

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

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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.

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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:

- Coastal and marine: Established invasive species abundance and distribution
- Coastal and marine: 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 Coastal and marine 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 SA's coastal and marine environments (Marine pests)

Biosecurity risks in South Australia's coastal and marine environments include established and non-established (or new) invasive species. This report summarises detections between 2019 and 2022 for key marine invasive species (established and non-established). This assessment addresses the abundance and distribution of established aquatic invasive species and the detection of non-established aquatic invasive species.

Marine invasive species can expand their range by both natural and human-mediated (anthropogenic) processes (Carlton 2002). They can be transported inadvertently by commercial and recreational vessels, attaching themselves to hulls, internal seawater systems, and damp spaces or boating gear. Vessels are potential carriers of invasive species, which may be spread as they move between locations.

Invasive marine species can cause ecological and economic harm through the loss of biodiversity, reduction in productivity from aquaculture and seafood industries, damage to infrastructure and change to culturally important areas (Hayes et al. 2005, Molnar et al. 2008). The impact of invasive marine species can be devastating to our seafood industries and environments. The state's seafood production is valued at over \$400 million with major exports being southern bluefin tuna, southern rock lobster, rrawn, abalone and oysters. South Australia generates 41% of Australia's oyster production and most of its southern bluefin tuna production (PIRSA 2022).

Preventing the introduction, establishment and spread of high-risk exotic species is supported through research, risk assessment, policies, regulation and education. An example is the International Convention for the Control and Management of Ships' Ballast Water and Sediment, which became active in September 2017. The prevention, detection and eradication of new incursions is vital to ensure that risks to South Australia's marine industries and environment are minimised. Early detection and prevention remain the best options for the successful management of aquatic pests.

Biosecurity is important to ensure risks from invasive marine species are appropriately managed and potentially significant impacts to South Australia's industries, community and environment are minimised and where possible prevented. Managing the biosecurity risks of invasive marine species in South Australia involves activities to:

- minimise the entry, establishment and spread of aquatic pests into and within South Australia (prevention)
- prepare for and respond to aquatic pest incursions and eradicate where feasible (emergency preparedness, response, and recovery)
- manage and contain aquatic pests where eradication is not feasible, including the protection of assets (ongoing management and control)
- monitor these activities to determine their effectiveness and adjust as needed.

The Department of Primary Industries and Regions (PIRSA) develops, coordinates, and implements projects, strategies, community awareness and policies to contribute to the delivery of the prevention, control and management of marine pests impacts in South Australia. PIRSA initiates response measures (e.g. eradication or containment) in the event of a new marine pest species being detected.

Invasive species on land, and in inland waters are discussed in separate technical reports:

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

2 Methods

2.1 Indicator

The indicator used for the Coastal and marine: Established invasive species abundance and distribution report card is the abundance and distribution of key established coastal and marine invasive species in South Australia using available data.

The indicator used for the Coastal and marine: New incursions of invasive species report card is the number of detections between 2019 and 2022 of key non-established (new) coastal and marine invasive species in South Australia.

2.2 Data sources

Records of detections of key coastal and marine invasive species were obtained directly through:

- Department of Primary Industries and Regions (PIRSA)
- South Australian Museum
- South Australian Research and Development Institute (SARDI) reports.

Priority pest species are those declared noxious and species in the national priority lists. South Australia contributed to the development of the national lists and endorsed them through various national committees. Priority Marine Pest species distribution in South Australia are detailed in Table 3.1.

Noxious species are exotic species declared under the Fisheries Management Act 2007 and are a severe threat to the natural environment. They cannot be held or traded and must not be returned to the water and should be disposed of humanely.

A rigorous literature review in 2010 found there were 99 invasive species present in South Australian waters, consisting of 62 animals (59 invertebrates and 3 vertebrates) and 37 algae (Wiltshire et al. 2010).

The National Marine Pest Sectorial Committee (MPSC) established an updated list of priority marine pests in line with the Australian Government national policies. The Australian Priority Marine Pest List (APMPL) identifies 10 of Australia's significant marine pests. This list includes 3 established and 7 exotic species (DAFF 2021). These species are a focus of national improvements in marine pest communication, surveillance, preparedness (including incursion response) and ongoing management.

The APMPL established marine pests of national significance are:

- *Undaria pinnatifida* (Japanese kelp)
- *Carcinus maenas* (European shore crab)
- *Asterias amurensis* (northern Pacific seastar).

The APMPL exotic marine pests of national significance are:

- *Eriocheir sinensis* (Chinese mitten crab)
- *Rhithropanopeus harrisi* (Harris' mud crab)
- *Mytella strigata* (Charru mussel)

- *Perna viridis* (Asian green mussel)
- *Perna perna* (brown mussel)
- *Perna canaliculus* (New Zealand green-lipped mussel)
- *Mytilopsis sallei* (black-striped false mussel).

In addition, the National Priority List of Exotic Environmental Pests, Weeds and Diseases (abbreviated to the Exotic Environmental Pest List (EEPL)) includes 168 exotic species of significant environmental and social amenity risk to Australia, including 5 marine pests (DAFF 2022):

- *Perna viridis* (Asian green mussel)
- *Mytilopsis sallei* (black-striped false mussel)
- *Didemnum vexillum* (carpet sea squirt)
- *Eriocheir sinensis* (Chinese mitten crab)
- *Charybdis japonica* (lady crab / Asian paddle crab).

2.3 Data collection

At present, limited marine invasive species surveillance is undertaken in South Australia. There is ongoing passive surveillance (e.g. public reports through Fishwatch, PIRSA Fishing App, PIRSA website). All reports are recorded in PIRSA's SA Aquatic Pest Reports Database and investigated. Verified reports are available in the National Introduced Marine Pest Information System available online at www.marinepests.gov.au/pests/nimpis.

The Green Adelaide Landscape Board has settlement plates at two Adelaide metropolitan marinas and monitors for new marine pests at those locations. Settlement plates were previously also installed at Kangaroo Island. Ad hoc projects are undertaken from time to time when resourcing is available, which provides information on the presence of marine pests. SARDI undertook environmental DNA (eDNA) Ballast Water Port Surveys for the Australian Government in 2021–2022. Ports at Thevenard, Port Lincoln, Port Giles, Klein Point, and Adelaide were surveyed for marine pests using molecular methods (Wiltshire et al. 2022). In addition, marine sampling prior to marine development activities also provides marine pest data from time to time.

2.4 Data analysis and methods to assign trend, condition and reliability

2.4.1 Trend

Trend for the abundance and distribution of established coastal and marine invasive species in South Australia was assigned to a trend class based on the spread of established marine invasive species over time between 2019–2022 (Table 2.1).

Trend for new incursions of coastal and marine invasive species in South Australia was assigned to a trend class based on the change in the number of outbreaks over time between 2019–2022 (Table 2.2).

Note that the number of outbreaks in a year can be influenced by short-term research projects that target specific pests (e.g. SARDI surveillance projects) and increase the likelihood of detections.

Table 2.1. Definition of trend classes used for established coastal and marine invasive species abundance and distribution

Trend	Description	Threshold
Getting better	Over a scale relevant to tracking change in the indicator it is improving in status with good confidence	Distribution and/or abundance decreased between 2019–2022
Stable	Over a scale relevant to tracking change in the indicator it is neither improving nor declining in status	No change in abundance and distribution between 2019–2022
Getting worse	Over a scale relevant to tracking change in the indicator it is declining in status with good confidence	Distribution and/or abundance increased between 2019–2022
Unknown	Data are not available, or are not available at relevant temporal scales, to determine any trend in the status of this resource	Abundance and distribution unknown
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above trend classes	No invasive species, or no water assets to assess

Table 2.2. Definition of trend classes used for new incursions of coastal and marine invasive species

Trend	Description	Threshold
Getting better	Over a scale relevant to tracking change in the indicator it is improving in status with good confidence	No detections of new invasive species between 2019–2022
Stable	Over a scale relevant to tracking change in the indicator it is neither improving nor declining in status	No change in detections of new invasive species between 2019–2022 (range 1-5 detections per reporting period)
Getting worse	Over a scale relevant to tracking change in the indicator it is declining in status with good confidence	Increase in the detection of new invasive species (>5 detections per reporting period)
Unknown	Data are not available, or are not available at relevant temporal scales, to determine any trend in the status of this resource	Abundance and distribution unknown
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above trend classes	No invasive species, or no water assets to assess

2.4.2 Condition

Condition class is a single state-level statement of condition for 2022 that has been derived from the *Landscape South Australia Act 2019* and related to invasive species in coastal and marine environments (see Table 2.3 for established coastal and marine invasive species abundance and distribution and Table 2.4 for new incursions of non-established invasive species).

Condition classes were assigned based on a qualitative assessment of the impact of invasive species, the number of outbreaks, and spread of established species to new regions relative to previous years and global levels, as described in the condition statements and thresholds detailed in Table 2.3 and Table 2.4.

For this assessment, condition has been scored at state-scale (and not regional landscape board scale) because of data availability.

Table 2.3. Definition of condition classes used for established coastal and marine invasive species abundance and distribution

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)	No new incursions of established invasive species in current reporting period. All previous incursions are under control.
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)	Abundance and distribution of established invasive species is stable and has a low risk of impacting environment and industry. Stable rate of incursions.
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)	Abundance and distribution of established invasive species is increasing, but has a low risk of impacting environment and industry.
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)	Abundance and distribution of established invasive species is increasing and has a moderate or high risk of impacting environment and industry.
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	-

Table 2.4. Definition of condition classes used for new incursions of coastal and marine invasive species

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)	No new incursions in current reporting period. All previous incursions are under control
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)	Incursion species are controlled and have low risk of impacting environment and industry. Stable rate of incursions
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)	Incursion species are controlled and have low risk of impacting environment and industry. Rate of incursion is increasing
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)	Incursion species are not controlled and have moderate or high risk of impacting environment and industry. Rate of incursion is increasing
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 Limitation

There is ongoing passive surveillance and limited active surveillance for coastal and marine invasive species in South Australia. Surveillance mainly targets shipping ports and marinas because the risk of pest incursion is higher (Hewitt et al. 1996, Cohen et al. 2002).

Trend and condition for abundance and distribution of established invasive species has been classified based on expert opinion and the current level of observations for these species. Trends have not been calculated for abundance or distribution of many established invasive plants, animals, algae and invertebrates (except for *Caulerpa taxifolia* in the Port River/Barker Inlet in the past) as extensive monitoring and data collection is unavailable.

2.4.4 Reliability

Information is scored for reliability based on the minimum of subjective scores (1 [worst] to 5 [best]) given for information currency, applicability and level of spatial representation. Definitions guiding the application of these scores are provided in Table 2.5 for currency, Table 2.6 for applicability and Table 2.7 for spatial representation.

Table 2.5. 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 2.6. 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 2.7. 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

2.5 Data transparency

Data transparency for these report cards is represented in Appendix A and B.

3 Results

3.1 Trend

3.1.1 Established invasive species abundance and distribution

The trend for the abundance and distribution of established marine pests was stable across South Australia. There was limited further spread of established exotic species from 2019–2022. Established aquatic plant species such as *Caulerpa taxifolia* continued to be present in the Port River/Barker Inlet, while *C. racemosa* remains present in the Port River/Barker Inlet and isolated locations along the metropolitan coast. The established crab species *Carcinus maenas* (green shore crab) remains isolated to Gulf St Vincent. *Magallana gigas* (Pacific oyster) remains established at Port Adelaide, Coffin Bay, Port Lincoln, Yorke Peninsula, Thevenard, and is limited at Kangaroo Island (Table 3.1).

Other invasive species are detected in South Australia, but are either eradicated on detection such as *Perna viridis* (Asian green mussel) which was found and treated on a visiting vessel, or do not establish a self-sustaining population such as *Charybdis japonica* (Asian paddle crab) of which 4 males were detected in the state (Table 3.1).

3.1.2 New incursions of invasive species

The trend in the number of detections of new incursions of marine pests was stable across South Australia.

There were three confirmed exotic species (light bulb sea squirt, false kelpfish, Asian paddle crab), two possible exotic species (Asian bag mussel and basket shell clam) and one exotic species transit vessel (Asian green mussel) detected during 2019–22 (Table 3.1). In comparison, there were two new exotic species detections in the previous reporting period 2015–2019. All confirmed detections of new incursions during 2019–2022 occurred in the Green Adelaide landscape region.

Table 3.1. Distribution and detections of key marine pests in South Australia’s coastal and marine environments.
Sources: Wiltshire et al 2010[#], Wiltshire et al 2022, PIRSA aquatic pest database, NIMPIS 2022

Marine pest	Reference list	SA Status	Information pre-2010 [#]	2022 update
European shore/green crab (<i>Carcinus maenas</i>)	Australian Priority Marine Pest list (APMPL) Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) trigger list Marine ballast water Decision Support System (DSS)	Established in SA	1976–2009: Pt Adelaide, Pt Vincent, and the Coorong Rarely found in recent years	Established in Gulf St Vincent: Common in metro Adelaide, detected at Klein Point by eDNA

Marine pest	Reference list	SA Status	Information pre-2010 [#]	2022 update
	Marine monitoring target species list SA noxious pest list			
European fan worm (<i>Sabella spallanzanii</i>)	CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Established in SA	1995–2010: Pt Adelaide, Adelaide coast	Established in both Gulfs: Common in metro Adelaide, detected at Adelaide, Klein Point, Port Lincoln by eDNA and consistent with previously reported distribution
toxic dinoflagellate (<i>Gymnodinium catenatum</i>)	Marine monitoring target species list	Established in SA	1996–2009: Widespread, common in Pt Lincoln	N/A
toxic dinoflagellate (<i>Alexandrium catenella</i>)	Marine monitoring target species list	Established in SA	1997–2008: Widespread, common in Pt Adelaide	N/A
toxic dinoflagellate (<i>Alexandrium minutum</i>)	Marine monitoring target species list	Established in SA	1986–2008: Widespread, common in Pt Adelaide	N/A
toxic dinoflagellate (<i>Alexandrium tamarense</i>)	Marine monitoring target species list	Established in SA	1988–2009: Widespread, common around Yorke Peninsula	N/A
green macroalga (<i>Caulerpa racemosa</i> var. <i>cylindracea</i>)	Marine monitoring target species list SA noxious pest list	Established in SA	2002–2010: Port Adelaide, O'Sullivan Beach	Established Adelaide metro: found Adelaide, O'Sullivan Beach and Pt Noarlunga
green macroalga (<i>Caulerpa taxifolia</i>)	CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Established in SA	2002–2009: Port River-Barker Inlet	Established Port River-Barker Inlet. Detected when sampling occurs prior to dredging

Marine pest	Reference list	SA Status	Information pre-2010 [#]	2022 update
green macroalga (<i>Codium fragile</i> ssp. <i>fragile</i>)	CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Established in SA	2002–2009: North Haven marina, West Lakes, American River	N/A
Pacific oyster (<i>Magallana gigas</i> formerly <i>Crassostrea gigas</i>)	Marine ballast water DSS Marine monitoring target species list	Established in SA	1969–2009: Aquaculture, some wild settlements near Kangaroo Island, Coffin Bay, Pt Adelaide	Established at Pt Adelaide, Coffin Bay, Pt Lincoln, Yorke Peninsula and Thevenard, and limited at Kangaroo Island
Japanese kelp (<i>Undaria pinnatifida</i>)	Australian Priority Marine Pest list CCIMPE trigger list Marine ballast water DSS Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA	N/A	Established in Tasmania and Victoria and has the potential to establish in SA. Detected at Portland, Victoria 2022, moving closer to SA
northern Pacific seastar (<i>Asterias amurensis</i>)	Australian Priority Marine Pest list CCIMPE trigger list Marine ballast water DSS Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA	N/A	Established in Tasmania and Victoria and has the potential to establish in SA based on sea surface temperature and tolerance modelling Not detected through eDNA port work in 2021–22
Asian green mussel (<i>Perna viridis</i>)	Australian Priority Marine Pest list EEPL CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA or Australia	N/A	Transit vessel detection in 2019 with treatment and removal from the vessel

Marine pest	Reference list	SA Status	Information pre-2010 [#]	2022 update
black striped false mussel (<i>Mytilopsis sallei</i>)	Australian Priority Marine Pest list EEPL CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA or Australia	N/A	N/A
brown mussel (<i>Perna perna</i>)	Australian Priority Marine Pest list CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA or Australia	N/A	N/A
Chinese mitten crab (<i>Eriocheir sinensis</i>)	Australian Priority Marine Pest list EEPL CCIMPE trigger list SA noxious pest list	Exotic - Not established in SA or Australia	N/A	N/A
Harris' mud crab (<i>Rhithropanopeus harrisi</i>)	Australian Priority Marine Pest list Marine monitoring target species list	Exotic - Not established in SA or Australia	N/A	N/A
bay barnacle (<i>Amphibalanus improvisus</i> formerly <i>Balanus improvisus</i>)	Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA or Australia	Unlikely to be present in SA	
Asian paddle/lady crab (<i>Charybdis japonica</i>)	EEPL CCIMPE trigger list Marine monitoring target species list SA noxious pest list	Exotic - Not established in SA or Australia	2001: 1 adult male recorded in Outer Harbor in 2000	Four physical detections since 2019: • 2019: retrospective report provided in 2020 (photo)- Port River • 2020: 2 detections in Gulf St Vincent

Marine pest	Reference list	SA Status	Information pre-2010 [#]	2022 update
				<p>and the other in Port River</p> <ul style="list-style-type: none"> • 2021: Port River <p>Detected through retrospective eDNA analysis of 2017 Port River plankton samples. Could be transient DNA from ballast water or hull-fouling or presence at that location</p> <p>eDNA surveillance in 2020, 2021–22 did not detect</p>
Asian bag mussel (<i>Arcuatula senhousia</i> formerly <i>Musculista senhousia</i>)	<p>CCIMPE trigger list</p> <p>Marine ballast water DSS</p> <p>Marine monitoring target species list</p> <p>SA noxious pest list</p>	Exotic - Not established in SA	1996–2009: in Pt Adelaide but not found since 2001. Surveys undertaken in the Port River in 2008 failed to detect <i>A. senhousia</i>	Possible detection - eDNA surveillance in Thevenard, South Australia February 2022. However further surveillance is needed to improve confidence in the assay/detection

Note: Non-priority marine invasive species were detected in South Australia during 2019–2022 since the last reporting period and include:

- Light bulb sea squirt (*Clavelina lepadiformis*) – West Lakes, North Haven Marina, and the Glenelg Marina (2022 confirmed, previously suspected in West Lakes 2019)
- False kelpfish (*Sebasticus marmoratus*) – Port River (2019).

The intention of developing the priority species lists is to facilitate improvements in marine pest communication, surveillance, preparedness, response, and management for pests. Some marine invasive species were assessed but not recommended for the APMPL as they failed to meet listing criteria for that list. For example, expert opinion during listing was that the exotic common acorn barnacle (*Balanus glandula*) could not be identified or distinguished from native barnacles in the field, particularly from the native six-plated barnacle (*Chthamalus antennatus*). For exotic species, to meet the National Environmental Biosecurity Response Agreement (NEBRA) criteria, control options must also be available to manage marine pests, with the aim of eradication, should they arrive. For some marine pests, no control options are available that could be employed to eradicate the pests or control their numbers should there be an incursion. In these cases, prevention measures are the only defence against the impacts of these marine pests on Australia’s environment.

3.2 Condition

3.2.1 Established invasive species abundance and distribution

At the whole-of-state scale, current condition for the abundance and distribution of established marine invasive species was assessed as 'Good' for 2022. South Australia has relatively few established marine pests in comparison to other south eastern states with minimal impacts reported. The spread of established species has remained localised with minimal spread from the historic distribution of most species.

Information on the spread of established marine invasive species is based on limited data and relies primarily on public reporting. Condition is determined based on a qualitative assessment of the impact of invasive species and the number of outbreaks, relative to previous years and global levels, as detailed in Table 3.1.

3.2.2 New incursions of invasive species

At the whole-of-state scale, current condition of marine invasive species outbreaks was assessed as 'Good' for 2022. South Australia is largely free of marine pests with minimal impacts reported. Boats and vessels regularly pass through from different locations. They pose a high risk of spreading marine pests. The highest detections are generally found at high vessel traffic areas such as ports and marinas.

The qualitative assessment used to determine condition class considers the marine invasive species that occur in the coastal and marine environment and their impact. It also considers the success of biosecurity measures and education that prevent the entry and spread of marine invasive species.

The potential impacts of the newly detected exotic species are:

- *Charybdis japonica* - Asian paddle crab (not thought to be established)

Asian paddle crabs are aggressive, non-native crabs that could out-compete native crabs like the iconic blue swimmer crab. The Asian paddle crab is not currently established in Australia, but has significant potential to do so, so it is important to immediately report any found in the wild.

- *Perna viridis* - Asian green mussel (not established - detected and treated on a transit vessel)

This is a priority species on the APMPL. *P. viridis* is a heavy fouler and spatial competitor. In its invasive range, densities can reach several thousand per square metre which can smother and displace native species. It readily fouls structures such as aquaculture netting, vessel and power plant intake pipes, vessels and buoys.

- *Clavelina lepadiformis* - light bulb sea squirt (established - West Lakes, North Haven Marina, and the Glenelg Marina)

C. lepadiformis is not native to Australia. Potential impacts are thought to be occupation of disturbed artificial habitats in the place of native species. Limited studies have been undertaken on this species.

- *Sebasticus marmoratus* - false kelpfish - single detection reported in 2019 by underwater photograph taken in 2018. Photo identified by SA Museum staff confirmed the species. No sample obtained and no further sightings.

False kelpfish is native to the western Pacific from southern Hokkaido, Japan to the Philippines. It has been detected in Oslofjord, Southern Norway (Hansen & Karlsbakk 2017), and Sydney Harbour, New South Wales (Australian Museum 2022). Impacts from this species are unknown.

- *Arcuatula senhousia* - Asian bag mussel (formerly *Musculista senhousia*), eDNA detection at Thevenard in 2022 that requires further confirmation.

A. Senhousia has previously been confirmed in South Australia in the Port River and at North Haven in 2001. Surveys undertaken in the Port River in 2008 failed to detect *A. Senhousia*.

This species has impeded the growth and propagation of a *Zostera* seagrass species in San Diego Bay. It has also inhibited suspension-feeding species such as the bivalve *Mytilaster minimus* in areas of the northern Adriatic. In Japan, cultivated beds of clams (*Macra chinensis*, *M. veneriformis*, *Tapes philippinensis* and *Meretrix luzoria*) were smothered by mats of *A. senhousia* resulting in high mortalities of all 4 species of clam through suffocation. In New Zealand there was a possible reduction in density of the native mussel (now *Xenostrobus neozelanicus*) in the Waitemata Harbour (DAWE 2022).

- *Varicorbula gibba* - basket shell clam was possibly detected at Thevenard and Port Lincoln (and other location in Australia) through eDNA surveillance in 2021–22, however the presence at the survey locations was unclear.

There are no reports of adverse environmental impacts in the species native range. *V. gibba* tends to become dominant when conditions become hypoxic. It has the potential to impact clam and cockle fisheries (DAWE 2023).

3.3 Reliability

The overall reliability score for the Coastal and marine: Established invasive species abundance and distribution report card is 1 out of 5, based on Table 3.2. This is considered to be 'Poor' reliability.

The overall reliability score for the report card for the Coastal and marine: New incursions of invasive species report card (i.e. reported detections of invasive aquatic species) is 1 out of 5, based on Table 3.2. This is considered to be 'Poor' reliability.

Table 3.2. Information reliability scores for coastal and marine invasive species trends

Indicator	Applicability	Currency	Spatial	Reliability
Coastal and marine: Established invasive species abundance and distribution	3	2	1	1
Coastal and marine: New incursions (reported detections) of invasive species	3	2	1	1

3.3.1 Notes on reliability

For both of the Coastal and marine invasive species cards: Applicability was given a score of 3 because most data are based on indirect indicators. Currency was given a score of 2 because data are from reports over various timeframes and some of these data are up to 10 years old. Spatial representation was scored 1, as the data are from a relatively small area of the state's marine environment and limited data exists across the state for marine invasive species' abundance and distribution.

Invasive species information can be detailed at local scale but does not inform trends in invasive plants or animals over time at state scale.

4 Discussion

4.1 Trend

4.1.1 Established invasive species abundance and distribution

At the scale of the whole-of-state, the current trend for the spread of established marine invasive species has been stable for 2019–2022. There was limited further spread of established species from 2019–22, and any further spread has been within the region where the species had already been found.

4.1.2 New incursions of invasive species

At the scale of the whole-of-state, the current trend in pest detections is stable, but was increasing in the Green Adelaide landscape region for 2019–22. There were 3 confirmed exotic species (light bulb sea squirt, false kelpfish, Asian paddle crab), 2 possible exotic species (Asian bag mussel and basket shell clam) and 1 exotic species transit vessel (Asian green mussel) detections during 2019–22. In comparison, there were 2 new exotic species detections in the previous reporting period 2015–2019. The confirmed detections in 2019–2022 occurred in the Green Adelaide landscape region. Overall, the numbers are low and only 2 time periods are being compared, so the confidence in determining the trend is low.

4.2 Condition

4.2.1 Established invasive species abundance and distribution

There has been limited spread of established marine invasive species, however this is based on limited data and a reliance on passive surveillance (public reporting). Statewide condition of established marine invasive species was assessed as good.

4.2.2 New incursions of invasive species

In 2020 and 2021, 2 Asian paddle crabs (*Charybdis japonica*) were detected (total of 4 since 2019), however, eDNA surveys after this period did not detect the species. The scarcity of molecular eDNA detections, and lack of recent physical detections suggests this species may not be established with a self-sustaining population. The Asian paddle crab is an aggressive, non-native crab species. It is not currently established in Australia but has significant potential to do so. The Asian paddle crab spreads via biofouling on shipping, competes for food and shelter with native crustacean species, and can carry disease which can impact native species such as lobster, prawn and crabs. Commercial and recreational crab fishing will likely result in further detections should the species be present.

Asian green mussel (*Perna viridis*) was detected on a visiting vessel prior to entering South Australia. This species was successfully removed from the vessel. This mussel forms dense colonies that outcompetes natives for food and space. They can clog seawater cooling pipes and intake systems. It has arrived in Australia in ships arriving from Asian or Pacific ports, attached to niche areas (such as around rudders and sea chests).

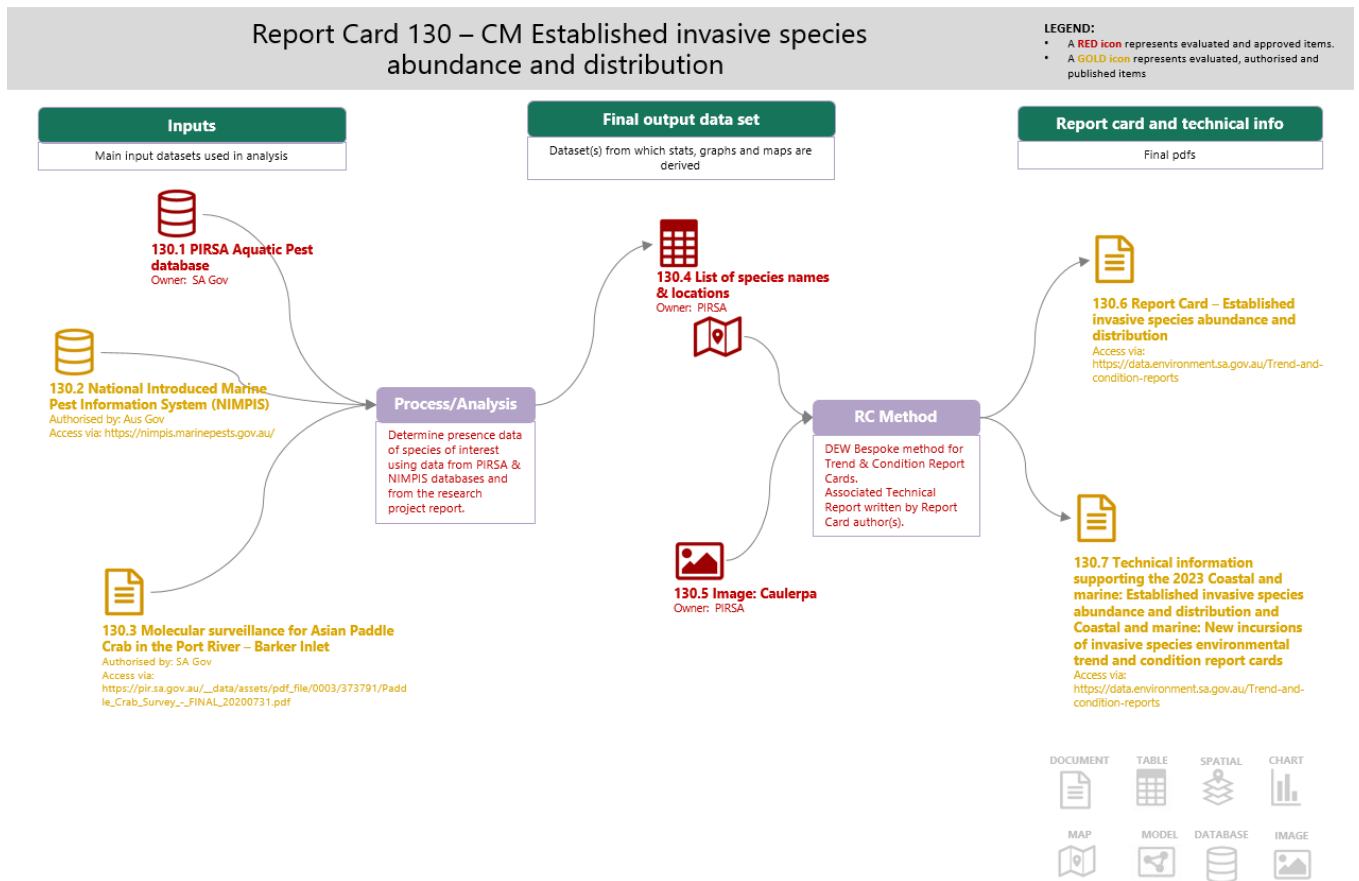
The light bulb sea squirt (*Clavelina lepadiformis*) is now thought to be established in West Lakes, Glenelg Marina, and North Haven Marina. Although the species is observed as abundant in these South Australian locations, it has only been observed in disturbed habitats, on vertical artificial structures and opportunistically interspersed within established species. There is a potential for future spread to disturbed artificial habitats (biofouling), where it may occupy opportunistically. Limited impact studies on this species have been undertaken, so impacts remain largely

unknown. Likewise, the nudibranch (*Spurilla braziliana*) and false kelpfish (*Sebasticus marmoratus*) impacts are not fully understood, and more research needs to be undertaken to determine impacts.

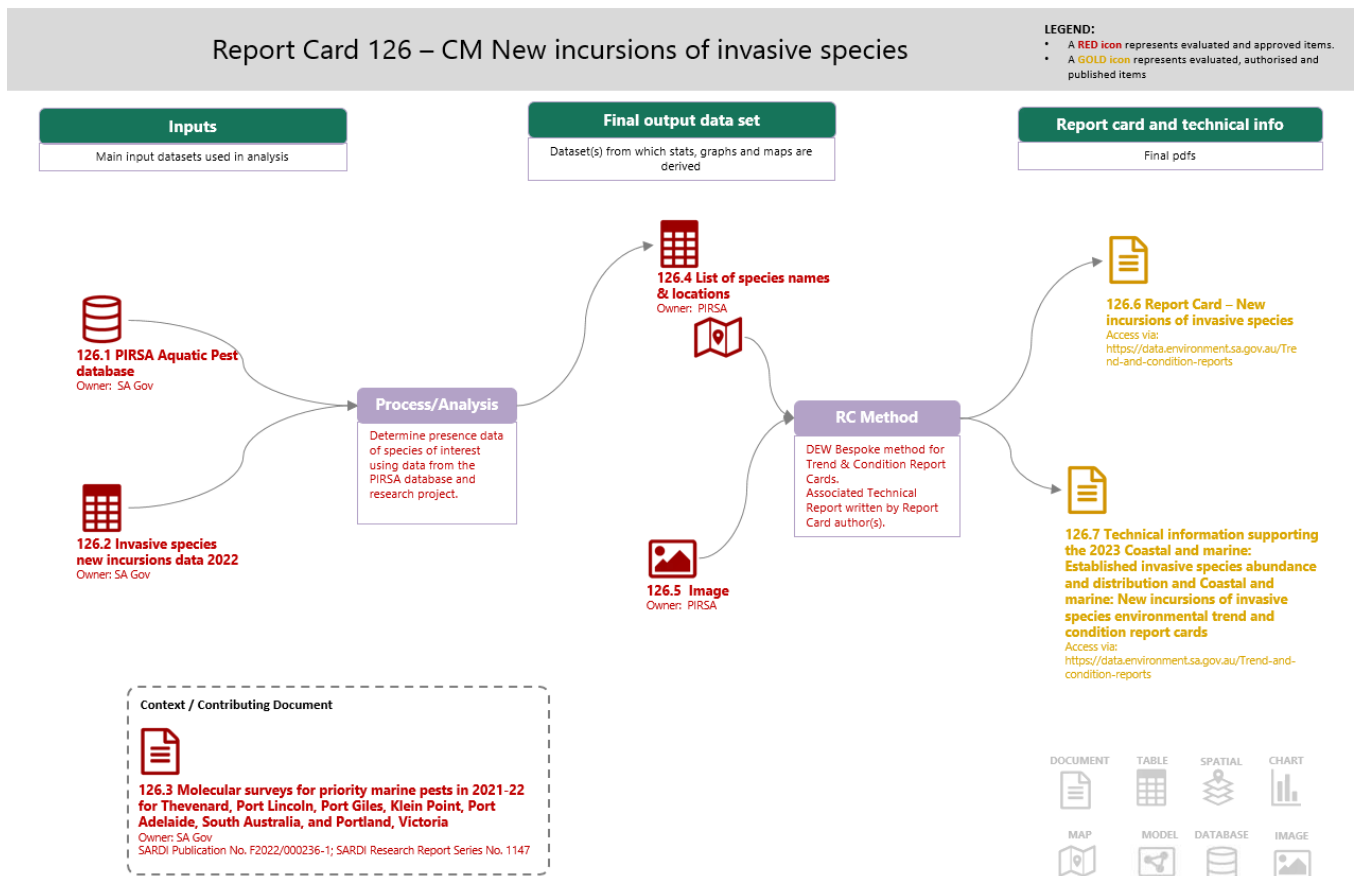
Asian bag mussel (*Arcuatula senhousia*) was detected at Thevenard, South Australia in February 2022 using eDNA surveillance. Further surveillance is required to detect a physical specimen for verification and to confirm presence. There have been issues with the assay for this species in tropical locations (Wiltshire *et al.* 2022). Similarly, the basket shell clam (*Varicorbula gibba*) was possibly detected at Thevenard and Port Lincoln (and other locations in Australia) through eDNA surveillance in 2021–22, however the presence at the survey locations was unclear. The assay for this species had specificity issues or possible cross-reacts with native species and further investigation is needed (Wiltshire *et al.* 2022).

5 Appendices

A. Managing environmental knowledge chart for Coastal and marine: Established invasive species abundance and distribution



B. Managing environmental knowledge chart for Coastal and marine: New incursions of invasive species



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7 Glossary

Biofouling — Biofouling is the attachment or accumulation of aquatic organisms such as microorganisms, plants, and animals, to any part of a vessel, on surfaces and structures immersed in or exposed to the aquatic environment. Biofouling is also known as hull fouling.

Detection — Interception of a suspected pest species or its identification in a location following incursion.

Exotic marine species — Any species not normally considered to occur and that may or may not be present in Australia's marine environment.

Marine pests — Non-native marine plants or animals that harm Australia's marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established (i.e. forming self-sustaining populations) or spread in Australia's marine environment. Many terms are used, sometimes interchangeably, to describe plants and animals that have been moved beyond their native range by humans, including alien, exotic, introduced, invasive, non-indigenous, non-native and nuisance species.



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