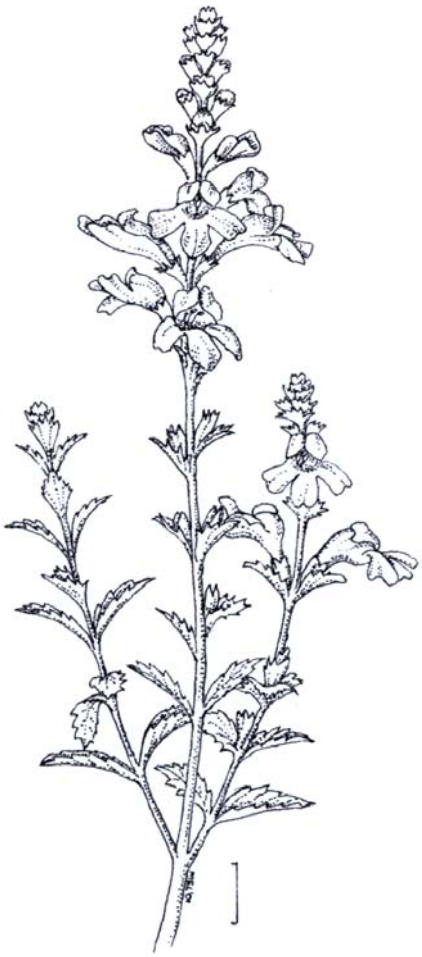
Australian Government

Government of South Australia
Department for Environment and Heritage

# Recovery Plan for the Endangered Osborn's Eyebright *Euphrasia collina* subsp. *osbornii*

## (2010)

**Kylie Moritz and Doug Bickerton**



A Recovery Plan prepared under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

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Note: This recovery plan sets out the actions necessary to stop the decline of, and support the recovery of, the listed threatened species or ecological community. The Australian Government is committed to acting in accordance with the plan and to implementing the plan as it applies to Commonwealth areas.

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

Further copies of this Recovery Plan are available from:
Department for Environment and Heritage
Threatened Species and Ecological Communities Unit
Plant Biodiversity Centre
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Adelaide SA 5000

Cover image: Drawing of *Euphrasia collina* subsp*. osbornii* by Mel Berris.

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**Abbreviations**

| | |
|---|---|
| AMLR | Adelaide and Mt Lofty Ranges |
| BDBSA | Biological Databases of South Australia |
| CITES | Convention on International Trade in Endangered Species |
| CP | Conservation Park |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| DEH | Department for Environment and Heritage, South Australia |
| DPIWE | Department of Primary Industries, Water and Environment, Tasmania |
| DTEI | Department of Transport, Energy and Infrastructure |
| ERT | *Euphrasia* Recovery Team, for *E. collina* subsp*. osbornii*** |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* |
| FNHCP | Friends of Newland Head Conservation Park |
| HA | Heritage Agreement |
| IUCN | International Union for the Conservation of Nature |
| KI | Kangaroo Island |
| N&Y | Northern and Yorke Region |
| NPW Act | *National Parks and Wildlife Act 1972* |
| NRM | Natural Resource Management |
| SE | South-East of South Australia |
| spp | species (plural) |
| subsp | subspecies |
| TFO | Threatened Flora Officer |
| TFL | Trees for Life |
| TPAG | Threatened Plant Action Group |
| TTERT | Tasmanian Threatened *Euphrasia* Recovery Team |

** A *Euphrasia collina* subsp*. osbornii* Recovery Team will be established through this recovery planning process.

**Acknowledgements**
The authors would like to thank the following people who greatly assisted in the development of this National Recovery Plan: Bill Barker, Peter Copley, Jody Gates, Anna Murphy, Marcus Pickett, Wendy Potts, Jerry Smith, Yvonne Steed, Rosemary Taplin, Ron Taylor, Peter Tucker and Roman Urban. Funding for the preparation of this plan was provided by the Australian Government.

# Part 1: Species Information and General Requirements

## 1.1 Species Conservation Status and Taxonomy

### 1.1.1 Current Conservation Status

*Euphrasia collina* subsp*. osbornii* (W.R. Barker) is currently listed in South Australia as endangered under the *National Parks and Wildlife Act 1972* (NPW, 1972) and as endangered at the national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). *Euphrasia collina* subsp*. osbornii* also meets the 2001 IUCN criteria EN B2ac (ii, iv), because its area of occupancy is less than 500km$^2$, it has a projected continuing decline in area of occupancy and number of mature individuals, and experiences extreme fluctuations in the area of occupancy and number of mature individuals.

The subspecies occurs in seven protected areas, five reserves and four heritage agreements within South Australia.

### 1.1.2 Taxonomy

| | |
|---|---|
| Family name: | Scrophulariaceae |
| Scientific name: | *Euphrasia collina* subsp*. osbornii* |
| Common name: | Osborn's eyebright |

*Euphrasia*, in the family Scrophulariaceae, is a widespread genus with 22 species occurring in Australia (Barker, 1982). *Euphrasia* are commonly known as eyebrights and the genus is characterised by a large degree of variation, a high degree of endemism and a large proportion of rare and threatened taxa (Jessop and Toelken, 1986; Potts, 1997a). *Euphrasia collina* is a polymorphic species with 16 geographically or ecologically defined subspecies (Barker, 1982). *Euphrasia collina* is a species of semi-parasitic, perennial terrestrial herb, with six subspecies occurring in South Australia, two of which are presumed extinct (Jessop and Toelken, 1986; Barker, 1982).

*Euphrasia collina* subsp*. osbornii* (Osborn's Eyebright) is a South Australian endemic plant. It is an erect, perennial, partly parasitic herb, 25 to 47 cm high (Barker, 1982), characterised by decussate leaves that are thick, fleshy and pale green. The leaves have 1-8, usually 3-6, pairs of blunt teeth along margins and are covered with glandular hairs (Barker, 1982). The flowers vary from white to pink or lavender and paler inside (Jessop and Toelken, 1986; Barker, 1982). The corolla is bilabiate with a tube, a hooded upper lip and a three lobed spreading lower lip (Jessop and Toelken, 1986). A yellow spot is sometimes found behind the lowest lobe (Barker, 1982). The lobes are pubescent over all but the tips (Jessop and Toelken, 1986). *Euphrasia collina* subsp*. osbornii* usually flowers from August to December, although collections have been made in March and June (Barker, 1982).

Experts on *Euphrasia* believe that based on morphological attributes there are five apparent races of *Euphrasia collina* subsp. *osbornii* (Barker, 1982):
1. A Yorke Peninsula mallee race that is robust in habit, and floriferous with purple to white corollas lacking a yellow spot in the mouth.
2. A Mount Lofty Ranges race which is less robust, with off-white corollas lacking a yellow spot in the mouth. This may extend to the northern Mt Lofty Ranges.
3. A southern Mount Lofty Ranges bog race, with a yellow spot in the corolla mouth (this race may exhibit some colour variation).
4. An eastern mallee race, which is robust in habit, and floriferous with purple to white corollas. This race has occasional plants with a yellow spot in the corolla mouth.
5. A population at Cape Hart on eastern Kangaroo Island is unusual in its short glandular indumentum (Barker, 1982).

## 1.2. International Obligations

*Euphrasia collina* subsp*. osbornii* is not listed under any relevant international agreements and the implementation of Australia's international environmental responsibilities will not be affected by this plan. The actions identified in the plan are fully consistent with Australia's obligations under the Convention on Biological Diversity, ratified by Australia in 1993 and the proceeding National Strategy for the Conservation of Australia's Biological Diversity.

## 1.3. Affected Interests

A total of 79 community groups, private landowners, land managers and statutory organisations have been identified as current and potential stakeholders in the management of *Euphrasia collina* subsp*. osbornii* within Australia (Appendix I).

Twenty-seven of these stakeholder groups/individuals, including 14 private landholders, currently directly own or manage habitat critical for this subspecies (Appendix I). During the development of this recovery plan many regional and state listed stakeholders were contacted and informed of the planning process. Each was invited to provide input into and/or comment on the plans development. Significant information contained within this plan, including information about new sites and threats, has been the direct result of this consultation.

Opportunities for the involvement of all potential stakeholders in the proposed recovery actions are outlined in full in the actions section 4.2 of this plan.

## 1.4. Roles and Interests of Indigenous People

Implementation of recovery actions under this plan aims to include consideration of the role and interests of Indigenous communities in the region. Consultation with the relevant South Australian indigenous groups has been undertaken by Aboriginal Partnerships, Department for Environment and Heritage (DEH), SA, since May 2009. No comments have been received.

## 1.5. Benefits to other Species/Ecological Communities

Through the implementation of this plan broader biodiversity benefits may include the protection and management of ecological communities and individual species that occur within the habitat critical to *Euphrasia collina* subsp*. osbornii*. The subspecies shares habitat with a number of floral species of conservation significance at the national level and occupies a number of habitats that are considered to be poorly or moderately conserved in South Australia.

*Euphrasia collina* subsp*. osbornii* is recorded from *Eucalyptus odorata* (Peppermint Box) low woodlands, which are classified as a poorly conserved community in South Australia as most remaining examples are small and/or degraded and/or atypical (Neagle, 1995). *Eucalyptus odorata* grassy woodlands are listed as an endangered ecological community under the EPBC Act (1999). *Eucalyptus odorata +/- E. leucoxylon* woodland is identified as an endangered community on the *Provisional List of Threatened Ecosystems of South Australia* (DEH in progress). *Euphrasia collina* subsp*. osbornii* is also recorded from *Eucalyptus porosa* (Mallee Box) woodlands, which are considered to be poorly conserved due to lack of populations in reserves and the isolated, fragmented and often degraded nature of remnants in South Australia (Neagle, 1995).

The subspecies is also found in the Fleurieu Peninsula swamps of the southern Mt. Lofty Ranges. Fleurieu Peninsula swamps are recognised as a critically endangered ecological community under the EPBC Act, as only a quarter of the original swamps remain and these are found only in the Southern Mt Lofty Ranges (Paton, 2003). Freshwater wetlands including aquatic Herblands / Sedgelands are identified as an endangered community on the *Provisional List of Threatened Ecosystems of South Australia* (DEH in progress). Most of these swamps are smaller than 5 hectares yet they host 167 native plant species, half of which are of State conservation significance (Paton, 2003). Swampy habitats of the Mt. Lofty Ranges, where *Euphrasia collina* subsp*. osbornii* has been recorded, also

contain significant fauna species including the endangered Mt Lofty Ranges Southern Emu-wren (*Stipiturus malachurus intermedius*).

There are ten plant taxa of national listing that are known to occur in areas where *Euphrasia collina* subsp. *osbornii* has been recorded (Table 1.1). Three of these plants are nationally endangered including *Acacia enterocarpa* (Jumping-Jack Wattle), *Caladenia argocalla* (White Beauty Spider-orchid) and *Caladenia rigida* (Stiff White Spider-orchid). The management requirements of *Euphrasia collina* subsp*. osbornii* will need to be balanced carefully with the management requirements of both the ecological communities and other species where it occurs to avoid negative impacts on these species and communities.

**Table 1.1 Plants of conservation significance that overlap the range of *Euphrasia collina* subsp. *osbornii*.**

| Species | Common name | National (EPBC Act) | State (NPW Act) |
|---|---|---|---|
| *Acacia enterocarpa* | Jumping-Jack Wattle | E | E |
| *Acacia rhetinocarpa* | Resin Wattle | V | V |
| *Acacia lineata* | Streaked Wattle | - | R |
| *Caladenia argocalla* | White Beauty Spider-orchid | E | E |
| *Caladenia brumalis* | Winter White Spider-orchid | V | V |
| *Caladenia rigida* | Stiff White Spider-orchid | E | E |
| *Olearia pannosa* subsp*. pannosa* | Silver Daisy-bush | V | |
| *Pomaderris halmaturina* subsp*. halmaturina* | Kangaroo Island Pomaderris | V | |
| *Prasophyllum pallidum* | Pale Leek-orchid | V | V |
| *Pterostylis cucullata* | Leafy Greenhood | V | V |
| *Spyridium coactilifolium* | Butterfly Spyridium | V | V |

E – endangered; V - vulnerable

## 1.6. Social and Economic Impacts

This recovery plan is unlikely to cause significant adverse social and economic impacts on the community. A number of beneficial social and economic impacts are likely to result from the implementation of many of the recovery plan actions. Amongst the social benefits are the education of the community about natural resource management, enhanced skills of community members for undertaking threatened plant management, employment of Threatened Flora Officers and communication between regional Natural Resource Management (NRM) boards. Identified economic benefits include managing weeds that may have potential to impact on productive land and providing assistance to landholders to construct and maintain stock fencing. In addition, *Euphrasia* spp. extracts are used medicinally for treating eye ailments and the genus is in the family Scrophulariaceae, of which members such as *Digitali*s spp. are well known for their medicinal properties (Potts, 1997a). Such applications have not been identified for this subspecies but there could potentially be a greater economic use for this species in the future.

Local Government may require financial assistance for the management of roadside reserves, as the protection of existing populations on road reserves may affect the manner in which road works, maintenance or service installations are conducted and a cost may be incurred. The cost of redirecting services such as powerlines or optical fibre cables or road realignment may be prohibitive and in such cases, alternative strategies for conserving populations might need to be canvassed.

Certain land management practices may need to be altered to better manage this subspecies, such as grazing regimes, use of fire and other mechanisms of disturbance. These activities could create an economic or resource impact on some landowners. Landowners may potentially experience loss of income through reduced grazing area or grazing time. Actions are outlined to consult and work with land managers to minimise any potential economic impact of implementing this recovery plan.

# Part 2: Distribution and Location

## 2.1. Current Distribution and Important Populations

### 2.1.1 Current Distribution

*Euphrasia collina* subsp*. osbornii* is a South Australian endemic. It is found in the Kangaroo Island (KI), Adelaide and Mount Lofty Ranges (AMLR), Northern and Yorke (N&Y) and South East (SE) NRM Regions of South Australia (Briggs and Leigh, 1995; BDBSA, 2009).

For the preparation of this plan, data was collated from the Biological Databases of South Australia (BDBSA), in particular the Threatened Plant Population Database and the State Herbarium Database of South Australia, and personal communications with individuals familiar with the subspecies. Over 160 records have been made of this subspecies across South Australia. Despite the large number of records, many are quite old, with only 46 recorded from the past 15 years. For this recovery plan records made since 1980 have been included as the current distribution of this subspecies. Data older than this was deemed historical data and is dealt with in Section 2.3. Recommended actions under Section 4.2 include surveying of some historic sites in order to search for plants. Studies by Potts (1997b) show that seeds of other *Euphrasia* taxa are suspected to persist for decades. Based on this, seed of *Euphrasia collina* subsp*. osbornii* could potentially persist in sites termed historic if conditions have remained suitable.

A total of 26 distinct populations have been identified in the current distribution of *Euphrasia collina* subsp*. osbornii* (Appendix II; Figure 2.1). These 26 populations include seven in the N&Y (Figure 2.2), 13 in the AMLR (Figure 2.3), five on KI (Figure 2.4) and one in the SE (Figure 2.4) (Appendix II).

The subspecies has a scattered distribution in the Mt. Lofty Ranges, from north of Nuriootpa to the coastal cliffs of the southern Fleurieu Peninsula (BDBSA, 2009) (Figure 2.3). In the N&Y Region there are several sites recorded from around Clare, and on Yorke Peninsula the current sites occur in the area between Curramulka, Minlaton and Pt Vincent, predominantly on roadsides and on private land (Graham *et al* 2001) (Figure 2.2). In the SE only one current site is known: SW of Coonalpyn (Appendix II). The subspecies is found in nine State protected areas, six Heritage Agreements, six unprotected reserves and five privately owned properties (Table 2.1).

The short lived nature of the subspecies means that populations can be transient and the number of plants and the area occupied can fluctuate greatly over time. As a result, the number of plants recorded at sites provides only a time dependent indication of the site (Appendix II).

**Table 2.1 Reserves where *Euphrasia collina* subsp*. osbornii* is currently known to occur.**

| DEH Reserves | Unprotected Reserves | Heritage Agreement |
|---|---|---|
| Coastal Reserve (AMLR) | Barossa Reservoir (AMLR) | Cape Willoughby (KI) |
| Coastal Reserve (KI) | Clare Cemetery (N&Y) | Curramulka Rd (N&Y) |
| Cox Scrub CP (AMLR) | Emu Flat (N&Y) | Investment HA (AMLR) |
| Deep Creek CP (AMLR) | Fitzgerald Rd (N&Y) | Lutze HA (SE) |
| Eric Bonython CP (AMLR) | Mylor Parklands (AMLR) | Moppa HA (AMLR) |
| Lesueur CP (KI) | Neagle Rock (N&Y) | Steele HA (AMLR) |
| Morialta CP (AMLR) | | |
| Ramsay CP (N&Y) | | |
| Stipiturus CP (AMLR) | | |

| | | | |
|---|---|---|---|
| KI | Kangaroo Island | N&Y | Northern and Yorke Region |
| SE | South East of SA | AMLR | Adelaide & Mount Lofty Ranges |
| CP | Conservation Park | | |

Figure 2.1. The location of known populations of *Euphrasia collina* ssp. *osbornii* in South Australia

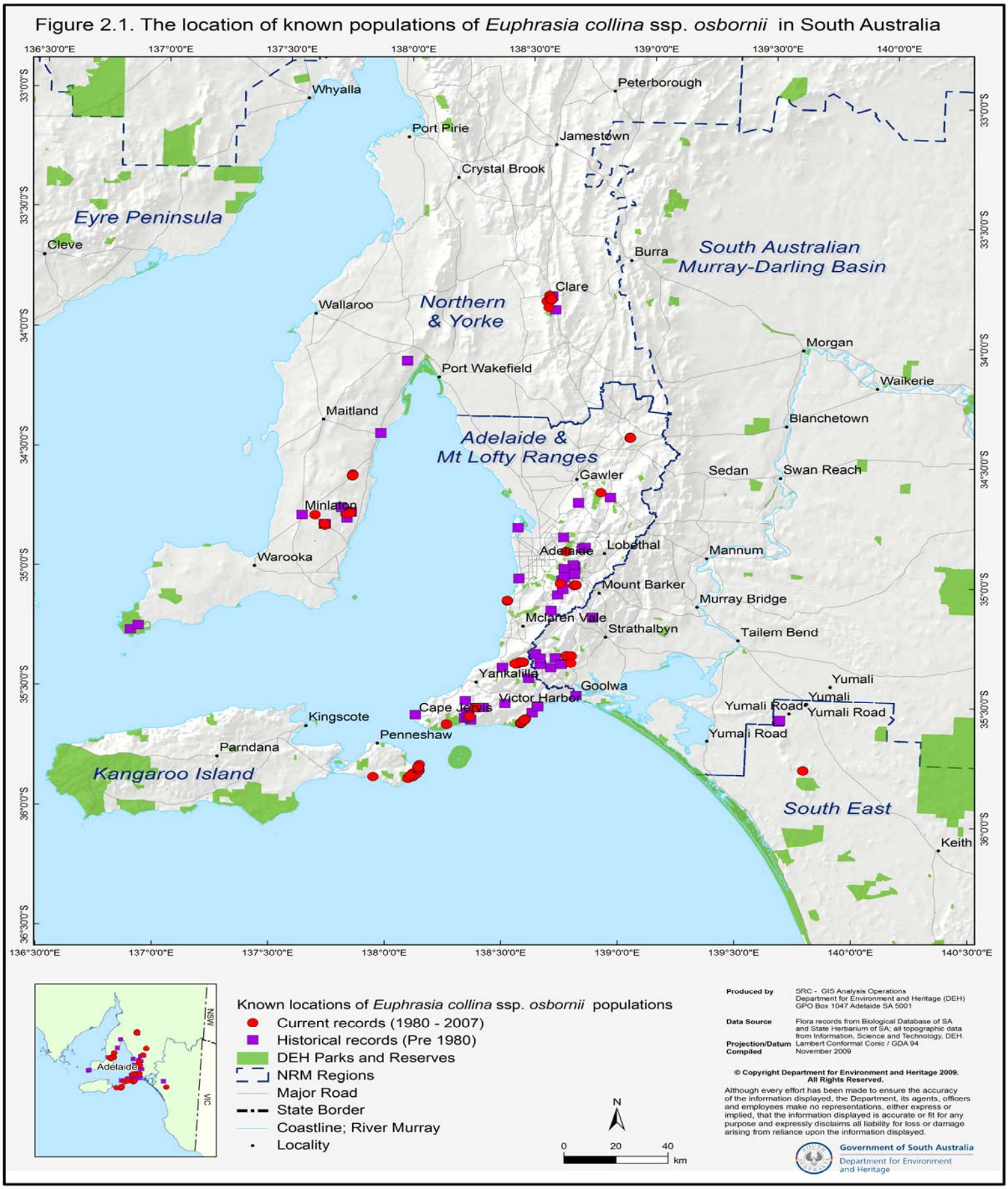

Figure 2.2. The location of known populations of *Euphrasia collina* ssp. *osbornii* in Northern and Yorke

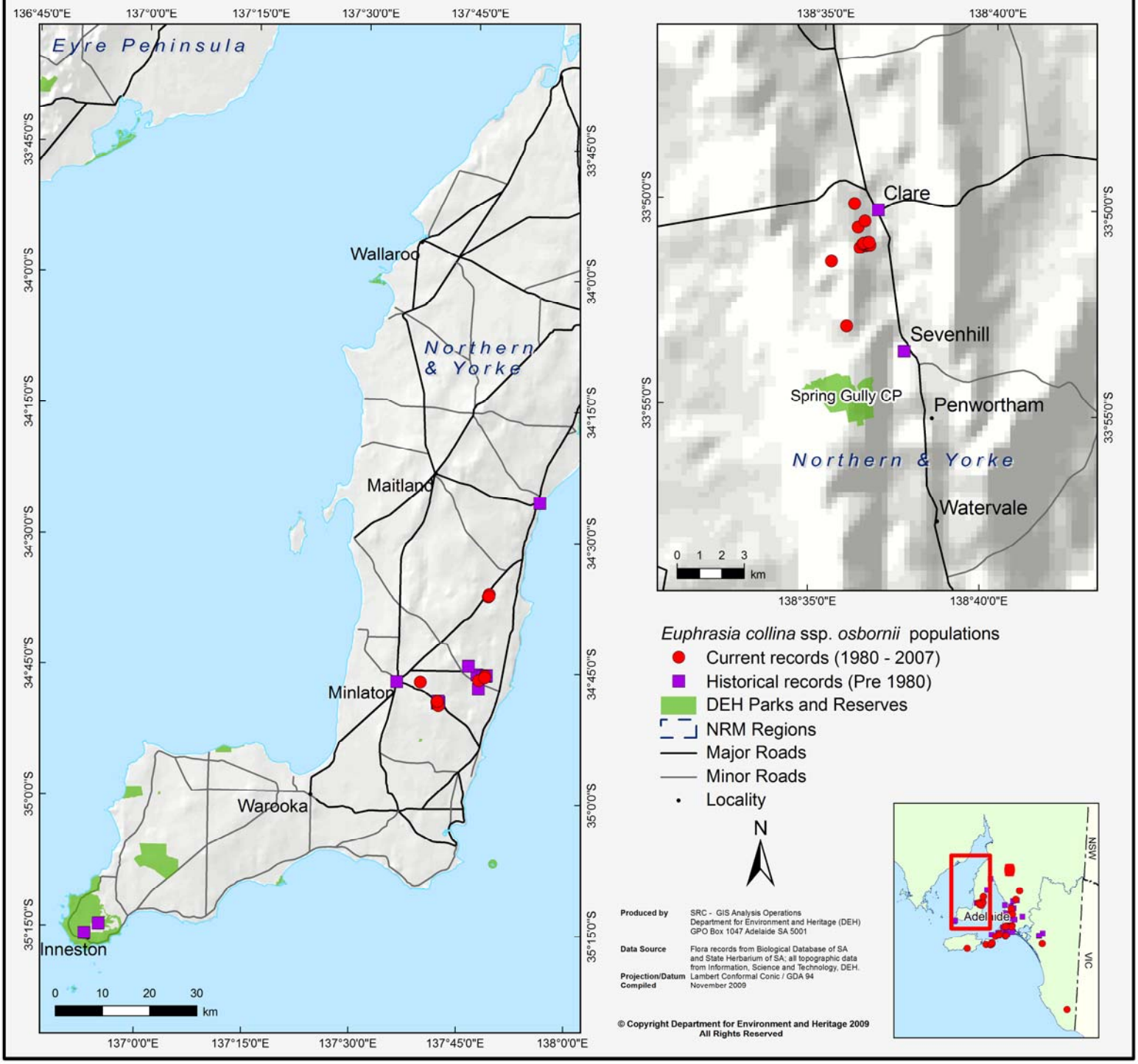

Figure 2.3. The location of known populations of *Euphrasia collina* ssp. *osbornii* in the Mount Lofty Ranges

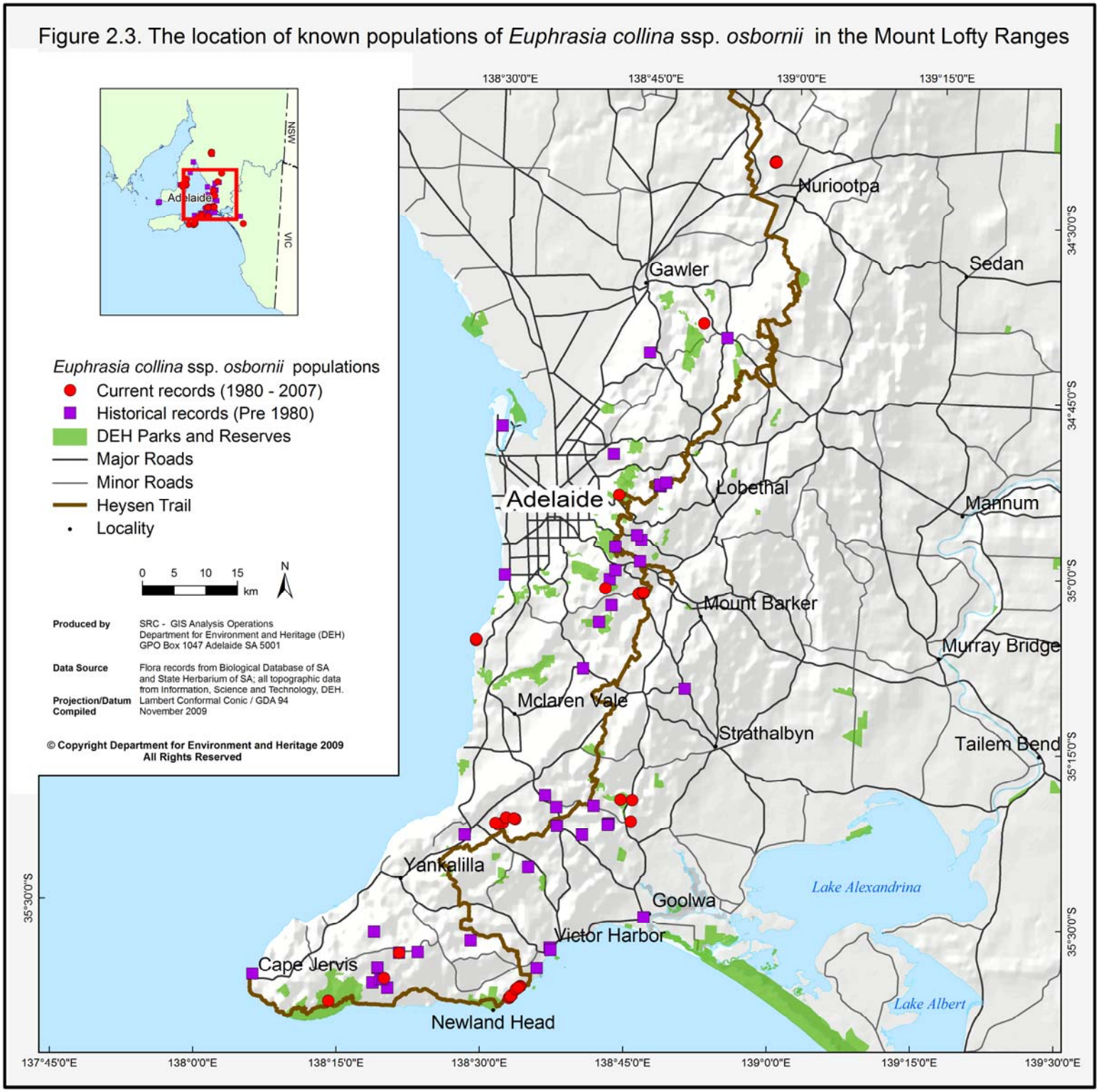

Figure 2.4. The location of known populations of *Euphrasia collina* ssp. *osbornii* in the South East and on Kangaroo Island




*Euphrasia collina* ssp. *osbornii* populations
- Current records (1980 - 2007)
- Historical records (Pre 1980)
- DEH Parks and Reserves
- NRM Regions
- Major Roads
- Minor Roads
- Coastline
- Locality

N

**Produced by** SRC - GIS Analysis Operations
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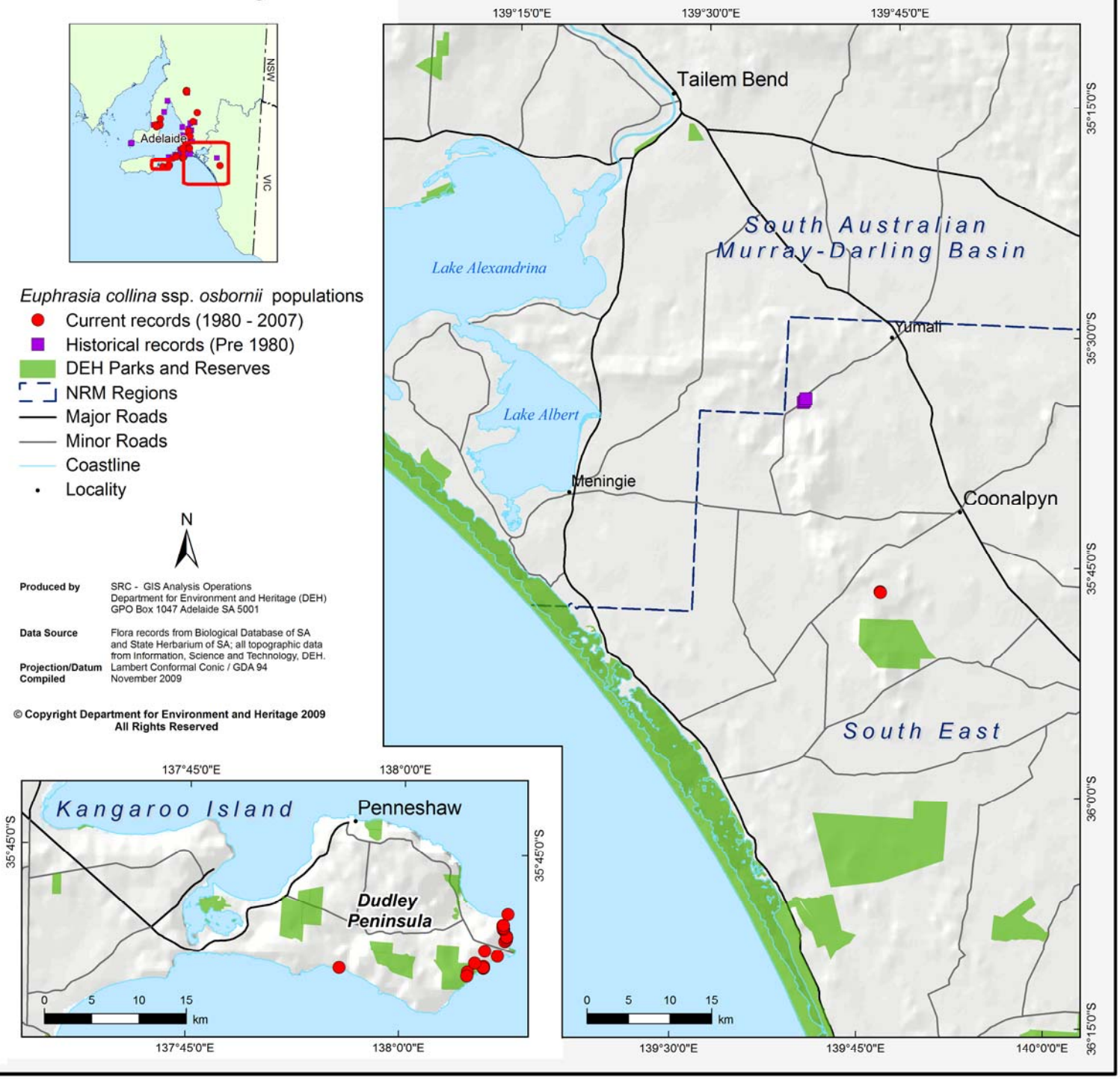
GPO Box 1047 Adelaide SA 5001

**Data Source** Flora records from Biological Database of SA and State Herbarium of SA; all topographic data from Information, Science and Technology, DEH.

**Projection/Datum** Lambert Conformal Conic / GDA 94

**Compiled** November 2009





### 2.1.2 Important Populations

*Euphrasia collina* subsp*. osbornii* exhibits morphological variation across its range. It has been postulated (Barker, 1982) that this may be due to genetic difference between populations (refer to Section 3.1). It also occurs in vastly different habitats from mallee scrubland, heathy openings in wet sclerophyll forests to exposed coastal cliffs (Barker, 1982), which is consistent with the suggestion that *Euphrasia collina* subsp*. osbornii* is a genetically heterogeneous taxon.

To conserve this subspecies adequately it is important that examples of the different morphological variants and plants within different habitat types across the range are conserved and managed. The identification of important populations must therefore be determined based on research into the genetic heterogeneity of the subspecies, and this is actioned in Section 4.2. At this stage all populations must be considered important for conservation.

Details of seven populations are provided below, covering a variety of sites across the subspecies range. This list does not assume a greater importance of these populations.

**Kangaroo Island**

Lesueur CP

*Euphrasia collina* subsp*. osbornii* occurs at eight sites on Dudley Peninsula, Kangaroo Island (Figure 2.4). The largest population is in Lesueur Conservation Park (formerly Cape Hart Conservation Park). The extent of the occurrence of this population is 4.0 $km^2$ (Taylor, 2003). There are also records from a cliff top west of Mouth Flat, a Heritage Agreement property between Cape Willoughby CP and Lesueur CP, and five sites from Pink Bay to Cape Albans. The eight sites could be considered to comprise four populations, as four of the sites near Pink Bay are less than 1 km apart. On the Island the subspecies occupies coastal heath habitat along cliffs close to the shoreline, where the vegetation is kept open by wind exposure.

**Northern and Yorke Region**

Clare and Gilbert Valley Council District

The earliest State Herbarium record from the Clare area is from 1892 (BDBSA, 2009). Osborn's eyebright occurs at five sites near Clare, the most significant being at Neagle Rock Reserve 3 km southwest of Clare. This council reserve has been observed to contain over 5000 plants in a favourable season, covering up to 3 ha, where it is common throughout the mid and upper hill slopes (Lang, pers. comm. 2004; Neagle, pers. comm. 2004). More than 1000 plants also occur on private land adjacent to the reserve, and in Clare Cemetery (BDBSA, 2009; Smith, 2000). These three sites could be considered to be a single population, as they are less than 1 km from each other.

A small number of plants have been recorded at Emu Flat Reserve, a small roadside reserve 2 km from Clare (BDBSA, 2009). At Emu Flat Reserve the plants occur near a *Caladenia argocalla* (White Beauty Spider-orchid) population (Tucker, pers. comm. 2004; Steed, pers. comm. 2004). A population has also been recorded further south, on Fitzgerald Road (BDBSA, 2009).

Yorke Peninsula

On Yorke Peninsula in the area between Pine Point, Minlaton and Stansbury, four populations containing *Euphrasia collina* subsp*. osbornii* have been recorded: in Ramsay CP, Stansbury scrub (private property), a Heritage Agreement property on the Ardrossan–Curramulka Road and in a patch of scrub east of Minlaton. The fourth record possibly refers to Stansbury scrub.

A survey on Yorke Peninsula identified two species-rich mallee sites containing more than 60 native species between Ardrossan and Stansbury where *Euphrasia collina* subsp*. osbornii* occurred (Graham *et al*, 2001). One site was dominated by a mixture of *Eucalyptus socialis* (Red Mallee) and the other dominated by *E. porosa* (Mallee Box) (Graham *et al*, 2001). A number of nationally listed plants are also recorded at *Euphrasia collina* subsp*. osbornii* sites on Yorke Peninsula, including the nationally endangered *Acacia enterocarpa* (Jumping-jack Wattle) and *Olearia pannosa* subsp*. pannosa* (Silver Daisy-bush), and the nationally vulnerable *Caladenia brumalis* (Winter Spider-orchid) (BDBSA, 2009).

**Mt. Lofty Ranges**

Moppa Scrub Heritage Agreement

A property under Heritage Agreement known as Moppa Scrub, north west of Nuriootpa in the AMLR Region, contained approximately 200 *Euphrasia collina* subsp*. osbornii* when last recorded in 1992 (BDBSA, 2009). This site was noted as one of the best remaining examples of *Eucalyptus odorata*

woodland in the district, where the shrub understorey and ground cover layer is extremely diverse (Graham *et al* 2001; Prescott, pers. comm. 2004). The nationally endangered *Caladenia argocalla* (White Beauty Spider-orchid) and the nationally vulnerable *Prasophyllum pallidum* (Pale Leek-orchid) have also been recorded at this site (BDBSA, 2009).

Parken's (east of Cox's Scrub)
East of Cox's Scrub Conservation Park, Parken's property was first recorded to contain *Euphrasia collina* subsp*. osbornii* in 1987. Pickett (pers. comm. 2004) visited the site in August 2000 and observed *Euphrasia collina* subsp*. osbornii* as occurring literally as sheets over some areas, but by January 2004 after some thickening of the vegetation, he noted that it was difficult to find plants. Heavy disturbance by cattle had occurred at the site just prior to the 2000 observation (Pickett, pers. comm. 2004). This suggests that the flush of *Euphrasia collina* subsp*. osbornii* plants was due to openness created by cattle and other associated disturbances.

Heysen Trail
Many sites along the Heysen Trail, dotted along the cliff top between Newland Heads and Encounter Bay, are recorded as containing *Euphrasia collina* subsp*. osbornii*. Most of the sites occur on the seaward side of the trail and many are found on the shale slope of the top of the cliff just before becoming near vertical. In this area the plants occur predominantly within the exposed coastal cliffs where the vegetation is kept open by wind exposure. The nationally vulnerable *Spyridium coactilifolium* (Butterfly Spyridium) is also recorded from several sites along the Heysen Trail in close proximity to *Euphrasia* sites. One section of the Heysen Trail, known as the Waitpinga Cliffs, contains many thousands of *Euphrasia collina* subsp*. osbornii* plants. Since the park was dedicated the plant population at this site has increased from approximately 800 plants to many thousands as a result of removing grazing and managing erosion. The plants are located along the cliff edge and are exposed to south-westerly and southerly winds. The area is managed by the Friends of Newland Head Conservation Park and management has been undertaken over the past six years (Taylor R., pers. comm. 2004).

Other populations in the Mt Lofty Ranges include Barossa Reservoir, Morialta CP, Mylor Parklands, a Heritage Agreement property near Ironbank, Curlew Pt (previously Pt Stanvac Refinery), Cox Scrub CP, Stipiturus CP, Tucker's Swamp / Upson Downs, Eric Bonython CP and Deep Creek CP.

**South-East**
Heritage Agreement
A population of Osborn's Eyebright was recorded on private property near Mt Boothby CP in 1986. This property was subsequently placed under a Heritage Agreement.

## 2.2. Past Distribution

The historic distribution of *E. collina* subsp*. osbornii* within South Australia is unknown. The earliest State Herbarium collections of this subspecies were made from Yorke Peninsula in 1876 and in the Mt. Lofty Ranges in 1896. Many collections have been made since this time, with Plant Biodiversity Centre containing over 160 records: 38 from before 1950 and 39 for the years 1951 to 1979. For the purpose of this recovery plan all records pre 1980 have been deemed historic (Figure 2.1).

Historic records from the Mt. Lofty Ranges include sites near Back Valley, Myponga, Square Waterhole, Tooperang, Nangkita, Macclesfield cemetery, Scott's Creek Conservation Park, Uraidla, Hope Valley, Montacute Conservation Park, Taperoo and Uley Scrub (Figure 2.3). It is also reported to have occurred along the Marino cliff line. This area is thought to have contained many thousands of plants and was suspected lost in the 1930s due to a combination of land development, clearance, weed competition and possibly sewage (Taylor R., pers. comm. 2004).

In the South East there are several records from the area between Meningie and Yumali (Figure 2.4). Populations have also been recorded in Innes National Park, near She-oak Flat and Sevenhills (N&Y) (Figure 2.2) (BDBSA, 2009). A population is noted to occur at Venus Bay on Eyre Peninsula; however there are no herbarium records from Eyre Peninsula (Barker, 1982; Jessop and Toelken, 1986).

The subspecies is short lived and possibly has a requirement for open sites and thus is very susceptible to changes in land use. Populations may have declined in areas as a result of change in land use

including, land clearing and grazing activities. Populations may however also have benefited from early settlement patterns and land use, creating open spaces for the subspecies to occupy.

## 2.3. Habitat Critical to the Survival of the Species

Given that this subspecies is nationally endangered it is considered that all currently occupied and potential habitat is critical to its survival. There are specific habitat types that appear to be preferred by this subspecies. *Euphrasia collina* subsp*. osbornii* has been recorded from eight main habitat types; generally open eucalyptus woodland, coastal cliffs and inland swamps. Even though these habitats vary greatly, they have two features in common; they are relatively moist and relatively open. *Euphrasia* require light, relatively high soil moisture levels and patches of open ground for seed germination, seedling establishment and to ensure population persistence (Potts, 1997a). The typical habitat that *Euphrasia collina* subsp*. osbornii* occupies meets these requirements.

Potts (1997b) states that habitat openness is achieved in two ways, namely habitats kept open by exposure to extreme environmental factors such as wind and cold temperatures, and habitats kept open by disturbance such as fire or grazing. Exposed habitats would include low wet vegetation types in exposed coastal areas, cliff faces and windswept rocky plateaux, while suitable habitat kept open by disturbance can be found in heathland, sedgeland, grassland and open woodland (Potts, 1997a). Importantly, populations in habitats kept open by disturbance tend to be transitory and fluctuate in size (Potts, 1997b).

Vegetation associations in which *Euphrasia collina* subsp*. osbornii* has been recorded (Appendix III) include mallee woodlands *Eucalyptus odorata* (Peppermint Box) with *Allocasuarina verticillata* (Drooping Sheoak), *Eucalyptus leucoxylon* subsp*. pruinosa* (SA Blue Gum*)* and *Callitris preissii* (Murray Pine) as co-dominants or emergents in these communities. It is also found in mallee dominated by *Eucalyptus incrassata* (Ridge-fruited Mallee) +/- *E. socialis* (Red Mallee) and *E*. *porosa* (Mallee Box) on Yorke Peninsula and in areas of *E. obliqua* (Messmate Stringybark) +/- *E. fasciculosa* (Pink Gum) in the Mt. Lofty Ranges. Coastal areas include vegetation dominated by *Allocasuarina verticillata.* Inland swamp vegetation in which it is found varies greatly, including rushes with *Drosera binata* and *Baumea* spp*.* at Cox's Scrub and *Empodisma* spp. at Square Waterhole*.*

Habitat critical to survival, as defined above, has not yet been mapped. Recovery actions include surveying the areas inhabited, habitat type and historic sites, and locating and surveying potential habitat.

# Part 3: Threats and Impediments to Recovery

## 3.1. Biology and Ecology Relevant to Threatening Processes

Research into the conservation biology of four threatened *Euphrasia* species undertaken by Ball (1994) and recovery planning and research into 14 lowland Tasmanian *Euphrasia* species by Potts (1997a; 1997b), has provided a solid basis of knowledge into the biology and ecology of other threatened *Euphrasia* taxa. Due to the lack of studies into *Euphrasia collina* subsp *osbornii* and the evidence suggesting that many *Euphrasia* taxa have similar ecology and biology, studies on *Euphrasia collina* subsp*. collina* and *Euphrasia collina* subsp*. diemenica*, have been used in this recovery plan to provide a background of information on the taxa.

Genetic heterogeneity

*Euphrasia* are characterised by a large number of rare taxa which show a high degree of endemism (Potts, 1997a). This is due to the interplay of specific habitat requirements and poor seed dispersal resulting in small isolated populations, together with a rapid generation turnover which hastens introgression after hybridisation as well as the effects of genetic drift and different selection pressures (Potts, 1997a).

Taxonomic studies of *Euphrasia collina* subsp. *osbornii* by Barker (1982) describe a geographical variation in the colour and coloration of the corolla. The Mt. Lofty Ranges populations have predominantly off-white corolla, although pink tinting sometimes occurs (Barker, 1982). In the remainder of the subspecies range, corollas are coloured in lilac or mauve, with only the lower sides of the mouth being white (Barker, 1982). In addition, the presence of a yellow nectar guide behind the lowest corolla lobe is also apparently geographically demarcated (Barker, 1982). In the Mt. Lofty Ranges only plants at Square Waterhole, which have white flowers, are recorded to have the yellow blotch (Barker, 1982). Yellow blotches have also been recorded from the Yumali population in the Upper South-East, although not in all plants, and also the population near Curramulka on Yorke Peninsula, again only on the occasional plant (Barker, 1982). Insufficient information is available to justify the creation of several infra-subspecific taxa within the subspecies *osbornii*, although the yellow blotching is suspected to be the result of introgression with the subspecies *tetragona* (Barker 1982). Morphological variation within the subspecies is suggested to be part of a continuum of variation across the species range from the hills and swamps to mallee habitats (Barker, pers. comm. 2004). This apparent genetic heterogeneity is an important consideration for conservation and examples across the range should be conserved and managed.

Life history

The life history and breeding system of *Euphrasia collina* subsp*. osbornii* has not been determined. The population size of other *Euphrasia* species is generally small and isolated due to specific habitat requirements and poor seed dispersal ability (Potts, 1997a). The range of a population is generally dependent on previous fire history (Potts, 1997b). Beneficial fire regimes are necessary to allow expansion of the range occupied by standing plants and therefore the soil seed bank (Potts, 1997b). *Euphrasia* are annuals or relatively short lived perennials (up to 5 years) and mortality rates can be high (Potts, 1997a; 1997b). *Euphrasia collina* subsp. *osbornii* plants senesce each year and are not easy to see during summer months (Taylor R., pers. comm. 2004). *Euphrasia* are semi-parasitic, and while they will survive in the absence of hosts, their growth rate and reproductive output is reduced (Barker, 1982). *Euphrasia* are not host specific and prefer the presence of low or sparse vegetation (Potts, 1997a). *Euphrasia* flowers are adapted for bee pollination (Barker, 1982).

Seed germination and propagation

*Euphrasia collina* subsp*. osbornii* has been raised with ease from seed (Taylor R., pers. comm. 2004). However there have been no studies into seed germination requirements, seedling survival or soil seed bank longevity for *Euphrasia collina* subsp*. osbornii*. The information that follows is based on 14 studies of Tasmanian *Euphrasia* species.

Studies into Tasmanian *Euphrasia* showed it to be a short lived genus that relies on successful recruitment of seedlings for persistence (Potts, 1997a). Seed is thought to be able to survive in the soil seed bank for decades (Potts, 1997a; 1997b). Seed production is copious; however there is low seed dispersal potential, with the vast majority of seed being shed within 30 cm of the plants (Potts, 1997a).

*Euphrasia* seed has a requirement for light for germination, thus patches of open ground and relatively high soil moisture levels for seedling survival (Potts, 1997a). Most seed is released from late summer to autumn and germinates in winter due after a period of low temperatures (Potts, 1997a). Refer to Potts (1997b) for details of germination experiments.

Disturbance requirements

No research has been conducted to determine the response of *Euphrasia collina* subsp*. osbornii* to disturbance. Observations suggest that it may rely on fire events or other disturbance, such as grazing, to reduce competition or provide light to promote regeneration and recruitment (Pickett, pers. comm. 2004; Taylor R., pers. comm. 2004). At one site (Parken's, east of Cox's Scrub Conservation Park), the subspecies appeared in sheets after heavy grazing disturbance in the area (Pickett, pers. comm. 2004). The subspecies has also been observed in some quite degraded cattle grazing sites near Myponga (Pickett, pers. comm. 2004) and on a property on Yorke Peninsula it was scattered throughout a firebreak (DEH, 2004).

Studies by Potts (1997a) show that other *Euphrasia* taxa require open areas for germination and persistence. *Euphrasia* occupy some habitats that are kept open through disturbance such as on the edge of tracks or in areas where fire or grazing has occurred (Potts, 1997a). Grazing has been identified as a potential factor in the survival of some *Euphrasia scabra* populations that were threatened by scrub invasion (Potts, 1997b). However, disturbance of soil or removal of vegetation to increase openness did not stimulate additional germination from the soil seed bank, only from around standing plants (Potts, 1997a, 1997b).

The role of fire is not fully understood and has not yet been investigated for *Euphrasia collina* subsp*. osbornii.* However, observations of this taxon in the Mount Lofty Ranges suggests that it may rely on fire events to promote regeneration and recruitment (Y. Steed, pers. comm., 2003, as cited by Taylor R., 2003). Observations of other *Euphrasia* subspecies suggest that fire is the main disturbance involved in increasing the size of populations in Tasmania (Potts, 1997a) and that fire may offer germination cues as well as allowing exposure of seed to light (Potts, 1997b). Recent observations of Potts (pers. comm. 2004) suggests that germination after fire only occurs close to parent plants and that smoke treatment does not appear to break dormancy of the seeds.

## 3.2 Identification of Threats

The identified threats are outlined in Table 3.1 and discussed below. Threats are not listed in any order of importance.

The major threats to *Euphrasia collina* subsp*. osbornii* include changes in land use and habitat destruction, inappropriate disturbance regimes, lack of ongoing monitoring for timely mitigation of threats, stock grazing and trampling and environmental weeds.

**Table 3.1 Identified potential threats to the recovery of *Euphrasia collina* subsp*. osbornii***

| | Potential Threats | |
|---|---|---|
| **Indirect Threats** | 1. | Incomplete knowledge of distribution and abundance |
| | 2. | Incomplete knowledge of threats |
| | 3. | Inappropriate disturbance regimes |
| | 4. | Loss of genetic heterogeneity |
| | 5. | Inadequate knowledge of biology and ecology |
| **Direct Threats** | 6. | Changes in land use and habitat destruction |
| | 7. | Road management activities |
| | 8. | Environmental weeds |
| | 9. | Inappropriate grazing pressure and trampling |
| | 10. | *Phytophthora* |
| | 11. | Over-collecting |

### 3.2.1 Incomplete knowledge of distribution and abundance

Reliable and up to date knowledge of the distribution and abundance of *Euphrasia collina* subsp*. osbornii* is essential if effective management is to be achieved. There is currently an incomplete knowledge of both the distribution and abundance of this subspecies. Many records of *Euphrasia collina* subsp*. osbornii* are considered historic (pre-1980), and the populations possibly lost, however surveys have not been undertaken to confirm this. For the more recent records there is a varying degree of information available, however generally only the location is recorded. The current status of the subspecies at these sites is therefore not fully known. Only 14 sites have been visited and reported on since 1998.

### 3.2.2 Incomplete knowledge of threats

A complete knowledge of the threats present at each site is required to determine appropriate management decisions for recovery of this subspecies. It is considered that current knowledge of the majority of sites is not adequate to identify the threatening processes or to make appropriate management decisions. Our understanding of the actual impact of these threatening processes also varies greatly.

### 3.2.3 Inappropriate disturbance regimes

The disturbance requirements of *Euphrasia collina* subsp. *osbornii* have not been determined. However, observation of *Euphrasia collina* subsp. *osbornii* at several sites showed an increase in the number of plants following heavy grazing, soil disturbance associated with construction of a firebreak and the subsequent fire (Pickett, pers comm.). Studies on 14 Tasmanian *Euphrasia* taxa concluded that they were reliant on regular disturbances of the appropriate intensity, timing and interval to persist in an area (Potts, 1997a). Openness can be maintained in an area through exposure from, for example, wind, or through disturbance such as fire or light grazing. Disturbance dependent openness tends to be transient and populations tend to fluctuate in size and are therefore more prone to extinction (Potts, 1997a). Inappropriate disturbance regimes or lack of disturbance therefore poses a threat to the recovery of this species.

### 3.2.4 Loss of genetic heterogeneity

Taxonomic studies of *Euphrasia collina* subsp. *osbornii* by Barker (1982) describe a geographical variation in the coloration of the corolla. This morphological variation indicates a genetic difference within the subspecies and is detailed in Section 3.1. Variation in the subspecies is also possibly based on the diversity of habitat the species occupies. Variation within the subspecies is suggested to be part of a continuum of variation across the species range from the hills, swamps and on to Yorke Peninsula (Barker, pers. comm. 2004). Potential loss of genetic heterogeneity is a threat to the full recovery of the subspecies.

### 3.2.5 Inadequate knowledge of biology and ecology

Deficiencies in the knowledge of ecology and biology of *Euphrasia collina* subsp*. osbornii* include the species disturbance requirements, the effect of fire on regeneration, mating system and pollinators, seed bank dynamics including seed bank location and viability, minimal viable population size and the environmental factors associated with germination and survival. Inadequate knowledge of these aspects limits the ability of land managers to identify and manage threats.

### 3.2.6 Changes in land use and habitat destruction

*Euphrasia collina* subsp. *osbornii* is potentially at risk from changes in land use and the destruction of its habitat. This is especially true due to the short lived nature of the species and the fact it may only be present at a particular time as seeds in the soil seed bank. This could easily result in the subspecies not being observed and land use changes occurring. The subspecies occurrence in some open habitats also makes it more susceptible to the threat of change in land use due to open habitats often being more suitable for other land uses. Sites occurring on private or council-managed land are also at risk of being lost or damaged through change of land use or habitat destruction. Currently *Euphrasia collina* subsp. *osbornii* is formally protected in seven state reserves, five Local Council reserves and four Heritage Agreements. However, none of these sites is managed specifically for *Euphrasia collina* subsp. *osbornii*.

### 3.2.7 Road management activities

Sites that occur on roadside reserves generally contain a small number of individual plants, occur in narrow remnant vegetation and are mostly small and isolated. Roadside populations are also subjected

to specific threats related to road management works, including vegetation clearance, dumping of rubbish and road building materials, burning for fire management, herbicide drift from adjoining properties and stock droving. Several *Euphrasia collina* subsp. *osbornii* sites on road reserves have been noted as being affected by vegetation clearance through road maintenance works. Roadside populations of this subspecies constitute only a very small percentage of known sites; however the inappropriate management of roadside reserves poses a serious threat to its long-term survival at these sites.

### 3.2.8 Environmental weeds

Environmental weeds present a possible threat to *Euphrasia collina* subsp*. osbornii*, but the extent and impact of this threat has not been fully determined. Weeds are currently only identified at a few sites where this subspecies occurs and current knowledge identifies topped lavender (*Lavandula stoechas*), soursob (*Oxalis pes-caprae*) and one-leaved Cape tulip (*Moraea flaccida*) as the main weeds in association with *Euphrasia collina* subsp. *osbornii.* These weeds have the potential to directly impact on the growth, recruitment and survival of the subspecies through direct competition for resources including light, nutrients, space and moisture. There may also be other weed species that pose a risk. Populations that are within small fragmented areas, including those on roadside reserves, are at greatest risk.

It should be noted that the presence of weeds is often the result of other causes of ecosystem degradation, such as land clearance and the spread of feral animals.

### 3.2.9 Inappropriate grazing pressure and trampling

The available information indicates that inappropriate grazing pressure and trampling by domestic stock pose a threat to the recovery of *Euphrasia collina* subsp*. osbornii* although the extent of this threat has not been fully determined. Stock grazing in areas where *Euphrasia collina* subsp*. osbornii* occurs is considered a potential threat to the growth, reproduction, survival and recruitment of this subspecies. Grazing may also have secondary impacts, in the form of weed dispersal and disturbance encouraging weed establishment and growth (Willoughby *et al*, 2001). Trampling by stock has also been identified as causing losses of plants and may also damage seed in the soil, especially during wet times when seed can be trampled deep into the soil (Taylor R., pers. comm. 2004). The impact of grazing has been noted at several populations and is considered particularly significant when the ground is soft.

However, grazing has also been the cause of a flush of new plants in some areas, for example thousands of plants appeared at Parken's, east of Cox's Scrub, after a period of grazing. Achieving the appropriate grazing regime is therefore very important.

### 3.2.10 *Phytophthora*

*Phytophthora* is a genus of water-borne moulds that attack the roots of susceptible plants, cutting off water supply and eventually killing the host plant. *Phytophthora cinnamomi* is the most common species recorded in South Australia and has a large host range. *Euphrasia collina* subsp. *osbornii* occurs in the general area where the water mould has been recorded, specifically in the Mt. Lofty Ranges. *Phytophthora* is reliant on moisture for dispersal and is commonly recorded from naturally wet areas such as along creeks and other waterways. Although there is no evidence to confirm or deny that *Euphrasia collina* subsp*. osbornii* or any related taxa are directly susceptible to *Phytophthora cinnamomi,* the association with wet locations does increase the risk of this subspecies and associated habitat coming into contact with the fungus. Since *Euphrasia collina* subsp*. osbornii* is known to be semi-parasitic, it is also possible that host plants could become infected with *Phytophthora cinnamomi.*

### 3.2.11 Over-collecting

The population at Neagle Rock Reserve near Clare has been mentioned as a site potentially threatened from over-collecting (Smith, 2000); however the extent of this threat is unknown. Osborn's Eyebright is an attractive plant when flowering, and the sub-population at Neagle Rock is easily accessed by the general public, so it is not unlikely that people pick the flowers.

## 3.3 Populations and Areas under Threat

*Euphrasia collina* subsp*. osbornii* plants are threatened at most sites; however threats at specific sites are currently not well known. Where specific threats are known these have been outlined below and in the previous section 3.2, 'Identification of Threats'.

The population at Neagle Rock Reserve, Clare, is threatened by the invasive topped lavender (*Lavandula stoechas*) and there is also a potential threat from plant collectors over-collecting specimens (Smith, 2000). Similarly, the population 8 km from Neagle Rock is also threatened by topped lavender. This site occurs on a very narrow and potentially dangerous road and it is envisaged that some future earthworks may be required that could threaten the *Euphrasia* population (Smith, 2000). Another roadside population at Emu Flat Reserve is also potentially threatened by road building activities. At this site there is also a significant level of weed invasion including topped lavender, soursob and one-leaved Cape tulip.

*Euphrasia collina* subsp*. osbornii* is reported to have become extinct or been reduced in number from some swamp areas in the Mt. Lofty Ranges where it had previously been recorded. This is suggested to be the result of changed land management practices including removing grazing and reducing or ceasing burning activities. One swamp in which this species had occurred is reported to have had a reduction of approximately 15% of plant species (Taylor R., pers. comm. 2004). A change of land use, including fencing to remove stock and preventing burning, is suggested to have resulted in plants being very hard to find at this and similar sites.

# Part 4: Objectives, Recovery Actions and Performance Criteria

## 4.1 Objectives

**Long-term Objective:**
The overall objective of this Recovery Plan is to reduce the extinction risk of this subspecies so that it is downlisted from an IUCN category of endangered to one of vulnerable.

**Short-term Objectives:**
1. Maintain or increase the number of populations, area of occupancy and abundance of the subspecies.

2. Minimise threats caused by grazing, weed invasion, change of land use, road management activities and *Phytophthora*.

3. Identify and conserve genetically heterogeneous populations.

4. Manage populations to promote persistence by introducing regular small-scale disturbances, following investigations into appropriate disturbance methods.

5. Establish a program to monitor priority populations to enable early management intervention.

## 4.2 Actions Required

Currently there is incomplete knowledge regarding the distribution, abundance and threats to *Euphrasia collina* subsp. *osbornii.* Actions that follow are therefore based on the limited knowledge available and will need to be adjusted as new information is gathered. The first action is to obtain a better understanding of the status and to determine what threats are present at each site. Other actions include undertaking studies to determine if genetic heterogeneity exists, and to prioritise sites to ensure variation across the species range is conserved and managed.

A regional recovery plan has been developed for *Euphrasia collina* subsp. *osbornii* on Kangaroo Island, with implementation commencing in 2004 (Taylor, 2003). Recommendations within the regional plan are incorporated into the current national recovery plan.

The timelines for implementation of recovery actions have been summarised as follows and detailed timelines are contained in Section 6.1.

| | |
|---|---|
| P1 | Action required to commence immediately, in Year 1. |
| P2-P3 | Action required to commence in short term, Years 2 - 3. |
| P4-P5 | Action required to commence in longer term, Years 4 - 5. |

***1. Survey existing populations.***
1.1 Survey existing populations recording details of location, number of plants, life history structure, % survival, area inhabited and habitat type. (P1)
1.2 Survey key historic sites to verify if the species is present / able to occupy the site. (P1)
1.3 Assess major threats to each population. (P1)

Justification and Methods
Quantitative data needs to be obtained covering the exact location, number of plants, area of occupancy, morphological variation and description of plant habitat, including plant association and topography, to allow for effective recovery. Habitat descriptions should aim to identify variable ecological habitats. Surveys to determine the presence and extent of threats at each site will also need to be undertaken, recording the type of threat present and to measure the extent of threats. Surveys should be undertaken during spring and autumn, if possible, to identify seasonal threats, such as weeds. The surveys should include consideration of any potentially new threatening processes to each

site. Baseline data will need to be gathered from all sites that have not been visited since 1998, to ensure information is current. Surveys will also need to be conducted of key historic sites to determine if the subspecies does or could potentially occur at the site. The presence of extant plants will be recorded and any changes of land use that would prevent the species from occupying the site will be identified. Sites will need to be accurately mapped and information reported back to the centralised state threatened species database.

Responsibility: DEH, Euphrasia Recovery Team (ERT), Threatened Flora Officer (TFO).

***2. Identify priority sites to conserve by evaluating information gained in Action 1.***

2.1 Assess the information obtained in Action 1 to determine the priority sites to conserve and manage. (P1)

Justification and Methods:
Priority sites for the protection and management of *Euphrasia collina* subsp. *osbornii* will be identified using the results of surveys of current and historic sites. Priority sites will be identified to ensure that the best examples, covering habitat type and providing conservation of genetic heterogeneity across the species range are protected and managed. Priority sites may include historic sites where no adult plants are present, but where a soil seed bank has been identified, as part of Action 4.

Responsibility: ERT, TFO.

***3. Ensure protection of priority sites.***

3.1 Negotiate Heritage Agreements or binding conservation covenants if appropriate. (P2)
3.2 Speak to appropriate stakeholders including landowners, local councils, Transport Dept (DTEI). (P2)
3.3 Undertake the initial reduction of risks at priority sites. (P2)
3.4 Work with Local Government to ensure that development approvals do not adversely affect the subspecies. (P2)
3.5 Monitor and evaluate to ensure risk reduction is having the desired effect. (P2)

Justification and Methods:
Long-term formal protection and management of priority sites will be pursued with private landowners to protect areas from the threat of negative changes in land use. Priority sites to be targeted for protection will be identified in Action 2. Options for formal protection will be pursued include Heritage Agreements or conservation covenants that are binding on present and subsequent landowners. Current land managers will also be approached to ensure that management and land uses do not change to impact on the subspecies. Advice and assistance will be provided to landowners for management of priority sites and landowners or managers will be encouraged to actively manage populations. The initial reduction of threats to the subspecies at priority sites (identified through Action 2) will be undertaken. For example if grazing is determined to be the primary threat then the site may be fenced, if weeds are the major threat then weed management will be undertaken, if lack of disturbance is identified as the major threat then the results of Action 7 will be implemented. Local Government will be provided with information to prevent new developments adversely affect the subspecies. Mitigation actions will be monitored and evaluated during the recovery plan implementation to ensure that the risk reduction is occurring.

Responsibility: DEH, ERT, TFO, Local Government, land owners/managers.

***4. Collect and store seeds for the Millennium seed bank project.***

4.1 Collect samples of seed from a sample of populations. (P1)
4.2 Collect soil samples from a sample of suitable historic sites where adult plants are not present to determine if a soil seed bank is present (P1).
4.3 Run seed viability tests on a sub-sample of these seeds and soil samples in order to identify whether seeds are present and estimate what percentage of the seeds are viable. (P1)
4.4 Place the remaining seeds in storage. (P1)

Justification and Methods:
It is necessary to store germplasm as a genetic resource ready for use in translocation and as an *ex situ* genetic 'blueprint' of the subspecies. A sample of seed should be collected from a sample of populations across the subspecies range to provide an adequate representation of the genetic diversity. Seed should be collected as a priority from small populations to ensure a future supply in case of population extinction. Soil samples will be collected from key historic sites and treated to determine if a soil seed bank containing *Euphrasia collina* subsp*. osbornii* is present. Key historic sites should include Square Waterhole and Yumali where genetically heterogeneous populations are suspected to occur.

Responsibility: ERT, TFO, State Seed Bank.

***5. Evaluate genetic heterogeneity within the subspecies.***

5.1 Using previous studies and survey data, determine if morphological variation and occurrence within variable habitats warrants an investigation into genetic heterogeneity. (P2)

5.2 If the presence of genetic variation is supported, collect plant samples across the range of habitat and morphological variability. (P2)

5.3 Undertake multivariate morphological analysis and genetic testing for genetic heterogeneity. (P3)

5.4 If genetic heterogeneity is identified, reassess the relative priorities of sites (Action 2), to ensure that this variation is conserved. (P5)

Justification and Methods:
Taxonomic and ecological studies of *Euphrasia collina* subsp. *osbornii* describe a geographical variation in this subspecies in its morphology and the diversity of habitat occupied. This variation suggests genetic heterogeneity within the subspecies. The maintenance of genetic heterogeneity is an important consideration for conservation, as any variation should be conserved and managed.

Working with experts in the field, the genetic heterogeneity of the species will be determined. Sites to be sampled will be based on the surveys and previous studies. Note that key sites where morphological variation has previously been recorded (Square Waterhole and Yumali) may have already been lost. Morphological differences in the field will be recorded and samples taken for testing. Samples will also be collected from across the species range covering all habitat types. Multivariate morphometric analysis and genetic testing will be undertaken using techniques to identify genetic variation. If genetic heterogeneity is identified, results will be used to identify priority sub-populations to ensure that a representative sample of this variation is protected and managed.

Responsibility: DEH, ERT, TFO, AD.

***6. Evaluate population persistence at each site, and investigate the use of small-scale disturbance to promote persistence.***

6.1 Evaluate survey data to determine whether there is a lack of recruitment and small numbers of plants at each population. (P3)

6.2 In a sample of small populations with low recruitment, conduct field surveys to identify which step or steps are limiting recruitment and population persistence (e.g. pollination, germination, soil seedbank, availability of open areas). (P4)

6.3 Conduct field/glasshouse experiments to determine why this step is limiting, how to overcome it and the minimum viable population size. (P5)

6.4 If small population size and low recruitment are found to be limiting, investigate the use of small-scale disturbances to promote persistence (e.g. burning, grazing and slashing). (P5)

Justification and Methods:
It is suspected that the subspecies is present as small populations and experiences low recruitment at many sites. It is also suspected that regular disturbance is required to promote the long-term persistence of the subspecies in some habitats. There is however no formal evidence to support this for *Euphrasia collina* subsp*. osbornii.* Other *Euphrasia* species have been found to be dependent on disturbance to create patches of open ground to persist and generally without such disturbance they are transient and at greater risk of extinction (Potts, 1997a). Detailed research is required to determine (a) whether recruitment is limiting, (b) the minimal viable population size for persistence, and (c) whether disturbance promotes persistence.

If necessary, research methods will be developed from field and laboratory experiments to determine why recruitment is limiting. Disturbance experiments will attempt to stimulate germination using small-scale disturbances such as burning, various stock grazing densities, vegetation slashing and soil disturbances. This will require communication with the *Euphrasia* Recovery Team (ERT) and the Tasmanian Department of Primary Industries, Water and Environment. This will ensure that research can be targeted, duplication does not occur, and that information sharing can occur with experts in *Euphrasia* ecology and biology.

Responsibility: ERT, TFO, volunteers, land owners/managers.

***7. Manage populations to promote persistence.***

7.1 Evaluate the information gained from Action 6 to hypothesize the best method of promoting persistence within each site. (P3)

7.2 Manage each population to ensure population persistence based on the hypotheses derived for each population in 7.1. (P4)

7.3 Monitor and evaluate whether these actions are having the desired effect, changing the hypotheses and management techniques if necessary. (P5)

Justification and Methods:
The results of this action will be used to adaptively manage the species by determining appropriate management methods that promote persistence.

Responsibility: ERT, TFO.

***8. Monitor populations to enable early management intervention.***

8.1 Develop a monitoring program for priority populations to enable early management intervention. (P1)

8.2 Implement the monitoring program at priority sites. (P2)

8.3 Adaptively manage populations based on monitoring outcomes. (P3)

Justification and Methods
A comprehensive monitoring system should be developed to monitor distribution, abundance and threats at priority sites. Monitoring is a key for the protection and management of this subspecies as populations could easily be lost due to its short-lived and transitory nature. Monitoring should be used to trigger adaptive management of key sites to ensure their long-term survival. Monitoring the effectiveness of threat abatement actions should be undertaken. Monitoring programs should be developed to minimise the effort required to meet all monitoring needs. Many factors should be monitored at the same time from established monitoring sites. These sites could also be the location for experimental research where additional monitoring will occur. Links should be developed with the Tasmanian Threatened *Euphrasia* Recovery Team to discuss the monitoring kit that has been developed by the group for use by volunteers in Tasmania. Threatened Flora Officers and volunteers would undertake the monitoring.

Responsibility: ERT, TFO, volunteers, land owners/managers.

***9 Manage the risk of Phytophthora.***

9.1 Ensure hygienic practices are employed when undertaking survey and threat mitigation works at all sites. (P1)

Justification and Methods:
To manage the risk of *Phytophthora* hygienic practices will be employed when working in areas containing *Euphrasia collina* subsp. *osbornii*. Information should be provided to volunteers and land managers undertaking recovery or other works in and near the populations. Hygienic practices will include cleaning all footwear, tools and other equipment before entering a site and cleaning the same before leaving the site. An approved disinfectant chemical will be used for all cleaning. Any collected plant material will be free of soil. Soil samples taken from sites to undertake soil seed bank analysis will be disposed of appropriately. The Recovery Team will adhere to the Department for Environment and

Heritage *Phytophthora* Standard Operating Procedures (Velzeboer, 2002). The disposal of any waste chemicals will be done in accordance with state and federal government guidelines.

Responsibility: ERT, TFO, DEH, volunteers, land owners/managers.

***10. Survey for potential habitat and undiscovered populations.***

10.1 Identify, map and survey possible habitat for undiscovered populations. (P3)

Justification and Methods:
Possible habitat of *Euphrasia collina* subsp*. osbornii*. will be identified through interrogating GIS mapping looking at preferred vegetation associations, soil type, topography and rainfall. Possible habitat maps will be developed based on this work and used to undertake dedicated surveys to search for new populations.

Responsibility: ERT, TFO, DEH.

***11. Recovery process and communication.***

11.1 Establish and maintain *Euphrasia collina* subsp*. osbornii* Recovery Team. (P1)

11.2 Employ Threatened Flora Officer to coordinate recovery process and conduct recovery actions as indicated above (P1)

Justification and Methods:
The Recovery Team shall consist of representatives from Nature Conservation Branch and regional Conservation Programs Units (DEH), NRM Boards. Local Government and interested community groups.
The Threatened Flora Officer will conduct communication activities and be involved in and coordinate the implementation of recovery actions, with advice from the Recovery Team.

Responsibility: DEH, TFO.

## 4.3 Evaluation of Success or Failure

The Department for Environment and Heritage, South Australia in conjunction with the Recovery Team will evaluate the performance of this recovery plan. The plan is to be reviewed within five years of its implementation. Any changes to management and recovery actions will be documented accordingly.

## 4.4 Performance Criteria

| Action | Associated Performance criteria |
|---|---|
| 1. Survey existing populations. | All extant sites and key historic sites surveyed, baseline information collated and threats and potential threats will be determined within two years. |
| 2. Determine the priority sites to conserve and manage. | Priority sites for formal protection will be identified within two years. |
| 3. Ensure protection of priority sites. | All priority sites will be protected either formally or through threat mitigation within five years |
| 4. Collect and store seeds with the Seed Conservation Centre. | Seed from priority sites will be collected, tested for viability and stored in the Seed Conservation Centre within two years. Soil samples will also be collected and tested to determine the nature of the soil seed bank within the same timeframe. |
| 5. Evaluate genetic heterogeneity within the subspecies. | Multivariate morphological analysis and genetic testing for genetic heterogeneity will be completed within three years, and priority sites will be reassessed as required. |
| 6. Evaluate population persistence at each site and investigate the use of small-scale disturbance to promote persistence. | The cause of recruitment limitation at relevant sites will be understood and the use of disturbance will be investigated if appropriate within five years. |
| 7. Manage populations to promote persistence. | Monitoring, evaluation and adaptive management will be implemented to ensure sufficient recruitment at each priority population within five years. |
| 8. Monitor populations to enable early management intervention. | A monitoring program will be developed and implemented for priority sites within two years, and will reliably inform adaptive management within three years. |
| 9. Manage the risk of Phytophthora. | The implementation of hygiene practices within one year will ensure that Phytophthora cinnamomi has not established at any sites within five years. |
| 10. Survey for potential habitat and undiscovered populations. | Suitable habitats will be surveyed within five years. |
| 11. Establish a Recovery Team and appoint a Threatened Flora Officer. | A Recovery Team will be established and a Threatened Flora Officer (TFO) will be appointed within one year. The TFO will conduct communication activities and ensure the implementation of recovery actions, with advice from the Recovery Team, for five years. |

# Part 5: Management Practices

Management practices undertaken in the vicinity of *Euphrasia collina* subsp*. osbornii* should be planned and implemented with careful consideration to ensure that this species and its habitat is not impacted upon.

Management practices required to avoid significant impacts on *Euphrasia. collina.* subsp*. osbornii* include:

- management of all formally protected areas where *Euphrasia. collina.* subsp*. osbornii* is known to occur (Table 2.1);
- compliance with the DEH *Phytophthora* Standard Operating procedures;
- implementation of the regional recovery plan for *Euphrasia. collina.* subsp*. osbornii* on Kangaroo Island;
- maintenance of State threatened species database;
- continuation of voluntary conservation programs; and
- maintenance of Plant Biodiversity Centre seed storage facilities.

To reduce the likelihood of development activities negatively impacting upon *Euphrasia collina* subsp*. osbornii* the recovery plan outlines under Action 3.4 to provide relevant information to Local and State Governments, including information on distribution, ecology and habitat. Approval authorities have a key role in the approval of new developments and in preventing developments that may have the potential to impact on this subspecies. Increased awareness of all relevant parties should allow for better decisions to be made to prevent negative impacts.

Actions within currently occupied or potential habitat for *Euphrasia collina* subsp*. osbornii,* which result in any of the following, could have a significant impact on the subspecies*:*

- increased grazing pressure;
- changes in land use (including removal of grazing or preventing burning);
- habitat destruction/clearing;
- changes in the fire regime;
- decreases in habitat quality;
- increase in weeds; and
- spread of phytophthora.

# Part 6: Duration of Recovery Plan and Estimated Costs

## 6.1 Duration and Indicative Costs

| Action | Description | Cost estimates per year | | | | | |
|---|---|---|---|---|---|---|---|
| | | **First** | **Second** | **Third** | **Fourth** | **Fifth** | **Total** |
| **1** | Survey existing population | 3500 | 3500 | | | | **7000** |
| **2.** | Identify priority sites | 4000 | | | | | **4000** |
| **3.** | Ensure protection of priority sites | | 5000 | 5000 | 8000 | 11000 | **29000** |
| **4.** | Collect seeds | 2500 | 2600 | | | | **5100** |
| **5.** | Evaluate genetic heterogeneity within the subspecies | | 2000 | 3500 | 3500 | 1000 | **10000** |
| **6.** | Evaluate population persistence at each site, and investigate the use of small-scale disturbance to promote persistence | | | 2000 | 4000 | 6000 | **12000** |
| **7.** | Manage populations to promote persistence | | | 4000 | 3000 | 3000 | **10000** |
| **8.** | Monitor populations to enable early management intervention | 3000 | 3000 | 3000 | 3000 | 3000 | **15000** |
| **9.** | Manage the risk of Phytophthora | 500 | | | | | **500** |
| **10.** | Survey for potential habitat and new populations | 2000 | 2000 | 1000 | 1000 | | **6000** |
| **11.** | Recovery Process and Communication | 20000 | 20000 | 20000 | 21000 | 21000 | **102000** |
| | **Total** | **35500** | **38100** | **38500** | **43500** | **45000** | **200600** |

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# Appendices

## Appendix I List of current and potential regional, State and Nationally based stakeholders in the management of *Euphrasia collina* subsp*. osbornii*

| Organisation | Group / Individual contact | Manage / own | Contacted |
|---|---|---|---|
| **Regional Stakeholders** | | | |
| General South Australian community | General community / Private landholders | X | |
| DEH Regional Conservation | Innes District | X | X |
| | Lofty Barossa District | X | X |
| | Kangaroo Island Region | X | X |
| Friends Groups | Friends of Upper South East | | X |
| | Friends of Innes NP | | X |
| | Friends of Dudley Parks | | X |
| | Friends of Black Hill & Morialta Inc | | X |
| | Friends of Heysen Trail | X | X |
| | Penneshaw School & Comm LC | | X |
| | KI Flora and Fauna Club | | X |
| Local Action Planning Associations / Landcare groups / private companies | Eastern Hills & Murray Plains LAP | | X |
| | Goolwa to Wellington LAP | | X |
| | Coorong LAP | | X |
| Natural Resources Boards | SAMDB NRM | | X |
| | SE NRM | | X |
| | N&Y NRM | | X |
| | AMLR NRM | | X |
| | KI NRM | | X |
| Catchment Board | River Murray Catchment Board | | X |
| | Adelaide Plains Catchment Board | | X |
| PIRSA and Greening Australia | PIRSA revegetation SE | | X |
| | PIRSA revegetation AMLR | | X |
| | Greening Australia N&Y | | X |
| Councils | DC Yorke Peninsula | X | X |
| | Clare & Gilbert Valleys Council | X | X |
| | KI Council | | X |
| | City of Victor Harbor | X | X |
| | D C Mt Barker | X | X |
| | Alexandrina Council | X | X |
| | Yankalilla District Council | X | X |
| DEH Regional Conservation Programs (Bush Management Advisers, Regional Ecologists) | South East | | X |
| | Northern and Yorke Region | | X |
| | Eyre Peninsula | | X |
| | Mt. Lofty Ranges | | X |
| | Kangaroo Island | | X |
| Threatened Flora Officers | South East | | X |
| | Kangaroo Island | | X |
| Botanists / enthusiasts | Jerry Smith | | X |
| | Anna Murphy (*Euphrasia collina* subsp *muelleri* recovery plan) | | X |
| | Ron Taylor – Friends of Heysen Trail | | X |
| | Marcus Pickett – Southern Emu-wren Recovery Team | | X |
| | Bill Barker – Taxonomist, Plant Biodiversity Centre | | X |
| | Wendy Potts, Tasmanian Threatened *Euphrasia* Recovery Team | | X |
| Grassy Ecosystem | Mid North Grasslands Working Group | | X |
| | AMLR Grassy Ecosystem project | | X |

| Organisation | Group / Individual contact | Manage / own | Contacted |
|---|---|---|---|
| **State Stakeholders** | | | |
| General Public | | | |
| Indigenous community | | | |
| Department for Environment and Heritage, South Australia | Nick Neagle, Peter Lang, Rob Brandle, Peter Copley | | X |
| Primary Industries and Resources South Australia | | | |
| Department for Land, Water and Biodiversity Conservation, South Australia | | | X |
| Department of Primary Industries, Water and Environment, Tasmania. | Wendy Potts | | X |
| Department for Transport, Energy and Infrastructure | Tim Reynolds | X | X |
| SA Water | | X | X |
| Country Fire Service | | | |
| Native Vegetation Council | Craig Whisson | | X |
| Conservation Council of South Australia | | | |
| Threatened Plant Action Group | Tim Jury | | X |
| Greening Australia | | | X |
| Botanic Gardens of South Australia (DEH) | Manfred Jusaitis | | X |
| Plant Biodiversity Centre (DEH) | Bill Barker, Rosemary Taplin | | X |
| Coastal Protection Board (DEH) | | X | |
| Trees for Life | Andrew Allanson | | X |
| **National Stakeholders** | | | |
| General public | | | |
| Department of the Environment, Water, Heritage and the Arts (DEWHA) | | | |
| Threatened *Euphrasia* Recovery Team | | | |
| Worldwide Fund For Nature | | | |
| CSIRO | | | |
| Australian Network for Plant Conservation | | | |

## Appendix II Details of the known current distribution of *Euphrasia collina* subsp*. osbornii* populations and sites.

| Population Number | Region | Population name | No. of plants | Date last recorded | Source | Tenure |
|---|---|---|---|---|---|---|
| 1 | Kangaroo Island | Lesueur CP | ? | 2002 | BDBSA | Conservation Park |
| 2 | Kangaroo Island | Moncrieffe Bay | ? | 2002 | BDBSA | Coastal reserve |
| 2 | Kangaroo Island | Pink Bay | ? | 2002 | BDBSA | Coastal reserve |
| 3 | Kangaroo Island | Heritage Agreement, Cape Willoughby | ? | 1996 | BDBSA | Private HA |
| 4 | Kangaroo Island | Cape Albans | ? | 1994 | BDBSA | Coastal reserve |
| 5 | Kangaroo Island | Mouth Flat | ? | 1984 | BDBSA | Coastal reserve |
| 6 | South East | Lutze HA | ? | 1986 | BDBSA | Private HA |
| 7 | Northern & Yorke | Neagle Rock | 2000 | 2004 | BDBSA | Council Reserve |
| 7 | Northern & Yorke | Policeman's Paddock | 1000 | 1984 | BDBSA | Private property |
| 7 | Northern & Yorke | Clare cemetery | ? | 1980 | BDBSA | Council Reserve |
| 8 | Northern & Yorke | Stansbury Scrub | 50 | 1995 | TPAG, BDBSA | Private property |
| 9 | Northern & Yorke | Emu Flat Reserve | 20 | 2001 | BDBSA, Smith (2000) | Conservation Reserve |
| 10 | Northern & Yorke | Fitzgerald Rd | ? | 2007 | BDBSA | Road Reserve |
| 11 | Northern & Yorke | Ramsay CP | ? | 2006 | BDBSA | Conservation Park |
| 12 | Northern & Yorke | Curramulka Rd HA | ? | 1994 | BDBSA | Private HA |
| 13 | Northern & Yorke | Scrub east of Minlaton | ? | 1986 | BDBSA | ? |
| 14 | Mt. Lofty Ranges | Moppa HA | 200 | 2005 | BDBSA | Private HA |
| 15 | Mt. Lofty Ranges | Mylor Parklands | >100 | 2000 | BDBSA | Reserve, Local Council |
| 16 | Mt. Lofty Ranges | Heysen Trail | >2000 | 1997 | BDBSA | Coastal Reserve |
| 16 | Mt. Lofty Ranges | Waitpinga sec 191 | ? | 2000 | BDBSA | Private property |
| 16 | Mt. Lofty Ranges | Investment HA | ? | 1996 | BDBSA | Private HA |
| 17 | Mt. Lofty Ranges | Stipiturus CP | 50-100 | 1994 | BDBSA | Conservation Park |
| 18 | Mt. Lofty Ranges | Parken's Swamp | 50 | 1991 | BDBSA | Private property |
| 19 | Mt. Lofty Ranges | Steele HA | 25 | 1995 | BDBSA | Private HA |
| 20 | Mt. Lofty Ranges | Curlew Pt / Pt Stanvac Refinery property | 3 | 2000 | BDBSA | Private property |
| 21 | Mt. Lofty Ranges | Morialta CP | ? | 2003 | BDBSA | Conservation Park |
| 22 | Mt. Lofty Ranges | Barossa Reservoir | ? | 1999 | BDBSA | Water Reserve |
| 23 | Mt. Lofty Ranges | Tucker's Swamp / Upson Downs | ? | 1992 | BDBSA | Private property |
| 24 | Mt. Lofty Ranges | Eric Bonython CP | ? | 1990 | BDBSA | Conservation Park |
| 25 | Mt. Lofty Ranges | Cox Scrub CP | ? | 1987 | BDBSA | Conservation Park |
| 26 | Mt. Lofty Ranges | Deep Creek CP | ? | 1983 | BDBSA | Conservation Park |

## Appendix III Plant associations in which *Euphrasia collina* subsp*. osbornii* has been recorded in South Australia

| Region | Site name | | Dominant overstorey species | Understorey species |
|---|---|---|---|---|
| Northern and Yorke Region | Neagle Rock | Low woodland | *Eucalyptus odorata* +/- *E. leucoxylon* subsp*. pruinosa* | *Allocasuarina verticillata* +/- *Acacia pycnantha* +/- *Bursaria spinosa* +/- *Acacia paradoxa* over sparse shrubby understorey of *Pultenaea largiflorens*, *Hibbertia exutiacies* and *Hybanthus floribundus*. |
| | 8km from Neagle Rock | Low woodland | *Eucalyptus odorata* and *Allocasuarina verticillata* | |
| | Emu Flat Reserve | Low Woodland | *Eucalyptus leucoxylon* subsp*. pruinosa, Callitris gracilis, Allocasuarina verticillata* | *Acacia paradoxa, A. pycnantha, Bursaria spinosa* and ground flora *Cheilanthes austrotenuifolia*, *Lagenophora huegelii*, *Hibbertia exutiacies* |
| | Nuriootpa | Low woodland | *Eucalyptus odorata* | |
| Kangaroo Island | | Coastal shrubland | *Allocasuarina verticillata.* | |
| Yorke Peninsula | | Open sclerophyllous Woodlands | *Eucalyptus odorata* | |
| | | | *Eucalyptus incrassata* +/- *E. socialis* | Over *Melaleuca uncinata*, *Acrotriche cordata*, *Correa backhouseana var. coriacea* and *Dodonaea hexandra* |
| | Richard Way | Low woodland | *Eucalyptus porosa* *E. porosa* +/- *Allocasuarina verticillata* | over *Lepidosperma spp.* understorey. Heavy soils (Steed pers comm.) |
| Mt Lofty Ranges | Montacute | Woodland | *Eucalyptus obliqua* - *E. fasciculosa*. | |
| | Curlew / Heysen | Low shrubland | In remnant coastal. Cliff top | |
| | In swamps Tooperang | | In water and rushes with *Drosera binata*. | |

DEH (2004), Jessop and Toelken (1986), Smith (2000), Taylor (2003)