

Technical information supporting the 2023 Terrestrial: Established invasive species abundance and distribution and Terrestrial: New incursions of invasive species environmental trend and condition report cards

Department for Environment and Water
August, 2023

DEW Technical note 2023/37



**Government
of South Australia**

Department for
Environment and Water

Department for Environment and Water
Government of South Australia
August 2023

81-95 Waymouth St, ADELAIDE SA 5000
Telephone +61 (8) 8463 6946
Facsimile +61 (8) 8463 6999
ABN 36702093234

www.environment.sa.gov.au

Disclaimer

The Department for Environment and Water and its employees do not warrant or make any representation regarding the use, or results of the use, of the information contained herein as regards to its correctness, accuracy, reliability, currency or otherwise. The Department for Environment and Water and its employees expressly disclaims all liability or responsibility to any person using the information or advice. Information contained in this document is correct at the time of writing.



With the exception of the Piping Shrike emblem, other material or devices protected by Aboriginal rights or a trademark, and subject to review by the Government of South Australia at all times, the content of this document is licensed under the Creative Commons Attribution 4.0 Licence. All other rights are reserved.

© Crown in right of the State of South Australia, through the Department for Environment and Water 2023

Preferred way to cite this publication

Department for Environment and Water (2023). *Technical information supporting the 2023 Terrestrial: Established invasive species abundance and distribution and Terrestrial: New incursions of invasive species environmental trend and condition report card*, DEW Technical report 2023/37, Government of South Australia, Department for Environment and Water, Adelaide.

Download this document at <https://data.environment.sa.gov.au>

Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present. We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country. We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

Acknowledgements

This document was prepared by Kate Fielder (Department of Primary Industries and Regions (PIRSA)) with input from PIRSA, regional landscape boards and the Department for Environment and Water (DEW). Lindell Andrews (PIRSA) provided principal oversight throughout and technical review of this report. Brady Stead and Ainsley Calladine (DEW) provided mapping support. Improvements were made to this report and associated report card based on reviews by Felicity Smith (DEW), Lindell Andrews, Brad Page and Nathan Rhodes (PIRSA).

Contents

Acknowledgement of Country	ii
Acknowledgements	ii
Summary	v
1 Introduction	1
1.1 Environmental trend and condition reporting in SA	1
1.2 Purpose and benefits of SA's trend and condition report cards	1
1.3 Invasive species in South Australia's terrestrial environments	2
2 Methods	4
2.1 Indicator	4
2.1.1 Established weeds and pest animals	4
2.1.2 Incursions of non-established invasive species	5
2.2 Data sources	6
2.2.1 Established weeds and pest animals	6
2.2.2 Incursions of non-established invasive species	6
2.3 Data analysis	7
2.3.1 Established weeds and pest animals	7
2.3.2 Incursions of non-established invasive species	7
2.4 Methods to assign trend, condition and reliability	8
2.4.1 Trend	8
2.4.2 Condition	8
2.4.3 Reliability	9
2.5 Data transparency	10
3 Results	11
3.1 Trend	11
3.1.1 Established weeds and pest animals	11
3.1.2 Incursions of non-established invasive species	11
3.2 Condition	17
3.2.1 Established weeds and pest animals	17
3.2.2 Incursions of non-established invasive species	17
3.3 Reliability	17
3.3.1 Notes on reliability	18
4 Discussion	19
4.1 Trend	19
4.1.1 Established weeds and pest animals	19
4.1.2 Incursions of non-established invasive species	19
4.2 Condition	20
4.2.1 Established weeds and pest animals	20

5	Appendices	21
A.	Managing environmental knowledge chart for Terrestrial: Established invasive species abundance and distribution (established invasive species)	21
B.	Managing environmental knowledge chart for Terrestrial: New incursions of invasive species (non-established invasive species)	22
6	References	23

List of figures

Figure 3.1	Trends in abundance and distribution (2018-2022) in key terrestrial species	12
Figure 3.2	Number of incursions through the State 2018-2022 with trendline	16

List of tables

Table 2.1	Key established invasive species that are addressed in the report	4
Table 2.2	Key non-established invasive species that are addressed in the report	5
Table 2.3	Definition of trend classes and score	7
Table 2.4	Definition of trend classes used	8
Table 2.5	Definition of condition classes used	9
Table 2.6	Guides for applying information currency	9
Table 2.7	Guides for applying information applicability	10
Table 2.8	Guides for applying spatial representation of information (sampling design)	10
Table 2.9	Guides for applying accuracy information	10
Table 3.1	State distribution and trend scores for key established invasive species	12
Table 3.2	Abundance scores (2018-2022) for key terrestrial species	14
Table 3.3	Number of incursions (2018-2022) for key terrestrial species	15
Table 3.4	Number of new incursions in South Australia 2018-2022	16
Table 3.5	Regional landscape board and Statewide condition	17
Table 3.6	Information reliability scores for terrestrial: abundance and distribution of established species and terrestrial: number of incursion trends	18

Summary

The 2023 release of South Australia's environmental trend and condition report cards summarises our understanding of the current condition of the South Australian environment, and how it is changing over time.

This document describes the indicators, information sources, analysis methods and results used to develop this report and the associated 2023 report cards:

- Terrestrial: Established invasive species abundance and distribution
- Terrestrial: New incursions of invasive species.

The reliability of information sources used in the report card is also described.

The report cards sit within the report card Biodiversity theme and Terrestrial sub-theme. Report cards are published by the Department for Environment and Water and can be accessed at www.environment.sa.gov.au.

1 Introduction

1.1 Environmental trend and condition reporting in SA

The Minister for Climate, Environment and Water under the *Landscape South Australia Act 2019* is required to 'monitor, evaluate and audit the state and condition of the State's natural resources, coasts and seas; and to report on the state and condition of the State's natural resources, coasts and seas' (9(1(a-b))). Environmental trend and condition report cards are produced as the primary means for the Minister to undertake this reporting. Trend and condition report cards are also a key input into the State of the Environment Report for South Australia, which must be prepared under the *Environment Protection Act 1993*. This Act states that the State of the Environment Report must:

- include an assessment of the condition of the major environmental resources of South Australia (112(3(a))), and
- include a specific assessment of the state of the River Murray, especially taking into account the Objectives for a Healthy River Murray under the *River Murray Act 2003* (112(3(ab))), and
- identify significant trends in environmental quality based on an analysis of indicators of environmental quality (112(3(b))).

1.2 Purpose and benefits of SA's trend and condition report cards

South Australia's environmental trend and condition report cards focus on the state's priority environmental assets and the pressures that impact on these assets. The report cards present information on trend, condition, and information reliability in a succinct visual summary.

The full suite of report cards captures patterns in trend and condition, generally at a state scale, and gives insight to changes in a particular asset over time. They also highlight gaps in our knowledge on priority assets that prevent us from assessing trend and condition and might impede our ability to make evidence-based decisions.

Although both trend and condition are considered important, the report cards give particular emphasis to trend. Trend shows how the environment has responded to past drivers, decisions, and actions, and is what we seek to influence through future decisions and actions.

The benefits of trend and condition report cards include to:

- provide insight into our environment by tracking its change over time
- interpret complex information in a simple and accessible format
- provide a transparent and open evidence base for decision-making
- provide consistent messages on the trend and condition of the environment in South Australia
- highlight critical knowledge gaps in our understanding of South Australia's environment
- support alignment of environmental reporting, ensuring we 'do once, use many times'.

Environmental trend and condition report cards are designed to align with and inform state of the environment reporting at both the South Australian and national level. The format, design and accessibility of the report cards has been reviewed and improved with each release.

1.3 Invasive species in South Australia's terrestrial environments

Invasive species are animals, plants, parasites or disease-causing organisms that have become or could become established outside their natural range and become pests (IUCN 2000). Some invasive species are already established in South Australia while others have the potential to establish. This technical report looks at the abundance and distribution of key invasive species that have established populations in terrestrial (land) environments of South Australia, and the number of new incursions of non-established species that could affect the terrestrial environments of South Australia.

Invasive species have an economic, environmental and social impact on agriculture, biodiversity, natural and built environments, public health and productivity (Bomford 2008). Invasive species can compete with crops, pasture, livestock and native plants and animals. They contribute to land degradation, reduce farm and forest productivity, contaminate crops and grains, increase bushfire fuel and can be toxic to people, livestock or native animals. Weeds and pest animals also impact cultural sites, for example, camels can foul and denude waterholes.

It has been reported that since 1960 invasive species have cost Australia about \$389.59 billion in impacts and management (Bradshaw et al. 2021). Whilst weeds were the most costly at the kingdom level (\$197.91 billion), mammals were the costliest (\$63.45 billion) at the class level (Bradshaw et al. 2021).

Monitoring and evaluating pests provides on-ground information to natural resource managers so they can respond appropriately to community, economic and environmental needs. In 2019 on average, 81% of land managers in Australia actively managed weeds, and 74% actively managed pest animals, costing an average of \$11,576 per annum per land manager (Stenekes & Kancans 2021).

In South Australia invasive species are governed under the *Landscape South Australia Act 2019* (the Act) and the *Landscape South Australia (General) Regulations 2020*. The associated List of Declared Animals and List of Declared Plants records what sections of the Act apply to the individual species listed. Under the Act, controlling invasive species is the responsibility of landholders. Landscape SA boards and other Government of South Australia departments oversee programs to support landholders to destroy or contain invasive species, and develop management policies to prevent new weeds and pest animals from coming into South Australia. Typically the management of weeds and pest animals is based on a risk assessment of their potential impact and spread, and the cost to contain the weed or pest animals. For example, if the species is widespread, management actions are focused to protect assets. If the species is localised or in small numbers, management actions focus on eradication of the species. The percentage of weed programs that met their objectives between 2012–2016 ranged between 53 and 57% (DEWNR 2017). Over the same period 63 to 100% of pest animals programs achieved their management objectives (DEWNR 2017).

There is an ongoing risk that new invasive species could form established populations in South Australia. Adequate prevention, incursion detection and eradication measures are required to prevent the establishment of invasive species that may have an adverse effect on the environment, primary production or the community in South Australia. Prevention, early detection and intervention are the most cost-effective investments in biosecurity.

The risk posed by introduced animals is categorised as extreme, serious, moderate, or low (Bomford 2008), depending on the risks posed to public safety, establishment in the wild and the potential to become a pest. When these animals are livestock, common pets, avicultural birds or other animals that are common in captivity, some of the strategies recommended in the national guidelines are not required for practical, economic and social reasons. Where an introduced animal has not been assessed, the precautionary approach is taken to categorise that animal as extreme (provisional), and management strategies are implemented. This report classifies the new incursions based on their threat categories.

This technical report will address some of the terrestrial declared plants and animals that are established in South Australia (see Table 2.1). Key species are selected by staff from DEW and Biosecurity (Department of Primary Industries and Resources (PIRSA)) based on current policies, regulations and the perception of existing or potential

impact as defined by risk assessments. The technical report will also identify terrestrial species that are not established but have had incursion reports in South Australia (see Table 2.2).

Invasive species in inland waters and in coastal and marine waters are discussed in separate technical reports:

- Inland waters: Established invasive species abundance and distribution and Inland waters: New incursions of invasive species environmental trend and condition report cards
- Coastal and marine: Established invasive species abundance and distribution and Coastal and marine: New incursions of invasive species environmental trend and condition report cards.

2 Methods

2.1 Indicator

2.1.1 Established weeds and pest animals

This technical report for established species focuses on established Weeds of National Significance in South Australia, established pest animals considered nationally significant by the Vertebrate Pest Committee (VPC) (National Land & Water Resources Audit and Invasive Animals Cooperative Research Centre 2008), camels and the house mouse (Table 2.1). Camels and the house mouse, although not included on the VPC assessment as one of the high priority species, were listed in the VPC report for future consideration (National Land & Water Resources Audit and Invasive Animals Cooperative Research Centre 2008) and were included in the report card because they impact a substantial area of South Australia.

The indicator used for established species in the Terrestrial: Established invasive species abundance and distribution report card is the abundance and distribution of those established invasive species in South Australia.

Table 2.1 Key established invasive species that are addressed in the report

Common name	Species name
African boxthorn	<i>Lycium ferocissimum</i>
asparagus weeds	Weeds in Genus <i>Asparagus</i>
athel pine	<i>Tamarix aphylla</i>
boneseed	<i>Chrysanthemoides monilifera</i>
bridal creeper	<i>Asparagus asparagoides</i>
broom	<i>Cytisus scoparius</i> , <i>Genista linifolia</i> , <i>G. monspessulana</i>
buffel grass	<i>Cenchrus pennisetiformis</i> , <i>C. ciliaris</i>
Chilean needle grass	<i>Nassella neesiana</i>
European blackberry	<i>Rubus fruticosus</i> ssp.
gorse	<i>Ulex europaeus</i>
opuntoid cacti	<i>Austrocylindropuntia</i> , <i>Cylindropuntia</i> & <i>Opuntia</i> genera, excluding <i>O. ficus-indica</i>
silverleaf nightshade	<i>Solanum elaeagnifolium</i>
willow	<i>Salix</i> ssp.
feral camel	<i>Camelus dromedarius</i>
feral cat	<i>Felis catus</i>
feral deer (all species)	<i>Cervus</i> , <i>Axis</i> and <i>Dama</i> ssp.
feral fox	<i>Vulpes vulpes</i>
feral goat	<i>Capra hircus</i>
feral pig	<i>Sus scrofa</i>
house mouse	<i>Mus musculus</i>
starling	<i>Sturnus vulgaris</i>
wild dog	<i>Canis familiaris</i>
wild rabbit	<i>Oryctolagus cuniculus</i>

2.1.2 Incursions of non-established invasive species

The technical report also focuses on the number of incursions of key species of concern to South Australia, reported between 2018–2022 (Table 2.2). These species are currently not established in South Australia.

The indicator used for non-established species in the Terrestrial: New incursions of invasive species report card is the number of incursions in South Australia based on reports to the National Pest Alert Hotline and the Biosecurity Invasive Species Unit. The number of new incursions was summed across regions. Records were considered separate incursions if they were by all reasonable assumptions a new report of a different individual. For example, reports of two male Alexandrine parrots were repeatedly recorded in Morphett Vale throughout 2022 and it is assumed that all reports were of the same two individuals.

Table 2.2 Key non-established invasive species that are addressed in the report

	Common name	Species name
Plants	African rue	<i>Peganum harmala</i>
	arrowhead	<i>Syngonium podophyllum</i>
	buffel grass	<i>Cenchrus ciliaris</i> , <i>C. pennisetiformis</i>
	Chilean needlegrass	<i>Nassella neesiana</i>
	Coolatai grass	<i>Hyparrhenia hirta</i>
	horsetail	<i>Equisetum</i> spp.
	khaki weed	<i>Alternanthera pungens</i>
	leafy elodea	<i>Egeria densa</i>
	Mexican feathergrass	<i>Nassella tenuissima</i>
	red dodder	<i>Cuscuta planiflora</i>
	serrated tussock	<i>Nassella trichotoma</i>
	Texas needlegrass	<i>Nassella leucotricha</i>
Amphibia	Asian black spined toad	<i>Duttaphrynus melanostictus</i>
	cane toad	<i>Rhinella marina</i>
	Red-eared slider	<i>Trachemys scripta elegans</i>
Aves	Alexandrine parrot	<i>Psittacula eupatria</i>
	Canada goose	<i>Branta canadensis</i>
	common myna	<i>Acridotheres tristis</i>
	conure species	<i>Pyrrhura species</i>
	monk parakeet	<i>Myiopsitta monachus</i>
	Eurasian skylark	<i>Alauda arvensis</i>
	golden pheasant	<i>Chrysolophus pictus</i>
	gunieafowl	<i>Numida meleagris</i>
	Indian ringneck	<i>Psittacula krameri</i>
	macaw species	<i>Ara</i> spp.
	ostrich	<i>Struthio camelus</i>
	peafowl	<i>Pavo species</i>
	red-whiskered bulbul	<i>Pycnonotus jocosus</i>
Mammalia	blackbuck	<i>Antilope cervicapra</i>
	red panda	<i>Ailurus fulgens</i>

Reptilia	common house gecko	<i>Hemidactylus frenatus</i>
	common tree frog	<i>Polypedates leucomystax</i>
	corn snake	<i>Pantherophis guttatus</i>
	oriental garden lizard	<i>Calotes versicolor</i>
	paradise flying snake	<i>Chrysopelea paradisi</i>
	tokay gecko	<i>Gekko gecko</i>

2.2 Data sources

2.2.1 Established weeds and pest animals

Records of established invasive species were sourced from the Biological Database of South Australia (BDBSA) and the State Herbarium of South Australia for each of the landscape regions. Additional distribution data from PIRSA Biosecurity were used to supplement the BDBSA data for invasive fauna species. The BDBSA is a central collection point for all biological data in South Australia. It obtains its records from many sources including key partners such as:

- SA Museum
- conservation organisations
- private consultancy companies
- Birds SA
- Birdlife Australia
- Australasian Wader Study Group.

Occurrence data between 2000 and 2020 for each key invasive species were mapped using the PIRSA Biosecurity data, and to calculate distributions for each landscape region (**Error! Reference source not found.**1). Information on the change in abundance and distribution of key invasive species was derived from an expert elicitation process of landscape board regional staff based on 5 years of observations. South Australia's landscape regions include:

- Alinytjara Wilurara
- Eyre Peninsula
- Green Adelaide
- Hills and Fleurieu
- Kangaroo Island
- Limestone Coast
- Murraylands and Riverland
- Northern and Yorke
- SA Arid Lands.

2.2.2 Incursions of non-established invasive species

Incursion records from 2018–2022 (inclusive) were sourced from PIRSA Biosecurity. These records were gathered from public reports and government staff either directly associated with the Invasive Species Unit or through the National Pest Alert Hotline.

2.3 Data analysis

2.3.1 Established weeds and pest animals

Species' distribution was calculated using data from the BDBSA and the State Herbarium of South Australia. Point records (latitude and longitude) from the BDBSA for each weed and pest animal from 2000–2022 were projected to a 10 by 10 kilometre grid. The percentage of the state and landscape region where each weed and pest animal have been recorded was calculated with ArcGIS and graphed using Microsoft Excel. While these data can be used to indicate distribution, there are major limitations as this method cannot account for annual changes in abundance or distribution.

Condition of the environment due to the impacts of weeds and pest animals and the trends in abundance and distribution of weeds and pest animals were obtained by surveying regional staff with expert field knowledge. A series of questions was provided to regional staff, typically the people in charge of invasive species management and compliance or landscape ecology; regional data from previous surveys were also provided for reference. The survey required respondents to assign trend and abundance categories for each species, a condition score for the entire landscape region, and to select a method for the data source (e.g. project scale, systematic). For example, for each of the key weeds and pest animals in the region, survey respondents were asked to allocate a trend category for the last five years (2018–2022) based on the change in the abundance and distribution per landscape region. These trend categories and the scores they represent are outlined in Table 2.3.

Table 2.3 Definition of trend categories and score

Trend category	Score
Major increase in abundance and/or spreading	2
Moderate increase in abundance and/or spreading	1
No change/stable	0
Moderate decrease in abundance and/or receding	-1
Major decrease in abundance and/or receding	-2
Effectively eradicated	-
Not applicable	-
Not present	-
Unknown	-

Survey responses were often guided by on-ground works in the region, work plans with landholders, field inspections, surveys and monitoring. Evidence tends to be ad-hoc and therefore has low reliability at the regional or state spatial scale.

State trends for each species were calculated using the median value reported for each species at the landscape region level. The median value of the state trends for each species was used to determine the statewide trend class.

The survey also asked respondents to score the current condition of the landscape region as a whole. The median value of the regional condition scores was used to calculate the statewide condition score.

2.3.2 Incursions of non-established invasive species

The total number of incursions reported from 2018–2022 was graphed. Due to the limited data, the trend is unknown.

2.4 Methods to assign trend, condition and reliability

2.4.1 Trend

Definitions of the trend classes assessed at a statewide level for key established invasive species, and for South Australia overall, are described in Table 2.4.

Table 2.4 Definition of trend classes used

Trend	Description	Threshold
Getting better	Over a scale relevant to tracking change in the indicator it is improving in status with good confidence	Median score is -0.5 or less
Stable	Over a scale relevant to tracking change in the indicator it is neither improving or declining in status	Median score is -0.4 – 0.4
Getting worse	Over a scale relevant to tracking change in the indicator it is declining in status with good confidence	Median score is 0.5 or more
Unknown	Data are not available, or are not available at relevant temporal scales, to determine any trend in the status of this resource	More than half records in calculation are unknown
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above trend classes	

2.4.2 Condition

Condition class is a single state-level statement of condition that has been derived from the *Landscape South Australia Act 2019* and relates to weeds and pest animals affecting the land environment (**Error! Reference source not found.**).

Table 2.5 Definition of condition classes used

Condition	Description	Threshold
Very good	The natural resource is in a state that meets all environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for all processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought)	N/A
Good	The natural resource is in a state that meets most environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for only some processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought)	N/A
Fair	The natural resource is in a state that does not meet some environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from many processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought)	N/A
Poor	The natural resource is in a state that does not meet most environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from most processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought)	N/A
Unknown	Data are not available to determine the state of this natural resource, based on this indicator	-
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above condition classes	-

2.4.3 Reliability

Information is scored for reliability based on the minimum of subjective scores (1 [worst] to 5 [best]) given for information currency, applicability, level of spatial representation and accuracy. Definitions guiding the application of these scores are provided in Table 2. for currency,

Table 2. for applicability, Table 2. for spatial representation and Table 2. for accuracy.

Table 2.6 Guides for applying information currency

Currency score	Criteria
1	Most recent information > 10 years old
2	Most recent information up to 10 years old
3	Most recent information up to 7 years old
4	Most recent information up to 5 years old
5	Most recent information up to 3 years old

Table 2.7 Guides for applying information applicability

Applicability score	Criteria
1	Data are based on expert opinion of the measure
2	All data based on indirect indicators of the measure
3	Most data based on indirect indicators of the measure
4	Most data based on direct indicators of the measure
5	All data based on direct indicators of the measure

Table 2.8 Guides for applying spatial representation of information (sampling design)

Spatial score	Criteria
1	From an area that represents less than 5% the spatial distribution of the asset within the region/state or spatial representation unknown
2	From an area that represents less than 25% the spatial distribution of the asset within the region/state
3	From an area that represents less than half the spatial distribution of the asset within the region/state
4	From across the whole region/state (or whole distribution of asset within the region/state) using a sampling design that is not stratified
5	From across the whole region/state (or whole distribution of asset within the region/state) using a stratified sampling design

Table 2.9 Guides for applying accuracy information

Reliability	Criteria
1	Better than could be expected by chance
2	> 60% better than could be expected by chance
3	> 70 % better than could be expected by chance
4	> 80 % better than could be expected by chance
5	> 90 % better than could be expected by chance

2.5 Data transparency

Data transparency for this technical report is represented in Appendix A and Appendix B.

3 Results

3.1 Trend

3.1.1 Established weeds and pest animals

Overall at the state level, abundance and distribution of key terrestrial established weeds and pest animals were stable (Table 3.1 and Figure 3.1) between 2018–22. Regional data are highly varied for the abundance of Weeds of National Significance (Table 3.2). For example buffel grass is moderately increasing in Alinytjara Wilurara, Eyre Peninsula, Northern and Yorke and SA Arid Lands but is moderately decreasing in Murraylands and Riverland, and Green Adelaide, and there is a major decrease in Limestone Coast.

Of the Weeds of National Significance that were assessed, 92% (n=12) were stable and 8% (n=1, Chilean needlegrass) were getting better. All other species of weeds were reported as stable.

Of the pest animals that were assessed 80% (n=8) were stable, 10% (n=1; feral deer) were getting worse, and 10% (n=1; starlings) were unknown. All other species were reported as stable. At a regional level, feral deer was the only species that scored any level of increase in all but one of the landscape regions where they are known to exist (Table 3.2).

The distribution of pest animals is regarded as stable if they have already spread to their environmental (climate, landscape, and habitat) limits, e.g. feral cats, feral foxes and wild rabbits. There are no weeds addressed in this technical report that have spread to their environmental limits.

3.1.2 Incursions of non-established invasive species

The statewide trend in the number of terrestrial new incursions from 2018–2022 is unknown (Table 3.3, Table 3.4, Figure 3.2). Whilst the numbers of reported incursions in 2022 are lower than reported in 2018 this number has been slowly increasing since 2019. In the reporting period, the three highest years of incursion reports were influenced by high numbers of incursion reports for birds. However, there is insufficient data to determine a trend in the number of new incursions of terrestrial invasives species.

Table 3.1 State distribution and trend scores for key terrestrial established invasive species in South Australia

Established weeds and pest animals		Distribution (%) of State (2000–2022)	Trend 2018–22
weeds	African boxthorn	6.29	Stable
	asparagus weeds	6.02	Stable
	athel pine	2.22	Stable
	boneseed	1.61	Stable
	bridal creeper	6.01	Stable
	broom (all species)	1.00	Stable
	buffel grass	6.00	Stable
	Chilean needle grass	0.10	Getting better
	European blackberry	1.56	Stable
	gorse	1.04	Stable
	opuntoid cacti	3.03	Stable
	silverleaf nightshade	1.28	Stable
	willow (all species)	0.48	Stable
pest animals	feral camel	69.46	Stable
	feral cat	99.94	Stable
	feral deer (all species)	2.95	Getting worse
	feral fox	99.52	Stable
	feral goat	33.25	Stable
	feral pig	8.82	Stable
	house mouse	7.29	Stable
	starling	19.60	Unknown
	wild dog*	22.17*	Stable
	wild rabbit	99.53	Stable
Statewide trend			Stable

*Wild dogs are not a declared species north of the dog fence.

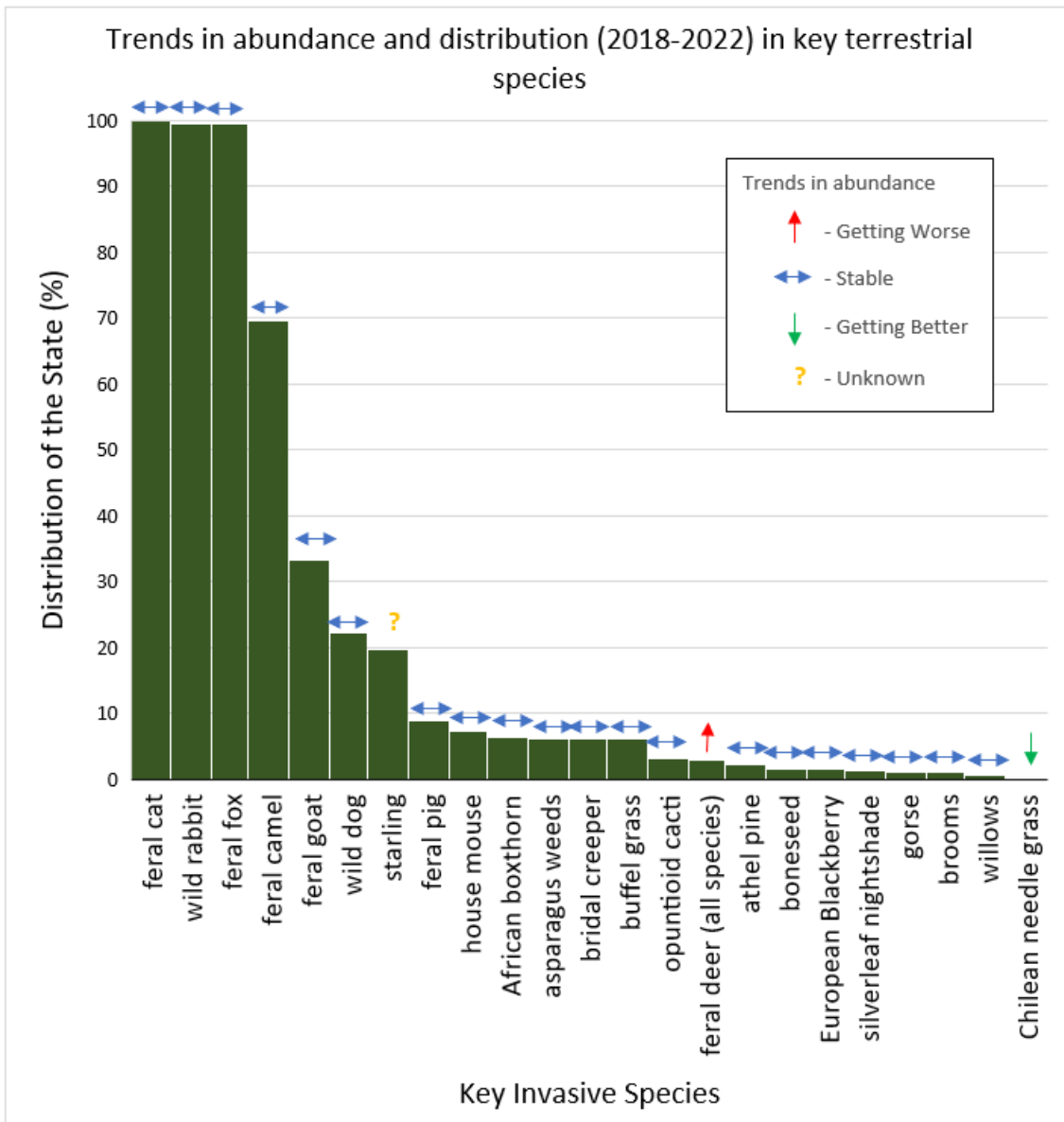


Figure 3.1 Trends in abundance and distribution (2018–2022) in key terrestrial established invasive species in South Australia

Table 3.1 Abundance scores (2018–2022) for key terrestrial established invasive species in South Australia (see Table 2.3 for score definitions)

Established weeds and pest animals	Hills & Fleurieu	Alinytjara Wilurara	Eyre Peninsula	Kangaroo Island	Northern and Yorke	SA Arid Lands	Murraylands & Riverlands	Limestone Coast	Green Adelaide
Weeds									
African boxthorn	Unknown	0	0	0	0	0	0	-1	0
asparagus weed	1	Unknown	0	-1	0	Not present	0	0	-1
athel pine	0	0	Not present	0	0	0	-1	Unknown	0
boneseed	1	0	-1	Not present	-1	0	0	1	0
bridal creeper	1	Not present	0	-1	1	Not present	1	0	0
broom (all species)	1	Unknown	Effectively eradicated	-2	0	Not present	0	0	Unknown
buffel grass	Effectively eradicated	1	1	Not present	1	1	-1	-2	-1
Chilean needle grass	0	Not present	Not present	Not present	Not present	Not present	Not present	Not present	-1
European blackberry	0	Not present	0	-2	0	Not present	0	0	1
gorse	0	Not present	0	0	0	Not present	0	-2	0
opuntoid cacti	0	0	0	Not present	-1	-1	0	0	0
silverleaf nightshade	0	0	1	-1	1	Unknown	0	0	-1
willow (all species)	0	Not present	0	0	0	Not present	0	0	0
Established pest animals									
feral camel	Not present	1	0	Not present	Not present	1	Not present	Not present	Not present
feral cat	Unknown	0	0	-1	0	0	Unknown	2	0
feral deer (all species)	1	Not present	1	Not present	1	0	1	2	1
feral fox	1	0	0	Not present	0	0	0	1	0
feral goat	-1	Not present	1	Not present	1	0	1	0	1
feral pig	Not present	Unknown	0	-2	0	1	0	1	-1
house mouse	0	0	0	0	0	0	Unknown	Unknown	0
starling	Unknown	Unknown	1	Unknown	Unknown	Unknown	Unknown	1	Unknown
wild dog	Not present	Not applicable	1	Not present	0	-1	0	0	Not present
wild rabbit	1	0	0	Not present	0	0	0	1	1

Table 3.2 Number of new incursions (2018–2022) of key terrestrial non-established invasive species in South Australia

Non-established weeds and pest animals		2018	2019	2020	2021	2022
weeds	African Rue					2
	arrowhead			1		
	buffel grass				1	1
	Chilean needlegrass			2	1	1
	coolatai grass			2	2	2
	heath speargrass	1				
	horsetail		3			
	khaki weed	2		3	3	1
	leafy elodea	1				
	Mexican feathergrass	1	2	2	2	
	red dodder			1		
	serrated tussock	1	1			
	Texas needlegrass			1		
	Amphibia	Asian black spined toad	1		1	
cane toad		1	3	3		2
red-eared slider		3				1
Aves	Alexandrine parrot	2	3	1	12	11
	Canada goose					2
	common myna		1	1	2	
	conure species				1	
	Eurasian skylark		1			
	golden pheasant				1	
	guineafowl	15				
	Indian ringneck	13	1	3	8	13
	macaw species				1	
	monk parakeet				1	
	ostrich	1	1			
	peafowl	1				
	red whiskered bulbul	11				
Mammalia	blackbuck			1		
	red panda (*zoo escapee)					1
Reptilia	common house gecko					
	common tree frog					1
	corn snake			1		
	oriental garden lizard					3
	paradise flying snake				1	
tokay gecko				1		
Total		54	16	23	37	41

Table 3.3 Summary of number of new incursions (2018–2022) of key terrestrial non-established invasive species in South Australia

	2018	2019	2020	2021	2022
Birds	43	7	5	26	26
Amphibian	5	3	4	2	4
Reptile	0	0	1	0	3
Mammals	0	0	1	0	1
Weeds	6	6	12	9	7
Total	54	16	23	37	41

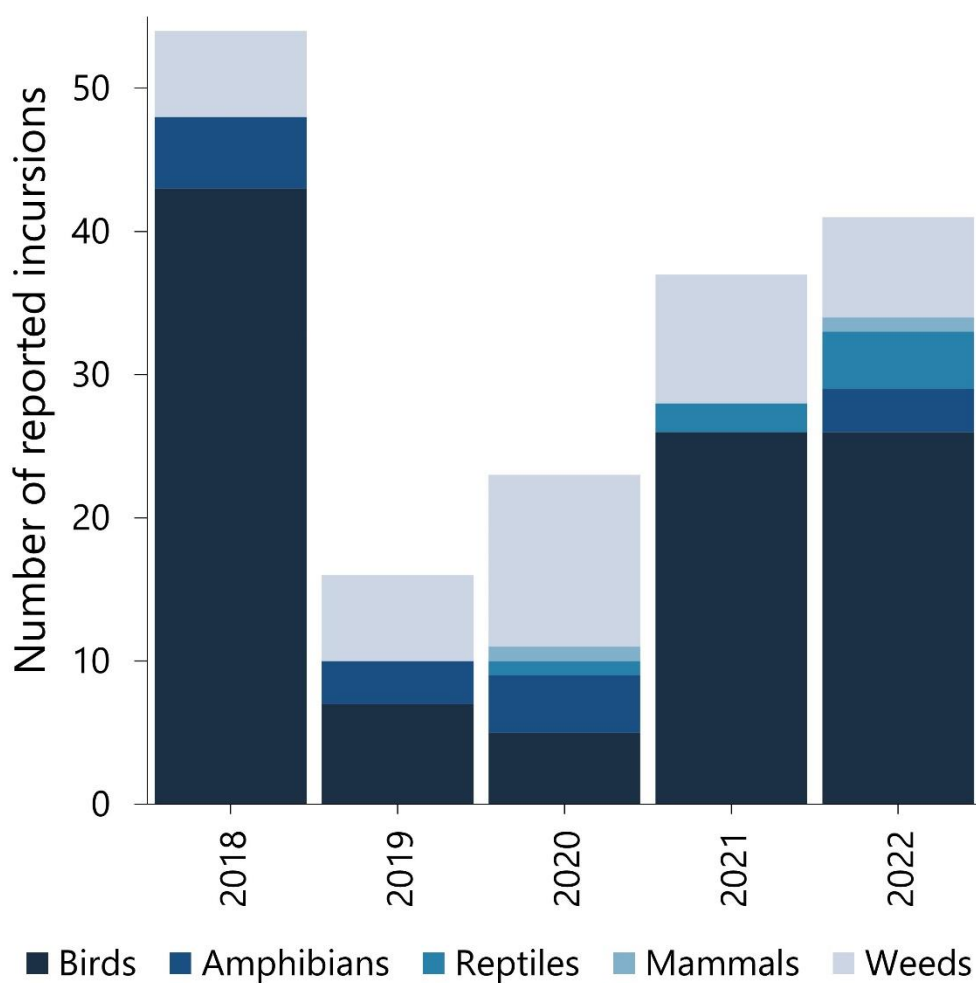


Figure 3.2 Number of new incursions (2018–2022) of non-established invasive species in South Australia

3.2 Condition

3.2.1 Established weeds and pest animals

The current statewide condition of established terrestrial invasive species in South Australia has been classed as fair. Rabbits have the ability to halt vegetative growth, wild dogs can kill livestock, foxes kill native animals and invasive herbivores can reduce pastures, crops and compete with native herbivores. Despite this, invasive species are deemed to have a moderate impact on the environmental, social and economic expectations of our natural resources. The degree of impact varies depending on the species, environment and land use and management.

Five out of the nine regional landscape boards listed their region as having a fair condition (Table 3.5). Kangaroo Island Landscape Board was the only board to list its condition as poor and this score was based on disease prevalence surveillance programs associated with feral cats. The Hills and Fleurieu, Alinytjara Wilurara and Eyre Peninsula landscape boards listed their regions as having good condition.

Table 3.5 Landscape region and statewide condition

Landscape region	Condition
Alinytjara Wilurara	Good
Eyre Peninsula	Good
Green Adelaide	Fair
Hills and Fleurieu	Good
Kangaroo Island	Poor
Limestone Coast	Fair
Murraylands and Riverlands	Fair
Northern and Yorke	Fair
SA Arid Lands	Fair
Statewide condition	Fair

3.2.2 Incursions of non-established invasive species

A condition score was unknown for the number of terrestrial new incursions of non-established invasive species. There has been no research undertaken to determine how these individual incursions affect the condition of the environment.

3.3 Reliability

The overall reliability score for the *Terrestrial: Established invasive species abundance and distribution environmental trend and condition report card* is 1 out of 5 based on Table 3.6. This is considered to be 'Poor' reliability.

The overall reliability score for the *Terrestrial: New incursions of invasive species (non-established) environmental trend and condition report card* is 2 out of 5 based on Table 3.6. This is considered to be 'Fair' reliability.

Table 3.6 Information reliability scores for terrestrial: Established invasive species abundance and distribution (established) and terrestrial: New incursions of invasive species (non-established) report cards

Indicator	Currency	Applicability	Spatial	Accuracy	Reliability
Terrestrial: Established invasive species abundance and distribution	1	1	4	1	1
Terrestrial: New incursions of invasive species (non-established)	5	2	4	2	2

3.3.1 Notes on reliability

For the *Terrestrial: Established invasive species abundance and distribution (established)* report card: A score of 1 was given for applicability as the data for abundance and distribution were based on expert opinion. A score of 1 was given to currency as most of the distribution data are more than 10 years old. A score of 4 was given for spatial as the data are collected from the whole state but not with specific sampling, and a score of 1 was given for accuracy as the data provided is better than expected by chance.. Evidence tends to be ad-hoc and therefore has low reliability at the regional or state spatial scale.

For the *Terrestrial: New incursions of invasive species (non-established)* report card: A score of 2 was given for applicability as the incursion data are reliant on incidental sightings and follow up reporting. A score of 5 was given to currency as most of the incursion data are less than 5 years old. A score of 4 was given for spatial as the data are collected from the whole state but the sampling design is not stratified, and a score of 2 was given for accuracy because reporting is reliant on people, including members of the public, sighting and reporting the incursions.

4 Discussion

4.1 Trend

4.1.1 Established weeds and pest animals

The trend in the overall abundance and distribution of established invasive species across South Australia was determined to be stable.

Most of the data collected for established invasive species are from on-ground control activities and are captured in an adhoc manner. This is because control is generally better resourced than monitoring. For example, reports of particular weeds in an area may be the result of management actions by land managers in those areas. Where control efforts are minimal and a species is common, little reporting is undertaken. For example, the house mouse is common and widely distributed through South Australia (based on informal reports), but based on official reporting only occupy 7.29% of the state (as presented in this technical report). The ad-hoc reporting allows for somewhat accurate distribution mapping for some species over a long period, but is not reliable enough to assess annual changes in a species' abundance or distribution across its entire range.

At times there are dedicated monitoring efforts, although these tend to be limited to local scales in line with specific projects. For example, a program to eradicate feral pigs from Kangaroo Island has implemented a suite of monitoring techniques including cameras, aerial survey and culling, and environmental DNA (eDNA). The data generated by targeted and resourced programs will always be better than data from ad-hoc sources. Therefore regional information may not represent the region as a whole, but rather specific target areas or species.

Feral deer were the only pest animal listed for which the trend in abundance was assessed as getting worse on a statewide scale (Figure 3.1). Feral deer were reported as getting worse in 6 of the 7 landscape regions where they are present, and were considered stable in the other landscape region (Table 3.1.2). Feral deer are recognised as one of Australia's worst emerging pest animals. In South Australia, an independent economic analysis (BDO EconSearch 2022) has highlighted the impacts of feral deer. Research data collated for the economic analysis has contributed to the trend data for each of the landscape regions and represents the most up to date information. While feral deer are the only pest animal recorded as getting worse, this could be because it is the only species for which recent statewide research on abundance and distribution has been undertaken.

4.1.2 Incursions of non-established invasive species

Insufficient information is available for the period from 2018 to 2022 to determine a trend in the number of new incursions of terrestrial invasive species. Fluctuations observed year to year for pest animal incursions can be largely explained through targeted campaigns. For example, red-whiskered bulbuls were detected in the Adelaide Hills in 2018 and it was presumed that they had been captive birds that were released or escaped. This instigated a media campaign to report any bulbuls seen or known to occur, resulting in increased reports and a subsequent seizure. Similarly in 2021 and 2022 a pair of Alexandrine parrots successfully bred in the wild leading to a targeted campaign to find the birds. This resulted in an increase in calls about Indian ringnecks and Alexandrine parrots. The increase in the number of incursions since 2019 could be a result of these campaigns or incursions numbers may be increasing.

Reports of weed incursions are not as reliable as those reported for pest animals. Whilst a reporter can identify how many individual animals have been observed and each individual counted as an incursion, the extent of one weed incursion is harder to determine. Grasses are usually reported by the size of the area they are occupying. Other weeds are counted as individual plants, but in situations where they are occupying an area in dense

concentrations are recorded by area. Each incursion report for a weed, whether it is one plant, multiple plants or occupying a large area, is only considered as one incursion.

4.2 Condition

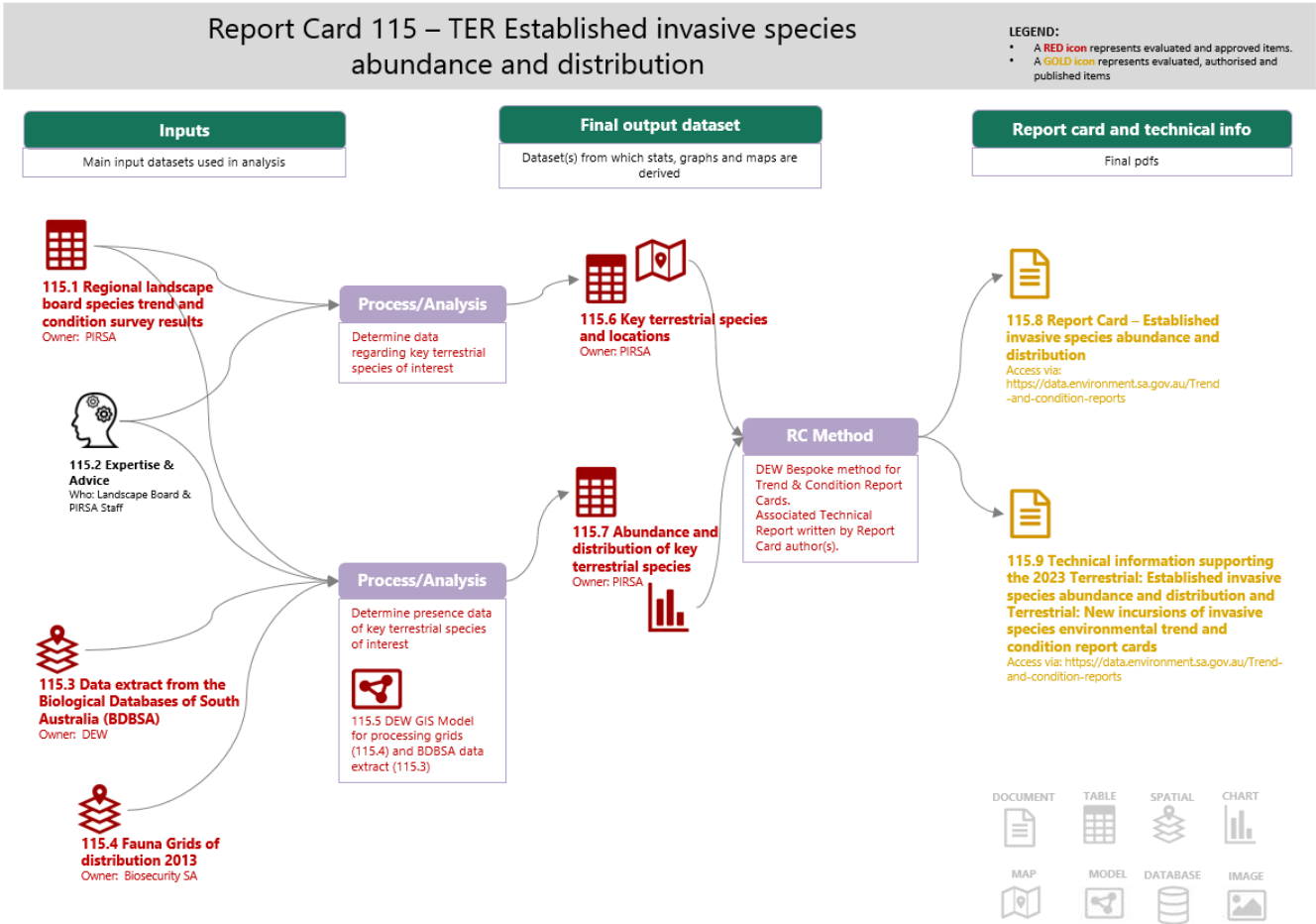
4.2.1 Established weeds and pest animals

Overall the condition of the environment presumed due to established terrestrial invasive species has been assessed as 'fair' because these invasive species are deemed to have moderate impacts on our primary industries, natural resources and way of life.

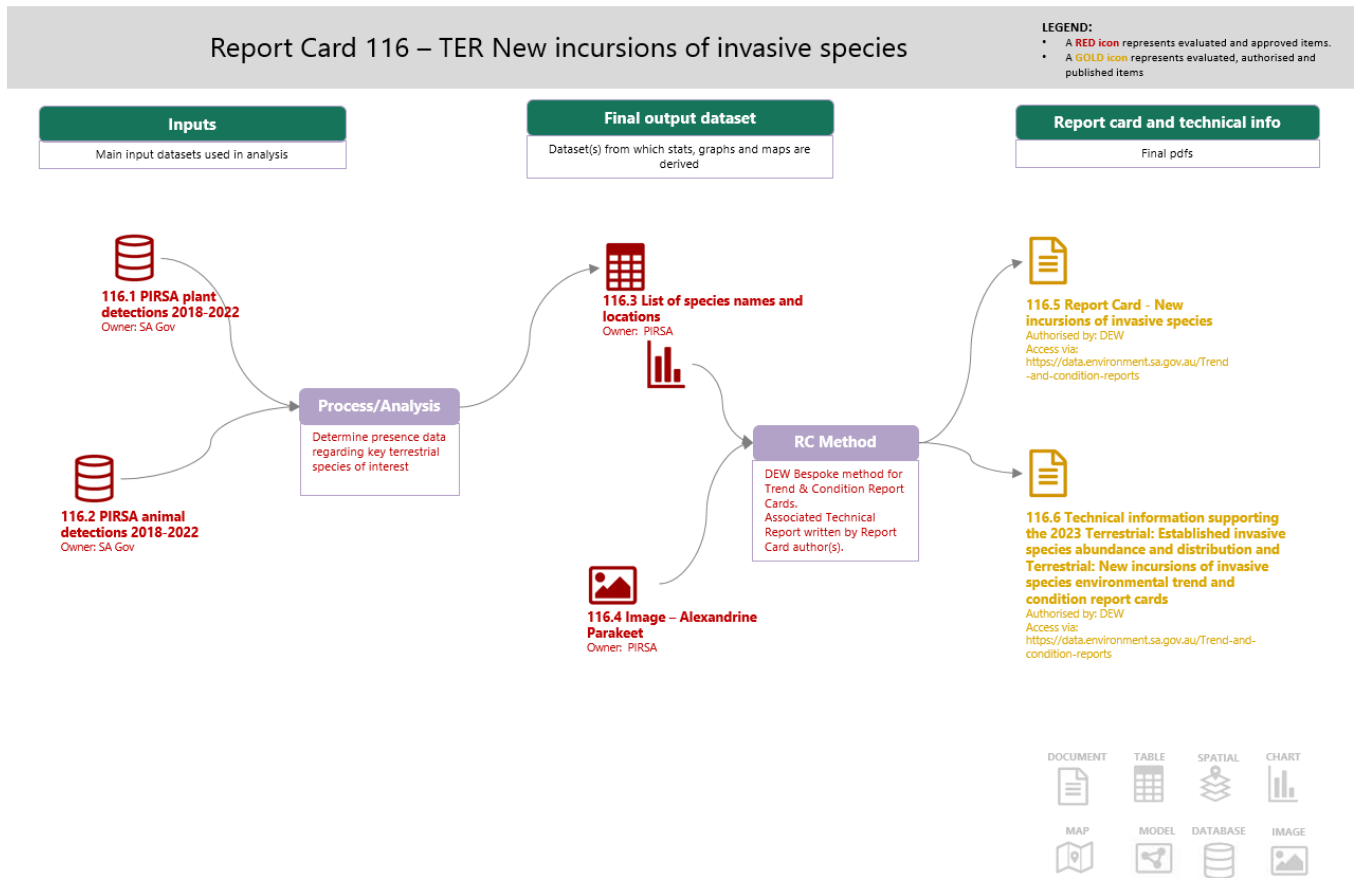
As noted in the discussion on trend, most of the data collected about established invasive species are from on-ground reporting collected during the control of invasive species, as control is better resourced than monitoring. Limited quantifiable information exists about the abundance and distribution of invasive species in each region or across South Australia, with the exception of the information obtained to inform the economic impact analysis for feral deer. The condition score is mostly based on expert opinion from the regional landscape boards and is therefore subjective, with a few exceptions. The Kangaroo Island Landscape Board was the only region to report a 'poor' condition score and that was based on disease prevalence surveillance programs and published economic and environmental impact data relating to the impacts of feral cats. The Eyre Peninsula Landscape Board listed a condition score as 'good' based on bushland condition monitoring, however this does not take into account impacts to primary industries.

5 Appendices

A. Managing environmental knowledge chart for Terrestrial: Established invasive species abundance and distribution (established invasive species)



B. Managing environmental knowledge chart for Terrestrial: New incursions of invasive species (non-established invasive species)



6 References

BDO EconSearch (2022) Feral deer control economic analysis: a report for Primary Industries and Regions SA, Adelaide, https://pir.sa.gov.au/_data/assets/pdf_file/0003/422175/feral-deer-control-economic-analysis.pdf

Bomford M (2008). Risk assessment models for establishment of exotic vertebrates in Australia and New Zealand. Invasive Animals Cooperative Research Centre, Canberra.

Bradshaw CJA, Hoskins AJ, Haubrock PJ, Cuthbert RN, Diagne C, Leroy B, Andrews L, Page B, Cassey P, Sheppard AW & Courchamp F (2021). Detailed assessment of the reported economic costs of invasive species in Australia, In: Zenni RD, McDermott S, García-Berthou E, Essl F (eds) The economic costs of biological invasions around the world. *NeoBiota* 67, 511-550. <https://doi.org/10.3897/neobiota.67.58834>.

DEWNR (2017). NRM 2016 Report Cards: What are the distribution and abundance of weeds, South Australian Department of Environment, Water and Natural Resources, Adelaide.

IUCN (2000). *IUCN guidelines for the prevention of biodiversity loss caused by alien invasive species*, IUCN–The World Conservation Union, Gland, Switzerland.

National Land & Water Resources Audit and Invasive Animals Cooperative Research Centre (2008). Significant invasive species (vertebrate pests) — Status of information for reporting against indicators under the National Natural Resource Management Monitoring and Evaluation Framework, NLWRA, Canberra

Stenekes N & Kancans R (2021). Pest Animal and Weed Management Survey 2016-19: National land manager survey results. ABARES research report, Canberra, https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1032082/0 (accessed 12/01/2023).



**Government
of South Australia**

Department for
Environment and Water