Conservation risk assessment report for little penguins in South Australia

DEWNR Technical report 2016/33

Government of South Australia
Department of Environment, Water and Natural Resources

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Government of South Australia
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1 Introduction

1.1 Little penguins in South Australia

The little penguin (*Eudyptula minor*) is an iconic, flightless seabird, which lives and breeds in Australia and New Zealand. It is a relatively common species in the waters of southern Australia (Stahel and Gales 1987), where there are an estimated 300-500,000 breeding individuals[1] (Maher 2014).

In South Australia, the most recent estimate of population size is by Wiebkin (2011), who estimated 36,600 breeding individuals, unevenly distributed in approximately 100 colonies. The location of each of these colonies is shown in Figures 3 and 4, and information about observations of penguins at each colony are summarized in Appendix 1.

Some South Australian colonies have shown declines in recent years, others appear to be stable, but for many there are no trend data available (Wiebkin 2011, Appendix 1). Where there are declines in little penguin colonies the causes are mostly unknown, however, several combinations of factors have been suggested, including predation by native and introduced predators, diseases and parasites, and pollution, among others (Trathan *et al*. 2015). Documented declines at three colonies in, or adjacent to, Victor Harbor, Kingscote and Penneshaw have affected local tourism businesses and raised concerns within local communities.

1.2 Conservation risk assessment process

The information in this report formed the basis for a risk assessment process conducted by the Department of Environment, Water and Natural Resources (DEWNR), to identify, analyse, and evaluate risks to little penguins in South Australia.

The risk assessment process is based upon the concepts and processes adapted from the National Ecological Sustainable Development risk assessment framework used by Commonwealth and State fisheries management authorities[2]. This framework has been applied by PIRSA (Primary Industries and Regions SA) and SARDI (South Australia Research and Development Institute) when assessing the ecological risk of South Australian fisheries on the marine environment. DEWNR has also applied the framework to water planning risk assessments (DEWNR 2012). The framework adopts Standards Australia's Risk Management Standard (AS 2009), which is the most widely used risk management approach in Australia.

The framework adapted by DEWNR is shown in Figure 1. The framework considers all known pressures on little penguin populations and the socio-economic values of penguin populations (such as tourism businesses, or community values). This risk assessment enables the identification of pressures that pose high levels of risk to populations. Management options that may be available to mitigate these high risks can be considered. The use of this framework can also guide adaptive management of penguin populations through the identification of appropriate monitoring methods and measurable indicators to assess the success of any management options applied.

[1] Throughout this document population and colony estimates are given as numbers of breeding individuals. Some sources have used estimated numbers of breeding pairs or active burrows. Care should therefore be taken in interpreting different count data.

[2] http://frdc.com.au/Documents/All%20Other%20Documents/Ecologically%20Sustainable%20Development%20-%20how%20to%20guide%20for%20wild.pdf

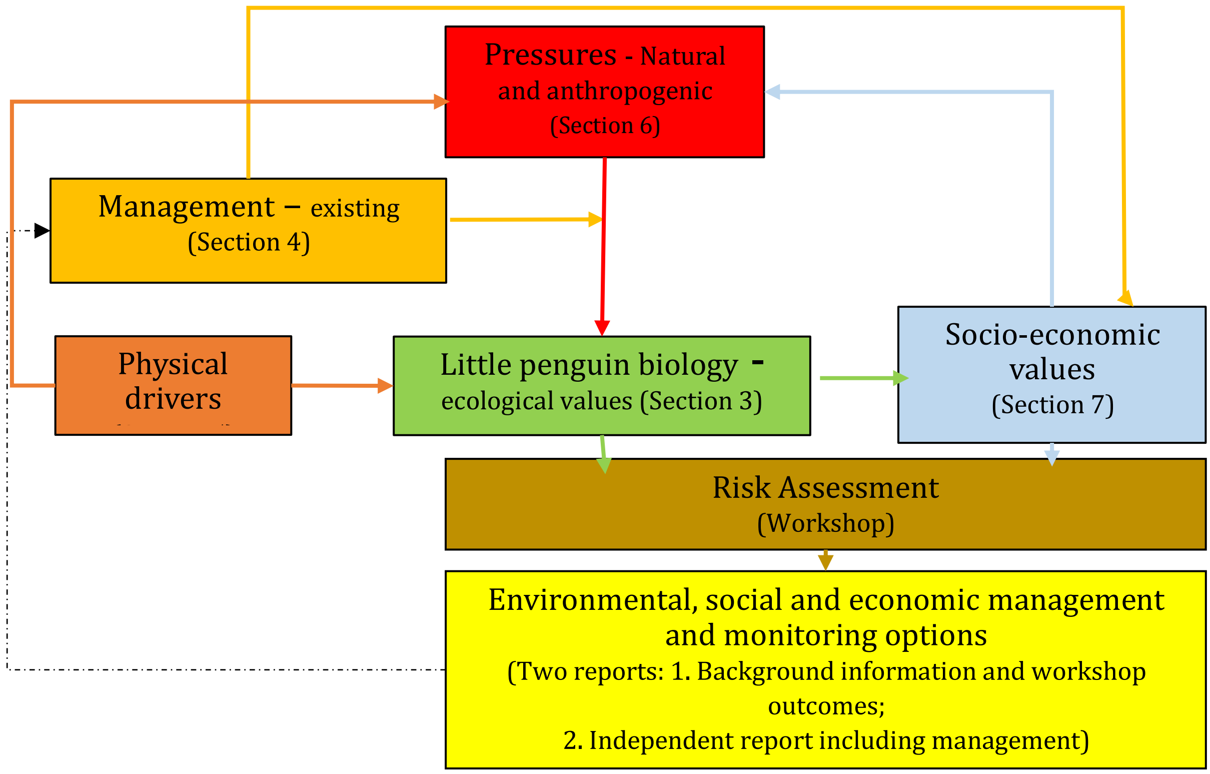

Figure 1. Framework indicating how ecological, social and economic values of little penguin colonies and pressures on them inform how risks to little penguin colonies are considered, as well as management options. The direction and colour of the arrows show how the components influence each other. Image adapted from Bryars *et al* (2016).

This framework considers the influence of the physical drivers, pressures and existing management on little penguin colonies, and assesses the likelihood of those factors operating at a particular colony, and the severity of decline that each factor would cause (i.e. the risk of decline). The risk of any declines impacting on socio-economic values, are also assessed.

DEWNR compiled a list of all known penguin colonies in South Australia as well as estimations of abundance, trends in populations and the likely pressures on each colony. This list was used to prepare a draft risk assessment for each colony, based on the assessed likelihood and consequence of each pressure (threat) at each colony (see Appendices 2 and 3).

A draft background report identified physical drivers, pressures and existing management at little penguin colonies across South Australia. A draft risk assessment spreadsheet was also prepared and forwarded to experts and stakeholders for consideration and modification, prior to a discussion workshop on 24 May 2016.

The stakeholders were invited to participate in the workshop to seek agreement on the draft colony-specific risk assessments. After consensus was made on the risk assessment ratings (Appendix 6), stakeholders discussed management and feasibility options for high-risk pressures and socio-economic values (those with risk ratings of 'high' or 'very high', see Appendix 2).

This risk assessment report incorporates the information that was collated in the background report, together with outcomes of the workshop (risk analyses and management options). It summarises five important components that influence management options for populations of little penguins in South Australia (Figure 1), namely:

- the biology of little penguins (Section 3),
- the current management programs that are in place to protect a range to little penguin colonies and their habitats from identified pressures (Section 4),
- the physical/ecological drivers that influence large-scale characteristics of their environment (Section 5),

- the pressures that are acting upon individual penguins, their colonies and, more broadly, their overall population (Section 6), and
- the social and economic (socio-economic) values of little penguins to local communities and to the State of South Australia (Section 7).

These components are linked because, for example, many of the socio-economic values are reliant on ecological values, and some of the socio-economic values can place pressure on ecological values.

The primary audience for this report is staff from DEWNR and other government agencies, as well as Natural Resource Management (NRM) boards, tourism industry stakeholders, and monitoring, research and funding partners.

This risk assessment process will be reviewed by independent consultant Dr Peter Dann, Research Manager at Phillip Island Nature Park. The consultant will submit an independent assessment of the workshop proceedings and the collated results, and will provide recommendations for future research, monitoring and management of little penguin populations in South Australia.

1.3 Uncertainties in little penguin data

Information for this report has been sourced from scientific literature, research reports, newspaper articles, and experts, including attendees at the risk assessment workshop.

The information presented in this report is based on data that are highly variable in nature. Information varies from descriptive observations to detailed scientific studies that are specific to particular locations. Research findings may not always be applicable to other locations where little penguins occur. For some locations there are recently collected data, but not for others, and many datasets have not been repeated through time. There is also inconsistency between studies (both within and between locations) in the type of data collected or how it was collected (e.g. data can be collected at different times of the year, in different years, at different frequencies, at different times within the breeding cycle, on breeding or non-breeding individuals, or on nests, breeding pairs, or individuals). Historical information on little penguins and the pressures that acted upon them, is lacking. Little penguins occurred in South Australia before European settlement, but there is little information on where they occurred and what their local abundances were. There are also limited data on changes in little penguin populations over time.

2 Distribution and conservation status

2.1 Taxonomy

Little penguins occur in New Zealand and Australia (Figure 2). In 1990, little penguins were classified into six sub-species based on morphological variations in bill and plumage, five occurring in New Zealand and one that includes all little penguins in Australia (Figure 2) (Kinsky and Falla 1976, Marchant and Higgins 1990). More recent genetic analysis suggests that the genus (*Eudyptula*) comprises two species, one across most of New Zealand and the other across southern Australia and parts of New Zealand's Otago region (Grosser *et al.* 2015, Figure 2). Based on these findings, Grosser *et al*. (2015) recommended the Australian little penguin be renamed *Eudyptula novaehollandiae*, and the New Zealand little penguin should remain *Eudyptula minor*.

All studies to date indicate that little penguins in Australia are of the same species and subspecies (Banks *et al.* 2008, Overeem *et al.* 2008, Peucker *et al.* 2009, Burridge *et al.* 2015, Colombelli-Négrel 2015a). On a finer spatial scale, some genetic differences are apparent between colonies in the Troubridge-Granite Island region of South Australia (Burridge *et al.* 2015, Colombelli-Négrel 2015a), which appears to be a 'hybrid-mixing-zone' between eastern and western Australian colonies.

Little penguins typically show strong fidelity to their natal colonies (Dann 1991, Stahel and Gales 1987; Marchant and Higgins 1990), but movements between colonies and migration do occur (Reilly and Cullen 1982, Dann *et al.* 1996a, Priddel *et al.* 2008, Wiebkin 2011). For example, some penguins banded at Troubridge Island and Encounter Bay have been recorded in Gulf St Vincent, on Kangaroo Island, in the South-East and interstate as far as New South Wales (M. Waterman *unpubl. data*, Copley 1996). These results are consistent with genetics studies, which indicate a small amount of migration of little penguins between colonies (Burridge *et al.* 2015).

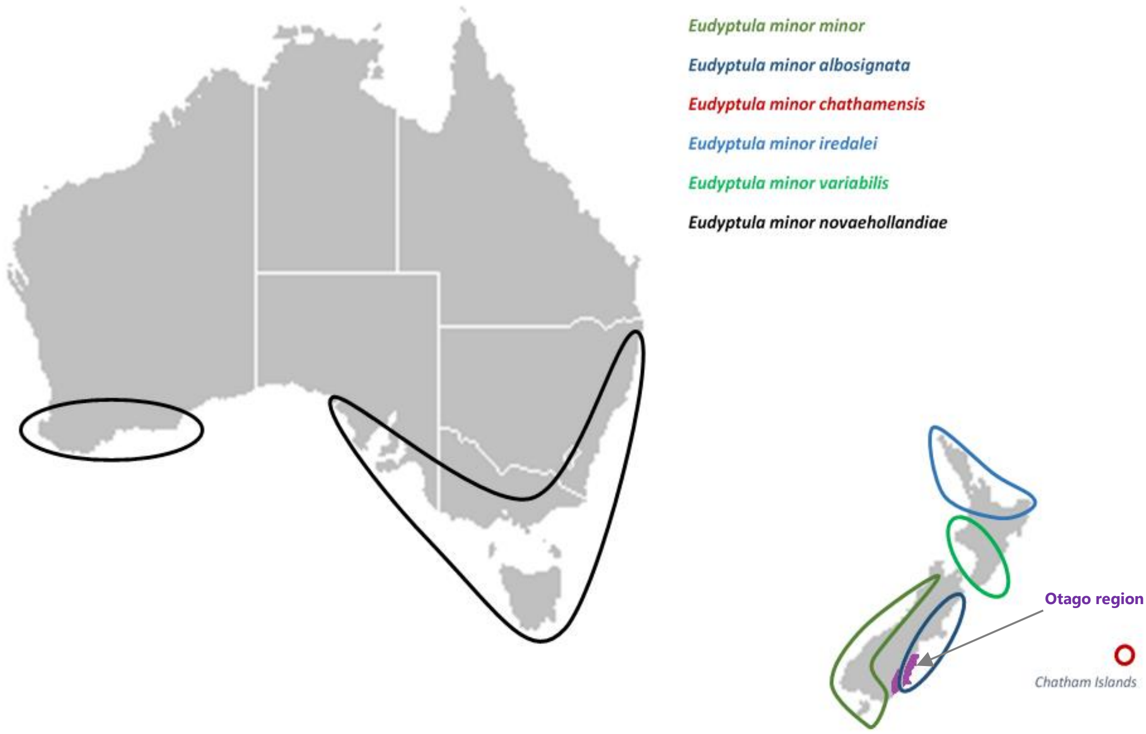

Figure 2. Distribution of little penguins in Australian and New Zealand, and previously inferred sub-species classification based on morphological variations (Kinsky and Falla 1976). Image adapted from Avibase and Handbook of Australian, NZ and Antarctic Birds, V1, Part A (Marchant and Higgins 1990).

2.2 Distribution

In Australia, little penguins occur along the southern coastline, extending from Perth in Western Australia, to near Coffs Harbour in New South Wales as well as Bass Strait and Tasmania (Dann *et al.* 1996a). Little penguins breed along the coast and on offshore islands in colonies (Dann *et al.* 1996a). In South Australia there are records of colonies from approximately 100 sites (Copley 1996, Wiebkin 2011, see also Appendix 1), distributed along the West Coast, Eyre Peninsula, Spencer Gulf, Gulf St Vincent, Kangaroo Island, Encounter Bay and in the South East (Figure 3).

2.3 Historical distribution and abundance

Little penguins were present in South Australia prior to European settlement, but there is very little information on the distribution and abundance of little penguins at the time of settlement or in the early years of settlement. The South Australian Museum has 17 egg clutches collected before 1940: eight from at least five locations on Kangaroo Island; two from Althorpe Island (Yorke Peninsula); one from South Neptune Island; one from Flinders Island (western Eyre Peninsula); five from Baudin Rocks (South-East). The earliest of these is dated 1883. SA Museum archaeological surveys have also found penguin skeletal material at historical whaling and sealing sites along the

South Australian coastline; however these have not yet been examined to attempt to fill the early distributional knowledge gaps.

There are few written records of penguins during the 1880s and early 1900s (Appendix 1). Among the earliest records is an observation about a painting of a sea-lion at Rivoli Bay (Robe, South-East) by George French Angas in 1844 which refers to penguins on Penguin Island: "whalers transported Grey's party to the island, which thereupon was named Penguin Island in allusion to the abundance of those birds on it" (Ray and Ling 1981). [N.B. little penguins are still found on Penguin Island.]

Penguins also rated a mention in a newspaper article about a trip to the Neptune Islands to collect mutton bird eggs in 1876 (*South Australian Register* 1876). The article noted that "the absurd little penguins are very often found enjoying the hospitality of the mutton birds [i.e. within their burrows], and when disturbed, waddle away on their short stout legs …" [N.B. Penguins have not been seen on the Neptune Islands in recent years (2004-2016).]

Early naturalist and collector, Captain S.A. White also made observations of little penguins during cruises from Adelaide to southern Yorke Peninsula, Kangaroo Island and nearby islands, on the Avocet in 1916 (White 1916). During these cruises he recorded penguins "in their burrows, under the bushes at Beatrice Spit, Kangaroo Island and, on two visits to Althorpe Island, Yorke Peninsula. On the first visit to Althorpe in January, he was "greatly surprised to find numbers of penguins in holes and cracks in the rock nearly at the top [of the island]. These seemingly awkward birds on land have to scramble down more than 250 feet of perpendicular rock to get their food in the sea below and struggle back up again before daylight." On his second visit he "captured many penguins" at the base of the cliffs to record their body temperatures. [N.B. Penguins are still present on the Althorpe Islands.]

It is notable that on two visits to Troubridge Island in the early 1900s, White made careful notes of the birds seen, but did not record any penguins on either occasion. [N.B. There is now a large colony of little penguins on Troubridge Island.]

Aboriginal names for little penguins have been recorded for a few locations in South Australia, New South Wales, Tasmania and SW Western Australia. The Narangga people of Yorke Peninsula were using the word "indala" in the nineteenth and early twentieth centuries to describe little penguins (Tindale 1936, cited in Hill and Hill 1975). While there may have been other indigenous words for "penguins" in South Australia, in researching this report, only the one word was found.

The general lack of early records makes it difficult to determine whether current distribution patterns are the same as, or substantially different from, pre-European times.

While the abundance of little penguins prior to European settlement is unknown; it is likely that European activities directly affected both the abundance and range of little penguins. People are historically known to have used little penguins for crayfish bait (*The Kangaroo Island Courier* 1912, *The Advocate* 1947) and food. They have also directly and indirectly influenced the abundance of penguin predators at sea and on land, and have introduced other anthropogenic pressures (see Section 6).

2.4 Recent population abundance and trend

In 1996 the population of little penguins in Australia was recently estimated at 300-500,000 breeding individuals (Dann *et al.* 1996a), which equates to about 150-250,000 breeding pairs. Since then, declines have been documented at some colonies near Perth, Western Australia (Cannell *et al.* 2012); in southeastern Tasmania (Stevenson and Woehler 2007); Victoria (Norman *et al.* 1992) and parts of South Australia (Colombelli-Négrel 2015b, Bool *et al.* 2007), but so have increases including Melbourne's St Kilda breakwater (Preston *et al.* 2007) and Victoria's Phillip Island (Sutherland and Dann 2015).

Based on limited information, the population of little penguins in South Australia was estimated to be about 36,600 breeding individuals (Wiebkin 2011) or 18,300 breeding pairs. Breeding individuals are estimated to comprise about 73% of the little penguin population (Goldsworthy *et al.* 2011). Available information indicates that little penguins breed at about 100 colonies, with numbers of breeding individuals ranging from 10 to about 12,000 (Figure 3, Appendix 1). Pearson Island is considered to have the largest colony, followed by Wardang, Franklin and Reevesby

Islands. Population size estimates are not available for most colonies (Figure 3, Appendix 1). Where estimates are available, they have been collected with a range of methods and therefore have variable accuracies (Appendix 1). For many colonies, observations are little better than records of their presence. Observations of 'few', 'some', 'many', 'common', or 'abundant' have frequently been reported, confounding attempts to assess colony trends.

Trends in the abundance of little penguin colonies vary between locations (Figure 4, Appendix 1). Up to 21 colonies have declined or are suspected to have declined around Encounter Bay, on Kangaroo Island, and on some islands in lower Spencer Gulf. By comparison, a number of colonies off Eyre Peninsula appear to be stable, including Waldegrave, Franklin, Lipson and Hareby Islands (Figure 4). Recent trends are not published for the Pearson Island colony; however they were in "high" numbers in the last survey in 2013 and may be stable (S. Goldsworthy *pers. comm*. 2013, Appendix 1). The Troubridge Island colony is suspected to be stable but it is difficult to determine the population trend due to the different survey methods used during the last 50 years (D. Colombelli-Négrel *unpubl. data* 2016, Appendix 1). Visits to six little penguin colonies on Kangaroo Island, in Encounter Bay and lower Spencer Gulf between 2004 and 2016 failed to locate any penguins, suggesting that they may be extinct from these sites (Figure 4, Appendix 1). Status and trends are unknown for 69 little penguin colonies.

Since 2004, SARDI researchers have observed large colonies of little penguins on Pearson and Olive Islands off the coast of western Eyre Peninsula. At the time of this report, recent survey data were being analysed to determine population trends.

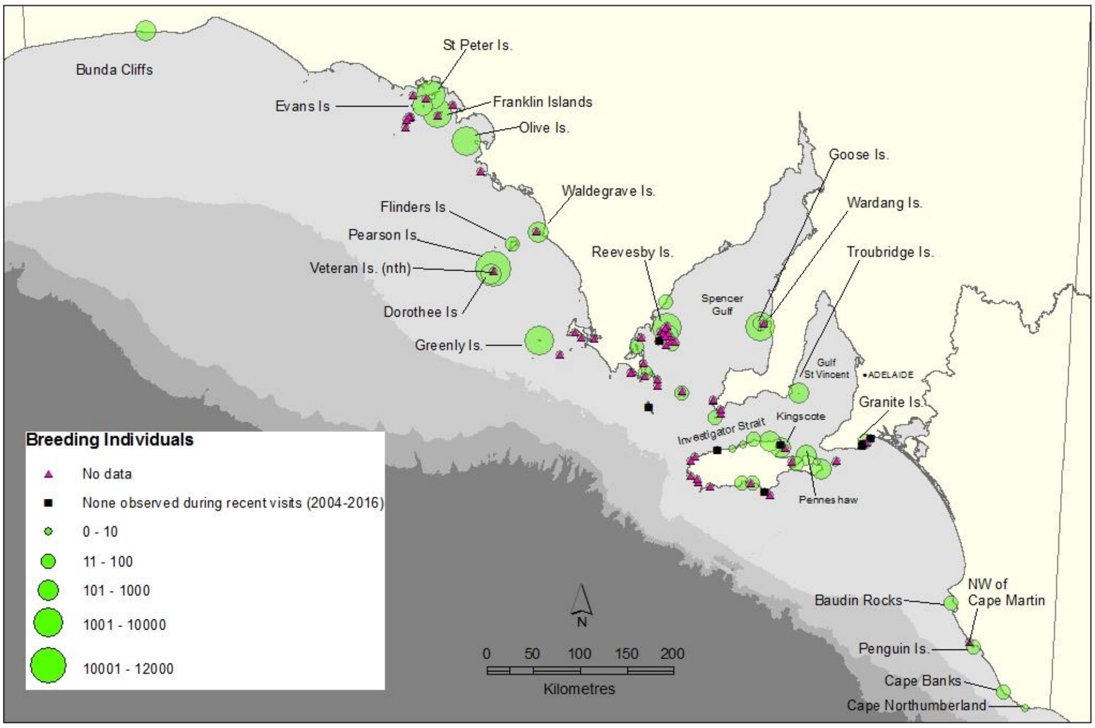

Figure 3. Distribution of little penguin colonies in South Australia and estimated number of breeding individuals in each colony (green circles). Black squares indicate places where penguins were recorded historically, but not observed during subsequent visits between 2004 and 2016, suggesting these colonies are possibly extinct. Purple triangles indicate historical colonies for which there are no recent population data. The mapped data are a compilation of observations from 2004-2015 and have variable accuracies. Appendix 1 lists the colonies depicted on the map, their most recent documented population sizes and historical trends, where known.

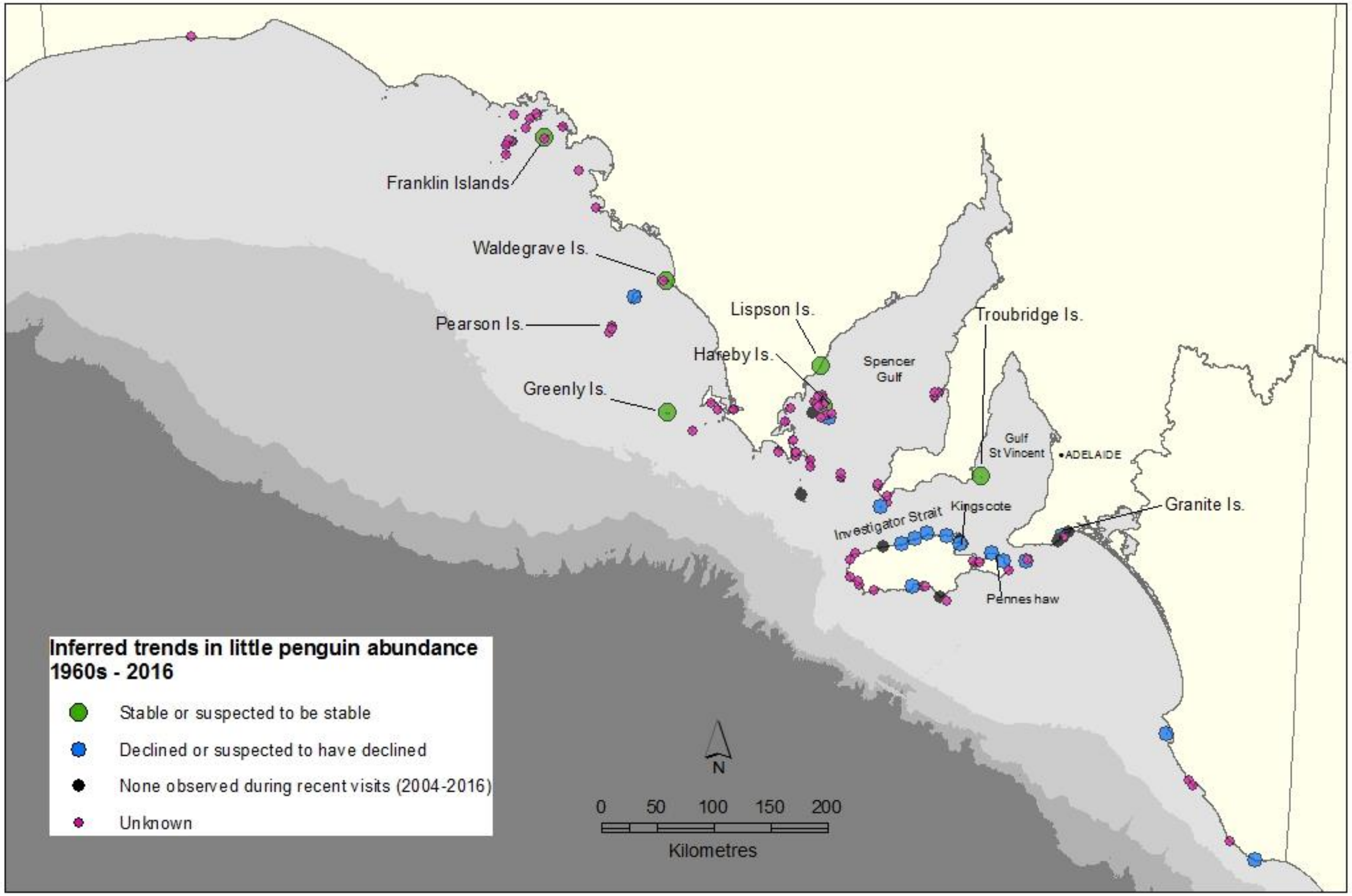

Figure 4. Inferred trends in abundance (breeding individuals) of little penguin colonies in South Australia. Trends have been inferred based on a compilation of surveys and estimates from the 1960s to 2016, and have variable accuracies. Appendix 1 lists the colonies, historic estimates and inferred trends as depicted on the map.

2.5 Conservation status

Little penguins are listed as *least concern* on the IUCN Red List of Threatened Species (IUCN 2012). They are not listed as a threatened species at a national level (under the *Environment Protection and Biodiversity Conservation Act* 1999) or in any State in Australia (e.g. South Australian *National Parks and Wildlife Act* 1972).

There is uncertainty about the conservation status of little penguins in South Australia (Wiebkin 2011). Wiebkin (2011) indicated that they may meet the IUCN criteria (2001) for listing as *vulnerable* at the State level based on criterion A2: a *population reduction observed, estimated, inferred or suspected of ≥30% over the past 10 years OR three generations (whichever is longer), where the reduction or its causes may not be reversible, based on (b) an index of abundance appropriate to the taxon*. Wiebkin (2011) also indicated that they meet the listing criteria for *vulnerable* within the Gulf St Vincent (based on criterion A2b as above) and *least concern* at a national level.

The *Natural Resources Management Act 2004* (NRM Act) divides South Australia into eight NRM regions for planning, managing and implementing environmental management. For each of the five NRM regions with coastlines, the status of native species was assessed by DEWNR (Gillam and Urban 2008, 2009, 2011, 2014a, b). The assessments used data from the Biological Database of South Australia and experts to assess the status of each species against IUCN criteria (IUCN 2001). Little penguins were assessed as threatened in three NRM regions and *data deficient* in two of the five regions in which they occur (Table 1). This is similar to other States where individual colonies have been assessed as threatened, but not all. For example, the population at Manly in New South Wales was listed as *endangered* under the provisions of the NSW *Threatened Species Conservation Act* 1995 in 1997, but the species is not listed as threatened in New South Wales.

More recently, the regional status assessments were used as the basis for assessing the conservation status of all South Australian vascular plants and vertebrate animals at the State level. As part of this process, the assessment of little penguins in June 2015 resulted in a provisional recommended status of Near Threatened (Table 1).

Table 1. Summary of the regional and State-wide status assessments for the little penguin undertaken by DEWNR between 2008 and 2014.

SA NRM region	Conservation status based on IUCN 2001 criteria	Definition of IUCN criteria (m.i. = mature individuals)	Source
West (Eyre Peninsula)	Data deficient		Gillam and Urban 2009
Northern & Yorke	Data deficient		Gillam and Urban 2008
Adelaide & Mt Lofty Ranges	Critically endangered (CR A1a, D); definite decline	CR A1a: Direct observation of >90% regional population reduction over 10 yrs / 3 generations CR D: Estimated population size <50 m.i.	Gillam and Urban 2014a
South East	Vulnerable (VU); probable decline (C2ai)	VU C2ai: Regional population <10,000 m.i.; continuing decline; no colony >1,000 m.i.	Gillam and Urban 2011
Kangaroo Island	Endangered (EN C1); definite decline; possible escalation to critically endangered (CR A2)	EN C1: Regional population <2,500 m.i.; continuing decline of 20% over 5 yrs / 2 generations CR A2: >80% regional population reduction over 10 yrs / 3 generations	Gillam and Urban 2014b
State-wide	Near Threatened (NT A2a,e)	NT Aa,e: Does not qualify for Rare or Threatened status, but may qualify in the future, based on a direct observation of population reduction	Gillam *unpubl. data* 2016

3 Biology and Ecology

Little penguins nest in a wide variety of habitats on the shorelines of sheltered bays, either under bushes, in caves or under limestone capping, or in burrows (Klomp *et al.* 1991, Wiebkin 2011). They do not show affinities for particular species of vegetation, but vegetation density may limit access to their burrow areas (Klomp *et al.* 1991). Alternatively, vegetation may provide shelter from extremes of weather (Marchant and Higgins 1990) and refuge from predators and disturbance by people (Dann 1996a).

In South Australia, little penguins typically breed between April and November and double brooding is common (Johnson and Wiebkin 2008). They typically lay two eggs per clutch, have a 35-day incubation period and provision their chicks over an eight to ten week period (Reilly and Cullen 1981). Following hatching, for the first two to three weeks the parents alternate between guarding the chick and going on one to two day foraging trips. Little penguins reach sexual maturity at two to three years of age (Dann and Cullen 1990). Following fledging, the survival rates of little penguins are estimated to be 17%, 71% and 78% in each of the first three years, respectively, and 83% in subsequent years (Sidhu *et al.* 2007). Adults moult each summer after the breeding season, and this usually takes around two weeks. During this time they are restricted to land and can lose a large proportion of their fat stores (Stahel and Gales 1987). They are also vulnerable to extreme weather conditions such as heat during this time (P. Dann *pers. comm.* 2015). The average lifespan of the little penguin is 6.5 years (Dann and Cullen 1990, Reilly and Cullen 1981); but they have been recorded living for about 26 years in the wild (Dann *et al.* 2005, ABBBS).

Little penguins feed on a diverse range of fishes and cephalopods, but they do not use the same prey across their distributional range, or over time (Wiebkin 2012, Gales and Pemberton 1990, Chiaradia *et al.* 2003, Klomp and Wooller 1988, Hobday 1992, Kowalczyk 2015). In South Australia, little penguins feed largely on anchovy (61% of biomass), and southern sea garfish (11% of biomass), with at least 11 other small fish and cephalopod species contributing to the rest of their diets (Wiebkin 2012, Goldsworthy *et al.* 2011, Bool *et al.* 2007).

Little penguins are visual hunters and only forage during the day (Cannell and Cullen 1998, Collins *et al.* 1999, Ropert-Coudert *et al.* 2006), at 5-50 m of water depth (Bethge *et al.* 1997, Chiaradia *et al.* 2007, Ropert-Coudert *et al.* 2003). During the breeding season, they typically forage close (5-20 km) to their breeding colonies (Weavers 1992, Collins *et al.* 1999, Bool *et al.* 2007, Preston *et al.* 2008, Hoskins *et al.* 2008, Wiebkin 2012). During the non-breeding season, they may forage up to 500 km from their breeding colonies, on foraging trips that are up to one month in duration (Collins *et al.* 1999, Wiebkin 2011). In South Australia, the foraging behavior of breeding penguins is not directly driven by sea-surface temperature, primary productivity or bathymetry (Bool *et al.* 2007, Wiebkin 2011), which contrasts with findings of studies from Bass Strait (Hoskins *et al.* 2008), Penguin Island, Phillip Island, and Motuara and Oamaru in New Zealand (Chiaradia *et al.* 2007). In South Australia, the availability of anchovy is thought to drive the foraging behavior of breeding penguins (Wiebkin 2012).

4 Current Management

Investment in little penguin management is undertaken to mitigate pressures (Section 6) to improve their population status (Section 2) and the socio-economic values that they support (Section 7) (Figure 1). Penguin management is guided by government legislation, policies and strategies including the *National Parks and Wildlife Act 1972* (NPW Act), the *Natural Resources Management Act 2004* (NRM Act) and regional NRM Plans, as well as South Australia's Strategic Plan Target 69 - "Lose no native species as a result of human impacts".

A Memorandum of Understanding about penguin research, monitoring, and management was signed in early 2009 by Kangaroo Island, Northern & Yorke, and Adelaide & Mt Lofty Ranges regional NRM boards, outlining the terms of collaborative management in the Gulf St Vincent area (AMLR NRM 2009 in Wiebkin 2011). Management activities have included raising awareness, education and on-ground projects, including construction of boardwalks and signage and revegetation to protect nesting areas, nest-box installation, penguin surveys and monitoring, control of introduced land-based predators (cats, rats and foxes), weed control, erosion prevention, and rehabilitation of injured birds (AMLR NRM 2011, Wiebkin 2011). Research has included investigating occurrence or intensity of predation (Bool *et al.* 2007, Colombelli-Négrel 2015b, Goldsworthy *et al*. 2011). A mortality register was also established in 2011 to investigate causes of death, parasite loads and body condition of deceased little penguins found along the South Australian coastline (AMLR NRM 2011).

5 Physical drivers

To interpret changes in little penguin colonies it is necessary to consider the physical drivers of the ecosystem in which they occur (Figure 1). Two of the major physical drivers of change within this ecosystem are the Bonney upwelling and Leeuwin current. Physical factors that shape the ecosystem, but which do not drive change, such as bathymetry, topography and geology, are not considered here.

The influence of the following physical drivers on little penguin populations in South Australia is poorly understood. Changes in these drivers could impact the foraging behaviour and reproductive success of little penguins either positively or negatively. These drivers can vary naturally within and between years and climate change is likely to affect these drivers.

5.1 Upwelling

Upwelling of cold (11–12°C), nutrient-rich water occurs in summer along the edge of the continental shelf between Portland in Victoria and the Eastern Great Australian Bight (Herzfeld and Tomczak 1999). This upwelling, known as the Bonney Upwelling (shown in Figure 5 as 'Seasonal upwelling'), is driven by strong south-easterly winds, and it boosts primary, secondary and tertiary production (Middleton and Platov 2003, Middleton and Bye 2007, Ward *et al.* 2006), including the abundance of anchovy (Ward *et al.* 2006), which is the primary prey of little penguins in South Australia. El Niño – Southern Oscillation events can enhance upwelling (Middleton and Bye 2007).

5.2 Leeuwin Current

The Leeuwin Current (Figure 5) brings relatively warm and low nutrient waters to South Australia in winter (Middleton and Bye 2007). It is driven by the influx of tropical Pacific Ocean water into the Indian Ocean via the Indonesian through-flow. The strength of the Leeuwin Current is weaker during El Niño–Southern Oscillation events (Feng *et al.* 2003). The down-welling associated with the intrusion of the Leeuwin Current results in low productivity off South Australia (van Ruth *et al.* 2010).

5.3 Climate change

Climate change is an emerging issue for seabirds and mammals in Australia, with many impacts already evident (Chambers *et al.* 2011, 2012, 2015). Little penguin breeding and survival has been found to be influenced by warmer sea surface temperatures, as well as changes in the dynamics of ocean currents and wind components (Chambers *et al.* 2009a, 2011, 2012, Chambers 2004, Cannell *et al.* 2012, Mickelson *et al.* 1992, Cullen *et al.* 2009).

In Western Australia, rising sea-surface temperatures and periods of stronger Leeuwin Current have been correlated with lower abundances of fish and poor breeding outcomes in little penguins (Cannell *et al.* 2012). At Phillip Island, high sea surface temperatures before the breeding season have been correlated with earlier laying in little penguins, a greater number of chicks, and heavier chicks (Cullen *et al.* 2009), as well as increased survival in the first-year, but lower survival in adults (Sidhu 2007). Sea surface temperatures in Spencer Gulf and the Great Australian Bight have been rising (0.05°C per decade from 1900 to 2005 and 0.11°C per decade from 1950 to 2005) (Suppiah *et al.* 2006), but the impacts of this on little penguins in South Australia have not been studied.

Future impacts of climate change on little penguins (in the next century) are predicted to include some loss of breeding habitat due to sea level rise and increased fire risk (Dann and Chambers 2013). Increases in extreme fire days is predicted to lead to higher risk of injury or death for little penguins (Chambers *et al*. 2012), as little penguins are reluctant to abandon nests or emerge during daylight (Chambers *et al*. 2009a). Predicted increases in extreme events (winds, cyclones, storms, and floods) (Chambers *et al*. 2009b) could further reduce the nesting habitat, including at Troubridge Island in South Australia (Wiebkin 2011). Increases in the number of days >35^{0}C in the Perth and Adelaide region (Pearce *et al*. 2007) are predicted to have a negative impact on little penguins, as they are unable to withstand prolonged exposure (even a few hours) to air temperatures above 35^{0}C (Stahel and Gales 1987), with heat stress accounting for ~0.2% of adult annual mortality (Dann 1991). The risk of mortality from heat is increased during the moult period when penguins are restricted to land for 2 weeks while they grow a new set of feathers. This typically occurs in summer (P. Dann *pers. comm*. 2015).

For this report, risk assessments of the effects of climate change on little penguin colonies were limited to those that could have measurable effects on one or more colonies over the next five years. Longer-term risks were acknowledged, but not included in the risk assessment table at the end of this report (Appendix 6). Risk assessment scores were derived for sea level rise, sea temperature rise and extreme heat waves.

Stakeholders rated the risks posed by sea level rise and storm surges overall as either 'negligible' or 'low' for all colonies. Storm surges were considered 'likely to occur', with either a 'negligible' or 'minor' consequence depending upon the proximity of nest-sites to the high water mark (Appendices 2 and 6).

Stakeholders rated both sea temperature rise and extreme heat waves over the next five years as relatively 'low' ('likely to occur', but with 'minor' consequence) (Appendices 2 and 6). While an extreme heat wave could affect birds that are moulting, the whole population is unlikely to decline because not all birds moult at the same time.

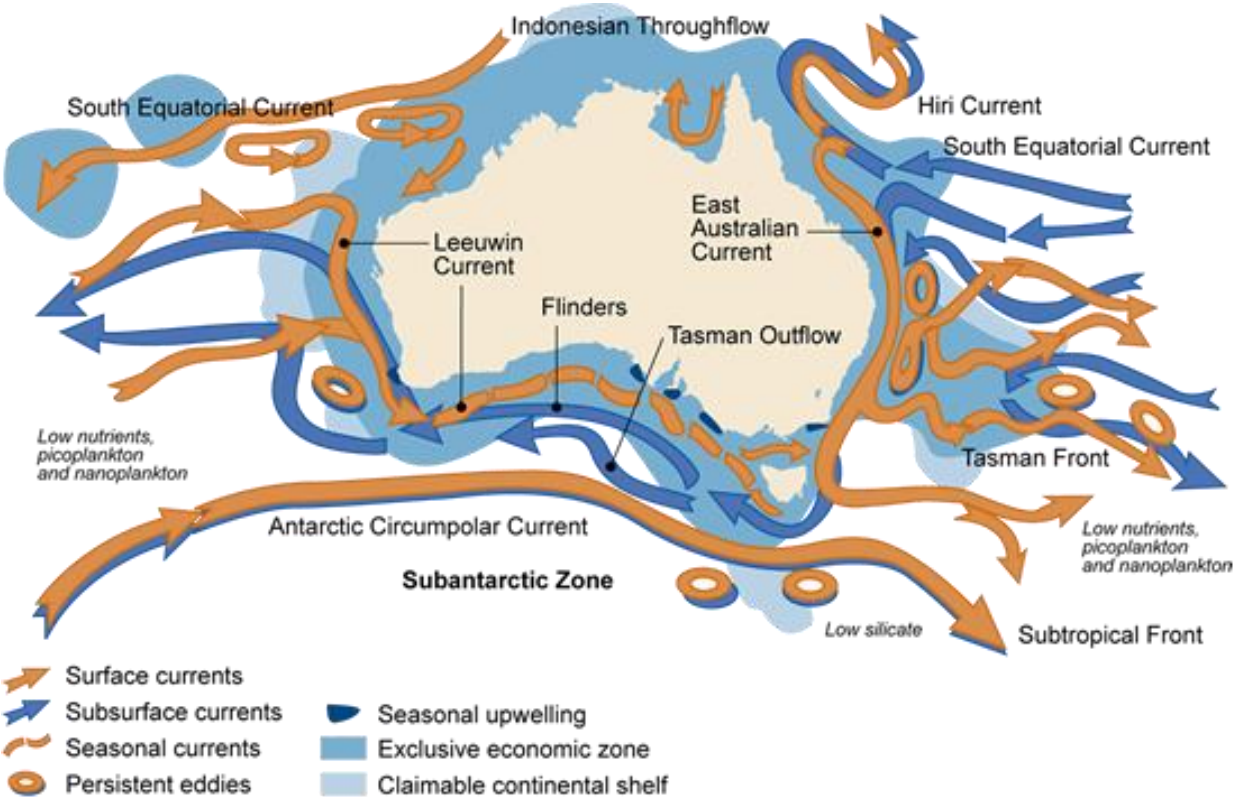

Figure 5. Ocean Currents surrounding Australia. The Leeuwin Current can be seen off the Western Australian Coast. © Commonwealth of Australia 2013, CC BY 3.0 au, https://commons.wikimedia.org/w/index.php?curid=36006341

6 Pressures

This section summarises natural and anthropogenic pressures on little penguins in South Australia under the following categories: marine predators, terrestrial predators, food availability, fisheries bycatch, entanglement, parasites, disease, loss of habitat, competition for nest sites, weeds, visitation by people, disturbance by people, coastal pollution and turbidity from dredging.

6.1 Predation by land predators

6.1.1 Cats (*Felis catus*)

Cats are known predators of little penguins (Stahel and Gales 1987, Reilly and Cullen 1979, Stevenson and Woehler 2007, M. McKelvey *unpubl. data* 2015, Masters 2007). On Phillip Island in Victoria, about 4% of cat stomach contents (based on total mass; n = 277), consisted of adult little penguins, which increased to >12% when shearwaters were absent from the island between 20 May and 19 September each year, 1983-1994 (Kirkwood *et al*. 2000). On Kangaroo Island, motion-sensor studies found that cats were the most commonly observed predator at penguin burrows (Wiebkin *et al*. 2012). One study monitored 110 sites around Kangaroo Island at least annually (1980 - 2010) and cats were found to be responsible for more than 80% of land-based kills of little penguins within those study sites (n = 321; M. McKelvey *unpubl. data* 2015). Kangaroo, Flinders and Wardang Islands are the only islands in South Australia where cats are still present (A. Sharp *pers. comm*. 2015; P. Copley *pers. comm*. 2016), although cats very occasionally access Granite Island (Bool *et al*. 2007). Cats were introduced to Althorpe, Reevesby and St Francis Islands in the Nineteenth Century, but were eradicated between 1990 and 2004 (Robinson *et al*. 1996, Wiebkin 2011, Pedler 1991, Pedler and Copley 1993). Cats have been found on Goose Island, but are controlled as required by the lessee (DEH 2009). (The island is one of a group comprising Goose Island CP, but the main island is leased to Scotch College.)

<u>On Kangaroo, Flinders and Wardang Islands, where cats are known to occur, or on mainland penguin colonies in the South-East that cats can access, the risk of cat predation was rated as ‘very high’ (‘likely to occur’, with ‘major’ consequence)</u>, because cats have the potential to cause major impacts to penguin populations (Wiebkin 2011, Achurch *et al*. 2015). <u>Other island penguin colonies had a ‘negligible’ risk rating for cat predation, since the likelihood of occurrence is ‘remote’</u> (Appendices 2 and 6).

6.1.2 Domestic dogs (*Canis lupis familiaris*)

Domestic dogs have been known to kill little penguins (Holderness-Roddam and McQuillan 2014). Dogs were found to be responsible for 15.4% of recorded little penguin mortalities on Phillip Island between 1986 and 1989 (Dann 1991). Dogs are also known to have killed 30 little penguins in a single incident at Ulverstone in Tasmania in 2008 (Holderness-Roddam and McQuillan 2014), 80 penguins at Penneshaw in one night in 1984 (*The Canberra Times* 1984), and one penguin at Penneshaw in 2004 (Wiebkin 2011).

Dogs co-occur with little penguins on the mainland and on Kangaroo Island. In a two month study of cat predation on penguins on Kangaroo Island, Achurch *et al*. (2015) noted the presence of dogs at the Point Ellen and Emu Bay little penguin colonies but not at the Cape Willoughby, Antechamber Bay or Penneshaw colonies. There was no correlation between dog presence and penguin breeding success (n=123), and dogs were considered to be an intermittent threat to these colonies (Achurch *et al*. 2015).

The risk ratings for predation by dogs at different colonies varied due to differences in the manner in which dogs can access colonies. <u>Where dogs are relatively common (e.g. near mainland coastal and Kangaroo Island towns) the risk of predation, based on a ‘worst case’ scenario, was rated as ‘very high’ (‘likely to occur’, with ‘major’ consequence)</u>. By default, the risk of dogs to all Kangaroo Island colonies was rated as ‘very high’; however the risk is unlikely to be equally spread across the island; consequently <u>the risk for other Kangaroo Island colonies has been</u>

modified to 'low' ('possible', with 'moderate' consequence). On Granite Island, the risk of predation by dogs was rated as 'high' ('possible', with 'catastrophic' consequence), because the impact of one dog attack on the small number of penguins could be catastrophic for the population. (Appendices 2 and 6).

For other island colonies with human habitation or favourable landing beaches in popular boating areas, such as Flinders, Reevesby, Spilsby, Thistle, Troubridge, Wedge and Wardang Islands, the risk of predation by dogs was rated as 'low' ('possible', with 'moderate' consequence). For colonies in the Sir Joseph Banks Group (excluding Spilsby and Reevesby Islands), the risk was rated as 'negligible' ('possible', with 'minor' consequence). All other more remote and inaccessible (rocky) islands were rated as 'negligible' risk ('remote' likelihood) (Appendices 2 and 6).

6.1.3 Foxes (*Vulpes vulpes*)

Foxes are known predators of little penguins in Australia, including surplus killings where birds are killed and left (Kirkwood *et al.* 2014, Dann 1991, Short *et al.* 2002, Wallach *et al.* 2015). A breeding colony on Middle Island (Victoria) decreased from 600 to 10 birds in 5 years due to fox predation (Wallach *et al.* 2015). In 1994, a fox killed 74 little penguins (of the 1500 colony) on Granite Island in 3 nights when it gained access via the causeway (Short *et al.* 2002). A fox killed 14 of the 29 little penguins at Melbourne Zoo when it gained access to the exhibit overnight (*The Age* 2015). Foxes contributed to the elimination of nine out of ten colonies on Phillip Island in the mid-1900s, and were later attributed to 58% of land mortalities in the remaining colony (Dann 1991). A study of fox stomach contents on Philip Island found 13% (based on total mass; n=147) consisted of little penguins and this increased when shearwaters were absent each year, 1983-1994 (Kirkwood *et al.* 2000). Foxes are not known to occur on any island where penguins are also present, except Granite Island, where foxes have occasionally accessed the island (Robinson *et al.* 1996, P. Copley *pers. comm.* 2016).

Foxes can only access colonies on the mainland coast, or island colonies via causeways where present (e.g. Granite Island), or by swimming to the few small islands that are very close to the mainland. Risks of predation by foxes was rated as 'very high' for three South-East mainland colonies ('occasional', but with 'catastrophic' consequences). The risk for Granite Island was rated as 'high' ('possible', with 'catastrophic' consequence), and 'moderate' for Lipson Island ('possible', with 'major' consequence). Risk was rated as 'negligible' for the Nullarbor (Bunda) cliffs ('unlikely' to occur, and 'minor' consequence). Other colonies were rated 'negligible' due to 'remote' chance of access (Appendices 2 and 6).

6.1.4 Snakes

Snakes are potential predators of little penguin chicks and eggs (Wiebkin 2011) but there are no published records of this. On Kangaroo Island, based on personal observations at more than 110 regularly monitored sites around the island (1980 - 2010), tiger snakes (*Notechis scutatis*) have been recorded sharing penguin burrows during incubation of eggs and after chicks are 25 days old, and direct observation over several days showed there was no aggression between the two species (M. McKelvey *unpubl. data* 2015). There was no evidence of any tiger snakes killing and eating chicks (M. McKelvey *unpubl. data* 2015).

However, tiger snakes are known to kill and consume young mutton bird chicks, and on islands where little penguins also breed it is possible that small penguin chicks may be taken occasionally. For islands where penguins coincide with mutton birds and tiger snakes, the risk of predation by snakes was rated as 'negligible' ('unlikely' and 'minor' consequence) (Appendices 2 and 6).

6.1.5 Goannas

Goannas are a known opportunistic predator of little penguins (Colombelli-Négrel 2015a). Goannas occur in the vicinity of the few mainland penguin colonies in existence, as well as on Kangaroo Island and a handful of other islands. Rosenberg's goannas (*Varanus rosenbergi*) on Kangaroo Island have been recorded visiting penguin nesting burrows on a daily basis and leaving when a parent bird was in attendance at the nest. At Emu Bay, Kangaroo Island, a Rosenberg's goanna was recorded on camera eating a six to seven week-old little penguin chick and was suspected of eating two others (one observed and one on camera) when a parent was absent (Colombelli-Négrel and Kleindorfer 2014, Colombelli-Négrel 2015a). Colombelli-Négrel (2015a) also observed goannas occasionally scavenging on penguin carcasses on Kangaroo Island. During monitoring at 110 sites around Kangaroo Island (1980 - 2010), researchers observed and filmed four chicks (3 already dead) being eaten by Rosenberg's goannas (M. McKelvey *unpubl. data* 2015).

Global mean temperatures are rising due to climate change (IPCC 2013). At Emu Bay, Kangaroo Island, this appears to coincide with goannas becoming active earlier in the spring and for longer. Also, the peak penguin breeding seasons at several colonies on Kangaroo Island and Gulf St Vincent were later in 2012-15 than in 2004-11 (e.g. in spring vs winter) (D. Colombelli-Négrel *pers. comm.* May 2016). If these trends continue, there may be an increased overlap between the presence of penguin chicks and the goannas that may prey on them.

As Kangaroo Island's Emu Bay penguin colony appears to have more goanna activity than other colonies (D. Colombelli-Négrel *pers. comm.* May 2016), the risk of predation was rated as 'high' ('likely' to occur, with 'moderate' consequence) due to the small population size. Where other island penguin colonies coincide with goannas, the risk of predation by goannas was rated as 'low' ('likely', but with 'minor' consequence). For the SE colony 6km NW of Cape Martin, the risk was rated as 'low' ('occasional' but with 'minor' consequence), and for the Cape Banks colony, the risk was rated as 'negligible' ('possible' with 'minor' consequence'). (Appendices 2 and 6).

6.1.6 Rats

Introduced black rats (*Rattus rattus)* are known predators of little penguin chicks and eggs when adult penguins are not present (Bool *et al*. 2007). Black rats are known to occur on Granite, Kangaroo, Flinders and Thistle Islands. It is possible that they also occur on other islands close to the mainland or where people live and/or visit regularly (e.g. Wardang, Boston and Spilsby Islands).

At Granite Island, tracking tunnels and motion sensor cameras have been used to determine that rat activity increases around the penguin colony during June and July (D. Colombelli-Négrel *pers. comm.* May 2016). Bool *et al*. (2007) recorded that black rats on the island killed four chicks and may have killed an additional 15 that were found with rat wounds. An extensive rat baiting programme on Granite Island in 2006 resulted in fewer dead chicks being discovered and also a suspected reduction in the rate of predation – both indicating a positive effect of rat-control efforts (Bool *et al*. 2007, Colombelli-Négrel and Kleindorfer 2014, Colombelli-Négrel 2015b). Permanent rat baiting stations have continued on Granite Island since 2006 (P. Unsworth *pers. comm*. 2016). The recent closure of the Granite Island kiosk may have also caused a decline in the rat population on the island (P. Unsworth *pers. comm*. May 2016).

On Kangaroo Island, Achurch *et al*. (2015) found that black rat abundances varied substantially both among sites (Emu Bay, Antechamber Bay, Brownlow, Cape Willoughby, Penneshaw, and Point Ellen) and seasons, and concluded from circumstantial evidence only (hatching and fledging rates), that the rats were not having a large impact on hatching success of little penguins (n = 123). Given the findings on Granite Island, this would appear to be a risk that needs further investigation.

The risk of predation by black rats on Granite Island has been rated as 'very high' ('likely', and with 'major' consequence), to reflect the potential outcome if the current rat baiting programme was to cease[3]. The risk for accessible colonies in the South-East, and on Kangaroo, Flinders and St Francis Islands was rated as 'low' ('occasional' occurrence, with 'minor' consequence). Any future control of feral cats on these islands would need to be integrated with rat control, otherwise this rating should be reassessed. Rats were not assessed as a risk for Thistle Island because of the belief that they had been eradicated from the island; however with the recent discovery

[3] Workshop participants rated the risk of predation by black rats on Granite Island as 'moderate' ('occasional' and with 'moderate' consequence), as an indication of the success of the current rat baiting programme. However this was corrected following the workshop to maintain consistency with the other 'Consequence' assessments, which considered the consequence if no management is undertaken.

of rats on the island (P. Copley *pers. comm*. 2016), there is concern for the penguin colony, considering there are no cats present (Appendices 2 and 6).

There has been one reported case of the native water rat (*Hydromys chrysogaster*) preying on a little penguin chick at the breakwater wall at St Kilda in Victoria (Preston 2008). Water rats do occur on Granite Island, but there is no information to suggest that they have been a significant predator of penguins or their eggs.

6.1.7 Mice

House mice (*Mus domesticus*) have been recorded attacking and preying on chicks of nesting seabirds (Cuthbert and Hilton 2004, Wanless *et al*. 2007), including on sub-antarctic Marion Island (<1% of albatross chicks were attacked) (Jones and Ryan 2010). At Gough Island in the South Atlantic Ocean, researchers filmed high numbers of healthy albatross and petrel chicks being attacked by mice (Wanless *et al*. 2007). There are no published records of mice preying on little penguins.

House mice exist in little penguin colonies on the mainland, Kangaroo Island, and several other offshore islands. As there is no evidence of mice preying on any South Australian seabird colonies, including penguins, the risk that they pose to little penguins was rated as 'nil' ('remote' likelihood) (Appendices 2 and 6).

6.1.8 Possums

Common brushtail possums (*Trichosurus vulpecula*) are known to prey upon eggs and chicks of a range of bird species, including chickens, Japanese quail, house sparrows, fantail, Westland black petrel and the endangered kokako in New Zealand (Brown *et al*. 1993, 1996), and the glossy black-cockatoo in Australia (Mooney and Pedler 2005). They are suspected opportunistic predators of little penguin chicks and eggs (Colombelli-Négrel and Kleindorfer 2014, Colombelli-Négrel 2015a) because they have been frequently filmed near the entrances of little penguin burrows on Granite Island and Kangaroo Island. No evidence of predation has been recorded since motion sensor cameras were installed at Granite and Kangaroo Island in 2011.

The risk of predation by possums in South Australian penguin colonies was rated as 'negligible' ('possible', but with 'negligible' consequence) (Appendices 2 and 6).

6.1.9 Feral bees

During monitoring at 110 sites around Kangaroo Island (1980 - 2010), there were five direct observations of feral bees (*Apis mellifera*) taking over occupied little penguin nesting burrows and apparently killing hatchlings on Kangaroo Island (M. McKelvey *unpubl. data* 2015). Other feral bee hives formed in unoccupied burrows (M. McKelvey *unpubl. data* 2015). There are no published records of feral bees killing little penguins.

The risk of impacts by feral bees on little penguin colonies was rated as 'negligible' ('unlikely' occurrence, and 'minor' consequence) (Appendices 2 and 6).

6.2 Predation by marine predators

6.2.1 Long-nosed fur seals

Long-nosed fur seals (*Arctocephalus forsteri*) are native to Australia and New Zealand and are known predators of little penguins (Page *et al*. 2005). They breed in Australia from Western Australia to New South Wales, with the majority breeding in SA (about 97,250 individuals, 80% of the population in Australia, Shaughnessy *et al*. 2015). In South Australia, the distribution of long-nosed fur seals overlaps with that of little penguins (Figure 6). Breeding colonies of the two species co-occur at a number of locations, including Olive Island, Pearson Island, Dorothee Island, Greenly Island, Baudin Rocks, Kangaroo Island, and historically at Cape Gantheaume and the Neptune Islands (Robinson *et al*. 1996, Copley 1996, Shaughnessy *et al*. 2015, B. Page *pers. comm*. 2015.).

Seal harvesting between 1801 and 1830 led to the functional extinction of long-nosed fur seals in South Australia (Ling 1999, Kirkwood and Goldsworthy 2013). Following the cessation of sealing in the 1830s, fur seal abundance remained low until a gradual change in community attitudes in the twentieth century, eventually leading to a series of marine protection measures from the 1950s onwards. The species then started to re-establish slowly and over the last 25 years has made a significant recovery (Shaughnessy and Dennis 2001, Shaughnessy and McKeown 2002, Shaughnessy *et al.* 2014, 2015). Recent surveys indicate that about 97% of the SA population is based on islands around Kangaroo, Liguanea and the Neptune Islands (Shaughnessy *et al.* 2015).

Shaughnessy *et al*. (2015) described the increase in the long-nosed fur seal population in South Australia up to early 2014, and considered it likely that the population would "continue to increase over the coming decade, primarily by expansion in colonies on Kangaroo Island and by establishment of new colonies". However, they have also noted since that the growth of the three largest fur seal colonies in SA has peaked. On the Neptune Islands, numbers have declined slightly since the mid-2000s. At Cape Gantheaume, pup numbers have peaked and population estimates have levelled out over the past five years. At Liguanea Island, pup numbers peaked in the mid-2000s and they have declined slightly since then (S. Goldsworthy *pers. comm*. May 2016).

Adult long-nosed fur seals feed on a broad range of species, including Southern Ocean arrow squid (*Todarodes filippovae*) (25.8%), Gould's squid (*Nototodarus gouldi*) (19%), redbait (*Emmelichthys nitidus*) (13.0%), calamari squid (*Sepioteuthis australis*) (7.9%) (Goldsworthy *et al.* 2011) and little penguins (*Eudyptula minor*) (Page *et al*. 2005, Bool *et al*. 2007). Scat content studies have found that long-nosed fur seal diets differ between regions in South Australia (Reinhold 2015), with the estimated biomass of little penguins in scats found to be 4% on Kangaroo Island (study sites at Cape du Couedic, Cape Gantheaume, Cape Kersaint, Penneshaw, Ballast Head, Kingscote, Hummocky and Pissy Boy Rock); 10% on Yorke Peninsula (study site at Port Giles) and 42% on Fleurieu Peninsula (study sites at Granite, West, and Seal Islands) (Reinhold 2015). Scat samples were collected between July and September 2014.

The component of diet made up of little penguins also differs between male and female long-nosed fur seals (Page *et al*. 2005). For example, a study on Kangaroo Island found little penguins made up 23-44% of the estimated biomass for males and 4.5-27% for females (Page *et al*. 2005). Reinhold (2015) found the majority of little penguin predation in scats collected at haul-out sites (10 haul-out sites versus two Kangaroo Island breeding sites; locations as listed in above paragraph), which are predominantly composed of non-breeding animals (sub-adult males and juveniles). In addition, Reinhold (2015) found a significant difference in prey biomass composition of Kangaroo Island samples between the six haul-out sites and two breeding sites. The scat samples collected at breeding sites contained proportionally higher prey from oceanic waters (beyond the continental shelf break) than scats collected from haul-out sites, which contained more prey from shelf waters (including little penguins) (Reinhold 2015).

These studies indicate that the consumption of little penguins by long-nosed fur seals is likely to have been considerably overestimated (Reinhold 2015). Diet studies are known to overestimate the abundance of prey consumed near shore and prey that have relatively more identifiable remains (such as penguin feathers) (Gales and Pemberton 1994, Fea and Harcourt 1997, Lake 1997, Fea *et al.* 1999, Hume *et al.* 2004). In contrast, diet studies underestimate, or do not detect prey that are entirely voided at sea, prey that have fewer identifiable remains (such as some fish and cephalopods), and prey that take a long time to digest.

The likely overestimation of little penguins in the diet of long-nosed fur seals is supported by tropho-dynamic modelling, based on the metabolic requirements, prey, population sizes and breeding rates of little penguins and fur seals (Goldsworthy *et al.* 2011). These models indicate that if consumption of little penguins by fur seals exceeds 0.15% of their diet (studies typically indicate that consumption is at least 10 times greater than that), then little penguins would be consumed faster than they can breed. Even though consumption of little penguins by fur seals is likely to be overestimated by most diet studies, only a low level of predation would be required to make little penguin populations locally extinct, particularly where fur seals are abundant or where their foraging distributions overlap (Figure 6).

To more accurately estimate the biomass of penguins in the diets of fur seals, a research project is currently investigating how quickly penguin prey pass through fur seal digestive tracts and how many scats contain the remains of a single penguin. (S. Goldsworthy *pers. comm*. May 2016).

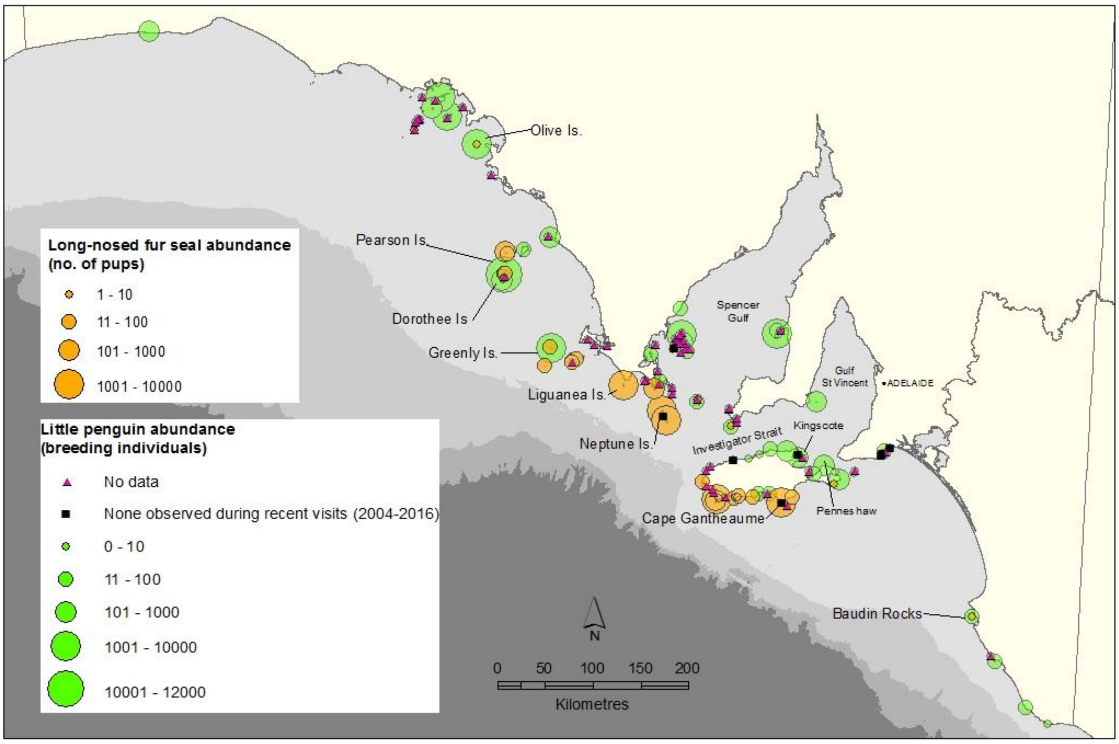

Figure 6. Distribution and size of little penguin breeding colonies (number of breeding individuals) and long-nosed fur seal breeding colonies (number of pups) in South Australia. Population size estimates for long-nosed fur seal breeding colonies are from Shaughnessy *et al*. (2015), primarily for the 2013-14 breeding seasons. Population size estimates for little penguin breeding colonies are a compilation of estimates from 2004-2016 as listed in Appendix 1.

Studies of fur seal scats and beach-washed penguin carcasses in Encounter Bay indicate that more penguins have been killed or preyed on than the number of penguins in the local colonies. This leads to the suggestion that much of the predation may have occurred outside of Encounter Bay. It is not known how many, or which, individual fur seals prey on the penguins.

Risks of predation by fur seals were assessed in three zones: western zone (west of Coffin Bay), central zone (Encounter Bay, Kangaroo Island, Gulf St Vincent and Spencer Gulf) and south-east zone (Murray Mouth to Victorian border).

The central zone has several penguin colonies that have declined in the last 5 to 20 years. Some colonies are now extinct. The largest fur seal breeding colonies and haul-out sites are also in this central zone, on the southern coast of Kangaroo Island (Figure 6). <u>The risk to penguin colonies from long-nosed fur seal predation in the central zone (between Coffin Bay and the Murray Mouth) was rated as 'very high' ('likely', with 'major' consequence[4])</u> (Appendices 2 and 6).

[4] For some colonies, such as Neptune Islands and Cape Gantheaume, predation by long-nosed fur seals appears to have had 'catastrophic' consequences, leading to local extinction, but these sites were not assessed during the workshop. because the risks no longer apply and are unlikely to do so within the next five years (i.e. recolonisation is not expected). The evidence for these 'extinctions' being caused by fur seal predation is circumstantial only. As these fur seal colonies expanded to become the largest in SA, they also became crowded. Because of such crowding, it is possible that at least some of the penguins coming ashore survived and moved to another location. However, there is no evidence for this contention either.

In the western zone (west of Coffin Bay), there is no evidence to suggest that penguin populations are declining. The number of fur seals breeding and hauling out in this zone is relatively low (Fig 6) and not predicted to increase quickly in the near future, as they have on Kangaroo Island (S. Goldsworthy *pers. comm.* May 2016). The risk of predation by long-nosed fur seals west of Coffin Bay was rated as 'low' ('possible', with 'moderate' consequence) (Appendices 2 and 6).

There are few published and reliable trend estimates for penguin colonies off the west coast of Eyre Peninsula. Workshop participants suggested it should be a priority to rectify this gap in knowledge, because if penguin declines are found to be widespread across the State, then causes of decline may be attributed to multiple pressures, including disease or predation by sharks (S. Goldsworthy *pers. comm*. May 2016).

In the South East zone there are few penguin colonies, and population trends are difficult to interpret. There is only one small long-nosed fur seal breeding colony: at Baudin Rocks. The risk of predation by long-nosed fur seals in the South East is 'negligible' or 'low' ('possible', with either 'minor' or 'moderate' consequence) (Appendices 2 and 6).

6.2.2 Australian fur seals

Australian fur seal (*Arctocephalus pusillus doriferus*) numbers have slowly increased in South Australia since harvesting ceased in the early 1830s. In recent decades, a small breeding population has established on and around Kangaroo Island. There is also a regular haul-out site at Baudin Rocks in the South-East.

In Victoria, Australian fur seals are the predominant fur seal species. Researchers from Phillip Island Nature Park have assessed Australian fur seal diet at Seal Rocks by identifying the remains of prey in bi-monthly scat collections. Prey includes 42 fish species and seven cephalopods. No penguins or other birds were found in scats (Deagle *et al*. 2009). The fur seal colony is within 5km of the large penguin colony on Phillip Island.

The risk of predation by Australian fur seals to penguins was rated as 'nil' ('remote' likelihood) (Appendices 2 and 6).

6.2.3 Australian sea-lions

Little penguins have been reported occasionally in the diet of Australian sea-lions (*Neophoca cinerea*) (Gales and Cheal 1992, McIntosh *et al.* 2007). Little penguin remains were found in one of 16 regurgitate samples from Seal Bay on Kangaroo Island (McIntosh *et al.* 2007). A tropho-dynamic model of the Great Australian Bight estimated the prey contribution of little penguins in the diet of Australian sea-lions to be 0.04%, with octopus and squid making up the largest proportions of their diet (Goldsworthy *et al.* 2011).

The risk of predation by Australian sea-lions was rated as 'negligible' ('possible', with 'minor' consequence) across the whole State (Appendices 2 and 6).

6.2.4 Sharks

The extent to which sharks eat little penguins is unknown (Hocken 2000). Most large pelagic sharks feed on fish but some, including white sharks (*Carcharodon carcharias*), feed on marine mammals and birds (Graham 2007). Dusky sharks (*Carcharhinus obscurus*) are known to consume birds in the Great Australian Bight, but the importance of birds in their diet was calculated to be less than 0.5% (Rogers *et al.* 2012). Birds were not found in the diets of bronze whalers (*Carcharhinus brachyurus*), smooth hammerheads (*Sphyrna zygaena*), common thresher (*Alopias vulpinus*), or shortfin mako sharks (*Isurus oxyrinchus*) (Rogers *et al*. 2012).

Given limited evidence, the risk of predation by sharks was rated as 'low' ('occasional', with 'minor' consequence) (Appendices 2 and 6).

6.2.5 Sea-eagles

White-bellied sea-eagles (*Haliaeetus leucogaster*) are predators of juvenile and adult little penguins in South Australia (Falkenberg *et al.* 1994, Marchant and Higgins 1993, Wiebkin 2012). The contribution of little penguins in the diet of white-bellied sea-eagles has not been published, but little penguins are believed to constitute a minor component of their diet (T. Dennis *pers. comm.* 2015). White-bellied sea-eagles have a diverse diet including fish, birds, reptiles, mammals, crustaceans and terrestrial carrion (del Hoyo *et al.* 1994, Ferguson-Lees and Christie 2001, Marchant and Higgins 1993, Rose 2001, Debus 2008). The majority of their territories are in the west of South Australia and on Kangaroo Island (Figure 7).

Because predation of penguins by sea-eagles was thought to be 'occasional' wherever sea-eagles occur (everywhere except in the South East), the risk was rated as 'low' ('occasional' likelihood, with 'minor' consequence) (Appendices 2 and 6).

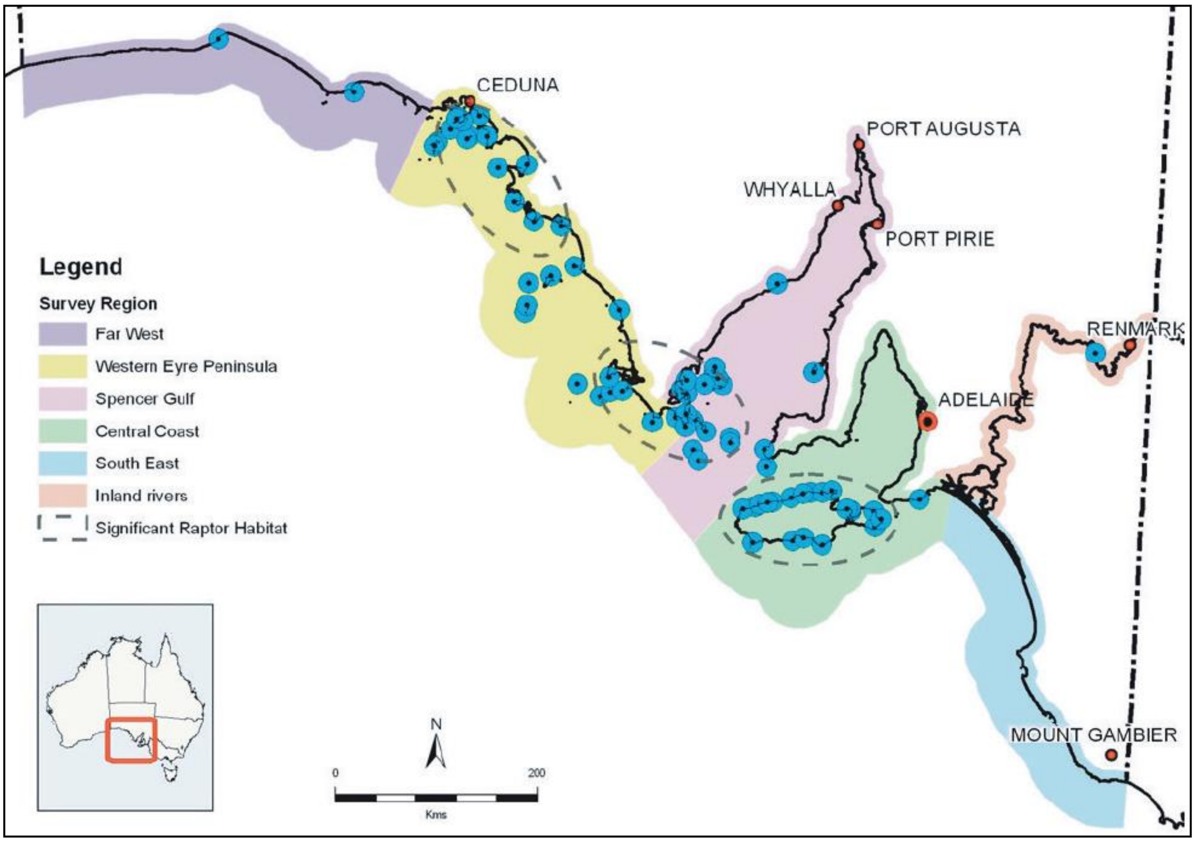

Figure 7. Map of distribution of white-bellied sea-eagle territories (●) in South Australian coastal regions. Map from Dennis et al. (2011).

6.3 Food availability

For the purposes of this risk assessment, natural food availability was assessed independently of availability influenced by the impacts of fisheries on penguin food sources.

In a little penguin diet study from 2004 to 2006 (Wiebkin 2012), natural food availability was not found to be a limiting factor to penguins in South Australia, contrary to findings in other states (Harrigan 1992). Widespread mortality of pilchard (*Sardinops sagax*) around the southern coast of Australia from March to May in 1995, was associated with an increase in little penguin mortality in Bass Strait (1926 dead penguins reported in Victoria) (Dann *et al.* 2000). Of 29 little penguins autopsied, 26 had died of starvation associated with mild-severe gastro-intestinal parasitism (Dann *et al.* 2000).

Causes of mortality in beach-washed little penguins was investigated by the South Australian Museum between 2011 and 2015. Of the carcasses examined, there were 112 individuals for which a primary cause of death was detectable, and of these, 27 penguin deaths were attributed to starvation (Tomo 2015, Kemper and Tomo 2015).

The risk of insufficient food availability from natural causes (including mass fish die-offs) was rated as 'high' ('likely' to occur, with 'moderate' consequence) (Appendices 2 and 6). Food shortages are generally periodic in duration and may affect breeding success of little penguins in some years. Seabird populations fluctuate naturally in response to food availability and recover rapidly.

There is no evidence for fisheries impacts on little penguin colonies. The most common prey of little penguins in South Australia is Australian anchovy (*Engraulis australis*) (Wiebkin 2012). Australian anchovy can be fished by the sardine fishery; however Ward *et al.* (2008) report that the fishery catches less than 1% of the total anchovy biomass. Tropho-dynamic modelling for the Great Australian Bight indicated that the sardine fishery was unlikely to be impacting little penguins in South Australia (Goldsworthy *et al.* 2011).

The second most important prey species for little penguins in South Australia is the southern sea garfish (*Hyporhamphus melanochir*), which comprises 13% of the diet. Garfish stocks have been heavily fished in South Australia since the 1930s (PIRSA 2016). The 'Management Plan for the South Australian Commercial Marine Scalefish Fishery' (PIRSA 2013) includes a harvest strategy for garfish that aims to rebuild stocks to specific levels over specific timeframes.

The risk of human induced food availability (including overfishing) was rated as 'low' in the Gulfs and Eyre Peninsula's west coast ('possible', with 'moderate' consequence) and 'negligible' elsewhere ('unlikely', with 'minor' consequence) (Appendices 2 and 6).

6.4 Fisheries bycatch and entanglement

Little penguins are susceptible to levels of gill-net mortality, but little is known about the extent of mortality in Australian waters (Zydelis *et al.* 2013). A mail survey of fishermen in southern Australia suggested little penguins die in gill-nets but in low numbers (Norman 2000). In south-eastern Tasmania, there is a record of 40-50 little penguins that drowned after being caught in a gill-net (Stevenson and Woehler 2007).

Between 2010 and 2015, seven of 112 little penguin carcasses examined in South Australia were found to have been entangled in fishing gear (Tomo 2015). Four little penguins were killed by entanglement in the same trawl fish net at Encounter Bay in April 2014 (Tomo 2014, *The Victor Harbor Times* 2014a), suggesting there are probably more instances that go unreported (Tomo 2014). On Kangaroo Island, two little penguins were found with fishing line tangled around their ankles and both of them were killed by associated trauma (Tomo 2014). One penguin carcass from Troubridge Island had a fishing hook embedded in its flipper (Tomo 2014). In each case, movement of the little penguin was likely to have been restricted by the entangled line and hence entanglement was likely to have been the primary cause of mortality (Tomo 2014).

The risk of entanglement and bycatch on little penguin colonies was rated as 'low' ('occasional', with 'minor' consequence) across all penguin colonies in South Australia (Appendices 2 and 6).

6.5 Coastal pollution: marine debris

For the purposes of the risk assessment, three separate forms of risk from marine debris were considered: (1) ingestion of coarse marine debris, (2) entanglement in marine debris other than fishing gear (e.g. plastic beer-can wrappers), and (3) ingestion of micro-plastics.

Little penguins are known to ingest pieces of buoyant plastic in SA (1% of samples contained hard plastic, n=493) (Wiebkin 2012). There are no records of mortalities recorded as a result of ingesting marine debris in South Australia (Tomo 2014, 2015). The risks of mortality from both (1) ingestion of coarse debris and (2) entanglement in general marine debris were rated as 'negligible' ('possible', but with 'minor' consequence) (Appendices 2 and 6).

The ingestion of micro-plastics is an emerging potential threat to marine life. However, there are no available data about rates of ingestion of micro-plastics by little penguins, nor the levels of risk these might pose. Verlis *et al*. (2013), Lavers and Bond (2013), Lavers *et al*. (2014) and Hardesty *et al*. (2014) reported the presence of micro-plastics in the stomachs of seabirds from around Australia, and Hardesty *et al*. (2014) correlated the tissue concentrations of three chemicals used in the manufacture of plastics with the numbers of particles in their stomachs.

<u>More research is required to assess the risk of (3) micro-plastic ingestion by little penguins</u> (Appendices 2 and 6).

6.6 Coastal pollution: oil spills and other pollutants

Little penguins have been negatively affected by oil spills in Australia and New Zealand (Giese *et al.* 2000, Goldsworthy *et al.* 2000a & b, Chilvers *et al.* 2015, Sievwright 2014). An estimated 10,000 to 20,000 little penguins were killed as a result of the *Iron Baron* oil spill near northern Tasmania (Goldsworthy *et al.* 2000b). The National Marine Oil Spill Contingency Plan (AMSA 2011) states that the Gulf St Vincent region is at high risk of oil spills, but this risk may now be lower because the Port Stanvac Oil Refinery has closed (Wiebkin 2011). The Baudin Rocks penguin colony was affected by oil in 2010 but the source was unknown and impact on penguins was not severe (Tania Rajic *pers. comm*. 2016). An exploration drilling program has been proposed for the Great Australian Bight, about 300 km south-west of Ceduna (BP 2015). This program may have negative impacts on little penguin colonies if hydrocarbon resources are discovered and exploited and an oil spill were to occur (ABC 2015). Any shipping activity creates a risk of an oil spill in the gulfs or along the coast of South Australia, but effects of any such spill are likely to be localised.

Trace metals and metalloids (mercury, lead, iron, arsenic and others) have been found in the blood and feathers of little penguins in Australia, but the potential health impacts on little penguins are unknown (Finger *et al.* 2015). Metal burdens appear unlikely to be causing any mortalities of little penguins, at least in Victoria (Choong *et al.* 2007). Pesticides have been found to accumulate in little penguins, including DDT (dichloro-diphenyl-trichloro-ethane) in South Australia (Falkenberg *et al.* 1994), but their effects on mortality of little penguins are unknown.

<u>The risk from potential and existing pollutants including oil spills was rated as 'low' ('possible', with 'moderate' consequence)</u> (Appendices 2 and 6).

6.7 Turbidity from dredging

At sites with high turbidity, penguins appear to dive to shallower depths when illumination is poor (Cannell and Cullen 1998, Ropert-Coudert *et al.* 2006). The foraging behavior of anchovy, the preferred prey of little penguins in South Australia, may also be affected by high turbidity, because they are visual predators (Chiappa-Carrara and Gallardo-Cabello 1993).

The effects of turbidity on penguins are known from one study. Kowalczyk *et al.* (2015) found little penguins in Port Phillip Bay, Victoria selectively foraged in areas with lower turbidity levels, likely due to the increased detectability of prey. While there is currently no dredging near little penguin colonies in South Australia, any future major port developments may increase the likelihood of this pressure (initial dredging for the development, and any ongoing maintenance dredging), although most of the currently-proposed developments of this nature are located north of little penguin populations (see the South Australian Government's Major Development website page: http://www.sa.gov.au/topics/housing-property-and-land/building-and-development/building-and-development-applications/major-development-applications-and-assessments/proposals-currently-being-assessed).

Eutrophication can also cause increased turbidity (Wiebkin 2011), which can affect foraging of little penguins.

<u>The risk of turbidity on penguin colonies was rated as 'negligible' ('possible', with 'minor' consequence) across the range of the little penguin in South Australia</u> (Appendices 2 and 6).

6.8 Parasites and disease

Penguins are susceptible to parasites and diseases, which can be fatal (Rose 2005, Cannell *et al.* 2013, Hocken 2000). Parasites in penguins include internal parasites (nematodes, trematodes and cestodes found in the stomach, liver, oesophagus, lungs and kidneys), blood parasites and external parasites (ticks and fleas) (Tomo 2012, 2014, 2015, Colombelli-Négrel and Kleindorfer 2014, van Rensburg 2010, Colombelli-Négrel 2015a, Vanstreels *et al.* 2015, Cannell *et al.* 2013). Infectious diseases in penguins include Avian Cholera, Avian Diphtheria, Salmonella, Chlamydia, Staphylococcus, Streptococcus, and others (Rose 2005, Dewar and Scarpaci 2011, Hocken 2000).

Globally, parasites and disease have been found to kill penguins (van Rensburg 2010), including little penguins in Victoria (Harrigan 1992), Western Australia (Cannell *et al.* 2013), and South Australia (Tomo 2014, 2015). In South Australia, 12 little penguins (from 112 autopsies of beach-washed carcasses) were recorded as having died from disease between 2010 and 2014 (Tomo 2015). One little penguin died from peritonitis at Encounter Bay and 11 from heart disease and other infections (Tomo 2012, 2014).

Only one penguin death in South Australia has been directly attributed to gastric parasitic burden (Tomo 2012). Combined with environmental stress, parasitic burden can lead to malnutrition and death (Tomo 2012, Flaherty 2002). For example, in 1984 following two to three weeks of heavy seas, more than 200 'wrecked' penguins were collected from the South-East of South Australia with a sample of those birds having heavy parasite loads and signs of starvation (Delroy 1985). Multiple incidences in Victoria have occurred where large numbers of little penguin carcasses washed up and showed signs of being malnourished and had high parasite loads (Harrigan 1992, Norman *et al.* 1992, Obendorf and McColl 1980).

D. Colombelli-Négrel (*unpubl. data* May 2016) reported blood parasites present in 86% of samples (n = 140) taken from South Australian study sites. She also found that high blood parasite loads correlated with heavier body 'condition'. The implication of this correlation on penguin reproductive success and colony size is not known. Little penguins with good body condition sometimes show a parasite burden without showing any pathogenic effects and supporting the contention that parasites do not (usually) cause mortality in healthy individuals (Tomo 2014).

The risk of mortality by parasites and diseases was rated as 'low' ('likely', but with 'minor' consequence) across all colonies (Appendices 2 and 6).

6.9 Loss of habitat

Sprawling urban development and modification of land for human uses has resulted in loss of habitat for some little penguin colonies (Dann *et al.* 1996b). For example, little penguin habitat has been lost due to agriculture, trampling of burrows, erosion, fire, coastal development and invasion by the introduced kikuyu grass (*Pennisetum clandestinum*) (Dann *et al.* 1996b, Pryor and Wells 2009, Wiebkin 2011). A penguin colony on low-lying, sandy Beatrice Island (near Kingscote, Kangaroo Island) was lost in the late 1970s due to the removal of African boxthorns *(Lycium ferocissimum*), allowing storms to erode the island. The island is now called Beatrice Shoals.

On Phillip Island in Victoria, little penguin habitat did not appear to be limited, hence losses of habitat caused by settlement are unlikely to have caused earlier observed population declines (Dann 1991). On Granite and West islands in South Australia, habitat loss caused by erosion, fire, slashing and infestation of weeds is considered a low risk (Wiebkin 2011). Habitat loss is considered a medium long-term risk to little penguins on Troubridge Island, caused by increased storm surges and sea-level rises, flooding portions of the nesting areas (see also Section 5.3 Climate change) (Wiebkin 2011). Elsewhere, habitat loss due to the removal of African boxthorns (that provide penguin habitat), localised coastal developments and effects of storm surges, may be a low risk in the short term (five years). At Penneshaw on Kangaroo Island, the sea-wall changed the natural water flow and deposition of sand in areas where little penguins come ashore (Wiebkin 2011). Conversely, man-made walls around Kingscote on Kangaroo Island and the boulders of the St Kilda breakwater in Melbourne, appear to provide favourable nesting habitat for little penguins (Kinloch and Brock 2007, Giling *et. al.* 2008).

The impact of habitat loss on little penguin colonies has not been quantified in South Australia. The risk of habitat loss in the next five years for low-lying penguin colonies such as Troubridge Island was rated as 'high' ('likely', with 'moderate' consequence). For all other colonies, the risk was rated as 'negligible' ('unlikely', and with 'minor' consequence) (Appendices 2 and 6).

6.10 Competition for nest-sites

There is limited information about nest competition between little penguins and other species. In south-eastern Australia, a study comparing the breeding habitat of four colonial burrowing seabirds: little penguins, common diving-petrels (*Pelecanoides urinatrix*), fairy prions (*Pachyptila turtur*) and short-tailed shearwaters (*Puffinus tenuirostris*), found that despite overlapping breeding areas, each species was associated with a different suite of habitat attributes (e.g. distance to the ocean, depth of soil), suggesting they were not competing for the same nesting habitat (Schumann *et al*. 2013). In South Australia, little penguins may compete for nesting habitat with feral pigeons (*Columba livia*) on Pullen Island (A. Wiebkin *pers. comm.* 2015). There may also be limited competition for nest-sites with brush-tailed bettongs (*Bettongia ogilbyi)* on St Peter Island (P. Copley *pers. comm.* 2015), and on occasion, with feral bees (see Section 6.1.9). In any one colony, the number of recorded incidents of penguins competing with other species is very low.

Shearwaters are unlikely to compete with little penguins due to differences in their breeding seasons (A. Wiebkin *pers. comm.* 2015). Workshop participants (*pers. comm.* May 2016) suggested that penguin breeding seasons appear to be becoming later in recent years; however more time series data is needed before this can be verified.

The risk of competition for nest-sites for penguin colonies was rated as 'negligible' ('unlikely' to occur, and with 'minor' consequence) (Appendices 2 and 6).

6.11 Weeds

Little penguins will nest in habitat that has been invaded by the introduced kikuyu grass (*Pennisetum clandestinum*) (Weerheim *et al*. 2003, Weber 1994, Holmes 2000), but when it becomes dense, little penguins have difficulty walking through it to their nests (Trezise 1999). Kikuyu is known to entangle little penguins and can cause death (Weber 1994, Trezise 1999, Weerheim 2001). Before kikuyu was removed on Montague Island (NSW), up to 300 penguin chicks died from entanglement each year (ECOS 2012). There are no records of kikuyu causing death of little penguins in South Australia.

There are four colonies on Kangaroo Island where kikuyu is known to be dense, and for these the risk of mortality from entanglement by weeds (especially kikuyu grass) was rated as 'low' ('likely', but with 'minor' consequence). For other colonies the risk was rated as 'negligible' ('unlikely', and with 'minor' consequence) (Appendices 2 and 6).

6.12 Direct anthropogenic disturbance

Direct anthropogenic disturbance includes any activity that may change the behaviour or physiology of one or more individuals (Nisbet 2000). Examples include, scientific research, tourism operations, conservation management, boating, artificial lights and uncontrolled human access to little penguin colonies.

The effects of scientific research on little penguins has included an increase in the transfer of pathogens when sampling stomach contents, an increase in mortality for flipper tagged penguins, and an increase in the energy expenditure and changes in foraging behaviour for penguins fitted with large data loggers (Dewar and Scarpaci 2011, Ropert-Coudert *et al.* 2007, Dann *et al.* 2014). Rigorous processes for obtaining permits and ethics approvals aim to minimise the impacts of research on animals (Seddon and Ellenberg 2008).

Little penguin colonies near urban centres are popular tourist attractions (Saltzer 2002, 2003, Dann and Chambers 2013). Lowered breeding success has been related to tourism on Granite Island (Gilbert 2010, Morcom 2005) and

Penguin Island in Western Australia (26% breeding success compared to 40% in non-tourist areas) (Klomp *et al.* 1991). Unmanaged access by people to penguin colonies can cause increased heart rates and metabolism in penguins, at times when they need to be conserving energy (Ananthawamy 2004).

Irresponsible and sometimes malicious human behavior has at times been responsible for the death of little penguins in Australia. Some penguin deaths on Phillip Island have been attributed to trampling of burrows, illegal poaching, road casualties and deliberate killing (Reilly and Cullen 1979). At least two penguins on Kangaroo Island have died after being run over by vehicles (Tomo 2012). There have been several reports in *The Islander* since 2006 of youths vandalising the Kingscote penguin colony, smashing eggs and killing chicks (M. Kinloch *pers. comm*. 2016). Thirteen penguins on Granite Island were reported to be kicked to death in 1998 (*The Victor Harbor Times* 1998). In February 2016, two teenagers were charged with killing nine little penguins in Tasmania (*Mercury* 2016). Anthropogenic trauma, most likely from watercraft, was found to be the main cause of little penguin mortality near Perth, Western Australia (26%, n=168) (Cannell *et al.* 2015).

The risks of mortality by land-based and marine-based (boat incidents) disturbances was rated as 'negligible' at most colonies ('unlikely', and with 'negligible' consequences), and as 'low' for land-based disturbances at Kingscote, Penneshaw, Point Ellen and Vivonne Bay on Kangaroo Island ('likely', but with 'minor' consequence) (Appendices 2 and 6).

7 Socio-economic values

The current and historical trends of socio-economic values of little penguins are discussed in two categories: tourism and social values.

7.1 Tourism

Little penguins are the most commonly accessed bird for tourism in Australia (Birtles *et al.* 2001). The largest little penguin tourist attraction is on Phillip Island in Victoria, which has attracted over 550,000 people per year in the last few years (PINP 2014, http://www.penguins.org.au/about/corporate-affairs/publications/annual-reports/) and is estimated to contribute $125 million to the economic activity of Victoria each year (Ernst and Young 2012).

Opportunities for tourists to view little penguins in South Australia include penguin enclosures, penguin tours, as well as overnight stays on Troubridge Island. Up to four tourism enterprises have operated in South Australia over the last 15 years, including Granite Island Penguin Centre, Penneshaw Penguin Centre, Kingscote Penguin Centre, and the National Parks and Wildlife 'Discovering Penguins' tours at Kingscote (Wiebkin 2011, DPC 2002).

Declines in the number of little penguins near urban centres have impacted the local tourism industry in recent years (*The Victor Harbor Times* 2014a, Channel 7 2013, *Adelaide Now* 2013, *The Islander* 2012, 2013a, 666 ABC 2013, 891 ABC 2013a, *The Advertiser* 2013a). As of June 2016, commercial tours still operate on Granite Island and at Penneshaw. The Granite Island Penguin Centre, which was not dependent on the wild population, closed in January 2016 but the Granite Island wild penguin night tours are still operating, where 10-12 penguins are seen each night (S. Hedges *pers. comm.* May 2016). On Granite Island, a decrease in the number of people attending night-tours has coincided with a decline in the penguin population (891 ABC 2013b). It was noted in the workshop that regular media coverage about penguin population decline has become a distraction from promoting the ongoing wildlife experiences of the area (including penguins) and, in general, has lowered tourist expectations about the area. At Penneshaw, penguin numbers have decreased over the last 15 years and few penguins are seen during some tours (http://www.users.on.net/~nickpike/penguins.html). An estimated 17,000 visitors attended penguin tours each year at Kingscote before the tours ceased in November 2013 due to a reduction in penguin numbers (*The Advertiser* 2013a, *The Australian* 2013, 891 ABC 2013a).

Local tour operators recognise that the most successful form of eco-tours are those that are multi-faceted and do not rely on just one attraction. Tours at Granite Island and in the greater Encounter Bay area focus on the diversity of local coastal and marine life. Tours include viewing and hearing ecological interpretive stories about shorebirds, leafy sea-dragons, penguins and other seabirds, fur seals, dolphins and whales.

Some local tourism businesses in Victor Harbor and on Kangaroo Island have been directly impacted by the decline of penguin numbers. The risk to tourism enterprises from declines in, or extinction of, local penguin colonies at Granite Island, Kingscote and Penneshaw was rated as 'very high' ('likely', with 'major' consequence). The risk to tourism businesses at Troubridge Island and other locations was rated as 'negligible' ('unlikely', with 'moderate' or 'minor' consequences (Appendices 2 and 6), because tours at other sites have other attractions.

7.2 Social values

In addition to the economic benefits that little penguins have provided in some communities, they have also provided social benefits. For example, 'local identity', the phenomenon where people identify themselves with the social system, people, culture, traditions and landscape of an area (Raagmaa 2002), is an important aspect of rural life in South Australia (Smailes 2002). Little penguin colonies provide social benefits because they contribute to recreational opportunities, stories, and formation of community groups (AMLR NRM 2011). Community involvement with little penguins has included activities by friends groups and volunteers, councils, penguin centres, tourism operators, schools, and individuals (Wiebkin 2011).

The high social value of penguins is further evidenced by the number of media articles (*The Victor Harbor Times* 2011, 2013a,b, 2014a,b; Channel 7 2013; *Adelaide Now* 2013; 891 ABC 2013a,b; *The Advertiser* 2013a,b; Today Tonight 2014a,b; *The Islander* 2011, 2012, 2013a,b, 2015; *The Australian* 2013; 5AA 2013; 666 ABC 2013; *The Sunday Mail* 2015), petitions (Parliament of South Australia 2015b), fundraising campaigns (*The Victor Harbor Times* 2013a,b, 2014), parliamentary enquiries (NRC 2011; Parliament of South Australia 2013a,b, 2015a,b), movie nights and other events and activities (*The Victor Harbor Times* 2014; AMLR NRM 2011; Colombelli-Négrel 2015a), that have increased locally as Kingscote, Penneshaw and Granite Island penguin colonies have declined.

The risk of declining penguin colonies impacting on local social values was based on three levels of concern. The Granite Island, Kingscote and Penneshaw colonies have attained a high public profile due to tourism. For these colonies, the risk that declines would impact on social values was rated as 'very high' ('likely', with 'major' consequence). Some colonies have a local profile through families living on, and/or tourists visiting, particular islands with penguins present. These include other Kangaroo Island colonies, as well as Troubridge, Wedge, Thistle, Wardang, Pearson, Flinders, Boston and Spilsby Islands, and a few others. For these colonies the risk of declines impacting on social values was rated as 'high' ('likely', with 'moderate' consequence). Other colonies have no public profile and would be unlikely to be 'missed' if they became extinct. For the remainder, the risk of declines impacting on social values was rated as 'negligible' ('possible', but with 'minor' consequence) (Appendices 2 and 6.

8 Summary of the Highest Risk Ratings

The colony-specific risk assessments were based on available information and evidence, some of which is more than 10 years old, as well as current expert knowledge. This information was used by stakeholders to inform a consensus on all risk ratings.

Workshop participants discussed the feasible management options to provide conservation outcomes for specific little penguin colonies. The participants agreed to prioritise pressures and socio-economic values that had risk ratings of 'high' or 'very high' (listed below) (Appendices 2 and 6). Further consideration of these management options was developed by independent consultant Dr Peter Dann of Phillip Island Nature Park, who was an observer at the risk assessment workshop.

The highest risk ratings obtained were:

1. **'Very High' Risk Rating**
    a. Predation - Land-based
        i. Feral cats
            - Flinders Island
            - Wardang Island
            - All colonies on Kangaroo Island (excluding islets)
            - Mainland colonies, South-East
        ii. Domestic dogs
            - Kangaroo Island townships (in particular, Kingscote, Penneshaw, Vivonne Bay)
            - Mainland colonies, South-East
        iii. Foxes
            - Mainland colonies, South-East
        iv. Black rats
            - Granite Island

    b. Predation - Marine-based
        i. Long-nosed fur seals
            - Encounter Bay / Victor Harbor islands
            - Kangaroo Island and islets
            - Islands of the southern gulfs

    c. Socio-Economic Risks
        i. Tourism values
            - Granite Island
            - Kingscote, Penneshaw
        ii. Social values
            - Granite Island
            - Kingscote, Penneshaw

2. **'High' Risk Rating**
    a. Land-based predation
        i. Domestic dogs
            - Granite Island
        ii. Foxes
            - Granite Island
        iii. Goannas
            - Emu Bay, Kangaroo Island

    b. Food availability ('natural' mass fish die-offs)
            - State-wide

    c. Habitat loss
            - Troubridge Island

    d. Social Values
            - Baudin Rocks and Penguin Island, South East
            - Kangaroo Island colonies excluding Kingscote, Penneshaw and islets
            - Althorpe Island, Southern Yorke Peninsula

- Troubridge Island, Gulf St Vincent
- Goose and Wardang Islands, Spencer Gulf
- Reevesby and Spilsby Islands, Sir Joseph Banks Group
- Boston, Thistle and Wedge Islands, Southern Eyre Peninsula
- Flinders and Pearson Islands, Western Eyre Peninsula
- St Peter Island, Far West Coast

9 Risk Management Options

Workshop discussions focused on management options for land-based predation, marine-based predation, and socio-economic values at local scales (detailed below). Because the risk assessments have been done for all colonies, this report can also form the basis for more targeted management of lower priority pressures.

Some pressures exist at large spatial scales (state, national or global scales), including natural food availability, over-fishing, entanglement, coastal pollution, parasites and climate change impacts of increasing or extreme temperature. Clearly, there is probably little that can be done to manage these pressures, and for this reason, they were not discussed. By comparison, site-based management may be feasible at and around specific colonies and at specific life-cycle stages (breeding, moulting). The management options discussed at the workshop are as follows:

9.1 Land-based Predation

a) Feral cats on Flinders and Wardang Islands and black rats on Granite Island were rated as 'very high' risks. The workshop participants suggested that eradication or control of these pests (and continued control on Granite Island) would provide conservation outcomes for penguins and other species. Eradication of feral cats from Wardang Island (and of black rats if present) would also be a priority; provided rabbits are eradicated first, as cats are probably keeping the rabbits in check to some extent.

b) Eradication of feral cats on Kangaroo Island, or control at and around the island's penguin colonies, would benefit little penguin populations. Eradication of feral cats from Kangaroo Island is a 15-year objective of both the local NRM Board and District Council (NRKI 2015). A cat eradication program is currently being planned under the National Threatened Species Strategy. As a consequence of such a program, there is a risk that the black rat population may increase.

c) Control of feral cats and foxes at mainland penguin colonies in the South-East is considered a high priority. Some of the practical issues facing such a task include the difficulty of access to locations, and the potential for baits to be detrimental to off-target species, such as domestic dogs and gulls. Techniques applied successfully at Phillip Island may provide a useful guide as to what can be done to manage this latter issue.

d) Killing events by domestic dogs are rated as a 'very high' risk for Kangaroo Island and as a 'high' risk for Granite Island. Dogs can be feasibly managed on Granite Island by ensuring they are unable to access the causeway. Practical management of dogs elsewhere includes public education, and awareness-raising for visitors through signs and effective visitor information.

e) Predation by goannas at Emu Bay on Kangaroo Island was rated as a 'high' risk on account of recent observations by researchers. The risk that this may impact on the status of a penguin colony increases, as the colony size gets smaller – which has been happening at Emu Bay. More monitoring is required to quantify the impact of goannas on little penguins at Emu Bay.

9.2 Marine-based predation

There remains some uncertainty as to the extent to which predation by fur seals has contributed to the observed declines in individual penguin colonies. The frequency of occurrence of penguin remains in fur seal scats is a misleading measure of the numbers of penguins eaten by fur seals. There may also be other 'un-detected' marine predators, such as sharks, contributing to the rates of colony declines; however data on the impact of these other predators are not available.

Based on available evidence, risks to little penguins through predation by long-nosed fur seals ranked higher for penguin colonies in Encounter Bay, on Kangaroo Island and the Gulfs than elsewhere. Workshop participants discussed management options to reduce or remove predation by seals from these little penguin colonies, and the practicality, sustainability and feasibility implications:

- Scare the fur seals (e.g. with 'seal crackers') at haul-out sites (where fur seal scats contain penguin remains) so that they depart the area.

  Implications:

  - There are many fur seals across many sites that would need to be 'treated' with scare strategies, on an on-going basis.
  - Such strategies have been shown to have only short-term effects because fur seals become accustomed to harassment methods such as seal crackers (MMIC 2002).
  - Such techniques, if successful in moving the fur seals from target haul-out sites, may result in shifting predation to other penguin colonies.
  - Such techniques would be expensive (in terms of both time and resources), especially given the difficulty of access to most of the haul-out sites). Although the cost of materials per site is generally not prohibitive (MMIC 2002), many sites would have to be visited on a continuing basis.

- Capture the fur seals at haul-out sites (where fur seal scats contain penguin remains) and translocate them elsewhere.

  Implications:

  - There are many fur seals across many sites that would need to be captured and translocated. Such capture-and-translocate exercises have been attempted elsewhere (e.g. southern Tasmania to protect salmon farms) and are expensive and time-consuming, especially given the difficulty of access to haul-out sites and the numbers of individual fur seals likely to be involved. In 1994 in Tasmania the cost per fur seal of translocating a distance of 300 – 470 km was $670 (MMIC 2002).
  - For many fur seals, translocations are ineffective due to their high mobility. In the Tasmanian example above, a significant number of translocated fur seals were recorded returning more than 300 km to their point of capture within seven days on average (Robinson *et al.* 2008). This correlates with satellite tracking records showing that they frequently swim many hundreds of kilometres, e.g. from Kangaroo Island colonies to Bass Strait and southern Tasmania (MMIC 2002). Data collected from translocated fur seals between 1990 and 2001 showed some were recaptured more than ten times (MMIC 2002).
  - There is potential for such a strategy to cause a shift in predation to penguin colonies nearby.
  - The capture and translocation of fur seals can result in death of fur seals, although the proportion of deaths per translocation is not high (0.65%, n = 5403) (Hindell *et al.* 2013).

- Cull the fur seals at local haul-out sites:

  Implications:

  - In response to community concerns, and two recent petitions tabled in State Parliament, the targeted culling of fur seals was discussed at the workshop. It was pointed out that, like most native animals in SA, the long-nosed fur seal is protected under the *National Parks and Wildlife Act 1972*. Additionally the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) has listed long-nosed fur seals as a marine species. Marine mammals have high social values in Australia and culling of fur seals in SA is likely to be unpopular with the broader community.
  - The State Government's policy is that there will be no culling of fur seals in South Australia (see Hansard 2015).
  - According to independent fur seal expert Dr Peter Shaughnessy, in order to achieve a sustainable level of population reduction in South Australia a substantial number of fur seals would need to be culled. Shaughnessy's research, monitoring and modelling of harvested Cape fur seal colonies in South Africa and Namibia in the 1970's and 1980's are outlined in Appendix 5 to indicate the implications of a cull for South Australia (Shaughnessy and Best 1982, Shaughnessy 1987).
  - Such management considerations would be highly contentious in the context of supporting local tourism enterprises. There would be public condemnation for killing native fur seals.

9.3 Socio-economic impacts

The risk to both tourism and social values, of declines or extinctions of local penguin colonies was rated as 'very high' for Granite Island, Kingscote and Penneshaw. Penguins, and night-time penguin tours, have been local tourist attractions at these locations. Possible management options suggested for maintaining penguin-viewing opportunities include:

- the establishment of a captive-breeding centre (that releases penguins to the wild) for little penguins to
  - maintain local penguin genetic pool
  - re-build numbers of penguins for re-introduction to the wild
  - provide facilities where penguins could be easily displayed, and
  - promote penguin conservation.

  Implications:

  - A captive breeding and release program would need to produce and hold a large number of penguins in order to be successful.
  - The wound burden for animals in captivity is greater than in the wild. These wounds can easily become infected in captive environments, and the disease can be spread back into the wild when birds are released (D. Kelly *pers. comm.* 2016).
  - There is a lack of suitable release sites. We are not yet fully certain why the current wild population is declining and the pressures have not been mitigated. The release of penguins may not work because they would still be released into an environment with the same pressures.

- the establishment of a new penguin centre (that does not release penguins into the wild) to:
    - provide facilities where penguins could be easily displayed, and
    - promote penguin conservation through education.

  Implications:

    - Similar concerns to the above were raised regarding the potential for the spread of disease if a penguin centre was reinstated on Granite Island. Such a centre would have greater chance of success if it is not used as a penguin rescue centre, as penguin rescue is a recognised pathway for the spread of disease into a captive colony (D. Kelly *pers. comm.* 2016).

Workshop discussion also focused on opportunities for tourism, including the potential for income from tourism to fund research. At this stage no costed business case has been developed for such as scenario.

As a counter narrative to long-nosed fur seals being a tourism problem, several tourism businesses operating in South Australia use long-nosed fur seals as a significant part of their tourism experience, including:

- Canoe the Coorong uses fur seals as an attraction on its promotional video.
- Cruise the Coorong has fur seals as a main feature on its web page.
- Big Duck Boat Tours advertises fur seal and dolphin tours with 'Seal Island' being the first stop on its itinerary.
- Spirit of the Coorong boat tours uses fur seals as a feature on its web page.
- Little Rock 4WD Beach Tours uses the opportunity for clients to relax and watch fur seals as an attraction on its web page.
- Adventure Bay Charters, operating out of Port Lincoln, offers close encounters with Australian sea lions and other marine life. This tourism operator was the 2015 South Australian Tourism Award winner for the Best Tourist Attraction category.

Nationally, the 2015 winner of the Australian Tourism Award for Best Tourist Attraction was Bruny Island Cruises in Tasmania, where colonies of long-nosed fur seals are a central part of the wildlife viewing experience.

Internationally, Seal Swim Kaikoura, a small family-run business located on the eastern seaboard of New Zealand's South Island was named in 2013 as one of the world's top 10 'Best Marine Encounters' by the influential travel writers of Lonely Planet for their business based solely on long-nosed fur seals.

9.4 Food availability (natural mass fish die-offs)

While natural, mass fish die-offs were recognised as 'high' risk to penguins, there is little that can be done to prevent, or to manage, such events. Surveillance and rapid responses to determine likely sources or causes of die-offs may help to restrict impacts on penguins and other marine wildlife, especially if toxins (e.g. from 'red tide' events) are involved.

9.5 Habitat Loss

The potential for nesting habitat on Troubridge Island to be lost through storm surges killing and eroding protective vegetation. Sandbagging is used on the island to protect against erosion, and is recommended in the island's management plan (DEH 2009) as an on-going measure to protect the State Heritage-listed lighthouse and cottages present. This measure is likely to indirectly benefit the little penguin colony. Regular monitoring of local sand movement patterns will inform future reassessments of the need for the continuation of sandbagging activities.

10 Monitoring and Research Gaps

During the workshop several critical monitoring and research gaps were highlighted.

There is a need for reliable population and trend data for colonies off the west coast of Eyre Peninsula and within Spencer Gulf, especially the Sir Joseph Banks Group, because some of the state's largest colonies exist in these areas and their population trends are unknown. This will contribute to understanding the State-wide status of little penguins. Focal islands for this work need to be agreed by key stakeholders. Appropriate monitoring methods and measurable indicators should be identified for any management options chosen, in order to evaluate their success.

Further monitoring and assessment of the status of penguins on Troubridge Islands remains a high priority because it is potentially one of the largest colonies in South Australia, and is located in close proximity to the area of the State where the largest declines are occurring.

The workshop also raised the possibility that blood parasites may be playing a part in colony health; however the evidence show that although parasites are prevalent within the population there is no indication that they are impacting on population abundance or causing mortalities. It was suggested that blood samples could be collected and stored relatively easily and could become a standard part of sampling at any penguin colonies visited. Should this be implemented, DEWNR would expect Scientific or Research Permits to be in order, and Workplace Health and Safety procedures and technical standards to be followed.

Current research on fur seal diets and how to interpret the relative numbers of penguins consumed from fur seal scat analysis should help in explaining the likely impacts of fur seal predation on penguin colonies.

The workshop also highlighted the fact that little is known about the impact of micro-plastic ingestion on little penguins. This is another subject that needs research.

11 Conclusions

This report documents a risk assessment of the pressures acting on little penguin colonies across South Australia and the impact of declining colonies on social and tourism values. It describes what is known about the penguins, their past and current distributions, and the key gaps in our knowledge and understanding of the majority of colonies. Workshop participants reached consensus on the risk ratings provided in this report. The ratings are based on best available knowledge of current penguin colonies and can be refined as more information becomes available.

The following is a summary of issues and opportunities, based on the workshop and the information in this report:

- Nationally, and state-wide, little penguins currently do not appear to be at risk of becoming extinct. Most pressures and declines, and even some colony extinctions appear to be localised rather than global, but more survey work is required to understand population trends that underpin conservation status.
- Despite some notable individual projects, there is generally a paucity of data with which to determine changes in total abundance of little penguins in South Australia.
- Cats, dogs and foxes remain the greatest pressure on little penguins at sites where these predators are able to access little penguin colonies. For the survival of those colonies, tight controls are needed over these and other introduced predators. Some sites need additional efforts and many sites need to maintain their existing pest control programs.
- There is insufficient and contradictory evidence to clearly identify the roles and impacts of marine predators, including long-nosed fur seals and sharks, in the declines of some colonies.

- Consideration of management options to increase penguin numbers in key tourism areas such as Granite Island and Kingscote must take into account feasibility, underpinning evidence and likelihood of success.
- There are opportunities for government, NGOs and the private sector to work with key tourism communities to identify wildlife-related experiences that could value-add to existing coastal and marine tourism initiatives.

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Appendix 1: Summary of recent numbers (breeding individuals) and inferred trends for little penguin colonies in South Australia

Updated from Wiebkin (2011). Colonies are ordered by regional areas and then alphabetically. Historical estimates are from data with unknown levels of confidence. A record of x active burrows or x pairs is interpreted as 2x breeding individuals.

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
SE Coast (incl. Encounter Bay)	Baudin Rocks (also known as Godfrey Islands)	<60	E (2006)	**Unknown** (insufficient recent data)	
				Jan 1922: "hundreds breeding"	Morgan (1922) in Copley (1996)
				BDBSA records 1968 & 1980s: present	Parker *et al*. (1979); BDBSA observation record Offshore Islands Survey 1968 (extracted 11/03/2016); BDBSA observation record from Peter Ellyard 1980s (extracted 11/03/2016)
				Jan 1968: most nests in use Jan 1974: diminishing July 1981: 12 birds Jan 1982: only 7 nests found (incomplete search)	Bonnin (1982) and May *pers. comm*. in Copley (1996)
				1960s – 1985: ca 100 – 150 pairs 1986 – 1992: 100 – 300 pairs. Total 7 visits, in Jan (1), Mar (1), Aug (1), Sep (1), Oct (1), Oct-Dec (1), Dec (1)	M. Watermann *pers. comm*. in Copley (1996)
				1994: Present	DENR (1994) in Wiebkin (2011)
				2006: <60 breeding individuals	S. Goldsworthy *unpubl. data* (2006) in Wiebkin (2011)
				13/05/2008: "Several were seen under bushes and ledges of southern island. Looked freshly moulted. None observed to be breeding"	BDBSA observation record from Ross Anderson (extracted 23/02/2016)
	6km NW of Cape Martin	ND	-	**Unknown** (data deficient)	
				May 1978: "at least 2 nests"	Copley (1996)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Cowrie Island (tidal island near Beachport)	ND	E (1996)	**Unknown** (data deficient)	
				17/01/1996: Approx. 100 adults + approx. 12 chicks. Evidence of injured birds, probably from dog or fox attack	DEWNR *unpubl. data* provided by G. Jackway (2016)
	Granite Island	22	S (2015)	**Declined** (numbers below are breeding individuals)	
				July 1943: Present	Francis (1944) in T&M Ecologists (in prep.)
				Aug 1950: Several nests found	Francis and Francis (1951) in T&M Ecologists (in prep.)
				1962: about 100	M. Watermann *pers. comm*. in Copley (1996)
				1990 – 1992: about 1000	R. Brandle *pers. comm*. in Copley (1996)
				Mid-May till Jan every year 2001: 1548 2002: 828 2003: 588	Colombelli-Négrel (2015b)
				2004: 1084	Bool *et al*. 2007 (2004)
				Mid-May till Jan every year 2005: 622 2006: 586 2007: 408 2008: 358 2009: 166 2010: 146 2011: 102 2012: 26 2013: 38	Colombelli-Négrel (2015b)
				2014: 32	AMLR NRM *unpubl. data* (2014)
				19/04/2015 to 3/12/2015: None found during 4 separate land surveys	T&M Ecologists (in prep.)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				2015: 22	AMLR NRM *unpubl. data* (2015)
	Hindmarsh Island	Not likely to have ever bred there; suspect occasional sightings only	-	**Not likely to have ever bred there**; suspect washed up dead birds and occasional sightings only	P. Copley *pers. comm.* (2016) and G. Carpenter *pers. comm*. (2016)
				1970s: Present	Parker *et al*. (1979)
				22/12/1988, 9/02/1990, 2/07/1990 & 2/12/1991: 4 observations of dead birds recorded in the Atlas of Living Australia. One dead bird sighted on each occasion.	OEH Atlas NSW Wildlife, Australian Bird and Bat Banding Scheme, Atlas of Living Australia (extracted 17/02/2016)
	Penguin Island	19 (most adults breeding, but not certain)	S (2015)	**Declined**	Known as Penguin Island from very early days of European settlement due to presence of penguins (Smith and Smith 1880; Ray and Ling 1981)
				09/05/1965: 150 adults, 1500 chicks. 1500 banded by SA Field Nats. Many had parasites	DEWNR *unpubl. data* provided by G. Jackway (2016)
				1970s: Present	Parker *et al.* (1979)
				06/01/1971: Some penguins on eggs, most finished. Oct 1971: Present southern island, absent northern island. Dec 1971: Present southern island, absent northern island. 52 chicks banded by P.N. Reilly. 29, 30/10/1976: 643 adults, 118 chicks, 260 eggs	DEWNR *unpubl. data* provided by G. Jackway (2016)
				1980s: Present	BDBSA observation record Peter Ellyard 1980s (extracted 11/03/2016)
				1981: Island named after "abundance of those birds"	Ray and Ling (1981)
				1994: Present	DENR (1994) in Wiebkin (2011)
				Pre 1996: "…is a major local haven and breeding ground for seabirds, including…the Little Penguin…" (no date)	Robinson *et al.* (1996)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				7/02/2001: 3 adults & 9 large chicks (down present) on southern island (northern island not checked)	DEWNR *unpubl. data* provided by G. Jackway (2016)
				13/05/2008: 7 present	BDBSA observation record from R. Anderson 13/05/2008 (extracted 23/02/2016)
				12/11/2009: 53 adults & 10 chicks (down present) on southern island (no birds on northern island)	DEWNR *unpubl. data* provided by G. Jackway (2016)
				24/01/2012: 3 adults and 7 very large chicks (down present) on southern island (no birds on northern island)	
				21/01/2015: 2 adults and no chicks on southern island (no birds on northern island)	
				19/11/2015: 19 adults, plus 5 chicks (down present) and 6 eggs on southern island (northern island not checked)	
	Cape Banks (between Gerloff Bay and Bucks Bay)	16	E (2015)	**Unknown** (data deficient)	
				1983: Present	Atlas of Living Australia database observation record from T. Palliser 1983 (extracted 2015)
				2015: 16 breeding individuals	M. Christie *unpubl. data* (2015)
	Port MacDonnell/ Cape Northumberland	~10	E (2016)	**Suspected to have declined**	
				May 1978: ~60 breeding individuals	Cox (1978); Parker *et al.* (1979)
				Jan 2015: ~10 seen in Jan 2015 plus 4 juveniles	DEWNR (T. Rajic) *unpubl. data* (2015)
				Jan 2016: DEWNR staff at Cape Northumberland saw 12 birds, 5 of which were juvenile.	DEWNR (D. Mount) *unpubl. data* (2016)
				Apr 2016: Population size reduced after predator attack, probably by a fox	T. Rajic, G. Jackway, D. Mount *pers. comm*. (2016)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Pullen Island	None observed during the most recent visits 2013 - 2016	S (2016)	**Declined, suspect extinct**	
				Nov 1978: large numbers present	NPWS (1983) in T&M Ecologists (in prep.).
				Pre 1983: breeding colony present	Anon. (1983) in Robinson *et al.* (1996)
				2011: Several present	N. Gilbert *unpubl. data* (2011) in Wiebkin (2011)
				25/11/2013: two inactive burrows found (used by pigeons or seagull chicks as refuge)	Colombelli-Négrel and Kleindorfer (2014)
				10/02/2016 (land survey): "no evidence of nests was found…with suitable sites occupied by nesting Rock Doves"	T&M Ecologists (in prep.).
	Seal Is/Rocks	ND	S (2016)	**Unknown** (data deficient)	
				2002: Dead bird found	Atlas of Living Australia database observation record 2002 (extracted 2015)
				25/11/2013: 15 inactive burrows found (used by pigeons or seagull chicks as refuge)	Colombelli-Négrel and Kleindorfer (2014)
				11/06/2015 to 10/02/2016: 5 surveys (3 scope from Granite Is, one from boat, one on land (10/02/2016)) – one flipper found during 2016	T&M Ecologists (in prep.)
	West Island CP	None observed during recent visits 2013 - 2015	S (2015)	**Declined**	
				Late 1920s: "Casual visitors…observed large numbers…"	Anon. (1927) and Mengersen in Anon. (1929), in T&M Ecologists (in prep.)
				No date (pre 1977): "Many nests are located under rocks or in burrows over most of the island. Eggs and chicks have been found in December and January, but otherwise no data	Paton and Paton (1977a)
				1975-1978: "abundant burrows"	Copley (1996)
				22/12/1975 & 1/12/1978 (boat landings): large breeding colony present	Robinson *et al.* (1996)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				1990 – 1992: about 4000 birds	R. Brandle *pers. comm*. in Copley (1996)
				Mar – Nov 2006: 120 active burrows	Bool *et al.* (2007)
				2010: <20 breeding individuals	N. Gilbert *unpubl. data* (2010) in Wiebkin (2011)
				24/11/2013: 5 inactive burrows found (used by pigeons or seagulls for nesting)	Colombelli-Négrel and Kleindorfer (2014)
				3/06/2015 & 9/12/2015: None found in two separate land surveys	T&M Ecologists (in prep.)
	Wright Island CP	None observed during recent visits 2013 - 2015	S (2015)	**Declined, suspect extinct**	
				1920s: Present	Cleland (1924) in T&M Ecologists (in prep.)
				1928 to 1954: Present, usually with eggs and chicks in Spring and Summer	Paton and Paton (1977b)
				Sept 1941: Many penguins	Rumbelow (1941) in T&M Ecologists (in prep.)
				Mar 1954: Many penguins	Barker (1954) in T&M Ecologists (in prep.)
				1970s: "Nests regularly in burrows or under rocks over most of the island in spring and summer. Some eggs and chicks are usually present from September to January"; "Estimated 150 breeding pairs" (about 300 birds)	Paton and Paton (1977b)
				1990-1992: 200+ breeding individuals	R. Brandle *pers. comm.* in Copley (1996)
				24/11/2013: 8 inactive burrows found (used by pigeons or seagulls for nesting)	Colombelli-Négrel and Kleindorfer (2014)
				29/06/2015 & 3/12/2015: None found in two separate land surveys	T&M Ecologists (in prep.)
Kangaroo	American River	ND	-	**Unknown (data deficient)**	
				1970s: Present	Parker *et al.* (1979)
				1987: Present	DEP (1987)
				4/10/2010: Present	Atlas of Living Australia database observation record from BirdLife Australia (extracted 2015)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Antechamber bay	10	S (2015)	**Declined.** Numbers below are breeding individuals.	
				2008: 178	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 190 Sep 2012: 152 Sep 2013: 106 Visited fortnightly Aug – Nov.	KI NRM penguin census *unpubl. data* (2011-13)
				Sep-Nov 2014, fortnightly: 22	KI NRM penguin census *unpubl. data* (2014)
				2015: 10 Visited fortnightly Aug - Nov	Colombelli-Négrel *unpubl. data* (2015)
	Beatrice Island	Presumed extinct	-	**Presumed extinct** due to erosion	
				Jan 1916: Present	White (1916)
				Late 1970s: Present	Parker *et al.* (1979)
				Note: Removal of African boxthorn in the 1970s made the low lying island (1m) susceptible to erosion and unsuitable for penguins to breed	Robinson *et al.* (1996).
	Breakneck River	ND	-	**Unknown** (data deficient)	
				1970s: Present	Parker *et al.* (1979)
	Browns Beach	32	S (2008)	**Unknown** (data deficient)	
				2008: 32 breeding individuals	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
	Busby Islet (Kingscote Spit)	None observed during recent visits 2003 – 2014	E (2014)	**Presumed extinct**	
				1989: About 20 burrows (<40 breeding individuals) "in lunettes stabilised by Boxthorn and Nitre Bushes at east and west end of islet"	C. Baxter *pers. comm.* in Copley (1996) and C. Baxter *pers. comm.* (2016)
				2003 – 2013: None seen by C. Baxter during regular visits to the island	C. Baxter *pers. comm*. (2016)
				2014: no burrows or other evidence of presence (seemed to have disappeared from the island between 1990 and 2002)	C. Baxter *pers. comm*. (2016)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Cape Cassini	12	S (2013)	**Declined**	
				Late 1970s: Present	Parker *et al.* (1979)
				2008: 116 breeding individuals	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 52 breeding individuals Sep2012: 46 breeding individuals Oct 2013: 12 breeding individuals	KI NRM penguin census *unpubl. data* (2011-13)
	Cape Gantheaume	None observed during recent visits 2000 - 2004	E (2004)	**Declined**	
				1988: "Numbered in tens, not hundreds"	Baxter (1989)
				Pre 1992: About 100 pairs (about 200 breeding individuals)	S. Robinson *pers. comm.* in Page *et al.* (2005)
				Breeding season 1990s: 60 banded	S. Robinson (2005) in Wiebkin (2011)
				1992 – 2000: ceased to exist	S. Robinson *pers. comm.* in Page *et al.* (2005)
				2001 - 2004: not found on island during regular 3 month visits across all seasons	B. Page *pers. comm.* (2016)
	Cape Willoughby	116	S (2008)	**Unknown** (data deficient)	
				Late 1970s: Present	Parker *et al.* (1979)
				2008: 116 breeding individuals	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
	Cape Younghusband	ND	-	**Unknown** (data deficient)	
				1989: About 50 pairs (about 100 breeding individuals)	C. Baxter *pers. comm.* in Copley (1996)
	Emu Bay	42	S (2015)	**Declined** (numbers below are breeding individuals)	
				2008: 298	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				Oct 2011: 228 Sep 2012: 160 Aug 2013 (Boat Ramp & Whittle only): 112 Sep 2013: 102 Visited fortnightly Aug-Nov	KI NRM penguin census *unpubl. data* (2011-13)
				Sep-Nov fortnightly 2014 (Boat Ramp & Whittle only): 36	KI NRM penguin census *unpubl. data* (2014)
				Sep 2015: 42 Visited fortnightly Aug-Nov	KI NRM penguin census *unpubl. data* (2015)
	Harvey's Return	ND	S (2006)	**Unknown** (data deficient)	
				Late 1970s: Present	Parker *et al.* 1979
				2006: None found	A. Wiebkin *unpubl. data* (2006) in Wiebkin (2011)
	Kingscote	128	S (2014)	**Declined** (numbers below are breeding individuals)	
				2006: 410 2007: 868 2008: 748 2009: 654 2010: 706 2011: 380 2012: 300 2013: 154 2014: 128	Kinloch *et al.* KI NRM *unpubl. data* (2006-2014). Report available from: http://www.naturalresources.sa.gov.au/kangarooisland/plants-and-animals/native-animals/sea-and-shore-birds
	Nobby Islet	ND	-	**Unknown** (data deficient)	
				22/11/1982 (helicopter landing): Present	Robinson *et al.* (1996)
	Maupertius Bay	ND	-	**Unknown** (data deficient)	
				1970s: Present	Parker *et al.* (1979)
	Page Island (North)	ND	-	**Unknown** (data deficient)	
				1967-1982: 50 "nesting"	T. Dennis *pers. comm.* in Copley (1996)

Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
			22/11/1982 (helicopter landing): breeding colony present	Robinson *et al.* (1996)
			1999: Present 2003-2004: Present	Atlas of Living Australia observation records from Birds Australia (1999, 2003-04) (extracted 2015)
Page Island (South)	Present (few) (Figure 3. mapped as <10)	E (2009)	**Declined**	
			26/03/1967 (boat landing): breeding colony	Robinson *et al.* (1996)
			1984-1992: ~100-200 pairs (~200-400 breeding individuals)	T. Dennis *pers. comm.* in Copley (1996)
			2009: a few birds present	P. Shaughnessy *unpubl. data* (2009) in Wiebkin (2011)
Pelorus Islet	ND	-	**Unknown** (data deficient)	
			22/11/1982 (helicopter flyover): breeding colony present	Robinson *et al.* (1996)
Penneshaw	112	S (2013)	**Declined** (numbers below are breeding individuals)	
			1970s: Present	Parker *et al.* (1979)
			2008: 356	C. Gibbons *unpubl. data* (2008); KI penguin census *unpubl. data* (2011-13)
			Oct 2011: 304 Sep 2012: 148 Sep 2013: 112	KI NRM penguin census *unpubl. data* (2011-13)
Ravine des Cassoars	ND	S (2006)	**Unknown** (data deficient)	
			1970s: Present	Parker *et al.* (1979)
			2006: None found (evidence of old colony)	A. Wiebkin *unpubl. data* (2006) in Wiebkin (2011)
Rocky River	ND	-	**Unknown** (data deficient)	
			1970s: Present	Parker *et al.* (1979)
Seal Bay	32	S (2010)	**Unknown** (data deficient)	
			2010: 32 breeding individuals	T. Soutar *unpubl. data* (2010)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Snellings Beach	4	S (2013)	**Declined** (numbers below are breeding individuals)	
				2008: 16	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 18 Sep 2012: 4 Late Sep 2013: 4	KI NRM penguin census *unpubl. data* (2011-13)
	Stokes Bay	8	S (2013)	**Declined** (numbers below are breeding individuals)	
				Late 1970s: Present	Parker *et al.* (1979)
				2008: 60	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 38 Sep 2012: 26 Oct 2013: 8	KI NRM penguin census *unpubl. data* (2011-13)
	Vivonne Bay	10	S (2015)	**Declined**	
				1989: ~100 pairs (~200 breeding individuals)	C. Baxter *pers. comm.* in Copley (1996)
				2008: 150 breeding individuals	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 126 breeding individuals Sep 2012: 130 breeding individuals Oct 2013: 68 breeding individuals	KI NRM penguin census *unpubl. data* (2011-2013)
				Late Sep 2015: 10	KI NRM penguin census *unpubl. data* (2015)
	Western River Cove	None observed during recent visits 2012 - 2013	S (2013)	**Declined** (numbers below are breeding individuals)	
				1987: Present	DEP (1987)
				2008: 16	C. Gibbons *unpubl. data* (2008) in Wiebkin (2011)
				Oct 2011: 12 Sep 2012: None observed Late Sep 2013: None observed	KI NRM penguin census *unpubl. data* (2011-13)
G	Albatross Island	ND	-	**Unknown** (data deficient)	

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				27/11/1982 (helicopter landing): "several burrows"; breeding colony present	Robinson *et al.* (1996)
	Althorpe Islands	84	S (2013)	**Suspected decline** (need further surveys and consistent methodology for longer time period)	
				Jan 1916: present Apr 1916: many penguins	White (1916)
				24-25/11/1982 (helicopter landings): "common"; breeding colony present	Robinson *et al.* (1996)
				1980s: "…1980s decline of the fairy penguin…"	Lawley and Shepherd (2005)
				Apr or May 2004: 132 breeding individuals	Velzeboer and Shepherd (2004), R. Velzeboer *pers. comm.* (2016)
				2012: 104 breeding individuals	Wiebkin *et al.* (2012)
				15/10/2013: 84 breeding individuals	Colombelli-Négrel and Kleindorfer (2014)
				Note: 1989 – 2016 "The loud eerie sound of the Little Penguin was common at night in the late 1980's early 2000's. In recent years that choir sound has become rare and from all accounts, the population around the bay seemed to have declined, if not the island itself."	M. Lucieer *pers. comm.* (records of the Friends of Althorpe Island) via D. Colombelli-Négrel *pers. comm.* (2016)
	Blythe Island	ND	-	**Unknown** (data deficient)	
				28/06/1979 & 17/09/1980 (2 boat landings): breeding colony present	Robinson *et al.* (1996)
				2009: Present	Atlas of Living Australia observation records from T. Robinson and D. Armstrong (2009) (extracted 2015)
	Boston Island	<100	E (2006)	**Unknown** (data deficient)	
				29/11/1982 (helicopter landing): Present	Robinson *et al.* (1996)
				2006: <100 breeding individuals	A. Peucker *unpubl. data* (2006) in Wiebkin (2011)
	Boucaut Island	ND	-	**Unknown** (data deficient)	
				26/06/1979 & 22/09/1980 (2 boat landings): Present	Robinson *et al.* (1996)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Chinaman's Hat Island	ND	-	**Unknown** (data deficient)	
				24/11/1982 (helicopter landing): "numerous"; breeding colony present	Robinson *et al.* (1996)
	Dalby Island	ND	-	**Unknown** (data deficient)	
				27/06/1979 & 21/09/1980 (2 boat landings): Present	Robinson *et al.* (1996)
	Dangerous Reef	Not likely to have ever bred there	E (2010)	**Not likely to have ever bred there**	P. Shaughnessy *pers. comm.* (2016); B. Page *pers. comm*. (2016) and S. Goldsworthy *pers. comm*. (2016)
				Jan 1972: At least 5 found moulting in cavities under rocks. "It is possible that these cavities are also used for breeding".	van Tets and Marlow (1977)
				29/11/1982 (helicopter landing): not recorded as present	Robinson *et al.* (1996)
				1990's: No penguins seen during several visits when searching for sea lion pups from boat	P. Shaughnessy *pers. comm.* (2016)
				2009 & 2010: No penguins found in two 4 week stays on the island in each of 2009 and 2010 (they were thorough observations of island)	B. Page *unpubl. data* (2010)
	Duffield Island	ND	-	**Unknown** (data deficient)	
				26/06/1979, 18/09/1979 & 22/09/1990 (3 boat landings): breeding colony present	Robinson *et al.* (1996)
	English Island	None observed during recent visits 2003 – 2011)	E (2011)	**Presumed extinct**	
				26/06/1979 & 22/09/1980 (2 boat landings): breeding colony present	Robinson *et al.* 1996
				2001: Present	Atlas of Living Australia observation record from Birds Australia (2001) (extracted 11/03/2016)
				2003 – 2011: not seen on island during 20 visits between 2003 and 2011	B. Page *unpubl. data* (2016)
	Goose Island	<20	E (2005)	**Unknown** (data deficient)	

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
Gulf St Vincent and Spencer Gulf				24/11/1981 (boat landing): breeding colony present; "common"	Robinson *et al.* (1996)
				1993: Present	Atlas of Living Australia observation record, unknown observer (1993) (extracted 2015)
				2005: <20	Wiebkin *unpubl. data* (2005) in Wiebkin (2011)
	Green Island	ND	-	**Unknown** (data deficient)	
				1981: "breeding"	SANPWS database in Copley (1996)
	Hareby Island	500	E (2008)	**Presumed to be stable**	
				28/06/1979, 20/09/1979 & 17-18/09/1980 (3 boat landings): breeding colony present	Robinson *et al.* (1996)
				2008: 500 breeding individuals	A. Wiebkin *unpubl. data* (2008) in Wiebkin (2011)
				2009: Present	Atlas of Living Australia observation record from J. Van Weenan (2009) (extracted 2015)
	Kirkby Island	ND	-	**Unknown** (data deficient)	
				27/06/1979, 20/09/1979 & 20/09/1980 (3 boat landings): large breeding colony present	Robinson *et al.* (1996)
	Langton Island	ND	-	**Unknown** (data deficient)	
				28/06/1979, 20/09/1979 & 18/09/1980 (3 boat landings): breeding colony present	Robinson *et al.* (1996)
	Lewis Island	<100	S (2006)	**Unknown** (data deficient)	
				28/11/1982 (helicopter landing): "many little penguin burrows"; breeding colony present	Robinson *et al.* (1996)
				2006: Thorough search in breeding season of whole island – no birds seen, but estimated <100 penguins from number of burrows with signs of recent activity	A. Wiebkin *pers. comm.* (2016), Wiebkin (2011)
	Lipson Island	52	S (2011)	**Stable**	
				1965-1987: ~20-40 pairs (~40-80 breeding individuals)	M. Waterman *pers. comm.* in Copley (1996)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				1990-1991: ~50 pairs (~100 breeding individuals)	R. Brandle *pers. comm.* in Copley (1996)
				2006: <100 breeding individuals	S. Harrison in Wiebkin (2011)
				29, 30/05/2011: 52 breeding individuals	DES (2011)
	Lusby Island	ND	-	**Unknown** (data deficient)	
				27/06/1979, 18/09/1979 & 15/09/1980 (3 boat landings): present	Robinson *et al.* (1996)
				2009: present/diggings	Atlas of Living Australia observation record from D. Armstrong (2009) (extracted 2015)
	Marum Island	ND	-	**Unknown** (data deficient)	
				27/06/1979, 20/09/1979, 16/09/1980 (3 boat landings): Present	Robinson *et al.* (1996)
	Middle Island	ND	-	**Unknown** (data deficient)	
				25/11/1982 (helicopter landing): breeding colony present	Robinson *et al.* (1996)
	North Islet	ND	-	**Unknown** (data deficient)	
				2005: North of Wedge Island, "should be included as a breeding colony"	Goldsworthy and Page (2010)
	Neptune Islands	None observed during recent visits 2004 – 2014	E (2014)	**Presumed extinct**	
				1870s: "Often found" with the mutton birds on Neptune Islands during a voyage to the island to collect mutton bird eggs	*The South Australian Register* (1876) (newspaper article 27/11/1876)
				3/09/1980 or 27/11/1982 (2 helicopter landings): Dead bird found on North Neptune Island	Robinson *et al.* (1996)
				2004-2014: Not seen on island during 4 visits between 2004 – 2014 (thorough island searches)	B. Page *unpubl. data* (2014)
	Owen Island	ND	-	**Unknown** (data deficient)	
				29/11/1982 (helicopter landing): breeding colony present	Robinson *et al.* (1996)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Partney Island	ND	-	**Unknown** (data deficient)	
				20, 21 & 27/09/1979 (3 boat landings): breeding colony present; "many burrows"	Robinson *et al.* (1996)
				19/05/2009: Diggings/ skeleton/ feathers	Atlas of Living Australia observation records from D. Armstrong (19/5/09) (extracted 2015)
	Rabbit Island, near Pt Lincoln	ND	-	**Unknown** (data deficient)	
				1/12/1976 & 24/06/1983 (2 boat landings): breeding colony present	Robinson *et al.* (1996)
				23/7/08 and 3/9/08: present/nest sighted	Atlas of Living Australia observation records from P. Wilkins (23/7/08 and 3/9/08) (extracted 2015)
	Reevesby Island	1,857	S (2009)	**Presumed to be stable**	
				26-29/6/1979, 17-20/08/1979 & 15-22/09/1980 (boat expeditions): breeding colony present; "abundant, at least several 100s of pairs"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
				1996: 12 caught pitfall trap survey	J. van Weenen *unpubl. data* (1996) in Wiebkin (2011)
				1998: 39 & 10 caught pitfall trap surveys	J. van Weenen *unpubl. data* (1998) in Wiebkin (2011)
				1999: 30 caught pitfall trap survey	J. van Weenen *unpubl. data* (1999) in Wiebkin (2011)
				2009: 3 caught pitfall trap survey	J. van Weenen *unpubl. data* (2009) in Wiebkin (2011)
				2009: 1857 breeding individuals	A. Wiebkin *unpubl. data* (2009) in Wiebkin (2011)
				2010: Present	Atlas of Living Australia observation records from Birds Australia (21/6/2010) (extracted 2010)
	Roxby Island	ND	-	**Unknown** (data deficient)	ALA Observation records from D. Armstrong (19/5/09)
				27/06/1979, 18/09/1979 & 17-18/09/1980 (3 boat landings): breeding colony present	Robinson *et al.* (1996)
				2009: Diggings/ skeleton/ feathers	Atlas of Living Australia observation records from D. Armstrong (19/5/09) (extracted 2015)
	Royston Island	ND	-	**Unknown** (data deficient)	

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				25/11/1982 (helicopter landing): breeding colony present; "numerous"; "common"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
	Seal Island, YP (Althorpe group)	ND	-	**Unknown** (data deficient)	
				24/11/1982 (helicopter landing): breeding colony present	Robinson *et al.* (1996)
	Sibsey Island	Few (Figure 3. mapped as <10)	S (2004)	**Unknown** (data deficient)	
				26/06/1979 & 22/09/1980 (2 boat landings): breeding colony present	Robinson *et al.* (1996)
				2004: A few birds	Wiebkin *unpubl. data* (2004) in Wiebkin (2011)
				2008: Present	Atlas of Living Australia observation records from P. Wilkins (18/8/08) (extracted 2015)
	Smith Island	ND	-	**Unknown** (data deficient)	
				1982: "numerous"	SANPWS database in Copley (1996)
	Spilsby Island	<100	E (2010)	**Declined**	
				22/09/1980 (boat landing): Present	Robinson *et al.* (1996)
				2000/2005 to 2011: W. Goedseke (island farmer) observed a marked decline in penguins between approx. 2000/2005 and 2011 from a few thousand birds to a handful in 2011	W. Goedseke *pers. comm*. in Wiebkin (2012)
				2010: <100 breeding individuals	W. Goedseke *unpubl. data* (2010) in Wiebkin (2011)
	Stickney Island	ND	-	**Unknown** (data deficient)	
				26/06/1979, 19/09/1979 &22/09/1980 (3 boat landings): Present	Robinson *et al.* (1996)
	Thistle Island	ND	-	**Unknown** (data deficient)	
				1999: "Observed breeding" and "common"	van Weenen (1999)
				1999 – 2006: "Declined heavily on Thistle Island around the settlement area on the north coast"	J. van Weenen *pers. comm.* (2016).
	Troubridge Island	313	S (2015)	**Presumed to be stable**	Note: Survey methods same 2003 to 2011 (may be overestimates, but uncertain); method change from 2003-2011, but same 2013 to 2015.

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				Jan, Apr 1916: not mentioned by the author. NB Both visits were for natural history purposes	White (1916)
				1966-1992: 2000-5000 NB Between 1985 & 1992, 9 visits were made – 7 in Dec, 1 in Sep, 1 in June	M. Waterman historical banding data in Copley (1996)
				2003: 2528 Oct 2009: 3010	Wiebkin (2010)
				Jun 2011: 2600	Wiebkin *et al.* 2012
				Oct 2013: 270 (Note: Survey in June 2013 estimated 1966 breeding little penguins, but different method)	Colombelli-Négrel and Kleindorfer (2014), Bool and Wiebkin (2013)
				Oct 2014: 406	Colombelli-Négrel (2015a)
				Oct 2015: 313 (but 939 E from night acoustic surveys)	D. Colombelli-Négrel *unpubl. data* (2016)
	Wardang Island	~ 8000	E (2004)	**Unknown** (data deficient)	
				2004: ~8000	Lawley *et al.* (2005)
				2015: Present	A. Sharp and D. Furbank *pers. comm.* (2015).
	Wedge Island	<100	E (2004)	**Suspected to have declined** "Apparently once common along the north coast of the island (particularly in the old shearing shed), but now they appear to have gone from this area", as told by several residents.	J Van Weenen *pers. comm*. (2016)
				Jan 1916: not mentioned by the author. NB This visit was specifically for natural history purposes.	White (1916)
				2/11/1975 (visit), 26/11/1975 (helicopter landing) & 8/05/1983 (2 day visit): breeding colony present	Robinson *et al.* (1996)
				2004: <100 breeding individuals	J. van Weenen *unpubl. data* (2004)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				2015: "still present but probably in low numbers based on tracks"	D. Taggart *pers. comm.* (2015)
	Winceby Island	ND	-	**Unknown** (data deficient)	
				27/06/1979, 17/09/1979 & 16/09/1980 (3 boat landings): breeding colony present; "common"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
				2008/2009: Present	Atlas of Living Australia observation records incl. from J. van Weenan 12/05/08 and D. Armstrong 20/5/09 (extracted 2015)
Cape Catastrophe to WA border	Avoid Island (Sudden Jerk Is)	ND	-	**Unknown** (data deficient)	
				1981: "common"	SANPWS database in Copley (1996)
	Black Rocks	ND	-	**Unknown** (data deficient)	
				1981: Present; "common"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
	Blefuscu Island	ND	-	Unknown. Included in Franklin Is estimate?	Goldsworthy and Page (2010)
	Bunda Cliffs - GAB	>100	E (2006)	**Unknown** (data deficient)	
				1974: Present	Reilly (1974) in Wiebkin (2011)
				2006: >100 breeding individuals	B. Page *unpubl. data* (2006) in Wiebkin (2011)
				12/09/2008: Present	Atlas of Living Australia observation record 12/09/2008 (extracted
	Curta Rock (North)	ND	-	**Unknown** (data deficient)	
				28/11/1982 (helicopter landing): breeding colony present; "large colony"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
	Curta Rock (South)	ND	-	**Unknown** (data deficient)	
				28/11/1982 (helicopter landing): breeding colony present; "numerous"	Robinson *et al.* (1996); SANPWS database in Copley (1996)
	Dog Island	ND	-	**Unknown** (data deficient)	
				7-8/01/1971 (Royal Society Expedition) &/or 21/04/1982 (helicopter landing): Present	Robinson *et al.* (1996)
	Dorothee Island	~200	S (2004)	**Unknown** (data deficient)	
				Nov 1976: Present; "burrows on N half of island"	Parker and Cox (1978), Copley (1996)
				2004: ~200 breeding individuals	A. Wiebkin *unpubl. data* (2004) in Wiebkin (2011)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Egg Island	ND	-	**Unknown** (data deficient)	
				21/04/1982 (helicopter landing): Present; "colonies of little penguins"	Robinson *et al.* (1996)
	Evans Island	~500	E (2005)	**Unknown** (data deficient)	
				21/04/1982 (helicopter landing): Present	Robinson *et al.* (1996)
				2005: ~500 breeding individuals	A. Wiebkin *unpubl. data* (2005) in Wiebkin (2011)
	Eyre Island	ND	-	**Unknown** (data deficient)	
				10/03/1970 (boat landing) &/or 24/04/1982 (helicopter landing): Present	Robinson *et al.* (1996)
	Fenelon Island	ND	-	**Unknown** (data deficient)	
				20/ 04/1982 (helicopter landing): Present	Robinson *et al.* (1996)
	Flinders Island	<20	E (2006)	**Declined**	**Note**: Cats had overrun the island by the 1920s (Jones 1924 Vol 2:242 in Robinson *et al*. 2008) and were still common during the 2006 Investigator Group Expedition of the Royal Society of South Australia (Robinson *et al.* 2008).
				Feb-Mar 1938: "very numerous on north-east coast of Island"	Finlayson (1938)
				Jul 1968: only one freshly dead little penguin was seen and "the caves where Finlayson noted large numbers now seem entirely deserted."	Eckert (1970) in Robinson *et al.* (2008)
				14-29/05/2006 (expedition): "…heard penguins calling from the bay below Seal Point and fresh body parts were only found on top of cliffs in this area. It appears that the cat population has removed them from all but the most inaccessible areas of the island."	Robinson *et al.* (2008)
				2006: <20 breeding individuals	D. Armstrong (2006) in Wiebkin (2011)
		2000	E (2004)	**Stable**	
				16-23/02/1969: "Common, breeding."	Eckert (1971)

	Colony	Current Population (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	Method (S = survey, E = estimate from observer walking around colony)	Trend (inferred) and history of observations	Source (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Franklin Island - East and West			1971-1986: "common"; 2000+ breeding individuals	Copley (1996)
				2004: 2000 breeding individuals	Wiebkin *unpubl. data* (2004) in Wiebkin (2011)
	Freeling Island	ND	-	**Unknown** (data deficient)	
				21/04/1982 (helicopter landing): Present;	Robinson *et al.* (1996); SANPWS database in Copley (1996)
	Four Hummocks (South)	ND	-	**Unknown** (data deficient)	
				1/06/1980 (helicopter landing): Present	Robinson *et al.* (1996)
	Goat Island (off Saint Peter Is)	ND	-	**Unknown** (data deficient)	
				23, 24/04/1982 (2 helicopter landings): Present	Robinson *et al.* (1996)
	Greenly Island	1500	E (2004)	**Presumed to be stable**	
				May 1948: Large numbers observed by H.H. Finlayson (he wrote that it was the bird "…in greatest numbers on the island at this time…")	Finlayson (1948)
				28-30/11/76 (boat expedition) & 28/05/1980: Breeding colony present; "common"	Parker and Cox (1978), Robinson *et al.* (1996), Copley (1996)
				2004: 1500 breeding individuals	Wiebkin *unpubl. data* (2004) in Wiebkin (2011)
	West (Little) Waldegrave Island	ND	-	**Unknown** (data deficient)	
				30/05/1980 (helicopter landing): breeding colony present; "common"	Robinson *et al.* (1996)
				Feb 2001 - May 2006: 9 visits (3-4 hrs each) to island, little penguins were reported as nesting and roosting on the island and were "…widely and sparsely distributed around the island, and were seen on most visits to the island. Breeding was underway on 3 July 2003"	Shaughnessy *et al.* (2008)

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
				2013: "SARDI visited this island to count penguins also, but found their density was too low to apply their count technique" (2013); difficult to count, but not possible to infer decline	LP AMLR mtg *unpubl. data* S. Goldsworthy (2013), P. Shaughnessy *pers. comm.* (2016)
	Lounds Island	ND	-	**Unknown** (data deficient)	
				25/04/1982 (helicopter landing): Present	Robinson *et al.* (1996)
	Nicolas Baudin Island (CP)	ND	-	**Unknown** (data deficient)	
				Feb 2002 to Feb 2005: After 4 visits to the island during this period, it was reported that small numbers of little penguins were seen ashore on 5/02/2002 and offshore on 4/02/2003. "Despite these sightings the island is unsuitable for breeding as it is inundated in high tide."	Shaughnessy and Dennis (2007), B. Page *pers. comm*. (2016)
	North Veteran Island	ND	-	**Unknown** (data deficient)	
				29/05/1980 (helicopter landing): breeding colony present	Robinson *et al.* (1996)
				1980: "small numbers (only 1 burrow found"	Copley (1996)
	Olive Island	2290	S (2006)	**Unknown** (data deficient)	
				2006: 2290 breeding individuals	Wiebkin (2012)
	Pearson Island	12000	S (2006)	**Unknown** (data deficient)	
				Nov 1976: "many"	Parker and Cox (1978)
				2006: 12,000 breeding individuals	Wiebkin *unpubl. data* (2006) in Wiebkin (2011)
				Aug 2013: "Breeding was underway and there was evidence that the [penguin] runway on the eastern end of the southern island was still very active"	S. Goldsworthy, *pers. comm.* (2013)
		ND	-	**Unknown** (data deficient)	

	Colony	**Current Population** (Breeding individuals, unless otherwise stated. ND = no data available for recent population estimate)	**Method** (S = survey, E = estimate from observer walking around colony)	**Trend (inferred) and history of observations**	**Source** (survey/estimate years; BDBSA = Biological Databases of South Australia, DEWNR)
	Rabbit Island, Coffin Bay			1/12/1976 & 24/06/1983 (2 boat landings): breeding colony present	Robinson *et al.* (1996)
				23/07/2008: Present	Atlas of Living Australia observation record from P. Wilkins 23/7/08 (extracted 2015)
	St Francis Island	ND	-	**Unknown** (data deficient)	
				Between 1971 & 1988: breeding colony present; "common"	Robinson *et al.* (1996), SANPWS database in Copley (1996)
	St Peter Island	>1000	E (2005)	**Unknown** (data deficient)	
				Between 1982 & 1991: Breeding colony present; "common"	Robinson *et al.* (1996), SANPWS database in Copley (1996)
				2005: >1000 breeding individuals	Wiebkin *unpubl. data* (2005) in Wiebkin (2011)
	Waldegrave Island	>500	E (2006)	**Stable**	
				Between 1977 & 1980: Breeding colony present	Robinson *et al.* (1996)
				1991: "300(++) pairs [600+ breeding individuals], on small part of E. coast surveyed"	R. Brandle *pers. comm.* in Copley (1996)
				2006: >500 breeding individuals	Goldsworthy *unpubl. data* (2006) in Wiebkin (2011)

Appendix 2: Risk likelihood and consequences tables

Likelihood definitions and consequence categories are adapted from the Ecologically Sustainably Development (ESD) reporting framework developed by the Commonwealth Government - Fisheries, Research and Development Corporation (FRDC 2004). The framework and associated criteria have been applied by PIRSA and SARDI in undertaking ecological risk assessments for a range of South Australian fisheries.

Likelihood definitions

Level	Score	Likelihood of pressure operating (in 5 years)
Remote	0	Never heard of, but not impossible
Unlikely	1	Uncommon, but has been known to occur elsewhere
Possible	2	Some evidence to suggest this is possible here
Occasional	3	May occur
Likely	4	It is expected to occur

Consequence categories – pressures

Level	Score	Consequence of threat operating on LP colonies (in 5 years)
Negligible	0	Some level of interaction may occur but no mortalities generated
Minor	1	Minor reduction in population size where operating
Moderate	2	Moderate reduction in population size where operating
Major	3	Major reduction in population size where operating
Catastrophic	4	Catastrophic reduction in population size where operating

Consequence categories - socio-economic outcomes

Level	Score	Consequence of LP colony declines on socio-economic outcomes (in 5 years)
Negligible	0	None or not detectable
Minor	1	Possibly detectable, but minor impact on the socio-economic pathways for industry or community
Moderate	2	Moderate reduction on the socio-economic pathways for industry or community
Major	3	Major reduction on the socio-economic pathways for industry or community. May result in some intervention.
Catastrophic	4	Catastrophic reduction on the socio-economic pathways for industry or community. High levels of intervention likely.

Likelihood x Consequence

		Consequence level				
Likelihood levels		**Negligible**	**Minor**	**Moderate**	**Major**	**Catastrophic**
		0	1	2	3	4
Remote	0	0	0	0	0	0
Unlikely	1	0	1	2	3	4
Possible	2	0	2	4	6	8
Occasional	3	0	3	6	9	12
Likely	4	0	4	8	12	16

For the purposes of the Little Penguin Risk Assessment, the Likelihood x Consequence scores were rated as follows:

- 0 – 2: Nil or Negligible
- 3 – 4: Low
- 6: Moderate
- 8 – 9: High
- 12 – 16: Very High

Appendix 3: Risk analysis instructions - Little Penguin pre-workshop risk analysis

Thank you for participating in the risk analysis of little penguin colonies in South Australia.

The risk analysis draws upon the standard methodology for assessing ecological risks using Likelihood and Consequence criteria adapted from the Fisheries, Research and Development Corporation (FRDC) Risk Assessment process, and used by SARDI and PIRSA.

A separate Risk ID spreadsheet has been developed to list the pressures and socio-economic values present at each little penguin colony in SA (Appendix 6). To simplify the process the project team has pre-entered draft Likelihood x Consequence scores to give a 'risk rating' from 0-16. These draft pre-filled scores are based on the available evidence and expert opinion as documented in this Background Report.

Your task: to check the Likelihood x Consequence (L*C) scores for the pressures and socio-economic factors impacting on little penguin colonies and to amend them as you deem appropriate. Please refer to Tab 2. Risk analysis criteria of the Risk ID Spreadsheet, for an explanation of the Likelihood and Consequence scores. Note in some instances it may be easier to assess the pressures and socio-economic outcomes by region, in which case you can filter by 'location/island group'. Additionally, a number of columns/pressures have been hidden as these were pre-assessed to have a 'risk rating = 0', including predation by sharks/killer whales, snakes, mice, possums, and mortality directly caused by food availability, coastal pollution (ingestion of debris), and turbidity from dredging. Please feel free to unhide these columns and change them as you deem appropriate.

Please complete the spreadsheet and return to Xxxx Xxxxxxxxx at Xxxx. Xxxxxxxxx@sa.gov.au by 16 May 2016.

Scores will be de-identified and collated for the workshop. In the workshop, participants will receive a print-out of their pre-workshop scores. There will be group discussion of the pressures and possible socio-economic outcomes to little penguin colonies, including the existing controls in place and important factors to consider. Participants will then be given the opportunity to individually change their scores as they deem appropriate, and also rate their confidence in each of these scores (0-100%).

If you have any questions, please don't hesitate to contact Xxxx on Xxxxxxxxxx

Thank you very much for your time.

Appendix 4: South Australian Museum records of little penguin prior to 1940

Reg. Number	Object Form	Date Collected	Collectors	Nearest Named Place	Special Geographic Unit	Precise Location
29,586	Egg clutch	30 Dec 1883	White, W.	Althorpe Islands	Investigator Strait Yorke Peninsula	
32,132	Egg clutch	31 Dec 1883	White, W.	Althorpe Islands	Investigator Strait Yorke Peninsula	Kingscote Spit
32,130	Egg clutch	Aug 1885	White, W.		Kangaroo Island	
34,385	Egg clutch	02 Sep 1885	William White Collection	American River	Kangaroo Island	
3,873	Egg clutch	09 Sep 1885	White, A. and White, W.	Willson River	Kangaroo Island	
32,131	Egg clutch	28 Sep 1893	White, W.	Kingscote	Kangaroo Island	Kingscote Spit
16,116	Egg clutch	Apr 1896	Hawker, R.M.	Neptune Island	Southern Ocean	
51,447	Skin	06 Oct 1899		Tumby Island	Spencer Gulf	S of Tumby Bay
8,020	Skin	15 Oct 1900	Smart, G.	Glanville	Adelaide district	Glanville Blocks
8,021	Skin	26 Jun 1908	Bednell, W.		Gulf St Vincent	
33,196	Egg clutch	26 Nov 1912		Flinders Island	Spencer Gulf	Rabbit Island
14,347	Egg clutch	Nov 1912	Parsons, F.E.		Kangaroo Island	
1,495	Skin	Sep 1914	Waite, E.R.	South Neptune Island	Southern Ocean	
1,496	Skin	Sep 1914	Waite, E.R.	South Neptune Island	Southern Ocean	
51,445	Skin	Mar 1916	White, Captain S.A.	Coorong	Coorong	
51,443	Skin	23 Apr 1916	White, Captain S.A.	Althorpe Islands	Investigator Strait	
1,827	Egg clutch	1916	Henderson, G.B.	Baudin Rocks	South-East South Australia	Guichen Bay
2,045	Skin	21 Aug 1917	Collyer, H.C.D.	Brighton	Adelaide district	beach
28,219	Skin	06 Feb 1921	Cleland, J.B.	Encounter Bay	Encounter Bay	
14,606	Egg clutch	17 Dec 1921	Bell G.P.	Stokes Bay	Kangaroo Island	
4,404	Skin	26 Mar 1923	Thompson, H.A.	Adelaide	Adelaide district	
17,340	Egg clutch	04 Jan 1924	Morgan, A.	Baudin Rocks	South-East South Australia	
31,939	Egg clutch	04 Jan 1924	Bonnin, J.M.	Baudin Rocks	South-East South Australia	
28,220	Skin	23 Jan 1924	Cleland, J.B.	Waitpinga Beach	Encounter Bay	
30,587	Skeleton-Cranium	30 Dec 1924	Bonnin, J.M.	Robe	South-East South Australia	Boatswains Point

30,586	Skeleton-Cranium	1924	Bonnin, J.M.	Robe	South-East South Australia	
30,588	Skeleton-Cranium	02 Jan 1925	Bonnin, J.M.	Robe	South-East South Australia	Long Gully
30,589	Skeleton-Cranium	02 Jan 1925	Bonnin, J.M.	Robe	South-East South Australia	Long Gully
5,301	Skeleton-Cranium	Jan 1925	Morgan, A.	Robe	South-East South Australia	
6,935	Skeleton-Cranium	Nov 1926	Morgan, A.	Robe	South-East South Australia	
23,059	Skin	28 Aug 1928		Robe	South-East South Australia	
11,580	Skin	05 Sep 1928	Hoskins, J. and Balfour, J.	Brighton	Adelaide district	
12,909	Skin	11 Aug 1930	Lewis, G.	Normanville	Mount Lofty Ranges Gulf St Vincent/	
16,890	Skin	27 Jun 1933	Cook, C.	Cape Jervis (lighthouse)	Backstairs Passage	
16,991	Skin	08 Sep 1933	Rowe, J.	Glenelg	Adelaide district	
17,685	Skin	27 Oct 1934	Johnston, K.G.	Seacliff (Adelaide Metropolitan Area)	Gulf St Vincent	
17,861	Skin	16 Jun 1935	Cotton, B.	Goolwa	Fleurieu Peninsula	
17,981	Skeleton	17 Aug 1935	Condon, H.T.	Salt Creek	Coorong	Younghusband Peninsula, coast shore
31,940	Egg clutch	06 Dec 1935	Bonnin, J.M.	Baudin Rocks	South-East South Australia	
31,941	Egg clutch	06 Dec 1935	Bonnin, J.M.	Baudin Rocks	South-East South Australia	
18,158	Skin	23 Feb 1936	Harry, S.J.	Brighton	Adelaide District	
18,509		27 Jul 1936	Adcock, A.	Corny Point	Yorke Peninsula	
18,519	Skin	07 Aug 1936	Jobbins, A.E.	Noarlunga	Adelaide District	
19,177	Egg clutch	17 Aug 1936	Lashmar, A.F.C.	Cape Willoughby	Kangaroo Island	Back Beach
19,178	Egg clutch	17 Aug 1936	Lashmar, A.F.C.	Cape Willoughby	Kangaroo Island	Back Beach

Appendix 5: Outline of implications for a fur seal cull

Over the last few years there have been public calls (media, State parliament) for the development and implementation of strategies for the control of long-nosed fur seals. These calls have included suggestions for relocation, sterilisation and culling and have recently been supported by petitions tabled in the South Australian Parliament on 30 July and 3 December 2015, “requesting the House to urge the Government to immediately implement a management plan, which should include a sustainable harvest of the New Zealand fur seals / Long-nosed fur seals” (Hansard 2015).

In April 2016, South Australia's Environment Minister Ian Hunter reaffirmed the Government's no-cull position stating "the best available science" showed a cull "would not work".

International seal experts, Drs Peter Shaughnessy and Simon Goldsworthy have stated: **“**Culling would be futile unless applied intensively because other fur seals are likely to replace alleged perpetrators quickly. Proposals for an intensive cull are unlikely to be viewed favourably by conservation bodies, the general public or by tourism operators in SA who utilise fur seals” (Shaughnessy and Goldsworthy 2015).

The calls for implementation of a sustainable harvest of long-nosed fur seals have not considered what this might require in terms of effort or costs. The only qualification suggested in the media was by the South Australian Member for the seat of Hammond, i.e. that it should be undertaken as a humane shooting program (891 ABC 2015).

For the benefit of those promoting such a strategy, it may be instructive to examine the scale and detail of a program that was implemented, monitored and modelled for sustainable harvest of Cape fur seals in southern Africa. During the 1970s, a population model was used to set harvest quotas in South Africa and Namibia at 33% of the estimates of pup abundance (Shaughnessy and Best 1982). The harvest was directed at animals in their first year. During that period, pup numbers were increasing at 3.2% per annum despite the harvest (Shaughnessy 1987).

The model was also applied to the mature female class, for which the maximum sustainable sealing rate would be reached when a very small proportion of the mature females were harvested annually (0.04). Alternatively, the model indicated that harvesting 10% of the adult females each year would result in their number being reduced by half in 10 years. Four years would be required if 20 % of the adult females were removed annually. This harvest accounted for many tens of thousands of fur seals being harvested annually.

Appendix 6: Conservation Risk Assessment of Little Penguin Colonies in South Australia – Workshop Scores 24th May 2016

PRE-WORKSHOP RISK ANALYSIS			Risk statement: there is potential that predation/attack by [X] causes a decline in little penguins in the next 5 years (L*C)														Risk statement: there is potential that [X] directly causes a decline in little penguins in the next 5 years (L*C)																		Risk statement: there is potential that a decline in little penguins leads to a decline in [X] in the next 5 years (L*C)	
Level of Confidence			★★★		★		★★	★★★	★	★★		★★	★★	★		★			★				★★		★	★	★	★	★	★★	★★	★★★	★	★★★	★★★
LP colonies (Copley 1996, Wiebkin 2012, DENR 1996, BDBSA, van Weenen 1999)	Location/island group	Mainland/ Island	Long-nosed fur seals (Shaughnessy et al. 2015, Reinholds 2015)*	Australian fur seals (Deagle et al. 2009)	Australian sea lions (Goldsworthy et al. 2011)	Sharks/ killer whales (Robinson et al. 1996, Rogers et al. 2012)	White-bellied sea eagles (Dennis et al. 2009)	Cats (Wiebkin et al. 2012, DEH 2009, van Weenen 1999)	Domestic dogs (Wiebkin et al. 2011, van Weenen 1999)	Foxes (Dann 1991, Short et al. 2002, Kirkwood et al. 2000, 2014, Wallach 2015)	Snakes (all species) (Wiebkin 2011)	Goannas (Colombelli-Négrel and Kleindorfer 2014, Colombelli-Négrel 2015)	Rats (Bool et al. 2007, Colombelli-Negrel and Kleindorfer 2014, Achurch et al. 2012)	Mice (Cuthbert et al. 2004, Wanless et al. 2007)	Brushtail possums (Colombelli-Negrel and Kleindorfer 2014, Colombelli-Negrel 2015a, van Weenen 1999)	Feral bees (M. McKelvey pers. comm. 2015)	Food availability Natural causes (incl. mass fish kills) (Wiebkin 2012, PIRSA 2014)	Food availability Human induced (incl. overfishing) (Wiebkin 2012, PIRSA 2014)	Fisheries bycatch and entanglement (Tomo 2014, 2015)	Coastal pollution - ingestion of marine debris (Wiebkin 2012)	Coastal pollution - entanglement (Wiebkin 2012)	Coastal pollution - microplastics	Coastal pollution - oil spills and other pollutants (Giese et al. 2000, Goldsworthy et al. 2000a, b, Chilvers et al. 2015, Sievwright 2014)	Turbidity from dredging (Wiebkin 2011)	Sea level rise from climate change (Wiebkin 2011).	Sea temperature rise from climate change (Wiebkin 2011)	Extreme heat waves from climate change (Wiebkin 2011)	Parasites and disease (Tomo 2012, 2014, 2015)	Loss of habitat (incl. boxthorn removal) (Wiebkin 2011)	Competition for nest sites (e.g. pigeons, feral bees) (Schumann et al. 2013)	Weeds (Kikuyu) (Weber 1994, Trezise 1999, Weerheim 2001)	Direct anthropogenic disturbance - land (tourism, research, management, uncontrolled access, hit by vehicles) (Tomo 2012, DEH 2005, Ananthawamy 2004, Reilly and Cullen 1979, Dewar and Scarpaci 2011, Ropert-Coudert et al. 2007, Dann et al. 2014)	Direct anthropogenic disturbance - marine (e.g. hit by boats) (Cannell et al. 2015)	Tourism (Wiebkin 2011, media articles)	Social values e.g. local identity, recreational opportunities (Wiebkin 2011, media articles)
6km NW Cape Martin	SE Coast	Mainland	2*1 or 2*2	0	2	3	0	12	12	12	0	3	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Baudin Rocks	SE Coast	Mainland	2*1 or 2*2	0	2	3	0	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	8
Cape Banks (between Gerloff Bay a	SE Coast	Mainland	2*1 or 2*2	0	2	3	0	12	12	12	0	2	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Penguin Island	SE Coast	Island	2*1 or 2*2	0	2	3	0	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	8
Port MacDonnell/ Cape Northumbe	SE Coast	Mainland	2*1 or 2*2	0	2	3	0	12	12	12	0	0	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	2
Granite island	FP	Island	12	0	2	3	3	0	8	8	0	0	6	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	12	12
North Page Island	FP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
South Page Island	FP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
X Hindmarsh Island	FP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X Pullen Island	FP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X Seal Island/rocks, Encounter Bay	FP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X West Island	FP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X Wright Island	FP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
American River	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Antechamber Bay	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Beatrice Island	KI	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Breakneck river	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Browns Beach	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Busby Islet	KI	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Cape Cassini	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Cape Willoughby	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Cape Younghusband	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Christmas Cove	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	4	0	0	2	8
Emu Bay	KI	Island	12	0	2	3	3	12	4	0	0	8	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	4	0	0	2	8
Harvey's Return	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Kingscote	KI	Island	12	0	2	3	3	12	12	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	4	4	0	12	12
Maupertuis Bay	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Nobby Islet	KI	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Pelorous Islet	KI	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	0	2
Penneshaw	KI	Island	12	0	2	3	3	12	12	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	4	4	0	12	12
Point Ellen	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	4	0	2	8
Ravine des Cassoars	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Rocky River	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Seal Bay	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Snellings Beach	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Stokes Bay	KI	Island	12	0	2	3	3	12	4	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Vivonne Bay	KI	Island	12	0	2	3	3	12	12	0	0	4	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	4	0	2	8
X Cape Gantheaume	KI	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X Western River Cove	KI	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Althorpe Island	Southern YP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Chinamans Hat Island	Southern YP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Middle Island	Southern YP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Royston Island	Southern YP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Seal Island, Althorpe group	Southern YP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	2
Troubridge Island	Gulf St Vincent	Island	12	0	2	3	3	0	4	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	4	1	1	0	0	2	8
Goose Island	Spencer Gulf	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	2	8
Green Island	Spencer Gulf	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Wardang Island	Spencer Gulf	Island	12	0	2	3	3	12	4	0	0	4	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Albatross Island	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Avoid Island (Sudden Jerk Is.)	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Black Rocks	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Boston Island	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Curta Rocks - North	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Curta Rocks - South	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Four Hummocks	Southern EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Lewis Island	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Lipson Island	Spencer Gulf	Island	12	0	2	3	3	0	0	6	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Owen Island	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Rabbit Island, Pt Lincoln	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Smith Island	Southern EP	Island	12	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Thistle Island	Southern EP	Island	12	0	2	3	3	0	4	0	0	4	not assessed	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Wedge Island	Southern EP	Island	12	0	2	3	3	0	4	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
X Neptune Island	Southern EP	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Blythe Island	SJBG	Island	12	0	2	3	3	0	2	0	1	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Duffield Island	SJBG	Island	12	0	2	3	3	0	2	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
English Island	SJBG	Island	12	0	2	3	3	0	2	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Hareby Island	SJBG	Island	12	0	2	3	3	0	2	0	1	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Kirkby Island	SJBG	Island	12	0	2	3	3	0	2	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Lusby Island	SJBG	Island	12	0	2	3	3	0	2	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Partney Island	SJBG	Island	12	0	2	3	3	0	2	0	1	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Reevesby Island	SJBG	Island	12	0	2	3	3	0	4	0	1	4	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Roxby Island	SJBG	Island	12	0	2	3	3	0	2	0	1	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Sibsey Island	SJBG	Island	12	0	2	3	3	0	2	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Spilsby Island	SJBG	Island	12	0	2	3	3	0	4	0	0	4	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
X Dangerous Reef	SJBG	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
X Winceby Island	SJBG	Island	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dorothee Island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Flinders Island	Western EP	Island	4	0	2	3	3	12	4	0	1	4	3	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Greenly Island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
North Veteran Island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Pearson Island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8
Rabbit Island, Coffin Bay	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Waldegrave Island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
West (Little) Waldegrave island	Western EP	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	4	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Bunda Cliffs/Nullarbor Cliffs - GAB	Far West Coast	Mainland	4	0	2	3	3	0	0	1	1	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Dog Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Egg Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Evans Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Eyre Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Fenelon Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Franklin Islands (E)	Far West Coast	Island	4	0	2	3	3	0	0	0	1	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Franklin Islands (W)	Far West Coast	Island	4	0	2	3	3	0	0	0	1	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Freeling Island Nuyts Arch	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Goat Island, off St Peter Island	Far West Coast	Island	4	0	2	3	3	0	0	0	1	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Lound Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
Olive Island	Far West Coast	Island	4	0	2	3	3	0	0	0	0	0	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
St Francis Island	Far West Coast	Island	4	0	2	3	3	0	0	0	1	0	3	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	2
St Peter Island	Far West Coast	Island	4	0	2	3	3	0	0	0	1	4	0	0	0	1	8	1	3	2	2	?	4	2	4*0 or 4*1	4	4	4	1	1	1	0	0	1	8

Evidence star ratings	
no supporting evidence	☆☆☆
minimal supporting evidence	★☆☆
specific data for region	★★☆
specific data for colony	★★★

Government of South Australia
Department of Environment,
Water and Natural Resources