# Biodiversity

## 1 Why is it important?

Biodiversity is the variety of all life forms, from genes to species to entire ecosystems, that occur in all environments on Earth—land, water, air and sea. Healthy, natural ecosystems underpin South Australia's economic, environmental, cultural and social wellbeing.

The components of biodiversity, including animals (birds, mammals, reptiles, fish, amphibians, invertebrates), vegetation, soil, biogeochemical cycles and microorganisms, provide a range of essential ecosystem services. 'Ecosystem services' describes the benefits that humans derive from the environment, such as:

- purification of air and water
- pollination, seed dispersal and pest control
- soil generation and fertilisation
- detoxification and decomposition of wastes
- flood and drought mitigation
- ultraviolet protection
- stabilisation of climate.

For example, the rivers, wetlands and floodplains of the Murray–Darling Basin are estimated to provide $187 billion in ecosystem services each year (Lindenmayer 2007). Biodiversity also provides the basis for many economic uses. For example, apart from our obvious use of crops and domestic animals, invertebrates such as worms, ants, spiders, wasps, leafhoppers and mites are being used in adhesives, antibiotics and industrial products.

The South Australian Government's No Species Loss Strategy (Government of South Australia 2007a), the State Natural Resources Management Plan (Government of South Australia 2012) and the state of the environment report for South Australia in 2008 (EPA 2008) all report that, despite our efforts, biodiversity in South Australia continues to decline. Climate change impacts are expected to exacerbate the decline.

The following messages about Australia's biodiversity in *Australia state of the environment 2011* (State of the Environment 2011 Committee 2011) equally apply to South Australia:

- Biodiversity has declined since European settlement.
- Pressures are not being substantially reduced, nor is the decline in biodiversity being arrested or reversed.
- Most pressures on biodiversity that arise directly or indirectly from human activities appear to still be strong.
- The major future drivers of change—climate change, population growth, economic development and associated consumption of natural resources—must be managed carefully if a sustainable relationship between biodiversity and human society is to be achieved.
- Data on long-term trends in biodiversity are limited, making it difficult to interpret the state or trends of major animal and plant groups.
- Australia can improve its biodiversity management.

Opposite page: Insects of South Australia
State Library of South Australia B15276/48

# In summary

| Aspect and observation | Assessment grade | | | | Confidence | |
|---|---|---|---|---|---|---|
| | Very poor | Poor | Good | Very good | In grade | In trend |
| **Native vegetation** | | | | | | |
| Native vegetation extent and condition is fair to moderate and declining.<br>There has been an increase of about 10% in the area under some form of protected status since 2008.<br>There has been an increase in illegal clearing.<br>There has been a decrease in the area of revegetation since 2008. | | ↙ | | | ● | ● |
| **Threatened species and ecological communities** | | | | | | |
| There has been an increase in recovery plans and actions.<br>There is a variable to positive trend in the status of 20 indicator species.<br>The status of threatened species and ecological communities is poor and declining.<br>There has been a net increase in the number of endangered and vulnerable species and ecological communities since 2008.<br>Climate change has altered fire regimes. | | ↙ | | | ● | ● |
| **Soil and land management** | | | | | | |
| There has been a steady increase in cropping land protected from erosion.<br>Soil condition in production areas is fair to moderate and stable.<br>There has been an increase in crop area using no-till sowing methods.<br>There has been an increase in the area and rate of soil acidification.<br>There is a variable trend in dryland salinity and depth to groundwater, with most measures declining or stable (positive), and some rising (negative). | | – | | | ● | ● |

| Aspect and observation | Assessment grade | | | | Confidence | |
|---|---|---|---|---|---|---|
| | Very poor | Poor | Good | Very good | In grade | In trend |

**Introduced species**

There has been an increase in number, distribution and abundance of most pest plants, animals and diseases. Only a few have decreased.

For key established pests and diseases:

- rabbits, feral goats, European fanworm, oriental weatherloach, silverleaf nightshade, *Phytophthora cinnamomi* and sarcoptic mange of wombats have increased in distribution and abundance
- feral deer, European carp, bridal creeper and opuntioid cacti are steady in distribution and abundance
- feral camels, *Caulerpa taxifolia* and gorse are decreasing in distribution and abundance
- chytridiomycosis is unknown in distribution and abundance.

For new pests and diseases:

- the numbers of weeds, marine pests, aquatic pests and native plant diseases are increasing
- the number of terrestrial vertebrate pests is steady
- the number of wildlife diseases is unknown.

There have been six confirmed detections of new vertebrate pest incursions since 2008.

Recent trend: ↗ Improving; ↙ Deteriorating; — Stable; ? Unclear

Level of confidence: ○ Evidence and consensus too low to make an assessment; ◎ Limited evidence or limited consensus; ● Adequate high-quality evidence and high level of consensus

Grades: Very poor; Poor; Good; Very good

# 2 What do we know about it?

The State Natural Resources Management Plan (Government of South Australia 2012) provides an assessment of the condition and extent of key natural resources in South Australia, shown in Table 1.

Table 1 Condition and extent of key natural resources in South Australia

| Key natural resource | Condition | Trend |
|---|---|---|
| Native vegetation extent and condition | Fair/moderate | Declining |
| Soil condition in production areas | Fair/moderate | Variable |
| Geological features and landscapes | Variable | Variable |
| Aquatic ecosystem extent and condition | Variable | Variable |
| Coastal and marine ecosystem extent and condition | Variable | Declining |
| Status of threatened species and ecological communities | Poor | Declining |
| Impact of introduced species | Poor | Declining |

Source: Government of South Australia (2012)

In this section, biodiversity is discussed with reference to native vegetation, and threatened species and ecological communities. Wetlands and rivers, and their associated flora and fauna, are covered in the *Water* chapter.

## 2.1 Native vegetation

Native vegetation is a key component of South Australia's environment. It provides habitat and a source of food for wildlife; maintains the health of land, soil and water (Williams 2005); and mitigates the impacts of a warming climate through carbon storage and climate regulation (Australian Greenhouse Office 2006, Emes et al. 2006). Native vegetation provides many economic, social and cultural benefits, and is important for Aboriginal culture (Williams 2005).

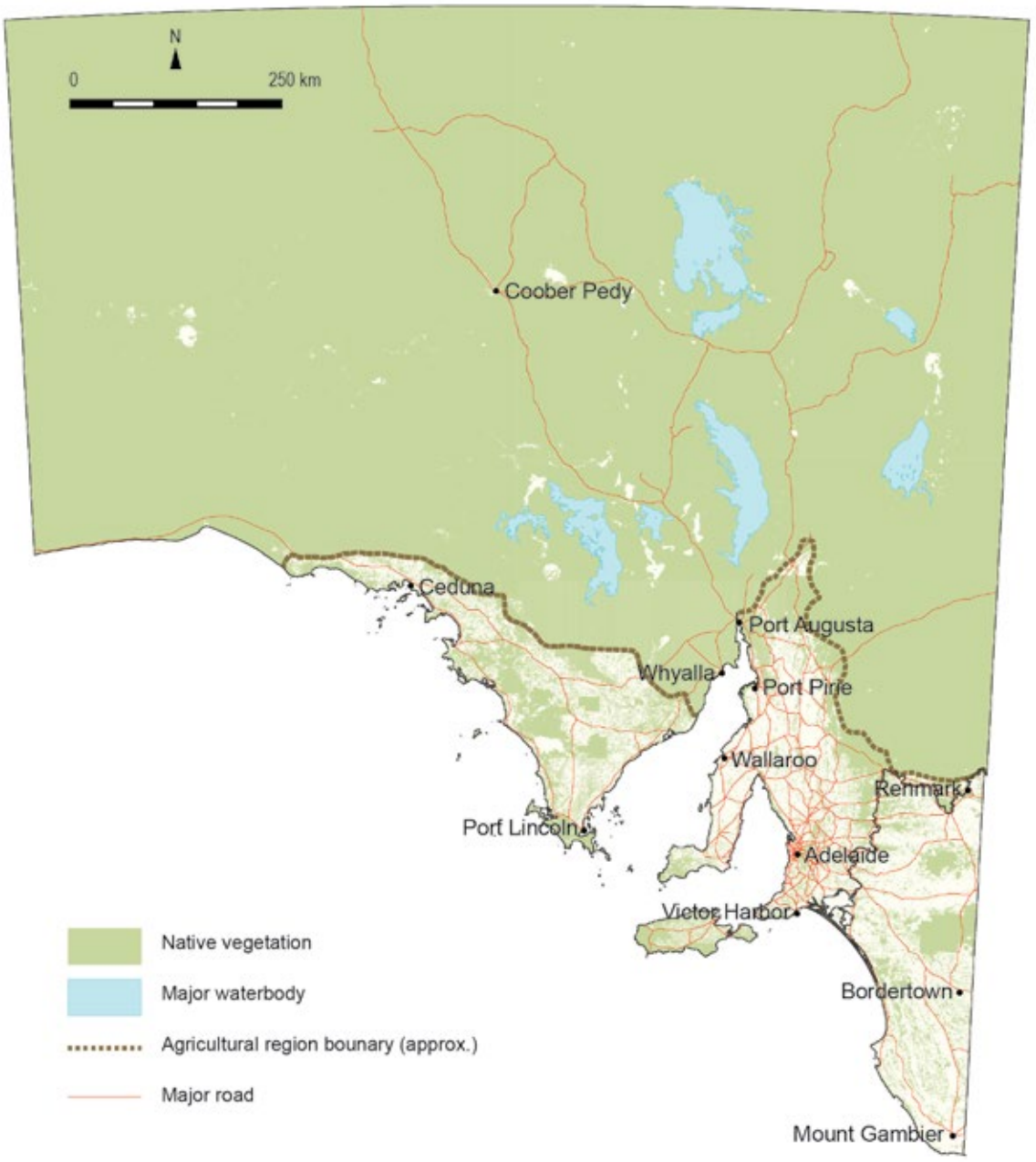
### 2.1.1 Native vegetation extent

Of South Australia's 984 221.37 square kilometres in land area (DSEWPaC 2010), native vegetation covers approximately 85%. The arid northern parts (covering 87% of the state) have had minimal vegetation clearance, and approximately 96% of vegetation cover remains. Much of this is used to sustain pastoral industries and is degraded as a result.

In contrast, temperate areas (the remaining 13% of the state) with higher rainfall have experienced much higher vegetation clearing rates in the past, and only 26% of native vegetation remains in these areas. Much of the native vegetation in the southern parts of South Australia has been cleared for agriculture and human settlements since the 19th and 20th centuries (Figure 1). The remaining vegetation is now fragmented, especially in the southern Mount Lofty Ranges, where the patches are too small to support bird biodiversity (Westphal et al. 2003, 2007; Bradshaw 2012). Native forests are now estimated to cover only 9% of the state's total area and in some areas, such as the Adelaide Plains and adjacent Mount Lofty Ranges, as little as 4% cover remains (Bradshaw 2012).

Large-scale clearing of native vegetation ceased after the introduction of the *Native Vegetation Act 1991*. Vegetation clearing can be undertaken under some circumstances, but it must be offset by restoration work (see Section 4.1.1). Table 2 shows statistics for vegetation clearance applications under the Act between 2009–10 and 2011–12.

Barking owl
Barbara Hardy Institute




Source: DEWNR (2013)

Figure 1 Native vegetation extent in South Australia

Illegal clearing continues to occur. Table 3 presents the number of reports alleging clearance of native vegetation by natural resource management (NRM) region for 2011–12 and the six preceding years (see the *Introduction* for information about NRM regions). The number of reports received for 2011–12 is above the average recorded over the seven years of collecting data.

### 2.1.2 Native vegetation condition

Human enterprise has had an impact on native vegetation throughout South Australia and much of it has been modified to some degree. However, it is difficult to quantify native vegetation condition systematically on a state scale. This is due to methodological and technical issues, and to inconsistent investment of

effort in monitoring and evaluation in different South Australian regions.

There is currently no standard definition for the term 'vegetation condition', but it has continued to grow in importance with the implementation of NRM programs throughout Australia. A number of different vegetation condition assessment methods have been developed. In South Australia, the Bushland Condition Monitoring method has been applied since 2003 in different parts of the agricultural zone (NCSSA 2010).

The method focuses on 'lead' and 'lag' indicators to track changes in vegetation condition and how these relate to management of native vegetation (NCSSA 2010). Lead indicators represent attributes of vegetation that can change soon after management of disturbance or threat reduction, while lag indicators tend to change after some time has elapsed after management intervention (O'Connor et al. 2009) (Table 4).

Table 2 Vegetation clearance statistics for South Australia, 2009–10 to 2011– 12

| Year | Clearance applications (under section 28 of the *Native Vegetation Act 1991*) | | | |
|---|---|---|---|---|
| | Degraded native vegetation consented to clear (ha) | Scrubland refused to clear (ha) | Individual trees consented to clear (n) | Individual trees refused to clear (n) |
| 2009–10 | 1074.24 | | 356 | |
| 2010–11 | 1107.09 | 135.57 | 334 | 47 |
| 2011-12 | 1712.55 | 30.00 | 115 | 110 |

ha = hectare; n = number
Source: Native Vegetation Council (2012)

## Nothomyrmecia

The dinosaur ant *Nothomyrmecia macrops* is a rare nocturnal ant found only in mallee habitat in South Australia. This predatory insect is very similar to a group of previously widespread but now extinct Cretaceous ants. The farm town of Poochera in South Australia (population 24) is perhaps the only place in the world with ant-based tourism. *Nothomyrmecia* was rediscovered here in the 1970s, and the area still attracts myrmecologists. The town has stencilled ants in various places along the public streets.

## Table 3 Reports of illegal clearance in hectares by natural resource management region, 2004–05 to 2011–12

| Region | 2004–05 | 2005–06 | 2006–07 | 2007–08 | 2008–09 | 2009–10 | 2010–11 | 2011-12 |
|---|---|---|---|---|---|---|---|---|
| Adelaide and Mount Lofty Ranges | 41 | 60 | 54 | 59 | 77 | 49 | 50 | 53 |
| Eyre Peninsula | 16 | 29 | 15 | 25 | 31 | 48 | 34 | 14 |
| Kangaroo Island | 14 | 27 | 12 | 4 | 10 | 18 | 14 | 15 |
| Northern and Yorke | 26 | 23 | 17 | 11 | 23 | 37 | 28 | 29 |
| South Australian Arid Lands | 9 | 6 | 8 | 2 | 2 | 1 | 1 | 1 |
| South Australian Murray–Darling Basin | 31 | 36 | 21 | 30 | 44 | 48 | 36 | 36 |
| South East | 26 | 48 | 31 | 30 | 36 | 54 | 48 | 33 |
| Change Detection Program (CDP)[a] | | | | | | | | 50 |
| Total | 163 | 229 | 158 | 161 | 223 | 255 | 211 | 231 |

a CDP uses satellite imagery to detect changes in native vegetation cover.
Note: No clearing was recorded for the Alinytjara Wilurara region.
Source: Native Vegetation Council (2012)

## Table 4 Lead and lag indicators of bushland condition in the Bushland Condition Monitoring method

| Lead indicators | Lag indicators |
|---|---|
| Feral animal impact | Hollow trees |
| Total grazing pressure | Primary canopy health |
| Weed threat and abundance | Recruitment of species |
| Fallen logs and trees | Fallen logs and trees |
| | Plant species diversity |
| | Structural diversity A: ground cover |
| | Structural diversity B: plant life forms |
| | Lerp damage |
| | Mistletoe infestation |

The following case study (Box 1) examines vegetation condition data from 840 sites in three South Australian regions—Adelaide and Mount Lofty Ranges, Northern and Yorke, and part of the South Australian Murray–Darling Basin. The results provide a snapshot of vegetation condition in the three regions based on 11 of 12 Bushfire Condition Monitoring indicators.

The South Australian Pastoral Board is required to assess the condition of land in pastoral leases at intervals of not more than 14 years. The first round of assessments was completed in 2000 and a second round, begun in 2005, is due for completion in 2014. It is not possible to report any data analysis at this time, but the Pastoral Board reported on general trends in their 2010–11 annual report (Pastoral Board 2011). The report noted that extended dry periods over the 10 years to 2010 resulted in extensive losses of bladder saltbush, and no recruitment of the species had occurred, despite some heavy rainfall events in 2009. Positive responses to rainfall events were noted with high rates of production of ephemeral stockfeed and recruitment of many shrubs such as pearl bluebush and

low bluebush. Areas that were affected by severe dust storms in 2009 were showing signs of recovery.

An emerging threat to vegetation in the pastoral zone is an expansion of mining exploration and operations; however, no comprehensive data were available at the time of writing.

## 2.2 Threatened species and ecological communities

Threatened species are those species deemed to be at risk of extinction within the foreseeable future, under certain International Union for Conservation of Nature (IUCN) risk assessment criteria (IUCN 2011). Different species have different levels of risk based on their biology and ecological requirements; geographic range; population size and numbers of populations; rates of range contraction and population decline; habitat quantity, quality and connectedness or isolation; and relative risks posed by threats such as predation, competition, fire and climate change.

Threatened ecological communities are threatened 'geographically distinct assemblages of interacting native species and their associated abiotic environments' (Bonifacio and Pisanu 2012). They are one of several 'matters of national environmental significance' listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Threatened ecological communities are not generally recognised in South Australian law; however, there are provisions under the *Native Vegetation Act 1991* that protect such communities where 'the vegetation comprises the whole, or a part, of a plant community that is rare, vulnerable or endangered'.

The conservation status of species can be assessed at four levels:

- global—recognised through the IUCN Red List of Threatened Species (IUCN 2012)
- national—recognised through lists of species threatened within Australian, with lists linked to the EPBC Act
- state—recognised in South Australia through schedules of threatened species under the South Australian *National Parks and Wildlife Act 1972* (NPW Act)
- regional—recognised in South Australia through priority lists in regional NRM plans.

In South Australia, the assessment of conservation status is undertaken at all four levels and uses the standardised IUCN assessment criteria:

- range of distribution
- area of habitat occupied
- number of populations
- number of individuals (measured, estimated)
- rate of population decline (measured, estimated).

As a result of these assessments, species are assigned to a standardised IUCN conservation status category of presumed extinct, critically endangered, endangered, vulnerable, near threatened or least concern. Although assessments in South Australia apply the standards described, the South Australian NPW Act has not yet been amended to use the contemporary IUCN categories. Instead, species that are assessed as presumed extinct, critically endangered or endangered are all included under the endangered species schedule (Schedule 7). Species assessed as vulnerable align with Schedule 8: vulnerable species. Species assessed as near threatened mostly align with Schedule 9: rare species.

South Australia's Strategic Plan (Government of South Australia 2011) includes a target to 'lose no native species as a result of human impacts'. The measure for this target is a set of 20 indicator species—threatened species that are representative of South Australia's organisms and habitats, and where much effort is focused on their protection by organisations across the state. An assessment is made of trends in population abundance of each species, taking into account its population numbers, distribution, prevalence of native habitat, food sources, predators, etc. All species on the indicator list are reviewed annually (half of the list is assessed every six months). A summary of the most recent review is provided in Table 5.

## Box 1 Case study: Vegetation condition in the South Australian agricultural zone

Vegetation condition is summarised for the Adelaide and Mount Lofty Ranges, Northern and Yorke, and South Australian Murray–Darling Basin natural resource management regions of South Australia, using data from 2011.

### Positives

Plant species diversity remains reasonably high in the majority of sites, though an average of 25–30% of species has been lost from each site. Ground cover is relatively intact, and the abundance of fallen logs and trees is good or excellent in 40–70% of sites.

### Negatives

Vegetation condition remains affected by grazing pressure; the most serious consequences are low recruitment of plant species and high weed threat and abundance. There is a low number of hollow trees in all regions, and low structural diversity in some regions. Tree health is poor because of dieback resulting from land management impacts.

The 2008 state of the environment report for South Australia (EPA 2008) reported the condition of native vegetation in the pastoral zone. Historically, livestock impacts have been prevalent around permanent water points, resulting in degradation of vegetation, soil disturbance and erosion. The condition of native vegetation varies from property to property, and impacts such as selective grazing by stock, grazing by feral herbivores and weeds continue.

### Table A Vegetation condition in South Australia's agricultural zone

| Indicator | AMLR (2009) | NY (2011) | SAMDB (2010) | Summary of regions |
|---|---|---|---|---|
| Plant species diversity | 69% of sites with good or excellent species diversity | >75% of sites with moderate to good species diversity | >70% of sites with good or excellent species diversity | Species diversity generally good; however, the abundance of species may have changed, and rare or sensitive species may be lost |
| Recruitment of species | Around 40% of sites with poor or very poor recruitment | 57% of sites with poor or very poor recruitment | >35% of sites with poor or very poor recruitment | Recruitment is generally poor to very poor, with lowest recruitment where domestic grazing is most prevalent. This probably relates to differences in land-use type and mixed farming models in different regions |
| Hollow trees | 69% of sites with poor numbers of hollow trees, with only 4% of sites classified as excellent | Only 40% of sites with good or excellent numbers of hollow trees | >75% of sites with very poor numbers of hollow trees | Hollow tree numbers are very poor in all regions |
| Total grazing pressure | 91% of sites with excellent control of grazing pressure impacts | 60% of sites with either poor or very poor control of grazing pressure impacts, 25% with control of grazing pressure | 70% of sites with excellent control of grazing pressure impacts | Grazing pressure impact is variable (high in NY and low–moderate in AMLR and SAMDB) and probably relates to differences in land-use type and mixed farming models in different regions |

## Box 1 continued

| Indicator | AMLR (2009) | NY (2011) | SAMDB (2010) | Summary of regions |
|---|---|---|---|---|
| Weed threat and abundance | Around 40% of sites with poor or very poor weed threat and abundance control | 75% of sites with poor or very poor weed threat and abundance control | 29% of sites with poor or very poor weed threat and abundance control | Weed threat and abundance is high in NY and moderate in AMLR and SAMDB. This probably relates to differences in land-use type and mixed farming models in different regions |
| Fallen logs and trees | Around 40% of sites with good or excellent abundance of fallen logs and trees | 70% of sites with good or excellent abundance of fallen logs and trees | >55% of sites with good or excellent abundance of fallen logs and trees | Retention of fallen logs and trees is generally good |
| Primary canopy health | >70% of sites with moderate to very poor canopy health | 70% of sites with poor to very poor canopy health | 50% of sites with poor to very poor canopy health | Canopy health is generally poor, probably because of dieback from soil compaction, fragmentation and competition with weed species |
| Ground cover | >80% of sites with good or excellent ground cover | 90% of sites with moderate or good ground cover | 90% of sites with good or excellent ground cover | Ground cover is generally good, with lower cover in NY than other regions, probably relating to differences in land-use type and mixed farming models in different regions |
| Plant life forms diversity | 77% of sites with moderate or good plant life form diversity | 24% of sites with good or excellent plant life form diversity | >85% of sites with moderate or good plant life form diversity | Plant life form diversity was generally good in AMLR and SAMDB, and poor in NY. This is probably because of differences in grazing impacts in the different regions |
| Lerp damage | 73% of sites with little or no lerp infestation | 80% of sites with little or no lerp infestation | >75% of sites with little or no lerp infestation | Lerp damage is isolated to some locations and some tree species |
| Mistletoe infestation | All sites across the region had very low mistletoe infestation | 85% of sites with very low mistletoe infestation | All sites across the region had very low mistletoe infestation | Mistletoe infestation is isolated to some locations and some tree species |

AMLR = Adelaide and Mount Lofty Ranges; NY = Northern and Yorke; SAMBD = South Australian Murray–Darling Basin

Notes:

1. Some indicators were only measured in woodlands and forests (e.g. canopy health and fallen logs and trees).
2. Sites included represent 'better' native vegetation because data collection programs favour measurement in intact native vegetation (i.e. eligibility criteria for some programs exclude sites of low to very low quality).
3. Results are highly consistent with those found through stratified random sampling of vegetation condition across vegetation types in the NY region (n = 57; Milne and Mahoney 2011).

Sources: O'Connor et al. (2009), NCSSA (2010), O'Connor NRM Pty Ltd (pers. comm, 2012)

Table 5 Trend in status of 20 indicator species

| | Positive | Stable | Negative | Total number of species |
|---|---|---|---|---|
| Mammals | Southern right whale<br>Yellow-footed rock-wallaby<br>South Australian mainland tammar wallaby | Southern brown bandicoot<br>Southern bent-wing bat | Australian sea lion | 6 |
| Fish | | | Yarra pygmy perch<br>Murray hardyhead | 2 |
| Molluscs | | | Giant Australian cuttlefish (upper Spencer Gulf population) | 1 |
| Birds | South Australian glossy black cockatoo | South-east Australian red-tailed black cockatoo<br>Black-eared miner | Malleefowl<br>Mount Lofty Ranges southern emu-wren | 5 |
| Reptiles | | Pygmy blue-tongue skink | | 1 |
| Plants | Small-flowered daisy-bush<br>Pin-lipped spider-orchid | Hindmarsh greenhood<br>White beauty spider-orchid<br>Monarto mintbush | | 5 |
| Total number of species | 6 | 8 | 6 | 20 |

Note: For some of the indicator species, negative trends were recorded in consecutive assessments, including for the Australian sea lion, southern bent-wing bat and black-eared miner. Progress reports for the Strategic Plan 2011 (SASP Audit Committee 2012) include assessments of the causes of these trends, which include bycatch, drought and habitat destruction by bushfire.

Source: Government of South Australia (2007a)

### 2.2.1 National lists of threatened species

The extinction rates and declines of Australia's mammals and birds are well documented, as is the proportion of those extinctions that were South Australian species (e.g. Burbidge et al. 1988). Box 2 shows the nationally listed threatened species that have been recorded in South Australia.

Box 2 and Table 6 show that South Australia is a major centre of modern (last 200 years) species extinctions and ongoing threats to many surviving species. The high proportions of endangered, vulnerable and rare mammal and bird species still listed within the state may also reflect an 'extinction debt'—where the future extinction of species is likely due to events in the past (Szabo et al. 2011)—which is still to reach full effect following habitat and population declines, fragmentations and isolation, and periodic random events such as fires and droughts.

There are proportionally more South Australian species of mammals, birds and freshwater fish in national lists of threatened species than other taxonomic groups (Figure 2).

## Box 2 Nationally listed threatened species, as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, that have been recorded in South Australia (as at April 2012)

### Plants (115 listed)

#### Presumed extinct (1 listed)

- *Senecio helichrysoides*

#### Critically endangered (8 listed)

- *Acanthocladium dockeri*
- *Caladenia intuta*
- *Cassinia tegulata*
- *Hibbertia tenuis*
- *Prasophyllum murfetii*
- *Pterostylis bryophila*
- *Thelymitra cyanapicata*
- *Veronica derwentiana* subsp. *homalodonta*

#### Endangered (43 listed)

- *Acacia cretacea*
- *Acacia enterocarpa*
- *Acacia pinguifolia*
- *Acacia spilleriana*
- *Acacia whibleyana*
- *Allocasuarina robusta*
- *Brachyscome muelleri*
- *Caladenia argocalla*
- *Caladenia audasii*
- *Caladenia behrii*
- *Caladenia colorata*
- *Caladenia conferta*
- *Caladenia gladiolata*
- *Caladenia hastata*
- *Caladenia lowanensis*
- *Caladenia macroclavia*
- *Caladenia richardsiorum*
- *Caladenia rigida*
- *Caladenia tensa*
- *Caladenia xanthochila*
- *Caladenia xantholeuca*
- *Dodonaea subglandulifera*
- *Eriocaulon australasicum*
- *Eriocaulon carsonii* subsp. *carsonii*
- *Eucalyptus paludicola*
- *Euphrasia collina* subsp. *muelleri*
- *Euphrasiacollina* subsp *osbornii*
- *Frankenia plicata*
- *Haloragis eyreana*
- *Lachnagrostis limitanea*
- *Leionema equestre*
- *Lepidium monoplocoides*
- *Olearia microdisca*
- *Prasophyllum frenchii*
- *Prasophyllum goldsackii*
- *Prasophyllum pruinosum*
- *Prostanthera eurybioides*
- *Pterostylis despectans*
- *Pterostylis lepida*
- *Pterostylis* sp. Hale (R.Bates 21725)
- *Pultenaea trichophylla*
- *Senecio behrianus*
- *Thelymitra epipactoides*

#### Vulnerable (63 listed)

- *Acacia araneosa*
- *Acacia carneorum*
- *Acacia glandulicarpa*
- *Acacia latzii*
- *Acacia menzelii*
- *Acacia pickardii*
- *Acacia praemorsa*
- *Acacia rhetinocarpa*
- *Asterolasia phebalioides*
- *Beyeria subtecta*
- *Caladenia brumalis*
- *Caladenia calcicola*
- *Caladenia concolor*
- *Caladenia formosa*
- *Caladenia ovata*
- *Caladenia versicolor*
- *Caladenia woolcockiorum*
- *Cheiranthera volubilis*
- *Codonocarpus pyramidalis*
- *Correa calycina* var. *calycina*
- *Correa calycina* var. *halmaturorum*
- *Corybas dentatus*
- *Dodonaea procumbens*
- *Eleocharis papillosa*
- *Glycine latrobeana*
- *Grevillea treueriana*
- *Hibbertia crispula*
- *Ixodia achilleoides* subsp. *arenicola*

continued

## Box 2 continued

- *Lepidium pseudopapillosum*
- *Limosella granitica*
- *Logania insularis*
- *Microlepidium alatum*
- *Olearia pannosa* subsp. *pannosa*
- *Phebalium lowanense*
- *Pleuropappus phyllocalymmeus*
- *Pomaderris halmaturina* subsp. *halmaturina*
- *Prasophyllum pallidum*
- *Prasophyllum spicatum*
- *Prasophyllum validum*
- *Prostanthera calycina*
- *Prostanthera nudula*
- *Pterostylis arenicola*
- *Pterostylis chlorogramma*
- *Pterostylis cucullata* subsp. *cucullata*
- *Pterostylis cucullata* subsp. *sylvicola*
- *Pterostylis mirabilis*
- *Pterostylis tenuissima*
- *Pterostylis xerophila*
- *Ptilotus beckerianus*
- *Pultenaea villifera* var. *glabrescens*
- *Senecio macrocarpus*
- *Senecio megaglossus*
- *Senecio psilocarpus*
- *Solanum karsense*
- *Spyridium coactilifolium*
- *Spyridium eriocephalum* var. *glabrisepalum*
- *Stackhousia annua*
- *Swainsona murrayana*
- *Swainsona pyrophila*
- *Taraxacum cygnorum*
- *Tecticornia flabelliformis*
- *Thelymitra matthewsii*
- *Xerothamnella parvifolia*

### Animals

### Amphibians (1 listed)

#### Vulnerable (1 listed)

- *Litoria raniformis* Southern bell frog

### Birds (39 listed)

#### Presumed extinct (1 listed)

- *Dromaius baudinianus* Kangaroo Island emu

#### Critically endangered (2 listed)

- *Cinclosoma punctatum anachoreta* Spotted quail-thrush (Mount Lofty Ranges subsp.)
- *Neophema chrysogaster* Orange-bellied parrot

#### Endangered (15 listed)

- *Anthochaera phrygia* Regent honeyeater
- *Botaurus poiciloptilus* Australasian bittern
- *Calyptorhynchus banksii graptogyne* Red-tailed black cockatoo (south-eastern subsp.)
- *Calyptorhynchus lathami halmaturinus* Glossy black cockatoo (South Australian subsp.)
- *Diomedea epomophora sanfordi* Northern royal albatross
- *Diomedea exulans amsterdamensis* Amsterdam albatross
- *Diomedea exulans exulans* Tristan albatross
- *Hylacola pyrrhopygia parkeri* Chestnut-rumped heathwren (Mount Lofty Ranges subsp.)
- *Lathamus discolor* Swift parrot
- *Macronectes giganteus* Southern giant-petrel
- *Manorina melanotis* Black-eared miner
- *Pezoporus occidentalis* Night parrot
- *Stipiturus malachurus intermedius* Southern emu-wren (Mount Lofty Ranges subsp.)
- *Stipiturus mallee* Mallee emu-wren
- *Thalassarche chrysostoma* Grey-headed albatross

#### Vulnerable (21 listed)

- *Acanthiza iredalei iredalei* Slender-billed thornbill (western subsp.)
- *Amytornis barbatus barbatus* Grey grasswren
- *Amytornis modestus* Thick-billed grasswren

continued

## Box 2 continued

- *Diomedea epomophora epomophora*
  Southern royal albatross
- *Halobaena caerulea*
  Blue petrel
- *Leipoa ocellata*
  Malleefowl
- *Macronectes halli*
  Northern giant-petrel
- *Pachycephala rufogularis*
  Red-lored whistler
- *Pedionomus torquatus*
  Plains wanderer
- *Phoebetria fusca*
  Sooty albatross
- *Polytelis alexandrae*
  Princess parrot
- *Polytelis anthopeplus monarchoides*
  Eastern regent parrot
- *Psophodes nigrogularis leucogaster*
  Western whipbird (eastern subsp.)
- *Pterodroma mollis*
  Soft-plumaged petrel
- *Rostratula australis*
  Australian painted snipe
- *Stipiturus malachurus parimeda*
  Southern emu-wren (Eyre Peninsula subsp.)
- *Thalassarche bulleri*
  Buller's albatross
- *Thalassarche cauta cauta*
  Shy albatross
- *Thalassarche cauta salvini*
  Salvin's albatross
- *Thalassarche melanophris*
  Black-browed albatross
- *Thalassarche melanophris impavida*
  Campbell albatross

### Fish (10 listed)

#### Endangered (3 listed)

- *Craterocephalus fluviatilis*
  Murray hardyhead
- *Maccullochella macquariensis*
  Trout cod
- *Macquaria australasica*
  Macquarie perch

#### Vulnerable (7 listed)

- *Galaxiella pusilla*
  Dwarf galaxias
- *Maccullochella peelii peelii*
  Murray cod
- *Mogurnda clivicola*
  Flinders Ranges purple-spotted gudgeon
- *Nannoperca obscura*
  Yarra pygmy perch
- *Nannoperca variegata*
  Ewen's pygmy perch
- *Prototroctes maraena*
  Australian grayling
- *Carcharodon carcharias*
  Great white shark

### Invertebrates (2 listed)

#### Critically endangered (1 listed)

- *Synemon plana*
  Golden sun moth

#### Endangered (1 listed)

- *Euastacus bispinosus*
  Glenelg spiny freshwater crayfish

### Mammals (52 listed)

#### Presumed extinct (17 listed)

- *Bettongia lesueur graii*
  Burrowing bettong (boodie)
- *Bettongia penicillata penicillata*
  Brush-tailed bettong
- *Caloprymnus campestris*
  Desert rat-kangaroo
- *Chaeropus ecaudatus*
  Pig-footed bandicoot
- *Conilurus albipes*
  White-footed rabbit-rat
- *Lagorchestes hirsutus hirsutus*
  Mala (rufous hare-wallaby)
- *Lagorchestes leporides*
  Eastern hare-wallaby
- *Leporillus apicalis*
  Lesser stick-nest rat
- *Macropus eugenii eugenii*
  Tammar wallaby (South Australia)
- *Macropus greyi*
  Toolache wallaby
- *Macrotis leucura*
  Lesser bilby
- *Notomys amplus*
  Short-tailed hopping mouse
- *Notomys longicaudatus*
  Long-tailed hopping mouse
- *Onychogalea lunata*
  Crescent nail-tailed wallaby

continued

## Box 2 continued

- *Perameles bougainville fasciata*
  Western barred bandicoot (mainland)
- *Perameles eremiana*
  Desert bandicoot
- *Pseudomys gouldii*
  Gould's mouse

### Critically endangered (1 listed)

- *Miniopterus schreibersii bassanii*
  Southern bent-wing bat

### Endangered (11 listed)

- *Balaenoptera musculus*
  Blue whale
- *Bettongia penicillata ogilbyi*
  Brush-tailed bettong
- *Dasycercus hillieri*
  Mulgara
- *Dasyurus maculatus maculatus*
  Spotted-tailed quoll (south-eastern mainland population)
- *Eubalaena australis*
  Southern right whale
- *Isoodon obesulus obesulus*
  Southern brown bandicoot
- *Notoryctes typhlops*
  Marsupial mole (itjari-tjari)
- *Perameles gunnii* unnamed subsp.
  Eastern barred bandicoot (mainland)
- *Phascogale calura*
  Red-tailed phascogale
- *Sminthopsis aitkeni*
  Sooty dunnart (Kangaroo Island dunnart)
- *Sminthopsis psammophila*
  Sandhill dunnart

### Vulnerable (23 listed)

- *Arctocephalus tropicalis*
  Subantarctic fur seal
- *Balaenoptera borealis*
  Sei whale
- *Balaenoptera physalus*
  Fin whale
- *Dasycercus cristicauda*
  Ampurta
- *Dasyuroides byrnei*
  Kowari
- *Dasyurus geoffroii*
  Western quoll
- *Isoodon auratus auratus*
  Golden bandicoot
- *Isoodon obesulus nauticus*
  Southern brown bandicoot (Nuyts Island subsp.)
- *Leporillus conditor*
  Greater stick-nest rat
- *Macrotis lagotis*
  Greater bilby
- *Megaptera novaeangliae*
  Humpback whale
- *Mirounga leonina*
  Southern elephant seal
- *Myrmecobius fasciatus*
  Numbat
- *Neophoca cinerea*
  Australian sea lion
- *Notomys fuscus*
  Dusky hopping mouse
- *Nyctophilus corbeni*
  South-eastern long-eared bat
- *Petrogale lateralis*
  Black-footed rock-wallaby (McDonnell Ranges race)
- *Petrogale xanthopus xanthopus*
  Yellow-footed rock-wallaby
- *Potorous tridactylus tridactylus*
  Long-nosed potoroo
- *Pseudomys australis*
  Plains mouse (Plains rat)
- *Pseudomys fieldi*
  Shark Bay mouse
- *Pseudomys shortridgei*
  Heath rat
- *Pteropus poliocephalus*
  Grey-headed flying fox

## Reptiles (9 listed)

### Endangered (3 listed)

- *Caretta caretta*
  Loggerhead turtle
- *Dermochelys coriacea*
  Leathery turtle
- *Tiliqua adelaidensis*
  Pygmy blue-tongue skink

### Vulnerable (6 listed)

- *Aprasia pseudopulchella*
  Flinders worm-lizard
- *Chelonia mydas*
  Green turtle
- *Delma impar*
  Striped snake-lizard
- *Liopholis kintorei*
  Tjakura
- *Notechis scutatus ater*
  Krefft's tiger snake
- *Ophidiocephalus taeniatus*
  Bronzeback legless lizard

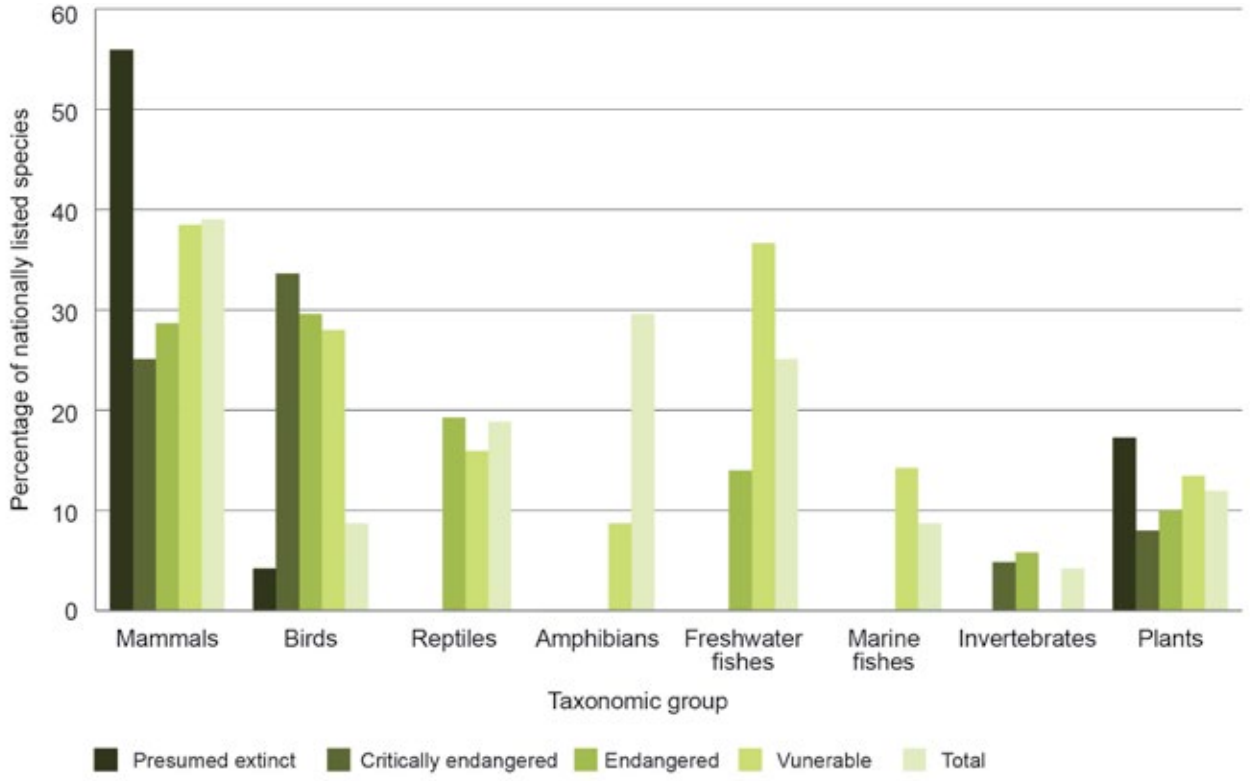



Figure 2 Proportions of nationally listed threatened species recorded in South Australia by taxonomic group, April 2012

Since the last South Australian state of the environment report in 2008 (EPA 2008), 14 species that occur in South Australia have been added to the lists under the EPBC Act:

- nine plant species: five *critically endangered* (*Caladenia intuta*, *Cassinia tegulata*, *Hibbertia tenuis*, *Thelymitra cyanapicata* and *Veronica derwentiana* subsp. *homalodonta*), three *endangered* (*Acacia spilleriana*, *Prasophyllum pruinosum* and *Pultenaea trichophylla*) and one *vulnerable* (*Acacia praemorsa*)
- four bird species: three *endangered* (Australasian bittern, mallee emu-wren and grey-headed albatross) and one *vulnerable* (fairy tern)
- one freshwater crustacean: the *endangered* Glenelg spiny freshwater crayfish. This freshwater crayfish has also been added to the list of protected species under the South Australian *Fisheries Management Act 2007*.

Over the same period, three *vulnerable* plant species (*Austrostipa nullanulla*, *Acacia imbricata* and *Basedowia tenerrima*), one *vulnerable* mammal species (Pearson Island rock-wallaby), one *vulnerable* reptile (Pernatty knob-tail gecko) and one *vulnerable* bird species (Gawler Ranges thick-billed grasswren) have been de-listed from the EPBC Act list of threatened species. A further 14 South Australian taxa have also been recommended for removal from the national list of threatened birds. These recommendations are primarily due to better knowledge of distributions, population sizes or degrees of threat and, for some, because new criteria have been used to define *near threatened*. None has yet been removed because of recovery (see Section 4.2).

### Birds

The continuing decline of Australia's bird species has underpinned a revision of the EPBC Act list of threatened species in *The action plan for Australian birds 2010* (Garnett et al. 2011). This follows earlier action plans for Australian birds (1990 and 2000). The 2010 action plan recommends new listings for 19 species or subspecies that breed in South Australia. Eight of these were already listed but are now assessed to be in a worse status category than 10 years earlier. Eleven others are listed in a threat category for the first time, including six because of recent taxonomic recognition of new subspecies of grass-wrens. The list also includes at least 14 threatened oceanic seabirds that do not breed in South Australia, but use South Australian waters. It also includes an assessment of non-breeding migratory waders for the first time,

and 15 taxa assessed as *threatened* visit South Australian mudflats and shorelines on a regular basis.

As a follow-up analysis to the three decadal action plans for Australian birds, Szabo et al. (2012) demonstrate that South Australia has the second-worst IUCN Red List indices of species survival for continental birds of all Australian states and territories, excluding status changes driven by threats operating outside of Australia. However, their analyses also suggest that, if conservation actions had not been in place over the past decade or more, eight listed threatened bird species that occur in South Australia would now be listed (or recommended for listing) in a worse conservation status category (Szabo et al. 2102).

Yellow-tailed black cockatoo
Barbara Hardy Institute

### Fish

The plight of many fish species that depend on our inland waters has come to the fore relatively recently (e.g. Hammer et al. 2009) and, as Figure 2 indicates, fish species that occur in South Australia appear to be overrepresented in the lists of those that are declining (25% of native freshwater fish species listed nationally are found in South Australia). In addition, three commercially exploited fishes that occur in South Australia—school shark, orange roughy and southern bluefin tuna—have been added to a different EPBC Act list of 'conservation dependent' species, acknowledging that their conservation status needs to be recognised nationally and their populations carefully managed through sustainable fisheries management practices.

## 2.2.2 South Australian lists of threatened species

Table 6 lists the numbers of threatened plant and vertebrate animals in South Australia as listed under Schedules 7, 8 and 9 (Threatened Species Schedules) of the NPW Act.

The threatened species schedules that Table 6 is based on have not been revised since the 2008 state of the environment report was published. This is not a reflection on actual changes in the status of threatened species in South Australia. It is primarily because revisions to the schedules require a complex legal process for gazetting, which has meant that rather than one, two, or a few species being added to, deleted from, or changed between schedules, the entire schedules are revised periodically.

### Freshwater fish

Status assessments undertaken as a basis for the Action Plan for South Australia's Freshwater Fishes (Hammer et al. 2009) have indicated that, at the state level, there are three species of freshwater fish presumed to be extinct, eight that should be listed as *critically endangered*, nine as *endangered*, nine as *vulnerable* and three as *rare* (or near threatened). Only 26 species (45%) were considered secure enough to not be recommended for listing.

Several of the small-bodied threatened fish species identified in the action plan have been added to the lists of aquatic species that are protected under the *Fisheries Management Act 2007*. All species await reassessment in light of much more information now being available. Amendments will need to be made to the NPW Act before any of them can be added to the South Australian Threatened Species Schedules.

Table 6 Numbers of South Australian state-listed threatened species, 2012

| **Status under the** *National Parks and Wildlife Act 1972* **(No. of South Australian native species)** | **Plants (5858)** | **Mammals (180)** | **Birds (473)** | **Reptiles (235)** | **Amphibians (27)** |
|---|---|---|---|---|---|
| Critically endangered and endangered (%) | 161[a] (3) | 21[b] (26) | 34[c] (7) | 9 (4) | 0 (0) |
| Vulnerable (%) | 196 (3) | 21 (12) | 32 (7) | 9 (4) | 4 (15) |
| Rare (%) | 431 (7) | 32 (18) | 89 (19) | 35 (15) | 4 (15) |
| Total (%) | 788 (14) | 74 (56) | 155 (33) | 53 (23) | 8 (30) |

a Includes 26 species *presumed extinct*
b Includes 26 species *presumed extinct*
c Includes 8 species *presumed extinct*
Note: The total number of native species within each taxonomic group used to calculate the percentage in each threat category is the same as used in the 2008 state of the environment report. Fish are not included in the table because they are not listed under the *National Parks and Wildlife Act 1972*.

### 2.2.3 National lists of threatened ecological communities

Six ecological communities that occur in South Australia are currently listed as threatened under the EPBC Act. These are:

- *critically endangered*
  - iron grass natural temperate grassland of South Australia
  - peppermint box (*Eucalyptus odorata*) grassy woodland of South Australia
  - swamps of the Fleurieu Peninsula
- *endangered*
  - buloke woodlands of the Riverina and Murray–Darling Depression bioregions
  - grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia
  - the community of native species that depend on natural discharge of groundwater from the Great Artesian Basin.

An additional two ecological communities in South Australia have been nominated for listing:

- lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling River to the sea
- Kangaroo Island narrow-leaf mallee communities.

# 3 What are the pressures?

The 2011 Australian state of the environment report (State of the Environment 2011 Committee 2011) identifies the following pressures on Australia's biodiversity:

- fragmentation of habitat
- climate change
- land-use change
- invasive species and pathogens
- grazing pressure
- altered fire regimes
- changed hydrology.

The most frequently cited threats in listings under the EPBC Act and resulting recovery plans are habitat fragmentation and the spread of invasive species.

There is also increasing recognition that climate change is having, and will continue to have, a significant impact on Australia's biodiversity (Prober and Dunlop 2011). Climate change will impact species and ecological communities both directly and by exacerbating existing stresses or pressures such as fragmentation, introduced species, overharvesting, modification of the hydrological cycle and changed fire regimes (Prowse and Brooks 2010). It remains difficult to predict impacts accurately, but plants and animals are likely to experience shifts or changes in genetic composition, geographic ranges, lifecycles and population dynamics (Steffen et al. 2009).

## 3.1 Pressures on native vegetation

In South Australia, the extent of native vegetation has been greatly reduced in temperate parts of the state (see Section 2.1.1) and in many areas its condition (see Section 2.1.2) has declined since the time of European colonisation. Native vegetation remains subject to a number of pressures that can lead to further degradation.

### 3.1.1 Clearing and fragmentation

Vegetation is no longer cleared to the extent that this occurred in the past, but continued degradation of remaining native vegetation cover contributes to ongoing fragmentation and incremental changes (Forman 1995).

Fragmentation tends to exacerbate the impacts of other threatening processes by reducing the area of remnant patches of native vegetation and increasing the exposure of the edges of these remnant patches to invasions from pest plants, animals and pathogens (Lindenmayer and Fischer 2006).

### 3.1.2 Fire

Fire plays an important role in shaping Australia's biodiversity and is a factor that influences the composition, structure and function of native vegetation. Inappropriate fire regimes can lead to major changes in the structure of ecological communities and increase the risk of extinctions. As a result of climate change, fires are likely to be larger and more frequent (Driscoll et al. 2010) because of more frequent and prolonged droughts (Pittock 2009).

Prescribed burns are an important management tool used by South Australian Government agencies (Department of Environment, Water and Natural Resources [DEWNR]; Forestry South Australia; South Australian Water) to reduce the risks that fire poses to human assets, as well as for ecological outcomes such as regenerating fire-dependent plants. There are many uncertainties about how to use fire to meet conservation goals, and existing programs throughout Australia have insufficient data to determine if they are being implemented successfully (Penman et al. 2011). This is the case for both vegetation and wildlife management because the response of a range of species to fire remains poorly understood and documented (Clarke 2008, Driscoll et al. 2010).

### 3.1.3 Other pressures on vegetation

A number of other pressures that impact native vegetation were identified in the 2008 state of the environment report for South Australia. These pressures remain, and include:

- stock grazing—trampling of plants, browsing of adults and seedlings, weed dispersal and disruption of native plant recruitment

- senescence (ageing and deterioration) of adult plants and low rates of seedling recruitment, symptomatic of land cleared for agriculture and other purposes
- pest animal, plant and pathogen invasions—displacement of native species, disruption of lifecycles and ecosystem processes, and degradation of habitat quality
- dryland salinity, which impacts productive land and native vegetation; of 300 000 hectares affected by dryland salinity in 2008, 18 000 were native vegetation and 45 000 were classified as wetlands
- direct human impacts such as trampling and vehicle movement, soil compaction, destruction and disturbance of vegetation, and illegal firewood collection.

## 3.2 Land management and effects on soil

Approximately 10.4 million hectares of cleared land are used for agriculture in South Australia. Most of the land in the state has been changed through grazing, cropping, and the application of fertilisers, herbicides and pesticides. Changes in the soil as a result of these land uses affect biodiversity primarily by affecting vegetation.

Figure 3 shows a conceptual model of soil processes and pressures.

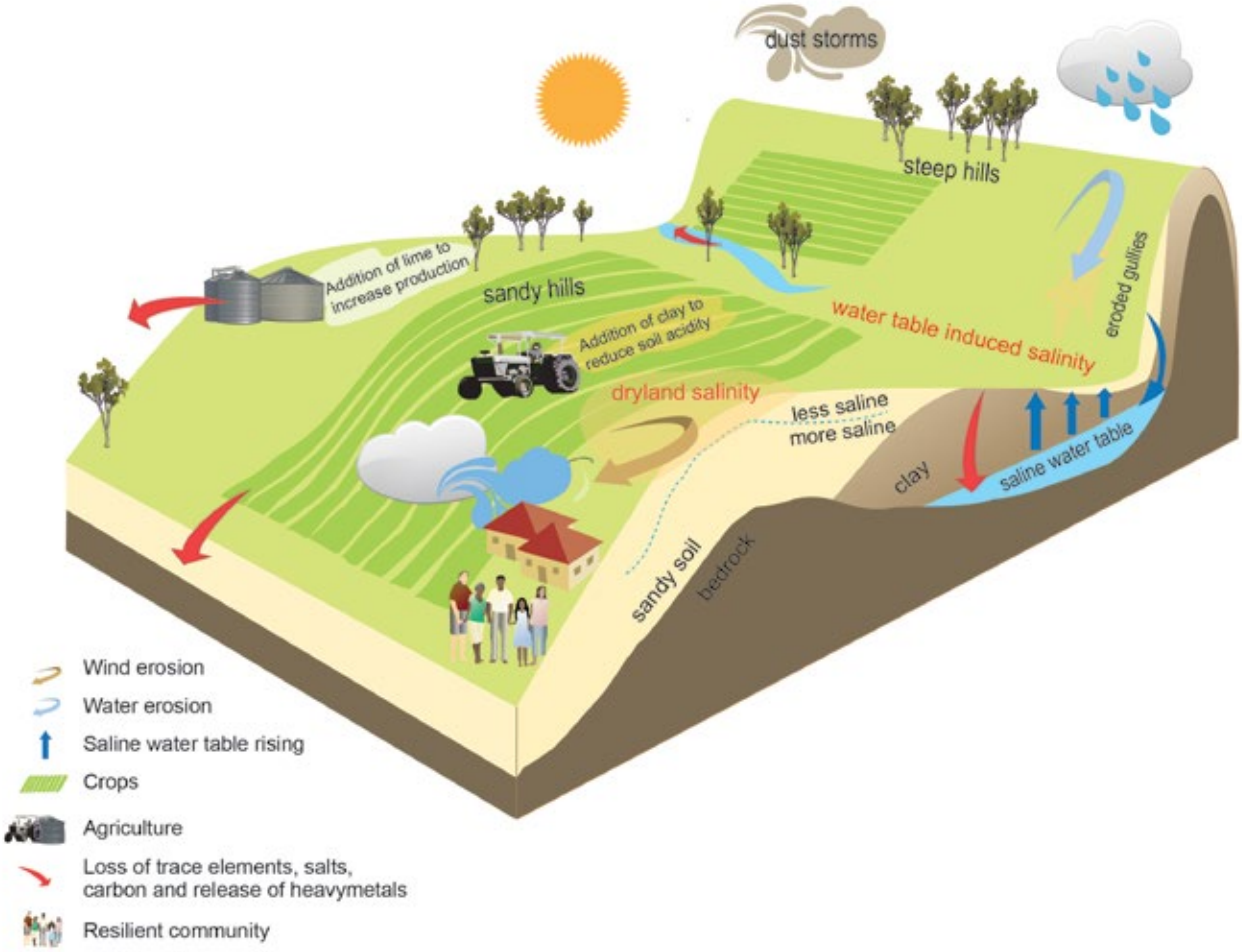
### 3.2.1 Soil erosion

Erosion is a natural process; however, the clearance and cultivation of land for agriculture has resulted in rates of soil loss that are many times higher than in undisturbed environments. Soil erosion is the highest priority threat to the agricultural soils in South Australia. Approximately 6 million hectares of agricultural land (58% of cleared land) are inherently susceptible to wind erosion, and 3.2 million hectares (31%) are inherently susceptible to water erosion (Soil and Land Program 2007ab). The magnitude of this threat is recognised in Target 70 of South Australia's Strategic Plan: Sustainable land management (Government of South Australia 2011).

Without intervention, soil erosion can have adverse social, economic and environmental impacts. Soil erosion depletes the productive capacity of land as it removes nutrients, organic matter and clay from soil, which are most important for plant growth. Soil erosion also has a wide range of costly offsite impacts, including damage to roads; disruption to transport and electricity supply; contamination of wetlands, watercourses and marine environments; and human health impacts caused by raised dust.

Soil is predisposed to a risk of erosion by physical disturbance or removal of surface vegetative cover. Very dry seasonal conditions increase the risk of erosion where there is reduced vegetative cover resulting from poor crop and pasture growth.

Grey-box forest, Mt Lofty
Barbara Hardy Institute




This agricultural land system exists in 6 NRM regions: Adelaide and Mount Lofty Ranges, Eyre Peninsula, Kangaroo Island, Northern and Yorke, South Australian Murray–Darling Basin and South East

| | | |
|---|---|---|
| Erosion by wind or water | • Loss of surface soil, carbon and soil biota<br>• Exposure of saline subsoil leading to dryland salinity<br>• Increase in sedimentation in streams | Loss of production |
| Soil acidification | • Decline in soil structure<br>• Loss of biological activity<br>• Loss of trace elements and nutrients<br>• Release of heavy metals<br>• Aluminium toxicity | |
| Salinity (dry saline land or water table induced) | • Poor water accessibility by roots in saline soils<br>• Leaching of salts<br>• Salinisation of streams | |

Figure 3 Conceptual model of soil processes and pressures

The critical management practices that affect the risk of soil erosion are:

- the occurrence, intensity and timing of tillage operations
- the quantity and nature of surface cover.

Most of the erosion risk is due to cropping practices such as tillage and stubble burning. Grazing management is also an important factor, especially in dry years and droughts. The highest risks associated with grazing occur in late summer and autumn, when feed availability and the cover of annual crop and pasture residues is declining.

Soil erosion has steadily declined in the agricultural areas of South Australia over the past 70 years because of improvements in farming practices, but soil losses still occur with extreme wind or rainfall events, and after severe or prolonged drought.

Soil erosion is difficult to measure directly because its occurrence is highly sporadic. Instead, the protection of soil from the risk of erosion is monitored, because any trend in the risk would result in a matching trend in actual erosion in the long term. The DEWNR has used observational field surveys to assess the protection of agricultural cropping land from erosion since 1999. Telephone surveys of agricultural land managers are also conducted to assess trends in land managers' knowledge of, and attitudes towards, soil management issues, and the land management practices they use. These trends provide quantitative evidence of practice change that can explain observed changes in erosion protection.


Spreading lime
Tim Herrmann

Soil protection is expressed as the average number of days per year that agricultural cropping land is adequately protected from erosion. There has been an overall upward trend in soil protection over the last 10 years, despite several years of drought and other challenging management issues (Figure 4). South Australia's Strategic Plan 2011 has a target to achieve a 25% increase in South Australia's agricultural cropping land that is adequately protected from erosion by 2020, from the 2003 baseline. The target requires an increase from 272 days of protection in 2002 to 340 days in 2020. From 2003 to 2011 there was a 21% increase, from 272 to 328 days.

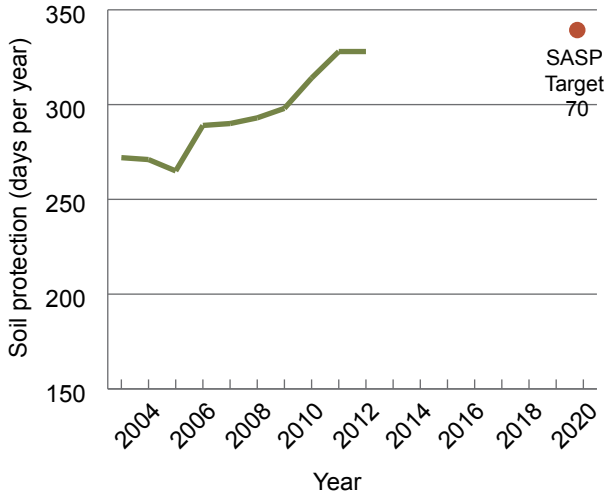



Figure 4 Trend in the average annual period of protection of agricultural cropping land from soil erosion in South Australia,2002–12 (days soil protection per year, 3-year rolling mean

Source: DEWNR (2011)

The adoption of more sustainable land management practices, such as no-till sowing and stubble retention, has improved the protection of soil from erosion. No-till sowing involves sowing the seed in a narrow slot in the soil to minimise soil disturbance and maximise residue protection on the soil surface.

Telephone surveys show that the proportion of crop area sown using no-till methods has increased from 16% in 2000 to 66% in 2011 (Figure 5). This trend has occurred in all the major cropping regions. There has also been a corresponding reduction in the use of tillage and stubble burning before sowing the crop. The trend in adoption of no-till sowing is levelling off, and this may limit further improvement in erosion protection.

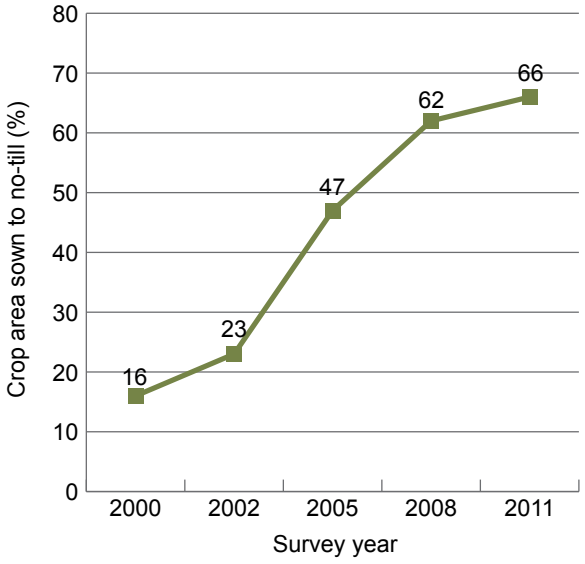



Figure 5 Change in the proportion (%) of crop area sown using no-till sowing methods in South Australia, 2000–11

Source: DEWNR (2011)

The use of clay spreading and delving to manage water-repellent soil is becoming a factor in the protection of soils from wind erosion. These techniques are widely used in the Southern Mallee and upper South East areas, where there are large areas of severely water-repellent soils. Clay spreading and delving increases the clay content of the surface soil, improving soil strength and resistance to erosion. Crop and pasture production is also increased, providing higher levels of plant cover to protect the soil from erosion. Confinement feeding allows stock to be removed from paddocks before surface cover declines below critical protective levels. It is a very important technique for preventing erosion during droughts and in late summer and autumn when ground cover declines.

### 3.2.2 Soil acidity

After erosion, soil acidity is the second highest priority threat to the sustainable management of agricultural soils in South Australia. Approximately 1.9 million hectares of agricultural land (20%) are affected by soil acidity (Soil and Land Program 2007ab). Many soils in the higher rainfall areas of the state are naturally acidic. Soil acidification can be accelerated by agricultural practices including removal of grain, hay and livestock products from the paddock, use of ammonium-containing or ammonium-forming fertilisers, and leaching of nitrogen derived from legume plants or fertilisers. Sandy-textured soils and higher levels of production also tend to lead to higher acidification rates.

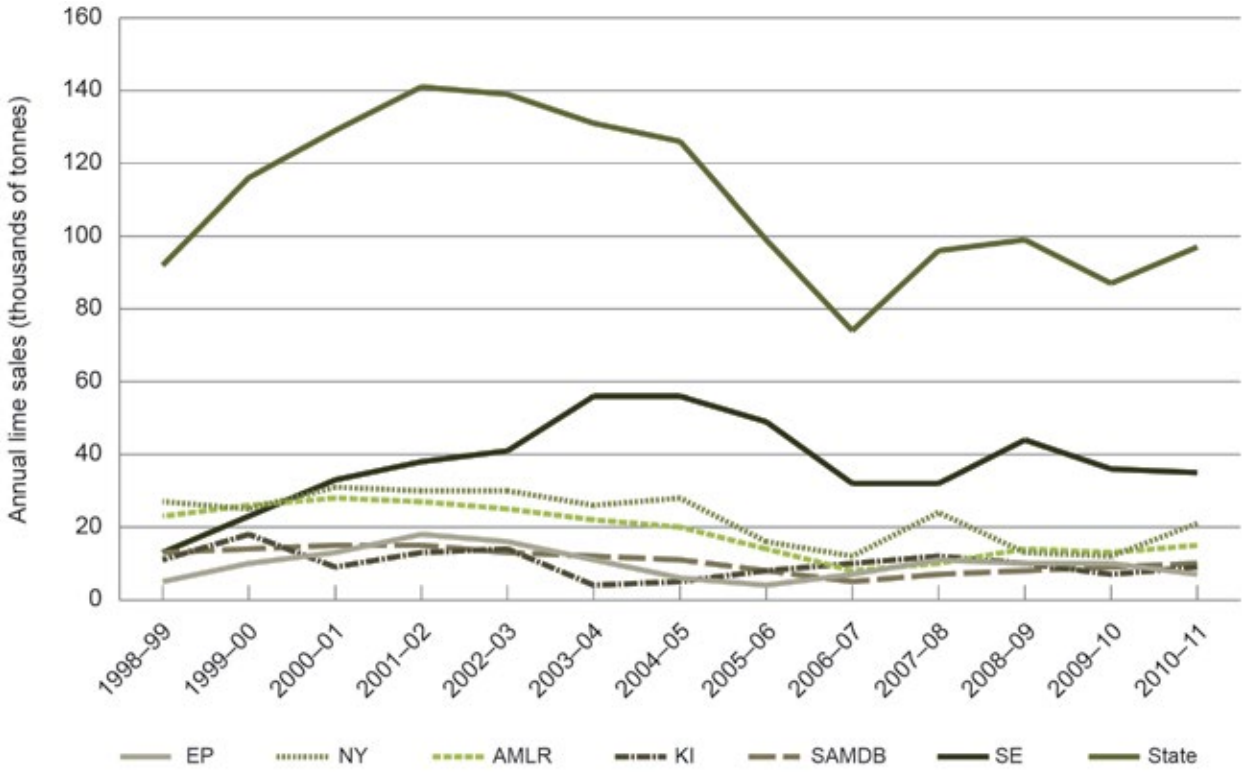
The consequences of untreated highly acidic soils include:

- reduced growth and production of most agricultural plants
- increased soil salinity due to increased drainage of rainfall to groundwater
- increased leaching of iron, aluminium and some nutrients, leading to contamination of surface and groundwater
- structural breakdown of the soil.

Surface soil acidity can be readily treated by applying liming products. Acidity can also be ameliorated by incorporating calcareous or alkaline clay, or using alkaline irrigation water. The use of deeper rooted perennial plants and effective management of soil nitrogen can reduce the rate of acidification. However, subsurface acidity (below 10 cm depth) is more difficult and expensive to treat. If acidic topsoils are not adequately treated, there is an increased risk of subsurface acidification.

The DEWNR has monitored the amount of lime sold annually in the agricultural regions of South Australia since 1999. This provides an indirect measure of the extent to which farmers have both recognised and addressed the soil acidification problem.

Lime use in the state rose through the late 1990s but then declined through the early 2000s, and has been relatively steady since 2007–08 (Figure 6). The estimated amount of lime required to balance the annual acidification rate in the agricultural zone of South Australia is approximately 213 000 tonnes. The average amount of lime applied per year over this period was approximately 113 000 tonnes—only 53% of that required to balance acidification. There are still large areas of land where acidification continues to damaging levels. The DEWNR land manager surveys indicate that there is inconsistency in land managers' understanding and awareness of soil acidity in acid-prone areas. Despite the relatively low cost of lime in South Australia compared with other states, farmers often cite cost as a key barrier to its use.




EP = Eyre Penisula; NY = Northern and Yorke; AMLR = Adelaide and Mount Lofty Ranges; KI = Kangaroo Island; SAMDB = South Australian Murray–Darling Basin; SE = South East
Note: Regional lime sales data is approximate because of difficulties in delineating lime sales between regions.

Figure 6 Estimates of the amount of lime sold from 1998–99 to 2010–11 by natural resource management region, and total for South Australia

Lime also needs to be applied to raise the pH of soils that are already acidic. An estimated additional 1.1 million tonnes of lime is required to treat topsoils that are already acidic (DEWNR 2011).

Soil acidification is becoming an increasing issue in cropping districts due to high levels of production and increased use of nitrogenous fertilisers. Subsurface acidity is more widespread than previously recognised, and is an issue in the Mount Lofty Ranges, Kangaroo Island and South East regions. Soil acidification will continue to increase unless remedial action is improved.

### 3.2.3 Dryland salinity

Dryland salinity in South Australia impacts land, water and biodiversity assets, and the productivity and quality of crops and pastures. Dryland salinity has many economic impacts, particularly in regional communities, because of to lost agricultural production and salt damage to roads, buildings and other infrastructure. In many parts of the state, historical clearance of native vegetation and its replacement with annual crops and pastures has resulted in higher groundwater levels. This has caused streams, wetlands, native vegetation and agricultural land to become salt affected, waterlogged and degraded.

Dooley et al. (2008) reported that approximately 360 000 hectares were affected by dryland salinity in South Australia. This equates to 2.3% of all land in the agricultural zone. They also reported that the net extent of salinity in South Australia has not measurably increased since 2000, largely due to 11 years (1997–2008) of lower than average rainfall experienced across South Australia's agricultural districts.

From the early 1990s to the mid-2000s, the extent of land that was affected by dryland salinity in most regions decreased by around 2% per year. The one exception was Kangaroo Island, where factors such as time since clearing the original native vegetation, and a continuation of close to average rainfall, resulted in an average 2% increase in land affected by dryland salinity in monitored catchments. Field visits to monitoring sites through the

state have shown little change in the extent or severity of dryland salinity since 2008 (DEWNR 2012a).

Depth to groundwater is the main indicator used for monitoring trends in dryland salinity. Late in 2011, records of depth to groundwater from 130 bores across the state were analysed to determine whether trends had changed since 2008 (DEWNR 2012a). The impact of a return to average or above-average rainfall in recent years on depth to groundwater can be summarised using four response trends (Table 7).

In summary, the analysis shows that from the mid-1990s to 2008, the majority of groundwater levels across South Australia were exhibiting stable or falling trends due to the rainfall deficit and, as a result, the risk that salinity posed to valuable assets across the state had decreased. Figure 7 illustrates a declining linear trend in depth to groundwater (13 centimetres per year) since the early 1990s.

However, a return to above-average rainfall since 2008 has resulted in episodic rise of groundwater from more than 4 metres deep to within 1 metre of the soil surface (Figure 7; trend 1 in Table 7). This scenario was observed in both local and regional groundwater flow systems. If these rises in groundwater are sustained such that previously falling trends in depth to groundwater are reversed, a corresponding increase in the risk of new or reactivated outbreaks of dryland salinity is likely.

Of more immediate concern are areas where episodic recharge has brought shallow groundwater to within a critical salinisation depth of the soil surface (less than 2 metres, which then induces surface soil salinity), and areas where long-term rising trends in depth to groundwater have continued unabated, such as on the Northern Adelaide Plains.

The future impact and risk of dryland salinity will depend largely on future rainfall patterns, climate change, the nature of the groundwater system and the effectiveness of interventions to slow or halt a rise in groundwater.

### 3.2.4 Soil carbon

Soil organic carbon is a measure of the amount of organic matter in soils and is an indicator of soil health. The amount of organic carbon is a balance between inputs (from plants and microorganisms) and losses (from natural breakdown and erosion). Rainfall and soil texture are two key factors that determine the amount of carbon that can be grown and stored in soils. The various components of organic carbon have varying degrees of resistance to breakdown, and the relative proportions of these can be used as an indicator of soil health.

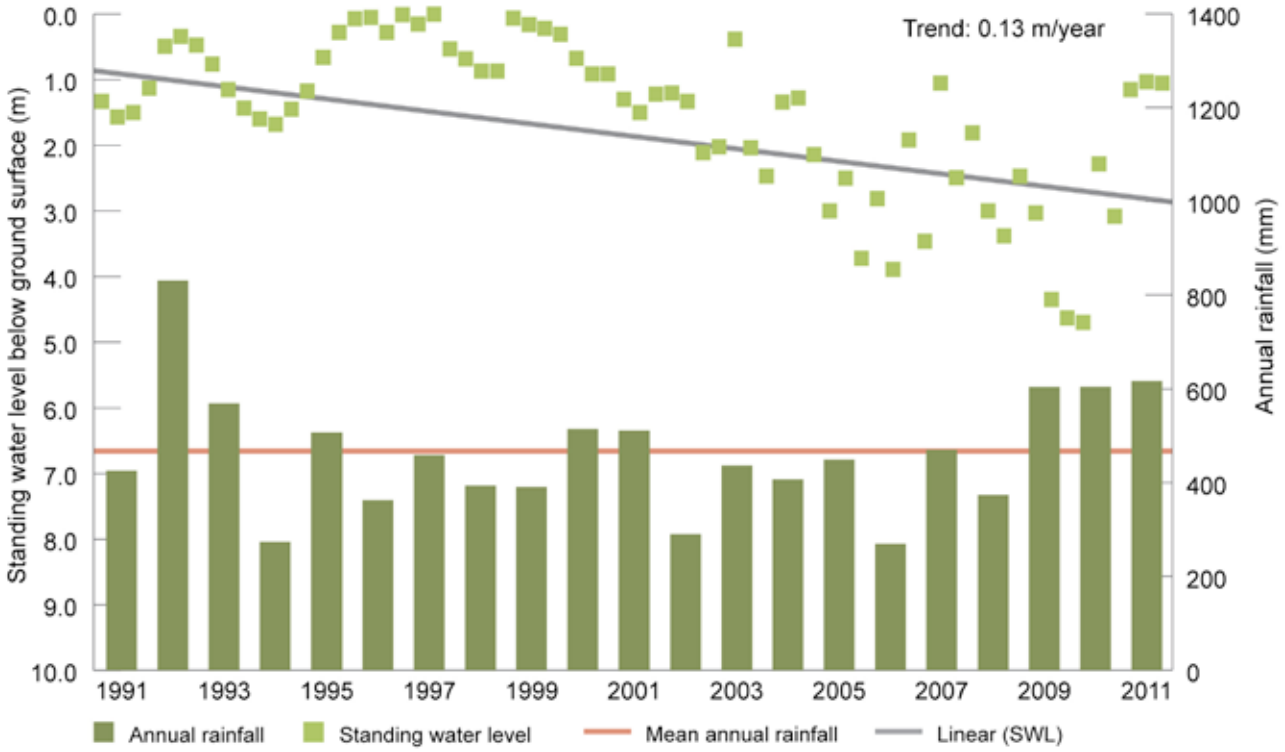
A long-term decline in soil organic carbon has a negative impact on fertility, productivity, resilience and mitigation of climate change. Soil carbon loss has occurred as a result of historical land clearance for agricultural production, but some of the loss can be reversed by using appropriate management practices such as reduced tillage. The carbon deficit in soils provides opportunities for mitigating climate change through carbon sequestration.

Currently, there are too few data available on soil carbon, and research is continuing to improve sampling techniques, analytical methods, and relationships with management practices, soil health and productivity.

Table 7 Trends for groundwater depth and salinity risk, 2012

| Trend | 2012 groundwater response to rainfall | Percentage of bores |
|---|---|---|
| 1 | Bores maintain a falling linear trend, but with a marked episodic rise in 2010 and/or 2011. No increased salinity risk in the short term, except where episodic rise brings groundwater to within 2 metres of the soil surface | 35 |
| 2 | Bores maintain a falling linear trend, but with no marked episodic rise in 2010 or 2011. No increased salinity risk. The lack of an observed episodic rise in groundwater levels may be related to time lags associated with regional groundwater flow systems and depth of groundwater, or to site-specific rainfall variability | 15 |
| 3 | Bores continue to exhibit a variable or seasonal response to rainfall. Salinity risk remains unchanged in the short term | 30 |
| 4 | Bores maintain a rising linear trend, with or without a marked episodic rise in 2010 or 2011. Salinity risk is increasing where groundwater is approaching 2 m of the soil surface | 20 |

Source: DEWNR (2012b)




SWL = standing water level
Source: Data from DEWNR and the Bureau of Meteorology

Figure 7 Bore hydrograph from the Jamestown area (Northern and Yorke natural resource management region) with long-term mean rainfall and annual rainfall for Jamestown, 1991–2011

## 3.3 Pests and diseases

Introduced pests and diseases cover a wide range of life forms—vertebrates, invertebrates, plants, algae and pathogens (including fungal, bacterial and viral organisms). Some pests originated as deliberate introductions, such as garden plants and pets, which escaped or were released to form wild populations. Since European settlement, approximately 70% of garden plants in Australia have become naturalised (i.e. established wild populations; Virtue et al. 2004), though many fewer have become major weeds. Other pests originated from accidental introductions, such as marine pests in ballast water or soilborne diseases on vehicles and footwear.

The impacts and management of invasive introduced species pose costs to both productivity and the natural environment. The Australian Bureau of Statistics (ABS 2008) estimated the annual cost of weed and pest control to South Australian farmers in 2006–07 as $209 million for weeds and $68 million for pests. Gong et al. (2009) estimated the total annual economic loss to Australian agriculture and horticulture from pest animals was $620 million per year. Difficulties in valuing natural ecosystems in dollar terms means that there are no equivalent figures for environmental costs. However, biological invasions by non-native species are recognised internationally as a leading threat to natural ecosystems and biodiversity (Vitousek et al 1997). International and national trade and tourism means there is a constant risk of entry of new pests and diseases to South Australia. There is also an ongoing risk of animals and plants held in captivity or cultivation becoming new pests. This requires effective systems to identify new pests and diseases early so that their establishment can be prevented.

Distribution and abundance trends have been derived for this report from expert knowledge in Biosecurity South Australia (Biosecurity SA) and the DEWNR, based on a range of data sources including study sites, field reports, specimen records, control programs and observations by land managers. Such trends can be variable across the state, according to whether a pest is new or widespread in a region, and whether there have been coordinated control programs.

Trends in distribution and abundance of key established pests and diseases are as follows:

- Increasing—rabbits, feral goats, European fanworm, oriental weatherloach, silverleaf nightshade, *Phytophthora cinnamomi*, sarcoptic mange of wombats
- Steady—feral deer, European carp, bridal creeper, opuntioid cacti
- Decreasing—feral camels, *Caulerpa taxifolia*, gorse
- Unknown—chytridiomycosis.

Trend in numbers of new pests and diseases are as follows:

- Increasing—weeds, marine pests, aquatic pests, native plant diseases
- Steady—terrestrial vertebrate pests
- Unknown—wildlife diseases.

### 3.3.1 Vertebrate pests

In South Australia, terrestrial vertebrate pests (invasive mammals, birds, reptiles and amphibians) are managed under the *Natural Resources Management Act 2004* (NRM Act), with regionally led programs by the NRM boards in the DEWNR, and state coordination through Biosecurity SA in the Department of Primary Industries and Regions South Australia (PIRSA). Fish are managed under separate legislation (see Section 3.3.2). The intergovernmental Vertebrate Pests Committee and the Australian Pest Animals Strategy provide national policy frameworks for pest animal management.

There are currently 35 exotic vertebrates (excluding fish) established in the wild in South Australia. This figure has not changed since the 2008 state of the environment report.

#### Incursions

There have been six confirmed detections of vertebrate incursions since 2008: three lone cane toads arrived on interstate transport, a red-eared slider turtle was illegally offered for sale in Adelaide, an Indian mynah was discovered at Adelaide airport, and a red-whiskered bulbul was discovered in the Adelaide suburbs. South Australia remains at risk from natural or human-aided incursions from interstate, and escape or release of illegally held species within South Australia.

Cane toads (*Bufo marinus*) are currently moving down south-western Queensland river systems towards Cooper Creek, which flows into north-eastern South Australia. A survey by Biosecurity SA in 2011 confirmed that cane toads are currently about 500 kilometres from the South Australian border, having moved approximately 80 kilometres downstream the previous season. Expert opinion is divided on whether conditions are suitable for their long-term survival in arid central Australia.

#### Established vertebrate pests

Rabbits (*Oryctolagus cuniculus*) occur across most of mainland South Australia and continue to be a difficult animal pest to manage. Favourable seasonal conditions and the waning effectiveness of rabbit haemorrhagic disease have both contributed to increased rabbit numbers in the state since 2008. For example, in the Flinders Ranges National Park, numbers have recovered to pre-disease levels (DEWNR 2012b).

Feral goats (*Capra hircus*) 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. Based on DEWNR aerial counts (collected with kangaroo survey data), goat numbers across some of the rangelands area declined during 2010 to about 300 000, countering four consecutive years of strong increase in preceding years. This coincides with a program of landholder incentives for goat control and ongoing helicopter culling. However, in 2011, the estimated population rose again to 390 000, most likely in response to favourable seasonal conditions and greater breeding success.

Feral deer (*Cervus* spp.) occur infrequently across southern South Australia, particularly the Mid North and Mount Lofty Ranges, with the highest abundance occurring in the upper South East. Feral deer impact native vegetation, damage pasture and crops, host livestock diseases and can be traffic hazards.

Feral camels (*Camelus dromedarius*) are widely distributed across the rangelands north of the Dog Fence. Nationally, the feral camel population was estimated at approximately 750 000 in 2012 (Australian Feral Camel Management Project, unpublished data), with considerable seasonal movement across state and territory borders. A substantial reduction in feral camel numbers is required to reduce severe impacts on rangelands biodiversity, Aboriginal cultural sites, pastoral production, community and rural infrastructure, and scarce water resources.

### 3.3.2 Aquatic pests

Aquatic pests include exotic fish, shellfish, invertebrates and algae that pose a threat to South Australia's marine and freshwater environments. Such pests can impact biodiversity and industries by outcompeting native species for habitat and food, and adversely affecting the ecosystems on which fishing, aquaculture and tourism industries often depend. At the state level, aquatic pests are managed by Biosecurity SA through the *Fisheries Management Act 2007*.

### Marine pest species

South Australia's coastal waters are under increasing threat from a range of marine pest species as a result of increases in vessel traffic and climate change. Commercial shipping is one of the most commonly recognised carriers of marine pests. Recent research by Hewitt and Campbell (2010) suggests that vessel biofouling—where organisms attach to the outside of ships—has been a larger contributor (60%) to the translocation of marine pests than commercial shipping ballast water (24%) in Australia, based on those species examined in the study.

There are 20 introduced marine species that could be considered currently established in South Australia (Wiltshire et al. 2010). This number includes the naval shipworm *Teredo navalis*, which was confirmed in Port Lincoln by Biosecurity SA in 2011 after Wiltshire et al. (2010) could not list it as a confirmed report. An additional three species are likely to be present based on recent records.

The invasive seaweed *Caulerpa taxifolia* has declined in its range in the Port River since 2008. The West Lakes area remains clear after the 2003 eradication program and the secondary infestation in the North Haven marina in 2008 was effectively eradicated.

The European fanworm *Sabella spallanzanii* has increased its range after reaching Kangaroo Island and potentially other regions of the state in disturbed habitats.

### Freshwater pest species

Freshwater pest fish compete with native species for available food and habitat, predate on native species and affect water quality, with adverse impacts on entire ecosystems. There is very little information available on the distribution and extent of these species in South Australia.

Newer threats are directly related to the accidental or intentional release of exotic aquarium species. Species that are native to other drainage basins in Australia are also increasingly being released into South Australian waterways, with unknown biological repercussions.

Oriental weatherloach (*Misgurnus anguillicaudatus*) was detected for the first time in South Australia in 2011, when several fish were caught during survey work in the upper reaches of the Murray–Darling Basin. Release of any of these species, following capture, is illegal under the *Fisheries Management Act 2007*.

European carp (*Cyprinus carpio*) has extended its range to almost the whole of the Murray–Darling Basin. Carp can reduce water quality and damage aquatic habitats, and large-scale control is difficult (Koehn et al. 2000).

Speckled livebearer (*Phalloceros caudimaculatus*) was found in a four-kilometre stretch of Willunga Creek in 2008. This was the first record of this species in South Australia, and an eradication program was implemented. Following treatment of the area over 18 months, the population was eradicated and native galaxia species were reintroduced into the treated area.

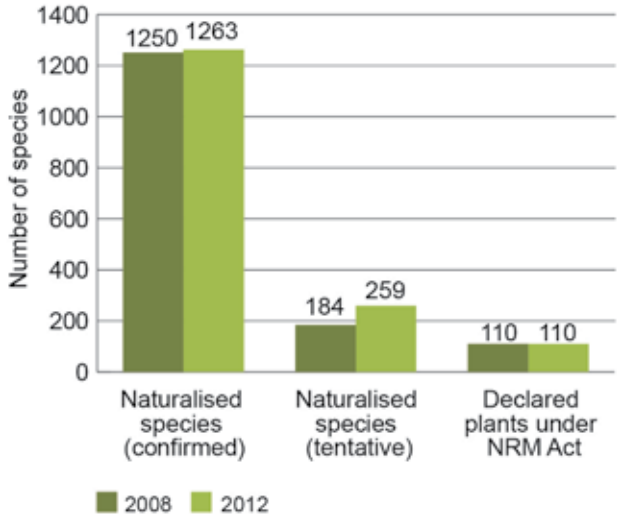
## 3.3.3 Weeds

Weeds are wild plants that require some form of management action to reduce their harmful effects on the economy, the environment, human health or amenity. In South Australia, the government's oversight role in managing weeds is primarily through the NRM Act, with regionally led programs by the NRM boards in the DEWNR, and state coordination through Biosecurity SA in PIRSA. The Australian Weeds Committee and the Australian Weeds Strategy provide national policy frameworks.

### Incursions

A plant that is introduced into an area and maintains itself without human help is considered naturalised and can become a weed. The recorded number of naturalised plant species in South Australia has increased since 2008 (Figure 8). The increase is indicative of the ongoing process of plants escaping from cultivation (e.g. ornamental plantings), but is also linked to increased government investment in field surveillance since 2009. The declaration of plants under the NRM Act provides a legal basis for containing the spread of serious weeds. Numbers of declared plants have not changed since 2008 (Figure 8). However, Biosecurity SA and regional NRM boards have been collaboratively reviewing state-level policies and plant declarations under the NRM Act, and the total number of declared plants is likely to increase pending the outcomes of this review.

The most serious incursion of a declared plant since 2008 was the sale of Mexican feathergrass (*Nassella tenuissima*) by several retailers. NRM boards undertook a traceback and destroy program to detect Mexican feathergrass plantings. In addition, a garden planting of serrated tussock (*Nassella trichotoma*) was detected and destroyed by the Adelaide and Mount Lofty Ranges NRM Board in 2010.




NRM Act = *Natural Resources Management Act 2004*

Figure 8 Changes in indicators for introduced plants, 2008 and 2012

### Established weeds

Weeds of National Significance (WoNS) are high-impact established weeds that have been formally endorsed by the Australian Government and state and territory governments as requiring nationally coordinated management, following a risk assessment process (Australian Weeds Committee 2012). Of the 32 WoNS, 11 are widely established in South Australia (African boxthorn, asparagus weeds, athel pine, blackberry, boneseed, brooms, Chilean needlegrass, opuntioid cacti, gorse, silverleaf nightshade and willows) and 10 are subject to surveillance and response programs (alligator weed, cabomba, mesquite, parkinsonia, parthenium weed, prickly acacia, sagittaria, salvinia, serrated tussock and water hyacinth). Full details on WoNS, including their impacts, biology, current distribution and management, are available at www.weeds.org.au/wons.

Bridal creeper (*Asparagus asparagoides*) is a vigorous South African vine that spread from gardens to invade bushland across much of southern South Australia. Rust and leafhopper biological controls are now widely established. However, a variant of the weed, termed Western Cape bridal creeper, has established in the South East and north-east Adelaide and is not susceptible to the biological controls.

Gorse (*Ulex europaeus*) is a spiny shrub that causes a problem in high-rainfall areas including the Mount Lofty Ranges, Clare Valley and the lower South East. The overall distribution of gorse is declining as a result of intensive control programs.

Wheel cactus (*Opuntia robusta*) and other opuntioid cacti (known generically as prickly pears) are spiny, succulent shrubs with the potential to spread widely across the state's extensive rangeland regions. They displace native vegetation and reduce pastoral productivity.

Silverleaf nightshade (*Solanum elaeagnifolium*) is a deep-rooted perennial weed of pasture and cropping land, present in all regions but most abundant in the Mid North, eastern Eyre Peninsula and upper South East region, where regular control programs are implemented. Its distribution is slowly increasing because of dispersal of seed by movements of livestock and fodder.

Besides WoNS, there are other established weeds in South Australia that have the potential to increase their range and impacts. A key example is buffel grass (*Cenchrus ciliaris*), a perennial tussock grass that has been planted in northern Australia for pasture production and dust control. In South Australia, it is now scattered across the northern pastoral zone, with extensive infestations in the far north-west (Biosecurity SA 2012). Buffel grass invasion poses a high risk to arid rangelands, forming dense monocultures that displace native plants and increase fire frequency.

Jumping cholla at Arkaroola Wilderness
Department of Primary Industries and Regions South Australia

### 3.3.4 Native plant and wildlife diseases

Exotic diseases have the potential to devastate populations of native plants and animals, as well as potentially impact agricultural crops, domestic animals and human health. An outbreak is likely to reduce the number of native plants and/or animals in a population, particularly if they are already stressed by other factors such as drought, habitat loss and climate change, with risks to the long-term survival of vulnerable populations and species.

*Phytophthora cinnamomi* is a water mould that is carried in soil and water and rots the roots of susceptible plants, causing eventual death of a wide variety of native plant species. *P. cinnamomi* has spread throughout the Mount Lofty Ranges and parts of Kangaroo Island, and is suspected to have spread to the lower Eyre Peninsula. It has recently been detected in the South Australian Arid Lands NRM region. There is no known method of eradicating *P. Cinnamomi* and controlling its spread relies on quarantining affected areas and adopting strong hygiene procedures.

Chytridiomycosis (caused by *Batrachochytrium dendrobatidis*) is a potentially fatal epidermal disease of amphibians (Berger et al. 2004), including the nationally vulnerable southern bell frog (Voros et al. 2012). The fungal disease emerged in Australia in the 1970s. It is believed to be widespread in Australia, although its prevalence in South Australia is largely unknown.

Sarcoptic mange is a skin disease that affects wombats. It is caused by a parasitic mite (*Sarcoptes scabiei* var. *wombati)* that burrows under the skin, resulting in intense itching, wounds, scabs and hair loss, and may eventually lead to liver and kidney damage and pneumonia. Wombats can die within two to three months of contracting the disease. In the Murraylands, 75% of the southern hairy-nosed wombat population is affected by the mite (Ruykys et al. 2009), and it also threatens the survival of some of the smaller wombat populations on the Yorke Peninsula (Taggart and Sparrow 2010).

# 4 What are we doing about it?

There are many organisations and individuals, as well as the three spheres of government (local, state and federal), that contribute to the protection and management of natural resources. The Government of South Australia, through its NRM Program, invests money through several subprograms. Table 8 describes some of the activities and outputs between 2008 and 2011.

Table 8 Number of activities and outputs delivered between 2008–09 and 2010–11, as reported in Natural Resource Management Program annual reports

| Activity | 2008–09 | 2009–10 | 2010–11 |
|---|---|---|---|
| Number of training or awareness-raising events | 213 | 159 | 436 |
| Number of awareness-raising materials developed | 135 | 148 | 251 |
| Area treated for sustainable land management | 260 750 ha | na | 3167 ha |
| New conservation agreements established | na | 453, covering 4130 ha | 141, covering 11 139 ha |
| New areas of native vegetation protected or improved | na | 10 500 ha | 44 852 ha |
| Extent of fencing | na | 104 km | 68 km |
| Area revegetated | na | 762 ha | 646 ha |
| New areas of native animal conservation measures | na | 3.1 million ha | 60 140 ha |
| Number of construction works to improve water quality completed | na | 10 | 27 |
| Number of cultural heritage sites protected or maintained | na | 8 | 1 |
| Number of studies/reports completed | 129 | 45 | 125 |
| Number of new monitoring programs established | 384 | 20 | 63 |
| Number of resource management plans/ strategies/guidelines completed | 65 | 106 | 81 |
| Number of volunteers and hours contributed | 9631 hours | 1227 volunteers, 31 140 hours | 2136 volunteers, 54 308 hours |

ha = hectare; km = kilometre; na = data not available

Table 9 shows the financial investment made in managing the state's natural resources. The Australian Government has made a large investment in South Australia through its Caring for our Country funding initiative; between 2008 and 2012, $17.5 million was allocated to fund 91 competitive projects. The eight NRM regions received $88.36 million (GST exclusive) in base-level funding, and an additional $18.7 million (GST exclusive) was allocated through Working on Country (a Caring for our Country subprogram).

The relative contribution made by individuals, groups, organisations and agencies, and a comparison of the value between different activities are complex and not reported here.

## Table 9 Funding allocated by the Government of South Australia, as reported in Natural Resource Management Program annual reports, 2008–09 to 2010–11

| Proponent | 2008–09[a] | | 2009–10 | | 2010–11 | |
|---|---|---|---|---|---|---|
| | No. of projects | Funding ($'000) | No. of projects | Funding ($'000) | No. of projects | Funding ($'000) |
| Adelaide and Mount Lofty Ranges NRM Board | 38 | 3 286 | 55 | 2 472 | 42 | 2 187 |
| Alinytjara Wilurara NRM Board | 2 | 20 | 7 | 1 043 | 2 | 850 |
| Eyre Peninsula NRM Board | 17 | 1 828 | 24 | 1 208 | 17 | 867 |
| Kangaroo Island NRM Board | 13 | 998 | 17 | 1 134 | 21 | 757 |
| Northern and Yorke NRM Board | 8 | 948 | 11 | 406 | 22 | 763 |
| South Australian Arid Lands NRM Board | 8 | 558 | 12 | 807 | 46 | 1696 |
| South Australian Murray–Darling Basin NRM Board | 46 | 1 802 | 41 | 1 328 | 9 | 389 |
| South East NRM Board | 16 | 1 088 | 11 | 1 223 | 14 | 592 |
| Other[b] | 35 | 7 674 | 27 | 6 379 | 13 | 4 500 |
| Total | 183 | 18 202 | 205 | 16 000 | 186 | 12 601 |

NRM = natural resource management

a Includes Australian Government funding

b Reported differently in different annual reports (combines state government agency, multiregion strategic projects and stormwater projects; does not include projects with no assessment process—for example, legislative review

Notes:

1. The 2008–09 figure combines the final year investment of the joint Natural Heritage Trust and National Action Plan for Salinity and Water Quality with South Australia's NRM Program investment; however, the 2009–10 and 2010–11 figures do not.
2. Other than 2008–09, the information does not include:
   - Australian Government Caring for our Country (CFOC) baseline funding, CFOC competitive grant funding, environmental stewardship, Community Action Grants, etc.
   - SA State Government Vegetation (and other small grant) funding
   - the contribution made by 'friends of' groups
   - the contribution and funding made by local government associations and environmental nongovernment organisations.

## 4.1 Native vegetation

At the state level, a range of legislation, policies, strategies and programs are being used to address pressures on native vegetation.

### 4.1.1 Native vegetation legislation

Native vegetation legislation has been in place since 1991 to provide a level of protection to what remains following historical clearance.

Under the *Native Vegetation Act 1991* and Native Vegetation Regulations 2003, authorised clearance of native vegetation in South Australia must be accompanied by an environmental benefit offset. This can be achieved through management or restoration of native vegetation (column 1) , or payment into the Native Vegetation Fund (column 2) (Table 10).

Table 10 Summary of environmental benefit offsets for native vegetation clearance, 2009–10 to 2011–12

| Year | Total benefit area (ha) | Financial offset ($) |
|---|---|---|
| 2009–10 | 320.24 | 39 804.59 |
| 2010–11 | 161.10 | 29 509.00 |
| 2011–12 | 2166.26 | 8 278.00 |

Source: Native Vegetation Council (2012)

The DEWNR is undertaking a review for the Native Vegetation Council of the way in which environmental benefit offsets are calculated. This is intended to improve consistency between methods used to determine offset requirements, and to ensure that payments made in place of an offset are equitable and realistically reflect the cost of restoration. This work is being done in conjunction with the Council of Australian Governments' national reform project on environmental offsets.

### 4.1.2 State government policy

The NRM Act provides regional NRM boards with powers and functions to integrate the administration of water, soil and land management, together with legislation for animal and plant control. The intent is to better integrate the management of all natural resources in the state.

A key goal of the 2012 State NRM Plan (DEWNR 2012b) is to improve the condition and resilience of the natural environment. This includes targets for native vegetation extent and condition. South Australia's Strategic Plan 2007 includes a target to 'lose no native species as a result of human impacts' (Government of South Australia 2011). The delivery of this target is supported by the strategy *No species loss—a nature conservation strategy for South Australia 2007–2017*, which aims to influence government, community and industry (DEH 2007).

### 4.1.3 Protected areas

In South Australia, protected areas are established under the NPW Act. In the 2008 state of the environment report, approximately 25 306 485 hectares of land, or 25.8% of the state, was under some form of protected status, an increase of 1% since 2003. In 2011, the total area increased to 27 906 210 hectares. The primary changes have been increases in the area of land classed as *Indigenous protected area* (an increase of 39.6% since 2008), *wilderness area* (an increase of 27.9%) and *native forests* (an increase of 35.6%) (Figure 9).

Public land conservation is managed by the DEWNR, and private land conservation is supported through heritage agreements under the Native Vegetation Act, sanctuaries under the NPW Act, and Indigenous protected areas under Commonwealth legislation. Forestry SA manages native forest reserves under the *Forestry Act 1950*.

### 4.1.4 Revegetation programs

Revegetation is a useful indicator of management response to the loss of native vegetation. Large-scale programs to restore native vegetation communities have been conducted over several decades in South Australia using state and national (e.g. Caring for our Country) funding.

Between 1999 and 2008, the total area of revegetation in South Australia fluctuated considerably, with a mean area revegetated of 12 876 hectares each year. Revegetation in 2008 was substantially lower than the average (50% less than the 2007 level) (Table 11). All revegetation activities decreased in 2008 from the previous year. The area of all revegetation activities (except forestry—softwood) was lowest in 2008.

Further investment in revegetation is occurring through new funding opportunities such as the Australian Government Biodiversity Fund. This has the potential to promote positive carbon and biodiversity benefits, but policymakers are aware that negative outcomes are possible. These potential 'bio-perversities' include clearing native vegetation to establish tree plantations, planting trees that become invasive taxa, and failing to anticipate how different groups of people respond to an environmental problem (Lindenmayer et al. 2012).

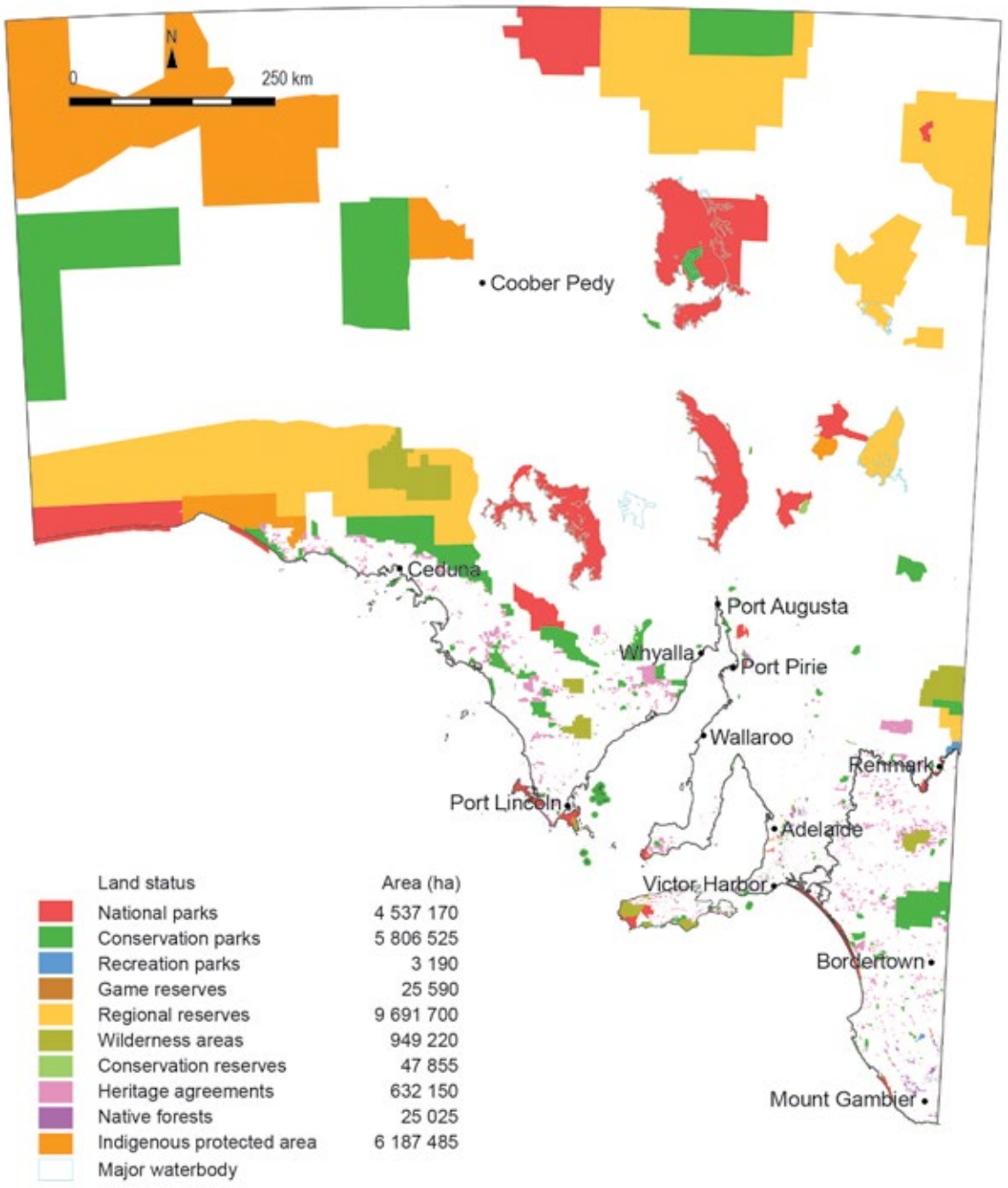



Figure 9 Protected areas in South Australia

Table 11 Area of South Australian revegetation activities (hectares), 1999–2008

| Type of vegetation | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Indigenous | 3 770 | 4 050 | 3 910 | 4 060 | 4 540 | 5 130 | 4 630 | 3 390 | 3 470 | 1 750 |
| Native (non-indigenous) | 1 050 | 380 | 790 | 330 | 100 | 190 | 920 | 230 | 80 | 180 |
| Native grasses | 10 | 20 | 40 | 60 | 20 | 30 | 30 | 50 | 20 | 10 |
| Farm forestry | 0 | 630 | 250 | 450 | 440 | 510 | 60 | 170 | 10 | 0 |
| Saltbush | 1 490 | 1 210 | 1 300 | 320 | 1 090 | 580 | 640 | 180 | 240 | 160 |
| Tagasaste | 570 | 210 | 70 | 10 | 50 | 10 | 10 | 0 | 0 | 0 |
| Product species | 10 | 50 | 10 | 100 | 30 | 70 | 30 | 10 | 0 | No data |
| Forestry—hardwood | 2 940 | 21 130 | 6 730 | 6 010 | 590 | 6 640 | 1 120 | 1 300 | 2 000 | 610 |
| Forestry—softwood | 3 050 | 2 940 | 90 | 890 | 560 | 590 | 4 430 | 3 810 | 5 180 | 4 030 |
| Total | 12 890 | 30 620 | 13 190 | 12 230 | 7 420 | 13 750 | 11 870 | 9 140 | 11 000 | 6 740 |

Source: DEWNR (2012)

### 4.1.5 Fire management policy and programs

The DEWNR fire management policy provides a framework for the management of fire on public and private lands. Since the 2009 Victorian bushfires and the subsequent Royal Commission, land management agencies have placed a stronger emphasis on planning and conducting prescribed burning to reduce fuel hazard levels. In 2010, the South Australian Government set a target to use prescribed burning for fuel reduction in 5% of high-risk public lands.

Between July 2008 and December 2011, 33 900 hectares were burnt in prescribed burning operations on land managed by the DEWNR, Forestry SA and SA Water. During the same period, 244 700 hectares were burnt by unplanned bushfires, including a small area of private land (DEWNR Fire Management Branch, pers. comm.).

The need to manage fire in a way that protects life and property and enhances biodiversity values, is well recognised in South Australia (*Fire and Emergency Services Act 2005*, DENR 2011a). If fire management of native vegetation is to provide ecologically sustainable outcomes for biodiversity conservation, management decisions need to be based on the best information available and need to look beyond an event-based management perspective to include a broader spatial and temporal view. Careful consideration of the different elements of fire regimes will therefore be needed when managing areas of native vegetation in South Australia. The DEWNR has a zoning policy that outlines the zoning used for fire management planning on DEWNR-managed lands (DENR 2011a). Zoning is derived from:

- the level of perceived risk to life, property and environmental assets, using the *Fire policy and procedure manual* (DENR 2011a)
- the overall fuel hazard, which is assessed using the *Overall fuel hazard guide for South Australia* (DENR 2011b) in accordance with the *Fire policy and procedure manual* (DENR 2011a)
- the activities considered appropriate to mitigate the threat that fire poses to life, property and environmental assets.

The management of fire to maintain or enhance biodiversity is therefore based on accumulating knowledge of flora and fauna species, populations and communities and their response to fire regimes, and then applying this knowledge to fire management practices to maximise biodiversity outcomes.

### 4.1.6 Native vegetation reform project

The Government of South Australia is undertaking a project to improve the integration of native vegetation in the land-use planning system. The outcome of the project will be the mapping of areas of high conservation value native vegetation as part of producing structure plans for priority urban growth areas.

### 4.1.7 Climate change policy and research

South Australia's adaptation framework, *Prospering in a changing climate: a climate change adaptation framework for South Australia* (Government of South Australia 2010), outlines South Australia's policy approach to climate change adaptation. This is complemented by *Tackling climate change: South Australia's Greenhouse Strategy 2007–2020* (Government of South Australia 2007b), *South Australia in a changing climate: blueprint for a sustainable future* (CCSA 2009) and *A regional climate change decision framework for natural resource management* (Bardsley and Sweeney 2008).

Management regimes need to increase the capacity of ecosystems to adapt to climate change, including by creating opportunities for plants and animals to migrate as climate change occurs through actions such as maintaining native vegetation corridors (DEH 2006).

The DEWNR is currently a partner in a number of research projects that focus on climate change. These include modelling flora species populations as part of an Adelaide University ARC Linkage project (Delean et al. 2011, Fordham et al. 2012), and participating in a project with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Government Department of Climate Change and Energy Efficiency (now the Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education) and the Future Farm Industries Cooperative Research Centre to improve carbon sequestration assessment methodologies and refine national carbon sequestration models (Hobbs et al. 2010).

## 4.2 Threatened species and ecological communities

Several conservation strategies are being used to try to slow, halt and, where possible, recover the decline in many of the state's threatened species, including:

- implementing local action plans to help protect individual populations of threatened species through feral animal management, weed management, fire management, assisted pollination and propagation
- implementing species recovery plans, with many activities carried out across the species' entire range
- collecting and storing seeds from a range of individuals in different threatened plant populations.

Table 12 summarises the numbers of state-listed threatened species for which one or more of these strategies is being employed. The table focuses only on those species listed in Schedules 7 and 8 of the NPW Act (*endangered* and *vulnerable*), as these are the priority species for immediate attention. The many other species listed in Schedule 9 (*rare*) often benefit from the activities undertaken to protect and improve the habitats and populations of endangered and vulnerable species. Figure 10 shows the percentage of threatened species that have current recovery plans.

Table 12 and Figure 10 demonstrate that investment has focused on the *critically endangered* and *endangered* species compared with those that are considered *vulnerable*. A proportion of the species for which no specific conservation activities are noted include oceanic seabirds, poorly known whale species and a few poorly known terrestrial species (e.g. night parrot).

For threatened ecological communities, recovery plans have been prepared for the buloke woodlands of the Riverina and Murray–Darling Depression bioregions, the community of native species that depend on natural discharge of groundwater from the Great Artesian Basin and iron grass natural temperate grassland of South Australia. Recovery plans are being prepared for peppermint box (*Eucalyptus odorata*) grassy woodlands of South Australia and for swamps of the Fleurieu Peninsula.

Systematic surveys underpin effective conservation actions for threatened species. One example is the surveys of freshwater fish habitats within the South Australian Murray–Darling Basin and the south-east of the state. Data collected over the past decade identified catastrophic declines in populations of several native fish species, such as the purple-spotted gudgeon, Yarra pygmy perch and Murray hardyhead. The loss of aquatic vegetation, and water-level declines due to drought and over extraction were identified as the causes. This information highlighted the need for emergency rescue action and resulted in the design of a captive breeding program. Different fish species were collected from the wild and bred in captive facilities, which included primary schools and farm dams. Activities to restore fish habitat were implemented and additional water was allocated in key sites. These management actions were undertaken by different organisations and groups until water levels

Table 12 Numbers of species for which conservation or recovery strategies are being employed, April 2012

| Taxonomic group | Presumed extinct in South Australia | Critically endangered | Endangered | Vulnerable | Total |
|---|---|---|---|---|---|
| Mammals (total species) | 26[a] | 3 (3) | 13 (18) | 10 (21) | 26 (42) |
| Birds (total species) | 8[b] | 1 (5) | 12(29) | 5 (32) | 18 (66) |
| Reptiles (total species) | 1[c] | 1 (1) | 2(7) | 0 (9) | 3 (17) |
| Amphibians (total species) | 0 | 0 | 0 | 1 (4) | 1 (4) |
| Vascular plants (total species) | 26 | 17 (20) | 62 (142) | 114 (196) | 193 (357) |

a Two mammal species previously considered extinct from South Australia—the burrowing bettong and the western barred bandicoot—are now well established at the Arid Recovery Reserve (Moseby et al. 2011)

b Mount Lofty Ranges spotted quail-thrush should now be presumed extinct given the time since last record and amount of searching undertaken (Garnett et al. 2011)

c Slater's skink has not been recorded in South Australia for many decades and should be listed as presumed extinct (Pavey 2004).

Note: Schedule 7 statistics have been divided into *presumed extinct*, *critically endangered* and *endangered* according to International Union for Conservation of Nature criteria (IUCN 2012b).

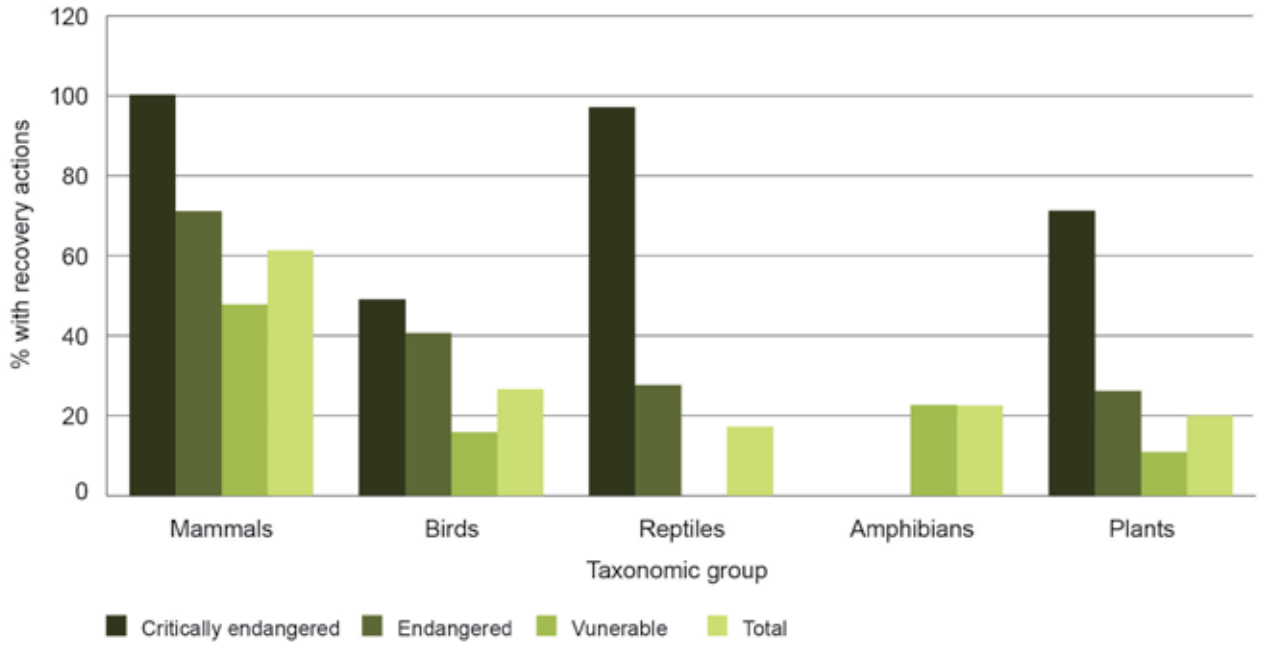



Figure 10 Percentage of state-listed threatened species in each threat category with recovery actions occurring, April 2012

increased and habitat was improved. Recovery plans for two threatened species are highlighted in Box 3.

Although it may not be feasible to manage all, or even most, threatened species and their various populations, the collection and long-term storage of seeds of threatened plant species is an important adjunct to the long-term conservation options for many plants. The State Seed Conservation Centre at the Adelaide Botanic Gardens has been accumulating such collections for more than a decade, originally based on a global project coordinated by the Royal Botanic Gardens at Kew in the United Kingdom. The seeds are carefully stored and occasionally checked for viability. The numbers of South Australian threatened species represented in these collections are summarised in Table 13.

## Box 3 Case studies: The most effective recovery plans depend on good science

### Australian sea lions

A good example of science informing effective management is the work undertaken on the Australian sea lion by researchers at the South Australian Research and Development Institute and collaborators over the past 20 years or more (Goldsworthy et al. 2010, 2011; Lowther et al. 2011). This research has shown that the large breeding colony of sea lions at Seal Bay is declining, and suggested that the same may be true for other colonies. It has also shown that sea lions drowning in nets used by the Southern and Eastern Scalefish and Shark Fishery is having an impact on the populations. As a consequence, the Australian Fisheries Management Authority has used relative numbers and proximity of sea lion colonies to establish an Australian sea lion management zone for this fishery. This level of management has recently detected bycatch levels that have triggered closures of some sectors of the fishery; over time, it is expected that fishers will adopt long lines in place of gill nets. These management protocols need to be maintained, and monitoring of breeding colonies continued, to determine when and if the colonies begin to recover.

### Red-tailed black cockatoos

Research has also guided recovery of feeding habitat for red-tailed black cockatoos in the south-east of South Australia. Research has shown that these cockatoos feed almost exclusively on the seeds of bulokes, desert stringybark and brown stingybark eucalypts (Koch 2003). It has also shown that the birds will often feed preferentially on isolated and small stands of stringybark trees because these trees have better seed crops than trees growing in larger clumps and in forest and woodland blocks. This information has demonstrated the importance that fence-line and paddock-corner plantings of stringybarks and bulokes can have for these birds. This is the basis for a project to restore these trees on farmland across their natural range in South Australia.

Adult female Australian sea lion and her pup at Lilliput Island, near Franklin Island

Dr Jane McKenzie

Table 13 Numbers of threatened plant species for which there are representative seed collections at the State Seed Conservation Centre, April 2012

| | Critically endangered | Endangered | Vulnerable | Rare | Total |
|---|---|---|---|---|---|
| Total number of threatened species | 20 | 142 | 196 | 431 | 789 |
| Seed bank and other actions | 17 | 62 | 114 | 256 | 449 |
| Seed bank only | 2 | 23 | 70 | 253 | 348 |
| Threatened plants with conservation activity if seed bank included (%) | 85 | 45 | 49 | 59 | 238 |

These seed collections also provide a basis for learning much more about seed biology for each species, including aspects of seed dormancy and how this may be broken, seed viability and longevity (what proportion of seed collected is actually fertile and how long it may remain viable in the soil), and seed tolerance to temperatures and climate change.

While focusing conservation effort on managing priority populations of threatened species, the DEWNR continues to reassess the status of plant and animal species across the state by leading a program of species status reviews for each NRM region, based on the Interim Biogeographic Regionalisation for Australia (IBRA) regions and subregions of Australia (see Section 2.1.1).

This process, involving state and local experts and interested individuals, has systematically been assessing regional status classifications of vascular plants and vertebrate animals using IUCN criteria, and assessing local population trends, to provide a detailed, ecosystem-related baseline from which state and national status assessments can be derived in the future. These reviews also assist in the identification of regional priority species, ecosystems and threats.

To date, regional assessments have been completed for the Eyre Peninsula, Northern and Yorke, South Australian Murray–Darling Basin and South East regions (see www.environment.sa.gov.au/managing-natural-resources/plants-and-animals/Threatened species ecological communities/Regional significant projects/Regional Species Conservation Assessment Project). Assessments have been completed for the South Australian Arid Lands NRM region and final reports are nearing completion. Assessments have commenced for both the Adelaide and Mount Lofty Ranges and Kangaroo Island regions.

## 4.3 Land management

The Government of South Australia has put into place programs to address various issues in land management and soil quality.

### 4.3.1 Soil erosion

Achieving the Strategic Plan target of increasing the area of cropping land protected from erosion requires an ongoing collaborative effort between the South Australian Government, regional groups, farming industry organisations, community groups and individual farming businesses.

A key achievement to date has been the inclusion of erosion protection targets and strategies in the NRM plans prepared by the Eyre Peninsula, Northern and Yorke, South Australian Murray–Darling Basin, and South East NRM boards. This reflects strong collaboration between the government and NRM boards in the grain farming zone. A range of community, industry and agency projects aimed at educating and informing landholders and encouraging best practice are driving the adoption of management practices to reduce the risk of soil erosion.

The DEWNR Sustainable Dryland Agriculture Initiative provides strategic and financial support for projects to implement the target. Partnership projects have been developed with farming industry organisations and the Eyre Peninsula, Northern and Yorke, and South Australian Murray–Darling Basin NRM boards. The industry collaborators include the Agricultural Bureau of South Australia, Agriculture Excellence Alliance, the South Australian No-Till Farmers Association and Mallee Sustainable Farming Inc. The projects focus on increasing the adoption of stubble retention and no-till practices, improving grazing management, and increasing communication between NRM staff and farming and industry groups.

The Australian Government's Clean Energy Future Plan includes initiatives that promote practices that complement the achievement of the target, such as reduced burning of crop residue and no-till practices. These practices also provide opportunities for farmers to manage carbon in their landscapes.

The Future Farming Industries Cooperative Research Centre (FFICRC) is evaluating and developing farming systems based on perennial plants in medium to low-rainfall areas. This will provide land managers with more options to protect the soil from erosion. The South Australian Government is one of the partners to the FFICRC through the DEWNR and the South Australian Research and Development Institute.

### 4.3.2 Soil acidity

The DEWNR, in partnership with industry groups and NRM boards, is developing and delivering programs to improve land managers' understanding and awareness of soil acidity, its causes and treatment options; retest previous monitoring sites; and test additional sites to assess the extent of surface and subsurface acidity.

### 4.3.3 Dryland salinity

The area in the state most severely affected by dryland salinity is the upper South East, with approximately 200 000 hectares affected. The Upper South East Dryland Salinity and Flood Management Program has established a drainage network that has reduced the risk of salinity over an estimated area of more than 100 000 hectares (Dooley et al. 2008). This is a reduction of 50% of land affected in the upper South East, or almost 30% of the state's dryland salinity–affected agricultural land.

Practical and profitable options for large-scale adoption of perennial plant systems and associated recharge reduction are being developed through the state government's partnership with the FFICRC.

The regional NRM boards' plans and investment strategies include salinity management. Programs to promote the management of dryland salinity through recharge reduction have been undertaken in all agricultural regions. Most projects have involved an integrated package of NRM and sustainable land management outcomes, including management of dryland salinity, soil erosion, water quality, and habitat and native vegetation.

Upper South East drain
Department of Environment, Water and Natural Resources

### 4.3.4 Soil carbon

A project conducted by the DEWNR and the CSIRO is assessing the influence of soil type, rainfall and farming system on the amount and nature of soil organic carbon. Increasing the clay content of sandy soils, through techniques such as clay spreading and delving, has the potential to dramatically improve the amount of carbon held in the soil. The DEWNR is also working with industry groups to gain a better understanding of how soil carbon can be improved to offset carbon dioxide emissions.

## 4.4 Pests and diseases

Pest and disease management is best achieved through partnerships between government, industry and community. Landholders have the prime responsibility for managing terrestrial pests, with government and industry (where applicable) providing support through research, provision of technical advice, regulation, education and coordination. The establishment of Biosecurity SA and the integration of NRM into the DEWNR aims to allow for a more efficient, collaborative and strategic approach to managing pests and diseases. Recent initiatives for managing pest species are described below.

### 4.4.1 Vertebrate pests

A number of pest vertebrate species are already established in South Australia and management strategies are under way.

#### Cane toads

Biosecurity SA has worked with transport industries, nurseries and other relevant organisations to raise awareness of the potential for human-assisted introduction of cane toads.

#### Rabbits

Large-scale, coordinated rabbit control programs have been conducted in the Eyre Peninsula, Northern and Yorke, South Australian Arid Lands, and South Australian Murray–Darling Basin NRM regions in recent years, funded by the NRM Program. Biosecurity SA is a partner in the Invasive Animals Cooperative Research Centre (IACRC), and is participating in research to improve the effectiveness of rabbit haemorrhagic disease and to identify prospective new biocontrol agents overseas.

#### Feral goats

The South Australian Arid Lands NRM Board has run 'Gammons Goats', a Caring for our Country–funded program of aerial culling in the Gammon and Flinders Ranges that focuses on areas associated with Bounceback, an ecological restoration program aimed at protecting and restoring the semi-arid environments of the Flinders and Gawler ranges and Olary Hills of South Australia. The South Australian Murray–Darling Basin NRM Board is running programs to control goats through fencing, shooting and trapping goats, and decommissioning water points. The Kangaroo Island NRM Board has eradicated feral goats from five of seven management units on the island, with only a few goats thought to be remaining in early 2012.

#### Feral deer

Feral deer control is a high-priority issue for the South East NRM Board. The board has implemented a five-year feral deer project (2008–13), with support from Caring for our Country, which involves aerial survey and culling. The Kangaroo Island NRM Board has a deer eradication program, also funded through Caring for our Country with technical assistance from the IACRC and Biosecurity SA. NRM boards across South Australia regularly inspect deer farms to ensure that they comply with fencing standards prescribed under the NRM Regulations.

#### Feral camels

Feral camel management is being implemented through the National Feral Camel Action Plan, primarily funded through the Caring for our Country Australian Feral Camel Management Project. In South Australia, complementary funding has also been provided via the NRM Program. South Australia is taking a strategic approach to feral camel management, with current removal activities focusing on aerial culling and mustering for slaughter to protect priority assets, plus capacity building of Aboriginal communities to self-manage the feral camel population in the long term.

Feral camels in the Simpson Desert
Department of Environment, Water and Natural Resources

### 4.4.2 Aquatic pests

Working under the *Fisheries Management Act 2007*, Biosecurity SA leads education, management and local eradication programs for aquatic pests within South Australia, often in collaboration with NRM boards and industry. Biosecurity SA regularly undertakes surveys and responds to incursion reports by the community and other stakeholders. It monitors areas where exotic species are known to be present, and supports and develops tools to stop the further spread of these species within the state. It is technically challenging to eradicate aquatic pests, and prevention methods to minimise the entry of exotic species and diseases is the most cost-effective management approach.

Nationally, the intergovernmental Vertebrate Pests Committee and its working group associated with pest fish management has developed a National Freshwater Pest Fish Strategy, which aims to develop a coordinated national approach to managing existing and new exotic freshwater species threats. Biological approaches to European carp control are 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 (Koehn et al. 2000). The IACRC is also investigating the potential for the koi herpes virus as a biological control agent for carp.

### 4.4.3 Weeds

Invasive garden plants remain a key source of new weed outbreaks. To address this, the South Australian Government has worked with the Nursery and Garden Industry Association of South Australia to produce the booklet *Grow me instead* for home gardeners. The review of declared plants (see section 3.3.3) is also likely to recommend declaration for sale of some key ornamental species that cause serious weed problems in certain parts of the state.

A number of weed species are already established in South Australia and management strategies are under way.

#### Bridal creeper

The Western Cape form of bridal creeper has now been extensively mapped in the South East, and the focus is on containing further spread and protecting high-value biodiversity assets. Western Cape bridal creeper in north-east Adelaide is being targeted for eradication by the Adelaide and Mount Lofty Ranges NRM Board.

#### Gorse

Isolated occurrences on Kangaroo Island, Eyre Peninsula, and in the South East and Mid North are the subject of long-term eradication programs under the National Gorse Strategic Plan. In the Adelaide and Mount Lofty Ranges region, grazing and forestry areas are protected from gorse infestations and gorse is managed in native vegetation in the region. Biological control using the gorse spider mite and the gorse thrips is reducing the weed's vigour. The University of Adelaide has investigated the phenomenon of the native parasitic plant *Cassytha pubescens* causing extensive dieback of gorse infestations.

#### Wheel cactus

A state-level strategy for opuntioid cacti was prepared and adopted by the Minister for Environment and Conservation in 2010. Opuntioid cacti were declared a WoNS in 2012, and Biosecurity SA is hosting a national WoNS coordinator for the weed. A national strategic plan proposes further development of chemical and biological control techniques and targeting of onground programs at outlier infestations and at key biodiversity assets threatened by opuntioid cacti.

#### Silverleaf nightshade

A state-level strategy for silverleaf nightshade was prepared and adopted by the minister in 2011. Currently, control programs administered by regional NRM boards concentrate on containment by eliminating small infestations and minimising the spread of seed ingested by stock. Silverleaf nightshade was declared a WoNS in 2012 and Biosecurity SA is hosting the national coordinator to develop and implement a national strategy for the weed.

#### Buffel grass

A workshop held in Port Augusta in September 2010 drafted a state operational plan that informed the development of the South Australia Buffel Grass Strategic Plan 2012–17, released in October 2012. The declaration of buffel grass under the NRM Act is being considered in the current review of plant declarations.

## 4.5 Overall direction for natural resources management

*Our place our future: state natural resources management plan, South Australia 2012–2017* provides overall direction for the management of South Australia's natural resources( Government of South Australia, 2012).

The plan includes 3 goals and 13 targets to guide the natural resources management effort (Table 14).

The NRM Council must audit, monitor and evaluate the state and condition of natural resources against these targets, the results of which should provide a valuable contribution of data for future state of the environment reporting.

### Table 14 Guiding targets for natural resources management

| |
|---|
| **Goal 1: People taking responsibility for natural resources and making informed decisions** |
| Target 1: Ensure people are better informed and improve capacity in NRM decision-making |
| Target 2: Involve more people in the sustainable management of natural resources |
| Target 3: Improve institutional and organisational capacity to support people to manage natural resources |
| Target 4: Improve capacity of individuals and community to respond to climate change |
| **Goal 2: Sustainable management and productive use of land, water, air and sea** |
| Target 5: All NRM planning and investment decisions take into account ecological, social and production considerations |
| Target 6: Maintain the productive capacity of our natural resources |
| **Goal 3: Improved condition and resilience of natural systems** |
| Target 7: Improve soil and land condition |
| Target 8: Increase extent and improve condition of native vegetation |
| Target 9: Improve condition of terrestrial aquatic ecosystems |
| Target 10: Improve condition of coastal and marine environments |
| Target 11: Increase understanding of the condition landscapes (geological and culturally important features) |
| Target 12: Improve the conservation status of species and ecological communities |
| Target 13: Limit the establishment of pests and diseases and reduce the impacts of existing pests |

Source: Government of South Australia (2012)

# 5 What can we expect?

While the Government of South Australia and its agencies are putting policies and programs in place to address the most pressing issues that are challenging biodiversity in South Australia, we will continue to see the effects of existing and past pressures for many years to come. Despite our efforts, many of the causes of biodiversity decline remain present. Some historical biodiversity loss may never be fully recovered, but it is possible to more effectively reduce future decline and to undertake focused restoration of important habitats to reduce further loss, degradation and fragmentation. This would require more effective responses to conventional threats such as invasive species and the unsustainable use and management of natural resources, as well as to more recent and emerging threats such as climate change. In addition, new pressures are emerging that will further challenge biodiversity and management practices.

## 5.1 Climate change

The 2011 Australian state of the environment report (State of the Environment 2011 Committee 2011) notes that climate change is likely to magnify the effects of existing pressures on biodiversity in coming decades. For example, the interactions of climate change with newly arrived pests and diseases has the potential to create pressures that are far stronger and more widespread than those currently experienced in Australia.

## 5.2 Alternative energy

The 2011 Australian state of the environment report identifies increased pressure from human energy needs such as land conversion for biofuels and carbon sequestration technologies like biochar as possible future challenges for biodiversity management (State of the Environment 2011 Committee 2011).

## 5.3 Information

It is widely recognised that there is not enough ongoing (especially long-term) monitoring information available in a form to support policy development and decision-making in relation to targeting, monitoring and evaluating investments in natural resources.

The South Australian Government is developing a regionally based NRM reporting framework that will allow state and regional natural resource managers to use the same information to make informed planning decisions. Decisions about where and how to invest will be improved by assessing the effectiveness of current and future investments against ecological, social and economic targets, and measures of the condition of natural resources.

The framework will ensure that information will be collected and used regionally, and the same information will then be aggregated to deliver credible, consistent and easily interpreted measures of natural resource health for the state. The framework will thereby underpin high-level investment in NRM programs and be used to regularly report on the state of the environment.

Key to this framework is the development of clearly articulated targets and indicators that are measurable and reflective of the condition of the natural resources. Without targets that can be measured, there is no way of comparing the cost-effectiveness of investments in different projects or management efforts. Information on these targets must be comparable: 1) across different times, 2) between different natural resources and 3) between different parts of the state. Only then can targets be used to guide when, and to what extent, to invest in the improvement of natural resources, and when to stop investing.

The success of the new approach will depend on an unprecedented level of whole-of-government cooperation and commitment, and on the long-term commitment of the South Australian Government.

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