RECOVERY PLAN FOR THE MOUNT LOFTY RANGES SOUTHERN EMU-WREN *Stipiturus malachurus intermedius* 2006–2011

by the

MLR Southern Emu-wren and Fleurieu Peninsula Swamps Recovery Team

2007

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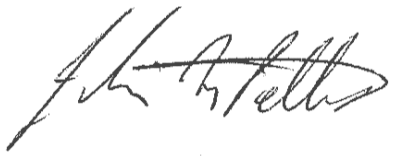

Julie Pettett
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3/9/2007

Foreword

The Recovery Plan for the Mount Lofty Ranges Southern Emu-wren (MLRSEW) *Stipiturus malachurus intermedius* 2006-2011 is the next exciting stage in the recovery of this unique and threatened bird and its habitats. Ensuring it will have a future on the Fleurieu Peninsula.

The MLRSEW was recognised as an endangered species under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* in the second phase of the recovery program.

The range of the MLRSEW is restricted to Fleurieu Peninsula Swamps and dry heath habitat. These areas are fragmented and under threat from many activities such as weed invasion, further fragmentation, land subdivision, changes in water regimes, changes in vegetation structure, grazing, mining, fire and the affects of long term climate change are unknown.

The Recovery Plan 2006-2011 is clearly based upon programs started in 1993 and has long term objectives, through community engagement, to down list the MLRSEW to vulnerable within 25 years. Statutory authorities, industries, and landholders are enabled through this plan to take responsibility for the management of threats to MLRSEW and their habitat and ongoing monitoring to ensure the long-term survival of the bird.

Over the past 13 years, many landholders have embraced the plight of the MLRSEW by fencing swamps to protect habitat. The MLRSEW has become an iconic species for action to change land management practices across the Fleurieu Peninsula. The next stage of its recovery will aim to increase the connectivity between existing MLRSEW populations. Community, local and state government involvement in protecting the habitats, increasing the knowledge of the MLRSEW's ecology and its habitats, monitoring and analysing the management and recovery program are all vital to the success of this plan.

It is essential that the community momentum created to date is not lost. Therefore it is important that this plan is adopted, owned and implemented to achieve lasting and mutually beneficial partnerships to ensure the survival of the MLRSEW and its habitat for future generations.

By Mary Crawford
Adelaide and Mt Lofty Ranges Land Management Program, Fleurieu Peninsula landholder, and Recovery Team member

Acknowledgments

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It also recognises the efforts of the University of Adelaide, SA Museum, the AMLR NRM Board and SA MDB NRM Board and their NRM regional facilitators, and the natural resource agencies of DEH SA, Forestry SA, DWLBC, SA Water, and the Strathalbyn Natural Resource and Normanville Environment Centres.

The large numbers of landholders in the region who have continued to contribute to the recovery of the MLRSEW are also acknowledged.

Graham Carpenter provided unpublished data on emu-wren records.

Funding for the Recovery Program is provided by the Australian Government's Department for Enviornment and Heritage, the Adelaide and Mount Lofty Ranges and South Australian Murray-Darling Basin Natural Resources Management Boards, and the South Australian Government's Department for Environment and Heritage. Significant contributions have also been made to date by the Threatened Species Network Community Grants and the Strathalbyn Natural Resource and Normanville Environment Centres.

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Acronyms used in this Recovery Plan

AMLR	Adelaide and Mt Lofty Ranges
CAMBA	China-Australia Migratory Bird Agreement
CCSA	Conservation Council of South Australia
CFS	Country Fire Service
CP	Conservation Park
DEH	Department for Environment and Heritage
DWLBC	Department of Water, Land and Biodiversity Conservation
EPA	Environment Protection Authority
EPBC Act	Australian Government *Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically sustainable development
FPS	Fleurieu Peninsula Swamps
INRM	Interim Natural Resource Management
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
LAP	Local Action Planning
MLR	Mount Lofty Ranges
MLRSEW	Mount Lofty Ranges Southern Emu-wren
NPW Act	South Australian *National Parks and Wildlife Act 1972*
NRM	Natural Resource Management
NV Act	South Australian *Native Vegetation Act 1991*
RT	Recovery Team
SA	South Australia
SAMDB	South Australia Murray-Darling Basin
SEW	Southern Emu-wren
TEC	Threatened Ecological Community

1.0 Summary of Recovery Plan

This document constitutes a Recovery Plan for the Mount Lofty Ranges Southern Emu-wren (MLRSEW) *Stipiturus malachurus intermedius* found on the Fleurieu Peninsula, South Australia. It was produced in accordance with the Commonwealth's *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* and Recovery Plan Guidelines for Nationally Listed Threatened Species and Ecological Communities (Environment Australia 2002). It will have an effective life-span of 5 years beginning in July 2006.

Status: The MLRSEW is listed as Endangered under the Australian Government EPBC Act and the SA NPW Act. It currently meets IUCN (2001) criteria for Endangered due to its: restricted geographic range; severely fragmented population; and continuing decline observed and projected in area of occupancy, area, extent and quality of habitat, and number of locations or subpopulations.

Habitat: The MLRSEW occurs in two general habitat types: swamp and dry-heath. Most populations occur in dense swamp (which includes wet-heath, sedgeland, reedland and occasionally lignum), although one of the two largest populations inhabits dry-heath. These habitats are dense at the 0–1m level. Swamp habitat occurs almost entirely on private property, is fragmented, rare and subject to incremental alteration or clearance. MLRSEW populations are apparently isolated due to the bird's poor ability to fly across open spaces, and thus may be susceptible to local extinction.

Threats: Existing and potential major threats to MLRSEW populations and habitats are bushfire, drought, climate change, livestock grazing, mining, water extraction, swamp (surface-water) drainage, plantation forestry, demographic stochasticity, vegetation succession, fragmented habitat and isolated habitat, and lack of habitat. Other threats are flood, storm damage, vegetation clearance, deliberate burning, residential development, changes in land-use affecting alienated but potential habitat, weed invasion, dieback due to *Phytophthora*, genetic stochasticity, introduced predators, native predators and parasites.

Long-term Objectives: The proposed long-term objectives (25 year vision) for this Recovery Plan are to achieve through community engagement:

1. the downlisting of the MLRSEW to Vulnerable within 25 years;
2. statutory authorities, industry and landholders enabled to take responsibility for the management of threats to MLRSEW populations and habitats and ensuring that all new threats are identified and managed appropriately; and
3. established ongoing monitoring that has the capacity to catalyse intense recovery activities if significant declines are detected once the status of Vulnerable is achieved.

Recovery Objectives:

1. Maintain and increase the conservation status of the MLRSEW and its habitat by:
   - 1.1 maintaining and increasing the area of MLRSEW occupancy, number of locations of subpopulations, number of individuals and the area, extent and quality of MLRSEW habitat;
   - 1.2 increasing the degree of connectivity between existing MLRSEW populations; and
   - 1.3 completing and maintaining a strategy for MLRSEW recovery.
2. Maintain and increase the capacity to recover the MLRSEW and its habitat by:
   - 2.1 improving the knowledge and understanding of MLRSEW ecology and habitat;
   - 2.2 increasing stakeholder engagement, capacity and responsibility in relation to managing MLRSEW populations and habitats;
   - 2.3 monitoring, analysing and evaluating MLRSEW management and recovery effort; and
   - 2.4 facilitating the MLRSEW Recovery Program.

Performance Criteria: The Performance Criteria for the life of the Recovery Plan are as follows:

1. Improve management of all known land-use and landscape threats at the majority of known occupied sites by 2011.
2. Input given to plans that minimise the risk of habitat loss due to bushfire by 2008.
3. Formally protect five MLRSEW populations and/or habitat sites not currently protected by 2011.
4. Identify new and emerging threats to MLRSEW populations and habitats and management options for addressing these threats annually.
5. If required, at least one release at one translocation site completed by 2010 and ongoing monitoring as necessary.

6. Re-establish habitat links and/or habitat expansion activities for at least five MLRSEW populations (totaling approximately 50 ha) by 2011.
7. A measured increase in the area of MLRSEW occupancy due to Recovery Plan implementation by 2011.
8. Reconstruct habitat links and/or undertake habitat expansion for at least one MLRSEW population or area of potential habitat (totaling approximately 5 ha) by 2010.
9. Demonstrated increase in habitat connectivity between MLRSEW populations within two key areas by 2011.
10. Complete a strategy for MLRSEW recovery by 2008 and review at least every two years.
11. Demonstrated improved knowledge and understanding of ecology and habitat by 2011.
12. Management of MLRSEW populations and habitats integrated into relevant land-use and landscape policy, planning and industry standard processes by 2009.
13. Demonstrated increased capacity and willingness of stakeholders to take responsibility for MLRSEW recovery by 2011.
14. MLRSEW population, MLRSEW habitat and stakeholder engagement monitoring undertaken and used to guide future management efforts by 2009.
15. Maintain the technical and funding base for recovery program coordination for the period of this Recovery Plan.

Biodiversity Benefits:
Through the work of the Recovery Program the Fleurieu Peninsula swamps have been listed as a Critically Endangered Threatened Ecological Community under the EPBC Act. Fleurieu Peninsula swamp habitats critically need further conservation. MLRSEW Recovery Actions will enhance biodiversity in swamp habitats, particularly where habitat is enhanced by on-ground revegetation work. Species that may benefit include threatened birds (e.g. the South Australian listed Lewin's Rail *Rallus pectoralis*, Spotless Crake *Porzana tabuensis*, Painted Snip *Rostratula benghalensis* and Latham's Snipe *Gallinago hardwickii*), native fish and other species of conservation significance including additional birds (e.g. Golden-headed Cisticola *Cisticola exilis*), as well as reptiles (e.g. Yellow-bellied Water Skink *Eulamprus heatwolei*), frogs (e.g. Bibron's Toadlet *Pseudophryne bibronii*), invertebrates and numerous plants. Findings regarding MLRSEW behavior and management may benefit other threatened species/subspecies of emu-wren, such as the Mallee Emu-wren *Stipiturus mallee* and the Eyre Peninsula Southern Emu-wren *S. malachurus parimeda*, both of which are Vulnerable (EPBC Act).

Estimated Cost and duration of Recovery:

Table 1. Cost of Recovery Plan from 2006 to 2011.

	2006/2007	***2007/2008***	***2008/2009***	***2009/2010***	***2010/2011***	***Totals Per Action***
Objective 1.1:						
Action 1	82216.13	85810.89	95468.90	117479.21	97318.46	**$478,293.59**
Action 2	5486.35	33474.60	3183.85	3259.08	2980.35	**$48,384.22**
Action 3	0	14714.76	4255.50	4383.16	4514.66	**$27,868.08**
Action 4	4396.35	4608.65	4780.24	4923.65	5071.36	**$23,780.25**
Action 5	33191.25	37597.58	33884.94	41270.93	18459.36	**$164,404.06**
Action 6	0	2947.08	1149.98	0	0	**$4,097.06**
Action 7	0	4350.99	0	0	0	**$4,350.99**
Objective 1.2:						
Action 8	0	4350.99	0	0	0	**$4,350.99**
Objective 1.3:						
Action 9	1203.37	4806.15	1660.64	5009.52	1555.26	**$14,234.94**
Objective 2.1:						
Action 10	22664	12273.72	19217.60	12565.51	19882.14	**$86,602.97**
Objective 2.2:						
Action 11	16357.24	20849.36	0	41806.50	1493.05	**$80,506.16**
Objective 2.3:						
Action 12	35279.01	32663.62	38862.16	32694.95	56646.71	**$196,146.45**
Objective 2.4:						
Action 13	$25,405.71	$24,596.03	$24,102.51	$56,425.08	$31,531.86	**$161,061.19**
Totals Per Year	**226,199.42**	**283,044.42**	**226,566.32**	**319,817.59**	**239,453.22**	**1,295,080.96**

Total Cost of Recovery Plan from 2006 to 2011: $1,295,080.96

N.B. the costs indicated above are those required by the existing Recovery Program to implement Recovery Plan actions. This table does not include the in-kind investment that external stakeholders already or may provide

2.0 Recovery Process and EPBC Act

2.1 Objects of the EPBC Act in Relation to Recovery

2.1.1 Promoting a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples

This Recovery Plan seeks to engage all relevant sectors in the recovery of the Endangered MLRSEW. Successful implementation of this plan will depend on the involvement of a wide range of stakeholders (see section 6.1). This combined involvement will be promoted through the new co-operative approach to natural resource management across Australia.

2.1.2 Assisting in the co-operative implementation of Australia's international environmental responsibilities

Implementation of this Recovery Plan will meet policy and legislative objectives at a national, state and regional level. Whilst this Recovery Plan does not include any Ramsar Convention of Wetlands of International Importance sites, some JAMBA/CAMBA listed species such as Latham's Snipe *Gallinago hardwickii* may benefit from improved swamp management. The involvement of a diverse range of stakeholders will assist in ensuring that implementation is conducted in a co-operative way.

2.1.3 Recognising the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity, and promoting the use of indigenous people's knowledge with the involvement of, and in co-operation with, the owners of the knowledge

A draft of this Recovery Plan will be referred to the Aboriginal Partnerships Section of the SA Department for Environment and Heritage, who will undertake consultation with the relevant indigenous communities. This consultation will assist in determining the role and interests of indigenous communities with regard to the implementation of this plan.

2.2 Purpose of Recovery Plan

This Recovery Plan meets the EPBC Act requirement for recovery plans for nationally threatened species, in this case the Endangered MLRSEW. This Plan is an important management document that enables recovery activities for the MLRSEW to be approached within a planned and logical framework.

2.3 History of Recovery Program

MLRSEWs are found only on the Fleurieu Peninsula where approximately 300–700 individuals occur in small, widely-spaced local populations in dry-heath and swamp habitats (Pickett in prep. a). The taxon has been adversely affected by habitat loss in the past and ongoing habitat degradation. Stochastic events such as bushfire threaten small, isolated groups of birds and, given the highly fragmented nature of MLRSEW habitats on Fleurieu Peninsula, chances of recolonisation are poor.

First Phase: The MLRSEW Recovery Program started in 1993 and from this time until 1998, the main emphasis was to create awareness about the Recovery Program with landholders and volunteers. Landholders were important so that the team could gain access to properties to determine whether there were new FPS or populations of MLRSEW previously unknown. Volunteers were necessary to help collect data during monitoring, because of the small budget.

Second Phase: In the period 1999 to 2004 further knowledge about the MLRSEW and its prime habitats (dry-heath and Fleurieu Peninsula Swamps) was gained through additional MLRSEW monitoring, population studies, habitat usage, and by conducting Swamp Experiments with follow-up monitoring to learn more about the response of swamp vegetation to disturbances such as grazing, bushfire, and plant translocations. Awareness-raising was continued, but with a more defined scope. An informative bus tour of MLRSEW sites for the regional wine industry was held, a working partnership between the program and other on-ground projects such as the Goolwa to Wellington LAP was established that still exists today, feedback was provided for many state and regional strategies, and much input was given to local council planning officers in terms of developments that could potentially affect MLRSEW habitat and FPS. Tools for community behavioral change

were also created such as the Swamp Management Guidelines (a booklet advising landholders how best to manage their swamps), the Revegetation Strategy, and several individual property management plans in conjunction with landholders. Other major accomplishments during this time included the re-establishment of the MLRSEW Population in Cox Scrub CP through translocation, an agreement with the Native Vegetation Council to allow a program to embark on a five year adaptive swamp management trial, the purchase and launch of Glenshera Swamp in the state reserve system (now known as Stipiturus Conservation Park), and in 2003, the acceptance of the FP swamps as a Critically Endangered community under the EPBC Act.

Third and Current Phase: In this phase the Fleurieu Peninsula Swamps, in their own right, became a main focus. Funding levels rose to their highest level in 2005/06, which enabled five personnel (a program coordinator, two extension officers, an ornithologist and a vegetation officer) to concentrate on the recovery of both the MLRSEW and FPS. The program also had a small-grant budget to help landholders fund approximately half the cost of on-ground works which physically and/or legally protect MLRSEW habitat and FPS from the main threats of grazing, invasive weeds and water extraction. As of 2006, the extra staffing and on-ground works money has allowed the Recovery Program to accomplish the following:

- work with over 25 landholders to produce management plans for over 30 swamp/dry heath areas;
- initiate the process and assessments for at least five Heritage Agreements and provide assistance to at least 28 existing Heritage Agreement owners;
- erect approximately 20 km of fencing to protect more than 200 ha of Fleurieu Peninsula Swamp/dry-heath habitat;
- complete a 2006 MLRSEW census;
- collect information about the vegetation and condition of at least 40 Fleurieu Peninsula Swamps;
- produce a draft booklet for landholders, NRM workers, and planning agencies on recommendations for swamp and emu-wren habitat management;
- speak at several industry meetings, such as Fleurieu Beef and the Parawa Ag Bureau;
- hold a Landholder Swamp Management Workshop and a Swamp Management Field Day;
- provide training and support to over 50 NRM professionals, 60 landholders and 9 community groups
- obtain over $140,000 of additional grant funding to help new landholders complete on-ground conservation activities;
- begin work on a Swamp Transition Model (looking at how Swamp vegetation might change over time due to disturbance/lack of disturbance/climate change and how this might ultimately affect swamps themselves, as well as the MLRSEW using it for habitat).

It is believed that the extent of these activities and the manner in which they were undertaken (i.e. attempting to connect properties working with the program and with known conservation areas, always attempting to include buffer zones when fencing vegetation or including it in heritage agreements, removing the most threatening weeds, etc.) will help to mitigate some of the potential impacts of climate change by:

- building resilience into habitat areas to enhance their capacity to respond to disturbance and stresses;
- improving ecological function and connectivity at a landscape scale (e.g. to facilitate MLRSEW movement to available habitat); and
- protecting habitats and important populations (considering genetic representativeness and viability, as well as numerical strength) from the consequences of extreme climate events, such as fire and flooding.

There is considerable overlap between this Recovery Plan and the Recovery Plan for Fleurieu Peninsula Swamps (Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamp Recovery Program 2007). Opportunities to integrate MLRSEW recovery and swamp recovery have been identified (see note at top of section 8.0 Recovery Actions and Milestones). However, integration of recovery actions is a progressive task and opportunities for integration are dependent on funding. The responsibility for integration of recovery actions rests with the Recovery Team(s), which have the expertise to make these decisions once funding has been obtained.

3.0 Species Information and General Requirements

3.1 Species Name and Description

The MLRSEW *Stipiturus malachurus intermedius* (Ashby 1920) is a subspecies of the Southern Emu-wren *S. malachurus*.

The MLRSEW is a small bird with body mass around 7 g and overall length 16–19 cm including the 9–12 cm characteristic filamentous tail comprising just six feathers. Its wings are short and rounded. Both sexes are tawny-brown with dark striations dorsally. MLRSEWs are sexually dichromatic, males being distinguished from females by pale-blue upper-breast, throat and eyebrows. This difference is discernable in nestlings, although the blue is dull blue-grey at first and quickly changes such that young males are essentially indistinguishable from older males by several months of age (Pickett in prep. a). Older males generally have a more rufous, unstreaked forecrown. Males retain the blue colouration throughout the year.

3.2 Taxonomy

Emu-wrens *Stipiturus* spp. are members of the passerine family Maluridae (Australian and New Guinean fairy-wrens). The genus is endemic to Australia.

The MLRSEW is one of eight subspecies of the Southern Emu-wren *S. malachurus* (Schodde and Mason 1999) which occurs mainly in southern coastal Australia. *S. m. intermedius* has no taxonomic synonyms. Its taxonomic circumscription is based on morphological differences and geographic separation (*ibid*.), which is only slight in relation to *S. m. polionotum* of southeast South Australia (see 4.5 Distribution).

There are two other *Stipiturus* species, apart from Southern Emu-wren. The Rufous-crowned Emu-wren *S. ruficeps* is widespread across arid spinifex-clad regions of central and central-western Australia and the Mallee Emu-wren *S. mallee* is locally distributed in mallee-heath in south-eastern South Australia and north-western Victoria (Schodde 1982; Rowley and Russell 1997; Schodde and Mason 1999).

3.3 Conservation Status

The MLRSEW is listed as Endangered under the Australian Government EPBC Act and the South Australian *National Parks and Wildlife* (NPW) *Act 1972*. It has been of conservation concern since at least the late 1970s, initially due to knowledge that only a few small populations remained, mostly in highly fragmented swamp habitats in extremely modified landscapes and subject to ongoing habitat loss and degradation (e.g. SAOA 1977; Reid and Vincent 1979; Ford and Howe 1980). It was listed as an endangered species as early as 1991 (SAOA 1991; Garnett 1992a, 1992b).

The MLRSEW currently meets IUCN (2001) criteria for Endangered (EN B1a,b(ii,iii,iv)+B2a,b(ii,iii,iv)) (Pickett in prep. a) due to its:

- restricted geographic range—extent of occurrence <5,000 km^2 (174 km^2) and area of occupancy <500 km^2 (20.75 km^2);
- severely fragmented population; and
- continuing decline observed and projected in:
  - area of occupancy;
  - area, extent and/or quality of habitat, and
  - number of locations or subpopulations.

It was previously considered Critically Endangered (CR B1+2abcde *sensu* IUCN 1994) (MLR Southern Emu-wren Recovery Team 1998; Garnett and Crowley 2000), but the disparity reflects differences in data and methods used to measure area of occupancy rather than actual change in status.

4.0 Behaviour

4.1 Diet

MLRSEWs feed predominantly on small invertebrates, chiefly insects (Higgins *et al*. 2001; Pickett in prep. a).

Published information on the diet of Southern Emu-wrens is limited. Barker and Vestjens (1984) list a large variety of arthropods, chiefly insects. Common food items, recorded from stomach contents and observations of feeding, are spiders, moths, butterflies, caterpillars, leaf-eating beetles, weevils, wasps, ants, bees, and water-beetles. Insect and spider eggs, seeds and pieces of vegetable matter have also been mentioned as food items (Fletcher 1915; Morgan 1919; Schodde 1982).

Emu-wrens use their curved beak, flanked with stout rictal bristles to protect the eyes, to glean along the shrubbery, and occasionally hawk for prey. Fletcher (1915) reported the stems of pale rush *Juncus pallidus* as an important food supply, the emu-wrens splitting open stems of reeds and rushes to obtain insects. In a common feeding method in shrubby habitat, emu-wrens work around and up through a shrub and then move from there to the base of the next shrub to start again.

4.2 Breeding Biology

MLRSEWs breed annually during spring–summer (Pickett in prep. a). The overall breeding season occupies nine months from start of August until end of March. This includes nesting and rearing of young to independence, but most young hatch during September–December (*ibid*.).

MLRSEWs breed as dispersed, socially monogamous pairs (Pickett in prep. a). Cooperative breeding and extra-pair paternity has been recorded occasionally for the SEW (Maguire and Mulder 2004; Maguire 2005), but not for the MLRSEW.

Breeding MLRSEW pairs usually require around one hectare in good quality habitat, with home ranges of pair members overlapped (Pickett in prep. a). There is little overlap with the ranges of neighbouring pairs, which often abut (*ibid*). Mate and site fidelity appears to be high within breeding seasons but low between seasons (*ibid*.), the latter possibly reflecting relatively high mortality during the non-breeding period. Pairs occupying the same sites across successive seasons remain in their respective areas during the non-breeding season (*ibid*.). Measured home ranges apparently represent territories that are defended from conspecific birds, or at least advertised, by the use of song by male MLRSEWs. Such territorial calling represents the only agonistic behaviour recorded.

MLRSEW pairs produce one (mostly) or two broods of 1–3 young during the breeding season (Pickett in prep. a). Although asynchronous amongst pairs at a given site, first broods generally fledge in September–October and second in December–January. Pairs sometimes commence a second brood before young are independent. A third brood is rare (*ibid*.).

SEW nests are domed, constructed mainly from loosely woven fine-leaved grasses and sedges, and are typically well-concealed in dense cover around 0.3 m above ground or sometimes water (Maguire and Mulder 2004; Pickett in prep. a). The usual clutch size is three eggs, which are laid on successive days (Fletcher 1915; Maguire and Mulder 2004; Pickett in prep. a). Both parents care for young, although the female does most if not all incubation of eggs and brooding of nestlings (Fletcher 1915; Hutton 1991; Maguire and Mulder 2004). Incubation lasts 10–20 days and young fledge around two weeks after hatching (Fletcher 1915; Maguire and Mulder 2004). Young then remain highly cryptic in dense cover for 1–2 weeks until more capable of flight and movement during family group foraging (Fletcher 1915; Maguire and Mulder 2004; Pickett in prep. a). MLRSEWs are independent by about three months of age and can breed in the next breeding season after hatching (i.e. <1 year of age; Pickett in prep. a).

SEW nests are vulnerable to terrestrial predators, cuckoos, (especially Horsfield's Bronze-cuckoo *Chrysococcyx basalis*) and trampling (e.g. by cattle). Relatively large introduced predators, such as Cats (a known predator—e.g. Maguire and Mulder 2004) and European Red Foxes, may have difficulty accessing nests in dense vegetation, and native animals such as snakes and cuckoos, both known predators/brood-parasites (Fletcher 1915; Maguire and Mulder 2004; Pickett in prep. a), probably have a greater influence on reproductive success.

Closely related MLRSEWs may inbreed where no other breeding options exist (Pickett in prep. a).

4.3 Demographic Parameters

Demographic data regarding MLRSEW survival, recruitment and reproductive success acquired from three study sites (two swamps and one dry-heath; Pickett in prep. a) are not conducive to a stable or growing population.

Recorded annual survival of adults is low (≤ 50%), as is breeding adult survival (*c.* 40–60% for breeders as a subset of all adults, based on two different estimators across three sites), these parameters not differing significantly between swamp and dry-heath habitat types (see section 4.5.3 Habitat description) (Pickett in prep. a).

Recorded recruitment of juveniles into the adult population (i.e. independence) is reasonably high (57%, unweighted average across three sites), but recruitment into the breeding population (i.e. observed breeding status) is very low (≤ 10%; Pickett in prep. a). These parameters do not differ significantly between sexes or habitat types, except for significantly higher (twofold) recruitment into the adult population in swamps, which possibly reflects limited dispersal opportunities in the isolated swamp patches studied (*ibid.*).

Recorded sex ratios for adults banded at study sites are male biased (1.1:1 to 1.4:1), but do not differ significantly across sites or habitats (Pickett in prep. a). Recorded sex ratios for banded non-adults are female biased, but also do not differ significantly across sites or habitats, nor is there any significant difference in recorded sex ratios across age classes (*ibid.*).

Although recorded adult sex ratios are slightly male biased, available data indicate that most if not all (50–100%, mean 85%, mode 100%) breeding-age females (at least 6 months old) engage in breeding activities each breeding season (Pickett in prep. a).

Taken as a whole however, low recorded values of overall productivity (1.45 fledged juveniles per clutch, and 1.94 juveniles per breeding female per breeding season), overall fecundity (0.92 juvenile females per breeding female per breeding season) and breeding female annual survival (0.48) are insufficient to maintain a stable population size, because production of female offspring cannot offset annual mortality (Pickett in prep. a). However, the realised values available are based on relatively short study periods (1–3 breeding seasons) and may underestimate actual values due to, for example, undetected young or emigration, and missed broods (*ibid.*). Also, given the MLRSEW's capacity to produce multiple broods of up to three young, potential values, at least for seasonal fecundity, are substantially greater and variability due to environmental or demographic stochasticity may result in long-term population stasis or growth (e.g. as consequence of positive 'spikes' in productivity across breeding seasons).

Reliable data regarding average MLRSEW life expectancy are not available. The oldest recorded individual was at least 5¾ years old when last observed (Pickett in prep. a).

4.4 Dispersal

MLRSEWs are considered dispersal limited, particularly in fragmented habitat in largely cleared landscapes, due to their short rounded wings that prevent sustained flight, and a preference for dense cover, however there is little available empirical information regarding dispersal. MLRSEWs have commonly been observed crossing cleared areas up to 10 m wide, such as fire-access tracks in heathland or small clearings in swamps, and sustained flight of up to twice as far over habitat has been observed occasionally (M. Pickett pers. obs.), but substantially cleared areas are probably barriers to movement (Pickett 2000) and more or less contiguous dense vegetation cover appears to be necessary for inter-patch dispersal.

Movements of up to 2.5 km between sites connected by dense vegetation have been recorded. For example, three individuals dispersed 2.5 km between swamps connected by a corridor of swamp vegetation (Pickett 2000) and another individual dispersed 1.8 km in dry-heath following translocation (Pickett in prep. b). Movements of up to 1 km between sites connected by more tenuous corridors such as growth along fencelines or drains, woody-weed thickets (e.g. Blackberry *Rubus* spp. thickets), seasonally dense pasture and relatively open heathy woodland have also been recorded or inferred (Pickett 2000, in prep. a).

4.5 Distribution

4.5.1 Former distribution

The MLRSEW's former (i.e. historical) recorded range in the South MLR–Fleurieu Peninsula region extended from Yundi in the north to Deep Creek in the south, and east to the Lower Finniss River (Littlely and Cutten 1994; Pickett in prep. a) (Appendix I). The MLRSEW presumably once occurred wherever suitable habitat existed throughout its former range—a reasonable assumption given records of past or present occupation for most extant vegetation remnants judged as suitable. It may also have occurred slightly beyond its former known range, but was not detected or reported (e.g. heaths and swamps north of Yundi towards the central MLR, and see section 5.4.1 Bushfire). SEW records from Hindmarsh Island, Younghusband Peninsula and Narrung in the late 1960s and early 1970s (Littlely and Cutten 1994; G. Carpenter unpubl. data) are not supported by recent data, but nevertheless suggest some historical linkage between SEW populations in the MLR and Coorong, which may thereby nullify or diminish the taxonomic circumscription of the MLRSEW.

The MLRSEW's pre-European distribution was probably naturally continuous in some areas and naturally fragmented in others. For example, it was probably more or less continuous along some drainage systems, particularly in the Myponga–Mount Compass–Finniss River region, where broad open drainage depressions most likely supported extensive, contiguous areas of wet-heath habitat. Dry-heath habitat on intervening hilly topography probably provided continuity independent of drainage systems. Conversely, for example, pre-European distribution was probably naturally fragmented by non-habitat forest in the deeply dissected topography of the Deep Creek–Parawa region.

4.5.1a Historical distribution changes: Considering the present distribution of populations and habitat in the context of known or inferred former habitat distribution (e.g. based on remnant vegetation mapping), historical changes in MLRSEW distribution are surmised to be substantial. Widespread contraction and fragmentation of the taxon's former range have been caused primarily by extensive native vegetation clearance for agricultural purposes (mainly livestock grazing). However, recorded losses in years preceding the last decade or so are relatively few. The MLRSEW is known to have disappeared from several separate general localities from 1920 to 1993 (M. Pickett unpubl. data), e.g. Back Valley (>1930s—habitat clearance), Currency Creek (>1967—habitat disturbance, isolation?) and Yundi (>1970s—habitat change, isolation?). For the same period, loss from several specific sites adjacent extant populations also occurred (*ibid*.), e.g. Hindmarsh Tiers (>1925—habitat clearance), Jacobs Swamp (>1960—habitat clearance/disturbance) and Cox Scrub CP (1983—fire).

4.5.1b Recent distribution changes: The distribution of the MLRSEW continued to contract during 1993–2006 and the population remained severely fragmented, with the southern sites completely separated from northern sites and fragmentation within these population groups (Pickett in prep. a; Appendix I). Although overall range effectively remained unchanged, 18 local extinctions during the period resulted in further contraction of northern and southern population groups and increased isolation within these disjunct groups (Appendix I). Notable losses included the most easterly of southern local populations (Sites 31 and 26), the most southerly of northern populations (Site 19) and central northern local populations (Sites 5, 6 and 7). A notable gain was the population reintroduced to Cox Scrub CP in 2001–2002 (Site 50). Excluding reintroduced occurrences, there was a 27% decline in area of occupancy (IUCN 2001) from 25 km^2 in 1993 to 18.25 km^2 in 2006 (Pickett in prep. a). In 2006, the 13 extant northern sites comprised five essentially isolated groups separated by at least 2 km, with sites within groups only tenuously connected, and the seven southern sites comprised another disjunct group, though having better connected sites, at least 30 km from nearest northern population (Appendix I).

4.5.2 Present distribution

The MLRSEW occurs in the South Mount Lofty Ranges–Fleurieu Peninsula region of South Australia. Its range extends broadly from Mount Compass in the north to Deep Creek in the south and east to the lower Finniss River (Littlely and Cutten 1994; Pickett in prep. a) (Appendix I). Occurrence outside this range is unlikely, except perhaps in the Hindmarsh Island–Murray Mouth region (e.g. R.J. Whatmough in Littlely and Cutten 1994 and South Australian Ornithological Association excursion in Glover 1971), but this has not been thoroughly investigated. Given recent survey efforts (Pickett in prep. a), it is unlikely that any relatively large populations remain undiscovered.

The MLRSEW's extent of occurrence (IUCN 2001) in 2006 was estimated to be 174 km^2 (Pickett in prep. a). Its area of occupancy (*ibid.*) in 2006, including occurrences established by translocation (see section *4.5.1b Recent distribution changes*; Pickett in prep. b), was estimated to be 20.75 km^2.

4.5.3 Habitat description

The SEW inhabits a range of habitats characteristically comprising low dense vegetation, e.g. shrub thickets, sedgelands and heathy shrubland, mallee, woodland or forest (Schodde 1982; Rowley and Russell 1997; Maguire 2005).

The MLRSEW inhabits two general habitat types—swamp and dry-heath—both characterised by low dense vegetation (Littlely and Cutten 1994; Pickett in prep. a; Appendix II). A key structural feature of swamp (reedland, wet-shrubland and wet-sedgeland) and dry-heath (mallee/woodland/forest and dry-shrubland) habitats (Appendix II) is a dense layer (e.g. >70% foliage cover and vertically dense), usually from ground level to about 1 m above ground, dominated by shrubs, sedges and ferns in swamps, and shrubs and sedges in dry-heath (Littlely and Cutten 1994; Wilson and Paton 2004; Pickett in prep. a). Some habitats have an additional, more open shrub layer and/or emergent shrubs (<5% cover), but any tree canopy present is usually low (<10 m) and sparse to mid-dense (10–70% cover) (Pickett in prep. a; Appendix II). Occupied swamps typically comprise a mosaic of structurally contrasting plant associations (e.g. sedgeland adjacent shrubland). Occupied dry-heaths are typically mallee tree dominated and more gradational than swamp habitats in terms of any structural changes across the area occupied by MLRSEWs.

MLRSEW swamp and dry-heath habitats are comparable in terms of habitat quality. Recorded survival, timing of disappearances, reproductive success, recruitment of breeders and home range size are all similar across habitats (Pickett in prep. a).

Despite floristic differences, swamp and dry-heath habitats are structurally similar, and it appears that MLRSEWs use habitat on the basis of structural rather than floristic components (Wilson and Paton 2004). The key characteristic of both habitat types is high density of vertical and horizontal vegetation below 1 m (*ibid*.; Pickett in prep. a). SEWs will use more open habitat, but areas of high vegetation density (e.g. shrub thickets) are always nearby and are favoured as refuge areas (Pickett 2002; Wilson and Paton 2004). The MLRSEW uses the densest vegetation of all SA subspecies of SEW (Pickett 2002; Wilson and Paton 2004), but its recognised habitat types may be an artefact of past vegetation clearance.

4.5.4 Habitat critical to survival and recovery

Habitat critical to the survival of a species (Environment Australia 2002) may include sites, areas or habitats that are necessary for:

- foraging;
- shelter;
- breeding;
- refuge;
- dispersal;
- important populations or occurrences;
- maintenance of genetic diversity;
- evolutionary development;
- reintroduction; or
- recovery.

The MLRSEW is a sedentary, dispersal-limited species that occupies a range of habitats that can be considered critical for its survival (see section 4.5.3 Habitat description). In the broadest sense, all of these habitats are critical when considered in terms of individual-level needs and requirements for short-term site-population persistence (e.g. area required by individual breeding pairs at a site, and minimum habitat requirements for an isolated local-population). However, when considered in terms of the entire population and its landscape-scale requirements for long-term viability (e.g. connectivity to facilitate dispersal and maintenance of existing site populations as well as occupation of vacant habitats as they become available) means that a subset of habitats represents the habitat most critical to survival, i.e. crucial for maintaining the taxon. This subset would not just include habitats occupied by important populations (e.g. core in a given area or likely source population for recolonisation; see section 4.6.1 Important populations), but would also include parts of the surrounding non-habitat matrix. These surrounding areas could be considered critical to survival in terms of their role as dispersal corridors or potential habitat (both now and in future, and considering possible effects of climatic change), or in terms of their effect on neighbouring habitat (e.g. the maintenance of hydrological or buffering processes).

Whilst basic habitat requirements of the MLRSEW have been identified (see section 4.5.3 Habitat description), there is currently insufficient knowledge to allow a clear-cut, comprehensive identification of habitat critical to its survival. This should be identified at the overall population level and further information is necessary to do this, particularly in terms of landscape-scale requirements. A systematic approach to identify and rank critical habitat should consider such factors as population importance (e.g. size, extent, viability and likely source–sink relationships), surrounding landscape (e.g. non-habitat matrix quality), habitat quality, patch configuration and interconnecting landscape elements. Identification of habitat critical to survival should be based on the best available information and modified accordingly as more and better information becomes available.

For the purposes of this strategy, habitat critical to survival and recovery is considered to comprise:

- all sites (Appendix I);
- areas occupied by important populations (see section 4.6.1 Important populations and Appendix I);
- specific habitat types identified in this plan (see section 4.5.3 Habitat description; Appendix II); and
- habitats re-established and expanded, or planned to be re-established or expanded to enable population expansion.

Mapping of habitat critical to MLRSEW survival using available data is problematic. In terms of occupied sites and areas occupied by important populations (see section 4.6.1 Important populations), habitat critical to survival is broadly represented in Appendix I, although area boundaries have not been defined for mapping purposes. In terms of specific habitat types and important landscape components (i.e. existing/potential habitat and corridors), a map of habitat critical to survival is not available, nor, as mentioned above, is adequate information available from which to derive spatial data for such mapping. For example, recent systematic efforts to reconcile observations and associated habitat data with existing floristic vegetation mapping for the South MLR indicate that available data at 1:50,000 scale inadequately reflects the patchiness of MLRSEW habitats at selected sites (e.g. Deep Creek CP).

See Appendix I for a map of MLRSEW distribution

4.6 Populations

Population Size: According to size classes ascribed to local populations (see next paragraph and Appendix I), the estimated MLRSEW population in 2006 was 315–660 individuals, with up to three quarters (37–72%) in dry-heath, although most occupied sites (65%) were in swamp habitats (Pickett in prep. a).

Local (Site) Populations: As at December 2006 there were 54 known MLRSEW sites (Appendix I), of which 20 were occupied in 2006. These local (i.e. site) populations comprise roughly six population groups that are essentially isolated from each other (Pickett in prep. a).

'Local population' is used here to refer to the population of MLRSEWs at a given site, and generally this is the set of individuals in a habitat patch. Some habitat patches, however, are poorly defined and one or more local populations could arguably be recognised as comprising the same population. For example, dry-heath habitat patches in Deep Creek CP merge with adjacent non-habitat vegetation, sometimes with little spatial separation from adjacent occupied patches. This is in contrast to often discrete, widely separated swamp habitat patches set amidst cleared areas or markedly contrasting vegetation, as occurs in the Mount Compass district.

In some cases local population is used here to refer to occurrences as small as one pair in a single habitat patch, although such occurrences would generally not be considered as populations *per se*.

Of the 20 specific sites where the MLRSEW was recorded during 2006, most (55%) were located on private property and most (55%) were in areas not managed specifically for nature conservation, but a large proportion (40%) was in formal nature conservation areas managed by State Government (Table 2).

Table 2. Summary of tenure, use and ownership of sites where the MLRSEW was recorded in 2006.

Primary Land Tenure	Number of Sites					Owner/Manager
	Total	Primary Land Use				
		Nature conservation	Remnant native vegetation—primary production area	Marsh/wetland	Grazing—cattle	
Private	11	*1	8	^1	1	Private
Conservation Park**	8	**8	–	–	–	National Parks and Wildlife SA
Unalloted Crown Land	1	–	–	1	–	Minister for Environment & Conservation / private
Total	**20**	**9**	**8**	**2**	**1**	

* Informal reserve (Mt Compass School Swamp)
** Formal reserve (legislative basis)
^ Black Swamp

4.6.1 Important populations

An important population can be considered one that is necessary for a species' long-term survival and recovery (Environment Australia 2002). This may include populations that are:

- key sources for breeding or dispersal;
- necessary for maintaining genetic diversity; and/or
- near the limit of the species' range.

Six important MLRSEW populations, each comprising a group of more or less connected site populations, are recognised (Table 3).

Table 3. Important MLRSEW populations.

Rank	Population	Sites	Habitat	Land Tenure	Importance
1	Deep Creek CP	38, 39, 41, 45, 46, 51	dry-heath	Conservation Park	*C.* 70% of entire MLRSEW population; scattered relatively well connected local populations, possibly 50 pairs at **Site 38**; arguably **the most important MLRSEW local population overall**; probably most viable and genetically diverse population; likely source for regional dispersal and for translocations.
2	Lower Black Swamp–Finniss Park Swamp–Reedlands	22–24	swamp	Private, Crown Land	Possibly 50 pairs—**Site 23**, arguably **the second-most important MLRSEW local population overall**; probably second-most viable and genetically diverse population; potential source for translocations.
3	Glenshera Swamp	14	swamp	Conservation Park	Larger swamp population in finest and largest remaining upland freshwater swamp habitat.
3	Square Waterhole–Ambersun Alpacas Swamps	15–17	swamp	Private	Larger swamp population in second finest/largest upland freshwater swamp habitat.
3	Cox Scrub CP	50	dry-heath	Conservation Park	Reintroduced population; largest dry-heath population outside Deep Creek CP.
4	Mount Compass–Nangkita	10, 53, 54	swamp	Private	Larger swamp population; includes most northerly swamp occurrences.

5.0 Known and Potential Threats

5.1 Causes of Past Decline

The population of MLRSEWs has been greatly reduced by clearance, degradation and fragmentation of both swamp and dry-heath habitat. Land clearance for primary production activities has been extensive on the Fleurieu Peninsula. Large areas have been developed for sheep and cattle grazing, dairying, forestry and horticulture. Water resource management has seen many natural drainage systems modified through construction of dams for water storage and drains to divert water from potentially productive sites. Fragmentation of habitat has exacerbated problems since isolated local populations of emu-wrens are now highly vulnerable to catastrophic events such as fire, with local extinctions known to have occurred as a consequence of such events (e.g. Cox Scrub Conservation Park and Toadspring Swamp sub-populations, lost as a result of bushfires in February 1983 and January 1997 respectively). In addition to outright clearance of previously available emu-wren habitat, degradation of remaining habitat by slashing, burning, draining and heavy grazing has further contributed to the reduction in MLRSEW habitat on the Fleurieu Peninsula.

Introduced predators such as the European Red Fox *Vulpes vulpes*, Cat *Felis catus*, and Black Rat *Rattus rattus* may prey upon the MLRSEW, however very little information is available on predation of emu-wren eggs, nestlings, juveniles or adults by introduced or other predators.

5.2 Overview and Priority of Current Threats

Threats to the MLRSEW include **natural catastrophes** and many **land-use threats** that lead to environmental or demographic impacts (Table 4). **Bushfire** is the most serious catastrophic threat, because all populations and habitats are potentially threatened. The largest remaining MLRSEW population occurs in a high fire-risk environment and could be extirpated by a single unchecked bushfire, and isolated swamps are unlikely to be reoccupied following extinction due to fire. Other catastrophic threats (i.e. natural, but extreme environmental-variation events) such as drought, flood and storm are lesser threats, although the direct (e.g. mortality) or indirect (e.g. reduced carrying capacity) impacts of these might be **exacerbated due to climate change**, and of these threats drought may therefore pose the greatest threat to populations in swamps. **Land-use threats** include **livestock grazing**, **vegetation clearance**, **deliberate burning**, **mining**, **water extraction**, **swamp drainage**, **plantation forestry**, **residential development** and **weed invasion**. These have evidently impacted considerably on the MLRSEW in the past, mainly populations in swamps. Climate change may exacerbate the impacts of land-use threats, particularly livestock grazing and water extraction. Considering the two general habitat types (swamp and dry-heath) land-use threats remain a greater threat to populations in swamps and to swamp habitat. Livestock grazing in swamps is viewed as the most serious land-use threat, because the practice is relatively common and it directly impacts on habitat quality, but other land-use threats that might affect swamp hydrology, such as water extraction, drainage and plantation forestry, have the potential for major impacts. More generally, **changes in land-use** for existing alienated habitat areas potentially threaten recovery through compromised habitat re-establishment options. Although **vegetation succession** is a natural process of gradual change, it might pose a serious threat to the MLRSEW due to reduced carrying capacity and habitat loss. **Predators and parasites** are not considered major threats, but the role of predation, in particular, requires further investigation. **Demographic and genetic stochasticity** are random (stochastic) processes that may affect MLRSEWs, although their significance is poorly understood. They are independent of external environmental factors and come into play in small populations. Importantly, demographic stochasticity may be a major threat to MLRSEWs, especially the smaller populations, which, across seasons, may drift to extinction due to chance variation in survival, reproduction and sex ratios. Similarly, genetic stochasticity may affect fertility, survival and ability to respond to environmental changes in small populations (e.g. inbreeding depression), and although poorly understood, its potential impacts should not be ignored. **Fragmented/isolated habitat** is a major threat because MLRSEWs have limited dispersal capabilities. Lack of habitat is a threat because it constrains population growth, area occupied, population viability, and inter-patch movement. Other threats (impediments) to recovery concern inadequacies or limitations in funding, knowledge, natural resource management integration and community engagement.

Table 4. Summary of threats to the MLRSEW.

Threatening Process		Type			Likely Impact					Habitat, Period and Likelihood						Notes
					Environmental		Demographic			Swamp			Dry-heath			
		Catastrophe	Land Use	Other	Habitat degradation/loss^	Habitat fragmentation	Reduced productivity	Reduced adult survival	Forced dispersal	Historic	Current	Potential	Historic	Current	Potential	
Climate change	Impacts via more direct catastrophic and land-use threats (see * below)			x	x	x	x	x	x		◘	◙		◘	◙	
Bushfire*	Accidental, malicious or natural (e.g. lightning) ignition	x			x	x	x	x	x	●	●	●	●	●	●	Most of Deep Creek CP population could be lost due to large fire; isolated swamps unlikely to be naturally reoccupied following extinction due to fire
Drought*		x			x		x	x		◘	◘	◙	◘	◘	◘	Populations in small swamp patches probably at greatest risk
Flood*		x			x	x	x	x	x	◘	◘	◘				Lowland floodplain sites and other low relief sites most vulnerable
Storm*	Unusually intense wind and/or precipitation	x					x	x	x	◘	◘	◘	◘	◘	◘	Possibly more significant impacts in confined swamp habitats if no refuge
Vegetation clearance	Incremental clearance - e.g. roads, dams, fire-hazard reduction		x		x	x			x	●	○	○	●	○	○	Broad-acre clearance has ceased in the area of interest
Livestock grazing	Sheep and cattle (includes trampling)		x		x		x		x	●	●	●				Cattle (largest, heaviest) have greatest impact
Deliberate burning	e.g. fuel-hazard reduction, small-scale vegetation clearance		x		x	x	x	x	x	◙	○	○	◙	○	○	More frequent in past—modern-day controls in place
Mining	e.g. sand mining		x		x	x	x			◘	◘	◙			○	Sand mining adjacent swamp habitat is of concern in the Mt Compass area
Water extraction*	e.g. dams, wells, bores		x		x	x	x			●	◙	◙				
Swamp drainage	Surface-water drainage		x		x	x	x			●	◙	◙				
Plantation forestry	e.g. Tasmanian Blue Gum, Radiata Pine		x		x	x	x			◘	○	◙	◘			Large areas of pines historically established vicinity swamps and dry-heath
Residential development	Rural/urban residences and associated infrastructure		x		x	x	x			●	○	◘				Disturbance, excluding vegetation clearance *per se*
Weed invasion	e.g. Blackberry, Gorse		x		x		x				○	○				Floristic/structural integrity compromised
Dieback due to *Phytophthora*	Vegetation dieback due to plant pathogen			x	x		x					◘			◘	No current infections in emu-wren habitat, but a few localised infections adjacent
Demographic stochasticity	Reflects random variation in birth and death rates			x			x	x			◙	◙			◙	Mainly potentially effects small populations in swamps, but also small re-established populations in dry-heath
Genetic stochasticity	Genetic drift			x			x	x			◙	◙			◙	As for demographic stochasticity (above)
Introduced predators	Cat, European Red Fox, Black Rat			x			x	x			○	◘		○	◘	Predation by introduced animals may be impacting population more than thought, but data are lacking
Native predators/parasites	Of early stages or adults - e.g. snakes, cuckoos, raptors			x			x	x			○	○		○	○	Native predators/parasites may potentially have a major impact on small populations, but data are lacking
Vegetation succession	Natural change in vegetation floristics/structure			x	x	x	x				◙	◙		◙	◙	Old-growth swamp shrubland habitats tend to be too tall and dense; old-growth dry-heath open mallee/woodland/forest habitats tend to have understoreys that are too open

● major - known/inferred/projected impact on large proportion of population, or on specific key local populations
○ minor - known/inferred/projected impact on small proportion of population or local populations
◙ major ? (i.e. uncertain)
◘ minor ? (i.e. uncertain)
blank negligible threat

* frequency/intensity may be exacerbated by climate change
x reduced/lost food, shelter and/or nest-sites

5.3 Biology and Ecology Relevant to Threats

5.3.1 Habitat requirements

MLRSEWs are found in habitat comprising wet sedgeland/shrubland or dry-heathy mallee/shrubland/forest having one or two low (<3 m high), vertically and horizontally dense layers (see section 4.5.3 Habitat description). Structural and floristic integrity of habitats is directly or indirectly impacted by catastrophies and land-use threats. Changes in floristic composition can be expected to affect MLRSEW food resources (i.e. invertebrates dependant on specific flora) and habitat structure (i.e. vegetation layering and density). Changes in habitat structure affect resources available for shelter, movement and nesting. Nests, which SEWs typically situate low in dense cover (see section 4.2 Breeding Biology), are vulnerable to trampling and disturbance. The dense cover of undisturbed habitat probably affords a degree of protection from introduced predators such as cats and foxes (see section 5.4.18 Introduced predators).

5.3.2 Sedentary habit and small home range

SEWs occupy relatively small home range areas of around 1 ha and are sedentary, at least when breeding (see section 4.2 Breeding Biology). This means that comparatively limited (i.e. spatially and temporally) local effects may disproportionately impact upon the population at a site. For example, entire territories may be affected as a consequence of localised fire or brief periods of heavy grazing in a confined area of habitat.

5.3.3 Limited dispersal

MLRSEWs have limited dispersal capabilities because their short rounded wings limit flight, and it appears that dense vegetation is required for dispersal, but this need not floristically correspond to habitat (see section 4.4 Dispersal). Although the maximum dispersal distance recorded is 2.5 km between sites connected by dense vegetation (Pickett 2000), the species is probably capable of movement over much greater distances.

Limited dispersal has known and potential implications for population viability. Once a local population has been lost, natural recolonisation of the site is dependent on successful dispersal from a connected source population. MLRSEWs can reproduce through inbreeding (Pickett 2000), but the effects of inbreeding on population viability (e.g. reduced survival and reproductive performance through inbreeding depression) are unknown.

5.3.4 Small population size

Most local populations of MLRSEWs are small and particularly vulnerable to the effects of genetic or, probably more importantly, demographic stochasticity (see 5.4.15 Demographic stochasticity and 5.4.16 Genetic stochasticity).

5.4 Current Known and Potential Threats Identified

As indicated below there is a wide range of existing threats already exerting pressure on MLRSEW habitat and populations. Of significant concern is that any additional threats will exacerbate the already tenuous nature of MLRSEW populations. As alluded to in section 5.6 below one of the knowledge gaps includes emerging threats, for example new industries that may arise in the future. In recent times the proposed planting of 10,000 hectares of Tasmanian Blue Gum plantations has highlighted the potential for a new range of risks to MLRSEW, such as new chemicals that may be used in the catchments and new potential environmental weeds. As more industries emerge there will continue to be additional impacts. Whilst it can be difficult to legislate retrospectively it is paramount to the recovery of the MLRSEW that guidelines for new industries afford appropriate protection for MLRSEW habitat.

Cumulative impacts are also of significance. Whilst all the aforementioned threats have potential or pose threats in isolation, the combination of these threats presents an even greater risk to MLRSEW habitat and populations. Each threat identified has the potential to exacerbate other threats and many threats are interrelated, for example water extraction whilst a threat in itself also has potential to increase the threat of weed invasion and bushfire. Interconnectedness between threats and the impact they have in conjunction is difficult to quantify although it is recognized that threats need to be considered both individually and cumulatively in order to mitigate risks to MLRSEW.

5.4.1 Bushfire

Bushfire is a major threat to MLRSEWs as it causes direct catastrophic loss of habitat and trapped individuals, and may force dispersal to areas unsuitable as habitat. Bushfire potentially threatens persistence at all occupied sites and is considered the most significant stochastic threat. Notably, the population in Deep Creek CP is highly vulnerable to extirpation by bushfire, since the reserve comprises a contiguous area of fire-prone vegetation (DEHAA 1999), and a single widespread fire could potentially result in the loss of up to three quarters of the entire MLRSEW population (Pickett in prep. a). Bushfire may be the consequence of natural (e.g. lightning strike), malicious or accidental ignition.

Bushfire may result in long-term loss of MLRSEWs from specific areas, but reoccupation of regenerating habitat can be expected provided unburnt occupied habitat is adjacent and adequately connected. For example, the Cox Scrub CP population was extirpated by bushfire in 1983, but the park was not naturally reoccupied, apparently due to its isolation from adjacent populations. The MLRSEW however was reintroduced there in 2001–2002 (Pickett in prep. b). Similarly, localised (accidental) fire caused the loss of a small population at Toadspring Swamp in 1997 and the site has not been reoccupied due to its isolation (Pickett in prep. a). In contrast, nearly all of the presently occupied area of Deep Creek CP was burnt-out by two major bushfires (*c.* 50% of the park vegetation burnt in 1980 and a further 15% burnt in 1983), but MLRSEWs are now widespread across these previously burnt areas, presumably because regenerating habitat could be recolonised from unburnt areas. In another case, MLRSEWs persisted at the Mount Compass School Swamp (Site 11) following an accidental fire in 2003 that burnt *c.* 60% of available habitat. Unburnt habitat patches, including degraded sedgeland, adjoined the burnt area. MLRSEWs took refuge in these areas and were using regenerating habitat for foraging within six months of the fire (Pickett unpubl. data).

Similar information regarding fire-effects on other SEW subspecies is available. For example, bushfires caused only short-term losses at Tulka (2000—widespread fire) and Kellidie Bay CP (2002—local fire, due to lightning strike) on Eyre Peninsula, since unburnt occupied habitat remained at both sites and both were reoccupied within several years of being burnt (Pickett 2004). But recent widespread bushfire (2005) on Eyre Peninsula has probably caused long-term losses in the Koppio Hills where all available occupied habitat appears to have been burnt-out and the nearest populations are isolated from regenerating habitat (Pickett 2005).

Responses to bushfire may vary by habitat type, because habitats are likely to differ in the post-fire time periods required to become suitable MLRSEW habitat once again. For example, sedgeland and shrubland associated with swampy areas may attain a sufficient density for habitation more rapidly than shrubland, woodland or mallee habitats on relatively dry sites where post-fire vegetation regeneration may be much slower. Furthermore, variation in fire-responses can be expected due to differences in fire frequency, intensity, speed and seasonal timing, as well as burnt-area extent and patchiness (Woinarski 1999). Such differences in MLRSEW fire response have not been thoroughly investigated.

Bushfire has likely played a major role in post European-settlement extinctions of MLRSEWs and the taxon may have been much more widespread than historical records indicate (see section 4.5.1 Former distribution). Some remnant patches of apparently suitable habitat, both inside and outside the MLRSEW's known former range, have suffered repeated catastrophic bushfires since creation of the modern landscape of patchily distributed isolated fragments, and any such vacant areas of formerly occupied habitat have almost certainly not been reoccupied due to isolation. This possibility warrants investigation, as it relates to perceived constraints regarding potential translocations.

A major concern is that climate change could increase the intensity, frequency, duration and extent of bushfires if a warming, drying trend prevails for the Mount Lofty Ranges (Bardsley 2006; see section 5.4.23 Climate Change)

Despite the potentially major threat of bushfire, and somewhat ironically, the MLRSEW is probably ultimately dependant on fire or particular fire regimes, as particular post-fire age-classes of swamp or dry-heath vegetation types may be required as habitat, and others may be unsuitable or marginally suitable (also see section 5.4.20 Vegetation succession).

5.4.2 Drought

Drought is a potential threat to MLRSEWs. Although there are essentially no data regarding its effects on MLRSEWs, serious drought can be expected to cause habitat degradation or loss due to changes in floristic and therefore structural attributes, which would then most likely lead to increased mortality and reduced productivity due to reduction or loss of food, shelter and nest sites.

Changes in habitat condition at Cox Scrub CP during 2002–2003 (M. Pickett pers. obs.) were possibly attributable to below average rainfall in the region (Australian Government Bureau of Meteorology archives[1]) and may have impacted on the reintroduced MLRSEW population. Widespread, substantial shrub and sedge dieback in occupied dry-heath habitats was observed (but not measured) during this period and this may have contributed to low survival of MLRSEWs released in 2002 and low reproductive success in the 2002–2003 breeding season (Pickett in prep. b).

Drought is potentially a major threat to MLRSEW populations in isolated fragments of swamp habitat, especially where swamp habitats are constrained to the only available hydrologically and edaphically suitable sites in the local landscape. Perturbations due to the drying effects of drought might result in catastrophic degradation and loss of swamp habitat with no prospect of emu-wrens dispersing to unaffected habitat.

In addition to the above-mentioned direct impacts, there are indirect drought-related impacts that may threaten MLRSEWs. For example, stock-grazing rates may be increased above normal, or habitat patches (particularly swamps, but also dry-heath) usually excluded or even formally protected might be grazed during drought periods (see section 5.4.6 Livestock grazing). Similarly, water extraction impacts (see section 5.4.9 Water extraction) may be exacerbated during drought, thereby potentially impacting on swamp habitats and populations.

A major concern is that climate change could increase the intensity, frequency, duration and extent of drought-related impacts (direct and indirect) if a warming, drying trend prevails for the Mount Lofty Ranges (Bardsley 2006; see section 5.4.23 Climate change).

5.4.3 Flood

Flood is a potential threat to MLRSEWs in swamp populations at lowland floodplain sites (e.g. Black Swamp on the Tookayerta Creek and Reedlands Swamp on the lower Finniss River) and other flood-prone low-relief sites along drainage lines (e.g. near Mount Compass). There are no data regarding direct effects on MLRSEWs, but localised flooding has been observed to cause substantial inundation and structural changes to swamp habitat, therefore catastrophic flooding would almost certainly directly cause nest failure or forced dispersal, or indirectly reduce survival and productivity due to reduction or loss of food, shelter and nest sites.

Climate change may result in more extreme and frequent flooding events in riparian areas of the Mount Lofty Ranges (Bardsley 2006), which could exacerbate flood-related impacts to swamp populations and habitats (see section 5.4.23 Climate change).

5.4.4 Storm

Storm is a minor potential threat to MLRSEWs. As for drought and flood, there are no data available on the effects of storms, but unusually intense rainfall and/or wind events could potentially cause death, nest failure or damage to habitat, which could in turn impact on survival and productivity due to longer term reduction or loss of food, shelter and nest sites. Impacts in confined swamp habitats may be substantial if there are no refuge areas.

5.4.5 Vegetation clearance

Vegetation clearance (which here excludes clearance by grazing and burning, but see sections 5.4.6 Livestock grazing and 5.4.7 Deliberate burning) is an ongoing minor threat to MLRSEW populations. Historically, widespread vegetation clearance has caused major loss, fragmentation and isolation of MLRSEW habitat, but broad-scale land clearance in SA has essentially ceased and further clearance of native vegetation is prohibited without approval under the SA *Native Vegetation Act 1991*. Minor clearance can still be authorised or exempt in

[1] http://www.bom.gov.au/cgi-bin/climate/rainmaps.cgi

some circumstances (e.g. dam construction, fire breaks, fencelines, roadwork) and a small amount of unlawful clearance will probably continue (e.g. conversion of swamp to pasture). Whilst individual authorised or illegal clearances may be small in area, incremental habitat loss may be substantial overall. Furthermore, clearances are localised, such that small fragments of habitat, especially swamp, and any MLRSEWs therein may be disproportionately impacted. Vegetation clearance in occupied habitats may directly cause nest failure and forced dispersal. In addition, clearance of habitat or non-habitat matrix may cause or exacerbate habitat fragmentation and/or isolation. Land clearance is a key threatening process listed under the EPBC Act.

5.4.6 Livestock grazing

Livestock grazing is a major threat to MLRSEW populations in swamp habitat. Dry-heath habitat is intentionally or accidentally grazed by livestock much less often. The main animals concerned are sheep and cattle, with alpacas and deer only occasionally grazing swamp habitat. Grazing and associated trampling of habitat may cause nest failure if grazing occurs during the spring–summer breeding season, and possibly forced dispersal if habitat structural integrity is substantially degraded throughout a small habitat patch. Grazing and trampling may generally impact on survival and productivity due to reduction or loss of food, shelter and nest sites. There are numerous instances of cattle markedly impacting on the structural integrity of occupied swamp habitat, especially in the intensively used northern part of the MLRSEW's range (i.e. Myponga–Mount Compass–Tookayerta Creek–lower Finniss River region), and cattle grazing may have directly contributed to declines or local extinction of several small swamp populations (e.g. Willowburn Swamp, Site 12; Upper Deep Creek Swamps, Site 36; Double Bridges Swamp, Site 21; and Ex Nangkita Study Site—Patch 3, Site 7) (M. Pickett unpubl. data). Sheep, being smaller and lighter than cattle, have relatively much less impact (i.e. in terms of grazing, trampling, pugging and erosion) on swamp habitat condition.

In addition to direct impacts on vegetation structure and floristic composition, inappropriate grazing regimes (e.g. too intense, too frequent, seasonally severe) may result in long-term changes in habitat structure due to changed plant population dynamics (e.g. altered recruitment, increased mortality), with consequent negative impacts on habitat suitability.

Many potential but degraded habitat patches are grazed, especially in swampy areas, and this also threatens the MLRSEW by restricting or compromising future habitat and population re-establishment options (e.g. linkage corridors, and sites for natural reoccupation or translocation).

Other threatening processes such as drought (see section 5.4.2 Drought) may worsen the threat posed by livestock grazing. For example, when usual stock-feed supplies are low during drought period, stock levels in traditionally lightly grazed habitat patches might be increased above usual rates, seasonal grazing patterns altered (e.g. increased summer grazing), or habitat patches normally excluded (or even formally protected) from grazing (especially swamps) might be grazed. Furthermore, the frequency, severity and duration of drought may be exacerbated by climate change (see section 5.4.23 Climate change).

Substantial damage to native vegetation due to livestock grazing constitutes a form of clearance under the SA *Native Vegetation Act 1991*.

5.4.7 Deliberate burning

Deliberate burning (excluding malicious acts leading to bushfire—see Section 5.4.1 Bushfire above) is a minor threat, mainly to MLRSEW populations in swamp habitat. Historically, the practice was used to reduce vegetation biomass for the purposes of conversion to pasture or to encourage growth more palatable to livestock, sometimes in conjunction with prior application of herbicide to promote foliage death and flammability, but the practice appears to be rare nowadays. There may be resultant nest failure if the burning occurs during the spring–summer breeding season, and most likely a forced dispersal if the habitat throughout a small habitat patch is substantially degraded. Burning may generally impact on survival and productivity due to reduction or loss of food, shelter and nest sites.

Inappropriate deliberate burning regimes (e.g. too frequent) may result in long-term changes in habitat structure, with consequent impacts on habitat quality.

Deliberate burning of native vegetation constitutes a form of clearance under the SA *Native Vegetation Act 1991*.

5.4.8 Mining

Mining is currently a minor, but potentially major (in terms of key sites), threat to MLRSEWs. Sand mining adjacent to swamps in the Mount Compass district potentially threatens the structural integrity of swamp habitat due to hydrological impacts, such as altered water tables, reduced water quality and changes to the flow regimes to the swamp systems. As such, ex-situ sand mining may potentially impact on survival and productivity due to consequent reduction or loss of food, shelter and nest sites, but data or anecdotal evidence demonstrating such an impact are lacking. Major impact would result if relatively large, occupied swamp patches (e.g. Glenshera Swamp, Square Waterhole Swamp) were affected. Other forms of mining (ex-situ or in-situ) could conceivably impact on MLRSEWs through direct loss, fragmentation or isolation of habitat due to associated vegetation clearance, or indirectly due to the effects of atmospheric (e.g. dust) and hydrological perturbations on habitat condition.

5.4.9 Water extraction

Water extraction (e.g. dams, wells, bores) is potentially a major threat to MLRSEW populations in swamp habitat. This includes those forms of water extraction that are not accounted for within existing or planned legislation, such as stock and domestic dams, for which the cumulative impacts could potentially be quite substantial. Water extraction potentially reduces stream flows and lowers water tables, thereby affecting the condition of vegetation and soil, especially peat, and therefore structural integrity of swamp habitat. As such, it may potentially impact on MLRSEW survival and productivity due to consequent reduction or loss of food, shelter and nest sites. Data demonstrating such an impact on MLRSEWs are lacking, but there are anecdotal reports of impacts on unoccupied swamp habitat.

Water extraction impacts may worsen during drought periods (see section 5.4.2 Drought), the frequency, intensity and duration of which may be exacerbated by climate change (see section 5.4.23 Climate change).

5.4.10 Swamp drainage

Swamp (surface-water) drainage is an ongoing major threat to MLRSEW populations in swamp habitat. Historically, deliberate swamp drainage has been used to convert swampy areas to pasture, prevent loss of pasture due to swamp incursion, or divert water to dams, water-wheels or away from infrastructure (e.g. houses, sheds and roads). Swamp drainage lowers swamp water tables, thereby threatening vegetation condition and therefore structural integrity of swamp habitat. As such, it may potentially impact on MLRSEW survival and productivity due to consequent reduction or loss of food, shelter and nest sites. It has evidently had a major impact on past and present swamp distribution and condition, with drainage canals evident in all swamp systems. Furthermore, swamp drainage threatens the MLRSEW by restricting or compromising future habitat and population re-establishment options (e.g. linkage corridors and sites for natural reoccupation or translocation).

5.4.11 Plantation forestry

Plantation forestry is potentially a major threat to MLRSEW populations, mainly in swamps that occur in areas having suitable physical (e.g. soil, slope, access) and climatic attributes (e.g. rainfall) for plantation establishment. Plantation forestry has the potential to have hydrological (e.g. drying,) or ecological (e.g. shading and weed incursion) impacts on adjacent swamp habitats, thereby threatening vegetation condition and structural integrity of swamp habitat. As such, it may potentially impact on MLRSEW survival and reproductive success due to consequent reduction or loss of food, shelter and nest sites.

Historically, radiata pine *Pinus radiata* plantations have been widely established in the MLR region, but the extent of MLRSEW habitat clearance to establish these, or resultant habitat fragmentation and/or isolation, has not been investigated. More recently, Tasmanian Blue Gum *Eucalyptus globulus* plantations have been established, or planned for establishment, in close proximity to swamp areas, and this constitutes a potentially major threat to swamp habitat. Plantation forestry also threatens the MLRSEW by potentially restricting or compromising future habitat and population re-establishment options (e.g. linkage corridors, and sites for natural reoccupation or translocation). Despite the perceived risk, data regarding hydrological perturbations to swamp habitats due to plantation forestry are very limited.

5.4.12 Residential development

Residential development is a minor threat to MLRSEWs. The greatest threat is to swamps in the rather highly developed urban/rural areas (e.g. Mount Compass district), due to incremental degradation, fragmentation or loss of habitat resulting from vegetation clearance associated with infrastructure (e.g. houses, sheds, fences, tracks, bridges, culverts, irrigation systems, water-supply systems) or localised land-use impacts (e.g. intensification of grazing, changes in livestock type, weed invasion, dogs, cats, fire-hazard reduction, pollution, recreational pressure). As such, residential development may impact on MLRSEW survival and reproductive success due to consequent disturbance, or reduction or loss of food, shelter and nest sites. Although the overall threat is considered minor, impacts are potentially substantial at a local scale or incrementally.

5.4.13 Changes in land-use affecting alienated but potential habitat

Apart from the specific known or potentially threatening land-uses referred to above, more general changes in land-use for existing alienated habitat areas potentially threaten MLRSEW recovery through lost habitat re-establishment options, such as patch augmentation or linkage corridors. This is especially the case where land-use changes are associated with relatively substantial and permanent infrastructure development (e.g. a commercial plantation) and has already been realised in some areas, for example where intensive viticultural development has occurred across potential corridor locations (e.g. east of Cox Scrub CP).

5.4.14 Weed invasion

Weed invasion is a minor threat to MLRSEWs. Weeds degrade the floristic and structural integrity of habitat, primarily swamp habitat, where woody weeds such as Gorse *Ulex europaeus*, Blackberry *Rubus* spp. and Montpellier broom *Genista monspessulana* are of most concern. Where weeds threaten to dominate occupied habitat, MLRSEW survival and productivity may be reduced due to reduction or loss of preferred or typically-used food, shelter and nest sites. Data regarding such impacts are lacking, but there are data illustrating how woody weeds can occasionally benefit SEWs by providing foraging habitat (Blackberry: Fletcher 1915; McNamara 1937), links between habitat patches (Blackberry: Pickett 2000), or even nest sites (Blackberry: Fletcher 1915; Pickett 2000; and Gorse: Maguire and Mulder 2004). The extent to which native or alien plants are associated with such use is rarely noted, but weeds alone are very unlikely to provide breeding habitat. Intensive weed-control works may disturb MLRSEW foraging or breeding (e.g. cause nest failure).

Climate change may exacerbate the threat of weed invasion. For example, habitat increasingly disturbed or stressed by flooding, wildfire, storm or drought may be more vulnerable to invasive alien species (Bardsley 2006; see section 5.4.23 Climate change). Increased weed invasion may in turn change the water balance of MLRSEW habitat, especially in swamp habitat.

Potential invasion by alien tree species (e.g. Tasmanian Blue Gum *Eucalyptus globulus*) may also pose a threat to the structural integrity of MLRSEW habitat.

5.4.15 Dieback due to *Phytophthora*

Dieback due to root-rot fungus *Phytophthora* spp., a key threatening process listed under the EPBC Act, is a potential, albeit probably minor, threat to MLRSEWs. *Phytophthora* is a plant pathogen that can be transported between infected sites in water or soil and potentially threatens MLRSEWs due to its capacity to kill key habitat species (e.g. Yacca *Xanthorrhoea semiplana*, bush-peas *Pultenaea* spp. and tea-trees *Leptospermum* spp.; DEH 2004) with consequent degradation of habitat quality and therefore reduced survival or productivity due to a reduction or loss of food, shelter and nest sites. Both dry-heath and swamp habitats in areas with sufficient rainfall (>500 mm yearly average) and high-risk soils (neutral–acid with poor drainage and low in nutrients and organic matter) are susceptible (Phytophthora Technical Group 2006; DEH 2004). No known *Phytophthora* infections are currently impacting occupied MLRSEW habitat, but suspected or confirmed infections have been recorded near MLRSEW habitat (e.g. Deep Creek CP).

5.4.16 Demographic stochasticity

Demographic stochasticity is considered a major threat to MLRSEWs. Demographic stochasticity refers to the unpredictable variability in population growth rates arising from random differences amongst individuals in seasonal survival, reproduction and sex ratios, i.e. it is independent of external environmental factors (Frankham *et al*. 2002). In small populations, such variation may be the ultimate cause of extinction, e.g. single-sex

(sexually reproducing) populations. Furthermore, since populations comprise a finite, integer number of individuals, demographic stochasticity can have an important effect on small populations, which, across seasons, can drift to extinction due to random within-season variation even if expected birth rates are higher than death rates on average (Krebs 1994; Akçakaya *et al*. 1999). This phenomenon is particularly relevant to the MLRSEW, which largely occurs in small populations and for which available demographic data are not conducive to a stable or growing population (see section 4.3 Demographic Parameters), and offers a plausible explanation for some recorded local population losses (see section *4.5.1b Recent distribution changes*). It therefore mainly potentially effects small populations in swamps, but also existing or future small re-established populations in dry-heath (e.g. Cox Scrub CP).

5.4.17 Genetic stochasticity

Genetic stochasticity is probably a relatively minor threat to the MLRSEW, although information is lacking and its impact may be markedly underestimated. Genetic stochasticity refers to random changes in the genetic composition of a population and encompasses consequences such as loss of genetic diversity, inbreeding depression, and deleterious mutation accumulation (Frankham *et al*. 2002). Random changes in genetic composition through time (i.e. genetic drift) can impact on the genetic character of populations by reducing genetic variation and increasing the likelihood that deleterious genotypes are expressed. Loss of genetic diversity could limit a population's capacity to respond adaptively to environmental changes or fluctuations, and increased expression of deleterious recessive alleles (increased homozygosity) could reduce individual survival and reproductive capacity (inbreeding depression). As for demographic stochasticity (5.4.16 Demographic stochasticity), this phenomenon is potentially very relevant to the MLRSEW because small populations, such as occur in many swamps or those re-established by translocation, are most vulnerable, and its potential impacts should not be ignored (e.g. Brook *et al*. 2002; Frankham 2003; Spielman *et al*. 2004). Unlike demographic stochasticity, the impacts of genetic stochasticity are dependent on effective population size, which relates to 'genetic' size rather than (usually larger) census population size (Frankham *et al*. 2002).

5.4.18 Introduced predators

Introduced predators are currently considered a minor threat to MLRSEWs, but more information is needed to confirm this view, especially given the potential impact on MLRSEW survival and reproductive success. It is thought that the dense, structurally complex and comparatively impenetrable nature of MLRSEW habitat affords substantial protection to adults and young from relatively large animals such as Cats *Felis catus*, a known (Maguire and Mulder 2004) or likely (Littlely and Cutten 1994; Higgins *et al*. 2001) predator, and European Red Foxes *Vulpes vulpes*, especially in swamps (Pickett 2000), which are particularly dense near ground level and probably less accessible to these predators due to periods of inundation. Young MLRSEWs are probably most vulnerable during nesting and cryptic post-fledging stages. Predation by feral cats and foxes is a key threatening process listed under the EPBC Act, but overall risk to MLRSEWs from feral cats has been rated as low (Dickman 1996). Predation by foxes has not been recorded, but the risk is probably similar. Introduced Black Rats *Rattus rattus* and Norway rats *R. norvegicus*, both known serious predators of birds, especially on islands (e.g. Atkinson 1977, 1985), are also potential predators of MLRSEWs, particularly their eggs or nestlings (Caughley *et al*. 1998), but this has not been recorded.

Climate change may exacerbate the threat posed by introduced predators by changing the population dynamics of such species (Bardsley 2006; see section 5.4.23 Climate change).

5.4.19 Native predators and parasites

Native predators and parasites are currently considered minor threats to MLRSEWs, but more information is required to confirm this view. Snakes and cuckoos (brood parasites) probably have a greater influence on MLRSEW reproductive success than introduced predators, and may be a major predator of nestlings. This view is supported by research on Victorian SEWs (Maguire and Mulder 2004), but more conclusive evidence is required. Cuckoos, especially bronze-cuckoos *Chrysococcyx* spp., which favour small passerine hosts with domed nests (Higgins 1999), are a known brood-parasite of SEWs (Fletcher 1915; Maguire and Mulder 2004; Pickett in prep. a). Very small MLRSEW populations are probably at greatest risk (Pickett in prep. b), however, the impact of cuckoos and snakes on MLRSEWs is poorly understood. Diurnal raptors that hover-search, such as Australian Kestrels *Falco cenchroides* and Black-shouldered Kites *Elanus axillaris*, hunt (e.g. skinks, rodents) in MLRSEW habitat (M. Pickett pers. obs.), but are not known to prey on MLRSEWs. Large native rodents such as Swamp Rats *Rattus lutreolus*, often common in swamps (Littlely 1998), and Bush Rats *R.*

fuscipes are not considered a threat to MLRSEWs, since both are predominantly herbivorous with animal prey restricted to arthropods (Cheal 1987; Norton 1987; *pace* Watts 1972 re *R. lutreolus*).

5.4.20 Vegetation succession

Vegetation succession, which refers to the natural, progressive change in vegetation's floristic and structural character through time, is potentially a major threat to MLRSEWs. Floristic and structural changes may lead to reduced habitat quality, which in turn potentially leads to reduced survival or productivity due to a reduction or loss of food, shelter and nest sites. For example, vertical and horizontal density of a critical (i.e. for foraging, shelter and nesting) ground or understorey layer may be reduced, an emergent or open shrub layer may be lost or thicken to form an unfavourable tall, dense shrub layer, or an unfavourably dense tree canopy may form. This process is occurring to varying degrees at all occupied sites, with evidence of impact on MLRSEWs (reduced population density) at one or two sites, e.g. Glenshera Swamp and dry-heath in Deep Creek CP (M. Pickett pers. obs.).

The spatial and temporal dynamics of vegetation communities are often influenced by disturbance events (Pickett and White 1985) and in spite of the threat posed by fire (see section 5.4.1 Bushfire), it probably plays a major role in the long-term maintenance of MLRSEW habitat. That is, the existence of post-fire age-classes, or successional stages, that provide swamp or dry-heath habitat is doubtless ultimately dependant on maintenance of particular fire regimes. This presents a dilemma regarding reactive or active management options, i.e. whether to let bushfires burn unhindered, fight bushfires, or perform controlled burns (Richards *et al*. 1999).

5.4.21 Fragmented/isolated habitat

Fragmented habitat and isolated habitat are major threats to long-term persistence and recovery of the MLRSEW. The terms fragmented and isolated have similar meaning, but fragmentation means overall division (natural or anthropogenic) of habitat suitable for occupancy into patches that may be discrete but are not necessarily disconnected in terms of potential for inter-patch movement, whereas isolation of habitat is absolute separation with no meaningful connectivity. Because more or less contiguous dense vegetation appears to be necessary for dispersal (see section 4.4 Dispersal), these habitat-configuration states threaten the MLRSEW at the population and landscape level. For example, natural recolonisation following local extinction may be very unlikely or impossible, as might colonisation of newly available habitat patches. Survival, reproductive success and capacity to adapt to long-term environmental changes may be diminished due to reduced genetic variability (inbreeding depression). Fragmented habitat and isolated habitat are interrelated to the threat posed by a lack of habitat (see section 5.4.22 Lack of habitat), and attributing factors include past habitat loss, current land-use and natural barriers. The MLRSEW population as a whole is highly fragmented and isolation affects all population groups outside Deep Creek CP (Appendix I).

5.4.22 Lack of habitat

Lack of habitat is a major threat, because present MLRSEW habitats are restricted in distribution, extent and quality. It is a threat to long-term recovery in terms of potential for population growth, potential for increased area of occupancy, population viability given spatial and temporal variability in habitat quality, and inter-patch movement, but is not considered a threat to short-term persistence. The importance of this threatening condition is based on the assumption that the MLRSEW once occurred wherever suitable habitat formerly occurred (see section 4.5 Distribution) and that habitat loss has contributed to population decline. Lack of habitat is primarily a condition that has resulted from past threatening processes such as land clearance, livestock grazing and swamp drainage (see section 5.4.B Land-use Threats).

5.4.23 Climate change

Climate change is a potentially major threat to the MLRSEW. Overall, climate change is expected to lead to increased risks, frequencies and intensities of floods, fire, storms and droughts in many regions, and could increase the risk of abrupt and non-linear changes in many ecosystems, which would affect their function, biodiversity, and productivity (IPCC 2001). Warming and drying trends are anticipated for much of South Australia, including the Mount Lofty Ranges (Suppiah *et al.* 2006). Biodiveristy in the Mount Lofty Ranges is considered particularly vulnerable to climate change impacts (Bardsley 2006).

For the MLRSEW then, climate change potentially exacerbates the overall impact of catastrophes and land-use threats (see section 5.4. Overview and Priority of Current Threats). It may also change the distribution and

amount of habitat available, due to vegetation responses. Whether this means more or less habitat has not been determined, but the area and quality of swamp habitat would decrease if a substantially dryer regional climate prevailed, whereas the amount of dry-heath habitat could conceivably increase due to changes in currently wetter forest plant communities. In any event, the capacity of the MLRSEW to naturally change its distribution to adjust due to climatically-induced shifts in habitat distribution would be limited due to fragmented and isolated habitat. Furthermore, levels of genetic diversity may already be low, especially for the smaller populations, and lost genetic diversity reduces the capacity to evolve in response to climate change (Frankham *et al*. 2002).

5.5 Populations and Areas under Threat

All MLRSEW populations and occupied areas (Appendix I) are potentially threatened by bushfire. All populations outside Deep Creek CP are variously threatened by land-use threats, lack of habitat and fragmented/isolated habitat. Risk of impact due to land-use threats is probably greatest for populations and habitats in the highly developed northern part of the MLRSEW's distribution (i.e. Myponga–Mt Compass–Tookayerta Creek–Finniss River region), although this needs be confirmed through a systematic analysis of threats.

5.6 Knowledge Gaps

Targeted studies of MLRSEWs have been underway for some time. The program has identified key knowledge gaps regarding:

- connectivity habitats and populations;
- population size and distribution in the two most significant sites;
- metapopulation dynamics;
- response to translocation;
- emerging threats and the nature of risk posed by climate change;
- predation and parasitism; and
- habitat carrying capacities, optimization and resource limitations.

Also see the MLRSEW Conservation Strategy (Pickett in prep c) for a Research Prospectus.

5.7 Operational Considerations

The recovery of MLRSEWs will require the integration of many actions in a complex natural resource management environment. It is particularly important that the recovery program maintains good structures, processes and appropriate stakeholder participation for sound decision-making and that the program attracts adequate funding to implement the recovery plan. Also the program needs to continue to be well integrated both internally and within the regions of the Adelaide MLR and SAMDB, and that there is adequate information management, monitoring and evaluation to maximize outcomes.

6.0 Affected Interests

6.1 Stakeholders

Stakeholder support and participation is essential for long-term recovery. Acceptance by relevant statutory authorities, industries and landholders of ongoing responsibilities for the cessation and management of threats is critical to achieving a long-term vision of stakeholder–community-based management (see section 7.3 Recovery Plan Objectives, Performance Criteria and Timelines).

An overview of key stakeholders in MLRSEW population and habitat management is presented in Table 5. Of these stakeholder groups, nine own or manage areas known to be current or potential habitat (dry heaths and swamps) for MLRSEWs. A more thorough stakeholder analysis and operational guidelines for communication are to be provided in a Communication Strategy (Cantono and Russell, in prep.).

Table 5. **Key stakeholders in MLRSEW population and habitat management.**

Key Stakeholder	**Relative Priority**
Regional Stakeholders	
Adelaide and Mount Lofty Ranges NRM Board (including Fleurieu and Southern Groups)	High
Commercial natural resource management advisors/contractors	
Country Fire Service brigades	
Dairy industry groups	
District Bushfire Prevention Committee	
District Council of Alexandrina*	
District Council of Victor Harbor*	
District Council of Yankalilla*	
Local Action Planning groups (including Goolwa-Wellington LAP)	
SA Murray-Darling Basin NRM Board (including Ranges to River Group)	
Sheep and cattle graziers	
Viticulture groups	
City Of Onkaparinga*	Medium
District Council of Mt Barker	
Fleurieu Development Board	
Friends of (conservation) parks groups	
Local indigenous community	
National Parks consultative committees	
NRM volunteer groups	
Olive industry groups	
Private landholders on Fleurieu Peninsula (not primary industry)*	
Adelaide-MLR Natural Resource Centres	Low
Fleurieu Birdwatchers Inc.	
General Fleurieu Peninsula community	
Strathalbyn Field Naturalists	
State Stakeholders	
Adelaide Blue Gum and other Blue Gum industry groups	High
Conservation Council of South Australia	
Environment Protection Authority	
Native Vegetation Council	
Primary Industries and Resources SA (includes Planning SA)	
SA Department for Environment and Heritage*	
SA Department for Water, Land and Biodiversity Conservation	
South Australian Museum	
Threatened Species Network SA	
Birds SA	Medium
Department for Transport, Energy and Infrastructure*	
Extractive Industries (e.g. mining)	
Forestry SA*	
General public (including volunteers)	

National Parks Foundation of South Australia	
Nature Conservation Society of South Australia	
Nature Foundation SA	
Research Institutions including The University of Adelaide, Flinders University and University of South Australia	
SA Water Corporation	
South Australian Farmers' Federation	
Trees for Life	
Field Naturalists Society of South Australia*	Low
Greening Australia	
Plant Biodiversity Centre	
Threatened Plant Action Group	
Tourism SA	
Wine and Brandy Corporation	
National Stakeholders	
Australian Government Department of Environment and Water Resources	High
Birds Australia	Medium
CRC Weeds	
CSIRO – Division of Wildlife and Ecology	Low
General public	
World Wide Fund for Nature – Australia	

* Group directly owns and/or manages swamps and/or dry-heaths on the Fleurieu Peninsula

6.2 Role and Interest of Indigenous People

This recovery plan covers an area that includes the traditional lands of the Kaurna, Peramangk and Ngarrindjeri people.

The *Native Title Act 1993* applies to land where Native Title rights and interests may exist. When implementing any recovery actions in this Recovery Plan where there has been no Native Title determination, or no clear extinguishment of Native Title, there will be consideration of the possibility that Native Title may continue to exist.

The relevant provisions of the *Native Title Act 1993* will be considered before undertaking any 'future acts' (i.e. recovery actions in this Recovery Plan) that might affect Native Title rights and interests.

This Recovery Plan is released and will be adopted subject to any Native Title rights and interests that may continue in relation to the land. Nothing in this plan is intended to affect Native Title.

Procedures under the *Native Title Act 1993* are additional to those required to comply with the *Aboriginal Heritage Act 1998.*

A draft of this Recovery Plan will be referred to the Aboriginal Partnerships Section of the SA Department for Environment and Heritage, who will undertake consultation with the relevant indigenous communities. This consultation will assist in determining the role and interests of indigenous communities with regard to the implementation of this plan.

6.3 Social and Economic Impacts

This Recovery Plan is expected to have minimal adverse social and economic impacts on the Fleurieu Peninsula community. The Recovery Team recognises that some short-term development and or production opportunities may be foregone, but these are likely to be offset by improved land management practices and improved water quality in swamp and riparian systems leading to potential increases in productivity and efficiency. For example some landholders engaged with the Recovery Program have indicated that exclusion of stock from swamp habitat has actually been beneficial by not having to search for stock within these remnant systems. The hydrological benefits through swamp protection are also significant with healthy swamps acting as natural filters that buffer catchments from excessive flooding and pollution. Potential for declining water flows to swamps if catchments are revegetated with local native species is expected to be relatively negligible and may be offset by improvements to soil conservation and water quality. Substantial support has been provided by the Recovery

Program to enable the removal of environmental weeds within remnant systems and this has flow on benefits to productive land by reducing weed sources with many of the targeted weeds are being issues in an agricultural context. Minor alterations to land management practices to accommodate the MLRSEW and MLRSEW habitat management will be required of some land managers. However, the Recovery Program seeks every opportunity to support landholders in making these changes, and believes they will be offset by improved land management practices in the region with flow-on effects to improved ecosystem services. Further to this, the program will benefit the community by attracting funding and professional human resources to the area, promoting and fostering co-operative community teamwork and the development of community interest and skills in natural resource management. To date there has been substantial positive interaction between the Recovery Program and the agricultural and general community and many have subsequently adopted management practices that will benefit MLRSEW. The biological management of plant communities associated with the MLRSEW will also provide ecosystem services that may benefit agriculture production and produce positive social and economic impacts.

Another example of beneficial economic impact of the Recovery Program are improved biodiversity protection through better management of bushfires, with indirect benefits in reducing infrastructure damage during bushfire and costs (time) to re-establish habitats minimised. In addition the Program can potentially provide assistance (e.g. Heritage Agreement fencing) to landholders for fencing.

6.4 International Obligations

The actions identified in the Recovery Plan are consistent with Australia's obligations under the Convention on Biological Diversity, ratified by Australia in 1993 and the preceding National Strategy for the Conservation of Australia's Biological Diversity. This Plan does not impact on obligations made under the Convention on Wetlands, World Heritage or the Convention on International Trade in Endangered Species (CITES). The Latham's Snipe *Gallinago hardwickii,* part of the Convention on Migratory Species, may benefit from wetland management actions in this plan.

6.5 Benefits to Other Species/Ecological Communities

Through the work of the Recovery Program the Fleurieu Peninsula swamps were listed as a Critically Endangered Threatened Ecological Communities under the EPBC Act.

Protection and appropriate management of MLRSEW habitat will conserve a wide variety of taxa, many of which are presently recognised as being of high conservation significance on a regional basis. Biodiversity benefits to swamp ecological communities are viewed as being closely associated with the implementation of MLRSEW conservation objectives.

As previously mentioned, Fleurieu Peninsula swamps are essentially unrepresented in the SA reserve system (with the major exception being Stipiturus Conservation Park which predominately contains Fleurieu Peninsula Swamps). Both Davies (1982) and Williams and Goodwins (1987) described these swamps as being in critical need of further conservation. Appropriate conservation efforts directed at the MLRSEW can be expected to enhance and encourage conservation of these particularly important ecological communities.

Lang and Kraehenbuehl (1987) calculated that 42% of the plants of conservation significance on the Fleurieu Peninsula are confined to upland freshwater swamps. The 1993 survey (Littlely and Cutten 1994) and subsequent vegetation survey (Littlely 1998) have confirmed this very high incidence of plants of conservation significance within the swamps. Littlely and Cutten (1994) and Littlely (1998) provide lists of plant species recorded from 41 and 12 swamp sites on the Fleurieu Peninsula respectively. The survey of 41 sites recorded 66 plants of conservation significance, and the survey of 12 swamp sites recorded 54 plants of conservation significance, although many species were common to the resulting two species lists (Littlely 1998).

Findings regarding MLRSEW behaviour and management may be of invaluable assistance in the conservation of other species/subspecies of emu-wren, such as the Mallee Emu-wren *S. mallee,* Eyre Peninsula Southern Emu-wren *S. malachurus parimeda* and Dirk Hartog Island Southern Emu-wren *S. m. hartogi* (Garnett and Crowley 2000; EPBC Act).

Other threatened birds that would benefit from efforts to conserve the MLRSEW include the Lewin's Rail *Rallus pectoralis* (Vulnerable), Spotless Crake *Porzana tabuensis* (Rare), Latham's Snipe (Vulnerable), and Golden-headed Cisticola *Cisticola exilis* (Rare), (NPW Act). Each of these species has been recorded in swamps used by MLRSEWs and also in other swamps that comprise apparently suitable emu-wren habitat (M. Pickett, pers. obs.).

Other vertebrate fauna which would benefit include a range of species of conservation significance that have been recorded in Fleurieu Peninsula swamps. Included are several threatened native fish (threatened in SA; Lamprey and Mitchell 1979), the Yellow-bellied Water Skink *Eulamprus heatwolei* (considered vulnerable in SA; preliminary classification, M. Hutchinson in Littlely 1988), and Bibron's Toadlet *Pseudophryne bibronii* (considered rare in SA; preliminary classification, M. Hutchinson in Littlely 1988).

Similarly, conservation and appropriate management of swamp communities will benefit species listed in the Recovery Statement for the Fleurieu Peninsula Swamps 2007-2011 (Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamp Recovery Program 2007) as well as species of regional conservation concern. FPS are also regionally important in terms of invertebrate conservation. Numerous important swamps occur along the Tookayerta Creek. A study of the aquatic macroinvertebrate fauna of this creek system (Suter 1987) found the most diverse mayfly (Ephemeroptera) and stonefly (Plecoptera) faunas in SA, and identified two species unique to the catchment; *Nousia fuscula* (Ephemeroptera) and *Leptoperla tasmanica* (Plecoptera). Furthermore, of the 143 taxa recorded, 24 had not previously been recorded from any other stream in the Mt Lofty Ranges or the River Murray in SA. More recent sampling efforts in Fleurieu Peninsula swamps (Littlely 1998) found several beetles of significance: *Acanthoferonia ferox* (Carabidae), previously thought to be extinct; *Platynectes bakewelli* (Dytiscidae), first record for SA; *Parosten gibbir* (Dytiscidae), a rare species; and a new species of *Cyphon* (Scritidae).

7.0 Objectives and Performance Criteria

7.1 Long-term Objectives

The proposed long-term objectives (25 year vision) for this Recovery Plan are to achieve through community engagement:

1. the downlisting of the MLRSEW to Vulnerable within 25 years;
2. statutory authorities, industry and landholders enabled to take responsibility for the management of threats to MLRSEW populations and habitats and ensuring that all new threats are identified and managed appropriately; and
3. established ongoing monitoring that has the capacity to catalyse intense recovery activities if significant declines are detected once the status of Vulnerable is achieved.

7.2 Strategy for Downlisting

The MLRSEW currently meets IUCN (2001) criteria for Endangered (EN B1ab(ii,iii,iv)+2ab(ii,iii,iv); see section 3.3 Conservation Status) due to restricted geographic range, severely fragmented population, and ongoing decline in range and habitat. There is little that can be done to address its extent of occurrence, since:

- preferred MLRSEW habitats have always been limited in extent[2]; and
- intensity of human settlement and land-use in the region precludes the type of broad-scale habitat and population expansion that would markedly influence extent of occurrence.

For the same reasons, it is very unlikely that the area of occupancy can be increased to greater than 500 km^2. Therefore, as there is no capacity to increase extent of occurrence or area of occupancy beyond EN thresholds, the focus of recovery efforts should be:

- increasing connectivity between existing populations; and
- maintaining and increasing:
  - area of occupancy;
  - area and quality of known and potentially suitable habitat;
  - number of locations or subpopulations; and
  - number of mature individuals.

The recovery approach should be based on threat-abatement, habitat re-establishment (including restoration of degraded habitats) and population management (including translocation) to address habitat and demographic limitations.

If recovery efforts are effective in increasing connectivity (reducing fragmentation), and area, extent and/or quality of habitat, and number of locations or subpopulations, as well as (at least) maintaining area of occupancy and number of mature individuals, it is feasible that the MLRSEW could be downlisted to Vulnerable (VU D1 *sensu* IUCN 2001[3]). This may be possible sometime during the next 10–25 years. Recovery efforts should thereafter, if necessary, focus on further increasing the number of mature individuals (i.e. to greater than 1,000) and the area of occupancy (if possible within habitat availability constraints) towards downlisting to Near Threatened[4] (NT *sensu* IUCN 2001).

7.3 Recovery Plan Objectives, Performance Criteria, and Timelines

7.3.1 Recovery Plan objectives

The Recovery Plan objectives are presented, along with key links to the relevant Recovery Actions.

1. Maintain and increase the conservation status of the MLRSEW and its habitat by:

[2] It is very unlikely that the former geographic range or extent of occurrence would have exceeded 5,000 km^2 as the area of the southern MLR is less than 5,000 km^2.
[3] VU D1 = Population size estimated to number fewer than 1,000 mature individuals.
[4] A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

1.1 maintaining and increasing the area of MLRSEW occupancy, number of locations or subpopulations, number of individuals and the area, extent and quality of MLRSEW habitat (actions 1–7);
1.2 increasing the degree of connectivity between existing MLRSEW populations (action 8); and
1.3 completing and maintaining a strategy for MLRSEW recovery (action 9) .

2. Maintain and increase the capacity to recover the MLRSEW and its habitat by:
   2.1 improving the knowledge and understanding of MLRSEW ecology and habitat (action 10);
   2.2 increasing stakeholder engagement, capacity and responsibility in relation to managing MLRSEW populations and habitats (action 11);
   2.3 monitoring, analysing and evaluating MLRSEW management and recovery effort (action 12); and
   2.4 facilitating the MLRSEW Recovery Program (action 13).

7.3.2 Performance criteria

The Performance Criteria based on the objectives for the life of the Recovery Plan are presented, along with key links to the relevant Recovery Plan Objectives and Actions.

1. Improve management of all known land-use and landscape threats at the majority of known occupied sites by 2011 (objective 1.1, action 1).
2. Input given to plans that minimise the risk of habitat loss due to wildlife by 2008 (objective 1.1, action 2).
3. Formally protect five MLRSEW populations and/or habitat sites not currently protected by 2011 (objective 1.1, action 3).
4. Identify new and emerging threats to MLRSEW populations and habitats and management options for addressing these threats annually (objective 1.1, action 4).
5. If required, at least one release at one translocation site completed by 2010 and ongoing monitoring as necessary (objective 1.1, action 5).
6. Re-establish habitat links and/or undertake extension activities for at least five MLRSEW populations (totalling approximately 50 ha) by 2011 (objective 1.1, action 6).
7. A measured increase in the area of MLRSEW occupancy due to Recovery Plan implementation by 2011 (objective 1.1, action 6).
8. Reconstruct habitat links and/or undertake habitat expansion for at least one MLRSEW population or area of potential habitat (totalling approximately 5 ha) by 2010 (objective 1.1, action 7).
9. Demonstrated increase in habitat connectivity between MLRSEW populations within two key areas by 2011 (objective 1.2, action 8).
10. Complete a strategy for MLRSEW recovery by 2008 and review at least every two years (objective 1.3, action 9).
11. Demonstrated improved knowledge and understanding of ecology and habitat by 2011 (objective 2.1, action 10).
12. Management of MLRSEW populations and habitats integrated into relevant land-use and landscape policy, planning and industry standard processes by 2009 (objective 2.2, action 11).
13. Demonstrated increased capacity and willingness of stakeholders to take responsibility for MLRSEW recovery by 2011 (objective 2.2, action 11).
14. MLRSEW population, MLRSEW habitat and stakeholder engagement monitoring undertaken and used to guide future management efforts by 2009 (objective 2.3, action 12).
15. Maintain the technical and funding base for recovery program coordination for the period of this Recovery Plan (objective 2.4, action 13).

8.0 Recovery Actions and Action Milestones

This Recovery Plan identifies 13 Actions for the five-year period 2006-2011, as shown below:

Please note:

# indicates actions likely to benefit MLRSEWs but have limited benefits for the Fleurieu Peninsula Swamps TEC; and

* indicates actions likely to commence in the latter half of the Recovery Plan's life

"Responsibility" in the context of this plan is intended to highlight stakeholders who may have a role (either currently or in the future) in implementing this action. Responsibility does not necessarily equate to an additional investment of resources or reporting obligation.

"Estimated costs" are those deemed necessary for the Recovery Program to implement the action identified.

Objective 1: Maintaining and increasing the conservation status of the MLRSEW and its habitat (objective 1; links with actions 1–9)

ACTION 1 Manage all known land-use and landscape threats to MLRSEW populations and habitats:

Landscape Scale:

ACTION 1a: Identify and prioritise factors contributing to the degradation of MLRSEW habitats.

ACTION 1b: Continue to provide information and expert advice to relevant authorities, industries and landholders regarding the management of habitat degradation threats to MLRSEW habitats.

ACTION 1c: Continue to provide expert advice to regional biodiversity conservation programs (e.g. weed management programs) to minimise degradation of MLRSEW habitat whilst maintaining other biodiversity outcomes.

ACTION 1d: Provide information and expert advice to relevant statutory authorities, industries and landholders regarding the likely impacts of changes in quantity and quality of ground and surface water on MLRSEW wren habitats.

ACTION 1e: Undertake a risk assessment of dieback from *Phytophthora* spp. for MLRSEW habitats, which identifies relative risks and strategies to minimise habitat loss.

ACTION 1f: Implement *Phytophthora* standard operating procedures where required, especially in relation to bushfire suppression and promote these to the wider community.

ACTION 1g: Continue to provide to agencies and land managers responsible for preparing and implementing biodiversity, reserve and land management plans information and expert advice relating to the conservation and management of local MLRSEW populations and MLRSEW habitats.

ACTION 1h: Continue to support existing control programs for feral Cats *Felis catus* and European Red Foxes *Vulpes vulpes* and other pest animals where MLRSEW populations occur. #

ACTION 1i: Implement predator and/or parasite control programs if identified as important. # *

Land Use Scale:

ACTION 1j: Identify highest priority sites where existing land management practices need to be modified to manage MLRSEW populations and habitats.

ACTION 1k: Engage and consult with landholders regarding possible modifications to current land management practices to ameliorate degrading influences.

ACTION 1l: Continue to provide information and expert advice to assist land managers, land management advisors and regional NRM officers to prepare and implement property management plans which provide for current and potential MLRSEW habitats.

ACTION 1m: Continue to provide information and expert advice to planning authorities and land management agencies regarding proposed developments and changes in land-use affecting MLRSEW habitats, with particular reference to potential effects on (a) efforts to ameliorate degrading influences and (b) future opportunities to restore habitat.

ACTION 1n: Contribute to review and revise planning policies affecting land management, land-use and natural resource management in the Fleurieu Peninsula and Southern MLR regions.

Action milestones:

- landscape and land-use degradation factors identified and prioritised;
- improved management of known land-use and landscape threats demonstrated;
- *Phytophthora* dieback risk assessment undertaken;

- highest priority sites identified where modified land management practices are required, along with planning and policy documents that support management of land-use and landscape threats to achieve conservation outcomes for MLRSEW populations and habitats; and
- landholders engaged in the implementation of property management plans that contribute to the conservation and management of local MLRSEW populations and habitats.

Key links: objective 1.1, performance criterion 1.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) sections 5.2.2 and 5.2.3.

Justification: Local MLRSEW populations are vulnerable to ongoing degradation of swamp and dry-heath habitats. The Recovery Program has provided advice to landholders and planning authorities regarding amelioration of degrading influences. As well as preventing degradation, existing habitat patches require improvement to promote persistence of local populations.

Habitat management actions for MLRSEWs need to include consideration of the state, condition and likely trajectory of both dry-heath and swamp habitats. Appropriate disturbance regimes may be required to maintain a range of successional stages in both habitat types in order to maintain habitat suitability in the longer term (also see Recovery Statement for the Fleurieu Peninsula Swamps 2007-2011 (Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamp Recovery Program 2007).

MLRSEWs appear to tolerate weeds provided their requirements for a dense ground layer are met. This has broader implications for regional efforts to control weeds such as Blackberry and, in some cases, a staged removal of weeds may be appropriate.

Techniques for improving habitat quality and managing habitat degradation threats will be identified through Actions 1a, 10b, 10c, 12d and 12e.

Both dry-heath and swamp habitats in MLRSEW areas with sufficient rainfall and high-risk soils are susceptible to dieback and consequent degradation of habitat quality (see section 5.4.15 Dieback due to *Phytophthora*). Although there is limited information regarding the effects this may have on MLRSEW populations, the risk of infection should be minimized as a precaution.

Further research into the impact of predators, both native and introduced, is needed to clarify the importance of these potential threats (see section 5.4.18 Introduced predators). As a precautionary measure existing control programs for feral Cats *Felis catus* and European Red Foxes *Vulpes vulpes* should continue.

Known land-use and management threats such as inappropriate stock grazing and inappropriate slashing or weed control in MLRSEW habitats should be replaced by appropriate management practices in accordance with technical advice provided by the recovery program through extension and communication material and activities. The management advice also should consider risks to other biodiversity assets in MLRSEW habitat.

Responsibility (including potential partners): Recovery Team, Project Manager, Project Officers, Landholders, DEH, Local Government, Planning SA, Forestry SA, NRM Boards and authorised officers.

Estimated costs for Action 1:

Year	**2006/07**	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**TOTAL**
	82216.13	85810.89	95468.90	117479.21	97318.46	**$478,293.59**

ACTION 2 Implement protection measures for catastrophic threats:

ACTION 2a: Undertake a bushfire risk assessment for MLRSEW populations and habitats.
ACTION 2b: Continue to provide to agencies with responsibilities for preparing and implementing Fire Management Plans information and expert advice relating to distribution, abundance and significance of local MLRSEW populations and habitats to minimise potential losses in the case of bushfire.
ACTION 2c: Continue to provide information and expert advice regarding highest priority areas and habitats and strategies to minimise potential losses and integration of fire hazard reduction works with other habitat management actions to landholders, CFS, local government, SA DEH and DWLBC.

Action milestones:

- bushfire risk assessment completed by 2008;
- necessary information and guidance provided to organisations responsible for preparing fire management plans to minimize bushfire risk to all high priority MLRSEW populations; and
- input given to plans that minimise the risk of habitat loss due to bushfire by 2008.

Key links: objective 1.1, performance criterion 2.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.2.1.

Justification: Local MLRSEW populations are vulnerable to bushfire. Loss of either Deep Creek CP or Finniss Park Swamp local populations would severely reduce the total population of MLRSEWs (an estimated 50-80% of all individuals would be lost; Pickett unpubl. data; see section 4.6.1 Important populations). Bushfire could threaten the translocated population in Cox Scrub CP. Risk of loss to bushfire for *all* local populations is currently unassessed.

Information regarding MLRSEW populations and habitats has been provided to the relevant agencies but is not yet fully incorporated into regional bushfire protection and planning and liaison with the organisations needs to continue.

Responsibility (including potential partners): Recovery Team, Project Manager, Project Officers, DEH, CFS, Local Government, Forestry SA, SA Water, landholders.

Estimated costs for Action 2:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	5486.35	33474.60	3183.85	3259.08	2980.35	**$48,384.22**

ACTION 3 Formally protect MLRSEW populations and habitats through reserves and covenants:

ACTION 3a: Identify highest priority MLRSEW populations and habitats for protection through the State's reserve system and private conservation covenants.

ACTION 3b: Investigate impediments to the use of formal agreements to conserve MLRSEW populations and habitats on private land. *

ACTION 3c: Facilitate the protection of highest priority MLRSEW populations and habitats through the State's reserve system and private conservation covenants by providing information and support to landholders, relevant land management agencies and NRM staff.

Action milestone:

- Five MLRSEW populations and/or habitat sites newly protected formally under the State's reserve system or under private conservation covenants.

Key links: objective 1.1, performance criterion 3.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.2.4.

Justification: The protection of MLRSEW populations and habitats in the State's reserve system or through private conservation covenants will help to secure the long-term commitment of landholders and land mangers to the species' recovery. It will also address some land-use and management threats affecting unprotected populations and habitat.

Responsibility (including potential partners): Recovery Team, Project Manager, Project Officers, landholders, SA DEH, NRM staff.

Estimated costs for Action 3:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	0	14714.76	4255.50	4383.16	4514.66	**$27,868.08**

ACTION 4 Recognise and address new and emerging threats to MLRSEW populations and habitats:

ACTION 4a: Review annually potential threats to identify new and emerging threats to MLRSEW populations and habitats.

ACTION 4b: Identify management options for addressing these threats (including climate change) and review and update Recovery Team activities that target existing threats.

Action milestones:

- new and emerging threats to MLRSEW populations and habitats identified at Recovery Team meetings; and
- management options for addressing new threats (including climate change) identified.

Key links: objective 1.1, performance criterion 4.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.2.5.

Justification: As land-use in the region is dynamic, and industries such as plantation forestry are expanding, new threats to MLRSEWs are likely to emerge over time.

The Recovery Team and Project Officers need to identify any new threats regularly, and this action and objective also needs to be considered in regional planning and policy setting (Action 11d). Options for addressing new threats should be identified as soon as possible.

Responsibility (including potential partners): Project Manager, Project Officers, Recovery Team, Landholders, LAP Boards, industry bodies, Local Government, DEH, DWLBC, Forestry SA, Planning SA, SA Water, EPA and NRM Boards.

Estimated costs for Action 4:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	4396.35	4608.65	4780.24	4923.65	5071.36	**$23,780.25**

ACTION 5 Scope options for increasing the area of MLRSEW occupancy through translocations:

ACTION 5a: Determine the feasibility of increasing the area of MLRSEW occupancy though translocation. #
ACTION 5b: Prepare a MLRSEW translocation proposal, if shown to be both desirable and feasible. #
ACTION 5c: Implement MLRSEW translocation. #
ACTION 5d: Monitor translocated MLRSEWs and source populations to assess translocation success. # *

Action milestones:

- translocation feasibility study completed; and
- at least one release at one translocation site and subsequent monitoring completed (if feasibility study supports the action).

Key links: objective 1.1, performance criterion 5.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.3.1.

Justification: Maintaining (which includes establishing new populations to offset anticipated local extinctions) and increasing the number of local populations, and ultimately the number of locations or subpopulations in which the MLRSEW occurs, is essential (also see Pickett 2001). Many local populations, population groups, or vacant habitat patches are isolated from each other. Reducing isolation and fragmentation is essential for enhancing population viability and facilitating additional occupied habitat through dispersal. Re-establishment of breeding (i.e. non-linkage) habitat through habitat restoration, patch augmentation or establishment of new patches is essential to increasing the area and quality of available habitat, and can facilitate increased area of occupancy and number of mature individuals. Re-establishment of linkage and breeding habitat therefore provides a passive means of re-establishing populations or increasing population size.

Translocation involves active manipulation of movement and demography. It is a widely accepted technique for active management of threatened passerines, with numerous successes (e.g. in New Zealand) and a means of establishing 'insurance' populations and spreading the risk of extinction across a greater number of sites. It is potentially the quickest means of establishing and supplementing populations (cf. natural reoccupation via re-established habitats). Translocation is a tool for establishing new populations to offset anticipated local extinctions and for genetic management of small populations (e.g. it may reduce extinction risk by minimising inbreeding and loss of genetic diversity), but is not a substitute for protection of existing populations *in situ.*

Responsibility (including potential partners): Recovery Team, Project Officers, Project Manager, DEH, landholders.

Estimated costs for Action 5:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	33191.25	37597.58	33884.94	41270.93	18459.36	**$164,404.06**

ACTION 6 Regenerate (potential) habitat adjacent and/or between existing habitats in key areas:

ACTION 6a: Identify highest priority sites for re-establishing habitat connecting and/or expanding existing sites.

ACTION 6b: Using incentives continue to facilitate habitat re-establishment at high priority sites.

ACTION 6c: Continue to provide information and expert advice to assist land managers, land management advisors and regional NRM officers to prepare property management plans that incorporate appropriate re-establishment of MLRSEW habitat.

ACTION 6d: Continue to integrate habitat re-establishment with NRM Resource Condition targets for Fleurieu Peninsula and other habitat establishment programs, e.g. Naturelinks.

Action milestones:

- highest priority sites for MLRSEW habitat re-establishment identified;
- re-establishment of habitat links and/or habitat expansion in progress for at least 5 MLRSEW populations (totaling approximately 50 ha) within 5 years; and
- measured increase in the area occupied by MLRSEW by 2011.

Key links: objective 1.1, performance criteria 6 and 7.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.3.2.

Justification: The area, quality and connectivity of habitats for MLRSEWs should be strategically increased to facilitate survival and expansion of MLRSEW populations. Considerable effort on habitat re-establishment has been expended as part of the previous recovery program (see Section 5) and this work needs to continue. Activities will be focused in two key regions (Pickett in prep. c)—Deep Creek–Parawa and Myponga–Mount Compass–Finniss River.

Restoration of swamp habitats for MLRSEWs needs to be consistent with objectives to restore Fleurieu Peninsula Swamps.

Responsibility (including potential partners): Recovery Team, Project Officers, Project Manager, landholders, LAP Boards, DEH, AMLR NRM and SA MDB NRM Boards, tertiary institutions.

Estimated costs for Action 6:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	0	2947.08	1149.98	0	0	**$4,097.06***

* Note that expenditure for these actions overlaps somewhat with Action 1, 7 and 8, thus reducing total expenditure here.

ACTION 7 Re-establish habitat potential adjacent and/or between existing habitats in key areas:

ACTION 7a: Identify highest priority sites for habitat re-establishment connecting and/or expanding existing sites.

ACTION 7b: Using incentives continue to facilitate habitat re-establishment at high priority sites. *

ACTION 7c: Continue to provide information and expert advice to assist land managers, land management advisors and regional NRM officers to prepare property management plans that incorporate appropriate re-establishment of MLRSEW habitat.

ACTION 7d: Continue to integrate habitat re-establishment with NRM Resource Condition targets for Fleurieu Peninsula and other habitat establishment programs e.g. Naturelinks.

Action milestones:

- highest priority sites for MLRSEW habitat re-establishment identified; and
- re-establishment of habitat links and/or extension in progress for at least one MLRSEW population (totaling approximately 5 ha) within 5 years.

Key links: objective 1.1, performance criterion 8.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.3.2.

Justification: The area, quality and connectivity of habitats for MLRSEWs should be strategically increased to facilitate survival and expansion of MLRSEW populations. Activities will be focused in two key regions (Pickett in prep. c)—Deep Creek–Parawa and Myponga–Mount Compass–Finniss River.

Re-establishment of swamp habitats for MLRSEWs needs to be consistent with objectives to restore Fleurieu Peninsula Swamps (Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamp Recovery Program 2007).

Reconstruction efforts must be closely linked to adaptive management research.

Action 7 will involve the same activities as Action 6 and Action 1 (managing and or eliminating threats), but addresses potential habitat rather than habitat that is currently occupied. Highest priority areas for implementing this action will be identified by Action 9.

Responsibility (including potential partners): Recovery Team, Project Manager, Project Officers, landholders, land management advisors, LAP Boards, SA DEH, AMLR NRM and SA MDB NRM Boards, SA DEH, Local Government, Forestry SA, NRM Boards and authorised officers, research/tertiary institutions.

Estimated costs for Action 7:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	0	4350.99	0	0	0	**$4,350.99***

* Note that expenditure for these actions overlaps somewhat with Action 1, 6 and 8, thus reducing total expenditure here.

ACTION 8 Increase degree of connectivity between existing MLRSEW populations.

ACTION 8a: Identify highest priority sites for habitat re-establishment connecting and/or expanding existing sites within two key regions.

ACTION 8b: Using incentives continue to facilitate MLRSEW habitat re-establishment at high priority sites.

ACTION 8c: Continue to provide information and expert advice to assist land managers, land management advisors and regional NRM officers to prepare property management plans that incorporate appropriate re-establishment of MLRSEW habitat.

ACTION 8d: Continue to integrate MLRSEW habitat re-establishment with NRM Resource Condition targets for Fleurieu Peninsula and other habitat establishment programs, e.g. Naturelinks.

ACTION 8e: Develop an indicator for estimating habitat connectivity within the two key regions identified and establish a baseline measurement prior to commencing on-ground recovery activities within the scope of this Recovery Plan.

Action milestones:

- highest priority sites for MLRSEW habitat re-establishment identified; and
- re-establishment of habitat links and/or extension in progress for at least five MLRSEW populations (totaling approximately 50 ha) within 5 years.

Key links: objective 1.2, performance criterion 9.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) section 5.3.2.

Justification: The connectivity of habitats for MLRSEWs should be strategically increased to facilitate survival and expansion of MLRSEW populations. Habitat connectivity activities will be focused in two key regions: the Deep Creek–Parawa region and the Myponga–Mount Compass–Finniss River regions where the greatest capacity to achieve population and habitat connectivity currently exists.

Restoration of swamp habitats for MLRSEWs needs to be consistent with objectives to restore Fleurieu Peninsula Swamps (Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamp Recovery Program 2007).

Priorities for re-establishing connectivity will be identified in the strategy prepared under Action 9.

Responsibility (including potential partners): Recovery Team, Project Officers, Project Manager, landholders, LAP Boards, DEH, AMLR NRM and SA MDB NRM Boards, MDB NRM Group, tertiary institutions.

Estimated costs for Action 8:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	0	4350.99	0	0	0	**$4,350.99***

* Note that expenditure for these actions overlaps somewhat with Action 1, 6 and 7, thus reducing total expenditure here.

ACTION 9 Complete and maintain a strategy for MLRSEW recovery.

Action milestone:

- Revised strategy for MLRSEW recovery completed by 2008 and reviewed at least every two years.

Key links: objective 1.3, performance criterion 10.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.).

Justification: Given the complexities of the MLRSEW recovery program, this Recovery Plan cannot accommodate the level of detail required for priority setting and identifying gaps in knowledge within these broad actions or for giving detailed methods and guidelines for implementation.

A strategy should be developed that will provide detailed and clear technical directions for achieving recovery objectives, by identifying the knowledge gaps, setting priorities within actions and providing technical guidelines for implementing actions. This strategy will inform the implementation of all actions.

Under the previous Recovery Plan documents such as 'The Mount Lofty Ranges Southern Emu-wren *Stipiturus malachurus intermedius* Recovery Program: Banding and Monitoring 1994-1999' (Pickett 2000), 'Revegetation for Mount Lofty Ranges Southern Emu-wren and Fleurieu Peninsula Swamps' (Duffield 2001) and 'Swamp Management Guidelines for the Fleurieu Peninsula' (Duffield and Hill 2002) partially fulfilled this role.

Where possible this strategy should build on and collate existing information. The strategy should be completed by June 2008 and reviewed and updated regularly to reflect new information and progress.

Specifically the strategy should address the following areas:

- identify guidelines, objectives, actions, methods and priorities for protection and management of populations
- identify guidelines, objectives, actions, methods and priorities for re-establishment of populations
- identify guidelines, objectives, actions, methods and priorities for protection and management of habitats
- identify guidelines, objectives, actions, methods and priorities for re-establishment of habitat
- identify knowledge gaps, priorities and methods for filling gaps for demography information and its application for management
- investigate potential to develop improved understanding of MLRSEW population genetics and the application of this information for management.
- identify information gaps regarding habitat dynamics and quality and methods for addressing these and the application of this information for management
- a consistent and effective method of information management.

Responsibility (including potential partners): Project Officers, Project Manager, Recovery Team.

Estimated costs for Action 9:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
	1203.37	4806.15	1660.64	5009.52	1555.26	**$14,234.94**

Objective 2: Maintaining and increasing capacity (objective 2; links with actions 10–13)

ACTION 10 Improve knowledge and understanding of ecology and habitat:

ACTION 10a: Develop and maintain research prospectus that identifies critical ecological, genetic and habitat research required, e.g. Population Viability Analysis.
ACTION 10b: Undertake internal ecological, genetic and habitat research projects as identified.
ACTION 10c: Facilitate and support external research projects based on identified ecological, genetic and habitat research priorities.
ACTION 10d: Undertake an internal report that scopes the value of adopting a landscape recovery approach centred around two key regions for the MLRSEW.

Action milestones:

- research prospectus completed by 2008 and updated every two years;
- facilitate the highest priority external research being undertaken by tertiary institutions on an annual basis;
- highest priority internal research undertaken in 2007 and 2011; and
- scoping report on value of two key region approach completed.

Key links: objective 2.1, performance criterion 11.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) sections 5.6.1, 5.6.2, and 5.6.3.

Justification: Many aspects of the demography and ecological requirements of the MLRSEW are poorly known, as is the genetic status of local populations. Localised declines in MLRSEW populations may be related to poor dispersal in a highly fragmented landscape. An improved understanding of the ecological requirements and demography of the MLRSEW will assist in better targeting recovery efforts and improving management protocols.

Further information and an improved understanding of habitat dynamics, quality and extent are required for recovery of the MLRSEW. This information is particularly important for Actions 1 and Actions 4–8 to assist decision-making in relation to management and identification of threats, targeted habitat restoration to link patches for population expansion, and also future translocations.

Detailed habitat information for individual swamps and dry-heath habitats in Deep Creek CP and Cox Scrub CP is available. However, these data should be revised, systematically described (structural/floristic attributes, current condition, land tenure, land-use) and used to refine habitat mapping across the region.

The identification of information gaps and monitoring/research methods will be done in the strategy prepared under Action 9.

Responsibility (including potential partners): Recovery Team, Project Officers, Project Manager, DEH, tertiary institutions.

Estimated costs for Action 10:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
$	22664	12273.72	19217.60	12565.51	19882.14	**$86,602.97**

ACTION 11 Increase stakeholder engagement, capacity and responsibility:

ACTION 11a: Complete and maintain a Communication Strategy.
ACTION 11b: Undertake a landholder survey to identify key benefits and barriers to MLRSEW and MLRSEW habitat conservation and benchmark existing effort.
ACTION 11c: Review and work to amend existing perverse incentives, policy or legislation if required. *
ACTION 11d: Continue to facilitate consideration and the integration of management of MLRSEW populations and habitats in relevant property plans, land-use and landscape policy, planning and industry standard processes at all levels affecting the region.
ACTION 11e: Develop and maintain partnerships with key identified stakeholders.
ACTION 11f: Build further capacity and commitment through facilitation of incentives and services, e.g. management planning to deliver recovery objectives.
ACTION 11g: Build further capacity through provision of information, training and decision support tools.

Action milestones:

- Communication Strategy completed, used and periodically updated;
- landholder survey undertaken, evaluated and used to guide recovery actions;
- review of perverse incentives, policy or legislation completed;
- management of MLRSEW populations and habitats integrated into relevant property plans, land-use and landscape policy, planning and industry standard processes;
- landholders engaged in the implementation of property management plans that contribute to the conservation and management of local MLRSEW populations and habitats;
- effective partnerships with key stakeholders demonstrated;
- facilitation of incentives undertaken contributing to recovery objectives at 25 sites over 5 years;
- further capacity demonstrated through provision of information, training and/or decision support tools;
- five MLRSEW populations and habitat sites not currently protected to be formally protected under the State's reserve system or under private conservation covenants; and
- monitoring of indicators undertaken as identified in the Communication Strategy.

Key links: objective 2.2, performance criteria 12 and 13.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) sections 5.4.1, 5.4.2, 5.4.3, 5.4.4, and 5.4.5.

Justification: The recovery objectives for the MLRSEW are all to be achieved through community engagement, and recovery objective 2, in particular, requires relevant stakeholders to accept ongoing responsibility for contributing to MLRSEW recovery. Successful communication and capacity building are therefore critical to meeting the objectives of this plan.

Land-use on the Fleurieu Peninsula includes primary production on large and small properties and areas set aside for biodiversity conservation. Some privately-held properties experience high rates of turnover (every five years; MLR Southern Emu-wren Recovery Team 1998). This creates a complex environment in which to engage, encourage and support stakeholders in recovery efforts.

A Communication Strategy is in progress (Cantono and Russell, in prep.) in which the interests and engagement methods of stakeholders are identified, building on information gathered during the previous MLRSEW Recovery Plan. The recovery program has also achieved significant progress towards increasing involvement of the community, landholders, and NRM professionals in recovery objectives and recognition of the MLRSEW in relevant planning documents, and this needs to continue.

Responsibility (including potential partners): Project Manager, Project Officers, Recovery Team, landholders, LAP Boards, industry bodies, Local Government, DEH, DWLBC, Forestry SA, Planning SA, SA Water, EPA, NRM Boards, volunteers.

Estimated costs for Action 11:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
$	16357.24	20849.36	0	41806.50	1493.05	**$80,506.16***

Note: Expenditure for actions 11d, 11e and 11f overlap somewhat with action 1 thus, reducing total expenditure here.

ACTION 12 Monitor, analyse and evaluate MLRSEW management and recovery effort.

ACTION 12a: Review and revise monitoring procedures and protocols if required to ensure data collected can adequately detect change.
ACTION 12b: Undertake detailed monitoring of important MLRSEW populations and selected local MLRSEW populations as required. #
ACTION 12c: Continue presence/absence monitoring at least biennially at other known MLRSEW sites. #
ACTION 12d: Undertake MLRSEW habitat monitoring to determine desirable management practices or evaluate the effectiveness of management applied.
ACTION 12e: Contribute technical information from MLRSEW monitoring to develop a Swamp Transition Model to assist in identifying transient changes in swamp vegetation communities according to environmental variables and landscape modification.
ACTION 12f: Maintain and enhance existing MLRSEW/habitat/extension database/information systems.
ACTION 12g: Undertake monitoring of indicators as identified in the Communication Strategy.
ACTION 12h: Develop a framework for ensuring that ongoing MLRSEW population monitoring is in place beyond the long-term objectives of the Recovery Plan with the capacity to catalyse intense recovery activities if significant declines are detected. *

Action milestones:

- agreed monitoring procedures in place and reviewed;
- biennial MLRSEW census undertaken;
- important MLRSEW populations monitored as required;
- MLRSEW habitat monitoring undertaken and used to guide future management efforts;
- information from MLRSEW monitoring contributed to develop Swamp Transition Model;
- MLRSEW/habitat/extension database/information systems up to date and providing access to information required for decision making within recovery program;
- monitoring of indicators undertaken as identified in the Communication Strategy; and
- long-term MLRSEW monitoring framework developed.

Key links: objective 2.3, performance criterion 14.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.) sections 5.5.1, 5.5.2, 5.5.3, 5.7.1, and 5.7.2.

Justification: MLRSEW population monitoring should continue in order to gauge the effectiveness of recovery efforts and trends in MLRSEW population numbers and area of occupancy. Census data should indicate changes in number and distribution of MLRSEWs and their local populations over time. This information will contribute to the assessment of the status of the MLRSEW and to informing recovery management decisions.

Monitoring effort should focus on higher priority MLRSEW populations such as sites:

- of source and release for current and future translocations;
- where declines (e.g. Stipiturus Conservation Park) or increases are known or suspected; and
- deliberately manipulated as part of the management of the Fleurieu Peninsula Swamps.

Actions identified within the Communication Strategy (Cantono and Russell, in prep.) to engage stakeholders should also be monitored for effectiveness.

Responsibility (including potential partners): Recovery Team, Project Officers, Project Manager, landholders, DEH, Forestry SA, volunteers.

Estimated costs for Action 12:

Year	2006/07	2007/08	2008/09	2009/10	2010/11	TOTAL
$ ('000s)	35279.01	32663.62	38862.16	32694.95	56646.71	**$196,146.45**

ACTION 13 Facilitate Recovery Program

ACTION 13a: Convene a Recovery Team to coordinate, review and prioritise recovery effort.
ACTION 13b: Maintain technical working sub-committees to support personnel and contractors in delivering recovery actions.
ACTION 13c: Review the effectiveness of the Recovery Team and sub-committees biennially.
ACTION 13d: Facilitate an external review to be commenced 6 months before the expiry of the Recovery Plan in 2011. *
ACTION 13e: Maintain funding for the recovery program to deliver on the objectives of the Recovery Plan.

Action milestones:

- recovery team convened at least twice per year and reviewed for effectiveness biennially:
- technical sub-committees convened at least once yearly and reviewed for effectiveness biennially;
- external review of Recovery Plan completed; and
- funding base for recovery program coordination maintained for the period of the plan

Key links: objective 2.4, performance criterion 15.

Other links: MLRSEW Conservation Strategy (Pickett in prep c.).

Justification: A Recovery Team drawn from representatives of land management agencies, landholders, funding bodies and people with relevant expertise should continue to be convened to oversee recovery of the MLRSEW. The Recovery Team will also provide a forum in which a broad range of information can be shared.

The previous Recovery Team effectively coordinated the activities of the recovery program, assisted by specialist sub-committees established to oversee scientific, extension and technical aspects of the recovery actions. These sub-committees of the Recovery Team should continue to provide technical support to project officers implementing the Recovery Plan.

The Recovery Team should review progress of the recovery program regularly and an external review of the recovery program should be undertaken in the final year (2011).

Responsibility (including potential partners): Recovery Team, Project Manager, Project Officers.

Estimated costs for Action 13:

Year	**2006/07**	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**TOTAL**
$ ('000s)	$25,405.71	$24,596.03	$24,102.51	$56,425.08	$31,531.86	**$161,061.19**

9.0 Management Practices

As a general guide, any management practice undertaken in or directly adjacent to critical or potential habitat of the MLRSEW should be considered carefully. In particular, management practices identified as a threat or that assist or promote the spread of one or more of the threatening processes identified within this plan (see Section 5.2) should be avoided where possible. This includes livestock grazing, vegetation clearance, deliberate burning, water extraction or swamp drainage, and weed invasion. This list is not exhaustive and should be treated as a guide only. Note that in some instances this section highlights management inaction as a key management practice which may increase the spread and impact of threatening processes on the MLRSEW. A major concern is that, in addition to potential intensification of catastrophic threats, impacts of land-use threats may be exacerbated due to climate change (see Section 5.4.23). This especially applies to livestock grazing and water extraction, the impacts of which may increase due to drought-related pressures to change land management practices (see Section 5.4.6 Livestock grazing and Section 5.4.9 Water extraction).

Management practices and actions benefiting the recovery of the MLRSEW are described in full in Section 8 of this plan. A number of these actions are currently partially or wholly being undertaken on the Fleurieu Peninsula by the MLRSEW and FPS Recovery Program and by other existing private and community based natural resource management programs.

Any development activities that affect the extent, integrity, structure, composition or functions of existing and potential dry-heath and/or swamp habitats may require environmental assessment and approval under EPBC Act.

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Appendices

Appendix I. Table and Map of MLRSEW Sites.

Site No.	Site Name	Location	Population Region	Easting (MGA Zone 54S)	Northing (MGA Zone 54S)	Acc. (m) *	Habitat	Main Land Tenure ^	Main Land Use (2006)	Main Threat to Population (2006)	Pop. Size Class ^^	Extant 2006	Last Record (if extinct)
1	Yundi - Northeast	2.5 km NE of Yundi	N	287000	6090800	500	swamp	P	unknown	na (local extinction)	0	No	1925
2	Bahloo Glen Swamp	2.5 km NE of Mount Compass	N	285725	6087400	25	swamp	P	remnant native cover - primary production area	na (local extinction)	0	No	1970s-1980s?
3	Cox Scrub CP - Hill	9.5 km E of Mount Compass	N	293025	6087075	25	dry-heath	CP	nature conservation	na (local extinction)	0	No	1969; 1970s-1980s?
4	Cox Scrub CP - Gully	10 km E of Mount Compass	N	294300	6086375	25	dry-heath	CP	nature conservation	na (local extinction)	3	No **	2005; formerly extinct 1983 (bushfires)
5	Ex Nangkita Study Site - Patch 1	10 km E of Mount Compass	N	293075	6085325	25	swamp	P	remnant native cover - primary production area	na (local extinction)	2	No	2000
6	Ex Nangkita Study Site - Patch 2	10 km E of Mount Compass	N	293725	6084525	25	swamp	P	remnant native cover - primary production area	na (local extinction)	2	No	2000
7	Ex Nangkita Study Site - Patch 3	10 km E of Mount Compass	N	294050	6083850	25	swamp	P	grazing - cattle	na (local extinction)	2	No	1999
8	Ex Nangkita Study Area - Patch 12	12 km ESE of Mount Compass	N	295075	6082075	25	swamp	P	remnant native cover - primary production area	na (local extinction)	1	No	1998 (transitory)
9	Jacobs Swamp	2 km WNW of Mount Compass	N	281925	6086375	500	swamp	P	horticulture	na (local extinction)	0	No	~ 1960
10	Nangkita Swamp	3.5 km ENE of Mount Compass	N	286575	6086375	25	swamp	P	remnant native cover - primary production area	fire - bushfire	3	Yes	
11	Mount Compass School Swamp	Mount Compass	N	283775	6085325	25	swamp	P	nature conservation	fire - bushfire	2	Yes	
12	Willowburn Swamp	3.5 km E of Mount Compass	N	287200	6085700	25	swamp	P	grazing - cattle	na (local extinction)	1	No	2004 (transitory)
13	Lawless Lane Swamp	8.5 km WSW of Mount Compass	N	276075	6081675	25	swamp	P	remnant native cover - primary production area	fire - bushfire	2	Yes	
14	Glenshera Swamp (Stipiturus CP)	7 km WSW of Mount Compass	N	277225	6083425	25	swamp	CP	nature conservation	fire - bushfire	4	Yes	
15	Square Waterhole Swamp	2.5 km S of Mount Compass	N	284225	6083275	25	swamp	P	remnant native cover - primary production area	fire - bushfire	3	Yes	
16	Ambersun Alpacas - East Swamp	3 km SSE of Mount Compass	N	284925	6083075	25	swamp	P	remnant native cover - primary production area	fire - bushfire	1	Yes	
17	Ambersun Alpacas - West Swamp	2.5 km S of Mount Compass	N	284575	6083175	25	swamp	P	remnant native cover - primary production area	fire - bushfire	2	Yes	
18	Toadspring Swamp	4.5 km SW of Mount Compass	N	287175	6082475	25	swamp	P	remnant native cover - primary production area	na (local extinction)	1	No	1993
19	Gum Tree Gully Swamps	5 km SE of Myponga	N	272825	6077400	25	swamp	P	grazing - cattle	na (local extinction)	2	No	2000
20	Hindmarsh Tiers	Hindmarsh Tiers	N	277225	6077575	2500	swamp	U	unknown	na (local extinction)	0	No	1925

Site No.	Site Name	Location	Population Region	Easting (MGA Zone 54S)	Northing (MGA Zone 54S)	Acc. (m) *	Habitat	Main Land Tenure ^	Main Land Use (2006)	Main Threat to Population (2006)	Pop. Size Class ^^	Extant 2006	Last Record (if extinct)
21	Double Bridges Swamp	5 km WSW of Finniss	N	298325	6079725	25	swamp	P	marsh/wetland	na (local extinction)	2	No	2002
22	Lower Black Swamp	4.5 km SSW of Finniss	N	301225	6077475	25	swamp	P	marsh/wetland	fire - bushfire	2	Yes	
23	Finniss Park Swamp	5.5 km SSE of Finniss	N	304300	6076700	25	swamp	UC	marsh/wetland	fire - bushfire	5	Yes	
24	Reedlands Swamp	2.5 km SSE of Finniss	N	303425	6079575	25	swamp	P	grazing - cattle	grazing - stock	4	Yes	
25	Currency Creek Swamp	Currency Creek	N	297425	6074375	25	swamp	P	grazing - cattle	na (local extinction)	0	No	1967
26	Maylands Swamp	5 km E of Parawa	S	265525	6061475	25	swamp	P	grazing - cattle	na (local extinction)	1	No	1993
27	Upper Boat Harbor Creek - North Swamp	4.5 km WSW of Parawa	S	256150	6059625	25	swamp	P	grazing - cattle	na (local extinction)	2	No	2005
28	Upper Boat Harbor Creek - South Swamp	5.5 km SW of Parawa	S	256925	6057250	25	swamp	P	remnant native cover - primary production area	na (local extinction)	1	No	1998 (transitory)
29	Forestry SA - Congeratinga Swamp	7.5 km W of Parawa	S	253200	6060575	25	swamp	NFR	nature conservation	na (local extinction)	2	No	2004
30	Forestry SA - Deep Creek Swamp	8 km WSW of Parawa	S	252125	6058975	25	swamp	SF	remnant native cover - primary production area	na (local extinction)	1	No	1995
31	Forestry SA - Illawong Swamp	4 km SW of Parawa	S	257050	6059200	25	swamp	SF	remnant native cover - primary production area	na (local extinction)	1	No	1993
32	Forestry SA - Tappa Nappa Road - West Swamp	8 km WSW of Parawa	S	252775	6058175	25	swamp	SF	remnant native cover - primary production area	na (local extinction)	1	No	1998 (transitory)
33	Tappa Nappa Road - East Swamp	7.5 km WSW of Parawa	S	253200	6058300	25	swamp	P	remnant native cover - primary production area	fire - bushfire	2	Yes	
34	Seabrook Swamps - Far West Swamp	8 km SW of Parawa	S	253475	6057250	25	swamp	P	remnant native cover - primary production area	na (local extinction)	1	No	1993
35	Seabrook Swamps - West Swamp	8 km SW of Parawa	S	253600	6057475	25	swamp	P	grazing - cattle	na (local extinction)	2	No	1993
36	Upper Deep Creek Swamps	9 km WSW of Parawa	S	252150	6057225	25	swamp	P	grazing - cattle	na (local extinction)	2	No	2004
37	Deep Creek CP - Boat Harbor Creek Swamp	10 km SW of Parawa	S	252100	6056100	25	swamp	CP	nature conservation	na (local extinction)	1	No	1998
38	Deep Creek CP - Boat Harbor Creek Study Site	9 km SW of Parawa	S	252925	6056575	25	dry-heath	CP	nature conservation	fire - bushfire	5	Yes	
39	Deep Creek CP - Tent Rock Road	7.5 km SSE of Delamere	S	248550	6053000	25	dry-heath	CP	nature conservation	fire - bushfire	4	Yes	
40	Deep Creek CP - Deep Creek Cove Track	9 km SSE of Delamere	S	248225	6051075	25	dry-heath	CP	nature conservation	na (local extinction)	4	No	2004
41	Deep Creek CP - Heysen Trail	8.5 km SSE of Delamere	S	249825	6052475	25	dry-heath	CP	nature conservation	fire - bushfire	4	Yes	
42	Tent Rock Swamp	7.5 km S of Delamere	S	246775	6052575	25	swamp	P	grazing - sheep	na (local extinction)	1	No	1997 (transitory)
43	Mount Billy CP	11.5 km S of Mount Compass	N	282175	6074225	100	swamp	CP	nature conservation	na (local extinction)	0	No	~ 1995?

Site No.	Site Name	Location	Population Region	Easting (MGA Zone 54S)	Northing (MGA Zone 54S)	Acc. (m) *	Habitat	Main Land Tenure ^	Main Land Use (2006)	Main Threat to Population (2006)	Pop. Size Class ^^	Extant 2006	Last Record (if extinct)
44	Deep Creek CP - Boat Harbor Road	10 km SW of Parawa	S	253475	6053775	25	dry-heath	CP	nature conservation	na (local extinction)	4	No	2004
45	Deep Creek CP - Eastern End	8 km SW of Parawa	S	254425	6055425	25	dry-heath	CP	nature conservation	fire - bushfire	4	Yes	
46	Deep Creek CP - Black Bullock Road	6 km SE of Delamere	S	248700	6054500	25	dry-heath	CP	nature conservation	fire - bushfire	4	Yes	
47	Forestry SA - Forest Rd Swamp	9 km WSW of Parawa	S	251325	6059675	100	swamp	SF	remnant native cover - primary production area	na (local extinction)	0	No	late 1970s
48	Yundi - Burma Rd Swamp	3.8 km NNE of Mount Compass	N	285250	6089375	25	swamp	P	remnant native cover - primary production area	na (local extinction)	0	No	~ 1975
49	Ex Nangkita Study Area - Patch 13	12.5 km ESE of Mount Compass	N	295475	6081525	25	swamp	P	remnant native cover - primary production area	na (local extinction)	0	No	1950s-1960s
50	Cox Scrub CP - Central	10 km E of Mount Compass	N	294125	6087175	25	dry-heath	CP	nature conservation	fire - bushfire	3	Yes **	
51	Deep Creek CP- Western End	9 km S of Delamere	S	245525	6051025	25	dry-heath	CP	nature conservation	fire - bushfire	4	Yes	
52	Back Valley Area	Back Valley Area	S	275275	6065525	2500	swamp	U	unknown	na (local extinction)	0	No	1920s
53	Nangkita Road Swamps - West	0.5 km E of Mount Compass	N	284200	6085800	25	swamp	P	remnant native cover - primary production area	weeds	2	Yes	
54	Nangkita Road Swamps - Central	1.25 km E of Mount Compass	N	285125	6085375	25	swamp	P	remnant native cover - primary production area	weeds	1	Yes	

* Positional accuracy

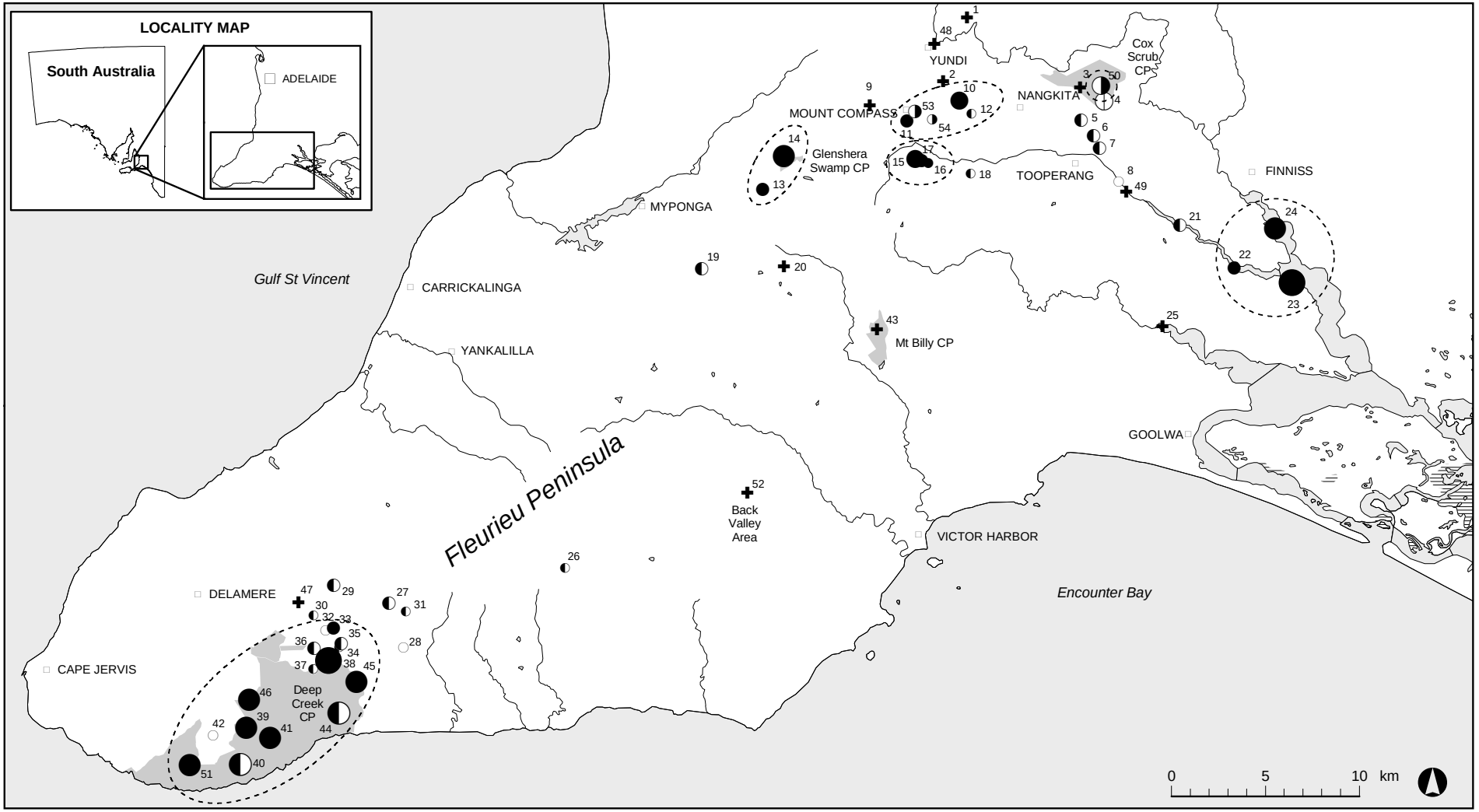
** Reintroduced 2001–2002

^ **Main Land Tenure:**

CP	conservation park
NFR	native forest reserve
NP	national park
P	private
SF	state forest
U	unknown
UC	unalloted Crown land

^^ **Probable population size (pairs):**

0	na (pre 1993-present monitoring period)
1	< or = 1
2	2-4
3	5-10
4	11-25
5	26-50



MLR Southern Emu-wren site

1993 status - 2006 status (max. prob. pop. size (pairs) 1993-2006; n)

- ✚ uncertain/extinct* - extinct (unknown; 11)
- ◐ extant - extinct (< or = 1; 7)
- ◐ extant - extinct (2-4; 9)
- ◐ extant - extinct (11-25; 2)
- ◑ uncertain - extant (< or = 1; 1)
- ◑ uncertain - extant (2-4; 1)
- ◑ extinct* - extant (5-10; 1)
- ◐ extinct* - extinct (5-10; 1)
- ○ transitory (< or = 1; 4)
- ● extant - extant (< or = 1; 1)
- ● extant - extant (2-4; 5)
- ● extant - extant (5-10; 2)
- ● extant - extant (11-25; 7)
- ● extant - extant (26-50; 2)

Population group - essentialy isolated (2006)

NPWSA reserve in which MLRSEW has been recorded

* Extinct as at 1993 = extinction 1920-1992
The earliest records relating to subsequently confirmed local-extinction sites are from the 1920s and there are no data for local extinctions that would have occurred pre-1920 due to widespread clearance of habitat for agricultural development across the MLR Southern Emu-wren's range.

Appendix II. Structure, Floristic Composition and Relative Importance of MLRSEW Habitats (Pickett in prep. c)

Table II-1. General structure and floristic composition of MLRSEW swamp habitats.

Tallest Stratum (with ≥5% cover)			**General Structural Formation**	**Typical Species***		
Dominant Life Form	**Height (m)**	**Foliage Cover (%)**		**Tallest Stratum (overstorey)**	**Understorey (generally >70% cover)**	**Emergent (<5% cover)**
reed/grass	2–4	>70	**reedland**	*Phragmites australis, Typha domingensis*	*Baumea juncea, B. rubiginosa, B. tetragona, Gahnia trifida, Juncus kraussii, Juncus* spp., *Isolepis nodosa*	*Leptospermum lanigerum, Acacia provincialis, Viminaria juncea*
sedge	1–2	>70	**(wet) sedgeland**	*Baumea rubiginosa, B. tetragona, Gahnia sieberiana, G. trifida, Carex appressa, Juncus sarophorus, Juncus* spp., *Lepidosperma longitudinale, Xyris operculata, Sprengelia incarnata, Leptospermum continentale*	*Blechnum minus, Gleichenia microphylla, Baumea juncea, Leptocarpus tenax, Empodisma minus, Epilobium pallidiflorum*	*Leptospermum continentale, L. lanigerum, Viminaria juncea*
shrub	>1	to >90	**(wet) shrubland**	*Leptospermum continentale, L. lanigerum, Melaleuca squamea, M. decussata, Sprengelia incarnata, Viminaria juncea*	*Baumea rubiginosa, B. tetragona, B. juncea, Gahnia sieberiana, G. trifida, Carex appressa, Lepidosperma longitudinale, Leptocarpus tenax, Patersonia* spp., *Phragmites australis, Empodisma minus, Xyris operculata, Goodenia ovata, Sprengelia incarnata, Blechnum minus, Gleichenia microphylla, Juncus* spp.	*Viminaria juncea, Eucalyptus ovata, E. cosmophylla, E. obliqua, Acacia provincialis*

* Major structural species, not necessarily in combination.

Table II-2. General structure and floristic composition of MLRSEW dry-heath habitats.

Tallest Stratum (with ≥5% cover)			General Structural Formation	Typical Species*		
Dominant Life Form	**Height (m)**	**Foliage Cover (%)**		**Tallest Stratum (overstorey)**	**Understorey (generally >70% cover)**	**Emergent (<5% cover)**
shrub	>1	>70	**(dry) shrubland**	*Allocasuarina muelleriana, A. striata, Hakea rostrata, H. carinata, Spyridium spathulatum, S. thymifolium, Melaleuca decussata*	*Austrostipa muelleriana, Pultenaea involucrata, Platylobium obtusangulum, Xanthorrhoea semiplana, Hypolaena fastigiata, Lepidosperma carphoides, L. semiteres, L. viscidum, Hibbertia* spp., *Leptospermum myrinoides*	*Eucalyptus baxteri, E. obliqua, E. fasciculosa, E. cosmophylla*
mallee/tree	<10	to 70	**mallee/ forest/ woodland**	*Eucalyptus baxteri, E. obliqua, E. fasciculosa, E. cosmophylla*	*Pultenaea involucrata, P. trinervis, Pultenaea* spp., *Phyllota pleurandroides, Acacia myrtifolia, Adenanthos terminalis, Daviesia* spp., *Hakea rostrata, H. carinata, Allocasuarina muelleriana, A. striata, A. pusilla, Banksia marginata, Platylobium obtusangulum, Hibbertia* spp., *Leptospermum myrsinoides, Xanthorrhoea semiplana, Lepidosperma carphoides, L. semiteres, Austrostipa muelleri, Gahnia ancistrophylla, Spyridium thymifolium, Cassytha* spp., *Calytrix* spp.	–

* Major structural species, not necessarily in combination.

Table II-3. Relative importance of habitats used by MLR Southern Emu-wrens and representative structural formations. c = closed, l = low, o = open, v = very.

Habitat Type	Relative Importance*	Representative Structural Formations**
mallee/woodland/forest	1	v.o.l., o.l., l., v.o., & o. mallee; mallee; v.l.o., v.l., l.o. & l. woodland; v.l.o & l.o. forest
wet-shrubland	2	v.o. & o.shrubland, shrubland, c. shrubland
wet-sedgeland	3	sedgeland, c. sedgeland
dry-shrubland	4	as for wet-shrubland
Reedland	not a major habitat type	c. grassland

* Derived from data for extant populations in 2006 and is based on relative-use scores. The relative-use score for each habitat type equals the sum (i.e. across all sites extant in 2006) of each site's ordinal value for its maximum probable population size 1993–2006 (i.e. 1–5 = smallest–largest) divided by the number of its major habitats (i.e. for sites with multiple major habitat types, considers these are equally used). For a given site, 'major habitat' is the primary habitat type(s) used at that site, although other types may be present but considered of minor use.
** South Australian vegetation structural formations (Heard and Channon 1997)