical habitat, and it is thought likely to contain more than the two flowering plants seen at that time. The vegetation is comprised of *Banksia attenuata* (candlestick banksia), *Agonis flexuosa* (peppermint), *Allocasuarina fraseriana* (sheoak) and *Eucalyptus marginata* (jarrah) woodland.

Negotiations between then-CALM and the proponent during the planning phase resulted in an agreement to develop part of the Lot but retain a small area of the development containing these two plants as Public Open Space managed for conservation. It will protect the population of *Caladenia huegelii* and also populations of priority flora species *Lasiopetalum membranaceum* and *Conostylis pauciflora* subsp. *pauciflora*. The protected area is opposite a Shire reserve, and hence is considered to be a viable conservation area for these species.

Population 56 - Jandakot Airport

The Jandakot Airport is Commonwealth land leased from the Commonwealth by Jandakot Airport Holdings Pty Ltd (JAH) and managed through the federal *Airports Act 1996*. One *Caladenia huegelii* plant was found in a narrow strip of bushland to the east of the main runway in October 2003. Several more were located in 2004.

JAH developed a draft Master Plan for the airport as required under the Airport Act. In responding to the draft Master Plan, then-CALM noted the likelihood of *C. huegelii* in the Jandakot Airport bushland, as it is adjacent and contiguous with Population 6 of the species, and some plants had been found elsewhere on the site.

As part of the Master Plan, JAH were seeking to develop an area of bushland for light industrial purposes (warehouses, showrooms, offices). Then-Commonwealth Department of Environment and Heritage required surveys to be undertaken to confirm presence or absence of *Caladenia huegelii*. In September 2005 surveys were undertaken by DEC staff and volunteers, and 169 *C. huegelii* plants were located within the area proposed for development. The Commonwealth Minister for Transport was notified of the presence of this species by the Commonwealth Minister for Environment, but in January 2006 approved the Jandakot Master Plan (Watson and Evans 2006) with advice that necessary environmental approval processes must be followed.

In July 2007 JAH submitted a Major Development Plan which included proposals to build a fourth runway, clear bushland for a commercial development and construct access roads to service the airport. The proposal, in particular clearing of 148 hectares of bushland for non-aviation development, posed a significant threat to *Caladenia huegelii* and if implemented will impact on other significant species (*Drakaea elastica* and Carnaby's black cockatoo). The proposed development would result in a significant net loss of *C. huegelii* habitat. As offset, JAH have proposed setting aside a small 10 hectare orchid reserve, the translocation of plants from the development area into this orchid reserve, and funding for the research associated with the establishment of the reserve and translocation.

As the land is owned by the Commonwealth, the WA State government and its agencies have no decision making powers in this case. Determination of the Major Development Plan lies with the Commonwealth Minister for Transport with advice from the Commonwealth Minister for Environment. This advice was provided by the Minister for Environment on 5 March 2008, who recommended that authorisation not be given for the proposal due to its significant impact on the listed threatened species (Department of the Environment, Water, Heritage and the Arts, 2008).

If the MDP is approved by the Commonwealth Minister for Transport and JAH wish to take the *Caladenia huegelii* (or Carnaby's black cockatoo) at Jandakot Airport they will require a permit from the Commonwealth Minister for Environment under Section 201 of the EPBC Act "for activities which may kill, injure, take, trade, keep or move a member of a listed threatened species or ecological community... in or on a Commonwealth area". Only at this time does the Commonwealth Minister for Environment actually have a decision making power (as opposed to an advisory role) in relation to *Caladenia huegelii* at Jandakot Airport. The advice provided by the Minister for Environment to the Minister for Transport further commented that "In particular, the proposal would have adverse impacts on the survival or recovery in nature of the Grand Spider-orchid, and a permit could not be given under the EPBC Act to take or move these plants" (Department of the Environment, Water, Heritage and the Arts, 2008, p20).

Description

Caladenia huegelii is a tall growing species, with a flower stem to 60 cm high but occasionally as tall as 1 m. It has a single erect, pale green, hairy leaf 10–18 cm long by 7–12 mm wide, the basal third usually irregularly blotched with red-purple. Plants have one or two (rarely three) predominantly pale greenish-cream flowers 7–10 cm across, with variable suffusions, lines and spots of red maroon. The sepals end in slender light brown to yellow clubs 6–40 mm long. The large labellum is prominently two-coloured with a pale greenish-cream basal lamina and a uniformly dark maroon recurved apex (Hopper and Brown 2001). The labellum contains particularly long, fine, often split fringes, which extend well above the column (Brown *et al*. 1998). Floral odour is absent (Hopper and Brown 2001).

The species is distinguished from other spider orchids by its large green-cream, maroon tipped labellum with particularly long, sometimes branched fringe segments. The maroon tip of the labellum is prominently channelled when viewed from the front. It also has generally larger flowers than most other members of the *C. huegelii* complex (Hoffman and Brown 1998; Brown *et al.* 1998; Hopper and Brown 2001).

Distribution and habitat

Caladenia huegelii is found on the Swan Coastal Plain within 20 km of the coast, from just north of Perth to the Busselton area over a distance of over 250 km.

Caladenia huegelii occurs in areas of mixed woodland of *Eucalyptus marginata* (jarrah), *Banksia attenuata* (candlestick banksia), *B. ilicifolia* (holly banksia) and *B. menziesii* (firewood banksia) with scattered *Allocasuarina fraseriana* (sheoak) and *Corymbia calophylla* (marri) over dense shrubs of *Stirlingia latifolia* (blueboy), *Hypocalymma robustum* (Swan River myrtle), *Hibbertia hypericoides* (yellow buttercups), *H. subvaginata* (buttercups), *Xanthorrhoea preisii* (balga), *Adenanthos cuneatus* (coastal jugflower) and *Conostylis* species. Throughout its range the species tends to favour areas of thick undergrowth. Soil is usually deep grey-white sand associated with the Bassendean sand-dune system. However, rare plants have been known to extend into the Spearwood system (in which calcareous yellow sands dominate) in some areas.

The species was probably once more common on the Swan Coastal Plain, however its distribution overlaps with the main areas of urban development between Perth and Bunbury. Clearing of native vegetation for urban or agricultural development has led to the increasing fragmentation of habitat with populations now confined to small areas of remnant bushland.

Clearing is continuing and there is increasing pressure being placed on remnants of uncleared bushland containing *Caladenia huegelii*. In the last five years proposed developments have threatened seven of the ten largest populations of *C. huegelii*.

Biology and ecology

Caladenia is one of Australia's largest and most complex orchid genera with about 260 species currently recognised, 112 of which occur in Western Australia. The genus comprises five subgenera (*Caladenia*, *Calonema*, *Drakonorchis*, *Elevata*, *Phlebochilus*) which in turn contain several species complexes of varying sizes. *Caladenia huegelii* is in subgenus *Calonema*, and is part of a distinct group of species within the subgenus that are distinguished by their elongate petals and elongate, prominently clubbed sepals.

All species in the group emit pheromones that attract male thynnid wasps as pollinators, with each species pollinated by a different species of thynnid wasp. The seed is very fine and is wind-dispersed, often for many kilometres. Recruitment is naturally low (<0.05%; Batty *et al.* 2001), balanced by generally long-lived individuals.

Caladenia huegelii has been found to have a low rate of pollination success, with less than 4% of flowering plants producing seed in the 2005 and 2006 seasons at Population 6. This level falls well below the range of seed set rates of other more common *Caladenia* species (R. Phillips[1] personal communication). Work undertaken by BGPA has found that fruit set is almost 100% successful with hand pollination (unless capsule is grazed), so pollinator presence seems likely to be a limiting factor. Pollinator baiting was undertaken to examine the abundance of pollinating wasps at Population 6, but no pollinators were detected at the site (Swarts 2007). There is a suggestion that other non-sexually related pollinators may occasionally be pollinating the orchid. Investigation by a PhD student of the role of food and sexual deception in *Caladenia* pollination is scheduled for spring 2008.

Like other species of south-western Australian orchidaceae, *Caladenia huegelii* relies on a symbiotic association with a mycorrhizal fungus for seed germination and a nutrient supply throughout its life cycle. Research using *in vitro* germination experiments and DNA sequencing has established that *C. huegelii* has a highly specific association with a fungal endophyte. The endophyte belongs to the fungal family Sebacinaceae within the basidiomycetes and is closely related to other known endophytes commonly associating with *Caladenia* species (Warcup 1971; Swarts 2008). Using *in situ* seed baiting techniques, the distribution of the *C. huegelii* endophyte was mapped inside and outside of the orchid's known habitat range. *Caladenia huegelii* compatible endophytes were only found within the species' habitat range, with a spare niche capacity observed within sites for potential recruitment to occur. Given that the orchid cannot survive without the endophyte, these results suggest that the orchid's mycorrhizal distribution restricts the orchid's distribution and may be a driver of rarity of this species in nature (Swarts 2007). *Caladenia huegelii* typically occurs in dense undergrowth in its Jarrah/*Banksia* woodland habitat. Although little is known about the ecological requirements for orchid mycorrhizas, it may be that this fungus survives better in these locations, with increased moisture, shade and organic substrate that the vegetation affords. Common sympatric *Caladenia* species utilise a range of available endophytes in both *in situ* and *in vitro* germination trials. Some congeneric species are able to utilise the *C. huegelii* fungus, which raises the potential of competition for that resource in *C. huegelii* populations (Swarts 2007).

Techniques that enable propagation of this species through symbiotic germination methods have been developed at BGPA, and greater than 60% *in situ* transplant survival and flowering can be achieved for seedlings within their third growing season. However, it is not currently known if these plants will achieve long-term survival. BGPA are conducting ongoing monitoring of *C. huegelii* seedlings planted at Population 6, with survival comparisons made against seedlings grown under glasshouse conditions. Propagation of *C. huegelii* through tissue culture techniques has not proved to be as effective as using symbiotic methods.

Like other south west orchids, *Caladenia huegelii* dehisces back to an underground storage tuber during the dry summer months, and resprouts following the onset of autumn rains. *Caladenia huegelii* has an active growing period from May to mid November during which it produces a single leaf. Between late September and early November some (but not all) plants flower and the leaf and flower begin to dry out by mid November. Research by BGPA indicates that the species is long-lived, with individual plants being recorded at 20+ years (A. Batty[2] personal communication). Preliminary studies conducted in eastern and Western Australia indicate that

[1] Ryan Phillips, Research Scientist Botanic Garden and Parks Authority
[2] Dr Andrew Batty, former Research scientist, Botanic Garden and Parks Authority

Caladenias are able to survive a single season as a dormant tuber, but that they are not capable of surviving two seasons without producing an emergent leaf. Evidence suggests that plants appearing at a later date are likely to be the result of seed germination.

Grazing of leaves and flowers reduces the reproductive and photosynthetic capacity of the species and reduces growth in subsequent years.

Phytophthora species are plant pathogens that cause roots to rot and results in death from drought stress. Orchids appear to have some resistance to *Phytophthora*, perhaps due to their ability to control their associated mycorrhizal fungi (K. Dixon[3] personal communication). Little research has been done, but it appears that *Phytophthora* is probably not competitive with the mycorrhizal fungi (K. Dixon personal communication). However, the *Banksia* woodland habitat which *C. huegelii* occupies is characteristically highly susceptible. Changes in the structure of the habitat caused by *Phytophthora*, for example opening up of the canopy, would impact severely on *C. huegelii* and probably also on its mycorrhizal fungus.

Caladenia huegelii plants are killed by fire during its active growing period (May – mid November) but not damaged during their dormant period (late November - April). Observations made during the species' flowering period (September - early November) in seasons following summer fire bear this out. Plants appear to be healthy and flowering at least as well as during preceding years. Conversely, an area containing a large number of plants at Pop 42 was burnt by a wildfire in late April 2005 when the plants would have had shoots just above or just below the soil surface. A total of 110 *C. huegelii* plants were recorded in 2004 prior to the fire but no flowering or vegetative plants were present in the burnt area in September 2005. Some *Caladenia* leaves were observed within the fire boundary in 2006 but were unable to be identified to species level. Approximately 16 flowering *C. huegelii* were observed in that area in the third flowering season after fire. If these were in fact the *Caladenia* leaves seen in 2006, they may be survivors of the wildfire, representing ca 15% of the plant numbers seen before the fire. The plants may also be due to germination of seed blown in from plants outside the burnt area.

The genetic variability of *Caladenia huegelii* has been studied, and the implications for conservation management considered. Samples were collected from approximately 600 plants from 15 populations, and analysis was completed using microsatellite markers developed for this species. Genetic variation within and between populations and any inter-regional variation was examined, with identification of genetically significant individuals or populations across the species' geographical range. Detailed analysis of the genetic composition of Population 6 was completed.

High levels of within-population diversity were found across all populations. Positive inbreeding was identified. Highly correlated paternity (thousands of seeds in a single fruit are full siblings) and typically low fruit set may contribute to this. Indirect estimates of gene flow among populations reflects a capacity for gene flow through long distance pollen dispersal by sexually deceived wasp pollinators, and long range dispersal of dust-like orchid seed. However, current levels of gene flow may be impacted by severe recent habitat destruction, fragmentation and reduced population size. A highly divergent population was identified (Population 38), requiring a high priority for conservation. There is a need for further study into how this genetic specialisation may be reflected in the biology and/or ecology of this population. With the exception of this population, very weak genetic differentiation indicates the exchangeability of seeds or seedlings sourced from different populations is justifiable for reintroduction programs (Swarts 2007).

Caladenia huegelii has been found to have a low rate of pollination success at Population 6, possibly due to pollinator scarcity (discussed in more detail in Biology and Ecology section). Investigation by a PhD student of the role of food and sexual deception in *Caladenia* pollination is scheduled to commence in spring 2008.

BGPA have undertaken hand-pollination, seed collection and mycorrhizal isolation in populations of *Caladenia huegelii*. *C. huegelii* seed has been collected from Populations 6, 18, 28, 31, 38, 42, 44, 45, 56, 60 and 62, and is stored at BGPA. Seed from all populations has been divided into duplicate collections, with some frozen in

[3] Dr Kingsley Dixon, Director of Science, Botanic Garden and Parks Authority; Permanent Visiting Professor, School of Plant Biology, University of Western Australia.

liquid nitrogen, and others stored at 5˚C. All seeds tested so far for viability have returned high levels of viability regardless of time since collection (the earliest collections in storage were made in 1996). *C. huegelii* seeds extracted from storage were used in germination experiments in 2007/2008 and returned consistently high levels of germination. Tests of viability will continue at BGPA, revealing any long-term influence of storage on viability of *Caladenia huegelii* seed.

All plant tissues collected for mycorrhizal isolation have contained strong mycorrhizal infections. All fungal isolates useful in germinating *Caladenia huegelii* seed have been stored in liquid nitrogen at BGPA. Viability testing of *C. huegelii* seed has revealed that in general, seed germinated best in association with endophytes isolated from the same site from which the seed was collected, indicating the need to use local seed and endophytes in conservation management.

Mycorrhizal fungi associated with *Caladenia* species have a fragmented distribution throughout the landscape, which may contribute to the rarity of some of these orchids (Batty *et al.* 2001). These fungi are necessary to provide nutrients to adult plants of *C. huegelii* during their annual growth phase. Fungal presence was confirmed in localised areas where plants were to be translocated.

Threats

Caladenia huegelii was declared as Rare Flora under the name *Caladenia* sp. (Coastal Plain) SD Hopper 3400 in September 1987 and as *Caladenia huegelii* in November 1990 under the Western Australian *Wildlife Conservation Act 1950*. The species is ranked as Critically Endangered (CR) under World Conservation Union (IUCN 2001) criterion B2ab(i,ii,iii,iv) due to: having an area of occupancy of less than 10 km2 (<1000 ha); the severe fragmentation of populations; and the continuing decline in the extent of occurrence, area of occupancy, area, extent and quality of habitat, and number of locations or subpopulations. *C. huegelii* is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Caladenia huegelii is currently known from 33 extant populations with surveys (conducted over the last decade) recording 1,614 mature plants. During the most recent survey, 17 of the 33 extant populations contained less than five flowering plants each and in many cases no plants were recorded. Eighty five percent (85%) of plants were contained within four populations: Populations 6 and 56 (which are in fact a single large population split over two adjoining properties) and Populations 42 and 45.

Three hundred and sixty three plants, or 22 percent, occur within Nature Reserves. An additional 196 plants, or 12 percent, occur on land that has been or is currently in the process of becoming reserved for conservation, largely as a result of development negotiations (Population 44 and Subpopulations 42a and 28b). If improved tenure or secure conservation management could be negotiated for Populations 6 and 56, a further 805 plants or 50% of the total number of known plants and their supporting habitat would be protected.

Although it appears that there are a high number of populations of this species, most are very small and occur in disjunct remnants of natural bushland along the Swan Coastal Plain, and many are subject to ongoing development pressures. Threats include loss of habitat through clearing of bushland for urban, industrial and infrastructure development, degradation of habitat by weed invasion, *Phytophthora* disease, roadworks, firebreak maintenance, inappropriate fire regimes, recreational activities and dumping of rubbish; and decline in populations due to collapse of important ecological relationships with the mycorrhizal fungus and wasp pollinator leading to poor survival and recruitment.

- The very high level of historical land clearing for agriculture and urban development over the range of *Caladenia huegelii* has resulted in a highly fragmented natural landscape. This has resulted in a **lack of suitable habitat** for the species making it less likely that new populations will be discovered, and limiting the number of areas suitable for translocation. The small size of remnants containing *C. huegelii* and the fragmented landscape is also likely to impede important natural processes such as pollination.
- Continuing clearing for **urban, industrial and infrastructure development** threatens most extant populations. Negotiations will occur between relevant parties at each site. As Declared Rare Flora listed under State legislation (Western Australian *Wildlife Conservation Act 1950*), no *C. huegelii* plants may be taken or damaged without State Ministerial approval. Other legislation and statutory planning processes also

- **Degraded habitat.** Many of the areas inhabited by *Caladenia huegelii* are becoming increasingly degraded and may not be able to support the orchid's associated mycorrhizal fungus or pollinating wasp.
- **Weed invasion** is a threat to all populations. Weeds are likely to affect recruitment, increase grazing pressure from invertebrates and vertebrates, and compete for soil moisture and nutrients needed by the orchid and associated fungus. Weeds also increase the fire hazard due to the easy ignition of high fuel loads produced annually by many grass weed species.
- **Grazing** threatens several populations including Populations 6, 24, 31 and 60. Specific observations at Population 6 have recorded grazing of buds, flowers and developing seed capsules by kangaroos, grazing and destruction of tubers by bandicoots and grazing of leaves and buds by caterpillars. Other populations occur in areas containing rabbit populations (Populations 25, 37 (high numbers), 38, 56 and 60).
- **Road, powerline, rail and firebreak maintenance** threaten several populations. Activities include clearing of vegetation for construction of new facilities and impacts during maintenance of existing facilities, such as re-grading, maintenance of drainage channels, chemical spraying and slashing of vegetation to maintain safe visibility conditions. Several of these actions also encourage weed invasion and spread of *Phytophthora* dieback.
- **Inappropriate fire** during the above-ground phase of the orchid is a major threat. Overly frequent fires are also likely to detrimentally alter the orchid's habitat.
- **Recreational activities** are a continuing threat. The orchid is very attractive and is often opportunistically picked by casual bushwalkers. Some populations are also affected by dirt bike riders, cyclists and/or pedestrians, further fragmenting the small areas of habitat.
- **Dumping of rubbish** is common in areas of natural bushland along the Swan Coastal Plain. These areas are often adjacent to heavily populated urban areas and are convenient places to dump garden refuse and other rubbish.
- **Disease** could be a serious threat to Population 6 as *Phytophthora* occurs in the immediate vicinity, and other populations if the disease is introduced to those remnants. This plant pathogen causes roots to rot and results in death from drought stress. Although orchids appear to have some resistance to *Phytophthora*, perhaps due to their ability to control their associated mycorrhizal fungus (K. Dixon personal communication), the *Banksia* woodland habitat that occurs at this site is highly susceptible. Changes in the structure of the habitat caused by *Phytophthora*, i.e. opening up of the canopy, would impact severely on *C. huegelii* and probably also its mycorrhizal fungus.
- **Poor recruitment** is evident at many populations, particularly small ones. This may be due to absence of pollinators at those sites, or perhaps because the mycorrhizal fungus is not sufficiently abundant to germinate seed.

Summary of population information and threats

Pop. No. & Location	DEC District	LGA	Vesting	Purpose	Manager	Year	No. plants	Condition	Threats
1. Canningvale	Swan Coastal	Canning	Freehold	Private property	Landholders	1983 1989 2004	1+ 0 0	Presumed extinct	Most vegetation in this area has been cleared for housing, and much of what remains is very degraded and weedy, with rubbish and tracks throughout.
2a. Canningvale	Swan Coastal	Canning	Freehold	Private property	Landholders	1983 1988 1997 2004	5 200 0 0	Presumed extinct	Presumed extinct due to urban development
2b. Canningvale	Swan Coastal	Canning	Freehold	Private property	Landholders	1988 1997	1 0	Presumed extinct	Presumed extinct due to urban development
2c. Canningvale	Swan Coastal	Canning	Freehold	Private property	Landholders	1985 1997 2004	1 0 0	Presumed extinct	Remnant vegetation entirely cleared
3. Bull Creek	Swan Coastal	Melville	Freehold	Private property	Landholders	1983 2004	2 1	Presumed extinct	Presumed extinct due to urban development
4. Jandakot	Swan Coastal	Melville	Freehold	Private property	Landholders	1983 2002 2004	1 0 0	Presumed extinct	This site no longer exists, possibly due to development
5. Yallingup (Now known to be *Caladenia thinicola*)	Unknown								
6. Jandakot (Now incorporates Population 20)	Swan Coastal	Melville	Freehold	Parks and Recreation	City of Melville	1992 1997 2001 2002 2003 2004 2005	8 0 94 47 280 248 632	Moderate	Roe Hwy extension, weed invasion, grazing by kangaroos, bandicoots and caterpillars, rubbish dumping, recreational activities, disease
7. Cowaramup (Now known to be *Caladenia thinicola*)	Blackwood								
8. Kenwick	Swan Coastal	Gosnells	Unvested	Prison and Telecommunications Site	Dept of Justice	1986 1989 1994 1997 2002 2003 2004	1+ 0 4 0 0 0 0	Habitat disturbed	Weeds dense in narrow strip of vegetation where plants previously reported, roadworks
9. Kwinana	Swan Coastal	Kwinana	Unallocated Crown Land			1987 1988	1 5	Habitat in good condition	Recreation - 4WD and bike tracks, weeds – low presence of grassy

						1992 5 1994 2 1997 0 2002 0 2004 0		weeds, limited supportive understorey, rubbish, firewood collection
10. Dunsborough (Now known to be *Caladenia thinicola*)	Blackwood							
11. Thornlie	Swan Coastal	Gosnells	Unvested reserve	Road reserve	City of Gosnells	1983 5 1989 0 1997 0 2003 0	Presumed extinct	Population presumed extinct due to urban development
12. Forrestdale	Swan Coastal	Armadale	Freehold	Private property	Landholders	1984 5 1988 1 1997 0	Presumed extinct	Population presumed extinct due to urban development
13. Busselton (Now known to be *Caladenia georgii*)	Blackwood							
14. Eagle Bay (Now known to be *Caladenia thinicola*)	Blackwood							
15. Lake Maringup (Doubtful record – *C. huegelii* not known from this habitat type)	Donnelly							
16a. Jandakot	Swan Coastal	Canning	Unvested reserve	Road reserve	City of Canning	1990 1+ 1997 0	Presumed extinct	Population presumed extinct due to urban development
16b. Jandakot	Swan Coastal	Canning	Freehold	Private property	Landholders	1990 1+ 1997 0	Presumed extinct	Population presumed extinct due to urban development.
17. Fly Brook Rd (Doubtful record – *C. huegelii* not known from this habitat type)	Donnelly							
18. Canningvale (Now incorporates Population 50)	Swan Coastal	Canning	Freehold	Public Open Space	City of Canning	1989 4 1997 0 2001 19 2002 0 2004 18	Healthy	Part of habitat area was cleared for housing development, but some vegetation and plants remain, urban development
19a. Forrestdale	Swan Coastal	Armadale	Western Australian Planning Commission	Jandakot Regional Park	DEC	1989 10 2002 0 2003 0 2004 0	Vegetation excellent; no plants seen	None evident
19b. Forrestdale	Swan Coastal	Gosnells	Freehold	Private property	Landholders	1989 1 1997 0	Presumed extinct	Population presumed extinct due to urban development

19c. Forrestdale	Swan Coastal	Gosnells	Freehold	Private property	Landholders	1989 1 1997 0	Presumed extinct	Population presumed extinct due to urban development
20. Jandakot (Now included with Population 6)	Swan Coastal	Melville	City of Melville	Conservation	City of Melville	1992 7 1997 0	Moderate	See Population 6 details
21a. Jandakot	Swan Coastal	Melville	City of Melville	Conservation	City of Melville	1992 25 1997 4 1998 20 1999 20+ 2004 0	Poor	Weeds (badly infested with weedy grasses, esp *Briza maxima* and *Bromus diandrus*), track formation, rubbish dumping and accumulation, dieback, firebreak maintenance, inappropriate fire
21b. Jandakot	Swan Coastal	Canning	City of Canning	Sanitation Reserve	City of Canning	1991 14 1993 10 1994 10 1998 4 2004 0	Presumed extinct	Presumed extinct due to clearing for sanitation purposes.
22. Pinjar	Swan Coastal	Wanneroo	Unvested reserve	Road reserve	City of Wanneroo	1990 3 1997 0 2004 0	Moderate	Weed invasion
23. Wilson	Swan Coastal	Canning	Freehold	Private Property	WAPC	1990 2 1991 2 2002 0 2004 0	Presumed extinct	Habitat degraded
24. Mundijong	Swan Coastal	Serpentine-Jarrahdale	Freehold	Private property	Landholders	1991 12	Moderate	Firebreak maintenance, grazing by kangaroos
25. Bullsbrook	Swan Coastal	Swan	Freehold	Private property	Landholders	1991 5 1997 0	Moderate	Disease, weed invasion, rabbit disturbance
26a. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
26b. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
26c. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
27. Scott National Park (Now regarded as *Caladenia thinicola*)	Blackwood							
28a. Murdoch	Swan Coastal	Melville	Minister for Transport	Carpark	Main Roads WA	1988 1 1997 0 2002 0 2003 22 2004 25 2005 0	Presumed extinct	Land cleared for Perth-Mandurah railway

28b. Murdoch	Swan Coastal	Melville	Minister for Transport	Conservation	Main Roads WA	2003 1 2005 27	Healthy	Lack of habitat, changes in hydrology
29. Mt Yates (Now regarded as *Caladenia thinicola*)	Blackwood							
30. Walpole (Doubtful record – *C. huegelii* not known from this habitat type)	Frankland							
31a. Mundijong	Swan Coastal	Serpentine-Jarrahdale	Freehold	Private property	Landholders	1990 1 2004 2 2005 2	Healthy	Weeds, disease, firebreak maintenance, grazing
31b. Mundijong	Swan Coastal	Serpentine-Jarrahdale	Unvested reserve	Road reserve	Shire of Serpentine-Jarrahdale	1990 1 2004 2	Healthy	Weeds, disease, grazing
31c. Mundijong	Swan Coastal	Serpentine-Jarrahdale	Freehold	Private property	Landholders	2004 1	Healthy	Weeds, disease, grazing
31d. Mundijong	Swan Coastal	Serpentine-Jarrahdale	Freehold	Private property	Landholders	2004 3 2005 68	Healthy	Powerline maintenance
32. Ellenbrook	Swan Coastal	Swan	Freehold	Private property	Landholders	1991 3 2004 0	Unconfirmed	Dieback
33. Cape Clairault (Now regarded as *Caladenia thinicola*)	Blackwood							
34. Ellenbrook	Swan Coastal	Swan	Freehold	Private property	Landholders	1991 4 1997 0 2004 0	Unconfirmed. Original discovery was not definitely identified as *Caladenia huegelii*.	Dieback, weeds, clearing, 4WD activities
35. Ellenbrook	Swan Coastal	Swan	Freehold	Private property	Landholders	1991 30 1997 0 2004 0	Unconfirmed. Original discovery was not definitely identified as *Caladenia huegelii*.	Dieback, weeds, recreational activities, firebreak maintenance, clearing
36. Cape Clairault (Now regarded as *Caladenia thinicola*)	Blackwood							
37a. Huntingdale	Swan Coastal	Gosnells	Freehold	Private property	Landholders	1981 15 2003 0 2004 0	Vegetation poor; no plants seen	Evidence of significant rabbit population

37b. Huntingdale	Swan Coastal	Gosnells	Unvested reserve	Road reserve	City of Gosnells	1981 15 1997 15 2003 0 2004 0	Vegetation moderate; no plants seen	Grass weeds (especially perennial veldt grass) dominate some areas, evidence of significant rabbit population
38a. Ruabon	Blackwood	Busselton	Conservation Commission of Western Australia	Conservation of Flora and Fauna (C class Nature Reserve)	DEC	1985 5 2005 2	Moderate	Weeds, rubbish dumping, rabbits present
38b. Ruabon	Blackwood	Busselton	Conservation Commission of Western Australia	Conservation of Flora and Fauna (C class Nature Reserve)	DEC	1993 3 1994 1+ 2004 10	Healthy	Weeds, firewood cutting, recreational activities
38c. Ruabon	Blackwood	Busselton	Unvested reserve	Road reserve	Shire of Busselton	1993 3 2004 3 2005 0	Moderate	Weeds (flatweed, grasses, arum near edges of vegetation), firebreak maintenance, recreational activities
39. Gracetown (Now regarded as *Caladenia thinicola*)	Blackwood							
40. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
41. Beeliar	Swan Coastal	Cockburn	Minister for Transport	Road reserve	Main Roads WA	1994 2 2002 0 2006 0	Presumed extinct	Entire remnant has been cleared.
42a. Banjup	Swan Coastal	Cockburn	Western Australian Planning Commission	Conservation	DEC	1996 23 1998 34 2003 11+ 2004 389 2005 155 2007 16+	Moderate	Sand mining, firebreak maintenance, roadworks, weeds (minor), markers and fence misses some plants, recreational off-road driving, clearing of nearby vegetation
42b. Banjup	Swan Coastal	Cockburn	Freehold	Private property	Landholders	2004 52	Moderate	Weeds
42c. Banjup	Swan Coastal	Cockburn	Freehold	Private property	Landholders	2004 5	Moderate	Weeds
42d. Banjup	Swan Coastal	Cockburn	Unvested reserve	Road reserve	City of Cockburn	2004 ca 6	Moderate	Weeds
43a. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
43b. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
43c. Yallingup (Now regarded as *Caladenia thinicola*)	Blackwood							
44. Huntingdale	Swan Coastal	Gosnells	Unknown			1996 1+ 1997 1	Healthy	None evident

						2002 0 2003 21 2004 8 2005 14		
45a. Coolup	Swan Coastal	Murray	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	1995 1+ 2004 0	Vegetation healthy; no plants seen	Firebreak maintenance, recreational picking, prescribed burning
45b. Coolup	Swan Coastal	Murray	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	2004 1	Healthy	Firebreak maintenance, recreational picking, prescribed burning
45c. Coolup	Swan Coastal	Murray	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	2005 247 2006 346	Healthy	Firebreak maintenance, recreational picking, prescribed burning
46. Dunsborough (Now regarded as *Caladenia thinicola*)	Blackwood							
47. Dunsborough (Now regarded as *Caladenia thinicola*)	Blackwood							
48. Forrestdale (Now incorporates Population 51)	Swan Coastal	Armadale	Freehold	Private property	Landholders	1999 8 2001 7 2002 7 2004 0 2005 0	Presumed extinct	Land cleared under permit
49. Australind	Wellington	Harvey	Unknown			1993 1+ 2004 0 2005 0	Presumed extinct	Repeated thorough surveys of this area have not detected any *Caladenia huegelii* plants in recent years. Remnant is a small area in urban context.
50. (Now included with Population 18)								
51. (Now included with Population 48)								
52. Lightning Swamp	Swan Coastal	Swan	Freehold	Private property	Landholders	2000 ? 2004 0	Unconfirmed	Original discovery was not definitely identified as *Caladenia huegelii*.
53. Unknown locality								
54. Dawesville (Possibly *Caladenia georgii*)	Swan Coastal	Mandurah	Freehold	Private property	Landholders	2002 2 2004 0	Unconfirmed	Original discovery was not definitely identified as *Caladenia huegelii*.
55. Roe Stage 6	Swan Coastal	Canning	Minister for Transport	Road reserve	Main Roads WA	2002 10	Unknown	Unknown
56a. Jandakot	Swan Coastal	Cockburn	Commonwealth	Airport	Jandakot	2003 1	Moderate to poor	Clearing for development, weeds,

			Airport Authority		Airport Holdings	2004	0		rabbits, narrow corridor, road maintenance, prescribed burning
56b. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2004	4	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56c. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	156	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56d. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	2	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56e. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	6	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56f. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	3	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56g. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	1	Healthy	Clearing for development, weeds, rabbits, prescribed burning
56h. Jandakot	Swan Coastal	Cockburn	Commonwealth Airport Authority	Airport	Jandakot Airport Holdings	2005	1	Healthy	Clearing for development, weeds, rabbits, prescribed burning
57. Melville	Swan Coastal	Melville	Freehold	Golf course	City of Melville	2003	11	Unknown	Unknown
58. Leeming	Swan Coastal	Melville	City of Melville	Recreation	City of Melville	2004	1	Healthy	Weeds
59a. Wandi	Swan Coastal	Kwinana	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	2004	1	Healthy	Weeds
59b. Wandi	Swan Coastal	Kwinana	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	2004	1	Healthy	
60a. Wandi	Swan Coastal	Kwinana	Freehold	Private property	Landholders	2004 2005	39 6	Moderate	Firebreak maintenance, rabbit grazing, weeds
60b. Wandi	Swan Coastal	Kwinana	Freehold	Private property	Landholders	2005	16	Unknown	
60c. Wandi	Swan Coastal	Kwinana	Freehold	Private property	Landholders	2005	3	Unknown	
61. Banjup	Swan Coastal	Cockburn	Freehold	Private property	Landholders	2004 2005	1 1	Healthy	Firebreak maintenance
62. Banjup	Swan Coastal	Cockburn	City of Cockburn	Recreation	City of Cockburn	2004 2005	1 18	Healthy	Firebreak maintenance
63. Island Point	Swan Coastal	Mandurah	City of Mandurah	Recreation and Camping	City of Mandurah	2004 2005	8 4	Healthy	Recreation, weeds, firebreak maintenance, salinity
64. Forrestdale	Swan Coastal	Armadale	Freehold	Private property	Landholders	1994	1	Unconfirmed	Original discovery was not

						2004	0		definitely identified as *Caladenia huegelii*.
65. Stratham	Wellington	Capel	Freehold	Private property	Landholders	2003	1	Unknown	
66. Waroona	Swan Coastal	Waroona	Shire of Waroona	Parkland	Shire of Waroona	2005 2006	3 0	Healthy	Construction of Perth-Bunbury Hwy
67. Banjup	Swan Coastal	Cockburn	Unvested reserve			2006 2007	4 19	Moderate	Banksia woodland habitat showing signs of water stress.
68. Toodyay	Swan Coastal	Toodyay	Freehold	Private property	Landholders	2006	3	Unknown	Dieback present in area
69. SW of Pinjarra	Swan Coastal	Murray	Conservation Commission of Western Australia	Conservation of Flora and Fauna	DEC	2005	2	Healthy	Firebreak maintenance
70a. Mandurah	Swan Coastal	Mandurah	Freehold	Private property	Landholders	2005	1	Healthy	Firebreak maintenance
70b. Mandurah	Swan Coastal	Mandurah	Freehold	Private property	Landholders	2005	1	Healthy	Firebreak maintenance
71. Whiteman Park	Swan Coastal	Swan	WAPC	Recreation and Conservation Reserve	Department of Planning and Infrastructure	2005	1	Healthy	Recreational picking, carpark expansion, weeds

Guide for decision-makers

Caladenia huegelii is declared as Rare Flora under the Western Australian *Wildlife Conservation Act 1950* and "taking" of plants of this species requires the approval of the State Minister for the Environment.

The species is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and proposals to take populations listed in this IRP may be considered a controlled action and require assessment.

Section 1 of this IRP provides details of current and possible future threats. A significant threat to *Caladenia huegelii* is vegetation clearing and other disturbance done during development and maintenance of infrastructure. Any developments or on-ground works (clearing, firebreaks, roadworks etc) in the immediate vicinity of any population of *C. huegelii* will require assessment. Developments, clearing or on-ground works should not be approved unless the proponents can demonstrate that they will not have an impact on the species, its habitat or potential habitat.

Because *Caladenia huegelii* is difficult to identify as being present when not in flower, agencies undertaking environmental and/or statutory planning assessments that involve vegetation clearing within the range of *C. huegelii* should consider the possibility that unknown populations may be present. This is particularly the case involving bushland adjacent to or near known populations. In these situations it is wise to request an appropriate (during the species' flowering period and by competent persons) flora survey as part of the assessment.

It is desirable to determine the presence, or not, of *Caladenia huegelii* as early in the planning process as possible as this will prevent a situation where the species is located very late in the process after expectations of development have been raised and significant investment has been made. This later situation has been a common occurrence with this and other species in the metropolitan areas as evidenced in the synopsis of significant development proposals included above.

Habitat critical to the survival of the species, and important populations

Habitat critical to the survival of the species includes the area of occupancy of important populations; areas of similar habitat surrounding important populations (i.e. jarrah/banksia woodland on Bassendean sands), as these areas provide potential habitat for natural range extension and are necessary to support viable populations of the associated mycorrhizal fungus and pollinating wasp species crucial to the orchid's survival, and to allow pollinators to move between populations; and additional occurrences of similar habitat that may contain important populations of the species or be suitable sites for future translocations or other recovery actions intended to create important populations.

Given that this species is listed as Critically Endangered, it is considered that all known habitat for wild and translocated populations is habitat critical to its survival, and that all wild and translocated populations are important populations. However, it is acknowledged that some of the smaller populations and populations in highly degraded or small areas of remaining habitat have lower potential for long-term survival and therefore resources will be focussed towards populations with greater potential for long-term survival.

Benefits to other species or ecological communities

A number of flora and fauna species of conservation significance co-occur with *Caladenia huegelii*, and may benefit from recovery actions listed in this IRP. These have been summarised in the tables below.

Summary of flora species of conservation significance that occur near populations of *Caladenia huegelii*

Associated *C. huegelii* Pop No	**Common Name**	**Scientific Name**	**DEC List**	**DEC Ranking**	**EPBC Ranking**
31, 38, 56, 69	Glossy-leafed hammer orchid	*Drakaea elastica*	Declared Rare Flora	CR	EN
69	Dwarf hammer orchid	*Drakaea micrantha*	Declared Rare Flora	EN	VU
38	Swamp honeypot	*Banksia nivea* subsp.	Declared Rare Flora	EN	EN

		uliginosa			
38	Long-stalked featherflower	*Verticordia densiflora* var. *pedunculata*	Declared Rare Flora	EN	EN
38	Vasse featherflower	*Verticordia plumosa* var. *vassensis*	Declared Rare Flora	EN	EN
38	Royce's waxflower	*Chamelaucium roycei*	Declared Rare Flora	VU	VU
38	Southern teraria	*Tetraria australiensis*	Declared Rare Flora	VU	VU
60c	-	*Eremaea asterocarpa* subsp. *brachyclada*	Priority Flora	P1	
54	-	*Lasiopetalum membranaceum*	Priority Flora	P3	
38	-	*Acacia semitrullata*	Priority Flora	P3	
38	Short-styled grevillea	*Grevillea brachystylis* subsp. *brachystylis*	Priority Flora	P3	
45c	-	*Dillwynia dillwynioides*	Priority Flora	P3	
45c	Jumping jacks	*Stylidium longitubum*	Priority Flora	P3	
54	Dawesville conostylis	*Conostylis pauciflora* subsp. *pauciflora*	Priority Flora	P4	

Summary of fauna species of conservation significance that have been recorded within 3 km, and are likely to utilise, areas of *Caladenia huegelii* habitat

Class Name	Common Name	Scientific Name	DEC List	DEC Ranking	EPBC Ranking
Birds	Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	Declared Threatened Fauna	EN	VU
Birds	Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	Declared Threatened Fauna	EN	EN
Birds	Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii* subsp. *naso*	Declared Threatened Fauna	VU	-
Mammals	Chuditch	*Dasyurus geoffroii*	Declared Threatened Fauna	VU	VU
Mammals	Brush-tailed Phascogale, Wambenger	*Phascogale tapoatafa* subsp. (WAM M434)	Declared Threatened Fauna	VU	-
Mammals	Western Ringtail Possum	*Pseudocheirus occidentalis*	Declared Threatened Fauna	VU	VU
Insects	(cricket)	*Throscodectes xiphos*	Priority Fauna	P1	
Insects	(bee)	*Hylaeus globuliferus*	Priority Fauna	P3	
Insects	(bee)	*Leioproctus contrarius*	Priority Fauna	P3	
Reptiles	Lined Skink	*Lerista lineata*	Priority Fauna	P3	
Reptiles	Black-striped Snake	*Neelaps calonotos*	Priority Fauna	P3	
Birds	Masked Owl (SW subspecies)	*Tyto novaehollandiae* subsp. *novaehollandiae*	Priority Fauna	P3	
Mammals	Western Brush Wallaby	*Macropus irma*	Priority Fauna	P4	
Mammals	Quenda	*Isoodon obesulus* subsp. *fusciventer*	Priority Fauna	P5	
Birds	Peregrine Falcon	*Falco peregrinus*	Other Specially Protected Fauna		
Reptiles	~ Western Swamp Tortoise	*Pseudemydura umbrina*	Declared Threatened Fauna	CR	CR
Birds	~ Hooded Plover	*Charadrius rubricollis*	Priority Fauna	P4	
Mammals	~ Water-rat, Rakali	*Hydromys chrysogaster*	Priority Fauna	P4	
Birds	~ Eastern Curlew	*Numenius madagascariensis*	Priority Fauna	P4	
Molluscs	~ (freshwater mussel)	*Westralunio carteri*	Priority Fauna	P4	

Note: The last five species (common names marked ~) are species associated with water or water edges rather than banksia woodland, but may also be protected by improved security of tenure of habitat area.

Recovery actions such as protection of habitat from clearing and the management of fire, disease and weeds is likely to protect these rare and priority species as well as *Caladenia huegelii*, and also the ecological community in which populations are located.

Population 38 occurs within 200 m of the boundary of a Threatened Ecological Community (TEC), and is within contiguous bushland. This TEC is identified as 'Herb rich saline shrublands in clay pans' as defined in the Gibson *et al.* (1994) report 'A floristic survey of the southern Swan Coastal Plain'. It is ranked as Vulnerable on the list of TECs in Western Australia. Recovery actions such as management of fire, disease and weeds will help to protect this TEC as well as *C. huegelii*.

International obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. *Caladenia huegelii* is listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), ratified by Australia in July 1976, under 'Orchidaceae'. The aim of that convention is to ensure that international trade in listed species does not threaten their survival. This plan is in full accord with that aim.

Indigenous consultation

Involvement of the Indigenous community is being sought through the indigenous reference groups for the Swan Catchment Council and South West Catchment Council to determine whether there are any issues or interests identified in the plan. A search of the Department of Indigenous Affairs' Aboriginal Heritage Sites Register has identified a number of sites in the area of *Caladenia huegelii* populations.

Summary of populations co-occurring with sites listed on the Register of Aboriginal Sites

Population No.	DEC District	Site ID	Site Name	Site Type	Additional Information
13 (ca 100m from site) Unconfirmed population	Blackwood	16807	The New River	Mythological	Hunting Place, Water Source, [Other: collect resources]
19c (ca 50m from site) Presumed extinct population	Swan Coastal	3712	Gosnells Golf Club	Mythological	
23 (ca 130m from site)	Swan Coastal	3536	Swan River	Mythological	
23 (ca 130m from site)	Swan Coastal	3538	Canning River	Mythological	Ochre, Named Place, Water Source
23 (ca 175m from site)	Swan Coastal	3453	Watts Rd Wilson		Plant Resource, Camp, [Other: Former]
23 (ca 175m from site)	Swan Coastal	24319	Wadjup	Ceremonial	Meeting Place, Camp, Named Place
24 & 31	Swan Coastal	3582	Serpentine River	Ceremonial, Mythological	
25, 32, 34 & 35 (32,34,35 Unconfirmed populations)	Swan Coastal	3525	Ellen Brook: Upper Swan	Mythological	
41 (ca 160m from site) Presumed extinct population	Swan Coastal	3423	Forrest Road	Mythological	Meeting Place, Plant Resource, Camp, Water Source, [Other: ?]
52 Unconfirmed population	Swan Coastal	21393	Lightning Swamp	Mythological	Meeting Place, Camp, Natural Feature, Water Source
68 (ca 180m from site)	Swan Coastal	3536	Swan River	Mythological	
69	Swan Coastal	3686	Nine Mile Lake	Mythological	

Where no role is identified for the indigenous community associated with this species in the development of the recovery plan, opportunities may exist through cultural interpretation and awareness of the species. Indigenous involvement in the implementation of recovery actions will be encouraged.

The advice of the relevant NRM indigenous reference groups is being sought to assist in the identification of cultural values for land occupied by threatened species, or groups with a cultural connection to land that is important for the species' conservation. Continued liaison between DEC and the indigenous community will identify areas in which collaboration will assist implementation of recovery actions.

The Indigenous Natural Resource Management Advisory Group (INRMAG) of the Swan Catchment Council has been consulted and subsequently has had the opportunity to provide culturally appropriate input into this recovery plan. Where registered sites co-occur with *Caladenia huegelii*, specific advice has been sought.

The INRMAG recognises that DEC, through the Recovery Plan process, seeks to conserve and protect areas of natural remnant vegetation. The INRMAG recognise that together we share similar goals of seeking to manage these areas for conservation and seek to include and support Aboriginal interest and involvement in the management and planning processes (INRMAG 2007).

Social and economic impact

The habitat type that *Caladenia huegelii* occupies is widespread but is being rapidly cleared for housing, commerce, industry and agriculture. Conflict between the protection and recovery of this species and the development of land for human use is particularly high in the Perth metropolitan area. Negotiations between DEC, land developers and other stakeholders are ongoing at a number of sites in efforts to seek a mutually acceptable compromise between these two aims. (Further details of these are provided in Section 1 – History). Protection of populations of this species has the potential for both social and economic impact, and individual situations must be resolved on a case-by-case basis.

Impacts can be at the level of regional social and economic infrastructure, such as the extension of Roe Highway and the public transport interchange at Murdoch. The inability to complete these projects would have a social impact on the community by making travel more difficult along those routes. Impacts can also be felt at a company or individual level, such as when protection of Population 42 at Banjup had a financial impact on a company which had gained earlier approval to extract the sand resource from the site.

Several populations of *C. huegelii* occur on private property and their protection has the potential to affect future development. Where populations are located on private property, recovery actions refer to continued liaison between stakeholders with regards to these areas. Where development is proposed on private property containing *C. huegelii*, the aim is to protect the populations through the statutory land use planning and environmental impact assessment processes.

Affected interests

Stakeholders potentially affected by the implementation of this plan include landowners and land managers of land on which *Caladenia huegelii* occurs. Other potential stakeholders include infrastructure providers (Main Roads WA, Western Power, Water Corporation etc), and developers of land containing *C. huegelii*.

Other stakeholders potentially affected by the implementation of this plan include decision makers such as Local Government Authorities (LGAs) City of Armadale, Shire of Busselton, City of Canning, Shire of Capel, City of Cockburn, City of Gosnells, Shire of Harvey, Town of Kwinana, City of Mandurah, City of Melville, Shire of Murray, Shire of Serpentine-Jarrahdale, City of Swan, Shire of Toodyay, City of Wanneroo and Shire of Waroona, Department for Planning and Infrastructure, WAPC, EPA, DEC and Commonwealth DEWHA.

Evaluation of the plan's performance

DEC will evaluate the performance of this IRP in conjunction with the Swan Region and South West Region Threatened Flora and Ecological Communities Recovery Teams. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

2. RECOVERY OBJECTIVE AND CRITERIA

Objective

The objective of this IRP is, during the five year term of the plan, to maintain or improve the conservation status of this species, by ensuring the continued survival of the known populations, abating identified threats to populations, and supporting future increases in area of occupancy and numbers of mature plants through translocation once successful techniques are established. However, it is acknowledged that some smaller populations and populations in highly degraded or small areas of remaining habitat have lower potential for long-term survival and that resources will be focussed towards populations with greater potential for long-term survival.

Criteria for success

The IRP will be considered to have succeeded if any two of A, B or C are met:

A. The area of occupancy is maintained or increased over the term of the plan.
B. There is an increase of 10% or more in the total number of mature plants and/or area of occupancy under secure conservation tenure.
C. Results of research conducted as per recommendations in this IRP (eg knowledge of appropriate fire regimes, pollinator and fungal ecology and biology, recruitment requirements and methodology, genetics etc) are applied in habitat management over 20% or more of the known area of occupancy of the species.

Criteria for failure

The IRP will be considered to have failed if either A or B are met:

A. The area of occupancy has decreased by ten percent or more over the term of the plan.
B. There has otherwise been a decline in the species, or worsening of the nature of threatening processes, leading to increased concern over the long-term survival of the species.

3. RECOVERY ACTIONS

Completed recovery actions

All relevant land managers have been notified of the location and threatened status of the species. The notification details the Declared Rare status of *Caladenia huegelii* and associated legal obligations.

A range of operational tasks have been carried out to protect populations of *C. huegelii*, including weed control, application of phosphite and general management of reserves and bushland. A large gate was installed in 2007 to close the access road leading to Population 42, protecting it from assorted activities including recreational driving, rubbish dumping and arson.

Ongoing and future recovery actions

Staff from DEC's Swan and South West Regions, Swan Coastal, Wellington and Blackwood Districts, and Nature Conservation Division continue to liaise with State and Commonwealth agencies, local government authorities, private property owners, developers and other relevant stakeholders in order to conserve the taxon.

Staff from DEC's Swan and South West Regions assess development applications for bushland containing *Caladenia huegelii* and participate in environmental impact assessment and statutory planning processes. This action is ongoing.

Over the past ten years, significant DEC resources have been expended seeking to identify and protect populations of *C. huegelii* from urban and other development. This has been very successful with staff working to protect hundreds of plants and tens of hectares of habitat that otherwise would have been cleared. (See Synopses of Key Developments in Section 1 – History.)

With many populations and areas of possibly suitable habitat under threat from urban development, and the species' short flowering period (2-4 weeks) during which it can be identified, it is difficult to meet monitoring

and survey requirements every flowering season. Large scale efforts were made in 2004, 2005 and 2006 to monitor all existing populations, survey for new populations and confirm the identification of suspected populations. These have drawn on DEC staff from Swan and South West Regions, Swan Coastal, Wellington and Blackwood Districts and Nature Conservation Division. In addition, many volunteers have taken part, drawn from interest groups such as WA Native Orchid Study and Conservation Group, Species Orchid Group and the Wildflower Society, and through local community newspaper articles.

Significant finds in 2005 include a new population of over 240 plants in a nature reserve south east of the Peel Inlet, and a new population of 169 plants at Jandakot Airport. The number of plants known from Subpopulation 31d also increased. 2006 represented a relatively poor flowering season, probably due to the paucity of winter rain prior to spring flowering. Flowering plants were present in known populations, but in lower numbers than in 2005. Significant finds in 2006 included an extension of 103 plants in Subpopulation 45c, and a new population of four plants (Population 67 - 19 plants in 2007). The 2006 survey season was focussed on getting a better understanding of whether *C. huegelii* occurred on conservation lands other than in those where it is currently known. Its preferred *Banksia* woodland habitat was surveyed in a number of large regional and national parks but no new populations were found.

In addition to seeking volunteers for surveys, community newspaper articles have promoted an appreciation of the value of native flora, raising the profile of rare flora in general and *Caladenia huegelii* in particular. To extend this promotion, a double-sided information sheet has been printed, which includes a description of *C. huegelii*, its habitat, threats, recovery actions and photos. This is distributed to stakeholders or in response to queries from the community. A separate information sheet highlights the differences in appearance and habitat of *C. huegelii* and similar orchids. This will continue to be provided to anyone expressing an interest in surveys, either those coordinated by DEC or independent surveys.

An extensive research project is underway, funded as part compensation for residual impacts on Population 6 due to the Roe Highway development. Key elements of the study include understanding the basis of rarity in the species, defining and abating threatening processes and developing translocation and management strategies to enhance the species resilience and persistence in existing locations.

BGPA have undertaken research into *in-vitro* and *in-situ* germination of seed, growing of plants in glasshouses and translocations to the wild (Population 6) of this propagated material. These symbiotic germination methods have proven more effective than the previously established tissue culture techniques. BGPA are conducting ongoing monitoring of *C. huegelii* seedlings translocated to Population 6, with survival comparisons made against seedlings grown under glasshouse conditions. So far, greater than 60% *in situ* transplant survival has been achieved for seedlings within their third growing season.

Experimental translocations were undertaken at Populations 6 and 44 in 2004. Other experimental translocations have taken place elsewhere (Population 18, 55 and Subpopulation 28b) by BGPA. However, details of location and success or failure are not currently available. These were initiated as salvage operations, with plants occurring in areas to be cleared for development being moved to adjacent reserved habitat.

Twenty two *Caladenia huegelii* plants at Population 6 were moved in 2004. Seventeen plants reappeared in 2005, and 11 in 2006, with eight of those flowering each year. Seven *C. huegelii* plants were moved in Population 44. In 2007 two translocated plants were observed in flower. Monitoring will continue at this site.

Results of propagation and planting out work undertaken so far indicates seedling survival and growth was found to be substantially enhanced by incubating seedlings in sand over agar containers prior to transfer to soil. Using sand layer treatments to reflect soil horizon layers under glasshouse conditions, seedlings were found to form tubers regardless of dropper depth, however, seedling survival into the following growing season was correlated with increased seedling and tuber size. Maintaining seedlings under glasshouse conditions for their first growing season enhanced seedling survival to 65% after transferring to field sites in plots containing mature plants. This study demonstrates that terrestrial orchid seedling development and establishment to field sites can be improved and potentially fast-tracked through careful manipulation of the environment during *in vitro* and *ex situ* propagation procedures.

Plant numbers reappearing in subsequent seasons are declining, but this may reflect seasonal factors, and initial results seem reasonably successful in comparison to benchmark populations. Previous experience with translocation of other orchid species has seen numbers of adult plants decline until no plants appear, possibly as the established tuber is exhausted, and it will be some years before the success or failure of these experimental translocations can be ascertained.

There is an urgent need for improved knowledge of the reponse of this species to fire, including the effect of fire on the species' pollinator and associated mycorrhizal fungus. A design for scientifically valid fire response trials has been developed by staff of DEC's Swan Coastal District to examine the species' response to fire in different seasons. It is proposed that these trials be implemented on a close relative, *Caladenia arenicola*. The two species often co-occur, indicating that the habitat requirements are very similar, and their biology is also very similar. Therefore, it is felt that the response of this common species could be expected to closely mirror that of *Caladenia huegelii*, providing good information for management without impacting negatively on this critically endangered species.

The Swan Region Threatened Flora and Communities Recovery Team and the South West Region Threatened Flora and Communities Recovery Team are overseeing the implementation of this IRP and will include information on progress in their annual reports to DEC's Corporate Executive and funding bodies.

Where populations occur on lands other than those managed by DEC, permission has been or will be sought from appropriate land managers prior to recovery actions being undertaken.

The following recovery actions are roughly in order of descending priority, influenced by their timing over the term of the Plan. However this should not constrain addressing any of the priorities if funding is available for 'lower' priorities and other opportunities arise.

1. Coordinate recovery actions

The Swan Region and the South West Region and Districts, under general guidance of the Threatened Flora and Ecological Communities Recovery Teams will coordinate recovery actions for *C. huegelii* and other Declared Rare Flora in their regions. They will include information on progress in their annual reports to DEC's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: DEC (Swan and South West Regions) through the Recovery Teams
Cost: $4,000 per year

2. Liaise with land managers

Staff from DEC's Swan Coastal, Wellington and Blackwood Districts will continue to liaise with all relevant land owners and managers of land on which *C. huegelii* is located. This is to ensure that plants are not accidentally damaged or destroyed and to provide advice on how best to manage DRF on their lands.

Input and involvement will also be sought from any Aboriginal groups that have an active interest in areas that are habitat for *C. huegelii*. Significant sites are listed on the Aboriginal Sites Register maintained by the Department of Indigenous Affairs. Listed sites that occur in the vicinity of *C. huegelii* populations are identified in the Indigenous Consultation section on page 25. The custodians of these areas will be identified, and their input and involvement will be sought in the management of populations in this area.

Action: Liaise with land managers
Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams
Cost: $12,000 per year

3. Carry out appropriate management of bushland that contains *Caladenia huegelii*

Clearing of native vegetation for urban or agricultural development has led to the increasing fragmentation of habitat with populations of *C. huegelii* now confined to small areas of remnant bushland. Remaining

populations are threatened through degradation of the remaining habitat on these small remnants by processes that clear or damage relatively small areas (chipping away at the total), or that reduce or damage the quality or function of the supporting bushland. These include weed invasion, *Phytophthora* disease, roadworks, firebreak maintenance, inappropriate fire regimes, recreational activities and dumping of rubbish.

These threatening processes apply on all remnants within the area of occurrence of *C. huegelii*, however priority for active management that supports or improves the condition or quality of bushland (eg to prevent introduction of disease or weeds) should be given to habitat critical to survival of *C. huegelii.* Specific recovery actions relating to access management, weed control, and fire management are noted below.

Action: Carry out appropriate management of bushland that contains *Caladenia huegelii*
Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams
Cost: $120,000 per year

4. Carry out environmental assessment of developments or actions that have the potential to damage *C. huegelii* plants or habitat

Any development that proposes to destroy any population or habitat of *Caladenia huegelii* would require environmental assessment under either the Western Australian *Environmental Protection Act 1986* or *Wildlife Conservation Act 1950*, and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). State and local government statutory planning decision makers should also consider any proposal to take plants. Developments, clearing or on-ground works should not be approved unless the proponents can demonstrate that they will not have an impact on the species, its habitat or potential habitat. Any proposal to take plants would also require State and Commonwealth ministerial approval under the Western Australian *Wildlife Conservation Act 1950* and the EPBC Act.

Environmental assessment is also required for on-ground works, such as maintenance of infrastructure (firebreaks, powerlines, road verges etc), and actions thought to be of positive benefit to habitat, such as access fencing or weed control, should also have an assessment of possible negative impacts on plants or habitat of *C. huegelii*. Any developments or on-ground works in the immediate vicinity of any population of *C. huegelii* will require assessment.

Because *Caladenia huegelii* can be difficult to identify when not in flower, agencies undertaking environmental and/or statutory planning assessments that involve vegetation clearing within the range of *C. huegelii* should consider that populations of *C. huegelii* may be present. This is particularly the case involving bushland adjacent to or near known populations. In these situations a flora survey (during the flowering season and by competent persons) should be conducted as part of the assessment. Such surveys should assess the flowering potential of the species during that season, and where the species is not flowering strongly, additional surveys in subsequent seasons may be required where there is reasonable probability that the species may occur in the project area.

Action: Carry out environmental assessment of developments or actions that have the potential to damage *C. huegelii* plants or habitat
Responsibility: DEC, EPA, WAPC, Local Governments, Commonwealth DEWHA
Cost: $20,000 per year

5. Seek positive conservation outcomes for future development proposals for lands containing *C. huegelii*

DEC staff will continue to assess development proposals for lands containing *Caladenia huegelii* and participate in environmental impact assessment and statutory planning processes to protect bushland containing the species. Where residual impacts will occur to *Caladenia huegelii* or its habitat, DEC will seek suitable offsets consistent with the EPA's position on environmental offsets (EPA 2006), including outcomes that formally protect populations by placing land into conservation estate.

Action: Seek positive conservation outcomes for future development proposals for lands containing *C. huegelii*

Responsibility: DEC (Swan and South West Regions, Environmental Assessment Branch)
Cost: $5,000 per year

6. Monitor populations

Monitoring of factors relating to populations, (such as plant numbers, area of occupancy, stability (expansion or decline), pollination activity, seed production, recruitment, longevity and predation) and habitat quality, (such as weed invasion, plant diseases such as *Phytophthora cinnamomi*, grazing, fire, physical damage or clearing), is essential. The visibility of DRF markers will also be monitored where present to ensure they remain effective, and have not faded or been covered by vegetation growth. Where possible, differential GPS systems will be used to record locations of plants accurate to within 1m, or at least to identify polygons around each population and subpopulation. As orchids do not flower every year, having accurate locations can assist with management in the future, such as responding to fire at times when plants are not able to be identified.

Annual monitoring of DRF populations is desirable. However, the time span available for monitoring and survey is restricted - depending on seasonal conditions, approximately 4-6 weeks in September/October. Therefore, significant (larger) and "at risk" populations will be monitored annually and Rare Flora Report Forms completed. Other populations will be inspected on an as-needs basis or up to every five years. This monitoring regime will also include inspections of habitat of known populations (including when flowering plants are not present) to monitor and report on habitat condition including any process that threatens habitat (eg weeds, fire, clearing).

Part of Population 42 was burnt in an intense fire in April 2005 and initial monitoring showed low numbers of plants following the fire. Continued monitoring of recovery at this site could provide valuable information on fire response in this species. A number of translocation trials have also been undertaken, and ongoing monitoring of these will provide valuable information in the success and appropriate methodology of such translocation s in the future.

Information gained from population monitoring will be used in mapping of critical habitat in Recovery Action 21, and in clarifying population and subpopulation identification and boundaries, and in determining priorities for recovery action for this species. It will also be provided to DEC's Species and Communities Branch (SCB) to update the Threatened Flora Data Management System (DEFL).

Action: Monitor populations
Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams
Cost: $10,600 per year

7. Increase area of *C. huegelii* habitat on secure tenure

Currently only 4 populations accounting for 22% of the total number of plants is located on secure tenure (Nature Reserve). Neither of the two sites that contain the largest number of plants (805 plants) and nearly half of the area of occupancy of this species (Populations 6 and 56) are in secure tenure. Acquisitions, transfers of management, or formalisation of conservation management of extant populations and subpopulations should be pursued. Most urgent are Populations 6, 42 and 56 but others, including Populations 18, 44, 55, 60, 62 and 67 and Subpopulation 28b, should also be reviewed, and the possibility of additional protection investigated.

This action will increase the security of tenure for a number of important populations and will allow DEC to better manage and protect this species.

On private land, this may include conservation covenants with a range of agencies or registration through the Land for Wildlife scheme.

Investigation will be undertaken into adding a 'Memorial on Title' to Private Property on which *C. huegelii* occurs to notify prospective buyers of the presence of this species, the significance of its Declared Rare status and their legal obligation to protect it. This action will help prevent accidental damage occurring through ignorance.

Action: Increase area of *C. huegelii* habitat on secure tenure
Responsibility: DEC (Swan and South West Regions) through the Recovery Teams with the WAPC
Cost: $1,500 per year (Note: costings do not include purchase price)

8. Manage access

There is a need to manage both recreational and managerial access at several populations. This management may take the form of fencing, track closure and rehabilitation, and/or interpretive signage. Fenced areas will ideally include a buffer of surrounding habitat. Liaison with land managers will be undertaken by district staff to determine the need for fencing, and the most appropriate size and type of fencing. Funding assistance may be sought from various sources, for example as part of a covenanting process.

Population 42 needs a particular focus, as this area is subject to heavy levels of use. Many tracks are cut through and used for recreation and rubbish dumping.

Action: Manage access
Responsibility: DEC (Swan Coastal District) through the SRTFCRT
Cost: $8,100 per year in years 1-4

9. Assess and install Declared Rare Flora markers

DEC staff will assess the need and placement of Declared Rare Flora (DRF) markers at all *Caladenia huegelii* populations. The installation of these will occur during monitoring in the flowering period, to ensure that all plants occur within the markers. Markers will help to avoid accidental damage to the plants or their habitat during road, firebreak and powerline maintenance.

Action: Assess and install DRF markers
Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams
Cost: $8,200 in year 1; $2,000 review and maintenance in years 3 and 5

10. Undertake weed control

Weeds are a threat to several populations of *Caladenia huegelii*. High levels of weeds impact on *C. huegelii* by competing for resources, degrading habitat, exacerbating grazing pressure, and increasing the risk and severity of fire. Recruitment is likely to be particularly affected. Populations 6, 8, 20, 21 and 41, and to a lesser extent Population 12, require weed control over several successive years. This will be undertaken in consultation with the land managers. Problem weeds will be identified and appropriate methods of control selected, with care taken to minimise impact on *C. huegelii* and the surrounding native vegetation. All applications of weed control will be followed by a report on the method, timing and success of the treatment against weeds, and the effect on *C. huegelii* and associated native plant species. Copies will be retained at the district and sent to Species and Communities Branch.

The following actions will be implemented:

Determine which weeds are present at which sites, and develop prioritized weed control program.
Select appropriate herbicide/s.
Control invasive weeds by hand removal or spot spraying around *Caladenia huegelii* plants when weeds first emerge.
Schedule weed control to include spraying at other threatened flora populations within the Region.
Monitor control sites to assess and document impact.
Undertake additional control as required.

The tolerance to herbicides of many of the native plant species associated with *C. huegelii* is not known and weed control programs will need to be undertaken in conjunction with research, or in an adaptive management framework.

Action: Undertake weed control

Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams; relevant land managers
Cost: $18,600 per year

11. Conduct further surveys

In addition to regular monitoring of known *Caladenia huegelii* populations to evaluate health, size and threats it is recommended that areas of potential habitat be surveyed for the presence of *C. huegelii*. This will be done during the species' flowering period (September-October). Where possible volunteers from the local community, wildflower societies and naturalists clubs could be involved in surveys supervised by DEC staff. All surveyed areas will be recorded and the presence or absence of *C. huegelii* documented to increase survey efficiency and reduce unnecessary duplicate surveys. Wherever possible, information captured will include GIS data, and mapping of any newly discovered populations. This will contribute to Recovery Action 21.

Initial priorities for surveys include appropriate bushland in the broader area of Populations 45, 31 and 56.

Action: Conduct further surveys
Responsibility: DEC (Swan Coastal, Wellington and Blackwood Districts) through the Recovery Teams; relevant land managers
Cost: $4,300 per year in years 2 and 4

12. Clarify identification of unconfirmed populations

Due to the sometimes subtle morphological differences between species in the *Caladenia huegelii* complex, identification can be difficult. Some populations previously identified as *Caladenia huegelii* have been re-determined as *Caladenia thinicola* (Hopper and Brown 2001), but not all were visited and confirmed *in situ* (Populations 5, 7, 10, 14, 26, 27, 29, 33, 36, 39, 40, 43, 46 and 47). Some populations likely to be *Caladenia huegelii* have not been adequately confirmed (Populations 32, 34, 35, 52, 54 and 64). Experts will survey these populations during flowering (in sequential years if necessary) to determine the correct identity of plants.

Action: Clarify identification of unconfirmed populations
Responsibility: DEC (SCB), BGPA through the Recovery Teams
Cost: $3,000 per year

13. Develop and implement a fire management strategy

Caladenia huegelii plants are killed by fire during the above-ground phase of their lifecycle (late April to early November). Fire should therefore be prevented from occurring in populations during these months. Fire also promotes the introduction and proliferation of weed species, and can affect the health of mycorrhizal fungi by removing necessary leaf litter.

A fire management strategy will be developed and implemented in conjunction with relevant authorities and land managers. The strategy will include preparation of Wildfire Response Plans, which will provide site-specific instructions to FESA and DEC fire-fighting staff about how best to respond to wildfire near populations of *Caladenia huegelii*. The strategy will also ultimately include a Fire Management Plan for the species, which discusses the fire ecology of this species, its pollinator and fungus, and their supporting bushland habitat. It will also provide recommendations on prescription fire frequency and intensity and the need for, method of construction, and maintenance of firebreaks and other precautions against wild fire. This Fire Management Plan will be dependent on completion of fire ecology research, discussed in Recovery Action 20, and will need to be a 'living' document, revised as knowledge is refined.

Action: Develop and implement a fire management strategy
Responsibility: DEC (Swan and South West Regions) with relevant land managers through the Recovery Teams
Cost: $10,000 in first year, and $4,000 in subsequent years

14. Develop and implement a grazing control strategy

Grazing of plant parts by a range of herbivores is a significant management issue. Kangaroos, rabbits and caterpillars have been identified as grazers of leaves and flowers, and bandicoots as grazers of tubers. Observations from Population 6 suggest that *Caladenia huegelii* is preferentially targeted for grazing. The extent of grazing at that site is likely to lead to a decline in the population based on current observed impacts, and this is likely to be also true of other populations.

Fencing is likely to form part of the control strategy. Consideration will need to be given to the type of fencing, and to its placement. Boundaries should be defined while plants are in flower, and be generous to accommodate other non-flowering individuals. Control of grazer populations may also be necessary at some sites.

Action: Develop and implement a grazing control strategy
Responsibility: DEC (Swan and South West Regions) with relevant land managers through the Recovery Teams
Cost: $8,000 per year

15. Collect and store seed and fungal material

It is necessary to store germplasm as a genetic resource, ready for use in translocations and as an *ex situ* genetic 'blueprint' of the species. Storage of cultured associated mycorrhizal fungus is also necessary to germinate seed at time of use and support the survival of the germinant. Seed has been collected from Populations 6, 18, 28, 31, 38, 42, 44, 45, 56, 60 and 62, but additional collections are desirable from those and other populations to maintain adequate representation of the genetic diversity of this taxon. Population 38 was highlighted as a genetically divergent population, and is a priority for collections. It may be appropriate to conduct hand pollination trials to support seed collection. This material will be stored at BGPA where appropriate expertise and storage facilities exist.

Action: Collect and store seed and fungal material
Responsibility: DEC (Swan and South West Regions), BGPA through the Recovery Teams
Cost: $3,500 per year

16. Promote awareness

This species has a public profile through newspaper coverage but it is desirable that the importance of biodiversity conservation and the need for the long-term protection of wild populations be further promoted. Wherever possible DEC and Recovery Teams will seek to promote conservation actions being carried out for *Caladenia huegelii* through local print and electronic media. Formal links with naturalist groups and interested individuals will also be encouraged. An information sheet has been produced, and includes a description of the plant, its habitat, threats, recovery actions and photos. This will continue to be distributed to the public through DEC's Swan Region and South West Region offices and also distributed to local land owners, relevant authorities and volunteer organizations, libraries and schools within targeted areas. Such information distribution may lead to the discovery of new populations.

To minimize the risk of deliberate destruction, it is recommended that the exact location of *C. huegelii* be kept from the general public. Such information should, however, be given to relevant landowners, land managers and other relevant authorities to prevent accidental destruction of plants.

Action: Promote awareness
Responsibility: DEC (Swan Region, South West Region) through the Recovery Teams
Cost: $1,700 in first year, and $1,100 in subsequent years

17. Manage small populations to increase numbers of individuals and area of occupancy

In areas where sufficient appropriate habitat exists around small extant populations, it is desirable to manage those populations in such a way that numbers of individuals and their area of occupancy increases. This may be

achieved through hand pollination of plants to increase seedset, direct seeding and inoculation with the appropriate fungus, and manipulation of the habitat to favour the fungus and seed germination.

Action: Manage small populations to increase numbers of individuals and area of occupancy
Responsibility: BGPA, DEC (Swan & South West Regions) through the Recovery Teams
Cost: $140,000 per year

18. Research and develop best practice protocols for translocations

Salvage translocations of extant wild plants from one location to another were undertaken in two areas (Populations 6 and 44) to ascertain if plants can successfully be moved to other sites. These were done in an experimental way to develop 'best practice' protocols that may be applied if translocation should become necessary at other sites, i.e. if plants are to be taken during development. Ongoing monitoring is essential to determine the success or failure of translocations. Success of a translocation is measured by the naturalising of a population and production of several generations of offspring, not by the immediate survival of individual plants.

Information on the translocation of threatened plants and animals in the wild is provided CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. All translocation proposals require endorsement by DEC's Director of Nature Conservation.

Action: Research and develop best practice protocols for translocations
Responsibility: BGPA and DEC (Swan Region) through SRTFECRT
Cost: $11,200 per year in the second and third years

19. Plan conservation translocations

If Recovery Action 18 is successful in establishing protocols that can enable *Caladenia huegelii* plants to survive translocation, conservation translocations should be planned. These should initially start with supplementing existing small populations but may in time include establishing new populations in appropriate habitat. As successful propagation from seed has been achieved, future translocations may include plants from this source.

Action: Plan conservation translocations
Responsibility: BGPA and DEC (Swan and South West Regions) through Recovery Teams
Cost: $4,000 per year in the fourth and fifth years

20. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *Caladenia huegelii* will provide a scientific basis for its management in the wild. An understanding of genetic variability within and between populations is being developed currently.

Of urgent importance is a more detailed understanding of the fire response of this species. It is known that fire during the orchid's dormant period does not harm the plant but that fire at other times of the year may have an adverse effect varying from death to reducing its vigour. A detailed study of fire seasonality and intensity is very important given the frequency with which its habitat gets burnt by accidental fire escapes and arson, and the pressure to conduct prescribed burns. This must include impact of fire season and intensity on *Caladenia huegelii* survival and growth, flowering, seed set and germination of seed. It must also include the effects of fire seasonality and intensity on the mycorrhizal fungus and wasp pollinator that *C. huegelii* depends upon, and their supporting habitat and food sources.

Trials should be carried out on a close common relative such as *Caladenia arenicola*. The two species often co-occur, indicating that the habitat requirements are very similar, and their biology is also very similar. Therefore, it is felt that the fire response of this common species could be expected to closely mirror that of *Caladenia huegelii*, providing information for management without impacting negatively on populations of this critically

endangered species. The results of all research trials will be monitored regularly and will be used to inform fire management strategy and fire management plans in Action 14.

A detailed study of the population biology of *Caladenia huegelii* is necessary to establish population age structures, rates of recruitment etc, so populations in need of management support can be strongly identified. The best methodologies to achieve that should also be investigated, and could include hand-pollination, supplementation of plants, or manipulation of variables to enhance fungus or pollinator populations.

Extensive pollinator baiting is necessary to establish which populations still have pollinators present and which do not.

A more detailed understanding of the biology, ecology and habitat requirements of the wasp pollinator and the associated mycorrhizal fungus is essential. This will inform managers about minimum viable habitat size for *C. huegelii*, including what requirements must be met to also support viable populations of its associated wasp and fungus. This is important for assessing development applications as well as managing populations. It may be necessary to establish what the requirements of the pollinator and fungus are before the effects of fire can be fully assessed.

Action: Obtain biological and ecological information
Responsibility: DEC (Swan and South West Regions) and BGPA through the Recovery Teams
Cost: $80,000 per year

21. Map habitat critical to survival

It is a requirement of the EPBC Act that spatial data relating to habitat critical to the survival of the species be determined. Although this is described in Section 1, the areas as described have not yet been mapped and that will be redressed under this action. If any additional populations are located, then this habitat will also be determined and mapped for these locations. This recovery action will also include the determination of "Area of Occurrence" and "Area of Occupancy" values for monitoring and reporting on recovery of the species.

Where possible, monitoring of populations under Recovery Action 6 and description of any new populations under Recovery Action 11 should include GIS mapping of populations that will inform this process.

Action: Map habitat critical to survival
Responsibility: DEC (Swan and South West Regions) through the Recovery Teams
Cost: $4,000 in the second year

22. Review the need for further recovery actions

At the end of its five-year term this Interim Recovery Plan will be reviewed and the need for further recovery actions assessed.

Action: Review the need for further recovery actions
Responsibility: DEC (SCB, Swan and South West Regions) through the Recovery Teams
Cost: $200 in the fifth year

4. TERM OF PLAN

Western Australia

This IRP will operate from April 2008 to March 2013 but will remain in force until withdrawn or replaced. If *Caladenia huegelii* is still ranked Critically Endangered after five years, this IRP will be reviewed and, if necessary, further recovery actions put in place.

Commonwealth

In accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) this adopted recovery plan will remain in force until revoked.

The recovery plan must be reviewed at intervals of not longer than 5 years.

5. REFERENCES

Atkins, K. (2007) *Declared Rare and Priority Flora List for Western Australia.* Department of Environment and Conservation, Western Australia.

Batty, A.L., Dixon, K.W., Brundrett, M. and Sivasithamparam, K. (2001) Constraints to symbiotic germination of terrestrial orchid seed in mediterranean bushland. *New Phytologist* 152 pp 511-520.

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

Department of Conservation and Land Management (1995) Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. Department of Conservation and Land Management, Western Australia.

Department of Conservation and Land Management (1994) Policy Statement No. 50 *Setting Priorities for the Conservation of Western Australia's Threatened Flora and Fauna*. Department of Conservation and Land Management, Western Australia.

Department of Conservation and Land Management (1992) Policy Statement No. 44 *Wildlife Management Programs*. Department of Conservation and Land Management, Western Australia.

Department of Environment and Conservation (2008) *Threatened Flora Database* (DEFL). Department of Environment and Conservation, Western Australia.

Department of the Environment, Water, Heritage and the Arts (2008) Recommendation Report – Commercial Development on Jandakot Airport (EPBC 2007/3599). Commonwealth Department of the Environment, Water, Heritage and the Arts.

EPA (2006). Environmental Offsets. EPA Position Statement 9. Western Australia

Evans, R., Willers, N. and Mitchell, D. (2003) Threatened Flora of Swan Region. Unpublished report to the Department of Conservation and Land Management, and Environment Australia.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A and Lyons, M. (1994*) A floristic survey of the Southern Swan Coastal Plain*. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Hoffman, N. and Brown A. (1998) *Orchids of South West Australia*, Revised Second Edition with supplement, UWA Press, Western Australia.

Honczar, K. (2005) Achieving threatened species conservation in conjunction with urban development – Roe Highway Stage 7 extension, Leeming, WA. *Australasian Plant Conservation* 14(2), 16-17.

Hopper, S.D. and Brown, A.P. (2001) Contributions to Western Australian orchidology: 2. New taxa and circumscriptions in Caladenia (Spider, Fairy and Dragon Orchids of Western Australia). *Nuytsia* 14(1/2), 27-307.

Hopper, S.D. and Brown, A.P. (2004) Robert Brown's *Caladenia* revisited, including a revision of its sister genera *Cyanicula*, *Ericksonella* and *Pheladenia* (Caladeniinae:Orchidaceae). *Australian Systematic Botany* 17, 171-240.

Jones, D.L., Clements, M.A., Sharma I.K. and Mackenzie A.M. (2001) A new classification of *Caladenia* R.Br (Orchidaceae). *Orchadian* 13, 389-419.

Reichenbach, H.G. (1871) *Beitrage zur systematischen Pflanzenkunde*. T.G. Meissner, Hamburg.

UNEP-WCMC United Nations Environment Program – World Conservation Monitoring Centre (2007) *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) website.* http://www.cites.org/eng/resources/species.html Accessed 2007.

Swarts, N. (2007) *Integrated Conservation of the Rare and Endangered Terrestrial Orchid* Caladenia huegelii. Thesis submitted for Doctor of Philosophy at the University of Western Australia's School of Earth and Geographical Sciences.

Warcup, J.H. (1971) Specificity of mycorrhizal associations in some Australian terrestrial orchids. *New Phytologist* 70 pp 41-46.

Watson, A. and Evans, D. (2006) *Jandakot Airport Master Plan 2005*. Jandakot Airport Holdings, Western Australia.

Western Australian Herbarium (1998-) *FloraBase – The Western Australian Flora*. Department of Environment and Conservation, Western Australia. http://florabase.calm.wa.gov.au/ Accessed 2007.

World Conservation Union (2001) *IUCN Red List Categories: Version 3.1*. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

6. TAXONOMIC DESCRIPTION

Excerpt from: Hopper, S.D. and Brown, A.P. (2001) Contributions to Western Australian orchidology: 2. New taxa and circumscriptions in Caladenia (Spider, Fairy and Dragon Orchids of Western Australia). *Nuytsia* 14(1/2), 27-307.

Caladenia huegelii

Plant solitary, rarely in loose clumps. *Leaf* erect, linear, 10–18 cm x 7–12 mm, pale green, basal third usually irregularly blotched with red-purple. *Scape* 25–60 cm tall. *Flowers* one or two (rarely three), *c*. 7–10 cm across, predominantly pale greenish-yellow with variable suffusions, lines and spots of red maroon; floral odour absent. *Sepals and petals* stiffly held, linear-lanceolate in basal quarter to third, then abruptly narrowing to a long-acuminate apex; osmophore tumescent, 12-40 mm long in dorsal sepal, 6–40 mm long in lateral sepals, absent from petals, light brown to yellow, consisting of minute densely packed globular sessile glandular cells. *Dorsal sepal* erect and slightly incurved, 4.5–12 cm x 2.5–4 mm. *Lateral sepals* obliquely spreading downwards, 4–12 cm x 4–7 mm. *Petals* spreading sometimes obliquely downcurved, 3–6 cm x 3–5 mm. *Labellum* obscurely 3–lobed, prominently two-coloured, basal lamina cream, becoming greenish towards fringe, with pale red radiating stripes, terminating in a uniformly dark maroon recurved apex, the latter prominently channelled and infundibular when viewed from the front, stiffly articulated on a claw *c*. 1.5–2.5 mm wide; lamina linear-cordate to cordate in outline, 23–30 x 13–20 mm, with dark midlobe almost parallel-sided and obtuse with a shortly acute apex when flattened, basal third curving from erect to oblique, middle third curving to horizontal, apical third sharply recurved, margins at widest point moderately curved upwards and terminated by vertically ascending calli; lateral lobes erect with entire margins near the claw, becoming fimbriate with slender acuminate linear sometimes bifurcate greenish-cream suffused maroon usually white-tipped calli to 15 mm long which are abruptly decrescent near midlobe; midlobe margins with short (to 3mm) slender slightly forward-facing obtuse (rarely acute) sometimes hooked or bifurcate dark maroon calli decrescent towards the apex. *Lamina calli* in four rows extending at least three-quarters the length of the labellum, dark maroon, becoming cream towards the base of the lamina, golf stick-shaped, the longest *c*. 2 mm tall, decrescent towards apex and becoming sessile. *Column* 17–22 x 10–14 mm, broadly winged, greenish yellow with pale maroon blotches. *Anther c*. 5 x 4 mm, greenish yellow with maroon suffusions. *Pollinia c*. 4 mm long, yellow. *Stigma c*. 3–4 mm wide, yellow-fawn. *Capsule* not seen. (Figures 91, 92).

Distribution and habitat. A species of scattered occurrence in *Banksia*, Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands from just north of Perth to the Margaret River area, usually within 20km of the coast. Grows amongst dense low shrubs in deep sandy soils, flowering in greater profusion following summer fire. (Figure 13D).

Flowering period. September to October.

Notes. A rare species (Declared Rare), probably once common on the coastal plain but due to extensive clearing now confined to scattered small areas of remnant bushland.

Since its description by Reichenbach in 1871 a good deal of confusion has surrounded the correct identity of *Caladenia huegelii*. It has been regarded by most authors as a widespread, variable species and as such has embraced a number of related but nevertheless distinct taxa including *C. pectinata* and *C. ferruginea*. The type sheet contains three distinct taxa, including *C. ensata*. George (1971) selected a lectotype from one of the

remaining two, remarking that it "best agrees with Reichenbach's description" of the species. However, the original description, published in the middle of a paragraph, appears to more closely match the third specimen found on the left side of the sheet, especially the reference to an oblong labellum, toothed at the front and with a rounded, shallowly notched end. In 1989 Hopper and Clements (*Australian Orchid Research, vol* 1) recognised this and proposed the specimen on the left (labelled as the syntype) be re-designated as the lectotype of *C. huegelii*. This was recorded on a determinavit placed on the type sheet by the senior author on 17 April 1991. The specimen previously labelled as lectotype is described herein as *C. paludosa*.

The location of King George Sound (actually "K.G.S. Hugel") on the type sheet is given immediately below the specimen of *Caladenia ensata* and may be accurate for that specimen (given that the species occurs in the Albany area). However, the two other specimens on the type sheet, including the lectotype, are of species (*C. huegelii s. str.* and *C. paludosa*) that are confined to the west coast and have not been recorded from the Albany area. Moreover, none of the three taxa on the type sheet flower into January when Huegel visited King George Sound (i.e. 1–12 January 1834 - Diels 1906). It is most unlikely, therefore, that Huegel collected any of these specimens from Albany. His visit to Perth, preceding that to Albany, was from 17 November to 19 December. Potentially, some late-flowering *C. paludosa* might have been collected at this time. However, typical *C. huegelii* is finished flowering by mid-October in the Perth area and, again, could not have been collected in the wild by Huegel.

The origin of the specimens on the type sheet is therefore enigmatic. Possibly, they were provided to Huegel by another collector such as Drummond. Alternatively, they were mistakenly bundled together and attributed to Huegel during subsequent shipping and curation of collections to Vienna prior to Reichenbach naming the species. Further research is needed.