# BIODIVERS

# Native Vegetation

### Trends

- Vegetation Extent: STABLE
- Vegetation Condition: UNKNOWN OVERALL but IMPROVED slightly for Kingoonya District in the Pastoral region
- Area of land under Protected Status: INCREASED 1% since 2003, but slowing compared to last SoE Report
- Indigenous Revegetation activity: DECREASING

'Lose no species' is a statement of aspiration. Species decline and become extinct naturally. This aspiration reflects the foresight, mindset and commitment needed by all South Australians if we are to prevent further loss of our known native species due to human impacts, and if we are to conserve our biodiversity for future generations.

# Goals

T3.1 Lose no species: lose no known native species as a result of human impacts.

#### South Australian Strategic Plan 2007

T3.2 Land biodiversity: by 2010 have five well-established biodiversity corridors aimed at maximising ecological outcomes particularly in the face of climate change.

South Australian Strategic Plan 2007

## Native Vegetation and a sustainable South Australia

To achieve a sustainable future for South Australia one of the key targets for sustainability in the South Australian Strategic Plan is to Lose No Species. Native vegetation is an integral component of our natural environment.

# Native Vegetation

As indigenous species provide habitat for animals native vegetation is fundamental to sustainability.

Natural landscapes and the native vegetation they contain are important components of the Australian identity. Native vegetation provides places of scenic beauty that are very important to our tourism industry and at an individual level, support our cultural, spiritual and recreational needs. Natural landscapes are utilised to derive livelihood and native vegetation in particular has a role in supporting farming and other production activities.

Native vegetation is an economic resource for genetic, biochemical and agricultural products, such as tannins or quandong fruits. Importantly, native vegetation protects landscapes against land and water degradation. Preventing degradation and loss of native vegetation is significantly less costly than restoring and replacing it (Williams 2005).

In gaining support for the conservation or sustainable management of native vegetation, the value that it can bring to the quality of people's lives is a critical consideration. The benefit of native vegetation falls into the triple bottomline concept of social, economic and environmental benefits.

Many of the environmental benefits, such as protecting soil from wind and water erosion, are identified as ecosystem services. Stemming from the observation that ecosystems provide a range of goods and services that underpin and benefit our economic production systems and quality of human life, ecosystem services are defined as the conditions and processes through which natural ecosystems sustain and fulfil human life (Williams 2005).

Over the last few years there has been greater recognition of the role of native vegetation ecosystems in supporting the healthy functioning of our catchments and landscapes. In Victoria, an assessment of the ecosystem services for the Goulbourn Broken Catchment highlighted vegetation including native species, for its value to ecosystems services (Binning *et al* 2001).

Case studies by Eamus *et al* (2005) drew attention to the role of native vegetation in the provision of ecosystem services. Services included carbon sequestration, climate regulation, maintenance of hydrological balance in catchments and water quality. These underscore the importance of native vegetation in maintaining a sustainable environment for humans. The economic value of these ecosystem services is identified as pertinent to ensure that their value is included in economic considerations.

In conjunction with afforestation and reafforestation, native vegetation could provide a response to climate change as carbon sinks included in emission trading schemes (Australian Greenhouse Office 2006). Climate change is likely to result in rising temperatures and changes in rainfall patterns, in turn affecting the intensity and frequency of droughts, bushfires, floods and storms (Australian Greenhouse Office 2006). Climate change is expected to impact on native vegetation but the extent of that is currently unknown (DEH 2007). The dependence of species or communities of species on the existing climate and their ability to respond to changes is an important consideration for the future sustainability of native vegetation.

### Indicators

#### CONDITION INDICATOR

#### Extent and Condition of remnant vegetation

The extent and condition of native vegetation is considered the best available measure currently available to determine the condition of ecosystem diversity.

#### **RESPONSE INDICATORS**

#### Area of land held under protected status

A comprehensive, adequate and representative reserve system is necessary to protect and maintain ecosystem, species and genetic biodiversity.

#### Area of revegetation using indigenous species, native species and exotics

While revegetated areas do not have the same environmental benefits as remnant native vegetation, they contribute towards the restoration of many ecological values. It is critical that land is revegetated with locally occurring native species to achieve maximum biodiversity outcomes.



# Paddock trees

Paddock trees are defined as scattered trees or small patches of trees located in paddocks used predominantly for grazing and cropping. In SA, as in most other temperate regions of Australia they are not mapped and their distribution and contribution to overall vegetation cover is unknown. Paddock trees represent tree species such as Red, Blue and Pink Gum that are not well conserved in patches of intact native vegetation. Paddock trees provide resources to all manner of wildlife.

A case study to map paddock trees across an area of 270,000 Ha in the state's South East region was completed in 2005 (Carruthers 2005). Canopy cover of these trees was found to represent 14.4% of the total native vegetation cover for the area. Results demonstrate that paddock trees are a geographically widespread feature of the region, distributed over approximately half of the study area. Within this distribution, paddock trees at very low densities (i.e. up to 2% canopy cover or 0.25 to 4 trees per Ha) cover one quarter of the study area.

The study found that tree recruitment in paddocks in the region is negligible. Legal clearance is the main threat to paddock trees in the study area. Extrapolating current rates of clearance and dieback, paddock trees are predicted to disappear from the study area within 150 years

Map 5.1: Remnant native vegetation cover across the agricultural zone of South Australia

SPAR ID: 2753



# What is the current situation?

# CONDITION INDICATOR: Extent and condition of remnant vegetation

This indicator is considered the best available measure of the condition of terrestrial biodiversity. The extent shows how much remains after clearing but is only half the picture. Humans have had an impact on most of South Australia and this has greatly altered the condition of much of the native vegetation. It is important to also consider that condition.

While 86% of South Australia is covered by native vegetation the majority of this area experiences an arid climate and there has been minimal clearance. Instead, the land is managed under a range of activities that have resulted in modification of the vegetation. In the State's agricultural region where rainfall is higher the amount of clearance has been high with only 29.5% of native vegetation remaining. This figure is based on the same definition of the agricultural region as was used in the State of Environment 2003 and remains unchanged.

South Australia has been mapped into 56 bioregions based on Interim Biogeographic Regionalisation for Australia (IBRA version 6.1) subregions (Thackway and Cresswell 1995). These bioregions provide an indication of the unique geographic and natural features of the State and are used to report biodiversity priorities. Within these regions, 33 of 56 have greater than 90% native vegetation cover and would be considered intact landscapes (McIntrye and Hobbs 2000). These bioregions have not been cleared because of an arid climate. Three other subregions included in the northern area are large areas of salt lakes that are typically bare. In the remaining 19 bioregions clearance occurred for agricultural pursuits and 26.5% of the native vegetation remains. (Table 5.1 and Map 5.2)

#### Condition of native vegetation

The importance of vegetation condition in land management policy has increased in recent years, in particular through Natural Resource Management (NRM). In its broadest sense vegetation condition is about the state of being or health of the vegetation, which includes the process of change (Keith and Gorrod 2005). However, there remains debate about how to measure condition depending on the purpose and practical difficulties of ecological

# Native Vegetation



Map 5.2: Percentage of native vegetation cover within IBRA sub regions of South Australia

SPAR ID: 2754

processes (Keith and Gorrod 2005). Within the National Natural Resource and Management Monitoring and **Evaluation Framework vegetation** condition has been defined as an indicator in the context of biodiversity conservation. At the national level work is being done to establish an approach to vegetation condition assessment at sites against benchmarks (Parkes and Lyon 2005), however the expansion of this process into the States is inconsistent. Vegetation condition information is required to monitor and report at regional, state and national levels with it being collected against varying criteria for site assessments, spatial modelling and remote sensing (Gibbon et al 2005).

#### Pastoral zone

During dry times, particularly in the early years of European occupation, large numbers of livestock concentrated around the few permanent water supplies resulting in high grazing pressure and trampling of vegetation. This in turn lead to soil disturbance and erosion. Today, the majority of pastoral leases in South Australia have been fully developed and management strategies have been implemented to reduce the impact of grazing by livestock on the native vegetation. Selective grazing pressures have resulted in changes to species composition. Feral grazing is also a major pressure on native vegetation in pastoral areas.

Subregion	Code	Ibra Area	Veg Area	Veg %
Barrier Range	BHC1	1088190	1087660	100
Barrier Range Outwash	BHC4	786385	786170	100
Sturt Stony Desert	CHC2	2319585	2315645	100
Diamantina-Eyre	CHC4	853910	850840	100
Lake Pure	CHC7	70080	70080	100
Mann-Musgrave Block	CR1	1903030	1902475	100
Wataru	CR2	424120	424120	100
Everard Block	CR3	519805	519805	100
Tieyon, Finke P3	FIN3	1115585	1115185	100
Pedirka	FIN4	846645	846645	100
Northern Flinders	FLB5	1684140	1683210	100
Kintore	GVD4	4379660	4379660	100
Tallaringa	GVD5	3646605	3646280	100
Northern band, Carlisle	NUL1	720980	720140	100
Central band, Nullabor Plain	NUL2	4096430	4095520	100
Simpson Desert	SSD2	2189840	2186265	100
Breakaways, Stony Plains	STP1	4370610	4362195	100
Peake-Dennison Inlier	STP4	256295	256295	100
Macumba	STP5	1009995	1009005	100
Coongie	CHC6	2099835	2074380	99
Kingoonya	GAW5	4946845	4916540	99
Eastern, Maralinga	GVD3	7534470	7476825	99
Yellabinna	GVD6	4497775	4457235	99
Hampton	HAM	44945	44510	99
Oodnadatta	STP2	4627370	4581095	99
Murnpeowie	STP3	2978195	2946545	99
Gawler Volcanics	GAW2	1778330	1746435	98
South Olary Plain, Murray Basin Sands	MDD1	1887680	1847960	98
Yalata	NUL3	1143560	1125930	98
Warriner	SSD4	949690	926705	98
Olary Spur	FLB3	2025260	1973210	97
Myall Plains	GAW1	974230	941675	97
Arcoona Plateau	GAW4	1185920	1161405	98
Strzelecki Desert, Western Dunefields	SSD5	5162630	4753660	92
Southern Flinders	FLB4	2057230	1802135	88
Dieri	SSD3	4679410	3526725	75
Gawler Lakes	GAW3	3424955	2184485	64
Aria Subregion Iotal	DN //	84280220	80/44650	96
Murray Scroll Belt	RIV6	1/3/90	100720	58
		1086015	004615	00
Lowan Mallee		900060	453400	4/
		441435	209065	4/
	ETDO	2200323	342015	30
	E I D3	2116400	J42710	29
		2110400	430/43	10
Southern Vorke	FVR1	/06020	70275	19
		200890	17340	10
Mutrav Lakes and Coorong	MDD3	277000	35615	14
Bridgewater	NCP1	447215	63010	14
Fleurieu	KAN2	370005	45360	12
	NCP3	7/3205	95500	12
Broughton	FLR2	1028760	105755	10
St Vincent	FYR2	1028700	97625	0
Glenela Plain	NCP2	142005	12975	, Q
Mount Gambier	VVP2	84645	3820	5
Wimmera	MDD5	133000	6135	5

Table 5.1: Vegetation area remaining within IBRA subregions

There is considerable information available on the current condition of native vegetation in the pastoral areas of the State, based on the scientific assessment and monitoring of all pastoral leases under the *Pastoral Land Management and Conservation Act* 1989. In some areas, inappropriate grazing practices over the past 150 years have lead to land degradation, a loss of productivity potential and an impact on biodiversity.

As part of the State Government's *Pastoral Lease Assessment Program* from 1990-2000, more than 5,500 permanent photopoint monitoring sites were established in the pastoral zone. These were set up to provide a baseline to monitor the condition of soil and vegetation resources over time. Under the *Pastoral Land Management* and Conservation Act 1989, lease assessments are to be carried out every 14 years. These include a revisit and remeasuring of these sites.

In 2005 the second lease assessment program began in the Kingoonya area and to date 22 stations have been reassessed. The lease assessment program for the Gawler Ranges began in late 2006 and it is due for completion statewide by 2014.

Land condition is assessed using the Land Condition Index (LCI) approach and has been carried out on the majority of leases south of the dog fence where sheep have traditionally been run. On the more extensive cattle properties north of that fence, the LCI has not been used, but for part of the Marla Oodnadatta NRM District, photopoint monitoring has been complemented by assessments of land cover changes using Landsat imagery. These measurements are limited instruments for measuring vegetation condition, particularly from an ecosystem basis and their value will be minimal in providing comparisons with condition measurements taken using more detailed methods.

In the sheep pastoral zone an additional 20,000 land condition sampling locations were assessed in the first round (1990-2000) with approximately 100 locations forming the basis for the calculation of LCI scores for each lease.

The LCI shows sampling locations as having high, moderate or low 'disturbance' or departure from the original, pristine condition. These disturbance categories are based on:

- soil surface disturbance and erosion;
- vegetation cover and composition;
- the level of visible grazing impact.

Mining and exploration expansion in South Australia has also tended to focus on the pastoral zone and poses a significant risk to native vegetation. The appropriate management of native vegetation at every stage of the development, operation and decommissioning of mines in South Australia is extremely important. At present, mines are exempt from most of the provisions of the Native Vegetation Act 1991 and while changes outlined elsewhere in this chapter have improved accountability within this sector, there is still considerable work required to protect native vegetation from mining and exploration activities.

#### Kingoonya District (SA Arid Lands NRM)

The completion of the second round of assessments for this district has enabled a comparison of the condition of the vegetation (Table 5.2). Data was collected at a total of 2,515 LCI points in 1991 (Round 1) and 2,325 in 2005/06 (Round 2). Hummock grasslands locations were picked up in the second assessment and an extra vegetation community (non chenopod shrubland) was assessed in the district. There has been an apparent increase in the number of pasture communities of Moderate Disturbance Rating, with the incidence of both the High and Low Disturbance Ratings decreasing.

Vegetation condition has improved slightly across the district with an average LCI of 2.12 in Round 1 and 2.17 in Round 2. All vegetation communities have generally remained stable with the exception of the ephemeral plains (Table 5.3). This may be attributed to the current dry conditions, the nature of ephemeral plains and grazing pressures. The chenopod shrublands are extremely resilient and have improved slightly.

#### Agricultural regions

In contrast, the assessment of the condition of native vegetation within the agricultural regions cannot be reported. The *State NRM Plan* identifies the following target:

"By 2011, no further net loss in natural habitat extent and condition below that of 2006" (DWLBC 2006).

### BushBids – market based incentive program for biodiversity stewardship

In the Eastern Mount Lofty ranges a program funded by the Maintaining Australia's Biodiversity Hotspots program (Commonwealth Government) was implemented to improve the condition and management of native vegetation.

The BushBids project used a single bid, reverse auction process to establish management contracts with owners of 2,274 Ha native vegetation on 70 privately owned sites in the Eastern Mount Lofty Ranges.

The approach required a relative biodiversity value to be determined and for landholders to enter a tender price for the cost of conservation and management of the native vegetation under 10 year agreements. Landholders committed to achieving targeted levels of management and threat control including controlling total grazing pressure, weeds, feral animals, litter removal and other types of unwanted disturbance. The project has protected habitat at 49 sites for 27 threatened species and over 400 Ha of threatened plant communities.

BushBids combined measures of landscape context (site area, connectivity, fragmentation indices, habitat type) with traditional measures of site scale, structure, function and plant species diversity to derive a relative biodiversity value score. Over the 10 year agreement period assessments will be undertaken to measure evidence of improvements in the biodiversity values of the sites.







Vegetation community LCI Score LCI Score Assessment 1991 Assessment 2005/6 2.31 Chenopod Shrublands 2.31 1.94 Low Woodlands 1.73 Mount Eba Country 1.69 1.82 Hummock Grasslands NA 1.67 1 88 Ephemeral plains 2.38 Non Chenopod NA 211 shrublands AVERAGE LCI 2.12 2.17

Table 5.2: Condition of pasture communities in the Kingoonya Soil Conservation District, 1991and 2005/06

Assessment 1991

Low

34.92

643

0.13

0.96

0.33

NA

42.77

Moderate

15.62

957

0.08

1.71

0.13

NA

27.11

Hiah

14.16

14 49

0.29

1.75

0.04

NA

30.06

LCI Disturbance Rating (% count)

Hiah

8.04

5.63

0

1.46

0.04

0

15.17

Total

64.03

30.49

0.50

4 4 2

0.50

NA

99.94

Table 5.3: Condition of pasture communities (average LCI) in the Kingoonya Soil Conservation District, 1991and 2005/06

Assessment 2005/6

Low

28.0

3.96

0

0.26

0

0.04

32.26

Moderate

29.16

20.56

0

2.19

0.30

0.34

52.55

Total

65.20

30 15

0

3 91

0.34

0.38

99.98

Waitpinga Headland after rehabilitation, 2006. Photos: Ron Taylor.

Note: Low Disturbance = 3; Medium Disturbance = 2; High Disturbance = 1

All NRM regions are developing processes to measure and monitor this target. In some regions data has been collected but the ability to report it meaningfully is not currently available.

#### Coastal vegetation

Vegetation community

Chenopod shrublands

Hummock grasslands

Mount Eba country

Non Chenopod shrubland

Ephemeral plains

Total

Low woodlands

Coastal vegetation is covered in the **Coastal Water Quality and Pollution** chapter

#### Forms of Clearance

Clearance of native vegetation takes several forms including active clearance or a decline through degradation and poor management.

Loss of native vegetation cover and associated habitat can occur through:

- Legal clearance resulting from formal consent with an offset environmental benefit, eg clearance of scattered trees for a centre pivot irrigator or clearance for approved house sites;
- Specific clearance activities under particular regulations that do not require consent, eg 5m fuel breaks and access tracks;
- Illegal clearance that is:

- o detected through satellite monitoring or reported by concerned local landowners; and
- undetected or not discovered 0 within the four year legally specified timeframe for the initiation of legal proceedings.

Threats to native vegetation that lead to decline and degradation include:

- vegetation. Damage arises from trampling of plants, browsing of seedlings and resultant poor recruitment and introduction of weeds
- Senescence of trees and plants combined with a lack of regeneration of replacement stock. In many areas there has been no occurrence of new trees, so that as old trees that survived land clearance for agriculture decline and die the landscape becomes increasingly sparsely vegetated.
- Invasion of remnant scrub by feral animals, weeds and overabundant native species (see Introduced Species). These displace native species, disrupt ecosystem processes and degrade habitat quality.
- Inappropriate fire regimes -

Grazing stock within native

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# Native Vegetation

frequency, intensity and seasonality. Most Australian vegetation communities have adapted to some degree to the incidence of fire with a number of species benefiting from fire-stimulated germination

. However if fire is too frequent, there may be insufficient time for germination, growth to reproductive age and seed production, all of which can lead to loss of species and degradation of habitat. Issues of potential changes to fire frequency and intensity associated with climate change are a significant issue for environmental managers.

- Fragmentation and isolation of remnants that can lead to species being unable to re colonise after a disturbance such as a fire. In a fragmented landscape the potential exists for the extinction of local and regional species following large scale natural disasters, or over time as remaining parcels of native vegetation become too small to support viable populations.
- Inappropriate maintenance and grazing pressures on remnant native vegetation on roadsides.
- Human impact such as trampling, vehicle movement, removal of dead wood, soil compaction, root disturbance.

#### Firewood removal

The removal of firewood from parks and roadsides is illegal and fines are endorsed under the *National Parks and Wildlife Regulations 2001.* 

Wood typically collected for firewood provides shelter for native species – small mammals, lizards and insects. As it is organic, wood provides nutrients to keep soil healthy and is a food source for micro-organisms. It can also shelter seeds until they propagate and regenerate conservation areas. Dead trees provide nesting sites for critically endangered species such as the South East Red-tailed Black Cockatoo. Fallen timber also provides perches and foraging habitat for ground foraging birds such as robins.

The impact of firewood removal is more than the removal of the timber as it also generates increased vehicle traffic that carves up the land damaging parks and increasing the risk of soil-borne diseases and the spread of weeds (DEH Media release www.environment.

#### sa.gov.au/data/press/firewood\_270707.

pdf). Recording the enforcement of regulations for firewood removal began in August 2005 and 10 fines have been issued when there was no doubt that an offence had been committed. Cautions are an alternative method for sending a message about inappropriate action to the public.

#### Fire management

Fire plays an important role in shaping Australia's biodiversity and is a significant factor affecting native vegetation and its ecological health.

Bushfires can have devastating effects on the community and native vegetation. However, many species of flora and fauna are well adapted to cope with fire and some even rely on it. Should fuel hazard levels accumulate to very high or extreme levels in long unburnt native vegetation or where there has been no lower risk mechanical fuel reduction activity, neighbouring communities and assets may be threatened. Frequent and/or very large bushfires can adversely affect biodiversity values and also have hydrological implications with increased water requirements as vegetation recovers. Habitat fragmentation and increased settlement, grazing pressure, disease and weed invasion in landscapes shaped by fire make ecologically appropriate fire management a complex task.

DEH Fire Management Policy provides a framework for the management of fire in South Australia's reserve system speecifically on or adjacent to DEH land. The implementation of this policy is facilitated through fire management plans for regions or parks that identify the risks associated with fire and detail strategies to manage it. Between September 2003 and June 2008, 1,253,700 hectares were burnt, including areas where native vegetation had been cleared.

Prescribed burns are undertaken to manage fire and these require approval under the Native Vegetation Act 1990. Both DEH and Forestry SA use this method to manage their land. Between September 2003 and June 2008, DEH conducted prescribed burns over 8,070 Ha. As part of the approval process, there is a requirement to monitor native vegetation before and after a burn. This information is used to assess the impact of burning against the objectives of the *Native Vegetation Act.* The program has





The aftermath of Kangaroo Island Bushfires, 2007. Photo: DEH.



Red Mallee (Eucalyptus oleosa) over Triodia, NW of S.Aust. Photo: Peter Lang

been conducted for almost three years and data analysis will investigate trends in:

- Species presence/absence at regional scales following fires;
- Species presence/absence for particular vegetation types on a regional basis;
- Presence/absence of weeds.

DEH's fire management program will be important for evaluating the long-term impact of fires on vegetation extent and condition across the state. It has high relevance for gaining understanding of the impact of climate change as the incidence of wildfires is expected to increase.

#### Climate change

Climate change will become a critical factor in the challenge to manage biodiversity. The ability of plants and animals to migrate as climate change occurs is a significant issue in the management of native vegetation as a corridor for the migration (DEH 2006). Native vegetation provides core areas of habitat for South Australian biodiversity.

Management of native vegetation needs to ensure adaptation can occur in the face of climate change while conserving the existing biodiversity. It is important to ensure that core areas are managed in such a way that their integrity is maintained and populations are viable. Providing linkages to other areas for migration across landscapes for species, genes or individuals are required. Linkages can be across rainfall gradients or topographic gradients depending on the needs of the entity that is to be conserved.

The effect of climate change is highlighted by increases in temperature and changes to rainfall patterns (CSIRO 2001). Changes in climate could lead to changes in suitable locations for plants and animals, which in a cleared landscape could become more restricted due to existing land uses. Sea level rises would reposition South Australia's coastline. Vegetation on the existing coastline would have to migrate to the appropriate new location however, due to existing land use in some areas there may be no capacity for this migration and vegetation such as Mangroves will be lost.

Climate change is a serious emerging threat to biodiversity and there is a need to improve our understanding of a species response and to develop the most appropriate and practical solutions to move forward in an informed way (DEH 2007). The objective in the state strategy, *Tackling Climate Change identifies* the need *"To increase the capacity of ecosystems to adapt to climate change"* (Department of Premier and Cabinet 2007). The strategy highlights the need to determine priorities for biodiversity conservation and to identify opportunities to build resilience in ecosystems and improve ecological function and connectivity.

#### Vegetation clearance

Historically South Australia has extensively cleared its cover of native vegetation, significantly contributing to the decline in biodiversity, land degradation and loss of ecosystem services. Clearance activities have contributed to a quarter of all plants and animals recorded in South Australia now being considered threatened.

#### Legal Clearance Approvals 2001-2007

The information presented reports only legal clearance requiring formal consent. In South Australia approval for broadacre clearance of previously undisturbed vegetation cannot be granted by the Native Vegetation Council. This level of clearance is easily detected and is now quite rare. Table 5.4 summarises native vegetation clearance approvals from July 2001 to June 2007. There is clearly an ongoing upward trend in total area cleared.

Care must be taken in interpreting these figures. In most years they have been heavily influenced by a small number of large applications. In addition the figures do not show the quality of the vegetation under application. It is difficult to meaningfully compare, for example, removal of 0.02 Ha of intact stringy-bark forest in the Adelaide Hills that has been cleared under the regulations for a house site, with the clearance of 100 Ha of degraded regrowth chenopod shrubland cleared for cropping. There are also provisions for Significant Environmental Benefits to offset this clearance as discussed later in the report.

#### Change Detection Program

The Native Vegetation Council has introduced a change detection program to monitor any loss in extent of native vegetation cover across the rural

#### Table 5.4: Vegetation clearance statistics for South Australia, 2001-07

Financial Year	(unde	Clearance App r Section 28 of Nati	Regulations <sup>b</sup> Area (ha)	Total Clearance Area (ha)		
	Area of (ha) degraded scrub	Scattered Trees	Canopy area of Trees	Total area cleared ª (ha)		
2001-02	148	933	18.7	167	0	167
2002-03	386	241	4.8	391	0	391
2003-04	254	271	5.4	259	7.2	267
2004-05	296	379	7.6	304	495	799
2005-06	930 °	413	8.3	938	56.1	995
2006-07	504	375	7.5	512	1880 <sup>d</sup>	2390

Notes: a. Equals area of degraded scrub plus canopy area of trees to give a total area of clearance approved under section 28 of the Native Vegetation Act. b. Area of clearance approved under the Native Vegetation Regulations c. Includes 891 ha of previously cleared regrowth. d. Includes mining applications totalling 1803 ha, with one application of 1660 ha. These figures do not include approvals where the vegetation is expected to regenerate: eg brush-cutting (Melaleuca uncinata) or ecological burns. Tree area was generated by multiplying tree numbers by the average canopy area of 0.02 hectares

Table 5.5: Reports of illegal clearance in hectares of native vegetation by region, 2004-2007

Region	04/05	05/06	06/07
Adelaide	41	60	54
Kangaroo Island	14	27	12
Murraylands	31	36	21
Outback	8	6	4
South East	26	48	31
Flinders Ranges	1	0	4
West	16	29	15
Yorke and Mid Nth	26	23	17
Total	163	229	157

agricultural regions of South Australia using satellite imagery. Reports of clearances can be provided by the public, officers of various government agencies as well as through the Change Detection Program.

Satellite imagery over the same location at different times provides the basis of the program. Any observed changes are then cross-referenced with aerial photography, contact with landholders and on ground inspections. This eliminates change detected due to, for example planted vegetation, approved or exempt clearance activities, seasonal variations and bushfire related vegetation changes. Archived satellite imagery and high-resolution aerial photography dating back to the 1950s are also accessed to help determine the age of the vegetation and its clearance history.

Where a detected change cannot be verified using external methods, the Department of Water Land and Biodiversity Conservation (DWLBC) will write to landholders inviting their assistance in providing additional relevant information. Where necessary an onsite inspection will be undertaken to verify detected changes that cannot be explained by other means. Clearance detected through this program from 2004 to 2007 indicates that illegal clearance is minimal in South Australia.

#### Other pressures

A number of other pressures on native vegetation overlap into other areas of this report and are covered elsewhere. These include:

- Changed hydrology see Water Quantity (which is particularly important in some of the southerly regions, like the Adelaide and Mount Lofty Ranges regions),
- Disease see Introduced Species,
- Abundant native herbivores see Introduced Species, and
- Urban sprawl see Urban Form and Population.



Waitpinga cliff erosion project at commencement of planting. Photo: Ron Taylor



Waitpinga cliff erosion project 8 years later. Photo: Ron Taylor.

# What are we doing about it?

# RESPONSE INDICATOR: Area of land held under protected status

#### Protected Area Statement

South Australia's protected area system is an important tool for the conservation of biodiversity within the broader context of integrated landscape management. In June 2008 it was estimated that 25.8% of the state was under some form of protected status subject to various legislation and ownership. The existing protected area system has increased by 1% since 2003. It is important to consider how successfully this land is being managed for biodiversity conservation and a measure of this should be considered for future reporting.

The Department for Environment and Heritage (DEH) manages the network of public protected areas and also supports landowners managing the private conservation system of Heritage Agreements and Indigenous Protected Areas. Since August 2003 the number of parks under formal protection and managed by DEH has risen to 338 and includes:

- 14 newly proclaimed parks (4,675 Ha);
- 13 parks that had additional areas proclaimed (41,450 Ha); and
- 23 parks that were proclaimed under a higher level of protection (733,020 Ha) with six of them (619,590 Ha) proclaimed under the Wilderness Protection Act, the highest form of statutory protection.

On 1 May 2006 the 1993 proclamation of pastoral lands as part of the Strzelecki Regional Reserve was deemed invalid resulting in a reduction to the reserve system of approximately 356,800 Ha. Therefore, when reporting on DEH managed reserves there is a decrease in area even though the number of reserves has increased as the resumption was greater than the additions.

Indigenous owners are supported in the management of their lands for the protection of natural and cultural features in accordance with internationally recognised standards and guidelines for the benefit of all Australians. Since 2003 an additional reserve has been added to the Commonwealth Indigenous Protected Areas in South Australia, an

#### increase in area of 597,810 hectares (www.environment.gov.au/indigenous/ ipa/index.html).

Under the Forestry Act 1950, Forestry SA manages Native Forest Reserves including since 2003, 3 additional reserves (1,595 Ha). Forest Reserves contain areas of native vegetation that are managed for conservation.

The Heritage Agreement Scheme was launched in 1980 to protect areas that have significant biodiversity under private ownership and predominantly operates across the agricultural region of the State. Once approved a landowner can apply for grants to assist with the management of the land, such as funding for fencing or weed control.

In 2003 the Heritage Agreement Scheme protected 557,870 Ha and since the last report that area has increased 8% to 611,170 Ha. It should be noted that the figure reported for 2003 has been revised due to the method of capturing heritage agreements. There was a considerable backlog in the capture of older agreements and this work has been accelerated in recent years.

Heritage Agreements in themselves do not directly address ongoing management requirements. To adequately measure whether positive outcomes are being achieved by the system details are needed of whether the condition in these remnants is increasing, stable or decreasing. There is also a need for a better system to provide long term management assistance for affected landholders.

South Australia has committed to the establishment of the National Reserve System (NRS) as part of a certified approach to the conservation of native biodiversity. In 2005, the Natural Resource Management Ministerial Council (NRMMC) issued the Directions for the National Reserves System – A Partnership Approach (the Directions Statement) to guide delivery of the NRS Program.

The Interim Biogeographic Regionalisation for Australia (IBRA) provides the national and regional framework for delivering the NRS program.

The Directions Statement outlines a strategic approach for making quantifiable progress towards the establishment and management of a Comprehensive, Adequate and Representative terrestrial protected

# Native Vegetation



Map 5.3: Areas protected under the NPW reserve system in South Australia

Data Source: Department for Environment and Heritage and Department of the Environment, Water, Heritage and the Arts. SPAR ID: 2749

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area system (CAR Reserve System) and its targets include:

- Examples of at least 80% of the number of extant regional ecosystems in each IBRA region are to be represented in the protected area system - Comprehensive
- Protected areas need to be selected and managed to maximise the probability of survival of their biota including replication of ecosystems; ensuring areas are of sufficient size and condition to ensure long term sustainability; are managed in a bioregional context and optimise opportunities for species dispersal - Adequate
- Examples of at least 80% of the number of extant regional ecosystems in each subregion are represented in the protected area system - Representative

South Australia's progress towards an effective CAR Reserve System has been assessed. The information used to measure the status is IBRA, a hierarchy of nested regions. Associations are nested in subregions that are in turn nested in regions. Comprehensiveness has been achieved for 82% of the regions, with representativeness achieved in 55% of them. The ability to measure the adequacy component of CAR assessments is still being developed nationally.

#### Park management plans

DEH manages 301 areas that are protected under the National Parks and Wildlife Act 1972 and the Wilderness Protection Act 1992 and for which there is a legal requirement to prepare formal management plans (reserves under the Crown Lands Act 1929 are not legally required to have management

#### Table 5.7: Details of South Australia's protected areas

Land Status	Number	Area (Ha)
Conservation Reserves	33	130,040
Conservation Parks	244	5,868,950
Game Reserves	10	25,890
National Parks	21	4,535,145
Recreation Parks	14	3,165
Regional Reserves	7	9,691,840 ª
Wilderness Areas	9	684,540
NPWS subtotal	338	20,939,570 <sup>b</sup>
Heritage Agreements	1372	611,170
Indigenous Protected Areas	5	3,739,695 °
Native Forests	61	16,050
Total	1776	25,306,485

#### Source: DEH 2008

Source: DEH 2008. Notes: Calculated in Lamberts Conformal Conic and rounded to the nearest 5 Ha. a. There was a resumption of 356,000 ha of the Regional Reserves which has caused a known decrease in protected areas. b. Due to improvements in the accuracy of the data, the reported area of reserve has become more precke compared to the last reporting period. c. One reserve overlaps with existing adjacent park and duplication has been removed. Locality Forests have been removed as they have no legal protection other than Native Vegetation Act 1991.

#### Table 5.6: Summary of South Australia's protected areas

% regional ecosystems (associations) with some protection in a subregion	number subregions	% subregions
Nil (0)	5	9
Very Low (<25)	1	2
Low (>25 – 50)	6	11
Medium (50 – 80)	13	23
High >80	31	55
	56	100

Source: DEH 2008

Note: Representativeness is based on numbers of IBRA associations protected within their respective subregion

plans). Prepared to provide direction over approximately a decade, these plans are used to establish the context of longer-term roles for reserves in meeting legislative and policy objectives such as conserving biodiversity in the face of climate change.

At 30 June 2008, management plans had been adopted for 189 of the DEH managed reserves. That represents a 30% increase from 2003 when 129 reserves had management plans from a total of 282 The preparation of management plans has been accelerated from an average of 3.9 plans per year between 1997-98 and 2003-04 — a total of 27 plans, to an average of 19 plans completed per year between 2004-05 and 2007-08 for a total of 75.

Management plans are prepared as soon as is practicable and until one is adopted for a reserve the area is managed in accordance with the appropriate Act. The current aim is to ensure that by 2011 all reserves will have a management plan no more than 10 years old.

To truly understand whether management plans are achieving good outcomes, progress towards their aims must be monitored. For future State of the Environment reports it will be desirable not only to measure the number of plans that have been adopted, but also which are being successfully implemented.

#### **RESPONSE INDICATOR:** Area of revegetation

Revegetation excluding regeneration is a very useful indicator for native vegetation as well as broader land management purposes and even carbon storage. Revegetation work in agricultural regions of South Australia has been undertaken to address a range of natural resource

management problems including those that have arisen from clearance of vegetation (Emes et al 2006). Information on revegetation activity in South Australia has been collected on an annual basis by DWLBC since 1999. Revegetation activity covers the establishment of perennial vegetation including indigenous native plants, fodder shrubs, farm forestry and commercial forestry.

Revegetation is undertaken for a range of reasons including adding value to traditional farming systems, such as providing windbreaks or new potential perennial crops, eg broombush. It is also used to address land and water degradation issues and biodiversity decline. Revegetation benefits differ depending on the application. The use of indigenous species mimicking a natural local plant association will have significant biodiversity value while others, like timber plantations, have high carbon value with limited biodiversity value. The effects of a drier climate are likely to have a considerable impact on the survival rate of plantings and needs to be considered in forward planning for future revegetation activities.

Table 5.10 summarises the major revegetation activity in South Australia from 1999 to 2006, and is based on the numbers and area of seedling or direct seeding and gives no indication of the success of the re-vegetation work.

Overall the table shows that revegetation activity has remained relatively constant throughout the period except for a large increase in hardwood plantings in 2000. Planting of indigenous species (revegetation for biodiversity) has remained stable over the period while industrial forestry plantings for commercial purposes show

# Native Vegetation

% regional ecosystems (subregions) with some protection in a region	number regions	% regions
Nil (0)	1	6
Very Low (<25)	0	0
Low (>25 - 50)	1	6
Medium (50 – 80)	1	6
High >80	14	82
	17	100

Table 5.8: Comprehensive, Adequate and Representative terrestrial protected area system (CAR Reserve System) – Comprehensiveness

Source: DEH 2008.

Note: Comprehensiveness is based on numbers of IBRA subregions protected within their respective region

% regional ecosystems (associations) with some protection in a subregion	number subregions	% subregions
Nil (0)	5	9
Very Low (<25)	1	2
Low (>25 – 50)	6	11
Medium (50 – 80)	13	23
High >80	31	55
	56	100

Source: DEH 2008.

Note: Representativeness is based on numbers of IBRA associations protected within their respective subregion. Table 5.9: Comprehensive, Adequate and Representative terrestrial protected area system (CAR Reserve System) – Representativeness



National Tree Day. Photo: Adelaide City Council

the greatest variability. Despite climbing steadily to a peak of 5,130 Ha in 2004, indigenous revegetation dropped by 34% to 3,390 Ha in 2006. This reduction needs to be further analysed and monitored for any longer term trend in the figures.

The expansion of Tasmanian Blue Gum plantings for wood chipping and carbon credits, has raised issues about the sustainable use of groundwater resources. In the South East of the state it was identified that deep rooted plantations were accessing shallow groundwater resources (Benyon 2004). This will result in plantations having a direct impact on groundwater recharge in the regions where watertables are shallow and as a result of this altered hydrology, will impact indirectly on local surface waters.

#### Significant Environmental Benefits 2001-2007

With the review of the Native Vegetation Act 1991 in 2003-04, amendments introduced a requirement for approved clearance to be offset by an environmental gain, referred to as a Significant Environmental Benefit (SEB).

Table 5.11 shows the SEBs established to offset the clearance summarised in the condition indicator section. Applicants

can offset the clearance through management or restoration of existing native vegetation or revegetation of a cleared area. Where this is not possible applicants can offset clearance via a payment into the Native Vegetation Fund, established in 2003. SEB money in the Fund is pooled by region and used to establish biodiversity benefits. The use of the payment option has increased over the past four years, indicating that it is more favourable to applicants and thus may need review to ensure that the two options remain equitable and there is active engagement in revegetation activities

#### Programs and policy

In recognition of the vital role that native vegetation plays in maintaining healthy ecosystems the high level of protection given to the remaining stock in South Australia continues and efforts are increasing.

South Australia has led the nation in vegetation clearance legislation, with the first such controls introduced in 1983. Since then native vegetation legislation has evolved with a number of amendments introduced through legislative reviews. The most recent and significant changes were amendments to the Native Vegetation Act 1991 in 2003

#### Table 5.10: Summary of major revegetation activity in South Australia

Type of revegetation	1999	2000	2001	2002	2003	2004	2005	2006
Indigenous	3,770	4,050	3,910	4,060	4,540	5,130	4,630	3,390
Native (non indigenous)	1,050	380	790	330	100	190	920	230
Native Grasses*	10	20	40	60	20	30	30	50
Farm Forestry	0	630	250	450	440	510	60	170
Saltbush	1,490	1,210	1,300	320	1,090	580	640	170
Tagasaste	570	210	70	10	50	10	10	0
Product Species (eg broombush)	10	50	10	100	30	70	30	10
Industrial Forestry - hardwood	2,940	21,130	6,730	6,010	590	6,640	1,120	1,300
Industrial Forestry - softwood	3,050	2,940	90	890	560	590	4,430	3,800
Total	12,890	30,620	13,190	12,230	7,420	13,750	11,870	9,120

Source: DWLBC Emes et al 2006, with numbers rounded to the nearest 10 hectares

Financial Year	Clearance Applications (ha)	Regulations (ha)	Total Benefit Area (ha)	Financial off-set \$
2001-02	1,120	0	1,120	0
2002-03	739	0	739	0
2003-04	944	36	980	10,100
2004-05	508	4,442.8	4,940	26,300
2005-06	1,500	288	1,790	217,000
2006-07	1,050	1,300	2,350	323,000

Table 5.11: Summary of Significant Environmental Benefit to offset clearance applications

and 2004. Those changes introduced the concept of no clearance of intact stratum of vegetation, in effect precluding the Native Vegetation Council from granting consent to applicants seeking approval for the broadacre clearance of native vegetation.

Clearance, including of intact stratum, that is associated with approved activities such as infrastructure works, major developments and mining were previously exempt from the provisions of the Native Vegetation Act. However following the introduction of amendments to the Native Vegetation Regulations in 2003, a significant environmental benefit must offset such clearances, in the same way as clearances approved by the Native Vegetation Council. Developers, mining companies and government instrumentalities are now bound by the same rules as other landholders.

Penalties (fines) handed down for breaches of the *Native Vegetation Act 1991* are paid into the Native Vegetation Fund and must be used by the Native Vegetation Council to achieve environmental benefits.

Natural Resources Management (NRM) legislation was introduced in 2004 providing for new regional NRM boards, a State NRM Council and the amalgamation of previously separate water, soil and land management, and animal and plant control legislation. The *State Natural Resources Management Plan* contains strategic policy for managing South Australia's natural resources and was released in 2006.

The intent is to better integrate the management of all our natural resources including native vegetation, through improved legislation, administration, communication and regional involvement. A review of the administration of the *Native Vegetation Act 1991* and Regulations is being undertaken and it is hoped a new direction will be developed for native vegetation management to improve the overall relationship between it, natural resource management and development.

South Australia's first statewide nature conservation strategy No Species Loss – A nature conservation strategy for South Australia 2007-2017 presents policy directions and targets that will guide the protection, conservation and sustainable use of South Australia's biodiversity over the next 10 years. No Species Loss is a direct response to the target of 'lose no species' (T3.1) within the SASP, The State Government will lead the implementation, but will be successful only with a committed and coordinated effort involving government, community and industry.

# Native Vegetation

While there is now a high degree of protection for native vegetation, many areas are isolated and in danger of further fragmentation and degradation through pressures such as pests and wildfire. In the past there has been insufficient emphasis on managing the state's remaining native vegetation as a whole.

The Government continues to move towards a landscape scale approach to protection of biodiversity with the establishment of five biodiversity corridors across public and private land through the NatureLinks program (T3.2, South Australia's Strategic Plan). The corridors support the delivery of No Species Loss by bringing together landscape scale biodiversity management, regional development and natural resource management.

The five biodiversity corridors build on existing major initiatives including the state's network of parks and reserves, large scale ecological restoration projects such as Bounceback, revegetation initiatives and programs for marine planning and Marine Protected Areas. Draft corridor plans are being prepared for community consultation with the draft NatureLinks East meets West corridor plan being released in 2006.

As well as increasing our understanding of the implications of climate change and addressing the underlying causes at an international and national level it is important that action is taken on the ground to address this issue, as well as the many other threats to biodiversity. It is believed that large-scale ecological restoration programs, such as those envisaged under the NatureLinks initiative, can have a valuable role in ameliorating the impact of climate change and improving ecosystem resilience by increasing the availability and connectivity of habitats.

To assist with the re-establishment of native vegetation, pre-European vegetation mapping has been completed for the South East, Murraylands, Mount Lofty Ranges, Mid–North and Yorke Peninsula and work has begun on creating a River Murray Forest.

The Biological Survey Program of South Australia commenced in 1971 with the intention of providing a systematic survey of South Australia's remaining flora and fauna. The program's goal is to achieve a complete survey of the state by 2015. The flora information is used to create complementary floristic vegetation maps for the state. The quality and coverage of the information collected as part of the Biological Survey will give South Australia one of the most complete inventories of native flora and fauna in Australia.

Regional Biodiversity Strategies are being developed as part of the implementation the *State Natural Resources Management Plan* and *No Species Loss.* These plans prioritise conservation activity and provide a regional approach to the implementation of *No Species Loss* for the conservation and management of biodiversity.

In 2004 the National Parks and Wildlife Act 1972 was amended to create a legislative framework for cooperative management of national and conservation parks over both Crown and Aboriginal freehold land. This innovative initiative leads development in this area in Australia. The amendments effectively enable greater application of the Act to protect conservation values of land without that land coming under government ownership.

Nationally, programs aimed at production outcomes of vegetation and biodiversity have utilised market-based instruments to provide or increase financial rewards for changes that result in environmental outcomes (DEH 2007). In general these instruments put an economic value on native vegetation and provide a tool for trading for its protection.

In the long term these incentives might improve sustainability of natural assets through expanding the responsibility from government and interested parties to the wider community. They can also play a role in measuring ecosystem services for guiding directions in policy (Maher and Thackway, 2007). Several programs exist in South Australia that enable individuals to become involved. To date there have been the Biodiversity Hotspots program in the South Australian Murray Darling Basin NRM region, the River Murray Forests along the River Murray and Sustainable Landscapes being trialled in the Adelaide and Mount Lofty Ranges NRM region. There is also a Hotspots Program in the Southern Flinders that is being run by Greening Australia.





Tulya Wodli Riparian Restoration project. Photos: Adelaide City Council.



Acacia cyperophylla (Minnie Ritchie). Photo: Wetlands International.

### What more should we be doing?

The Environment Protection Authority recommends the following:

- **R5.1** Improve revegetation and restoration through detailed information on techniques and selection of species.
- R5.2 Incorporate the protection of important ecosystems into land use planning.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R5.1	R5.2
Growing Prosperity		T1.1, T1.14
Improving Wellbeing		
Attaining Sustainability	T3.1, T3.2	T3.1, T3.2, T3.3, T3.5,1
		T3.7, T3.9, T3.1
Fostering Creativity and Innovation		
Building Communities		
Expanding Opportunities		

For further detail on South Australia's Strategic Plan visit www.stateplan.sa.gov.au

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### Further information

South Australia's Strategic Plan www.saplan.org.au/

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#### NatureLinks

www.environment.sa.gov.au/naturelinks

Biological Survey Program www.environment.sa.gov.au/biodiversity/ biosurveys.html



Acacia cyperophylla (Minnie Ritchie). Photo: Wetlands International.



Yellow Footed Rock Wallaby. Photo: Tim Lubcke

# Threatened Species

### Trends

- The number of plants and animals and ecological communities at risk is INCREASING
- Recovery efforts have INCREASED significantly across the state, but remain less than are required to minimise the potential for species loss.

## Goal

**T3.1** Lose no species – lose no known native species as a result of human impacts.

South Australia's Strategic Plan 2007

## Threatened Species and a sustainable South Australia

South Australia faces particular challenges and opportunities in managing our natural biodiversity into the future. Past vegetation clearance, leaving inadequate amounts of habitat for populations to survive, has left many South Australian native plants and animals highly vulnerable. This has left many of our natural systems and the species that inhabit those areas degraded and at risk of further decline from existing threats such as pest species, fragmentation and loss of ecological connectivity.

Under current conditions, based on the amount, distribution and condition of remaining habitat in the Mount Lofty Ranges, ecologists predict that as much as 50% of the bird species that once inhabited the area will be become locally extinct.

Climate change will greatly increase pressure on our natural systems and as temperatures increase and climatic events become more extreme the economics of using the land and marine environments will alter. Increases in the human population and regionalisation of the population such as that seen by the so-called sea change and green change phenomena will place greater pressure on all environments and need to be alleviated as a matter of urgency.

Healthy ecosystems are the foundation of South Australia's development. Examples of this can be seen along the River Murray and in the South Australian Arid Lands region where the viability of many industries including agriculture, horticulture and tourism, and the wealth that they generate is underpinned by natural environments. Ecosystem services provided by a healthy environment include cleansing of water, soil management and improvement processes and plant and animal interactions. The health of all our ecosystems and the species within them are vital to maintaining South Australia's current population, ongoing prosperity and sustainable development.

Loss of native species can also contribute to loss of future benefits. The genetic material in plants and animals can deliver social, economic and environmental benefits via the biotechnology industry. This includes the development of diseaseresistant crops and medicinal treatments for diseases.

In addition to providing the resource base for our water, food and fibre, indigenous species and ecosystems have their own intrinsic value. Many Australians place a high value on native plants and animals, which contribute to recreation activities as well as a sense of cultural identity and spiritual enrichment. Many native plants and animals are central to Aboriginal and Torres Strait Islander cultures. It could be argued on an ethical and moral basis that we do not have the right to exploit or cause the extinction of any species we share this planet with.

Australia is also party to a number of international conventions and agreements such as the Convention on Biological Diversity, which covers all ecosystems, species and genetic resources, and requires countries to develop and implement strategies for the sustainable use and protection of biodiversity.

Although much has been happening at all levels to halt the decline of biodiversity, the decline continues. At a state level, more species and ecological communities are threatened with extinction than are being managed for recovery leaving us with an extinction risk

# Threatened Species

that is expected to increase with climate change.

Climate change will increasingly affect public infrastructure, water supplies and primary production, but the rate and nature of these changes is currently unclear. The impact of climate change on primary industries and social factors will contribute to a worsening of problems faced by threatened species and ecosystems, as human capacity to manage the scale and relative suddenness of change across our vast landscapes will diminish in relative terms.

A new approach is needed to deal with the range of existing threats and additional risks of climate change. The government continues to move towards a landscape-scale approach to the management of natural resources and the protection of native species. A longterm landscape approach will help the development of strategies of sufficiently large scale to improve ecosystem resilience and enhance the ability of species to cope with stresses, both existing and those exacerbated by climate change. Additionally, specific recovery actions, particularly those that focus on the species recovery level, will also be required to aid the survival of individual threatened species.

This approach will be most effective when it is integrated with the land use planning system, NRM infrastructure, regional infrastructure and industry development, while engaging with the community and building capacity.

Future biodiversity programs need to consider whole of life impacts on biodiversity and integrate and make decisions on the long-term good and not on the short-term scales that currently detract from any long-term strategy to deal with biodiversity. The instruments and infrastructures have adjusted the spatial scale to the right level, however intergenerational considerations have yet to be fully incorporated into decision making in this area.

The community is also playing an active role in this area, particularly in on-ground activities. This engagement highlights the importance of protecting our threatened species from further decline and the value that the community places on this issue. These many groups include the Threatened Plant Action Group, the many Friends of Parks groups, Native Fish Australia and the Threatened Species Network.

### Indicators

#### CONDITION INDICATOR

 Number of extinct, endangered and vulnerable species and ecological communities.

The number of species considered extinct, endangered or vulnerable over time is the best available measure of the rate of decline of species, but is not ideal. Care must be taken with its interpretation as a number of species that may meet the criteria for these categories are not listed as such.

In South Australia the term *threatened* species refers to those that are classified as rare, vulnerable or endangered (including extinct) on Schedules 7, 8 and 9 respectively of the *National Parks and Wildlife (NPW) Act* 1972.

#### **RESPONSE INDICATOR**

#### The number of recovery plans prepared and being effectively implemented

The number of recovery plans prepared and more importantly being implemented provides an indication of the extent of our response to help reverse the declines in our threatened species and ecological communities. It doesn't however determine the success of these actions in bringing about change which is a shortcoming of the existing indicator.

# What is the current situation?

CONDITION INDICATOR: The number of extinct, endangered and vulnerable species and ecological communities

#### **Threatened species**

The number of species considered extinct, endangered or vulnerable is the best available surrogate for the rate of decline and, ultimately, loss of species. This is not an ideal measure and care must be taken with its interpretation. In many cases changes in status can be the result of changes in our knowledge and community concerns. Some recent changes in conservation status can largely be attributed to these factors. It may also be likely that changes to status in the future will be as a result of effective recovery actions. It does however provide some insight into which particular species

### Key Facts



Sea Lion. Photo: David Mudge

- Loss of South Australia's native plant and animal species since the arrival of European settlers has been significant with at least 26 plants, 28 mammals, seven birds and two amphibians having already become extinct.
- South Australia has two of the nation's 15 biodiversity hotspots, the South-East and the Mount Lofty Ranges/Kangaroo Island. These unique areas are rich in plant and animal species particularly endemic ones, i.e. those restricted to a specific region or site.
- The conservation status of South Australia's marine species and communities is largely unknown.



Tawny Frogmouth. Photo: David Mudge.

are believed to be threatened, and the status review assessment process provides useful indications of management and research needs and options, and allows us to focus on monitoring trends in those species.

In South Australia 1,136 of the 6,773 plant, mammal, bird, reptile and amphibian species recorded (that is 16.8%) are listed as threatened at the state level: 814 plant, 98 mammal, 163 bird, 53 reptile and eight amphibian species (Table 5.12). There are 26 plant, 28 mammal, seven bird and three freshwater fish taxa that are presumed to have become extinct in South Australia since European settlement.

Specifically, threatened flora statistics have changed from 785 species listed in 2000 to 814 in 2008. That's an increase of 29 species or 4% on the lists of endangered, vulnerable and rare species.

Threatened fauna statistics have changed from 256 species listed in 2000 to 323 in 2008, an increase of 67 species (26%). A total of 142 flora species and 93 fauna species have been added to the lists for the first time in 2008. A further 11 flora and 25 fauna species that were previously listed have been assigned to a worse status category. Six previously-listed flora species and 18 previously-listed fauna species have been placed in a better status category. 143 species have been removed from the threatened species schedules altogether: 123 because they did not meet the criteria for listing due either to a better status than previously assessed or a better status for different taxonomic entities, and 20 for taxonomic (recent name change), reasons alone.

Endangered species are under the most threat and likely to become extinct in the near future unless the underlying circumstances and factors threatening their survival cease to exist. Species that are considered to be extinct from the state are also included in this category under the NPW Act, in case a living population happens to be discovered. Vulnerable species are those likely to move into the endangered category in the near future unless the circumstances and factors threatening their survival cease to exist. Rare species are those that are under less threat, but due to their low numbers, restricted distribution, observed decline or because they are naturally uncommon, are at some risk.

Some species are also listed as threatened at the national level under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (EPBC Act 1999). These plants and animals tend to receive priority for conservation activities because they are threatened at both the national and state levels.

This increase in numbers does not necessarily mean that we now have 95 more threatened plants and animals, although some new ones have been added to the list. Other factors that have influenced the number include taxonomic revisions (which may result in one species being split into many) and records of new plants and animals previously unrecorded in South Australia. For example, in the last four years eight new species of reptile have been recorded in South Australia.

With improved information and knowledge, a number of extra species have now been identified as of conservation concern.

No species were removed from the 2000 list of threatened species due to population recovery. However, the Southern Marsupial Mole (*Itjari-itjari*) as an example has had its conservation status downgraded (that is from endangered to vulnerable) as a consequence of new information.

A recent assessment of the status of freshwater fish highlighted several threatened species. An action plan to guide recovery efforts has been developed from this assessment and is available online at the Department for Environment and Heritage website (www.environment.sa.gov.au).

Assessment of the conservation status of marine species has begun and information on the status of South Australian marine fish, sharks and rays is expected to be available in late 2008.

#### Nationally threatened species

A total of 183 species that occur in South Australia are threatened at the national level, this is around 10.8% of all nationally threatened species (*EPBC Act 1999*).

# Nationally threatened ecological communities

An ecological community is a group of interacting species that have adapted to particular conditions of soil, topography, water regimes and climate. A number of ecological communities are considered threatened with extinction. The Commonwealth Government has recognised the need to protect and recover these communities through enabling their listing as threatened under the EPBC Act 1999.

#### Table 5.12: Species listed as threatened in South Australia, 2007

NPWSA Status	Plants (as a % of the total number recorded in SA - 5858*)	Mammals (as a % of the total number recorded in SA - 180#)	Birds (as a % of the total number recorded in SA - 473#)	Reptiles (as a % of the total number recorded in SA - 235#)	Amphibians (as a % of the total number recorded in SA -27#)
Endangered**	187	47	42	9	0
%	(3)	(26)	(9)	(4)	(0)
Vulnerable	196	20	32	9	4
%	(3)	(12)	(7)	(4)	(15)
Rare	431	32	89	35	4
%	(7)	(18)	(19)	(15)	(15)
Total	814	98	163	53	8
%	(14)	(56)	(34)	(23)	(30)

Source: DEH

Total numbers of fauna species from BDBSA Fauna Taxonomic system (includes all current species accepted to

Total numbers of fauna species from BDBSA Fauna Taxonomic system (includes all current species accepted to occur officially in SA)
 Total numbers of flora species from BDBSA Flora Taxonomic system (includes all current species accepted to occur officially in SA)
 Includes species considered to be extinct in South Australia.
 Note: Fish are not currently listed in South Australia but the 32 fish are identified as threatened (17 Endangered, 11 Vulnerable and 4 Rare) in the Draft Action Plan for South Australian Freshwater Fishes

Table 5.13: Number of nationally threatened species occurring in South Australia

Status	Plants	Mammals	Birds	Reptiles	Amphibians
Extinct	0	16	1	0	0
Critically Endangered	1	0	2	0	0
Endangered	34	11	8	2	0
Vulnerable	59	21	18	8	1
Conservation Dependant	0	1	0	0	0
Total	94	49	29	10	1

Source: DEH

There are currently five ecological communities occurring in South Australia that are listed as endangered or critically endangered under the Act:

- Buloke Woodlands of the Riverina and Murray Darling Depression Bioregions;
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin;
- Swamps of the Fleurieu Peninsula;
- Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia;
- Iron-grass Natural Temperate Grassland of South Australia.

A nomination for the listing of Inland Grey Box Woodland under the EPBC Act 1999 is currently being assessed.

Since European settlement South Australia's landscape has been significantly reshaped and our native species seriously impacted as a result. Species decline has been observed across all regions of the state, particularly in the agricultural areas where habitat destruction or modification has disrupted ecosystems and created a landscape of remnant islands or fragmented patches of degraded native vegetation. Vegetation clearance was disproportionately higher on the better quality land.

Key threats to species identified in previous SoE reports still persist. These threatening processes include competition and land degradation by rabbits, feral goats and camels, inappropriate livestock grazing regimes, predation by feral cats and foxes, over-abundant native species, dieback caused by plant diseases such as the root rot fungus Phytophthora cinnamomi, invasion by weeds, degradation of water bodies, continued loss of habitat, loss of drought refuges and altered fire regimes. Many of these threats are statewide



# Legislation



Fish Passage, Torrens Outlet. Photo: Steven Mudge.

while others affect particular regions such as the pastoral or agricultural zones. Ongoing vegetation clearance and the expansion of mining operations across the state are also significant threats at a scale that impacts on threatened species.

In addition to these significant pressures, South Australia's species are now challenged by human induced climate change. Predictions suggest that South Australia will experience a 1-6% increase in mean temperature by 2070, warming more inland than near the coast.

Expected higher rainfall in the north will likely be accompanied by a 25-30% decline in rainfall in the agricultural regions by 2070, mainly affecting winter and spring falls. Weather patterns are likely to be more extreme. Environmental water flows are expected to decrease while drought and storm frequency will possibly increase together with the risk of flood and bushfire, rising sea levels and storm surges in some coastal areas.

The projected increase in water temperature in marine and coastal environments, increased storm surges, and rising sea level, will drown some coastal habitats such as mangroves and coastal samphires. They will also impact other coastal vegetation, change feeding patterns for marine species, change water current patterns and possibly alter nutrient upwellings – all of which threaten existing patterns in the distribution and extent of many marine communities and habitats.

How South Australia's species and ecosystems will respond to these climatic changes is uncertain. Species may simply become extinct in a short timeframe. Others may change in distribution and abundance, population dynamics, life history patterns and reproductive cycles. Threatened species, including some that are not currently listed, may be at increased risk of extinction, while invasive and over-abundant native species may gain opportunities to establish themselves in wider areas. Ecological processes could well change.

# What are we doing about it?

#### RESPONSE INDICATOR: The number of recovery plans prepared and implemented

A recovery plan is a document that outlines the management actions required for the recovery of a particular threatened entity (population, species, group of species or ecological community). The plan provides details on how to minimise or eradicate the threats and risks to these threatened entities. It also identifies knowledge gaps and research needs. At present, because recovery plans are required under national legislation and because the Australian Government funds recovery plan development and implementation, most recovery plans are written for nationally threatened species. A more suitable indicator for this section would focus on outcomes of recovery rather than being based on outputs however current data is insufficiently comprehensive to do this.

Table 5.14 summarises the current status of recovery plans and other recovery actions. This indicates that 82 species have formal recovery plans approved under Commonwealth legislation, the majority of which are being implemented to some degree.

A further 185 species have recovery plans in preparation and 120 species have no formal recovery plans, but are subject to a range of recovery actions including research and monitoring, or on-ground actions such as habitat protection.

The number of threatened species with completed recovery plans has increased to 82 from the 21 reported in the *State of the Environment Report* 2003. Due to the large number of recovery actions identified, funding shortfalls often mean that action cannot be implemented to the extent required for most species' recovery.

An "Action Plan for the Conservation of Threatened Freshwater Fish in South Australia" has recently been prepared. This plan provides significant guidance for conservation efforts for several threatened small-bodied freshwater fish species at risk from wetland habitat drying due to worsening drought conditions.

# Climate change impact on Native Species

Temperature and rainfall play major roles in determining where individual species of plants and animals can live, grow and reproduce. Some animal and plant species are likely to come under increasing stress from climate change, causing long-term changes that could result in loss of species or an increase in threatened species.

#### Reductions in the condition and reproductive performance of species

Species could become restricted to small areas or disappear altogether, for example Mallee Box (Eucalyptus porosa) communities currently occur in heavy soils over limestone in large shallow depressions eastwards of Streaky Bay on Eyre Peninsula. Should average rainfall and water table levels be reduced through climate change, it is likely this species will become restricted to drainage lines, as it has already in the northern agricultural districts of South Australia.

#### Changes to the timing of species lifecycles

Species may breed earlier or later in the season than previously. Cape barren Geese are a species that is dependent on the flush of new green grasses at the break of the season to begin breeding. Should climatic conditions change, the breeding pattern of Cape Barren Geese may be altered.

#### Changes in the location of species habitats

Species may need to move southwards or into ranges in order to keep pace with shifting climate zones. This has previously happened in the Flinders Ranges, which provide habitat for many species that would otherwise not survive the arid climate. The presence in the Flinders Ranges of at least 23 plant, four bird, three reptile and one frog species having southern affinities have been recorded. These populations are viewed as population isolates or relicts, from a much wetter period and contribute to the significance of the Flinders Ranges. They are likely to be severely affected by predicted temperature increases and lower effective rainfall associated with climate change.

 Increases in the risk of extinction for species that are already vulnerable Species with limited climatic ranges, dispersal ability, specialised habitat requirements, small populations and/or low genetic diversity, are the most vulnerable to extinction. Examples include the Nodding Grass-lily (Stypandra glauca), a small blue flowered lily that is restricted to cracks in granite outcrops, and the Southern Brown Bandicoot (Isoodon obesulus obesulus) now only found in the Mount Lofty Ranges, the South East and on Kangaroo Island.

Implementation of recovery plan actions, underpinned by strong, enabling legislation is not the only way to protect individual threatened species. Of South Australia's threatened plant species, 31% have been collected and are being conserved ex situ as a result of a partnership with the Royal Botanic Gardens, Kew, Millennium Seed Bank (UK). While individual species can be protected in this manner ecological relationships are unlikely to be reestablished.

In 2005 the Coongie Lakes were declared a National Park. This declaration provides protection and enables greater management of its biological assets and systems. The Coongie Lakes area provides habitat for a total of 205 bird species of which 24 are rare, vulnerable or endangered in South Australia.

Bounceback is a successful ecological restoration program that has been operating in the Flinders Ranges and Vulkathunha Gammon Ranges National Parks and on surrounding properties since 1992. The program has considerable community support which has been a significant contributor to its success. A dramatic reduction in grazing pressure has been achieved through the control of rabbits, feral goats and kangaroos. Combined with the virtual elimination



Southern Marsupial Mole (Itjari-itjari). Photo: Joe Benshemesh



Behr's cowslip orchid. Photo: Peter Lang.



Golden Bell Frog. Photo: Tony Robinson.

Table 5.14: Status of species recovery in South Australia, 2007

	Threatened species in South Australia	Completed recovery plan#	Recovery plan being implemented	Recovery plan in preparation	Other recovery actions underway
Mammals	98	20 (20%)	14 (14%)	21 (21%)	17
Birds	163	21 (13%)	7 (4%)	29 (18%)	21
Reptiles	53	6 (11%)	3 (6%)	7 (13%)	6
Fish	32*	1 (3%)	0 (0%)	17 (53%)	17
Amphibians	8	0 (0%)	0 (0%)	1 (13%)	8
Plants	814	34 (4%)	34 (4%)	110 (14%)	51
Total	1168*	82 (7%)	58 (5%)	185 (16%)	120

Source: DEH Notes: # Includes recovery plans that are complete but not current. Please note while fish are not listed under the National Parks and Wildlife Act 1972 there are 32 threatened fish species in South Australia listed in the Draft Action Plan for South Australian Freshwater Fishes

of foxes and the suppression of feral cat populations in key areas, this has enabled the recovery of local native species.

The government continues to move towards a landscape-scale approach to protection of native species by the establishment of five biodiversity corridors across public and private land through the NatureLinks program (T3.2, South Australia's Strategic Plan). These corridors build on existing major initiatives including the state's network of parks and reserves, large scale ecological restoration projects such as Bounceback, revegetation initiatives and programs for marine planning and Marine Protected Areas. Draft corridor plans are being prepared for community consultation with the draft NatureLinks East meets West corridor plan having been released in 2006.

The corridors support the delivery of No Species Loss – A Nature Conservation Strategy for South Australia 2007-2017, which was released in 2007. No Species Loss, the first statewide nature conservation strategy in South Australia is a whole-of-government partnership with the community. It is a response to South Australia's Strategic Plan target of 'lose no species' and provides a framework to achieve that aim. Implementation will only be successful with a committed and coordinated effort from government, community and industry.

#### **River Murray**

There are a number of threatened species projects along the River Murray Corridor that have provided greatly improved information on the regional status and ecology of their target species, and have helped to determine and implement appropriate action for their recovery. The species include the

Regent Parrot, Bush-stone Curlew, Carpet Python, Golden Bell Frog, Broadshelled Tortoise, Yarra Pygmy Perch and Southern Purple-Spotted Gudgeon. Many of these species have suffered from habitat loss and fragmentation, drought, river regulation and extraction of water, and habitat degradation.

Information is also being collected on threatened species in the Murray Mallee. The Threatened Mallee Birds project is assessing the distribution, status and habitat requirements (at both a site and landscape scale) of threatened mallee bird species in the region and a better understanding of management issues, such as grazing impacts and habitat restoration, is developing. The main threats facing mallee birds are fire, degradation of habitat and isolation of subpopulations, combined with the potentially exacerbating effects of climate change, particularly more frequent and prolonged droughts.

There is also a SA Murray Darling Basin Threatened Flora Recovery Project, which has been gathering information and implementing recovery actions for several threatened flora species.

The River Murray Forest project is a large-scale habitat establishment and biosequestration initiative, which aims to establish an additional 2.5 million trees in the River Murray corridor and northern Murray Mallee environments. This project has included an assessment of biodiversity 'assets' (including threatened species) which are likely to benefit from revegetation in the Murray Mallee.

# Arid Recovery Project

Arid Recovery has developed into Australia's premier arid zone conservation partnership. The program is a joint conservation initiative between BHP Billiton, the local community through the Friends of Arid Recovery, the SA Department for Environment and Heritage and the University of Adelaide.

This is a unique demonstration of how mining, tourism, pastoralism and conservation can provide mutually beneficial conservation outcomes. The development of a world class conservation project adjacent to the huge copper, uranium, gold and silver Olympic Dam mine and processing plant shows that contemporary mining operations can benefit regional environmental values.

Begun in 1997, Arid Recovery has now secured 86 square kilometres with rabbit, fox and cat proof fences, and removed these feral pests. The reserve has provided an area of complete protection enabling the regeneration of native vegetation and the reintroduction of four locally extinct mammals. To date, breeding populations have been established for the Greater Bilby, Burrowing Bettong, Western Barred Bandicoot and Greater Stick-nest Rat.

More recently, releases of Numbats and Woma Pythons have been trialled. The pythons are native predators that Arid Recovery hopes will restore a natural ecological balance required for the populations inside the reserve to become self-sustaining.

One of the long-term goals of Arid Recovery is to work towards feral species management and ecosystem regeneration beyond the fence. Ongoing cat, rabbit and fox control has been undertaken outside the reserve since the project commenced and Arid Recovery is now leading a major national research project into broad-scale cat and fox management.

Arid Recovery has recently undertaken releases of the Greater Bilby outside the fence. Hopefully, continued feral predator control outside the reserve will enable the Bilbys to expand their range to encompass more of their original habitat.

Not only have the reintroduced species benefited from the removal of feral animals, but many other species including the Spinifex Hopping Mouse are now thriving. Arid Recovery's research has shown there are now five times as many naturally occurring small mammals inside the reserve compared to outside the fence. The vegetation is also making noticeable recovery through the successful recruitment of new mulgas, wattles, hopbush and bullock bush.



Bilby awaiting release. Photo: Hugh McGregor



Small Monkey-flower. Photo: DEH

### What more should we be doing?

The Environment Protection Authority recommends the following:

- **R5.3** Develop conservation legislation to protect and restore threatened species and communities.
- **R5.4** Increase investment in landscape-scale habitat reconstruction to achieve South Australia's Strategic Plan target T3.1 (Lose no species) and to facilitate adaptation of ecosystems and species to climate change.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R5.3	R5.4
Growing Prosperity	T1.22	
Improving Wellbeing		
Attaining Sustainability	T3.1	T3.1
Fostering Creativity and Innovation		
Building Communities	T5.9	
Expanding Opportunities		

For further detail on South Australia's Strategic Plan visit www.stateplan.sa.gov.au

### References

NatureLinks East meets West Corridor Plan Draft, (2006). Department for Environment and Heritage, South Australian Government

No Species Loss – A Nature Conservation Strategy for South Australia, (2007). Department for Environment and Heritage, South Australian Government

State Natural Resources Plan 2006, (2007). Department for Water, Land and Biodiversity Conservation, South Australian Government

South Australian Arid Lands Draft Biodiversity Strategy Flinders and Olary Ranges Conservation Priorities, (2007 in preparation). Department for Water, Land and Biodiversity Conservation, South Australian Government

South Australian Arid Lands Draft Biodiversity Strategy Stony Plains Conservation Priorities, (2007 in preparation). Department for Water, Land and Biodiversity Conservation, South Australian Government

South Australia's Strategic Plan 2007, (2007). Department of Premier and Cabinet, South Australian Government

### Further information

South Australia's Strategic Plan http://www.saplan.org.au/

# Department for Environment and Heritage

http://www.environment.sa.gov.au

Department of Water, Land and Biodiversity http://www.dwlbc.sa.gov.au

State Natural Resources Management Plan

www.dwlbc.sa.gov.au/nrm/state\_nrm\_ plan/index.html

Department for Environment and Heritage (2007) No Species Loss – A Nature Conservation Strategy for South Australia 2007-2017 www.environment.sa.gov.au/ biodiversity/pdfs/nsl\_strategy.pdf

Threatened Species in South Australia http://www.environment.sa.gov.au/ biodiversity/threatened.html

# Introduced Species

# Introduced Species

### Trends

- Abundance of rabbits: INCREASING due to reduced frequency and sporadic nature of outbreaks of Rabbit Haemorrhagic Disease.
- Abundance of feral cats: INCREASING in the Adelaide and Mount Lofty Ranges region and Arid Lands.
- Abundance of feral camels:
  INCREASING
- Abundance of feral goats:
  INCREASING in the Arid Zone;
  DECLINING on Kangaroo Island due to
  effective eradication.
- Abundance of foxes: DECLINING in high priority conservation areas and where livestock protection is required.
   STABLE in other parts of the state.
- Abundance of feral pigs: STABLE in the Riverland and far northeast Arid Lands; SLOWLY DECLINING on Kangaroo Island due to eradication.
- Distribution of bridal creeper: INCREASING; abundance STABLE or DECLINING in most affected regions due to biological control.
- Distribution of feral olives and silverleaf nightshade: INCREASING in all affected regions.
- Distribution of blackberry: STABLE in most regions; DECLINING in the Adelaide and Mount Lofty region and on Eyre Peninsula.
- Distribution of boneseed: STABLE from the Arid Lands to South East regions;
   DECLINING in the Adelaide and Mount Lofty Ranges region.
- Distribution of gorse: DECLINING due to intensive control programs across all regions.
- Number of identified marine pests: STABLE

### Goals

**T3.1** Lose no species: lose no known native species as a result of human impacts.

#### South Australia's Strategic Plan 2007

Integrated management of biological threats to minimise risks to natural systems, communities and industry.

South Australian Natural Resources Management (NRM) Plan 2006 – Goal 4

### Introduced Species and a sustainable South Australia

Biological invasions by non-native species are a leading threat to natural ecosystems and biodiversity (Walker and Stefan, 1997). In South Australia, invasive animal species have caused the loss of abundance of native plant and animal species, which often leads to ecosystem change.

Since European settlement in South Australia 24 terrestrial mammal species have become extinct with the introduced fox and rabbit implicated in most of those losses. The vascular land flora of the state now consists of 3378 native species and 1288 introduced species (Barker *et al.*, 2005).

Invasive species impose enormous economic costs on agriculture, forestry, fisheries and other human enterprises. A recent national survey by the Australian Bureau of Statistics (ABS) found that weeds and pests ranked as the highest NRM issue amongst farmers, having significant financial impact in terms of losses in crops and livestock production, and the costs of control. Of the various invasive species, weeds cause the greatest financial losses, more than \$600m per annum in South Australia.

While the efforts to control established weeds continue, it is also necessary to minimise the chances of new ones becoming established. There is significant effort applied in agricultural areas due to the extent of the problem however, the pastoral area also has risk that require management. A number of new and small incursions that could be eradicated have occurred in pastoral areas, but are receiving minimal attention. It is important



# Key facts

- Around 65% of South Australia's weeds were originally introduced as garden plants.
- Seven species of feral deer have been detected in South Australia.
- Eight vegetables, 12 pulse and oilseed crops, and 12 native plants have been confirmed as potential hosts of the parasitic plant branched broomrape (Introduced species)
- Genetic resistance to rabbit haemorrhagic disease (RHD) has been confirmed in South Australian rabbits, with populations recovering to high densities.
- The Natural Resources Management Act 2004 provides the framework for management of key pest plants and terrestrial pest animals in South Australia.

# "Exotic" V "Alien"

Exotic species are those introduced from overseas. They include the classic weedy and pest animals found worldwide and a range of less invasive animals and plants that are human companions, but without a savage environmental impact (eg sparrows)

Alien species are Australian natives that are found in areas other than their original locations. These species may have been introduced accidentally or deliberately by humans, or may have introduced themselves to new areas due to of climate change or anthropocentric changes to land use. They may be very significant pests.

#### What defines a pest species?

A pest species is one that has a significant environmental, economic, social and/or health impact over a large area, for a significant proportion of the human population and/or threatens natural or agricultural environments. to recognise in the pastoral landscape that introduced species pose the most significant threat to landscape condition and there is a strong need for large scale, cross boundary programs.

Invasive species can also have social impacts, such as threats to the state's recreational fishing from Caulerpa taxifolia, impacts on human health due to starlings and feral pigeons fouling rainwater supplies and increased fire risk from invasive grasses such as Coolatai grass in peri-urban areas. The threat of stinging attacks from imported red fire ants highlights the importance of attempting to eradicate pests shortly after arrival to avoid great expansion of their range. These ants are currently present only in Queensland, and South Australia is contributing to a major eradication program to prevent them spreading elsewhere in Australia.

Many invasive species were originally imported for use as pets, garden plants or food, and have since become serious pests through deliberate release or escape from properties. Common (Indian) Mynas were released deliberately in Canberra in the late 1960s as a songbird, but are now an established pest in the city, pushing out native birds. Mynas are a potential pest for South Australia and reports of incursions are dealt with promptly.

Weeds such as bridal creeper, English broom, boneseed and fountain grass are escaped garden plants, while the state's *Caulerpa taxifolia infestation probably* originated from a household aquarium. There are strict controls over the keeping of exotic animals due to concerns for public safety and potential risks to the environment and primary industries.

Invasive species pose current and potential threats in terrestrial, riparian and marine environments statewide. Life forms include vertebrates, invertebrates, plants, algae and pathogens (including fungal, bacterial and viral). There are numerous ways in which invasive introduced species affect native species, ecosystems, primary industries and communities, including competition, predation, disease, physical barriers and injuries.

Some invasive species can irreversibly transform ecosystems by changing water, nutrient, soil and/or fire cycles. The acceleration of international trade and travel over the past century and the development of complex transport networks within Australia, has enabled both deliberate and inadvertent movement of introduced species, often delivering unexpected and sometimes disastrous consequences.

As a society we need to manage existing pests to reduce their impact and prevent further spread, while being prepared to respond to new threats from exotic incursions.

The impact of adverse climate change on the distribution of introduced species could be significant. Species that are currently restricted in range due to climatic unsuitability may spread with climate change. It is possible that predicted climate scenarios may better suit Mediterranean pest species such as feral olives and also in a drier climate, enable the spread of arid land species such as camels. A further impact of climate change will be that of increased fire risk with its potential impact on the establishment and distribution of pest plants and animals.

### Indicators

#### PRESSURE INDICATORS

 Distribution and abundance of key terrestrial, marine and freshwater pest animals and plants

The distribution of pest plant and animal species that are known to cause significant threats to biodiversity, primary industries and communities provides an indication of the extent of their current impact.

#### Number of new incursions of pest plants and animals and responses

Newly emerging pest plants and animals are additional threats to biodiversity, primary industries and communities.

# Introduced Species

Table 5.15 Percentage area of State infested by abundance class for key terrestrial pest animals

Density Category	Rabbits	Foxes	Feral	Feral	Feral	Wild Dogs	Feral Cats	Feral Pigs	Starlings
			Deer	Camals	Goats	·····		· · · · · · · · · · · · · · · · · · ·	g-
Absent	0.5	0.5	94.6	40.2	72.5	17.1	0.0	92.7	71.0
Abundant & Localised	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Abundant & Widespread	0.0	43.4	0.0	3.4	0.0	0.0	40.7	0.1	4.9
Common & Localised	14.0	0.0	0.5	1.7	1.3	0.0	0.0	4.1	0.6
Common & Widespread	85.5	56.4	1.1	35.2	11.1	47.9	59.5	0.0	10.6
Occasional & Localised	0.3	0.0	3.6	4.2	12.7	19.6	0.0	3.3	12.6
Occasional & Widespread	0.0	0.0	0.1	15.5	2.6	15.6	0.0	0.0	0.5
Present but Density Unknown	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Unknown occurrence	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Source: created from NLWRA Draft Distribution Maps for Invasive Animals – SA 2006 www.nlwra.gov.au/Natural\_Resource\_Topics/Invasive\_Species/index.aspx Note: figures are rounded up to nearest 0.1%, and therefore may total over 100%.

## What are the pressures?

#### Pressure Indicator: Distribution and abundance of key terrestrial pest animals

Table 5.15 shows the current percentage area of key terrestrial animals in South Australia, based on nationally agreed indicators of the National Land and Water Resources Audit (NLWRA). The greater the figure then the greater the extent of current impacts. Coordinated control programs seek to reduce the area and density of pests and maintain these at low levels.

#### European rabbit (Oryctolagus cuniculus)

Rabbits are still Australia's most widespread and destructive vertebrate pest despite the introduction of myxomatosis and Rabbit Haemorrhagic Disease (RHD). Rabbits are common and widespread through 85.5% of South Australia.

RHD is now common throughout the state following its introduction in 1995. Outbreaks occur regularly each year throughout the arid zone, but less predictably in high rainfall areas. At sites monitored by the Department of Water Land and Biodiversity Conservation (DWLBC) Animal and Plant Control Group RHD has dropped total rabbit numbers by more than 70% since its introduction.

Outbreaks of RHD were less common during the drought years of 2005-2007 and current research by DWLBC and Invasive Animals Cooperative Research Centre is endeavouring to determine whether this is a result of underlying genetic changes in rabbits or the virus, or if it is related only to seasonal conditions. The decrease in outbreaks has resulted in higher rabbit numbers since 2005.

Coordinated rabbit baiting and warren destruction programs by NRM Boards remain an important activity to complement biological controls. In the Arid Lands region, incentive payments for warren ripping and the 'Bounceback' program operate on reserves and pastoral properties. Several local action groups are supported in this way. On the Eyre Peninsula and in the upper South East and Murray Mallee, broadscale baiting with 1080 oats and warren ripping occur in collaboration with landholders. More incentive programs are needed to increase rabbit harbour destruction by landholders. Regular monitoring is required on Kangaroo Island to maintain its rabbit free status

#### European red fox (Vulpes vulpes)

The European red fox is common or abundant in most regions of the state with the notable exception of Kangaroo Island. Its distribution tends to correlate with that of rabbits, which form a major part of its diet. Foxes are well recognised as a key threat to native fauna.

Fox control is costly, labour intensive and must be maintained indefinitely. Eradication is not feasible because of the high reproductive and dispersal rate of the species.

Priority is given to managing fox numbers in selected, high conservation areas around the state. Large scale baiting programs, such as those carried out as part of Operation Bounceback (see *Threatened Species* chapter), have reduced fox numbers over the past 10 years in the Flinders and Gammon Ranges



Feral Cat.



Feral goats

# Repel the Invaders Program

Kangaroo Island and many other offshore islands have escaped invasion by some introduced pests including rabbits and foxes, two of Australia's most devastating invasive species.

The Kangaroo Island NRM Board's Repel the Invaders Program is designed to keep these pest out and to eradicate and control those already present. The Kangaroo Island Weeds Group assists the board. Species targeted include feral goats, deer, pigs and cats, and weeds such as bridal creeper, bridal veil and othe species that are declared under the NRM Act.

For more information on Kangaroo Island's Repel the Invaders Program see:

www.kinrm.sa.gov.au/TakingAction, Controllingpests.aspx and on parts of the Eyre Peninsula, and stabilised them in the Arid Lands region.

Elsewhere in the state, foxes remain a problem, despite significant baiting programs. The South East NRM Board has a large coordinated fox control program to reduce predation on lambs.

Development of biological control for foxes is required for areas such as the Arid Lands region where foxes have invaded extensive areas and labour is scarce. A number of NRM Boards are researching best practice design for baiting programs. In areas of South Australia with diverse land uses, such as the South East region, baiting is patchy and control is less efficient. In these regions varying landholder attitudes to poisons also impact on baiting efforts.

#### Feral goats (Capra hircus)

Feral goats occur in the southern and central areas of the state, particularly the Gawler and Flinders Ranges and eastern pastoral areas south of the dog fence. Aerial survey data indicate a recent reversal in the downward trend in goat numbers that had been apparent in the Arid Lands zone since 1990, with numbers increasing for each of the last three annual surveys (see Figure 5.1). Goats tended to concentrate around watering points during the drought of 2007, leading to severe local damage.

Elsewhere, numbers are believed to be declining, although there is a lack of accurate data.

In the Adelaide and Mt Lofty Ranges NRM region numbers are probably declining as a result of control programs in several large areas infested with feral goats. There is an increasing problem with escaping domestic goats.

On Kangaroo Island the 2008 bushfires provided an opportunity to aim for islandwide eradication. Radio-collared Judas goats are being used to locate and destroy feral goats in a major project being undertaken by the Kangaroo Island NRM Board, the Invasive Animals CRC, and South Australian government agencies. Parts of Flinders Chase National Park that were previously infested with goats are now believed to be free of this pest.

#### Feral deer (Cervidae)

Present in 5.4% of the state, feral deer still occur in relatively localised populations in the South East, Mid North, Kangaroo Island and Mount Lofty Ranges. There has however, been an increase in their abundance and distribution throughout the state in the past five to 10 years. This has been due to accidental and deliberate liberation of farmed deer as well as natural increases in the feral population.

The size of this increase and the absolute number of feral deer are unknown. In the South East region, accidental or deliberate liberation from deer farms and by hunters is causing the feral population to increase well above its expected recruitment rate. The South East NRM Board implements on ground deer control programs with shooting from helicopters being the most effective. Recent small liberations of deer were reported in the Eyre Peninsula region and coordinated landholder and NRM Board shooting programs are being considered.

On Kangaroo Island feral deer numbers were increasing until 2005 when intensive management of feral populations began to reduce the trend. Fallow deer have been wild on the island since 1999. A management plan is in place and eradication actions are being undertaken for this species. New methods of feral deer detection and control are being trialled on the island, stronger biosecurity measures are being investigated and deer farm fences are inspected annually.

Feral deer compete with native wildlife, graze on and damage native vegetation, pastures and crops, destroy the nests of ground laying birds and can pose a traffic hazard on regional roads.

#### Feral camels (Camelus dromedarius)

Common and widespread over 35.2% of the state, feral camels occur in the far north, where they compete with native herbivores and damage waterholes.

It is estimated that numbers have doubled over the past eight years and are growing at a rate of 10% per annum. An aerial survey conducted in a study area of 62,863 km<sup>2</sup> in the far north west of South Australia in June 2007 estimated an average density of camels ranging between 0.62-0.65 camels per squarekilometre (Lethbridge, 2007). South Australia is thought to support about 18% of the estimated 750,000 feral camels that occur nationally.

Feral camel control is a major project for the Arid Lands NRM Board. Currently,

# Introduced Species

cross border management of feral camels involves aerial shooting and research into re-invasion rates.

#### Feral cats (Felis cattus)

Feral cats are common or abundant in all regions of the state. Numbers have fallen to some extent following introduction of the RHD, as rabbits are a key source of prey.

Kangaroo Island data shows numbers of feral cats to be stable. Cat control on the island involves localised trapping and strong domestic cat control including sterilisation, confinement, micro-chipping and registration. Nontoxic baits will be trialled in the next 12 months to determine any effects on non-target species, potentially followed by trials to determine impacts of cats on the island's biodiversity.

Effective control of feral cats is difficult to achieve as domestic cats are continually recruited into the feral population. Priority is currently given to high conservation areas, which has resulted in reduced numbers in the Flinders and Gammon Ranges and parts of Eyre Peninsula.

Feral cat numbers are increasing in the Arid Lands due to increasing human population, although the feral population levels are also dependent on the prevalence of both rabbits and foxes in this region. Increased public awareness of the problems feral cats cause would be an effective future management strategy in all regions of South Australia.

In the Adelaide and Mount Lofty Ranges region numbers of feral cats are increasing and are actively managed.

Feral cats remain a significant problem statewide.

#### Feral pigs (Sus scrofa)

Feral pigs are found in more than 7.5% of the state, distributed across four areas.

In the far northeast they occur along the watercourses and at the waterholes of the Innamincka Regional Reserve and the Warburton Creek, and between Goyder's Lagoon and Birdsville on the Diamantina River. These populations are ephemeral and recede during drought when little permanent water is available.

In the Riverland feral pigs are present in the upper reaches of the Murray River

from Renmark to the South Australian border. They are also present at the western end of Kangaroo Island, where they are now being targeted for control following the 2007 fires. Feral pig control on Kangaroo Island involves trapping and shooting as well as baiting trials undertaken as a collaborative between the Kangaroo Island NRM Board and the Invasive Animals Cooperative Research Centre.

In the Adelaide and Mount Lofty Ranges feral pigs are also targeted for eradication. Feral pig distribution in inland or seasonally dry areas of Australia is restricted to the vicinity of watercourses and their associated floodplains.

There is a risk of further feral pig invasion through invasion corridors from Queensland and New South Wales.

#### Starlings (Sturnus vulgaris)

Starlings are distributed across the state's agricultural areas and are widespread in built environments. They are a pest for horticulture and viticulture, and the environment. They affect amenity and create social and health problems in urban and peri-urban communities.

Anecdotal evidence suggests that the abundance of starlings is increasing in the western areas of the state.

A research project on starling management is currently underway at Ceduna on the Eyre Peninsula. Starlings require management in the Adelaide and Mount Lofty Ranges region to protect cropping, grazing, perennial horticulture, native vegetation and urban land uses.

#### Feral horses and donkeys (Equus spp)

Feral donkeys are a considerable problem in the north of South Australia as to a lesser extent, are horses.

Donkeys are abundant in the north westerly areas, in the Alinytjara Wilurara NRM Region and particularly in the Musgrave Ranges. The abundance of feral horses is low in the central desert areas.

These pests are found particularly around permanent and semi-permanent water sources such as springs and rockpools, where they damage sensitive vegetation and negatively impact water quality. Their grazing impacts native vegetation across their entire range. Figure 5.1: Number of Goat Groups and Individual Goats, 1977 - 2007



Source: DWLBC



Feral horses

#### Table 5.16: Percentage area of State infested by abundance class for key terrestrial pest plants

Density Category	Blackberry	Bridal creeper	Branched broomrape	Feral olive	Gorse	Mesquite	Silverleaf nightshade
Absent	91.0	77.1	97.6	87.2	94.0	98.8	83.5
Abundant & Localised	0.0	2.8	0.0	0.5	0.0	0.0	0.0
Abundant & Widespread	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common & Localised	2.0	1.2	0.9	2.1	0.2	0.0	1.4
Common & Widespread	0.9	6.0	0.0	0.0	1.3	0.0	2.3
Occasional & Localised	5.9	9.0	1.6	9.5	4.1	1.2	10.9
Occasional & Widespread	0.7	3.8	0.0	0.7	0.4	0.0	1.9
Present but Density Unknown	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Unknown occurrence	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: created from NWLWA Draft Distribution Maps for Invasive Plants – SA 2006 see www.nlwra.gov.au/Natural\_Resource\_Topics/ Invasive\_Species/Index.aspx Note: figures are rounded up to nearest 0.1%, and therefore may total over 100%

# PRESSURE INDICATOR: Distribution and abundance of key terrestrial pest plants

Only a subset of the naturalised component of South Australian flora is abundant enough to have significant impact and of these some such as bromes (*Bromus spp.*) and rye grasses (*Lolium spp.*) have spread to their ecological limits.

Declarations under various sections of the Natural Resources Management Act 2004 are used to facilitate the containment of weeds that have not yet reached their limits and the destruction of weeds that are not yet established: 90 species are declared under this Act.

Of the 20 Weeds of National Significance (WoNS) that are targets of national control strategies, 10 are established in South Australia. These are alligator weed, athel pine, blackberry, boneseed, bridal creeper, Chilean needlegrass, mesquite, gorse, parkinsonia and willows. A further 72 plants declared under the Natural Resources Management Act 2004 have been mapped by DWLBC (data at www. dwlbc.sa.gov.au/biodiversity/pests).

Table 5.16 shows the current area infested by seven WoNS species considered key pest plants (weeds) in South Australia, based on nationally agreed indicators of the National Land and Water Resources Audit (NLWRA). Note that the relatively high percentages for "Absent" is largely due to intolerance of the listed weeds (excluding mesquite) to arid land conditions, however this may change under adverse climate change scenarios.

There is generally a greater diversity and abundance of weeds in southern areas of the state, which have higher rainfall and greater human activity. As with vertebrate pests, coordinated control programs seek to reduce the area and density of weeds and maintain these at low levels. All weeds listed in Table 5.16 are declared plants under the Natural Resources Management Act 2004.

# Bridal creepers (Asparagus asparagoides and A. declinatus)

Bridal creepers are the most significant weeds competing strongly with native vegetation in the state. Below ground they form a dense mat of tubers, which prevents regeneration of other plants. Above ground, annual climbing shoots occur from autumn to spring and smother native groundcovers. Berries are produced enabling seed to be spread long distances by birds.

A. asparagoides is common across the southern part of the State. The most common form is susceptible to the rust *Puccinia myrsiphylli*, which has been distributed as a biological control agent by CSIRO since 2000 and has reduced the weed's density at many sites.

Bridal creeper's distribution is still increasing at the margins of its range, but its abundance is stable or declining in many areas due to spread of the rust. Unfortunately a newly detected form of the species is not susceptible to the rust (see incursions below).

Populations of A. asparagoides are currently stable on the Eyre Peninsula, but increasing in isolated areas. The South East NRM Board is in the final year of a three year rust fungus distribution project and the rust is now established in most areas. Some chemical treatment to bridal creeper also occurs in this region.

The majority of bridal creeper infestations on Kangaroo Island are infected with the rust fungus.

A. declinatus is scattered on southern Eyre Peninsula, Yorke Peninsula, Kangaroo Island, Fleurieu Peninsula and

# Introduced Species

the South East, and is also unaffected by existing strains of the rust. It is being targeted for control by NRM Boards and the Department for Environment and Heritage (DEH), as is another emerging asparagus weed, A. scandens.

#### Blackberry (Rubus fruticosus sp. agg.)

Blackberry is found in the high rainfall regions of SA, from the southern Mount Lofty Ranges to the southern Flinders Ranges, southern Eyre Peninsula and the lower South-East. It is an invader of native bush and pasture, preventing access with its dense spiny growth.

This weed does have habitat value for a number of native mammals and birds, so it is very important to stage its removal to limit any adverse impact. The distribution and density of blackberry is stable; with accessible infestations contained by herbicide control.

New strains of the rust Phragmidium violaceum have been released in South Australia since 2007, but will require more time to become widespread and have a significant impact. Importantly, recent genetic and taxonomic work has shown there are many distinct species of blackberry and only some will be susceptible to the rust strains.

# Boneseed (Chrysanthemoides monilifera subsp. monilifera)

Boneseed was introduced to Australia as a garden shrub in the 1840s. It is most abundant among remnant native vegetation of the Mount Lofty Ranges, with smaller infestations in other settled areas of the state. Birds and foxes disperse the hard round seeds after being attracted by the thin flesh layer of the fruit.

Boneseed populations on the Eyre Peninsula are being targeted for eradication as they fall outside the National Boneseed Containment Line. Boneseed has an extremely large potential distribution in the South East region and external funding and a public awareness campaign have contributed to the maintenance of stable boneseed population levels there.

There is a single known patch of boneseed in the Parachilna Gorge in the Arid Lands region and that is being actively controlled. There is currently no boneseed on Kangaroo Island.

Intensive programs of boneseed removal by hand-pulling and herbicides, coordinated by NRM Boards, have reduced or eliminated many of the smaller infestations. However, as boneseed persists for many years as a seed bank in the soil, infestations may regenerate unless follow up inspection and control work is maintained. Its distribution must therefore be regarded as stable even though it is less visible due to the control programs.

Since 1990, a series of insects have been released in the Adelaide Hills as potential biological control agents. These have either failed to survive due to predation by native ants or have had a negligible impact on boneseed. First releases of the boneseed leaf buckle mite will be made in 2008.

#### Gorse (Ulex europaeus)

The spiny shrub, gorse is a problem in high rainfall areas including the Mt Lofty Ranges, Clare Valley and the lower South East. Isolated occurrences on Kangaroo Island, Eyre Peninsula and other areas of the South East region are the subject of eradication programs under the National Gorse Strategy. The overall distribution of gorse is declining due to intensive control programs.

The gorse spider mite is now widely distributed as a biological control agent, recently joined by gorse thrips. The most promising biological control has been the unexpected emergence of the indigenous parasitic plant *Cassytha pubescens* attacking gorse infestations, a novel phenomenon being studied by Adelaide University scientists.

#### Mesquite (Prosopis spp.)

Mesquites, various species of the genus *Prosopis* are thorny shrubs or small trees with the potential to form dense impenetrable thickets.

Experience in other states has shown their potential to spread and form thickets that compete with more desirable rangeland vegetation and exclude livestock, and for this reason all Prosopis species have been declared. They have persisted at a few localities in the state's pastoral zone where they were planted in the early twentieth century. Mesquite's range has always been small and is declining due to intensive control work.

Eradication has been successful at Lake Torrens Station, Iron Knob, Marree, Maldorkey, Whyalla and the old saltworks at Port Augusta. It is important for South Australia to continue support for the national strategy to manage mesquite, as



Feral deer



Silverleaf nightshade (Solanum elaeagnifolium). Photo: Steven Mudge.

it is a high risk for distribution in this state.

A survey conducted for DWLBC in 2003 04 located the remaining mesquite at Woomera, Port Augusta and several pastoral stations. Eradication of these infestations is continuing.

#### Feral olive (Olea europaea)

Feral olives are the descendants of trees planted for fruit production. They are most abundant in the Mt Lofty Ranges where they establish themselves in native vegetation and form dense canopies that permanently replace some native communities, notably blue gum (Eucalyptus leucoxylon) and grey box (E. microcarpa).

Olives are also widespread in the Northern and Yorke region. The cost and effort associated with control of olives is prohibitive to most landholders resulting in many roadside infestations remaining unmanaged. An externally funded and coordinated control program is required to address feral olive management across the state.

Olive seed is spread by birds, especially European starlings (*Sturnus vulgaris*), and foxes that feed on the fruits. Feral olives contribute to the fire risk as they form highly flammable thickets and regenerate densely after a fire.

Feral olive control has concentrated on their removal from sites of highest conservation value, often with volunteer labour, and on discouraging the siting of new olive groves in high risk areas. The distribution of olives is increasing due to long-range dispersal by birds, particularly with new orchard plantings around the state.

#### Branched broomrape (Orobanche ramosa)

Branched broomrape is a nonphotosynthetic, parasitic weed that overseas impacts heavily on vegetable crops, legumes and canola. It has dust-like seed and remains concealed underground except for a short flowering season.

Seeds germinate and attach to the roots of broadleaved host plants, including some native species. Its only South Australian population has been confined to 7,048 Ha within a 197,052 Ha quarantine zone east of Murray Bridge, monitored annually by a national eradication program.

The distribution and abundance of branched broomrape is declining and its spread has been contained by intensive inspection and quarantine.

#### Dodder (Cuscuta spp.)

Dodders are annual parasitic plants with thread-like stems that twine around their hosts, which include a wide range of legumes and broadleaf crop plants.

Golden dodder (*Cuscuta campestris*) is a major pest of lucerne and vegetable crops, and has been the subject of a state-level containment program in the Riverland since 1981. Its distribution is now stable and contained by intensive inspection of properties and riverbanks, with enforced control as necessary.

The South East NRM Board is implementing a regional policy to deal with isolated incursions of golden dodder into the seedgrowing areas, and to contain localised populations of red dodder (*C. planiflora*) and Chilean dodder (*C. suaveolens*). Remote detection methods are required to improve monitoring and surveillance of dodders in this region.

#### Silverleaf nightshade (Solanum elaeagnifolium)

Silverleaf nightshade is a deep-rooted perennial weed of pasture and cropping, now present in all regions of the State. The largest infestations are in the Mid North, eastern Eyre Peninsula and upper South East region where regular control measures are implemented.

There is one record of silver leaf nightshade on Kangaroo Island however it is suspected that more infestations are present. Improved public awareness is required to determine its full distribution.

Silver leaf nightshade is drought tolerant and forms large infestations through spread of seed and vegetative reproduction. Infestations are very difficult to destroy by herbicides or management practices. Control programs concentrate on containment by eliminating small satellite infestations and minimising the spread of ingested seed by livestock movements. Its distribution continues to increase due to lack of effective control techniques.

#### PRESSURE INDICATOR: Distribution and abundance of key marine pest plants and animals

The coastal waters of South Australia are under threat from a range of introduced marine pest species. There are currently 38 marine pest species recorded in South Australian waters. There have been no new species recorded since the 2003 State of the Environment Report. Marine pests can have major impacts on biodiversity and seafood production. Pest species can out-compete native ones for habitat and food, thereby adversely affecting the ecosystems on which fishing and aquaculture industries depend. Once a pest is established eradication is rarely possible and control is a very expensive exercise. Biosecurity programs are in place to identify, raise awareness, assess and respond to all pests that pose a significant threat to our fish stocks and their habitats.

Most marine pest species that have established themselves in South Australian waters have been introduced in ballast water or on the hulls and anchors of visiting vessels. Any severe incursion of marine pest species is potentially disastrous for the state's commercial and recreational fisheries causing significant environmental, economic and social impacts.

Early detection and monitoring by the community are vital tools in controlling the spread and minimising the impact of marine pests.

There are some marine pest species that, while not currently present in South Australian waters, pose a significant risk due either to the proximity of pest populations in interstate waters or the suitability of local conditions for their colonisation. Species currently of concern to South Australian marine scientists include the Japanese Sea Star Asterias amurensis and the Asian date mussel *Musculista senhousia* (both currently in Tasmania and Victoria) and Japanese Kelp Undaria pinnatifida (currently in Tasmania),

The most significant marine pests that have established in South Australian waters are the invasive seaweed *Caulerpa taxifolia* and the European Fanworm *Sabella spallanzanii*.

#### Invasive seaweed (Caulerpa taxifolia)

Caulerpa taxifolia was first discovered in West Lakes and the upper Port River in 2002. The species is likely to have been an escaped aquarium specimen or introduced through contaminated recreational equipment.

An eradication program began in June 2002 and has effectively eradicated the pest from West Lakes however, eradication of the Port River population is accepted to be unlikely. The weed was identified at North Haven marina in early 2008.

#### European Fan Worm (Sabella spallanzanii)

This species of marine worm is believed to form dense populations, out-competing native species for habitat. It is a fouling organism and may also impact marine infrastructure and aquaculture developments.

The species was first found in South Australia in 1985 at Outer Harbour and has since established itself. There are significant populations of European Fan Worm in upper Gulf St Vincent and although surveying has been limited, it is believed to be fairly widespread.

#### PRESSURE INDICATOR: Distribution of key freshwater pest animals

There are a number of introduced freshwater fish species in South Australia that significantly impact our freshwater ecosystems. Most pest fish are well established having arrived in the 19th century. Newer threats are directly related to the accidental and intentional release of exotic aquarium species.

Pest fish compete with native species for available food and habitat, can predate on native species and can also impact water quality with adverse impacts on entire ecosystems. There is very little information available on the distribution and extent of these species.

Key pest species include European Carp, Eastern Gambusia, Redfin Perch, Rainbow Trout, Brown Trout and Tench. Release of any of these following capture is illegal under the *Fisheries Management Act 2007*.

Species native to other drainage basins of Australia are increasingly being released into South Australian waterways, with unknown biological repercussions.

#### European Carp Cyprinus carpio

European Carp have extended their range to almost the whole of the Murray-Darling Basin and are difficult to control. Environmental rehabilitation is seen as a means of improving habitat quality to favour native fish. Biological approaches to carp control are also being explored.

Potential molecular approaches include immunocontraception to reduce carp fertility, 'daughterless technology' in which modification of a sex-determination gene results in the exclusive production of male offspring, and the introduction of a fatality gene to kill individuals at a later date (Koehn *et al*, 2000).



Feral pigs on Kangaroo Island. Photo: Scott Jennings.

#### Eastern Gambusia / Mosquitofish (Gambusia holbrooki)

The Eastern Gambusia was introduced to Australia in the 1920s for mosquito control. It had limited effectiveness at that task and is now a significant pest in freshwater rivers and streams. The species is able to breed several times a year enabling it to rapidly establish populations.

#### Redfin Perch (Perca fluviatilis)

The Redfin or European Perch is found in the Murray-Darling Basin, Gulf streams and the South East of South Australia. It is popular for recreational fishing and is widely stocked in dams and watercourses for this purpose. Although widely thought to be a native species, it is an introduced predator.

#### Rainbow Trout (Oncorhynchus mykiss)

The Rainbow Trout was introduced from New Zealand in the 1890s. Having a higher temperature tolerance than Brown Trout, it can easily establish self-sustaining populations in the Adelaide region. Rainbow Trout feed on a wide range of aquatic insects, crustaceans, molluscs, terrestrial insects and native fishes and as such pose a serious threat to biodiversity.

#### Brown Trout (Salmo trutta)

The Brown Trout was introduced in the 1860s and has spread with human assistance and by migration. Self-sustaining populations require cool, swiftly flowing waters – conditions that are generally restricted to the Australian Alps and Tasmania. Populations in the Mount Lofty Ranges are maintained through the systematic introduction of hatchery reared stock under state government permit. This is a serious threat to local biodiversity.

#### Tench (Tinca tinca)

Tench were introduced into the River Murray in 1876 and have spread rapidly throughout the Murray-Darling System. A small population is thought to exist in the Onkaparinga River. Tench do not represent as serious a threat to native fish as some other species.

# Other pest species of concern (diseases and pathogens)

**Phytophthora cinnamomii** is a fungus-like organism that rots the roots of susceptible plants causing death. A serious threat to biodiversity it is listed as a key threatening process under the *Environment Protection* and *Biodiversity Conservation Act 1999*. Phytophthora has spread throughout the Mount Lofty Ranges, parts of Kangaroo Island and is suspected to have spread to the lower Eyre Peninsula. There is no known method of eradicating Phytophthora and controlling its spread relies on quarantining affected areas and adopting strong hygiene procedures. Further information on Phytophthora can be found at www.environment.sa.gov. au/biodiversity/plantsand.html

**Chytridiomycosis** is a potentially fatal epidermal disease of amphibians, affecting South Australia's native frogs (Berger *et al*, 2004). Caused by the fungus *Batrachochytrium dendrobatidis*, the disease emerged in Australia in the 1970s and is believed to be widespread. Research in 2004 demonstrated that mortality rates from the fungus increase in cooler temperatures.

Mundulla Yellows is a slow, progressing yellowing and dieback disease of eucalypts and other native plants, first observed near Mundulla in the 1970s. The cause is not fully understood however, there is strong evidence to suggest that the cause is related to soil chemistry rather than pathogenic organisms and pests. The lack of availability to plants of trace elements within the soil, restricted by problematic pH and other soil characteristics, is likely to be a major factor. This has been evidenced by the recovery of affected trees that have had required trace elements implanted.

# PRESSURE INDICATOR: Number of new incursions and responses

There have been incursions of two vertebrate pest species since 2003. Single cane toads have been inadvertently transported to South Australian in produce or goods and a single common myna was detected at Port Augusta as well as two at Port Adelaide. All the birds were removed and no further individuals have been found at these sites.

There have been five incursions of declared pest plants at the state or regional level since mid 2003. The most significant has been the Western Cape ecotype of bridal creeper.

Poison buttercup (*Ranunculus sceleratus*) was found in November 2003 over 6 ha of floodplain heavily damaged by feral pigs at Chowilla in the Riverland. The site is a RAMSAR wetland managed by the Department for Environment and Heritage and the infestation is being addressed with a feral pig control

# Introduced Species

program. The only poison buttercup previously known in South Australia was a population near Murray Bridge that has been eradicated. One infestation of Acacia nilotica (prickly acacia, a WoNS) has been confirmed at Cordillo Downs in the Arid Lands region in the NRM Board's survey and program on prickle bushes. One additional outbreak of golden dodder was found in 2006 in the South East NRM region. Officers of regional NRM Boards have followed up several reports of the illegal sale of the declared waterweeds Eichornia crassipes (water hyacinth) and *Salvinia* sp. (salvinia).

#### Cane toads (Bufo marinus)

Cane toads are now found in the upper reaches of both the Murray-Darling Basin and Lake Eyre Basin in Queensland and are slowly moving downstream towards South Australia. Without significant human assistance, it will take the cane toads many years to cover the distance along rivers from Queensland to the Murray River in South Australia.

The risk of cane toads reaching the Lake Eyre Basin creeks and waterholes in the north-east of the state is a somewhat greater risk. Current populations are around 400 km upstream from South Australia and the likelihood of a significant flood event carrying them down the Cooper Creek is unknown.

Human-aided transport of cane toads into South Australia has occurred with occasional and random frequency over recent years. These incidents are responded to by DWLBC and to date only single animals have been located having been inadvertently transported in goods or produce from Queensland and the Northern Territory. Although there is no risk of a permanent population establishing when a single cane toad is involved, areas are thoroughly searched and industries and residents in the immediate vicinity are notified to confirm that no other toads are present. NRM Boards and DLWBC receive reports of cane toads each year from members of the public. Most turn out to be misidentified native frogs.

The risk pathways for human-aided movement of cane toads are broad and spread across many individual businesses and industries that move goods and produce from northern Australia. Cooperation has been sought from major industry sectors such as the road transport, nursery and fresh produce industries. Information fact sheets on cane toads have been distributed within these sectors to encourage vigilance in checking produce, machinery and packaging before and after arrival in South Australia for any cane toads inadvertently transported so that their capture is reported to DWLBC.

#### Western Cape form of bridal creeper

The Western Cape form of bridal creeper (Asparagus asparagoides) was first identified in 2004 at eight locations in the south-eastern South Australian and western Victoria border region (Coles et al., 2006). In 2006 a second infestation was located in the Adelaide Hills around the Anstey Hill nature reserve.

Field observations and laboratory research confirmed that this form is largely resistant to the rust biological control agent (*Puccinia myrsiphylii*), raising concerns that it could reinfest areas where common bridal creeper has been controlled.

The distribution of the Western Cape form in the southeast was surveyed in 2005, identifying 224 locations with a total infested area of 40 Ha, ranging from Millicent to just east of the border with Victoria. Infestations occur within national parks, forestry areas and on private land. The Adelaide Hills infestation was mapped in 2006, over an area 20 Ha. Both regional infestations are now subject to intensive control programs, managed through the South East and the Adelaide and Mt Lofty Ranges NRM Boards. It is hoped that longterm annual management will lead to total eradication in 10 to 15 years.

# What are we doing about it?

The Natural Resources Management Act 2004 provides the framework for management of key pest plants and terrestrial pest animals in South Australia. Former Animal and Plant Control Boards have been consolidated into eight NRM Boards, allowing an integration of management responses to water, soil and pest issues.

Under the Act, pest plants and terrestrial vertebrate pests are declared, prohibiting the movement, possession, sale and release of species and in most cases, requiring their control by landholders. Declarations are enforced by NRM Boards



Feral fox.



Blackberry.

# How do we manage species forced to move by climate change?

Species occur only in areas to which they are suited by factors such as climate, the fire regime, topography, soil type and the other species present. If any one of these factors changes too rapidly or by a significant amount, species need to relocate to survive.



Global warming has already caused some species to move higher up mountains in order to escape increasing climatic temperatures. Biological invasions resulting from climate change will create problems for human societies where production and land tenure are based on geographically fixed parcels of land. Many native species will migrate to more suitable habitats when necessary unless they have been confined to an isolated patch of the landscape by human settlement and/ or land clearance.

Migrating species (whether native or exotic) may be perceived as pests in their new home ranges. Native species with poor mobility or those living in fragmented habitats may be unable to move quickly enough to keep pace with a changing climate and may suffer range contraction and eventual extinction. Such species will require a range of strategies including translocation programs to ensure their survival. Migration of 1-2 km a year may be necessary to keep pace with the ecological consequences of climate change1. Native species unable to relocate that quickly will need translocation programs to ensure their survival.

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through coordinated control programs, with technical and policy support from DWLBC and overseen by the State NRM Council.

NRM Boards, DWLBC, DEH, Department of Primary Industries and Resources (PIRSA) and industry and community groups also collaborate on education and awareness activities, research, planning and strategic control programs for particular pests, industries or regions. This includes actions for non-declared pests. Goal 4 of the State NRM Plan 2004 gives overall direction for the management of biological threats, complemented by the inclusion of pest management actions in the strategic plans of each NRM Board.

Pest risk assessments for weeds and vertebrates have been undertaken by NRM Boards using a process developed by DWLBC. This has identified species of high risk and high feasibility for control, which are priorities for coordinated control programs. This risk management approach is fostering an increased focus on prevention and early intervention, to avoid a new set of pests becoming widespread.

For existing, widely established pests the emphasis is on development of improved control techniques, including biological control and provision of management information. A number of NRM Boards have pest management strategies either in place or in draft form. Landholders have primary responsibility for pest management.

The Natural Resources Management and Primary Industries Ministerial Councils (NRMMC and PIMC) have approved the development of a national framework titled AusBIOSEC to

# Introduced Species

improve preparedness and capacity to respond to biosecurity issues. A state biosecurity strategy is being developed in 2008 jointly by DWLBC, PIRSA and DEH to identify priority areas for preparedness, prevention, incursion response and ongoing management of pests and diseases within South Australia.

# Management of terrestrial vertebrate pests

At the national level, the Vertebrate Pests Committee sets policy directions to achieve better outcomes for managing pest animals and led the development of the Australian Pest Animal Strategy. The implementation of this strategy within South Australia is being led by DWLBC.

In 2005 the government adopted the South Australian Deer Strategy with the objective of reducing the impact of feral deer. Actions implemented include inspections of fences on deer farms, appointment of the South East Deer Advisory Committee, landholder surveys on the distribution and impact of feral deer for the Mid North and South East and an eradication program on Kangaroo Island.

The South Australian Arid Lands NRM Board is leading a Natural Heritage Trust funded Cross Regional Feral Camel Project. A strategic and integrated approach is required to reverse the rapid expansion of the camel problem using a combination of management options.

Recovery of rabbit populations from the impact of RHD and strategies to extend its usefulness as a bio-control agent are being addressed by NRM Boards. They are testing bait release of RHD as a means of initiating outbreaks in areas where the virus has been inactive. The boards are also raising community awareness of the re-emerging threat and need for conventional control activities.

DWLBC is currently conducting collaborative research through the Invasive Animals Cooperative Research Centre (CRC) to identify the factors influencing recovery of rabbit populations from RHD.

Large regional fox programs focus on key conservation areas where maximum benefits can be derived from reducing the impact of predation on a range of at-risk species and providing a substantial expansion of available habitat. Operation Bounceback is an example with landholders neighbouring the Flinders Ranges National Park getting involved in regional fox baiting.

The Common Starling is particularly problematic on Eyre Peninsula with very large flocks forming over the summer months and causing environmental, economic and social impacts. Collaborative research into aspects of starling biology, behaviour and management is being conducted on the West Coast and involves the Eyre Peninsula NRM Board, DWLBC, Pestat Pty Ltd and the Invasive Animals CRC.

#### Management of pest plants

The Australian Weeds Committee and the Australian Weeds Strategy provide policy and investment frameworks for national weed management, implemented in this state through DWLBC.

The branched broomrape eradication program is a nationally funded incursion response for one of the world's worst agricultural weeds. Collaboration between DWLBC, NRM Boards, PIRSA and the local community has enabled effective limitation of the weed's distribution and containment of its further spread. Research has identified control techniques, which are being applied by affected landholders to prevent the weed's emergence. Eradication is longterm due to longevity of soil seedbanks.

Hosting the WoNS coordinator for bridal creeper has facilitated greater awareness and uptake of best practice management for this and other WoNS in South Australia. Five regional asparagus weeds committees operate here, applying recently developed management guides to eradicate, contain and suppress priority infestations that threaten biodiversity.

Four NRM Boards have signed 25 year Memorandums of Understanding with the National Gorse Task Force to eradicate gorse infestations. Mapping of willow species and Athel pine has enabled strategic prioritization of infestations for control programs.

DWLBC collaboration with the CRC Australian Weed Management and the CRC Future Farming Industries has fostered uptake of weed risk management for the nursery and garden industries, botanic gardens and new pasture introductions, reducing future weed problems.



Rabbit plague



Feral olive tree

### What more should we be doing?

The Environment Protection Authority recommends the following:

- **R5.5** Improve incentives and support for environmental stewardship on private land, including for the control of invasive plants and feral animals by 2012.
- **R5.6** Promote a national weed labelling scheme that identifies the weed potential of species to plant buyers and sellers.
- **R5.7** Include the regulation of introduced freshwater fish species under natural resource management legislation.
- **R5.8** Improve the early identification of pest incursions to reduce their impacts and the cost of eradication.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R5.5	R5.6	R5.7	R5.8
Growing Prosperity	T1.14, T1.9, T1.14	T1.14	T1.14	T1.14
Improving Wellbeing				
Attaining Sustainability	T3.1, T3.2, T3.3, T3.5	T3.1, T3.3	T3.1, T3.3	T3.1, T3.3
	T3.9, T3.11			
Fostering Creativity and Innovation				
Building Communities				
Expanding Opportunities				

For further detail on South Australia's Strategic Plan visit www.stateplan.sa.gov.au

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# Further information

National feral animal information database www.feral.org.au

National weeds website www.weeds.org.au

Australian government weeds web portal www.weeds.gov.au

Department of Water Land and Biodiversity Conservation www.dwlbc.sa.gov.au/biodiversity/pests

National Land and Water Resources Audit www.nlwra.gov.au/Natural\_Resource\_ Topics/Invasive\_Species/index.aspx