Conservation management priorities for little penguin populations in Gulf St Vincent

A report prepared by Annelise Wiebkin, South Australian Research and Development Institute for the Adelaide and Mount Lofty Ranges Natural Resources Managment Board

June 2011

Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

CONSERVATION MANAGEMENT PRIORITIES FOR LITTLE PENGUIN POPULATIONS IN GULF ST VINCENT

Report to Adelaide and Mount Lofty Ranges Natural Resources Management Board

A. S. Wiebkin

SARDI Publication No. F2011/000188-1
SARDI Research Report Series No. 558

June 2011

This Publication may be cited as:
Wiebkin, A. S. (2011) Conservation management priorities for little penguin populations in Gulf St Vincent. Report to Adelaide and Mount Lofty Ranges Natural Resources Management Board. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000188-1. SARDI Research Report Series No.588. 97pp.

South Australian Research and Development Institute
SARDI Aquatic Sciences
2 Hamra Avenue
West Beach SA 5024

Telephone: (08) 8207 5400
Facsimile: (08) 8207 5406
http://www.sardi.sa.gov.au

DISCLAIMER

The author warrants that they have taken all reasonable care in producing this report. The report has been through the SARDI Aquatic Sciences internal review process, and has been formally approved for release by the Chief, Aquatic Sciences. Although all reasonable efforts have been made to ensure quality, SARDI Aquatic Sciences does not warrant that the information in this report is free from errors or omissions. SARDI Aquatic Sciences does not accept any liability for the contents of this report or for any consequences arising from its use or any reliance placed upon it.

Printed in Adelaide: July 2011

SARDI Publication No. F2011/000188-1
SARDI Research Report Series No. 588

Author(s): A. S. Wiebkin

Reviewer(s): S. D. Goldsworthy and B. Page

Approved by: M. Deveney
Subprogram Leader, Marine Pests – Marine Environment & Ecology

Signed: 

Date: 4 July 2011

Distribution: Adelaide and Mount Lofty Ranges Natural Resources Management Board, SAASC Library, University of Adelaide Library, Parliamentary Library, State Library and National Library

Circulation: Public Domain

Table of contents

1. Executive summary

The Gulf St Vincent (GSV) region supports a number of little penguin colonies. Recently the populations of penguins at some of these colonies have declined and if these rates of decline continue some colonies may disappear in the near future. The declines have prompted efforts to identify conservation management priorities for GSV penguin populations. Little penguins are a major tourism attraction, bringing significant economic revenue to the region. They are also an iconic species for the community and they encourage interest and stewardship of marine ecosystems. Conservation of little penguin colonies in GSV will help to maintain economic sustainability, regional biodiversity and ecosystem function.

This report commissioned by the Adelaide and Mount Lofty Ranges Natural Resources Management Board provides a prospectus for future conservation management, monitoring and research for little penguins in the region. The report includes: 1) evaluation of the current status of little penguins in GSV, across South Australia and across the range of little penguins in Australia, 2) background knowledge of little penguins from across their range; 3) identification and prioritisation of threats; 4) appraisal of ongoing management needs including monitoring and targeted research programs; 5) what they would cost, and potential funding sources to support these programs.

Little penguins are currently classified as "*common*" across South Australia (*National Parks and Wildlife Act 1972)* and of "*least concern*" nationally (under IUCN criteria). Recent population declines across the GSV region and the state warrant conservation status reviews and possibly reclassification. Priority should be given to research and monitoring programs on little penguins that improve information on their status and trends in abundance, and the significance and contributions of natural and anthropogenic factors in declining populations.

Funding should underpin the management objectives for little penguin colonies in GSV. Current management programs should be supported and expanded to include feral predator control (dogs, cats, rats, foxes), revegetation of nesting habitat (including provision of artificial nests), pollution control, protection of habitat from urban coastal development and protection of prey resources and habitats. Community awareness and education is also important if land-based impacts from people and pets are to be managed effectively.

Population monitoring should include long-term monitoring of the sizes of breeding populations, indices of breeding success and survival rates. Research programs should be targeted to address specific data gaps and management needs including the impact of threats such as disease and predation from seals, foxes, dogs, cats and rats, and management actions to minimise threats at sea and on land. These programs require strong scientific leadership and management to ensure that results and methods are regularly reported and reviewed. For conservation management, population monitoring and research programs to be effective, long-term recurrent funding will need to be secured. Funding options may include tourism licences, visitor fees or environmental levies to Granite and Kangaroo Islands. Other funding options are suggested for period-defined projects.

2. Introduction

Little penguins *Eudyptula minor* at Granite Island and Kangaroo Island contribute to a valuable tourism industry in South Australia. Approximately 170,000 people visit Granite Island (Carpenter et al. 2006) and 184,000 visit Kangaroo Island each year (Kangaroo Island Tourism Optimisation Management Model (TOMM) Annual Report 2009-2010). For most visitors at Kangaroo Island (92%), observing wildlife (including little penguins) is a major attraction; up to 30,000 visitors join a penguin tour each year (TOMM visitor exit survey 2009-2010). Similarly at Granite Island, an estimated 25,000 people participate in tours to view penguins each year. Recent surveys indicate that little penguin populations have been declining at Granite Island and possibly at some places on Kangaroo Island (Gilbert 2010, Kinloch unpubl. data, Somerfield unpubl. data). Further declines may reduce the opportunities for visitors to view little penguins and reduce economic input from tourism and regional biodiversity. The causes for these declines are not well understood.

South Australia's Strategic Plan aims to "lose no known native species as a result of human impacts" with a key performance measure being "no decline in species populations, and where possible an improvement, in the regional status of known native species, or the ecological communities that they come from" (Target T3.1). The Kangaroo Island (KI) Natural Resources Management (NRM) Region Plan aims to have "no additional taxa fulfil the criteria for inclusion on threatened taxa lists due to their changing status on KI" (RT1.14) and the Adelaide and Mount Lofty Ranges (AMLR) NRM Regional Plan aims to have "no decline in conservation status from current levels" (T9).

An Encounter Penguin Management Group (EPMG) was formed in 2007 to discuss cross regional issues related with penguin management and develop a coordinated approach to research and monitoring. The group consisted of managers, scientists and community members from state government departments (Department of Environment and Natural Resources (DENR), SARDI), Kangaroo Island NRM Board, Granite Island Nature Park, commercial tour operators and members of the public. This group identified the need to fund research and monitoring programs for little penguins across the region to determine the causes of population declines. The EPMG has been inactive since early 2008.

To progress collaborative management across Gulf St Vincent (GSV), a Memorandum of Understanding for Collaborative Approaches to the Management of Gulf St Vincent was signed by the three Natural Resources Management Boards (Adelaide and Mt Lofty Ranges, Kangaroo Island, Northern and Yorke) in early 2009.

Under the *Natural Resources Management Act 2004*, Regional NRM plans must address regional arrangements for the proper management of marine resources (*NRM Act* sub-section 75(3) (b) (iv)). It is through this requirement that the AMLR NRM Board has undertaken a number of collaborative marine related actions and investigations. With declines on Granite Island and West Island, the AMLR NRM Board facilitated a meeting with the KI NRM Board, marine wildlife researchers and the then Department for Environment and Heritage (DEH), in late July 2010, to try determine future action priorities. The meeting flagged the urgent need to assess the conservation and management priorities in GSV. Despite a number of studies on various penguin colonies, there has been limited examination of the coordinated management actions needed across the Gulf to address the declines at some penguin colonies.

Aims

This report aims to:

1. Make an assessment and highlight the conservation status of populations of little penguins in the region.
2. Assist decision making, prioritising investment and management to conserve populations of little penguin.
3. Guide investment of limited resources to maximise outcomes.
4. Provide a prospectus for seeking funding support for conservation management and research.

Methods

In this document, Gulf St Vincent (GSV) refers to the GSV marine bioregion (South Australia) (Fig. 1, 2.). This report focuses on the conservation of little penguin colonies in six biounits within this bioregion. Colonies around the southern coast of Kangaroo Island have also been discussed. Colony is defined as a group of penguins that aggregate to breed in a discreet area. Population refers to the number of penguins that are resident in a specified colony or region.

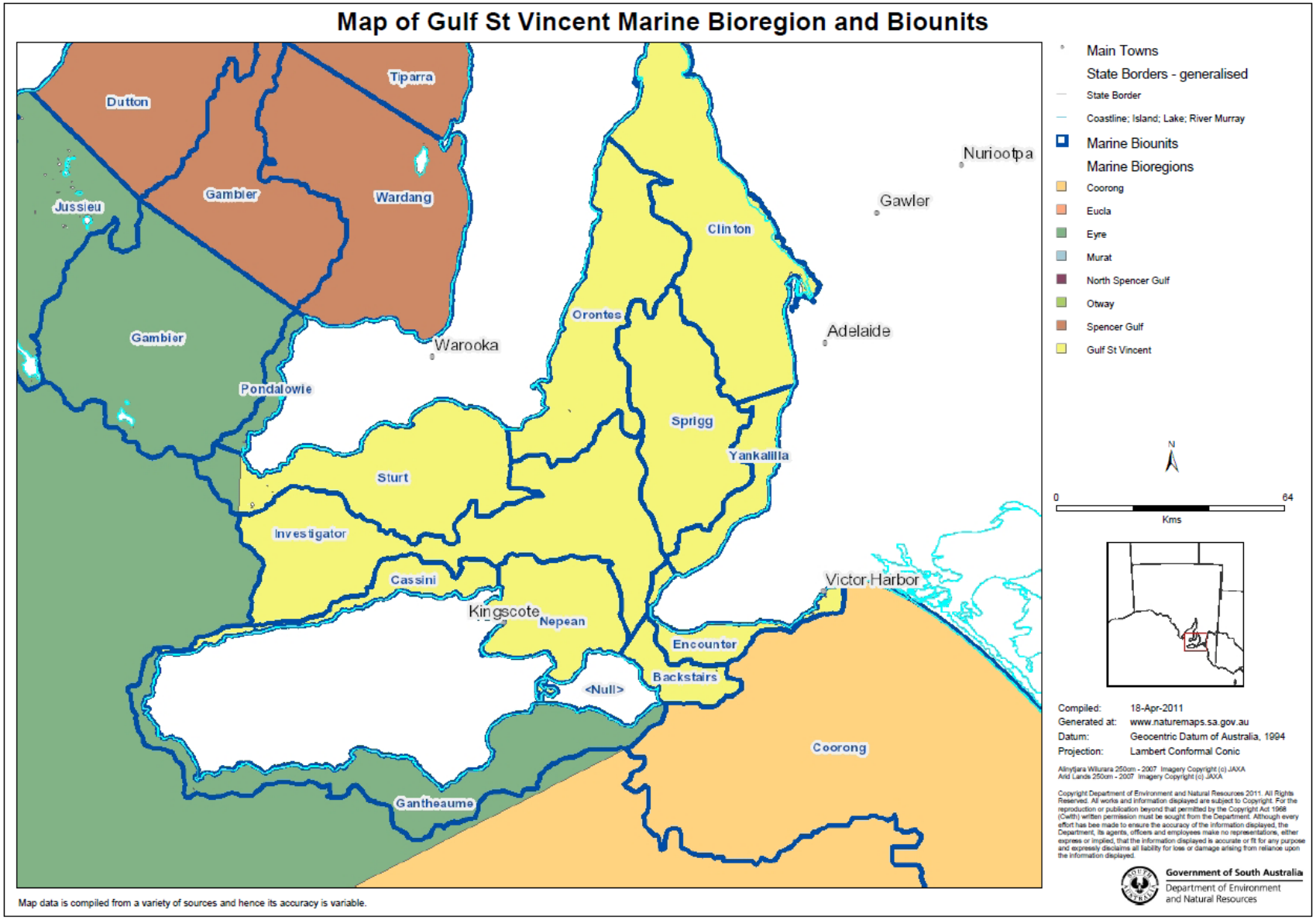

Figure 1. Map of Gulf St Vincent Marine Bioregion and Biounits.

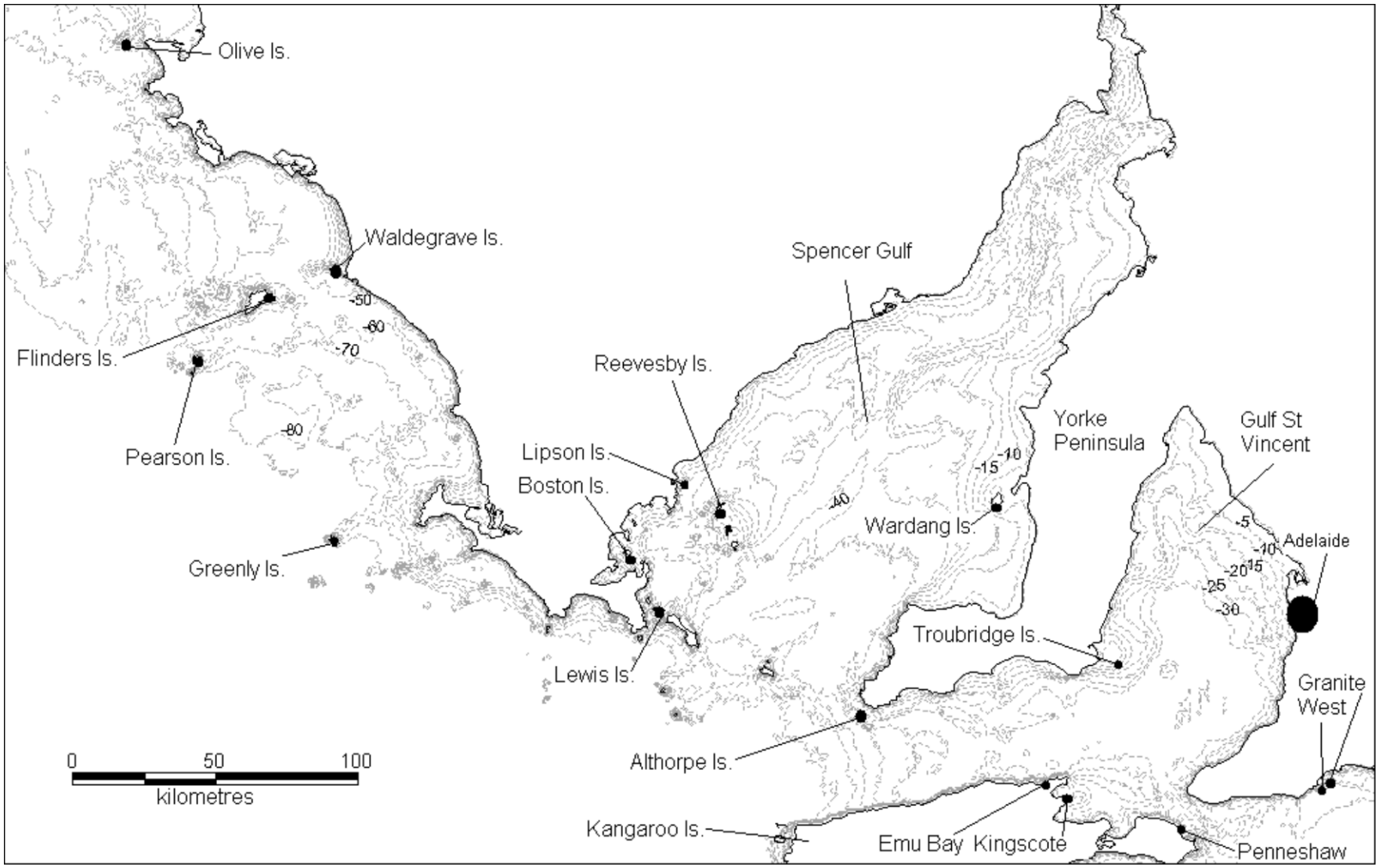

Figure 2. Locations of main penguin colonies in South Australia, including those in the GSV bioregion. Bathymetric contours shown (5m).

3. Background

The little penguin, *Eudyptula minor* (Sphenisciformes: Spheniscidae) is the smallest of 17 penguin species. There is growing concern over the status of penguins because 12 species are in decline. Two species (and one subspecies) are classified on the IUCN Red List as 'endangered', seven are 'vulnerable', one is 'near threatened' and seven are of 'least concern' (Table 1., Ellis et al. 1999). Population declines have been attributed to a range of threats including the loss of nesting and foraging habitat (Humboldt penguin *Spheniscus humboldti*), fisheries activities (macaroni *Eudyptes chrysolophus*, gentoo *Pygoscelis papua*, rockhopper *Eudyptes chrysocome*, African *Speniscus demersus*, Galapagos *Spheniscus mendiculus*, humboldt and chin-strap penguins *Pygoscelis antarctica*), disturbance by humans, urban development (yellow-eyed penguins), predation by domestic and feral animals (Galapagos, African, white-flippered *Eudytula minor albosignata*, crested penguins *Eudyptes spp*), oil pollution (magellanic penguins *Spheniscus magellanicus*), disease (yellow-eyed penguins *Megadyptes antipodes*), climate change and rising sea temperatures (African, adelie *Pygoscelis adeliae* , emperor *Aptenodytes forsteri* and eastern rockhopper penguins *Eudyptes chrysocome filholi*), and historic over-harvest of guano and eggs (African penguins) (Ellis et al. 1999, Woehler et al. 2007). Little penguins are classified as being of 'least concern' but recent censuses indicate that some colonies have declined or disappeared (Dann et al. 2005, Dann and Norman 2006, Stevenson and Woehler 2007, Gilbert et al. unpubl. data, Brock and Kinloch 2008, NSW NPWS report 2000).

Little penguins comprise several subspecies, only one of which breeds around mainland Australia; *E. minor novaehollandiae*. The other subspecies (*E. m. minor, E. m. albosignata, E. m. iredalei, E. m. variabilis and E. m. chathamensis*) breed in New Zealand, including the Chatham Islands (-44°00'S, -176°35'W), where they are known as little blue penguins or kororā (in Māori) (Cunningham et al. 1993). There remains some uncertainty about the number and distributions of these subspecies, particularly in New Zealand (Kinsky and Falla 1976, Wienecke 1993, Banks et al. 2002, Peucker et al. 2009).

Table 1. Penguin taxa (including four subspecies) and their assigned categories of threat according to IUCN criteria (from Ellis et al. 1999).

Penguin species	IUCN Red List category of threat
Emperor Penguin *Aptenodytes forsteri*	Lower risk
King Penguin *A. patagonicus*	Lower risk
Adélie Penguin *Pygoscelis adeliae*	Lower risk
Chinstrap Penguin *P. antarctica*	Lower risk
Gentoo Penguin *P. papua*	Lower risk
Eastern Rockhopper Penguin *Eudyptes chrysocome filholi*	Vulnerable
Southern Rockhopper Penguin *E. c. chrysocome*	Vulnerable
Northern Rockhopper Penguin *E. c. moseleyi*	Vulnerable
Royal Penguin *E. schlegeli*	Vulnerable
Macaroni Penguin *E. chrysolophus*	Near Threatened
Fiordland Crested Penguin *E. pachyrhynchus*	Vulnerable
Snares Island Crested Penguin *E. robustus*	Vulnerable
Erect-crested Penguin *E. sclateri*	Endangered
Little Penguin *Eudyptula minor*	Lower risk
White-flippered Penguin *E. m. albosignata*	Endangered
Yellow-eyed Penguin *Megadyptes antipodes*	Vulnerable
Humboldt Penguin *Spheniscus humboldti*	Vulnerable
Galapagos Penguin *S. mendiculus*	Endangered
Magellanic Penguin *S. magellanicus*	Lower risk
African Penguin *S. demersus*	Vulnerable

3.1 Distribution, abundance and trends

The distribution and abundance of little penguins in Australia has decreased (Stahel and Gales 1987, Reilly 1994). The distribution of little penguins once ranged along the coastline and associated islands from Freemantle in Western Australia (WA) through Tasmania (TAS) and possibly up to Moreton Bay in Queensland (Alexander 1928, Robertson 1955). Historical reports, as well as penguin bones found in archaeological sites indicate that Aboriginal people regularly ate penguins and their eggs along mainland coasts (Stahel and Gales 1987, V. Attenbrow Australia Museum 2009). Today, colony distributions in the east do not extend north of Port Stephens in New South Wales (NSW), and only a handful of small colonies remain on the mainland. These include Manly (NSW), Port Campbell in Victoria (VIC), St Kilda (VIC) and the Nullarbor (Bunda) cliffs (SA). Eight colonies are also located on mainland Tasmania (NPWS 2000, Stevenson and Woehler 2007). Large colonies of little penguins are still located on offshore islands where there are no or few terrestrial predators (Marchant and Higgins 1990, Robinson et al. 1996, Brothers et al. 2001).

In recent decades, some island colonies have declined or become extinct, including some in South Australia; there are currently no penguins on Neptune Islands but newspaper articles from the late 1800's gave accounts of recreational 'egging trips' to these islands where penguins were 'very often found' (The SA Register 1876). Penguins also occurred on Dangerous Reef (Spencer Gulf) but are now extinct (van Tets and Marlow 1977). Recent declines may also have occurred at Flinders Island (search by D. Armstrong, 2006) and Reevesby Island (van Weenen unpubl. data, A. Wiebkin unpubl. data) (Table 2). Local conservation groups and landholders also report that penguin populations in Spencer Gulf have crashed in the past 5 to 10 years, in particular, at Spilsby Island where ~2-3,000 penguins were present 5 years ago but there are few in 2011 (W. Goedseke pers. comm.).

In the GSV bioregion, reports from 15 to 30 years ago indicate that there were breeding colonies of little penguins on 14 small islands, and at more than 19 sites around the coast (and islets/islands) of Kangaroo Island (KI) (Parker et al. 1979, Copley 1996, Robinson et al. 1996, Page et al. 2005) (Table 2). Penguins were then described as "common", "numerous", and colonies were "large" at 11 of these sites (Paton and Paton 1977a, Paton and Paton 1977b, Robinson et al. 1996). Some GSV colonies are now declining or extinct. At Granite Island, nine annual censuses (nest counts) indicate that the colony has declined rapidly at ~23 % per year since 2001. Only 40 breeding adults are forecast to remain in 2016 if the population trend continues (Fig. 3). Nightly counts of penguins on the north shore of Granite Island support this trend (Fig. 4). At West Island, the population appears to have declined from an estimate of ~4000 in 1992 (account by R. Brandle in Copley 1996) to just 240 penguins in 2006 (Bool et al. 2007) and even fewer in 2010 (Gilbert 2010). During the 1980's, local people from Encounter Bay also reported that seabirds (including little penguins) had been declining at Pullen Island for "many years" (DEP 1983). Anecdotally, little penguins also occurred on the mainland around the Bluff and Petrel Cove but penguins are no longer found there. A decline in penguin numbers at Althorpe Island can probably be inferred from an account by Robinson et al. (1996), which stated that penguins were 'common' in 1982, but in 2004, two surveys estimated only 132 breeding penguins (Velzeboer and Shepherd 2004). At Penneshaw (KI) the number of penguins in one section of the colony (monitored by the Penneshaw Penguin Centre guides) appears to have declined over the last 10 years (S. Somerfield unpubl. data) (Fig 5). Other historic colonies on Kangaroo Island including Cape Gantheaume, Ravine des Casoars and Harvey's Return are

now probably extinct or consist of just a few penguins (Page et al. 2005, A. Wiebkin).

Population trends at other colonies in GSV are unclear. At Kingscote, four censuses have been conducted since 2006, and the colony appears to be stable or to have declined slightly. There are some sections of the colony that are declining and some that are increasing (Brock and Kinloch 2008) (Fig. 6). Other colonies at Kangaroo Island were surveyed in 2008 by C. Gibbons (Table 2.) but historical abundance data for these colonies to infer population trends are lacking. Surveys in 2008 suggested that colonies of more than 100 penguins still exist at Emu, Vivonne and Antechamber Bays, Cape Willoughby, Christmas Cove and Cape Cassini (C. Gibbons unpubl. data).

At Troubridge Island, the population of penguins was ~3000-5000 in the 1980s (Robinson et al. 1996, M. Waterman unpubl. data) and is currently ~3000 breeding adults (Wiebkin 2010a), which suggests that the colony is stable. Little penguin populations are known to fluctuate (see records for Baudin Rocks, Troubridge Island, Granite Island in Copley 1996), but the number of colonies in GSV where declines have been inferred outnumber those that appear stable or are increasing (Table 2.). This suggests that across the region the general pattern is for declining trends in abundance, which does raise concerns for the conservation status of little across the bioregion.

Table 2. Recent numbers of breeding penguins for colonies in South Australia (since 2004), recent population trends and history, and methods of recent population estimates (S = survey, E = estimate from observer walking around colony). EB= Encounter Bay, EP = Eyre Peninsula, KI = Kangaroo Island, SP = Spencer Gulf, WC = West Coast, YP = Yorke Peninsula, ND = no data is available for a recent population estimate, since those described by Robinson et al. (1996) and Copley (1996), * colonies in GSV bioregion. Colonies ordered by region and population size. Historical estimates are from data with unknown degrees of confidence. Historical data is from bird banding data (M. Waterman, used to calculate minimum numbers of pairs per colony), some surveys (Paton and Paton 1977, Robinson et al. 1996, R. Brandle, N. Gilbert) and an unknown degree of extrapolation (Copley 1996).

Colony	Current Population	Method	Trend and history	Reference
*Troubridge Is. (YP)	3,010	S (2009)	Stable or declining from 3000-5000 between 1966-92	M. Waterman, Wiebkin 2010a
*Althorpe Is. (YP)	132	S (2004)	Declining from “numerous” “common” in 1982	Robinson et al. (1996), R. Velzeboer and S. Shepherd
*Middle Islet (YP)	ND	-	“abundant” 1982	Robinson et al. 1996, SANPWS
*Royston Islet (YP)	ND	-	”common” “numerous” in	Robinson et al. 1996, SANPWS
*Chinaman’s Hat Is. (YP)	ND	-	“common” “numerous” in	Robinson et al. 1996, SANPWS
*Seal Is. (YP)	ND	-	“conspicuous” in 1980s	Robinson et al. 1996
*Granite Is. (EB)	146	S (2010)	Declining from 1548 in 2001	N. Gilbert 2010
*West Is. (EB)	<20	S (2010)	Declining from ~4000 in 1992	R. Brandle, N. Gilbert
*Pullen Is. (EB)	Several present	E (2011)	Probably declined “large numbers” in 1983	DEP 1983, Robinson et al. 1996, SANPWS, N. Gilbert
*Hindmarsh Is. (EB)	Extinct	-	Present in 1970s	Parker et al. 1979
*Seal Is./Rocks (EB)	ND	-	”common” in 1982	Robinson et al 1996, SANPWS
*Wright Is (EB)	ND	-	300 in 1977, 200+ in 1992	Paton and Paton 1977b, Parker et al. 1979, R. Brandle
*Kingscote Is. (KI)	706	S (2010)	Declining or stable in recent years	NRM-KI, Brock and Kinloch 2008
*Emu Bay (KI)	298	S (2008)	?	C. Gibbons
*Penneshaw (KI)	216	S (2008)	Probably declining in recent years, present in 1970s	Parker et al. 1979, S. Somerfield, C. Gibbons
*Antechamber Bay (KI)	178	S (2008)	?	C. Gibbons
*Vivonne Bay (KI)	150	S (2008)	Stable, ~200 in 1989	Copley 1996, C. Gibbons
*Christmas Cove (KI)	140	S (2008)	Present in early 2000s	LEED Engineering and Construction, C. Gibbons
*Cape Cassini (KI)	116	S (2008)	Present in late 1970s	Parker et al 1979, C. Gibbons
*Cape Willoughby (KI)	116	S (2008)	Present in late 1970s	Parker et al. 1979, C. Gibbons
*Stokes Bay (KI)	60	S (2008)	Present in late 1970s	Parker et al. 1979, C. Gibbons
*Browns Beach (KI)	32	S (2008)	?	C. Gibbons
*Seal Bay (KI)	32	S (2010)	?	T. Soutar
*Snellings Beach (KI)	16	S (2008)	?	C. Gibbons
*Western River Cove (KI)	16	S (2008)	Present in 1987	C. Gibbons, DEP 1987
*North Page Is. (KI)	ND	-	~50 in 1982	Copley 1996
*South Page Is. (KI)	Present (few)	E (2009)	~200-400 in 1992	Copley 1996, P. Shaughnessy
*Harvey's Return (KI)	Extinct ?	S (2006)	Declined, present late 1970s	Parker et al. 1979, A. Wiebkin
*Ravine des Cassoars (KI)	Extinct ?	S (2006)	Declining, evidence of old colony, present in 1970s	Parker et al. 1979, A. Wiebkin
*Cape Gantheaume (KI)	Extinct	E (2008)	Declined and now extinct, 60 banded in 1990s	S. Robinson, B. Page

Colony	Current Population	Method	Trend and history	Reference
*Rocky River (KI)	Extinct ?	-	Present in late 1970s	Parker et al. 1979
*Maupertuis Bay (KI)	Extinct ?	-	Present in late 1970s	Parker et al. 1979
*Breakneck river (KI)	Extinct ?	-	Present in late 1970s	Parker et al. 1979
*American River (KI)	Extinct ?	-	Present in 1970s and 1987	Parker et al. 1979, DEP 1987
*Busby Islet (KI)	Extinct ?	-	~40 in 1989	Copley 1996
*Cape Younghusband	ND		~100 in 1989	Copley 1996
*Beatrice Is. (KI)	ND	-	Present 1919 and late 1970s	White 1918, Parker et al. 1979
*Knobby Islet (KI)	ND	-	Present in late 1980s	Robinson et al 1996
*Pelorous Islet (KI)	ND	-	Present in late 1980s	Robinson et al 1996
Goose Is. (SG)	<20	E (2005)	Declined from “common”1981	Robinson et al. 1996, SANPWS
Wardang Is. (SG)	~ 8,000	E (2004)	?	J. Lawley
Reevesby Is. (SG)	1,857	S (2009)	Declining -pitfall trap surveys: 12 caught in 1996, 39 & 10 in 1998, 30 in 1999 & 3 in 2009	J. van Weenen, A. Wiebkin,
Hareby Is. (SG)	500	E (2008)	Probably stable, ”abundant” 1980	Robinson et al. 1996, A. Wiebkin
Spilsby (SG)	<100	E (2010)	Declining in last 5-10 years from 2000-3000	W. Goedseke
Lewis Is. (SG)	<100	S (2006)	Declined, evidence of old penguin “runways”	A. Wiebkin
Boston Is. (SG)	<100	E (2006)	?	A. Peucker
Lipson Is. (SG)	<100	E (2006)	Stable, 100 in 1991	Copley 1996, S. Harrison
Wedge Is. (SG)	<100	E (2004)	Declining from “common” 1983	Robinson et al. 1996, J. van Weenen
Sibsey Is. (SG)	few	S (2004)	?	A. Wiebkin
Dangerous Reef (SG)	Extinct	S (2009)	Declined and now extinct	van Tets and Marlow 1977, B. Page
Little English Is. (SG)	Extinct?	E (2004)	”few” in1980	Robinson et al. 1996, B. Page
Blythe Is. (SG)	ND	-	“large numbers nesting”	Robinson et al. 1996, SANPWS
Duffield Is.(SG)	ND	-	“common” 1980	Robinson et al. 1996, SANPWS
Green Is. (SG)	ND	-	“breeding” 1981	Robinson et al. 1996, SANPWS
Kirkby Is. (SG)	ND	-	“common” 1980	Robinson et al. 1996, SANPWS
Lusby Is. (SG)	ND	-	“present” 1980	Robinson et al. 1996, SANPWS
Owen Is. (SG)	ND	-	“common” 1982	Robinson et al. 1996, SANPWS
Partney Is. (SG)	ND	-	“many” 1980	Robinson et al. 1996, SANPWS
Roxby Is. (SG)	ND	-	“abundant “1980	Robinson et al. 1996, SANPWS
Smith Is. (SG)	ND	-	“numerous” 1982	Robinson et al. 1996, SANPWS
Winceby Is. (SG)	ND	-	“common” 1980	Robinson et al. 1996, SANPWS
Pearson Is. (EP)	12,000	S (2006)	Stable?, “many” in 1976	Parker and Cox 1978, A.Wiebkin
Greenly Is. (EP)	1,500	E (2004)	”common” in 1980	Copley 1996, A. Wiebkin
Waldegrave Is. (EP)	>500	E (2006)	Stable?, 600 in small area surveyed	Robinson et al 1996, S. Goldsworthy
Dorothee Is. (EP)	~200	S (2004)	Present in 1976	Parker and Cox 1974, A.Wiebkin
Flinders Is. (EP)	<20	E (2006)	Probably declining	D. Armstrong
Eyre Is. (EP)	ND	-	Present in 1990s	Robinson et al. 1996, SANPWS
Rabbit Island (EP)	ND	-	“few” 1982	Robinson et al. 1996, SANPWS,
Four Hummocks (EP)	ND	-	Present in 1980s	Robinson et al. 1996, SANPWS
Avoid Is. (EP)	ND	-	“common” 1981	Robinson et al. 1996, SANPWS
Black Rocks (EP)	ND	-	“common” 1981	Robinson et al. 1996, SANPWS

Colony	Current Population	Method	Trend and history	Reference
Albatross Is. (EP)	ND	-	”several” 1982	Robinson et al. 1996, SANPWS
Little Waldergrave (EP)	ND	-	”common” in 1979	Robinson et al. 1996, SANPWS
North Veteran Is. (EP)	ND	-	”one burrow”	Copley 1996
Curta Rocks (EP)	ND	-	”large colony” in 1982	Robinson et al. 1996, SANPWS
Neptune Is. (EP)	Extinct	E (2006)	Declined and now extinct	SA Register 1976, B. Page
Olive Is. (WC)	2,290	S (2006)	?	A. Wiebkin
Franklin Is. (WC)	2,000	E (2004)	Stable, 2000+ in 1986	Copley 1996, A. Wiebkin
St Peters Is. (WC)	>1000	E (2005)	”common” in 1993	Robinson et al. 1996, A. Wiebkin
Evans Is. (WC)	~500	E (2005)	?	A. Wiebkin
Bunda Cliffs-GAB (WC)	>100	E (2006)	Present in 1974	Reilly 1974, B. Page
Lounds Is (WC)	ND	-	Present in 1980s	Robinson et al. 1996, SANPWS
Goat Island (WC)	ND	-	Present in 1980s	Robinson et al. 1996, SANPWS
Egg Is. (WC)	ND	-	Present in 1980s	Robinson et al. 1996, SANPWS
Dog Is (WC)	ND	-	Present in 1980s	Robinson et al. 1996, SANPWS
Freeling Is. (WC)	ND	-	”common” in 1982	Robinson et al. 1996, SANPWS
Fenelon Is (WC)	ND	-	present in 1980s	Robinson et al. 1996, SANPWS
St Francis Is. (WC)	ND	-	“common” in 1988	Robinson et al. 1996, SANPWS
Baudin Rocks (SE)	<60	E (2006)	Declining from 200-600 in 1960s-1992, present in 1994	Copley 1996, Parker et al. 1979,DENR 1994 S. Goldsworthy
Port MacDonnell (SE)	ND	-	~60 in 1970s	Cox 1978, Parker et al. 1979
Nth of Cape Martin (SE)	ND	-	“at least 2 nests”	Copley 1996
Penguin Island (SE)	ND	-	Present in 1970s and 1994	Parker et al. 1979, DENR 1994

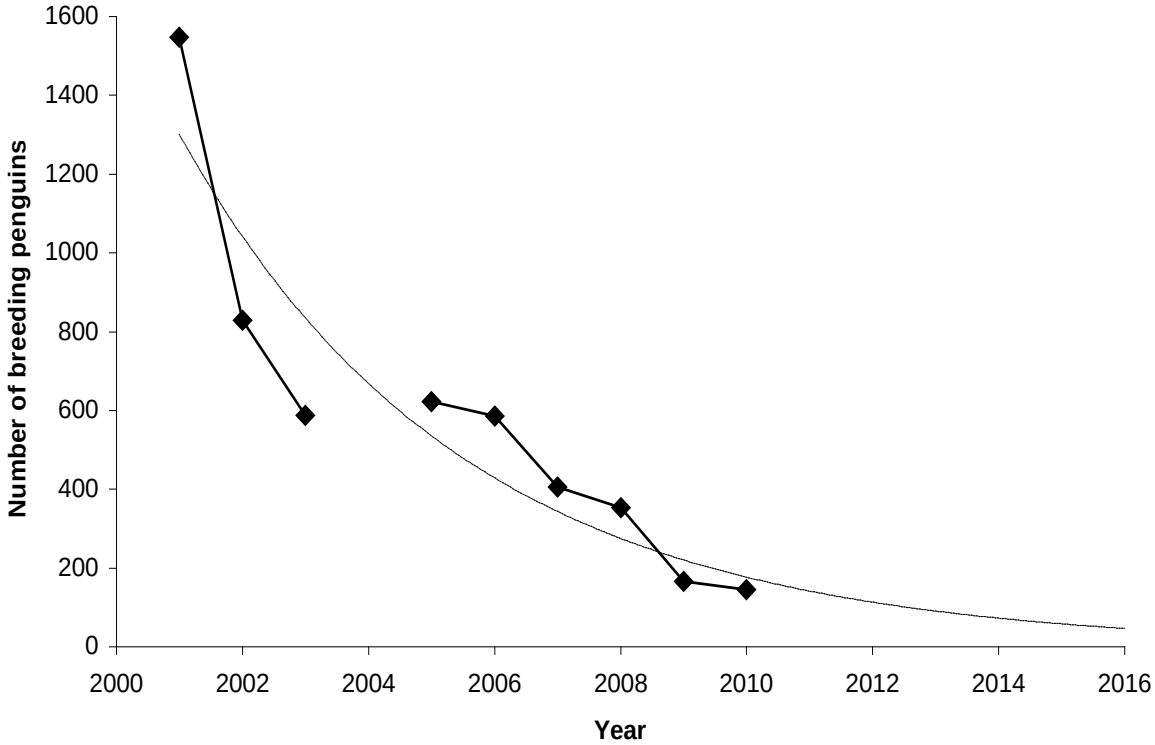

Figure 3. The number of breeding little penguins on Granite Island, as estimated from active nest censuses, during the main breeding season between 2001 and 2010. An exponential trend line (dashed) is projected for another six years into the future (R^2 = 0.88).

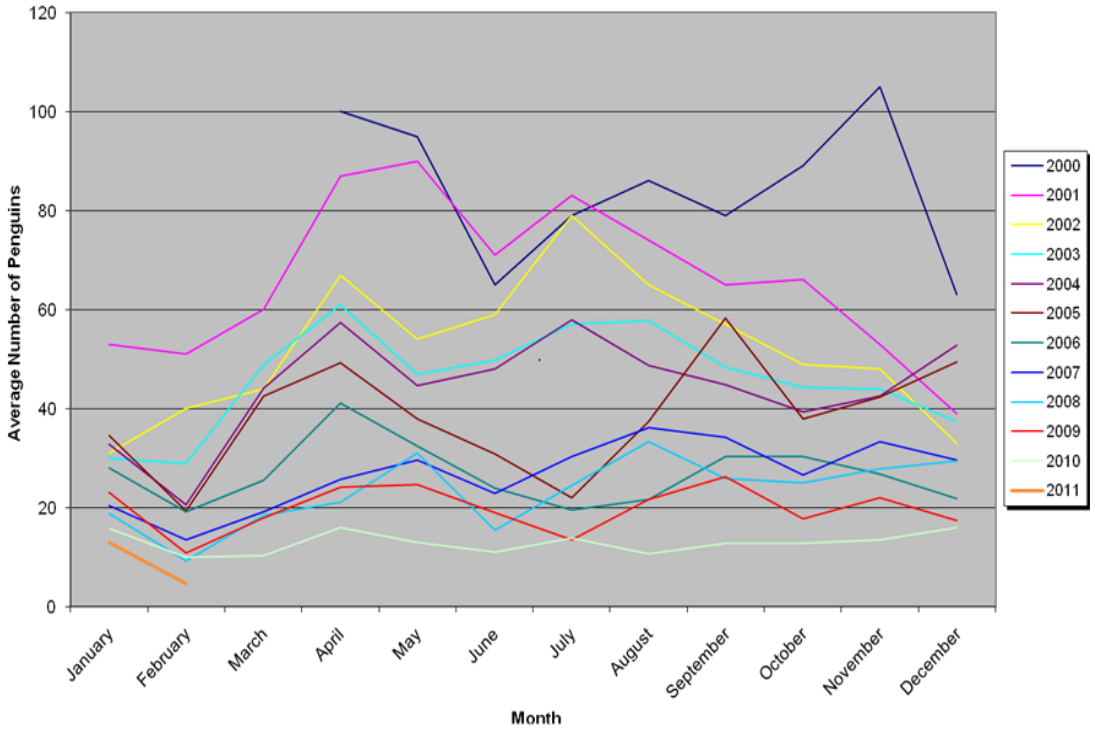

Figure 4. Nightly counts of penguins (averaged per month) on the north shore area of Granite Island where tours are conducted, between 2000 and 2011. Data from N. Gilbert 2011, collected by tour guides.

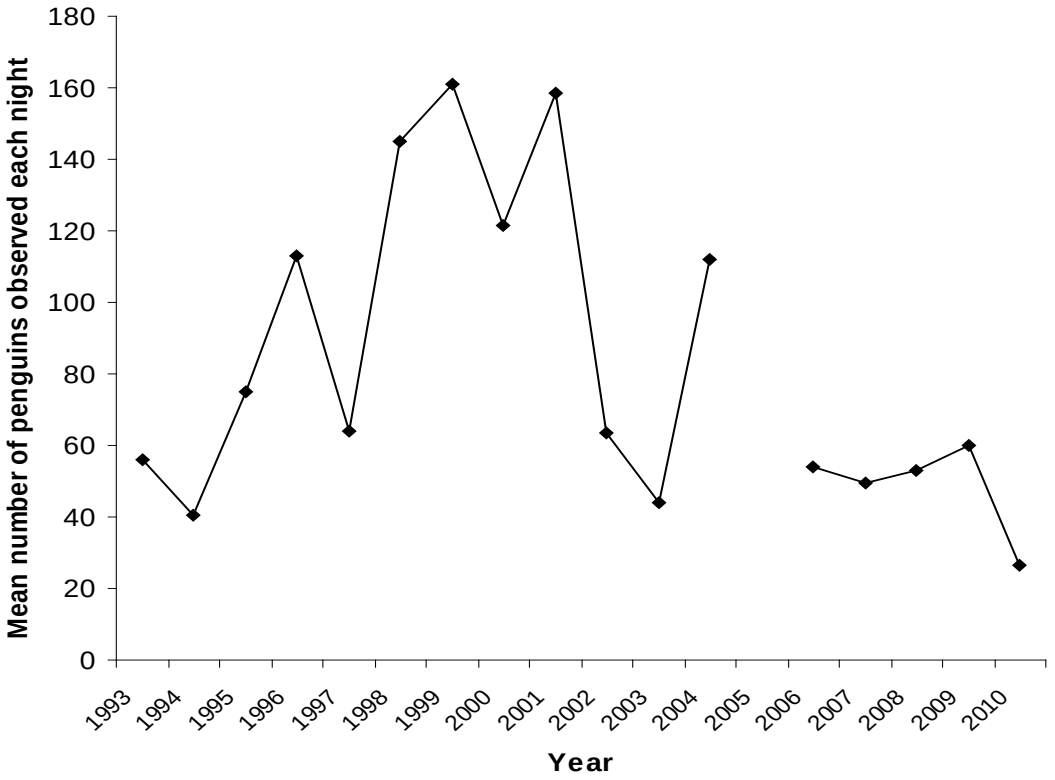

Figure 5. Average nightly counts of penguins that were observed in the Penneshaw colony (tour area only) by penguin tour guides during the month of August, (1993 – 2010). Data for 2005 was unavailable.

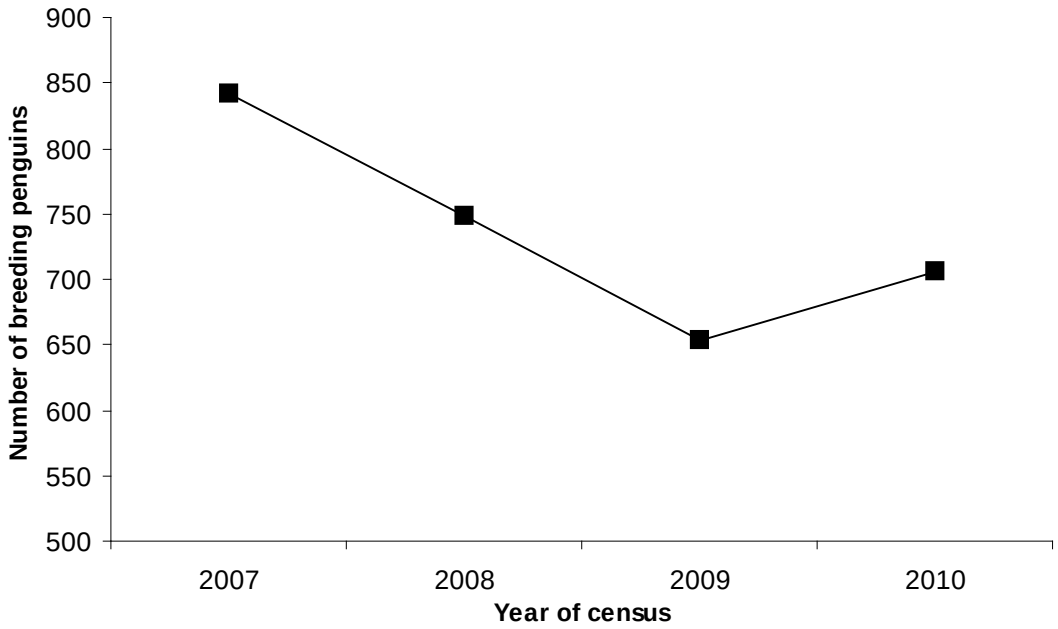

Figure 6. Number of individual breeding little penguins at Kingscote, as estimated from active nest censuses, during October of 2007, 2008, 2009 and 2010 (Brock and Kinloch 2008, http://www.kinrm.sa.gov.au/Marine/PenguinCensus.aspx).

3.2 Breeding and life history

The breeding chronology and life history of little penguins is well documented. Adults are mostly socially monogamous (Rogers and Knight 2006). Approximately one in four adult penguins change mates each year (Reilly and Cullen 1981). Each season, pairs of penguins lay two eggs in shallow nests or burrows under coastal bushes or man-made structures. The male and female take turns incubating the eggs for five weeks and chicks fledge at about seven to nine weeks of age. At least one parent remains with the chicks for the first two weeks, which is known as the guard-phase. Following the guard-phase, the chicks are able to thermoregulate, and both parents forage for prey during the day. Chick growth is relatively steady because meals are delivered to them frequently (once every 1-5 days) (Wienecke et al. 2000, Chiaradia and Nisbet 2006). One or two weeks before fledging, chicks often exceed the weight of their parents, after which their weight decreases due to the energetic expense of growth of adult feathers.

Adult penguins moult each summer. The moult follows breeding and one to two months of intense foraging and fat storage. During the moult, adults remain in the colony for two weeks whilst they grow a complete new coat of feathers. Stahel and Gales (1987) estimate that little penguins lose about 900 g (50 g per day) during the

moult. Many adult birds starve during this period because their fat reserves are insufficient (Stahel and Gales 1987).

The number of offspring that fledge is an indication of the availability of local food for parents during the breeding season. Breeding success (number of chicks that fledge per breeding pair of adults) can impact population dynamics, particularly if breeding success is consistently high or consistently low, relative to adult mortality rates. Breeding success is measured easily by checking nests each couple of weeks to establish the proportion of eggs that have hatched and the proportion of chicks that have fledged. Within GSV, breeding success has been measured at:

- Granite Island between 1990 and 2010, average breeding success = 0.84 ± $0.37_{SD,}$ *n*=15 years (Gilbert and Brandle unpubl. data).
- West Island between 1991 and 2006, average breeding success = 0.75 ± $0.24_{SD,}$ *n*=5 years (Gilbert and Brandle unpubl. data).
- Troubridge Island between 2004 and 2009, average breeding success = 0.86 ± $0.37_{SD,}$ *n*=4 years (Wiebkin 2010).
- Breeding success on Kangaroo Island and Althorpe Island is not known.

While breeding success is similar between colonies in GSV, it can vary considerably between years (ie. between 0.3 and 1.5 at Granite Island). The breeding success rate at Granite Island has been high for the past 3 years (1.3-1.5) but this has not been large enough to offset the dramatic decline in the number of adults breeding, with very few chicks being produced in recent years (Gilbert 2010). 105 chicks were estimated to have been produced in 2010, the lowest number recorded (Gilbert 2010). Assuming that the natural mortality rate of fledglings at Granite Island is the same as at nearby Troubridge Island (where 8% of fledglings survive to age 5, Wiebkin 2010a), then only ~8 of fledglings from 2010 can be expected to recruit to the adult population. This rate of recruitment at Granite Island is unlikely to be sufficient to reverse the declines in the population if adult survival and breeding success decrease.

3.3 Timing of breeding

Across their distribution, little penguins breed in different seasons. Penguins in the eastern part of their range (Tasmania, Victoria and New Zealand) breed during spring and summer (Stahel and Gales 1987, Goldsworthy et al. 2000, Chiaradia et al. 2003, Miyazaki and Waas 2003, Weerheim et al. 2003, Robinson et al. 2005).

Those in the western part of their range (South Australia and Western Australia) breed in autumn and winter (Klomp et al. 1991, Johnson and Wiebkin 2008, KI NRM Board, N. Gilbert 2010) (Fig. 7). There is some evidence that these penguins in the western part of their range also bred in summer in the early 1980s, when penguin eggs and chicks were reported in December and January on West Island (DEP 1983). Breeding in winter for little penguins brings challenges such as reduced daylight for diving (Wiebkin 2011), but good prey availability (such as clupeoid fish) may outweigh the challenges posed by reduced day lengths. Some clupeoid species descend to greater water depths in winter (Gomon et al. 2008) but little penguins have diving strategies allowing them to forage submerged long enough to catch them. A possible benefit of breeding in winter is that it reduces the impact of hot temperatures during summer months, particularly for surface-nesting penguins (Klomp et al. 1991). Prey availability is probably the main factor for the onset of breeding.

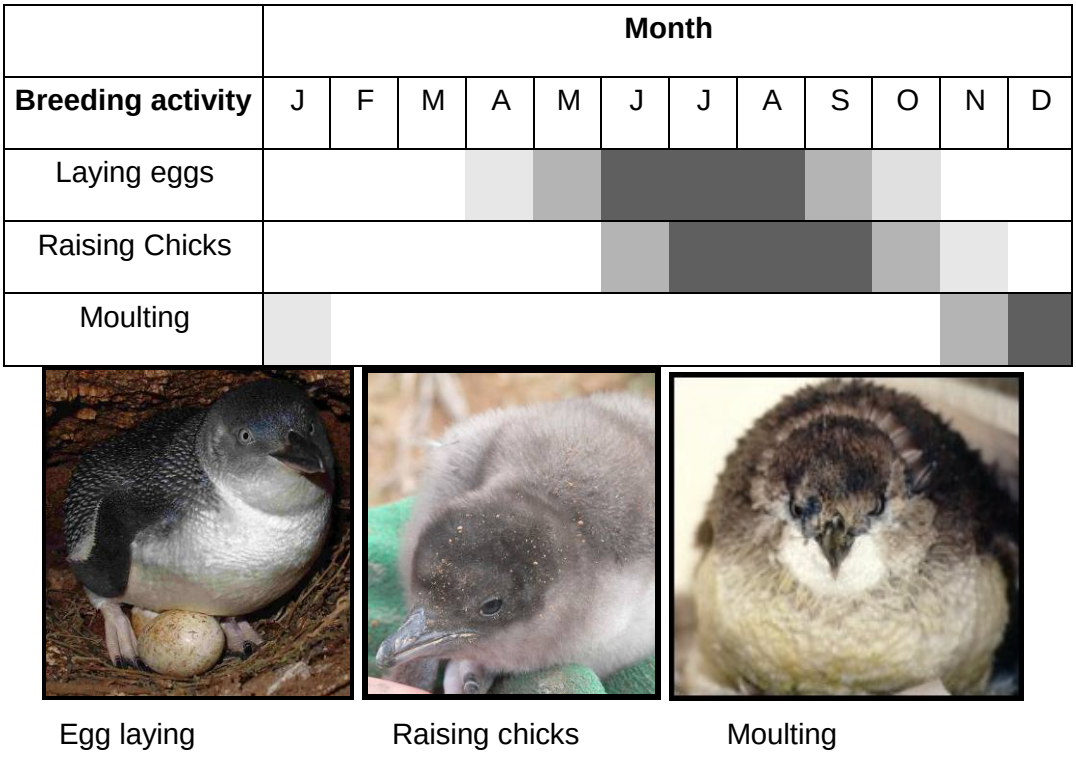

Figure 7. Breeding activities of little penguins in GSV, during each month of the year. Dark shading represents a peak in breeding activity.

In South Australia, little penguins often breed twice within a year (double brooding) (Gales 1985, Brandle et al. 1996, Johnson and Wiebkin 2008, KI NRM Board unpubl. data, S. Somerfield pers comm., G. Trethewy pers. comm.). At Kingscote, 27% of active burrows were used by penguins twice in 2010 (KI NRM Board unpubl.

data) and at Troubridge Island some tagged individuals bred twice per year between 2004-2006 (Wiebkin unpubl. data). This protracted breeding period may reflect prolonged availability of prey.

3.4 Habitat

Little penguins colonise areas where they can come ashore in sheltered bays or shorelines (picture of Troubridge Island below). Nests are either shallow scrapes in sandy soils, under bushes and roots of trees (especially where terrestrial predation and disturbance is minimal), or in deep burrows that are up to a metre long. Penguins also nest under man-made structures, such as foundations of buildings and rock-walls (picture right). The nest is lined with vegetation. Nests can be as close as a metre apart, or 10-50 metres apart in small colonies. In some locations, penguins will breed as much as 500 metres inland and more than 100 metres above sea-level (Pryor and Wells 2009, A. Wiebkin obs).

3.5 Diet

Little penguins are generalist predators that target locally abundant small schooling prey (Klomp and Wooler 1988, Montague and Cullen 1988, Gales and Pemberton 1990, Cullen et al. 1992, Chiaradia et al. 2003, Eberle 2003, Wiebkin 2011). Common prey include southern sea garfish *Hyporhamphus melanochir*, Australian sardine *Sardinops sagax*, Australian anchovy *Engraulis australis*, blue grenadier *Macruronus novaezelandiae*, Gould's squid *Nototodarus gouldi,* baracoutta *Thyrsites atun* and blue sprat *Spratelloides robustus*. Despite the apparent abundance of diverse prey, little penguins in South Australia are less generalist and exhibit a dietary preference for anchovies. Little penguins in South Australia target anchovies across most colonies (8 have been studied, including 3 in GSV), seasons and years (67% of the diet biomass) (Bool et al. 2007, Wiebkin 2011). This may be

because anchovy have a high energy value (Wiebkin 2011), and/or anchovy may be easier to catch. In South Australia, the population of little penguins is estimated to consume 3.3 x 10^{10} kJ or 5,688 tonnes of small fish per year, of which 2.4 x 10^{10} kJ or 3,811 tonnes is juvenile anchovy (Wiebkin 2011). Within coastal areas where penguins forage, little penguins are therefore significant consumers of anchovy, and are likely to play an important role in the pelagic ecosystem.

In South Australia penguins also consume non-prey items including shells, cuttlefish bones, isopods, nematodes and hard, buoyant plastic (Wiebkin 2011). Partly digested mollusc shells and cuttlefish bones are most common in female penguins, probably ingested as a source of calcium for eggshell development (Graveland and Berends 1997). Shells and stones may also be used as ballast to compensate for buoyancy while diving (Kato et al. 2006).

3.6 Foraging

Central place foragers, such as breeding little penguins, are restricted in the distance over which they can travel from the colony because they must regularly feed their young and rest (Wilson et al. 1998). This means that they remain tied to their colony throughout the year. Little penguins are multiple-prey loaders, meaning they consume many prey items before returning to the colony to feed their young, which gives them flexibility to forage for the entire day before returning to their chicks at dusk. Little penguins forage close (5-20 km) to their colony during the breeding season (Weavers 1992, Collins et al 1999, Bool et al. 2007, Preston et al. 2007, Hoskins et al. 2008, Wiebkin et al. 2010b) in comparison to other penguin species (Watanuki et al. 1993, Olsson and North, 1997, Clarke et al. 1998). In South Australia, longer foraging trips have been recorded by some parents during the guard phase at Pearson Island (up to 86km from the colony) (Wiebkin 2011) and during the post-guard phase at Kangaroo Island (up to ~200 km from the colony), probably as a response to reduced prey availability (KINRM, Wiebkin et al. 2010b). These long foraging trips demonstrate that the foraging range of penguins can be much larger when they are not provisioning chicks.

Resights of banded penguins and radio tracking studies in Victoria have shown that juveniles and non-breeding penguins disperse widely, up to hundreds of kilometres from their colonies (Dann 1992, Priddel et al 2008, Weavers 1992), although most fledglings return to their natal colonies to breed (Stahel and Gales 1987, Marchant and Higgins 1990, Dann 1992, Priddel et al. 2008).

Satellite transmitters have been deployed on 70 breeding little penguins at five colonies in the GSV bioregion since 2004 (Troubridge, Granite and West Islands, Kingscote and Penneshaw) to determine their foraging distribution and behaviour (Bool et al. 2007, Johnson and Wiebkin 2008, Wiebkin 2010b, Wiebkin 2011, KINRM) (Figs. 8, 9, 10). Tracking studies suggest that important foraging areas in GSV include an area off Rapid Head near Cape Jervis, south and west of Granite and West Islands, north of Penneshaw, and north of Troubridge Island. One penguin also foraged in an area offshore from Salt Creek, near the Coorong.

Most foraging trips were less than one day, commencing just prior to dawn and ending around dusk. At Troubridge Island, 77% of foraging trips throughout the year (*n* = 8598 trips) were less than 1 day in duration (14.6 ± 1.6 hr) (data from automatic microchip reader). The total distance travelled during foraging trips averaged 38 – 95 km, with travel speed averaging of 3.3 km/hr (maximum 8km/hr), similar to speeds of little penguins tracked from Phillip Island (4-8.5km/hr, Dann and Cullen 1989).

Little penguins can dive to ~50 m although most dives are only 5-13 m deep (Wilson 1995, Ropert-Coudert et al. 2003, Chiaradia et al. 2007). At Penguin Island in Western Australia, little penguins are mostly benthic foragers where they trap prey against the bottom (Ropert-Coudert et al. 2006). Penguins from the St Kilda colony in Port Philip Bay, Victoria, spend some of their time foraging along the sides of shipping channels (Preston et al. 2007). Little penguins at two colonies in South Australia appear to forage higher in the water column even when the seafloor is within their dive capacity (Wiebkin 2011). Penguins from Granite and West Islands, Kingscote and Penneshaw forage in both deep (20 - 40 m depth) and shallow water (< 20 m depth), although important foraging areas were often > 30 m in depth. Although penguins can use both benthic and pelagic diving strategies, the ability to exploit benthic prey in shallow water is an important influence on fledging success (Ropert-Coudert et al. 2003, Chiaradia et al. 2007). When a penguin cannot easily reach prey at, or chase prey to the seafloor, some prey may be able to escape downwards (Chiaradia et al. 2007).

The influence of large and fine-scale oceanographic factors on the foraging behaviour of little penguins has received increased research. Little penguins have been shown to benefit by foraging in waters with strong thermal stratification

because prey aggregate around such oceanographic features (Ropert-Coudert et al. 2009). Little penguins in Victoria chose to forage in water with slightly warmer sea-surface temperatures than average for the area (Hoskins et al. 2008). Warmer sea-surface temperatures in south-eastern Australia during autumn also appear to trigger early breeding (hatching) at Phillip Island, which suggests that warmer water improves the foraging success at this colony (Chambers 2004, Cullen et al. 2009). In South Australia, however, the foraging behaviour of most breeding penguins does not appear to be strongly influenced by sea-surface temperature, primary productivity or bathymetry (Bool et al. 2007, Wiebkin 2011).

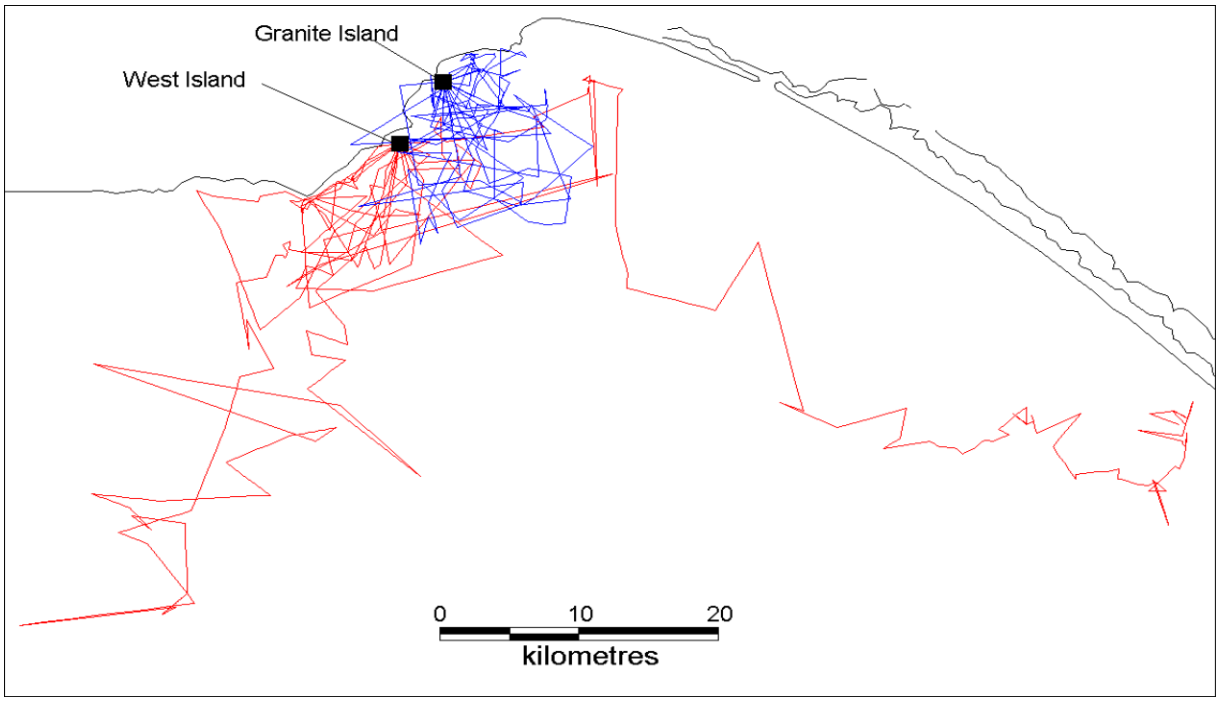

Figure 8. Summary of the inferred foraging routes undertaken by 18 little penguins at Granite Island (red) and West Island (blue) based on satellite tracking in 2006 (Bool et al. 2007).

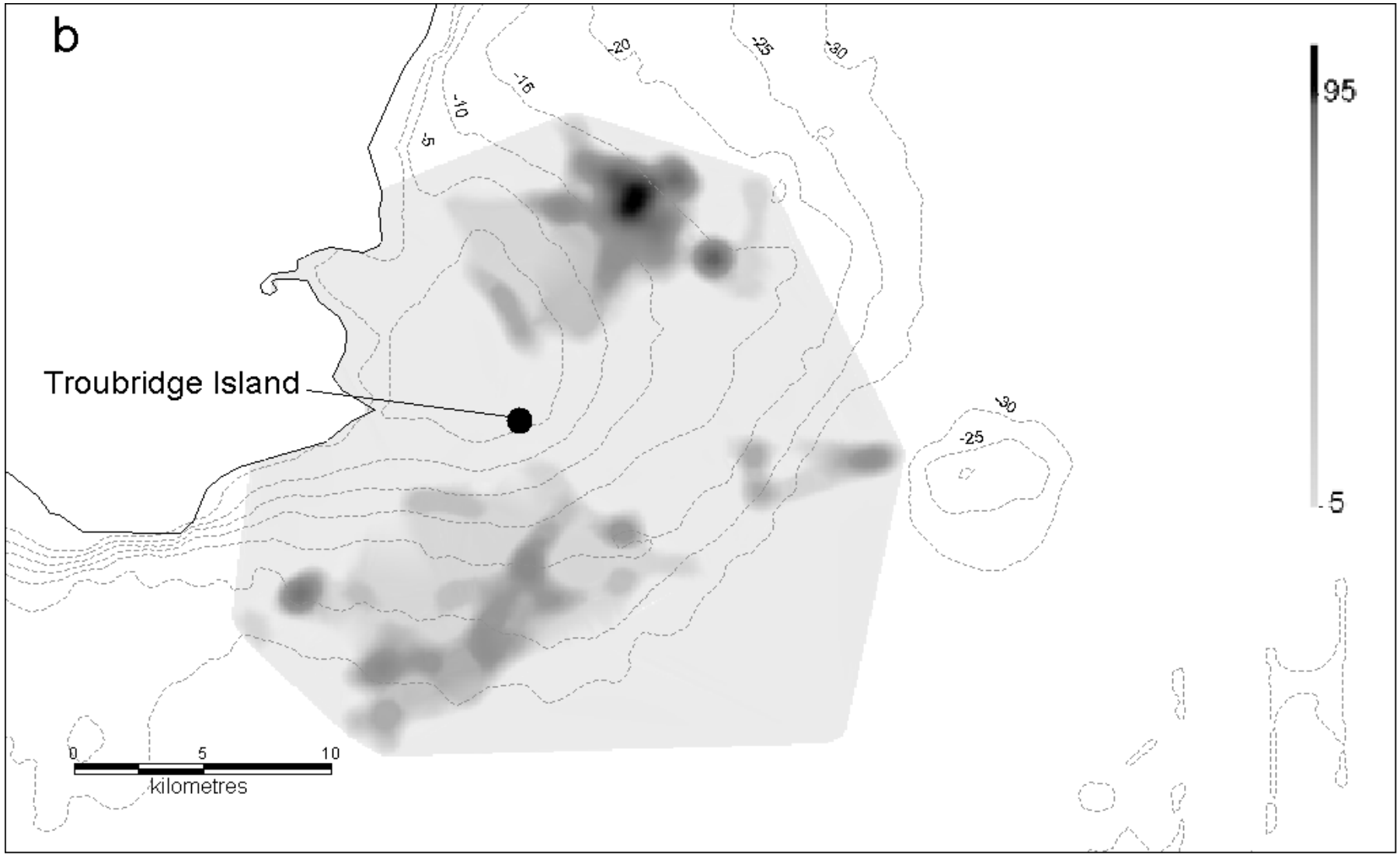

Figure 9. Kernel density plots showing areas where 15 little penguins spent time foraging, (from 5-95% time, shown in legend) at Troubridge Island in the winter breeding seasons of 2005 (Wiebkin 2011).

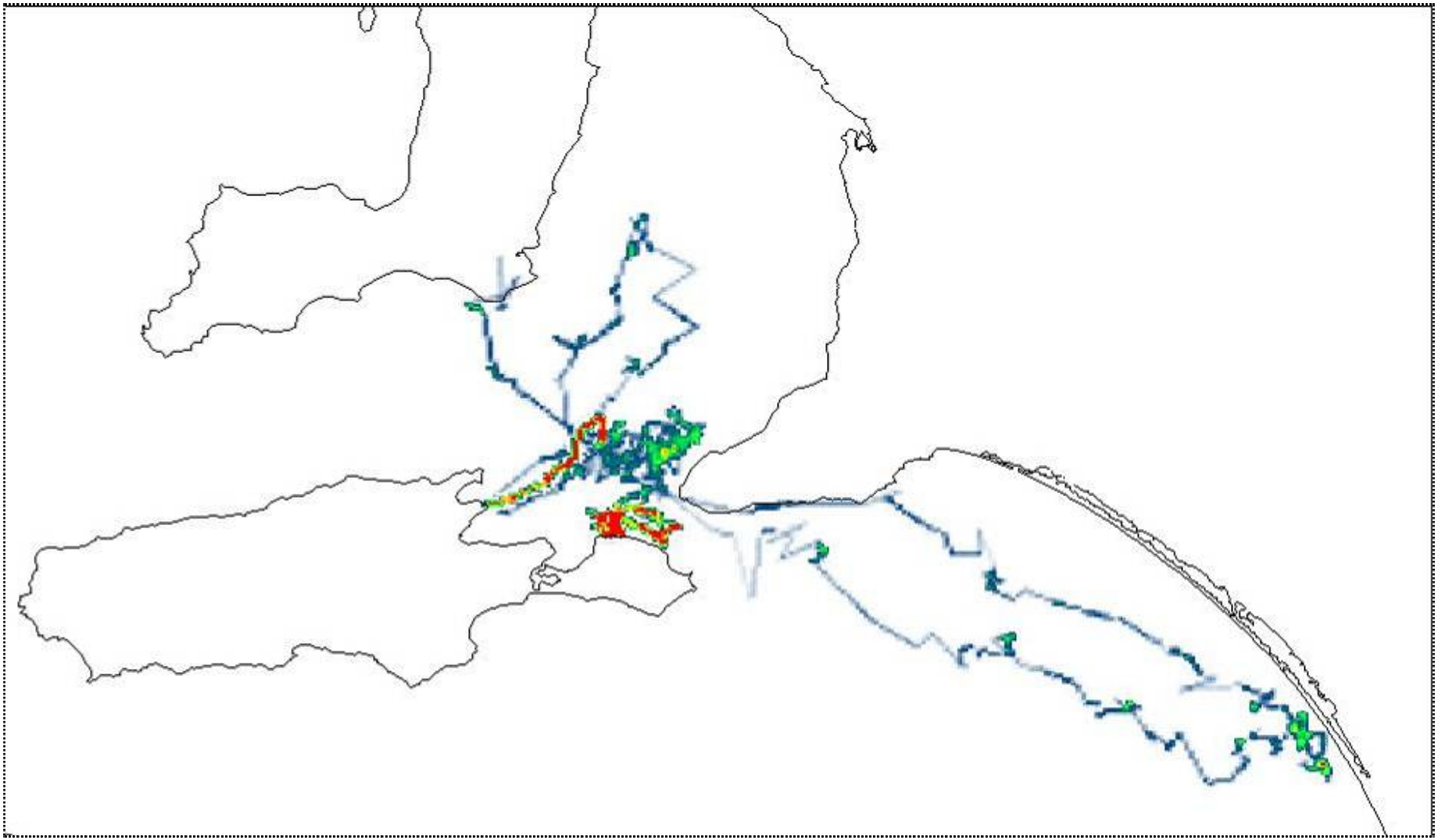

Figure 10. The proportional time spent in 1x1km grids for five satellite-tracked penguins from Kingscote and Penneshaw colonies. Blue represents least amount of time, green represents twice as much time as blue, yellow represents three times as much time as blue, and red represents four times as much time as blue (Wiebkin 2010b).

3.7 Morphology

In Australia, little penguins exhibit morphological variation by region, colony and sex (Kinsky and Falla 1976, Banks et al. 2002). Little penguins are sexually dimorphic; males have larger bills than females (Arnould et al. 2004). In South Australia and Western Australia, penguins of both sexes are heavier and have larger bills than those in Victoria (Kinsky and Falla 1976, Arnould et al. 2004, Overeem et al. 2006, Wiebkin 2011). Of the penguins at eight colonies across South Australia, those at Troubridge Island have the largest bills, and penguins at this island can access more food nearer the colony (Wiebkin 2011). The availability of food may also trigger early development of sexual size dimorphism in the bills of fledglings at Troubridge Island (Wiebkin 2011). The evolutionary drivers of sexual size dimorphism in little penguin bills are not well understood but males with larger bills have higher breeding success, possibly because large males are more adept at protecting the nest (Miyazaki and Waas 2003).

3.8 Genetics

In 27 colonies across the species' Australian range, no strong phylogeographic structure is evident, suggesting there are limited barriers to gene flow among colonies (Peucker et al. 2009), and supporting the view that there is only one subspecies (*Eudyptula minor novaehollandiae*) in Australia. In contrast, there is evidence of strong phylogeographic structure among 24 little penguin colonies in New Zealand, supporting the existence of five subspecies (*E. m. minor, E. m. albosignata, E. m. iredalei, E. m. variabilis and E. m. chathamensis*). Peucker et al. (2009) also suggested that little penguins probably originated in New Zealand, after which they colonised Australia, followed by some back-dispersal to New Zealand. The little penguin therefore has, or at least once had, good dispersal potential. Within Australia, little is known about which colonies or regions act as 'sources' or 'sinks' for this migration. The identification and protection of 'source' colonies could benefit other threatened or declining colonies nearby.

3.9 Migration and survival rates from tagging studies

Little penguins were traditionally tagged with flipper-bands (Dann 1992) (picture below left). The bands were marked with unique numbers that were administered by the Australian Bird and Bat Banding Scheme. A banding study at Phillip Island (Victoria) (Dann 1992), and banding studies on other penguin species (see review in Jackson and Wilson 2002) demonstrated that penguins fitted with flipper-bands

have reduced survival rates compared with non-banded individuals. For this reason, flipper-banding of penguins in Australia ceased in the early 2000s. There is now a moratorium on the approval of new penguin banding projects. More recently, researchers (including those working in the GSV bioregion) use subcutaneous microchips to tag penguins (TIRIS^{TM} Radio Frequency Identification transponder tags (RIFD), Texas, USA) (Table 3.). In South Australia, researchers have standardised the type of RFID microchip (TIRIS^{TM}) used so that microchip reading equipment can be shared between researchers (picture of portable wand reader below right).

In GSV, flipper-banding programs were established at Granite, West and Troubridge Islands between 1962 and 2005 by Max Waterman, Natalie Gilbert and Robert Brandle. At Granite and West Islands (3 km apart), banded penguins (pictured below) were mostly resighted within the colony where they were banded but a small number were resighted elsewhere (Table 4.). At the Granite and West Island colonies, 3 - 4% of banded penguins were resighted at the other colony. A further 2% were resighted elsewhere in the GSV bioregion (excluding Encounter Bay) and only 1% were resighted in other regions, mostly in the southeast of SA, VIC and NSW. Similarly, of the thousands of penguins banded at Troubridge Island over many years (Table 3.), very few (168) were recovered elsewhere (including Adelaide and Fleurieu coasts (70), South-east of SA (60), Kangaroo Island (4), Spencer Gulf (1), Victoria and New South Wales (12) (M. Waterman unpubl. data, Copley 1996). Since 2004, approximately 500 penguins from colonies outside of the GSV bioregion have been tagged (with microchips) and none have been resighted within GSV, despite frequent searches at some colonies (e.g. 36 trips to Troubridge Island). These findings support the results of population genetics studies, which indicated low migration rates of penguins between colonies in South Australia.

Table 3. The number of little penguins that were tagged with flipper bands and microchips at colonies in GSV.

Years	Colony	Type of tag	Number tagged	Researcher
1962-1989	Granite Island	Flipper band	20 adults and chicks	Max Waterman,
1990-2005	Granite Island	Flipper band	782 adults and chicks	Robert Brandle, Natalie Gilbert (NPWS/DENR) and Max Waterman
2006	Granite Island	RFID microchips (TIRIS®)	36 adults, (incl. 10 fitted with PTTs)	Natalie Bool (SARDI/Uni Adel)
1988-1989	West Island	Flipper band	1752 adults and chicks	Max Waterman
1990-2005	West Island	Flipper band	3107 adults and chicks	Robert Brandle, Natalie Gilbert (NPWS/DENR) and Max Waterman
2006	West Island	RFID microchips (TIRIS®)	10 adults, (including 8 fitted with PTTs)	Natalie Bool (SARDI/Uni Adel)
1960-2003	Troubridge Island	Flipper band	~13,000 adults and chicks	Max Waterman
2004-2006	Troubridge Island	RFID microchips (TIRIS®)	271 adults 153 chicks	Annelise Wiebkin (SARDI/Uni Adel)
2009	Troubridge Island	RFID microchips (TIRIS®)	126 adults 77 chicks	Annelise Wiebkin (SARDI/Uni Adel)
2008	Kingscote	RFID microchips (TIRIS®)	63 chicks	Phil Pisanu, Helen Achurch (DENR-KI)
2008	Kingscote	RFID microchips (Trovan®)	4 adults	Peter Frappell (Latrobe University)
2009-2010	Kingscote	RFID microchips (TIRIS®)	25 adults and chicks	Martine Kinloch, Danny Brock and Kym Lashmar (NRM-KI)
1990s	Cape Gantheaume	Flipper band	~60 adults	Sue Robinson
1980-2004	Several on Kangaroo Is.	Flipper band	unknown	Mike McKelvey (Pelican Lagoon RWC)

Table 4. Number (and percentage) of little penguins banded at Granite and West Islands between 1962 and 2005 (by Max Waterman, Natalie Gilbert and Robert Brandle), and resighted at other locations (including dead and alive penguins). Data provided by the Australian Bird and Bat Banding Scheme.

	Banded at Granite Is.	Banded at West Is.
Total banded	802	4859
Tag resight location		
Granite Island	Data not presented	146 (3.0%)
West Island	35 (4.4%)	Data not presented
Troubridge Island	0(0%)	20 (0.4%)
GSV	5 (0.6%)	51 (1.0%)
other regions	1 (0.1%)	47 (1.0%)

Little penguins in Victoria are relatively long-lived birds with high juvenile mortality (Reilly and Cullen 1979, Dann and Cullen 1990, Reilly 1994). Penguins at Phillip Island in Victoria suffer approximately 20% mortality in young fledglings. Adult mortality is lower (14.2% per year). Average life expectancy is 6.5 years, but this is left-skewed by the high rate of mortality of juveniles (Reilly and Cullen 1979). The data indicate that 4.7% of penguins that survive to breed and may then survive for up to 22 years (Reilly and Cullen 1979, Dann et al. 2005). One male penguin from Phillip Island was found breeding aged 25.7 years (Dann et al. 2005).

Survival rates of penguins within GSV are poorly understood, despite large numbers of penguins being tagged (Table 3.). This is because relatively few banded penguins have been resighted, and for many, their ages at banding are usually unknown because they were banded as adults. At Troubridge Island there is evidence that some penguins live well past the average life expectancy. Between 2004 and 2009, 161 banded penguins were resighted, and 13% of these were at least between 8 and 15 years old (Wiebkin 2010a). Another penguin from Troubridge Island was found on an Adelaide beach eleven years after it was banded (Flaherty 2002). Juvenile survival (and natal recruitment) at Troubridge Island is low (8% of tagged chicks were resighted at age 5) (Wiebkin 2010a) but not as low as other colonies (e.g. 5.7% at Manly (Dawson 2007) and 1.1% of 3500 fledglings were resighted over 11 years at Phillip Is. (Reilly and Cullen 1981)).

4. Preliminary review of the status of little penguin populations at regional, state and national levels.

The status of little penguins in South Australia was last assessed between 1993 and 1994, for the Oil Spill Response Atlas (Copley 1996). Copley (1996) reported that little penguins were locally common, abundant and evenly distributed in state waters. Little penguins do not have a threatened status (*Endangered, Vulnerable or Rare*) under the relevant Schedules of the South Australian *National Parks and Wildlife Act 1972* (SA NPWS Act). Nationally, little penguins are also not listed as *Threatened* pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). The Family Spheniscidae, including little penguins, is listed under s248 of the *EPBC Act* (relating to export assessment requirements). The New Zealand Department of Conservation has ranked the blue penguin *E. minor* as *Lower risk-near threatened* (Robertson and Bell 1984). Globally, little penguins are classified as *of least concern* (assessed 2009) by the IUCN Red List.

Given the absence of data on trends in abundance of little penguin populations in South Australia, there is marked uncertainty about the overall status of little penguins in South Australia. Given evidence for declines in some colonies within GSV, further questions are raised about the status of the species within GSV and across the State (Table 1). This report uses available data on the abundance of little penguins to provide a preliminary assessment of their status at the regional (GSV bioregion), state and national levels. This information is then interpreted using IUCN criteria (below).

Assessment Criteria

IUCN uses three threatened categories (from most to least threatened): *Critically Endangered, Endangered* and *Vulnerable*. IUCN categories are based on a number of criteria including population trends, reduction in geographic range, population size and probability of extinction (IUCN 2001). A taxon need only qualify for one of these criteria to be given the corresponding category. All taxa that do not qualify for a threatened category are categorised as *of Least Concern*. *Data Deficient* is used when there is inadequate distribution or population status data to make a direct or indirect assessment of a taxon's risk of extinction. A taxon (classification group of organisms) can be categorised as *Near Threatened* if it is likely to become threatened in the near future. Available information on little penguin populations at

the regional, state and national level have been interpreted below using these IUCN criteria, using current information (Table 4).

Table 4. Preliminary assessment of how little penguin populations at the regional (GSV), state and national level meet IUCN criteria (IUCN 2001). CE= *Critically Endangered*, EN= *Endangered*, VU= *Vulnerable*, LC= *least concern*, DD= *Data Deficient* (not a threatened category).

	IUCN criteria				
Population	**Reduction in population size**	**Geographic range**	**Population size**	**Probability of extinction**	**Highest category**
Regional (GSV)	Meets A2b (VU) (see IUCN description below)	Not applicable for this small region	Does not qualify for CE, EN, VU	DD	**VU**
State (SA)	Possibly meets A2b (VU) (see IUCN description below)	Does not qualify for CE, EN, VU	Does not qualify for CE, EN, VU	DD	**Possibly VU**
National (Australia)	Does not qualify for CE, EN, VU	Does not qualify for CE, EN, VU	Does not qualify for CE, EN, VU	Does not qualify for CE, EN, VU	**LC**

4.1 Regional population (GSV)

Without considering migration, the Gulf St Vincent region population of little penguins appears to meet criteria for classification as ***Vulnerable*** **(VU**) (IUCN 2001):

(A2) An observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations (whichever is longer), where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (b) an index of abundance appropriate to the taxon.

- The population of little penguins in the GSV region is approximately 5,226 breeding adults, as determined by a mixture of full and partial colony censuses (Table 2). Approximately 10-30 years ago the population was estimated to be approximately 14,222 breeding adults (assuming reports of "common" and abundant" represented populations of at least 100 and "present" represented populations of at least 50) (Table 2). This historical estimate for the region is consistent with the estimate made by Copley (1996) of 14,000-22,000 for the colonies in the southeast of SA, Encounter Bay, Kangaroo Island and Troubridge Island. It is important to recognise

that these historical estimates are produced from data with poor or unknown degrees of confidence because of the methods used to estimate the population sizes of many colonies. Historical counts were substantially from bird banding data (used to calculate minimum numbers of pairs per colony) and unknown extrapolation (Copley 1996). Copley (1996) concluded that the "presence of breeding little penguins on several offshore islands needs confirmation" and "estimates require considerable refinement". With this potentially large uncertainty in mind, the penguin population may have reduced by >60% over a 30 year period. If this decline has been linear for 30 years, the regional population would have declined by >30% in 10 years. This inferred or suspected population decline, where the reduction or its causes may not have ceased, or may not be understood or reversible, supports criteria A2 for ***Vulnerable*** (above).

Consideration of upgrading or downgrading IUCN categories for regional populations
The following assessment steps were used to determine whether the IUCN rating for the region should be changed on account of migration into and out of the region, which could influence the probability of extinction within the region (IUCN 2003).

1) Assess regional population according to the IUCN red-list criteria: **VU.**
2) Is the taxon a non-breeding vistor? **No.**
3) Does the regional population experience any "significant immigration" of individuals capable of reproducing in the region? **No:** flipper banding has indicated low migration for this region (Table 3.).
4) No change from step 1.

This preliminary assessment of the available data of the GSV bioregion population of little penguins supports categorising them as ***Vulnerable*****.**

4.2 South Australian population

Little penguins in SA are currently a protected animal under the provisions of the *South Australian National Parks and Wildlife Act 1972*, and they are not on schedules 7, 8 or 9 as *Endangered, Vulnerable* or *Rare*). However, recent knowledge and data on population abundance indicates that the population status should be considered for a listing as ***Vulnerable*** under IUCN population trend criteria (and therefore *NPW Act*, Schedule 8). The current information is assessed below:

- Copley (1996) estimated the state population as 40,000 – 90,000 breeding birds prior to 1996, but recent surveys indicate that the state population is now 36, 600 breeding penguins (Table 2). Copley's historical estimates are from a range of sources (bird banding, surveys, historical records and an unknown amount of extrapolation) which have unknown accuracies. It is also likely that some colonies were not included in Copley's estimates, such as Wardang Island, where a recent survey (J. Lawley 2004) suggested that ~8000 penguins live there. Some records are not quantified (e.g. "many burrows", "abundant", "common") so it is difficult to compare Copley's estimates with recent data (Table 2). However, given that both historical and recent data are the only data that are available, a population trend can still be inferred. The difference in population sizes indicates a decline of 45.7% from the average of Copley's estimate range (65,000), over the past 14 years. Assuming that the decline was linear, the population is estimated to have declined by ~33% in the past 10 years. This exceeds the thresholds for *Vulnerable* under the population trend criterion (>30% decline over 10 years). Some locations in the state have experienced significant declines or local extinctions in little penguin populations, including GSV and Spencer Gulf (e.g. Reevesby, Spilsby and Lewis Islands and Dangerous Reef) (Table 2). Causes of these declines are unknown. For these reasons, the declining population trend that is inferred by the available data supports criteria A2 for ***Vulnerable*****.** However, it may be that some of the apparent drop in numbers is an artefact of different methods used to estimate populations. For this reason, further investigations into regional and local trends would be warranted.

- An assessment of extinction probabilities is difficult because immigration and survival rates, as well as the impacts of threats are not known across most colonies in the state. The state now has at least 39 known colonies, eight of which each have more than 1000 breeding adults (Table 2), however some large colonies (>1000 penguins) have declined to very low numbers within the last 10-20 years (Granite, West and Spillsby Islands), which makes the possibility of extinction uncertain. It is therefore unknown if there is a "10% probability of extinction within 100 years". For this reason, probability of extinction is currently ***Data Deficient*****.** More surveys are required across the state before quantitative analysis can be used to predict extinction probabilities.

The preliminary assessment of the ***Vulnerable*** status of the South Australian population of little penguins does not require upgrading or downgrading according to the IUCN steps for assessing regional populations, for the same reasons as the GSV population (see above)**.** Further investigations into regional and local trends would be warranted because there is a high degree of uncertainty in the accuracy of population data for both historical and recent estimates.

4.3 Australian population

The national status of little penguins is likely to be of ***Least Concern***, for the same reasons that were used to classify the status of the species world-wide in 2009 (*Least Concern*) (http://www.iucnredlist.org/apps/redlist/details/144809/0).
The current information is assessed below:

- There is a consensus among researchers that the Australian population of little penguins is decreasing, because numerous colonies have recently declined or disappeared (Dann et al. 2005, Dann and Norman 2006, Stevenson and Woehler 2007, Gilbert et al. unpubl. data, Kinloch et al. unpubl. data, NPWS report 2000). Some colonies have been classified as *Endangered* (Manly, NSW (NPWS report 2000)) or *Critically Endangered* (Penguin Island, WA) under state Threatened Species Conservation Acts. The decline of the national population is not, however, sufficiently rapid to approach the threshold for *Vulnerable* under the population trend criterion (i.e. >30% decline over 10 years or three generations, which ever is longer).

- This species has a very large range, across southern Australia, with ~256 colonies (Dann et al. 1996), and hence does not approach the thresholds for *Vulnerable* under the range size criterion (Extent of Occurrence <20,000 km^2 combined with a declining or fluctuating range size, habitat extent/quality, or population size and a small number of locations or severe fragmentation).

- The breeding population of little penguins in Australia has not been accurately estimated but is thought to be approximately 500,000 by Ross et al. (1995) and under 1,000,000 individuals by del Hoyo et al. (1992). This population size does not approach the thresholds for *Vulnerable* under the

population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure, IUCN, 2001).

5. Main sites of penguin colonies in GSV

5.1 Granite and West Islands

Granite and West Islands (35°37'S, 138°36'E and 35°33'S, 138°37'E) are three kilometres apart in a wide bay associated with continental shelf waters, exposed only to the south-easterly oceanic weather. The islands are comprised of granite boulders and small bushes, providing nesting habitat for penguins. The islands support several predators of penguins including New Zealand fur seals *Arctocephalus forsteri,* water rats *Hydromys chrysogaster* and non-native black rats *Rattus rattus* (see Brandle et al. 1991) and white-bellied sea eagles *Haliaetus leucogaster* (see Paton and Paton 1977a). Access to Granite Island is via a bridge causeway with public pedestrian but restricted vehicle access. Tourism operations include a restaurant/café, a horse drawn tramway, a penguin rehabilitation and education centre and penguin tours.

West Island is rarely visited by people (although there is a research hut), it has no commercial tourism operations and access is by boat only. Paton and Paton (1977a) recorded that fires were regularly started in summer by fishermen and by artillery shelling practice on West Island until 1964. Penguins and rabbits were also used as bait for rock-lobster fishing up until the 1970s, after which rabbits were eradicated. Areas of West Island have also been slashed to allow for nesting of seabirds such as terns. The weed tree mallow *Lavatera arborea* has since been introduced (Rippey et al. 2002b). DENR currently runs a tree mallow control program on West Island (S. Iwao pers. comm.).

5.2 Kangaroo Island

Kangaroo Island supports several penguin colonies (Table 2). The three largest colonies that support >200 penguins are located at Kingscote, Penneshaw and Emu Bay (Gibbons unpubl. data). Predators of penguins on Kangaroo Island include rats, dogs, cats, goannas sea eagles and fur seals. The penguin colonies are mostly on crown land, which is managed the Kangaroo Island Council. The Emu Bay colony is adjacent to a small town, and Kingscote and Penneshaw colonies are surrounded by larger urban towns. These towns have marinas, wharfs, a ferry terminal with high

traffic volumes and growing development. Commercial penguin tour operations use the Kingscote and Penneshaw colonies. In the past 10-20 years, penguin tour operators have improved the nesting habitat in the visitation areas at both colonies, through vegetation, habitat protection and boardwalk infrastructure.

5.3 Troubridge Island

Troubridge Island (35°07'S, 137°50'E) is a sand cay of low profile (~2-7 ha in size depending on the tide), covered in coastal bushes and sedges. The land area has been reshaped dramatically by winter storms in the past century (Copley 1996, Johnston and Wiebkin 2008, C. Johnson pers. comm.). Thousands of other seabirds nest on the island between spring and autumn. Access to the island is by boat, and visitors require a permit. The lighthouse cottage provides accommodation for up to 12 visitors at a time, throughout the year, particularly in the warmer months (C. Johnson pers. comm.). A small haul-out of New Zealand fur seals is located on Yorke Peninsula 30km southwest of Troubridge Island.

5.4 Althorpe Island

Althorpe Island (35^{o}37'S, 136^{o}86'E) is a limestone island made of limestone and schist, located off the southern coast of Yorke Peninsula in Investigator Strait. Access is by boat and the island is not used regularly by people. The island has a small breeding colony of New Zealand fur seals and large colonies of fur seals are located within 100 kilometres at the North and South Neptune and Kangaroo Islands. Feral cats *Felis catus* were eradicated in 2004 (J. Lawley, pers. comm.).

6. Current management of little penguins in GSV

There are a number of management plans that provide some guidance for the management of penguin colonies across the GSV bioregion. The management plans for Encounter Bay Islands (West Island, Seal Island and Pullen Island) (NPWS 1983) outline the need for monitoring and research of bird populations (especially penguins at Pullen Island) as an ongoing priority. The management plans also recommend educating visitors about conserving wildlife in the conservation parks. While these objectives need to be implemented with respect to little penguins, the plans should be updated.

The Southern Fleurieu Coastal Action Plan and Conservation Priority Study (Caton et al. 2007) assists in priority setting for coastal management actions for the AMLR NRM Board, Councils and DENR, which implement management of penguin colonies in Encounter Bay. It outlines a proposed action of high priority (F11.2) to support research to clarify causes of penguin population decline. Key partners were identified as Friends groups, NPWS and Councils. It suggests that as an interim measure, the Granite Island causeway could be fenced to exclude foxes, dogs and cats, and a rat control program could be implemented.

Granite Island is managed by DENR but the northern shore is leased by Greater Granite Island Development Company; development includes a cafe, kiosk, souvenir shop and penguin centre. The penguin centre operates as part of the “Granite Island Nature Park”.

Penguins at Troubridge Island and Althorpe Island Conservation Parks are on lands managed by DENR (Yorke Peninsula). Significant on-ground maintenance and restoration is provided by the lessee of the Troubridge Island cottages and by the Friends of Althorpe Island. Management plans (2009) for both islands outline the importance of reducing disturbance to nesting seabirds, including little penguins, particularly during weeding operations for boxthorn. The plan for Troubridge Island also highlights the need to educate tourists, because visitors are not supervised during their stay. A major concern for Troubridge Island is the erosion of the island by wave action. The current lessee of the cottages, together with volunteer teams, has been instrumental in maintaining sandbags along the shore to prevent further erosion.

At Kangaroo Island, KI NRM Board currently coordinates a penguin monitoring and community education program. Two penguin centres have lease agreements for the development of parts of the Kingscote and Penneshaw penguin colonies. Management plans for conservation parks, national park and wilderness protection areas of Kangaroo Island (1987 and 1999) recommend that research should be conducted on the population dynamics of seabird species (of threatened status) as an ongoing, high priority. These plans also recommend that cats be eradicated from reserves. There is a feral animal control program on Kangaroo Island, which is managed by KI NRM Board.

7. Threats

Across their range, little penguins are susceptible to numerous threats, many of which originate from anthropogenic activities. These include disturbance of penguins by people and pets, noise and light, entanglement in fishing or aquaculture nets, prey depletion, predation by native, domestic pets and feral predators, traffic collision, loss of habitat, pollution and degradation of coastal and marine systems (Pryor and Wells 2009, DEC 2007, Dawson 2007).

The following sections discuss key threats and recommendations that are relevant to little penguin populations and have relevance to the GSV populations (Table 5).

Table 5. The potential threats facing little penguin colonies in the GSV bioregion. H = high risk, M = medium risk, L= low risk.

Colony	Threat	Risk	Rationale
Granite Island	Predation by introduced predators	M	Foxes, dogs and cats rarely access Granite Island, but one fox can kill many penguins in a night. Impacts from predation by introduced rats are poorly understood.
	Predation by seals	H	Seal numbers are increasing, and Bool et al. (2007) found penguin remains in 40% of seal scats.
	Predation by other species	L	Sea eagles eat penguins but there are no resident eagles (nests) on Granite Island. Predation rates by water rats and other predators such as sharks are not known.
	Anthropogenic disturbance /development	M	High visitation rate but tours, boardwalks and security guards ensure that disturbance is managed and that penguin breeding is not affected. However, if tours or security ceased, anthropogenic disturbance may increase. Education and awareness should continue. Netting (entanglement risk) occurs in foraging ranges.
	Loss of habitat	L	Revegetation and nest boxes have improved habitat in past 10 years but burrow damage still occurs from weather and weed infestation. More artificial nests and fencing may improve breeding success.
	Prey depletion (ie by fisheries)	L	Anchovies are not harvested in large amounts in the area. Penguins forage near the colony, which suggests there is sufficient food nearby, however ecosystem processes that underpin prey availability are poorly understood.
	Disease and parasites	?	Insufficient information.
	Pollution	?	Insufficient information. Netting occurs in foraging ranges.
	Climate Change	M	An increase in extreme heat or rain conditions may affect breeding success, and a decrease in thermoclines may affect foraging efficiency of penguins.
	Small population size	H	The population is declining rapidly and is currently small (146). Adult mortality must decrease and recruitment must increase for the population to recover.
West, Seal, Pullen, Wright, Althorpe Islands and southern Fleurieu coast	Predation by introduced predators	L	Foxes, dogs and cats cannot access islands, but they may access penguins on southern Fleuireu coast. Impact of predation by rats is poorly understood. Access is possible by boats at Wright and Althorpe Island.
	Predation by seals	H	Seal numbers are increasing. Bool et al. (2007) found penguin remains in 40% of seal scats.
	Predation by other species	L	A small number of sea eagles eat penguins. Predation by water rats and sharks is unknown.
	Anthropogenic disturbance	L	Low visitation rate. Fish netting occurs in foraging ranges but by-catch and entanglement risks are not known
	Loss of habitat	L	On West Is. habitat has changed over recent decades, through fire, slashing and weed infestation (eg. tree mallow and kikuyu grass), but habitat still exists along coasts. Other islands still have suitable habitat.
	Prey Depletion (ie. by fisheries)	L	Anchovies are not currently harvested in large amounts in the area. Penguins forage near the colony, which suggests there is sufficient food nearby, but processes that underpin prey availability are poorly understood.
	Disease	?	Insufficient information.
	Pollution	?	Insufficient information. Netting occurs in foraging ranges.
	Climate Change	M	An increase in extreme heat or rain conditions may affect breeding success, and a decrease in thermoclines may affect foraging efficiency of penguins.
	Small population size	H	The population is declining rapidly at West Is. and all populations are currently small. Adult mortality must decrease and recruitment must increase for these populations to recover or grow.

Colony	Threat	Risk	Rationale
Kangaroo Island	Predation by introduced predators	H	Dogs and cats have access to colonies, particularly near urban centers. Impacts from predation by introduced rats are poorly understood. A potential risk of fox introduction exists.
	Predation by seals	H	Seal numbers are increasing and are known to prey on penguins.
	Predation by other species	L	Sea eagles take penguins. Predation by water rats and sharks is unknown.
	Anthropogenic disturbance / development	M	Kingscote and Penneshaw have high rates of visitation, traffic, street lighting, noise and dogs have access to these colonies as well as Emu Bay. Visitation rates will increase. In tourism areas, guided tours, boardwalks and fencing ensure that disturbance is reduced. Netting (entanglement risk) occurs in foraging ranges.
	Loss of habitat	M	Revegetation and nest boxes have improved habitat in tourism areas but other areas have lost habitat through development, and clearing (backyards, roads, foreshores). Boxthorn removal may have also reduced some habitat where alternative vegetation was not provided immediately. Future foreshore development may reduce or enhance penguin habitat.
	Prey depletion (ie. by fisheries)	L	Anchovies are not currently harvested in large amounts in the area. Some penguins foraged far from Kingscote and Penneshaw, suggesting that availability of local prey is unpredictable. Ecosystem processes that underpin prey availability are poorly understood.
	Disease and parasites	?	Insufficient information.
	Pollution	?	Insufficient information. Netting occurs in foraging ranges.
	Climate Change	M	An increase in extreme heat or rain conditions may affect breeding success, and a decrease in thermoclines may affect foraging efficiency.
	Small population size	L-H	Population sizes vary between 16-706 breeding penguins. A slight rise in adult mortality or a slight decrease in recruitment would impact small colonies.
Troubridge Island	Predation by introduced predators	L	Foxes, dogs and cats cannot access Troubridge Island, but some access is possible with boat visitation.
	Predation by seals	L	Seal numbers are low in the area.
	Predation by other species	L	Sea eagles may take a few penguins. Predation by water rats and sharks is unknown.
	Anthropogenic disturbance	L	Medium visitation rate. There is no development. Visitors are briefed on minimising disturbance.
	Loss of habitat	M	Increased storm events and se-levels may cause inundation of penguin burrows and habitat.
	Prey Depletion	L	Anchovies are not currently harvested in large amounts in the area. Penguins forage near the colony, which suggests there is sufficient food nearby, but processes that underpin prey availability are poorly understood.
	Disease and parasites	?	Insufficient information.
	Pollution	?	Insufficient information.
	Climate Change	H	Increased storm events may cause inundation of penguin burrows and habitat.
	Small population size	L	The population is large.

7.1 Predation by introduced predators on land

Little penguins are susceptible to predation by introduced terrestrial predators . These include foxes *Vulpes vulpes,* dogs *Canis familiaris*, cats, Table 6)*,* as well as ferrets *Mustela putorius furo* in New Zealand (Hocken 2000, Dawson 2007, Pryor and Wells 2009). Predation by feral cats, foxes and rats are threatening processes recognised by the Commonwealth *EPBC Act* (1999) and threat abatement plans have been developed to guide control efforts. These include *Threat Abatement Plan For Predation By The European Red Fox, Threat Abatement Plan for Predation by Feral Cats and Threat Abatement Plan To Reduce The Impacts Of Exotic Rodents On Biodiversity On Australian Offshore Islands Of Less Than 100 000 Hectares.*

Foxes have caused declines in penguin colonies at Middle Island (VIC) and Phillip Island (VIC) (Peucker et al. 2007). Fox control (or detection) programs undertaken by the Fox Taskforce in Tasmania and by managers of the Phillip Island Nature Park involve baiting, shooting, trapping and den fumigation (van den Polanen Petel et al. 2004). Maremma guard dogs have been used to protect penguin colonies at Middle Island from foxes. Foxes occur rarely on Granite Island, but when they are detected, DENR rangers make considerable efforts to remove them (N. Gilbert pers comm.). Foxes are common in coastal areas of the mainland, where they pose a predation risk to penguins that occasionally rest mainland shores.

The presence of cats has coincided with declines of some little penguin colonies. Penguin numbers at Wardang Island (SA) ”declined markedly” in the 1990s as a result of a large cat population (Lawley 2004). The cats probably ate seabirds after the rabbit population was heavily affected by the calicivirus that causes rabbit haemorrhagic disease. On Flinders Island (SA), the handful of remaining penguins nest at the base of some cliffs where feral cats have limited access (D. Armstrong pers. comm.). While feral cats were probably once a threat to the Althorpe Island population, they have recently been eradicated (J. Lawley, W. Cliff pers. comm.). Feral and domestic cats are found on Kangaroo Island.

Dog attacks also threaten penguin colonies (Pryor and Wells 2009), including a colony at Eden (NSW), which was eventually wiped out (N. Klomp pers. comm.). There are a number of management tools that can reduce the presence of dogs in colonies. These include dog proof fences around areas where penguins nest and educational signs that request dog owners to keep their pets away from penguin

colonies (Dann 1992, Pryor and Wells 2009). A single dog attack can kill a large number of animals. A dog attack at Penneshaw in March 2003 resulted in over 30 penguins being killed (The Islander, 2003).

Predation by introduced rats is responsible for declined and localised extinction of many seabird colonies throughout the world (Lyver 2000, Martin et al. 2000, Stapp, 2002). There is evidence that feral black rats *Rattus rattus* predate on little penguin eggs and young chicks (Bool et al. 2007), and as such may be partly responsible for the decline of little penguins at Granite, West and Kangaroo Islands. Staff from DENR and the penguin centre conduct rodent control in some areas of Granite Island (with funding assistance from AMLR NRM Board).

Table 6. Potential predators of little penguins or their eggs, at colonies in GSV.

Penguin colonies	**Native and non-native predators**
Encounter Bay Islands	Black rats, water rats, New Zealand fur seals, white-bellied sea eagles, foxes, dogs, cats, Australian sea lions.
Kangaroo Island	Dogs, cats, black rats, water rats, New Zealand fur seals, Australian sea lions, white-bellied sea eagles, and sand goannas.
Troubridge Island	White-bellied sea eagles, Australian sea lions, and New Zealand fur seals (within 30 km).
Althorpe Islands	New Zealand fur seals, Australian sea lions white-bellied sea eagles and black rats. Cats were recently eradicated.
Marine waters in GSV	Sharks, killer whales (seen off Troubridge Island), dolphins, seals (above), other toothed cetaceans.

Recommended actions

- Monitor the relative density of rats (e.g. using movement-sensor cameras and/or Elliott traps) in the vicinity of active penguin nests. Where introduced rats are in high densities, implement (or continue to implement) rat control programs, using baits and traps that cannot be accessed by native wildlife, and support research into the diets and foraging behaviour of rats (e.g. using VHF radio collars).
- Examine broken penguin eggs and dead penguins for signs of predation by rats, as well as dogs, cats and foxes.
- Install rubbish bins with rat-proof lids (e.g. spring-shut lids) in areas of the colony that are frequented by people. Bins should be emptied regularly. Erect signs to encourage people to refrain from discarding food scraps.

- If water rats are considered a major threat to penguins (determined by camera footage of aggressive or predatory behaviour by water rats towards penguins), consider options for management.
- If swamp rats, *Rattus lutreolus* (Schedule 9: Rare status, *NPW Act 1972*) or bush rats *Rattus fuscipes* (on KI) are found in any colony, consider rodent management to ensure these native rats are not impacted by feral rodent control activities.
- Record predation events.
- Managers of penguin colonies should be vigilant for signs of feral foxes, cats or dogs (sightings or scats). Remove feral animals if detected. Discourage feeding of feral cats in foreshore areas and caravan parks near penguin colonies.
- Educate dog and cat owners through workshops and community events about the potential impacts their pets can have on penguins and ways to minimise impacts. While dog attacks may be sporadic, a single attack event may kill or wound a large number of animals.
- Install strategic fencing along public walkways or adjacent to housing areas to exclude domestic pets from little penguin colonies.
- Erect signs to inform dog owners not to enter seabird-nesting areas. Signs should be placed in areas that have high public visibility but at the same time should avoid indicating the presence of little penguin burrows (Pryor and Wells 2009).
- Liaise with councils, local progress associations and local Government to explore the potential for applications for new housing developments within 100 m of declining colonies to have covenants that prevent residents from keeping cats and dogs.

7.3 Predation by native predators on land

Little penguins have natural predators on land and at sea. White-bellied sea eagles *Haliaetus leucogaster* (listed as vulnerable, SANPW Act 1972) regularly take penguins from the surface of the sea (T. Dennis pers. comm.). One penguin fitted with a satellite tracker was carried 10 km to an eagle's nest (Wiebkin 2011). In GSV, pairs of sea eagles nest along the shores of Fleurieu Peninsula, at Newland Head Conservation Park, Waitpinga Beach (Fleurieu Birdwatchers 2006), Rapid Head, Port River/Barker Inlet, Port Gawler (T. Dennis pers. comm.), as well as Kangaroo Island and southeastern Yorke Peninsula (T. Dennis pers. comm.). These eagles

have access to most penguin colonies in GSV. The level of predation on penguins appears to vary between colonies. At Olive Island (Eyre Peninisula) many penguin carcasses surround an eagle's nest but at Troubridge Island, sea eagles target cormorants *Phalacrocorax fuscenscens*, silver gulls *Larus novaehollandiae* and crested terns *Sterna bergii* (see Johnston and Wiebkin 2008) despite the large number of penguins available. There are no records of northern giant petrels *Macronectes halli* taking little penguins, but they can kill and eat large seabirds in the water, such as cormorants (Troubridge Is.) as well as larger species of penguin (royal penguins) (A. Wiebkin obs.). While kelp gulls *Larus dominicanus* can take African penguin eggs and chicks (Ward 1998), these gulls are uncommon in GSV. Pacific gulls *Larus pacificus* do not venture into penguin nesting habitat at Troubridge Island and are unlikely predators of young penguins.

Water rats *Hydromys chrysogaster* prey on little penguin chicks and eggs (Preston et al. 2008). Bush rats *Rattus fuscipes* and swamp rats *R. lutreolus* live on off-shore islands but are unlikely predators of penguins, because they have selective diets of insects, fruits, seeds, grasses and fungi (Strahan 1995). Other potential predators of little penguin eggs or chicks include black tiger snakes, sand goannas and owls.

7.2 Predation by native predators at sea

Seals are known to prey on penguin species world-wide, and in some instances the level of predation can impact penguin populations (Crawford and Robinson 1990, Crawford et al. 2001, David et al. 2003, du Toit et al. 2004, Marks et al. 2007, Kirkman 2009 and references therein). In New Zealand, recolonising populations of New Zealand sea lion *Phocarctos hookeri* are threatening the viability of yellow-eyed penguin populations (Lalas et al. 2007). Macaroni penguins in the southern Atlantic are also being displaced and predated upon by the rapidly increasing population of Antarctic fur seals *Arctocephalus gazella* (see Isaksen et al. 2000, Keith and Harck 2001). In South Africa, some African penguin populations have also decreased in last 100 years, partly as a result of interference by Cape fur seals *Arctocephalus pusillus pusillus* (see Shaughnessy 1984). Predation of penguins by Cape fur seals appears to generally occur in the vicinity of seal breeding colonies, with relatively few individual juvenile and subadult male seals being responsible (Shaughnessy 1978, Navarro 2000, David et al. 2003, du Toit et al. 2004). While interactions between seals and penguins are likely to also occur further out at sea, it is difficult to obtain such information (Descamps et al. 2005).

Increases in New Zealand fur seal numbers have also coincided with the disappearance of little penguin colonies in South Australia. Penguin colonies at Neptune Island and Cape Gantheaume are now locally extinct (Table 1). The seal haul-outs near most of the declining penguin colonies in GSV are small, but numbers appear to be increasing. The following summarises our understanding of seal numbers at haul outs near penguin colonies in GSV:

- Granite Island- 1-7 seals seen on frequent visits 2006 (Bool et al. 2007)
- West Island- 5-12 seals in 2006 (Bool et al. 2007), 50 in 2011 (C. Taylor)
- Seal Island (Encounter Bay) – 13 - 32 seals in 2006 (Bool et al. 2007)
- 4km east of Penneshaw – 10 seals 2011 (A. Wiebkin)
- 4-6km west of Penneshaw – 29 seals 2011 (D. Brock)
- Emu Bay east – 12 seals in 2010 (T. Dennis)
- Point Morrison (KI, west of American River) – 25-30 in 2010 (T. Dennis, see Shaughnessy 2011)
- Newland Bay (KI) – 8 in 2010 (T. Dennis)

Some little penguin colony populations are stable, despite them coexisting with large populations of New Zealand fur seals. The population of penguins at Vivonne Bay (KI) has remained relatively stable between 1989 and 2008 (150 to 200 penguins), and there is a large fur seal haul-out within 10 km at Cape Kersaint (> 600 fur seals). Other stable colonies of little penguins include Pearson Island (with 12,000 penguins and up to 1,000 fur seals and sea lions), Banks Peninsula (in NZ, with an increasing New Zealand fur seal population) and Stephen's Island (in NZ, with a very large penguin colony and the largest population of New Zealand fur seals in the Sounds area) (L. Boren pers. comm.).

Surveys of New Zealand fur seals in South Australia indicates that populations have been recovering rapidly over the past 30 years, following cessation of sealing in the 1800s (Shaughnessy and Dennis 2001, Shaughnessy and McKeown 2002, Goldsworthy et al. 2003, Shaughnessy 2011). On Kangaroo Island's south coast, the population of New Zealand fur seals has increased at 11.9% per year since 1989 (Shaughnessy 2011); this region is also used by populations of little penguins, some of which appear to be stable.

In South Australia, New Zealand fur seals are known to prey on little penguins. At the main breeding colonies on the south coast of Kangaroo Island, the frequency of

occurrence of little penguins in fur seals scats has ranged between 2-5% (Baylis and Nichols 2009) whereas at Granite Island they average 40% (Bool et al. 2007). The extent to which fur seals prey on little penguins may vary with sex and age (Page et al. 2005), as well as their availability. In New Zealand, fur seals do not appear to predate on little (blue) penguins in significant amounts (Dix 1993, Holborow 1999, Boren 2010, L. Boren pers. comm.).

Little penguins have occasionally been reported in the diet of Australian sea lions *Neophoca cinerea* (see McIntosh et al. 2006) although the lack of quantitative dietary studies makes it difficult to assess the extent to which sea lion predation may pose a threat to little penguins. Leopard seals *Hydrurga leptonyx* are predators of penguins in Antarctic and sub-antarctic waters, but these seals rarely visit South Australian waters and do not pose a threat to little penguins. Sharks and cetaceans also take seabirds. There is no evidence that these native species are impacting substantially on little penguin populations in the GSV bioregion.

Management of seals

Public concern about little penguin declines, and a perception that fur seal predation is the cause, has prompted calls for seals to be managed so they do not interact with penguins. The culling of particular 'problem' seals has been undertaken in South Africa to reduce predation on seabirds, but there have been calls for stronger measures to be taken against seals (Kirkman 2009). A review by Kirkman (2009) outlined the problems and limitations of culling seals as a management tool to conserve seabirds. Culling programs require constant vigilance and continued effort to reduce or eliminate interaction because when individual seals are culled or removed, others may replace them (Lavigne 2003). Kirkmann (2009) concluded that the culling or displacing of seals is not likely to reverse trends in declining populations of African penguins, especially if conducted in isolation of other management actions, including measures to enhance or expand the breeding habitat of seabirds. Any management solution involving the reduction of a naturally occurring species for the conservation of another is complex because of ecological and ethical issues it may raise (Kirkman 2009 and references therein).

Seal management in Australia has been reviewed by the National Seal Strategy Group (NSSG) (of which DENR is a member). The NSSG produced a National Strategy to Address Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism (2007). This document states that seal culling is not

consistent with current community expectations about broader seal conservation objectives. The killing (and injury, taking, trading, keeping or moving) of seals in all Australian Commonwealth waters is illegal under the *EPBC Act*, unless conducted under stringent permit conditions or other form of exemption issued by the Minister for the Environment and Heritage. In South Australia, all seal species are protected species under the *NPW Act*, and a number are listed as Endangered Vulnerable or Rare. The *NPW Act* also contains regulations related to taking, illegal possession, molestation of and interaction with seals. The Strategy aims to obtain data on, report on, and minimise and mitigate adverse interactions between seals and humans, commercial fishing operations, aquaculture and tourism operations, as well as encourage stewardship of the marine ecosystem.

Methods to mitigate interactions between seals and humans have been trialled in Australia. These include relocation of 'problem seals' from Tasmanian aquaculture farms under protocols developed by the Tasmanian Department of Primary Industries, Parks, Water, and Environment (DPIPWE). Relocation of problem seals is a short-term, costly measure and efforts have resulted in mixed success. Of 4517 Australian and New Zealand fur seal relocations in 15 years, 56% were captured more than once (Robinson et al. 2008). There is concern that relocation spreads disease amongst seals. Tasmanian aquaculture-farms have also trialled the use of non-lethal explosive deterrents such as seal-crackers and acoustic devices, although seals apparently become accustomed to these measures (Reeves et al. 1996).

There is a perception among some members of local communities near penguin colonies that fur seal predation is causing a decline in penguins in GSV. This could be entirely true, partly true (ie. fur seals are just one of many factors contributing to the decline) or false (fur seals may predate on little penguins but the level of predation may be inconsequential to other sources of mortality/predation). Fur seals are natural predators of penguins, and like all populations, penguins can sustain a certain level of mortality from a range of sources. Before any action to manage seals as a threat could be justified, there needs to be a better understanding of the population status of little penguin colonies and broader population dynamics to provide a clearer understanding of which colonies are increasing, decreasing or stable.

Recommended actions

- Fur seal predation should not be examined in isolation of other factors.
- Develop a risk assessment model using population viability analysis (PVA) to establish the level of predation that the main penguin colonies can maintain.
- Research the extent to which fur seals are preying on penguins. Accessible fur seal haul-out sites should be surveyed regularly for seal scats that contain penguin feathers (Bool et al. 2007).
- Count and record the frequency of seals visiting the area where penguins come ashore.
- Identify whether particular seals are attracted to areas where penguins come ashore. Individual seals should be marked with flipper tags or bleach spots, and then observed on a regular basis (each 2-7 days). Alternatively, VHF transmitters may be deployed on seals, with a receiver erected in the colony. Two experienced seal handlers are required to capture and mark a seal. Permits and ethics approval is required. This research may be a suitable project for a postgraduate student.
- Research the foraging behaviour of fur seals (using tracking devices) in the vicinity of penguin colonies. Because non-breeding seals are difficult to recapture, trackers with remote data retrieval would be useful (e.g. Wildlife Computers). This research may be a suitable project for a postgraduate student.
- Determine the overlap of fur seal and penguin foraging areas (using tracking and spatial analysis) to estimate penguin-seal interaction probabilities and to gain a better understanding of seal and penguin foraging ecology.
- Educate the public about seal and penguin interactions, management options and implications.
- Reports of predation should be recorded in a central database.

7.4 Competition for nesting habitat

There is limited evidence of competition for nesting space and prey resources between little penguins and other species. There is concern that feral pigeons *Columba livia* outcompete little penguins for nests at Lipson Island (Spencer Gulf), West and Pullen Islands (Encounter Bay) (Paton and Paton 1977a, DEP 1983, S. Harrison pers comm.). Feral pigeons have increased in numbers during the early the 1980s in Encounter Bay (DEP 1983) and 2000s at Lipson Island (S. Harrison pers. comm.). Penguins have decreased at these sites in the last 1-2 decades (S.

Harrison obs, N. Gilbert 2010). It is not clear if the use of penguin nests by pigeons is a cause or a consequence of these population trends. Pied cormorants *Phalacrocorax varius,* nesting on small islands off the Perth coast have increased in number and have moved from nesting on the woody vegetation to the ground habitat of the plateau, where they are out-competing burrow-nesting seabirds, including little penguins (Rippey et al. 2002a). In South Africa, some researchers suggest that cape fur seals compete with African penguins *Spheniscus demersus* for colony space (Kirkman 2009) but there is no evidence of competition between New Zealand fur seals and little penguins.

Recommended actions

- Monitor feral pigeons where they exist in large numbers (West and Pullen Islands) and control if they are competing with penguins for nesting habitat.

7.5 Anthropogenic disturbance

Many little penguin colonies are near or adjacent to urban centres where penguins are at risk of impacts from anthropogenic activities. Several management plans have been developed to protect penguin colonies from such impacts (NSW NPWS 1995, NPWS 2000, DEC 2007, Dawson 2007, Pryor and Wells, 2009). These plans outline the need for habitat protection, tourism disturbance control, pet management, traffic management, education and the need to incorporate penguin management into urban development planning processes.

The penguin tourism industry is economically important at Philip Island (VIC), St Kilda (VIC), Oamaru (NZ), Montague Island (NSW), Penguin Island (WA), Kingscote, Penneshaw and Granite Island (SA) and eight locations in Tasmania (Birtles et al. 2001). The impacts of unmanaged access can cause increased heart rates and metabolism in penguins during times when they should be conserving energy (Ananthaswamy 2004). This can lead to low weights in young yellow-eyed penguins (McClung et al. 2004). To ensure tourism at these locations does not impact penguin populations, visitors are managed, although the degree of active management varies across Australia (Dawson 2007, Pryor and Wells 2009, Shoalwater Island Marine Management Plan 2007, Mason 1985):

- At Phillip Island, only 10% of the penguin population is exposed to tourism. Nest web-cameras enable tourists to view penguins remotely.
- At Phillip Island, Granite Island and Kangaroo Island, tour guides do not allow visitors to use cameras, and guides use red cellophane over torchlight.

- At Granite, Phillip, Penguin, Montague and Phillip Islands, Oamaru (NZ), Kingscote and Penneshaw, viewing platforms, fenced walkways and raised boardwalks restrict public access to sensitive areas of colonies including.
- At Katiki Point (NZ) penguin runways are fenced to reduce interactions between people and the penguins returning to their nests.
- In NSW, approach distance restrictions are enforced (e.g. 5 m).
- At Manly, to reduce disturbance caused by marine vessels (including jet skis), people are prohibited from entering, anchoring or mooring a motorised vessel in the little penguin critical habitat (marked by seasonal buoys) between sunset and sunrise during the breeding season, (*NPW Act 1974 Sec* 118C) (NPWS 2000).
- Similarly, the Department of Environment and Conservation introduced vessel speed limits (8 knots) in the vicinity of the Penguin Island colony (WA) (DEC 2007) to reduce collisions with penguins (Cannel et al. 2007).
- At Phillip Island and Oamaru (NZ), traffic restrictions and signage has reduced penguin mortalities on roads (picture of sign: right).

On Granite and West Islands Department of Environment and Natural Resources together with Granite Island Nature park has supported a monitoring program to assess the effects of human activities on penguin breeding success. Prior to 2005, the surveys indicated that breeding success was low where human visitation was high (North shore), compared with areas where visitation was low (South and West shores) (Morcom 2005, Gilbert 2010). In years when tourist facilities were being developed, the breeding success of penguins was particularly low within the construction zone (N. Gilbert unpubl. data). Since 2005, management strategies have reduced human impacts and breeding success has improved on the North shore. These include capping tour participants to 200 people per night with guide-tourist ratios of 1:25, and also using security guards to protect the colony during the two hours after dark, when penguins are most vulnerable to disturbance. There are still occasional reports of harassment, stealing and killing of penguins as well as damage to burrow entrances by people at Granite Island (D. Longden pers. comm.).

Recommended actions

- Introduce a tourism levy with funds collected used to support management and research aimed at improving penguin conservation.
- Continue to manage visitors, both during and after penguin tours, so that penguins do not alter their behaviour. Maintain the security guard at Granite Island. Establish caps on the number of visitors for tours (currently implemented at Granite Island). Tour guides and signage should educate visitors to ensure that noise, and torchlight is kept to a minimum during the 2 hours after dusk, and that penguins are not approached. Prevent visitors from obstructing penguin walkways (e.g. with fencing)
- Monitor breeding success in areas where visitors view penguins and in areas where they do not (currently implemented at Granite Island)
- Install security cameras where penguins are at risk of abuse by people.
- Minimise the illumination of penguin colonies and walkways areas because artificial lights may inhibit the birds' eyesight, exposing them to greater risk of predation on land (Pryor and Wells 2009).
- Educate urban planners to any potential adverse impacts of proposed development (e.g. marinas, seawalls and foreshores) on penguins (Pryor and Wells 2009) and review traffic management around urban colonies.
- Ensure council planners, construction and maintenance crews conduct ground works outside of breeding and moulting periods (February- April).
- Educate adjacent landholders and coastal users about potential impacts of their use of the coast on penguins (Pryor and Wells 2009)
- Ensure that local residents are included in management actions to encourage an active, supportive community that protects their local penguin colonies (Pryor and Wells 2009). Continue to support businesses to provide interpretive tours, interpretive centres and education that focus on the conservation of penguins.
- Determine if any penguin deaths or injury resulted from anthropogenic causes and track trends in causes of death or injury.

7.6 Habitat change and management

One of the major threats to the chick production and recruitment of a penguin population is the loss of nesting habitat (Pryor and Wells 2009), caused by:

- urban development (buildings, roads, wharfs, marinas, lawns, gardens, housing),
- fire (e.g. West and Montague Islands),

- erosion from human foot traffic,
- weed infestation (kikuyu on Montague, Bowen and Five Islands in NSW).
- grazing by rabbits (Encounter Bay islands,) and stock animals (NZ) and
- weather in areas that are already eroded (heavy rain can cause burrow collapse at Granite Is.).
- boxthorn removal (when other native plant species or shelter are not available as replacement nest habitat) (picture of nest in boxthorn: right).

Resident seabirds can also causes changes to island vegetation. Silver gulls may be responsible for the introduction of kikuyu grass *Pennisetum clandestinum* as nesting material to some islands (Smith and Battam 1998). Penguins avoid nesting in areas that are dominated by kikuyu, perhaps because they can become entangled and burrow entrances may become blocked.

Human structures such as sea-walls and marinas have mixed effects on penguin populations. A sea-wall at Penneshaw has changed the natural water flow and caused the deposition of sand in the bay where penguins come ashore. The effect on penguins is not known but there are fewer penguins nesting in this area than before the sea-wall was constructed. These structures, however, can provide nesting habitat, such as the sea-wall at St Kilda (Victoria) and the wharf and tidal pool at Kingscote. Development of the Kingscote wharf and foreshore has been proposed by the Kingscote Urban Design Framework (2005), with cafés, outdoor dining, tourist accommodation and ferry facilities. The Penneshaw Urban Design Framework (2005) also proposed “development investment in the wharf area”, which is adjacent to the penguin colony.

Some colony sites on Kangaroo Island have experienced habitat modification in recent years. There are insufficient historical data on penguin numbers at these sites (Table 2.) to determine the impact of habitat modification. In 2004, Kangaroo Island Animal and Plant Control Board (APCB) conducted boxthorn removal in Penneshaw penguin colonies. The removal was timed to coincide with period when penguins are spending more time at sea during February (The Islander, 2004). At Christmas Cove in 2003, a marina was constructed and the vegetation was

modified, including the removal of some boxthorn habitat where penguins were nesting. Prior to the project commencing the “penguin population was relocated” by the Penneshaw Penguin Management Committee (KI Council) (Leed Engineering 2011). The impacts of the habitat redevelopment are not known but 140 penguins still nest in the area (C. Gibbons unpubl. data).

A range of management plans outline the need to improve nesting habitat for penguins in colonies that are facing population declines (Penguin Protection Plan for Victoria 1985, NPWS 2000, DEC 1992–2002, Pryor and Wells 2009). Programs such as the Little Penguin Recovery Team for the Manly colony (including Penguin Watch) and the Derwent Estuary Little Penguin Program (DEPP) implement management plan recommendations at some Australian penguin colonies (Dawson 2007, Pryor and Wells, 2009). The DEPP works with community volunteers and schools to enhance habitat by revegetating sites, installing over 150 artificial burrows, upgrading 30 existing burrows, as well as reducing predators by erecting fencing, swing gates and signs at critical sites. These efforts appear to have resulted in an increase in the number of penguins breeding in these colonies from 98 breeding pairs in 2004/05 to 192 in 2007/08, and an extra breeding site in 2008/09 (Pryor and Wells 2009). At Bowen and Montague Islands, control of kikuyu grass, may also have reduced the number of little penguins killed by weed entanglement (Fortescue 1995, NPWS 1995, NPWS 2000). At Phillip Island, the Department of Sustainability and Environment purchased residential properties at Summerland Estate, adjacent to the little Penguin colony. Phillip Island Nature Park is endeavouring to restore this land to nesting habitat for penguins (Phillip Island Nature Park annual report 2010).

The marine habitats that are used by foraging little penguins also require management to ensure that prey is available. Marine habitats are at risk of benthic modification from trawling activities, agricultural and stormwater runoff, sewage and dust storms (Tanner 2005, Copley 1996). Seagrass beds are declining in GSV (Tanner et al. 2005) and they are important nursery habitats for juvenile baitfish (Connolly 1994), which are the main prey for penguins. Efforts to protect marine habitats to conserve biodiversity and ecosystem function are part of the South Australian Marine Parks Plan (DENR), which is now in community consultation. The rationale for two proposed marine park sanctuaries (Zone C-lower Yorke Peninsula, and Zone L-Encounter Bay) include little penguin feeding grounds.

Recommended actions

- Assess habitat restoration needs at each colony (ie. kikuyu infestation at West Island) and discuss restoration options with councils, NRM Boards, Local Progress Associations and managers of the land. Ensure habitat restoration plans are consistent with Coastal Action Plans of KI and AMLR NRM Boards and other council development plans.
- Fence vulnerable habitat to prevent erosion caused by human traffic.
- Maintenance of habitat should be ongoing as necessary and should include the removal of weeds that hinder the growth of plants that are preferred by nesting penguins. Large weeds such as African boxthorn, which provide nesting habitat, should be killed using the 'cut and paste', 'scrape and paint' or 'drill and fill' methods. If possible, boxthorn should not be removed or burnt until other native species have grown sufficiently to provide habitat. Spraying herbicides may harm nesting penguins and should be discouraged in colonies, especially those with sandy soils where herbicides break down slowly.
- Revegetate degraded nesting areas and coastal gardens adjacent to penguin colonies, with native shrub species that are suitable nesting habitat in early autumn, before penguins begin breeding. Provide refuges or islands of cover or vegetation that penguins can use to seek shelter between the landing site on the foreshore and their nests. Refrain from dumping garden waste on the foreshore that can block burrow entrances. See AMLR NRM Coastal Gardens Planting Guide for advice.
- Avoid removing vegetation, boulders and old logs as these actions can destroy burrow habitat.
- Install artificial nest boxes (pictured right) in degraded areas where penguins once nested. To maximise the potential for occupation, place nest boxes >2 m apart, facing away from each other and 2 m off existing penguin walkways to avoid territorial disputes by birds using walkways. Ensure boxes have thermal stability and ventilation (methods: Houston 1999, Pryor and Wells 2009).

- Work with Councils and Local Progress Associations (on KI) to develop guidelines for the most appropriate earthmoving and vegetation clearance methods around penguin colonies and incorporate into ongoing training for maintenance crews (Pryor and Wells 2009).
- Conduct prescribed burning activities outside of penguin breeding and moulting periods, because penguins remain in their nests during a fire, which results in death or injury of penguins (Chambers et al. 2005, 2009b).

7.7 Impacts on prey and competition

Across the world, seabird diets have been linked to variation in prey abundance and recruitment resulting from fishing pressure (Monaghan et al. 1989, Litzow et al. 2000). Populations of Guanay cormorants in South America which prey on anchovy *Engraulis ringens,* declined dramatically in the 1970s, when the local anchovy fishery declined (Furness and Monaghan 1987). Similar reductions of anchovies *Engraulis capensis* have caused breeding failures of African penguin *Spheniscus demersus* (Crawford and Dyer 1995). Impacts of disease on prey species, such as an exotic herpes virus that caused the Australian sardine (pilchard) mass-mortalities in 1995 and 1998 (Whittington et al. 1997, Gaughan et al. 2000) also have widespread impacts on those seabirds and other species that prey upon them (Bunce and Norman 2000, Dann et al. 2000, McLeay 2009). At Phillip Island, when local sardines became depleted as a result of mass-mortality events and fishing (Neira et al. 1999, Ward et al. 2001b), little penguins and other seabirds ate fewer sardines, which coincided with increased seabird mortality rates and poorer breeding success (Dann 1991, Cullen et al. 1992, Norman et al. 1992, Dann et al. 2000, Bunce and Norman 2000, Bunce, 2001, Chiaradia et al. 2002, Chiaradia et al. 2003).

Few data exist on the effects of sardine mass mortalities on South Australian little penguin populations (Dann et al. 2000). Large numbers of dead penguins were reported washed up on beaches following these events (T. Flaherty pers. comm.). The then Department of Environment, in association with the Marine and Coastal Community Network, sought to establish a process for reporting marine wildlife mortalities in the mid-1990's but there were limited resources for ongoing maintenance of a database of significant mortality events of seabirds (Flaherty 2002).

The South Australian sardine fishery is the largest fishery by volume in Australia and began in 1991 to provide feed for the Southern bluefin tuna, *Thunnus maccoyii*,

aquaculture industry in Spencer Gulf (Ward et al. 2001b, Ward et al. 2008). Human consumption is likely to become more important as a market for these fish. The SA sardine fishery harvests 36,500 tonnes of sardine per year (2009/10) and reports <1% anchovy by-catch (Ward et al. 2008, Ward et al. 2010). Therefore the SA sardine fishery is not currently removing significant amounts of the most important item of the penguin's diet. In 2011, sardine licensees will be able to fish for anchovies with a preliminary total allowable catch of 1000 tonnes to investigate whether an anchovy fishery and subsequent market can be established in South Australia. Detailed and ongoing impact assessments are required under the principals of Ecologically Sustainable Development regulations, for all species potentially influenced (i.e. through trophic interactions) by fishing operations (Fletcher et al. 2002). Trophodynamic studies have been undertaken in South Australia to assess the ecological effects of the South Australian sardine fishery (Goldsworthy et al. 2011). These studies recommend that the breeding success of little penguins be monitored and used as an indicator of the health of fish stocks to reduce the risk of the fishery having long-term impacts on populations of little penguins.

Recommended actions

- Monitor the effects of fish mortality events on little penguin populations.
- Develop a mortality register that records the location and number of little penguins that are found washed up on beaches, and relate these to sea state and weather conditions. The role of starvation (which may indicate localised depletion of prey), among other possible causes of mortality should be assessed.

- Include the foraging hotspots of little penguins in the design of marine park sanctuary zones, particularly near Althorpe Island, which is near the SA Sardine Fishery harvest areas.
- Monitor the diets and breeding success of little penguins both before and during the development of any commercial anchovy fishery that will operate within the foraging areas of declining little penguin colonies.
- Incorporate triggers within the development processes of any future anchovy fishery that alerts fishery managers to potential adverse impacts of increasing fish harvest on local little penguin colonies and liaise with penguin experts to undertake actions to mitigate these where possible.

7.8 Disease and parasites

Little penguins are susceptible to diseases and parasites, some of which can be fatal (Rose 2005). In post-fledglings, the liver fluke (trematode) *Mawsonotrema eudyptulae* appears to be the most pathogenic of these parasites. The fluke, which lives in the bile ducts, sometimes kills large numbers of juvenile penguins, which are found as 'wrecks' of carcasses on beaches, known as 'beach-wrecks' (Obendorf and McColl 1980, Harrigan 1992). Pathogenic bacteria found in penguins include *Pasteurella multocida* (avian cholera), *Pasteurella haemolytica* Type T, *Salmonella* spp, *Chlamydia* spp, *Staphylococcus* spp, *Streptococcus* spp, *Neisseria* spp, *Campylobacter rectus*, *Erysipelothrix rhusiopathiae* and *Corynebacterium spheniscorum* (Dewar and Scarpaci 2007). Renal and/or intestinal coccidiosis and intestinal cestodiasis are also common incidental findings in little penguin carcasses. Trypanosomes (protozoans), transmitted by biting midges, are often found in the peripheral blood of little penguins but they do not appear to be pathogenic. Little penguins (particularly those in captivity) are affected by trichomoniasis, a commensal protozoan within the alimentary tract, sometimes causing tissue necrosis and secondary infections. A *Babesia*-like piroplasm, most likely transmitted by ticks, is occasionally evident within the erythrocytes of little penguins, which causes regenerative anaemia (Rose 2005). Aspergillosis (fungus) was also found to cause respiratory mycosis and death in 3.3% of carcasses from north Otago, and the disease may be contagious amongst stressed penguins (Hocken 2000). Other less common parasites include ascarid helminthiasis *Contracaecum spiculigerum*, which parasitises the oesophagus and proventriculus causing gastric ulceration and occasionally death (Harrigan 1991). In South Australia, parasitic worms (including nematodes) are common in the stomach contents of healthy penguins (Wiebkin 2011) but large numbers of stomach parasites can cause rapid death (T. Soutar pers. comm., penguin rehabilitation). Ectoparasites such as fleas (*Parapsyllus longicornis*) and ticks (Ixo*des eudyptidis*) are also frequently found on little penguins, which can cause a decrease in white blood cells, but not generally death (Rose 2005, van Rensburg 2010).

Environmental conditions and stress combined with high parasite loads can cause high mortality rates in some seabirds (Copley 1996). For example, protracted storm activity may disrupt foraging at sea, which, combined with effects of internal parasites, may lead to malnutrition. Little penguins in South Australia are known to be susceptible to these mortalities (Flaherty 2002). In 1984, following a storm, more than 200 beach-wrecked penguins collected from the state's southeast were found

to have high parasite loads and signs of starvation (DeLroy 1985). Starvation is the most common cause of death on penguins found washed up on beaches in Victoria (Harrigan 1991).

It is not possible to evaluate trends, causes or the extent of these 'beach-wreck' events if there is no systematic approach to data collection and investigation. Some autopsies of penguins are reported by the Australian Marine Wildlife Research and Rescue Organisation (AMWRRO) but 'beach-wreck' events are not monitored. The South Australian Museum maintains a database of stranding events of marine mammals. A similar database together with pathology investigations for little penguins could be a useful tool to evaluate major trends and potential threats across GSV and the state.

Recommended actions

- Adult penguins that are found dead in the colony should be collected and autopsied to investigate the causes of mortality (eg. diseases, parasites, cause of death and confirmation of sex from internal organs).
- A mortality register for the GSV region should be developed and maintained. This may include observation records from the public (through a dead-penguin sighting record sheet), as well as autopsy reports appropriately trained professionals.
- Liaise with Australian Wildlife Health Network members to track potential issues nationally, ensure that incidents are documented through the AWHN Disease Incident Reporting process and update and keep track of disease issues via the AWHN Bulletin Board and Australian Registry of Wildlife Health, which focuses on detecting and diagnosing endemic, emerging and exotic diseases of wildlife.

7.9 Pollution

Oceanic pollution can affect little penguins. Oil spills are one of the most conspicuous forms of marine pollution. Populations of little penguins can be affected by local oil spills (Dann 1994, Goldsworthy et al. 2000). Oiling causes feathers to lose their waterproofing, which affects thermoregulation, swimming and foraging behaviour (Dann et al. 1994). If absorbed or ingested, oil, hydrocarbons and petrochemicals (from industrial areas) and can also kill seabirds (Copley 1996). The National Marine Oil Spill Contingency Plan (2011) states that the GSV bioregion is

at high risk of large oil spills. However, the risk is reduced with the closure of the Port Stanvac Oil Refinery and the reduction in loading and transit of large crude oil carriers.

Seabirds sometimes exhibit high levels of heavy metals, including mercury (Monteiro and Furness 1997) and lead, probably from ingestion of lead fishing sinkers (Harrigan 1991, Overeem 2006). Other heavy metal contamination, particularly cadmium from coastal smelters, has been recorded in fairy prions *Pachyptila turtur* off Tasmania, and in marine mammals in South Australia's gulfs (Kemper et al. 1994, EPA 2004). There is limited research on the effects of heavy metals on seabirds in South Australia.

Pesticides (e.g. organochlorines) accumulate in little penguins, amongst other predatory seabirds (Falkenberg 1994, Gibbs 1995). Fernandes et al. (2008, 2010) highlighted a need to better understand the toxicological response of South Australian marine fauna, such as seabirds, to persistent organic pollutants present in wastewater effluents. Concerns have also been raised over Endocrine Disrupting Chemicals (EDCs) contained in pharmaceuticals and personal care products, which enter aquatic environments in sewerage or reclaimed water (Environment Canada 1999, Ying et al. 2004). Some of these chemicals cause adverse effects on aquatic ecosystems and fish including feminisation (Colborn et al. 1993, Ying et al. 2004, Fernades et al. 2010).

Plastic marine debris from land based sources, fishing gear and ship-sourced, solid non-biodegradable materials disposed of at sea adversely affect a number of listed marine species (Threatened Species Scientific Committee 2003). At least 56 species of sea birds have been reported to ingest floating plastics, including hard plastics and polystyrene balls, which may be mistaken for food items. Ingested plastics can fill as seabird's stomach, and can lead to starvation (TSSC 2003, Hutton 2004). These plastics can also leach polychlorinated biphenyls (PCBs), which can cause suppression of the immune and reproductive systems, thereby reducing breeding success (TSSC 2003). In little penguins in South Australia, floating hard plastics were found in 1% of diet samples at the Pearson Island colony (Wiebkin 2011). This is probably because penguins primarily target prey in the water column, not on the surface.

Coastal eutrophication is a major marine pollution issue in South Australia, because it has caused inshore habitat loss of seagrass off the Adelaide metropolitan and related 'flow-on' impacts for fish, seabird populations and coastal erosion (Copley 1996, Tanner 2005, Westphalen et al. 2006). Eutrophication can cause increased turbidity. Penguins are visual predators but the reactions of little penguins to turbidity are not well understood. At sites where turbidity is high, penguins appear to dive to shallower depths when illumination is poor (Cannell and Cullen 1998, Ropert-Coudert et al. 2006). Highly turbid waters, such as those predicted to result from the dredging operations to deepen the Port Phillip Bay channel, are likely to hinder the foraging of little penguins (Preston et al 2008). The foraging behaviour of anchovy may also be affected by high turbidity, as these fish are also visual predators (Chiappa-Carrara and Gallardo-Cabello 1993).

Recommended actions

- Ensure that oil spill response kits are located strategically across the GSV, that they are maintained and their locations known to the relevant authorities. For large spills, follow the guidelines and protocols outlined in the National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances.
- Ensure relevant state and federal agencies involved in the National Marine Oil Spill Contingency Plan regularly review the capacity and training of wildlife response teams and personnel in place to respond to an oil spill in the marine environment.
- Educate local boat owners to conduct regular engine maintenance and dispose of oil responsibly (Pryor and Wells 2009)
- Ensure that local oil spills are reported, to provide an early response.
- Continue efforts for the minimisation of plastic packaging in SA fisheries.
- Continued community and industry awareness programs on preventing pollution impacts to the marine environment.
- Continue supporting penguin rehabilitation and rescue facilities in Adelaide (AMWRRO), Granite Island (Penguin Centre) and Kingscote.

7.10 Entanglement in fishing gear

Injury and fatality of marine life caused by entanglement in marine debris or active fishing gear is a listed Key Threatening Process (*EPBC Act* 1999). Penguins, like many seabirds, are at risk of entanglement and drowning in discarded or active

fishing gear such as gill nets (Copley 1996, Laist 1997, Simeone 1999, Lloyd 2003, Pryor and Wells 2009, Phillips 2010). Entanglement data are scarce for little penguins, but some penguins have been reported caught or drowned in fishing nets near Brownlow Beach/Nepean Bay on Kangaroo Island, in Encounter Bay, and in marine scale fishery nets (Knight and Vainickis 2011). Netting closures have been expanded around Yorke Peninsula since 2005, and netting is also prohibited in the near-shore areas of the Kingscote, Encounter Bay, and Troubridge Island colonies (Figure 11). Penguins that forage offshore (Figure 8, 9 and 10) may be at risk of net entanglement. The mesh sizes (distance between opposite knots when mesh diamond is pulled taut) used by state managed fisheries vary from 30mm (for garfish), 50 - 64 mm (for yellow-eye mullęt *Aldrichetta forsteri*) to 115-150mm (for mulloway *Argyrosous japonicus*) and those used by the Commonwealth managed shark fishery in State waters is 150-165 mm. Mesh of these sizes is capable of netting or entangling a little penguin. Based on logbook data from the shark fishery in Southern Australia there have been an average of 10 interactions with protected species annually between 1999 and 2008, of which 6% were seabirds. Within South Australia, the AMWRRO reported that over an 18 month period, 90% of over 90 call outs were to attend to birds (including little penguins) entangled in fishing tackle, mostly from active fishing practices (South Australian Seabird Rescue 2006). A current *Gulf St Vincent Marine Debris Threat Abatement* project has conducted debris surveys to gauge the extent of marine debris and determine key sources (K. Peters unpubl. data).

There have been proposals for aquaculture and mariculture developments in GSV near penguin colonies. These included tuna cages (with a tourism cage) off Penneshaw, as well as mussel leases off the coast of Kangaroo Island and oyster farms on Yorke Peninsula (Lloyd 2004). A tuna tourism cage was also relocated from Port Lincoln to Granite Island as an “aquarium” venture, but it closed and is no longer there. Significant amounts of marine debris in coastal environments are also attributable to the aquaculture industry (South-East Regional Marine Plan National Oceans Office, 2001). The potential risks of entanglement that mesh cages, bivalve farm structures and associated debris pose to little penguins are not known.

Recommended actions

- Liaise with state and Australian Government fishery agencies to further improve management of gill netting and fish farms within foraging ranges of little penguins to reduce the number of penguins that become entangled.

- Improve education and awareness on proper disposal of fishing gear and development of line recycling facilities such as T'angler bins (being trialled by Oceanwatch Australia, SeaNet and AMLRNRM Marine Debris Threat Abatement program) at key recreational fishing locations.
- Government departments should continue supporting penguin rehabilitation/rescue facilities in Adelaide (AMWRRO), Granite Island (Penguin Centre) and Kingscote.

Figure 11. Map of coastal waters in GSV, showing the areas closed to state managed net fishing prior to August 2005 (red) and additional areas closed to net fishing since August 2005 (green) (PIRSA 2005).

7.11 Climate change

The Marine Climate Change Report Card (Chambers et al. 2009) outlines the predicted effects of climate change on seabirds. These include an increase in extreme weather events, which will affect little penguins in Australia. Prolonged periods of extreme heat or heavy rainfall events can kill young penguin chicks in unprotected or surface nests (Klomp et al. 1991, A. Wiebkin obs.). Large storms bring sea surges and high tides, which may inundate low-lying colonies in the future. These colonies will be particularly threatened if there is limited habitat in which to

relocate (eg. small islands, or areas surrounded by urban towns) (Pryor and Wells 2009). An increase in windy events is also predicted to negatively affect little penguin breeding (Mickelson et al. 1992). In Victoria little penguins choose to forage in thermoclines (Ropert-Coudert *et al*. 2009) but these oceanographic features will potentially be frequently dispersed with more storms, making foraging less efficient (Chambers et al. 2009). A rise in the number of days with air temperatures at or above 27°C will also require little penguins to spend more energy thermoregulating (Marsh 2010), but increasing sea temperatures are predicted to improve breeding productivity and juvenile survival (Chambers et al. 2004a, 2004b, Cullen et al. 2009). The effects of climate change on prey stocks for little penguins are unknown.

The little penguin colony at Troubridge Island is the largest colony in the region and the population appears to be stable (Table 1, Wiebkin 2010a). The low-lying island is, at risk of erosion, which would reduce nesting habitat. Winter storms in 2009 inundated and destroyed significant areas of vegetation (A. Wiebkin unpubl. data). Similar storms and tidal damage appear to have caused fluctuations in the penguin population in recent decades (Copley 1996) but rising sea-levels and an increase in the frequency of large storms may further reduce the land mass.

Recommended actions

- Incorporate climate change information about coastal vulnerability to storm surges and high tides in GIS maps used by planners and land managers.
- Educate land managers about the potential impacts of climate change (particularly storm surge) on penguin colonies.

7.12 Cumulative effects of impacts on population size

Seabirds typically live in very large, dense colonies where individuals benefit from social interactions and more mate choice because they breed synchronously (Dornhaus et al. 2006, Drent 2006). Individuals in large colonies are also exposed to less predation risk due to the dilution effect of many individuals and only a few predators (Hamilton 1971). Little penguins exhibit communal behaviours such as a large repertoire of social calls and ‘rafting’ together at sea, which suggest they are adapted to living in large colonies (Stahel and Gales 1987). If a population becomes too small through the cumulative effects of various impacts, the potential for local extinction may increase (Copley 1996).

8. Rehabilitation and education facilities

Injured little penguins are rehabilitated at several facilities across the species' range including Taronga Zoo (NSW), Phillip Island (VIC), Wellington (NZ), Dunedin (NZ), Granite Island (Penguin Centre Granite Island), Kingscote (T. Soutar) and Adelaide, where the AMWRRO is based. The AMWRRO was formed from South Australian Seabird Rescue and Project Dolphin Safe. AMWRRO provides seabird rescue and handling training. They also coordinate community programs to clean-up and revegetate seabird habitats. The organisation has extensive pond and cage facilities to care for injured penguins. At Granite Island, a Penguin Centre was opened in 2003 and is located within the wild penguin colony in the Granite Island Recreation and Nature Park. A monitoring program of the wild penguin population is also part of the lease agreement with the Granite Island Nature and Recreation Park. The centre has a pond and quarantine facility, where up to 20 injured penguins are rehabilitated and where those penguins that cannot be returned to the wild are accommodated. These facilities across GSV are well placed to rescue and rehabilitate oiled penguins and they play an important role in the National Plan to Combat Pollution of the Sea (2007). They also report diseases to the National Wildlife Health Network. All facilities in GSV rely on experienced volunteers, donations, tourism grants as well as community and state government support. The centres, along with the three penguin tour operations at Penneshaw (Penneshaw Penguin Centre), Kingscote (Kingscote Penguin Centre) and Granite Island (Granite Island Recreation and Nature Park), also provide valuable education to thousands of visitors and school groups.

9. Monitoring and research needs in GSV.

Wildlife and resource managers generally have more ability to address terrestrial factors, such as terrestrial predation, nesting habitat and tourist behaviour, land-based sources of pollution, than marine factors, such as prey availability, marine pollution and predation at sea. Terrestrial factors are also more cost-effective and practical to implement. For this reason, most of the recommendations in this report are focused on improving the terrestrial environment for little penguins and monitoring their numbers on land. Fisheries managers and researchers can play a valuable role in ensuring recreational and commercial fisheries are managed sustainably and that impacts to marine wildlife through by-catch, gear loss and potential prey competition are addressed.

9.1 Monitoring populations and breeding

Copley (1996) noted that obtaining accurate baseline population and ecological estimates should be a focus for little penguins, because they have a high conservation value and are likely to be affected by competition from commercial fisheries and other threats.

While some monitoring of penguin populations at Kingscote, Penneshaw and Troubridge, Granite and West Islands has occurred, there has been little coordination and standardisation of methods between years or colonies. For example, Morcom (2005) highlighted inconsistencies in data that were collected at Granite Island prior to 2000. The tour-operators at Penneshaw count penguins that are seen during nightly tours (not the entire Penneshaw colony), whereas managers at Kingscote conduct a full-colony census once a year. These differences in methods are probably a result of varying resources, and limited collaboration across the different colonies as well as site-specific characteristics that render some methods unsuitable at certain sites. There has not been a formal assessment process to evaluate and report on the status and trends in abundance in the little penguin population across GSV. Colony declines were detected up to seven years ago (Morcom 2004) but until recently, there was a perception that such declines were localized. Monitoring of breeding success and survival has also been spatially and temporally limited.

In developing conservation programs for little penguin colonies in GSV, it will be important to clearly define goals, which should manage little penguin populations in GSV to ensure that:

1) The population (across the region) remains viable
2) Commercial use of the colonies for tourism does not adversely impact the populations,
3) The requirements under State and Australian Government threatened and protected species legislation and community expectations are met (see section 4 for status review recommendations)

To measure the success of conservation programs for little penguins, long term monitoring of penguin populations and breeding success are required. Monitoring should include:

- Annual surveys of active nests (burrows) after the peak of the breeding season.
- Regular surveys of a subset of nests throughout the breeding season to determine the proportion of eggs that hatched and chicks fledged.
- Strong scientific management and coordination of surveys
- Results reported and reviewed shortly after each breeding season.

Note: breeding success and annual surveys are already being conducted at Granite and Kingscote colonies by N. Gilbert and KI-NRM Board respectively.

General methods of monitoring penguin populations

To assess the effectiveness of management actions, penguin populations need to be annually monitored so that population trends can be detected. All or a subsample of active nests in a colony should be counted during or shortly after breeding activities when signs of nest use are most apparent. Signs of nest use include recent faeces (generally from chicks), a strong smell, recent diggings, unobstructed burrow entrances and the presence of eggs or egg shells and penguins. Population estimates from nest surveys are based on the assumption that each active nest represents a breeding pair of adult penguins. One of the disadvantages of this method is that surveys will not record nests that become active after the survey. Nest surveys cannot be used to estimate the number of juvenile and non-breeding adults. To assess the accuracy of this method in the region, Kangaroo Island NRM is currently conducting a nest activity study at Kingscote.

There are other methods of estimating a colony population. Tag-release-recapture techniques are suitable for colonies with limited access to nests. For this purpose, penguins can be tagged with microchips, feather dye or monitored by existing flipper bands. In colonies with sandy beaches, the population can also be estimated by counting sets of recent footprints heading seaward. The proportion of penguins departing the colony on any one day must be known and taken into account when using this method. Alternatively, a subset of nests may be permanently marked and revisited regularly to establish whether they are active. This last method is practical if the main goal is to determine population trends, rather than population estimates.

The ongoing population monitoring needs are:

- Survey each major colony (Kingscote, Penneshaw, and Granite, West, and Troubridge Islands) annually, using the most appropriate survey method for the size of the colony, terrain, and accessibility (above).
- Survey smaller colonies (Althorpe, Wright, Royston, Chinaman's Hat, Seal and Pullen Islands, Seal Rocks, Deep Creek Conservation Park, Pages Islands and others on Kangaroo Island) to determine whether penguins still remain at these sites, and then biennially if penguins are found. Ensure disturbance to Australian Sea lions is minimised during surveys of the Pages Islands.
- Monitor population trends at three other colonies across the state each two years as controls. Monitored colonies should be exposed to minimal anthropogenic influences and should not be situated near fur seal haul-outs. Colonies such as Pearson Island (off Elliston), Olive Island (off Streaky Bay), Franklin Islands (Nuyts Archipelago) would be suitable candidate colonies for this purpose.
- Other colonies in Spencer Gulf should also be monitored because there have been reports of considerable decline in penguin populations this region (W. Goedseke pers. comm.. Parker 1979.).
- Population trends are best interpreted using averaged data from 5-year cycles to account for annual natural variation.

Recommended census methods for main GSV colonies

Granite Island

The current census program should be continued without modification. A census of active nests is conducted twice annually, each a week apart, usually around August.

The timing of the census is relative to the peak of the breeding season. Population surveys are conducted during the 5th and 6th week after the sighting of the first eggs in at least 3 nests. Approximately 80 community volunteers participate. Two censuses are done to account for variation in counts between volunteers. The penguin nesting area is divided into sections and the two censuses of each section are averaged. The mean counts for each section are summed to estimate the number of nesting pairs of penguins. Nightly counts of penguins are also made by tour guides in areas where penguin tours are conducted. These counts are averaged each month (Fig. 3, Morcom 2005). These methods of monitoring the population have been consistent since 2000.

Kingscote

There is a full-colony census method in place, which is conducted by approximately 80 volunteer community members and coordinated by Kangaroo Island NRM Board in October each year. The penguin nesting area (~5km of coast) is divided into sections so that the workload can be divided between the volunteer groups. It is recommended that the amount of time after the peak in breeding activity (such as the number of weeks since the first eggs appeared) should be recorded so that correction factors can be developed to standardise survey results between years.

Troubridge Island, West Island and Penneshaw

At each colony, four appropriately experienced people could complete a full-colony census in one day. Each census should be during the 6th week after the sighting of the first eggs. Alternatively if the onset of egg-laying is not known, the census at these colonies should coincide with the census at Granite Island (where nests are regularly monitored) because the timing of breeding is usually similar between these colonies (A. Wiebkin unpubl. data).

Methods to monitor breeding success

The rate of reproduction (measured as breeding success) plays a role in population growth or decline.

Monitoring options:

- A subset of marked nests (up to 50 in each colony) should be visited at least three times during the breeding season, to observe and record the number of eggs that were laid, the number of eggs that hatched and the number of chicks that fledged (those observed in the nest a few days prior to when fledging can be expected). Further investigations should be made to

determine and mitigate the causes of consistently poor breeding if detected. A criteria for acceptable breeding success could be developed after normal breeding success is determined at each colony.

- Nest or motion-sensor cameras may also be used to observe nests.

9.2 Population demography

There is high variability in chick production from year to year at Granite Island (Bool et al. 2007) and elsewhere in Australia (Dann 1991). For this reason, breeding success does not always provide accurate measures of population status. Recruitment rates, as well as age-specific and cohort survival rates, are better measures of the longer-term demographic vulnerability of populations. They provide a better way to forecast population trajectories, but are difficult to monitor.

An ongoing demographic program would aim to determine:

- Breeding season and cohort-specific survival rates
- Pre- and post-breeding age survival

Because little penguin chicks have high mortality rates, many chicks would need to be tagged with microchips, sexed and weighed each year to gain long-term survival data (ie Phillip Island, Dann et al. 1992). Automatic and hand-held tag readers are available so that high-quality resight data can be recorded with minimal effort, disturbance to birds and with cost efficiency. Tagging programs would also require strong scientific leadership and management with results reported regularly.

Note: A tagging program was commenced at Troubridge Island between 2004-2009, and continuation would provide valuable long-term data on a colony that does not appear to be declining (i.e. a control colony). A tagging program is ongoing at Granite Island, but no data have been analysed.

Methods for a demography study

Demographic structure, survival and breeding success all contribute to the growth or stabilisation of a penguin population. Demographic studies can determine whether mortality is higher at some colonies than others and at what age penguins are most at risk. For example, if the number of juveniles in a population decreases, then fewer penguins will recruit to the breeding population in future years. On the other hand if the number of older, experienced penguins decreases, fewer chicks will be produced

in the colony each year. Demographic trends can only be estimated from long-term tagging studies.

Monitoring recommendations

- At main colonies, tag a subset of the chicks with microchips annually.
- Adults can be tagged, sexed (using bill measurements) and weighed at any time except when they are on eggs or young chicks and when they are moulting.
- Efforts to resight individual penguins in burrows and around the colony should be consistent between years and areas. These efforts should not be excessively disturbing to breeding penguins (e.g. use a wand-reader).
- If there are one or two regularly used pathways that many penguins use to commute between the shore and their nests, then an automatic microchip reader can be placed along this pathway to record tagged penguins.
- At least two declining colonies (Kingscote and Granite Island) and a control colony (Troubridge Island) should be subject to demographic studies.

9.3 Applied Research

To compliment long-term monitoring programs, there will be a need for targeted research to support population management. The most critical of these will be those that aim to identify the cause(s) of population declines. It is also critical that research aims to understand more about threatening processes with a view to monitor and mitigate them. The management of anthropogenic factors, such as overfishing of prey species, disturbance from urban development and tourism and predation from terrestrial feral animals are priorities. Rates of mortality from natural causes such as predation and disease are not known, however, predation is perceived by to be a major threat to some penguin populations in the GSV region and warrants further investigation.

Research is important in educating the public about the biology and ecology of little penguins and about the management of protected marine species in the ecosystem. The commercial tour operations at Kingscote, Penneshaw and Granite Island offer opportunities to educate the public and these sites also provide a base from which community volunteers can participate in research.

Targeted research should include:

- Develop a Population Viability Analysis (PVA) model to explore how variation in breeding success and survival effect population vulnerability.
- Studies on predation of little penguins by rats (all species), New Zealand fur seals and Australian sea lions.
- Variability in breeding success to determine “normal success” for each colony (taking into consideration double breeding seasons).
- Studies on survival of fledglings and adults.
- Tourist interaction issues.
- Causes of mortality (autopsies and mortality register).

9.4 Ethics and permit considerations

To effectively meet research needs, access to all colonies should be available under permit. Ethics approval applications for research actions should be prepared by an experienced penguin researcher. Staff should be trained properly before handling or monitoring penguins. Research and monitoring efforts that involve handling or approaching penguins should be conducted by the minimum number of people. In colonies where populations are declining, activities that disturb penguins e.g. handling or approaching) should be minimised. Microchips which allow identification from a greater distance should be used over those that require penguins to be handled. If any new projects on penguins commence in colonies where research is already being conducted, then all parties should consult to ensure that penguins are not unduly disturbed.

10. Cost of monitoring and research programs

10.1 Scenario 1

- Population monitoring of a selection of known colonies (Granite, West, and Troubridge Islands and Kingscote, Penneshaw, Emu Bay) and a one-off search for penguin colonies at Pullen, Seal and Wright, Althorpe Islands and in the vicinity of Deep Creek Conservation Park.
- Determine level of fur seal predation at nearby haul outs through scat inspections and numbers of seal in the vicinity.
- Investigate level of terrestrial predation by monitoring black rats, water rats and other native rats at Kingscote and Penneshaw, Granite and West Islands using traps, cameras and video monitoring. Survey before and during baiting management programs.
- Measure general breeding success at a subset of nests at Penneshaw, Kingscote, and Granite Island colonies as well as Troubridge Island (control).
- Assess the effect of tourism and development on breeding success at Kingscote, Penneshaw and Granite Island by measuring nests inside, near and distant from tourism or development (i.e. wharf, building, road) areas.
- Opportunistic collection of dead penguins for autopsy to determine cause of death and general health, including pathology and bacteriological analyses.
- Train volunteers at Victor Harbor and Kangaroo Island
- Compile and analyse data and write reports.

Annual budget

Note: the budget provides estimates of annual costs. * denotes activities which should be done each year. H = high priority, M = medium priority, L= low priority.

Research Activity	Priority	Time	Funding required	In kind
Personnel				
Research ecologist (RE) (coordinate, train volunteers, design projects, write manuals, assess progress, enter data, analyse data, write reports, educate, liaise with public and managers) – (0.3 FTE) (RE required for at least 3mths/yr in subsequent years).	H	3.6 months	$19,218	
Penguin pathology and histology PO2 (0.1 FTE)	H	2.4 months	$10,050	
Histology sample processing and preparation OPS2 x 20 d	H	20 days	$4,000	
Salary on-costs (23%)	H		$7,651	
Surveys of all in Encounter Bay: 1d at main colonies, 2d at Granite, 1d at Deep Creek CP, 1d for Pullen, Seal and Wright Islands, plus RE*	H	8 days		Volunteer labour
Fur seal observations at Penneshaw, Kingscote and Granite - 2hrs/week x 52 weeks per colony, plus RE	H	104 hours per colony		Volunteer labour
Scat inspection, 3 hrs/month x 12months per colony, plus RE	H	36 hours per colony		Volunteer labour
Check rat traps and camera data,1hr/day x 10 days per colony, plus RE	H	10 hours per colony		Volunteer labour
Measure breeding success at Penneshaw, Kingscote and Granite, 2 hrs/month x 4 months per colony, plus RE *	H	24 hours per colony		Volunteer labour
Measure breeding success at Troubridge Is 3 extra days, plus RE*	M	3 days		Volunteer labour
Collection of carcasses and transport to museum, plus RE*	H			Volunteer labour
Travel				
Flights to KI @ $300/return trip for 1 person x 2 trip	H		$600	
KI vehicle mileage 100km @ $1.20/km x 2 trip	H		$240	
Edithburgh vehicle mileage 550km @ $1.20/km x 3 trips	M		$1,980	
Edithburgh-Troubridge Is charter boat @ $200/day x 3 trips*	M		$600	
Marion Bay vehicle mileage 100km extra@ $1.20/km x1 trip*	H		$120	
Althorpe Island charter boat @ $300/day x 1 day* OR helicopter @ $1000	H		$300	
Victor Harbor mileage 250km @ $1.20/km x 12 trips*	H		$3,600	
Charter boat to Pullen, Seal and Wright Islands $100/d x 1d	H		$100	
Charter boat to West Island @ $70/day x 8 days*	H		$560	
Equipment				
Movement cameras @ $390 each x 10	H		$3,900	
Elliott traps for rats	H			Borrow from DENR
Histological analysis and consumables	H		$3,500	
Bacteriological analysis (20 animals)	H		$5,500	
Remote video monitoring of seal, dog and human impacts	H		$12,000	
Monitoring consumables, field safety equipment, data sheets	H		$1,200	
Total per annum (exclusing in-kind)			**$85,619**	

10.2 Scenario 2

- As per scenario 1 plus
- Risk assessment of colony viability (model overlap of known foraging areas of penguins and seals, and incorporate population size, trends, predation rates and demographic data).
- Rodent predation behaviour study at Granite Island (tracking rats with VHF) and other colonies if rodents are detected in high numbers.
- Assessment of survival rates for fledglings and adults by tagging penguins with microchips and resighting tagged penguins each year.

Research Activity	**Priority**	**Time**	**Funding required**	**In kind**
Scenario 1	H		$89,500	
Extra personnel				
Research ecologist (viability analysis, tagging penguins, analysis of rodent tracking data, training volunteers to tag penguins, ethics, write report) full time- 2 months*	M	2 months	$11, 825	
Additional on-costs (23%)	M		$2601	
Rodent tracking 4 hrs/week x 12 weeks, plus RE	M	48 hours per colony		Volunteer labour
Tagging penguins and collecting survival data, 3hrs/week x 24 weeks per colony where possible, plus RE*	M	72 hours per colony		Volunteer labour
Extra equipment				
TIRIS RFID microchips tags $8 x 400*	M		$3,200	
Tagging equipment and readers*	M			Borrow from Granite Is, KINRM
RIFD automatic reader $900 x 2 plus batteries ($20/ mth)	M		$2040	
VHF transmitter collars for rats $120 x 6	M		$720	
VHF receivers x 2	M			Borrow from DENR
Total per annum (exclusing in-kind)			**$98, 061**	

Note SARDI costs increase (with inflation) by 4% per year excluding GST

10.3 Scenario 3

- As per scenario 2 plus
- Track 5 individual seals from the haul-out near Granite Island and 5 individuals from a haul-outs near either Penneshaw or Kingscote (wherever there are more).
- Assessment of seal visitation rates at penguin colonies. A subset of seals would be marked with a tag or fur-bleach to aid in identification.
- Monitor penguin population trends at three other colonies (that have limited threats from fur seals and anthropogenic factors) in other regions as controls.

Research Activity	**Priority**	**Time**	**Funding required**	**In kind**
Scenario 2	H		$98, 061	
Extra personnel				
Research ecologist to design seal tracking project, analyse data and write report (1 month)	M	1 month	$5,912	
Additional on-costs			$1,360	
Seal field work (2 x SARDI PO2 casual staff) @ $99/hr x 10 days	M	10 days	$14,850	
SARDI overheads	M		$1,614	
SARDI on-costs	M		$2,021	
Observing visitation rates of marked fur seals to the colony- 1hrs/week x 52 weeks per colony	M	52 hours per colony		Volunteer labour
Survey three extra colonies outside of GSV, 6 days x 2 people	M	4 days	$2,000	
Extra travel				
KI vehicle mileage 100km @ $1.20/km x 2 trip	M		$120	
Flights to KI @ $300/return trip for 2 persons x 1 trip	M		$600	
Accommodation for 2 people, 10 days @$100/day	M		$2,000	
Charter vessel, flights or vehicle mileage to 3 extra colonies outside GSV for surveys	M		$3,000	
Extra equipment				
GPS trackers @ $6000 x 10	M		$60,000	
Satellite time @ $400/mth x 2 months x 10 trackers	M		$8,000	
Total per annum (exclusing in-kind)			**$199,538**	

Note SARDI costs increase (with inflation) by 4% per year excluding GST

11. Cost of conservation management programs

Cost of management activities are presented for each main colony (or group of colonies) because most activities will be undertaken by local volunteers and managers. Costs associated with educating and liaising with authorities, community groups and business operators, are not included in this section (see section 10, scenario 1). These budgets provide estimates of annual costs. Items identified with * would require ongoing management costs each year. H= high priority, M = medium priority, L= low priority.

11.1 Granite Island

Management Activity	Priority	Time	Funding required	In kind
Personnel				
Management coordination (1day/week)*	H	52 days		NPWS/DENR
Baiting rats (staff or volunteers and bait) (ongoing)	H	as needed		DENR-
Monitor rat bait stations (ongoing)	H	as needed		DENR-
Fox control (ongoing when required)	H	as needed		DENR-
Security guard, 2hrs/night x 364 days*	H	14hr/wk		Currently provided Granite Island Nature Park
Equipment				
Install rubbish bins with rat-proof lids x 5@ $300 each, if needed	H	1 day	$1,500	Volunteer labour
Install signs to educate visitors not discard food scraps	H	1 day	$2,000	
Fences for nesting habitat to reduce erosion or disturbance	M		$5,000	Volunteer
Vegetation habitat, planting (2 ha planting, 500 seedlings $1.80 ea)	M	5 days	$900	Volunteer labour
Nest Boxes for areas lacking vegetation (materials and construction)	L	5-20 days	$1,500	Volunteer labour
Buy/update small oil spill kits	H		$500	
Community Awareness and Education				
Educational material to educate public (interactive displays)	H		$1,000	Volunteer
Educational signs	H		$2,000	
Total per annum (excluding in kind)			**$14,400**	

11.2 West Island

Management Activity	Priority	Time	Funding required	In kind
Equipment				
Bait rats (cost of bait, charter boat and monitoring rats) 1 day/mth	H	12 days	$3,400	Volunteer labour
Weeding Tree Mallow and Kikuyu	M	as needed		DENR
Nest boxes for areas lacking vegetation (materials and construction)	L	5-20days	$1,500	Volunteer labour
Total per annum (excluding in kind)			**$4,900**	

11.3 Kingscote, Penneshaw and Emu Bay

Management Activity	Priority	Time	Funding required	In kind
Personnel				
Management coordination (0.5 day/week casual salary)*	H	26 days	$5,200	
Baiting rats or (staff or volunteers and baits) – 0.5 day/wk for 20 wks if needed trapping feral cats	H	10 days	$2,000	Volunteer labour
Trap for feral cats	H	As needed		Borrow DENR
Monitor rat bait stations or cat traps – 2hrs/wk x 1 person if	H	2hrs/wk		Volunteer
Equipment				
Rat and/or cat traps if needed	H			Borrow DENR
Vegetate and maintain nesting habitat (500 seedlings x $1.65 ea).	H	5 days	$825	Volunteer labour
Fence vulnerable nesting habitat (materials)	H		$4,000	Volunteer
Expand nesting habitat (ongoing at Penneshaw and Kingscote)	M			Volunteer labour
Nest Boxes for areas lacking vegetation (materials and construction)	H	5-20 days	$1,500	Volunteer labour
Buy/update spill kits	H		$500	
Community Awareness and Education				
Dog breakfasts events x 3, and material to educate public	M		$1,500	Volunteer
Security cameras to discourage malicious abuse of penguins	H		$2,000	
Signage and educational materials	H		$2,000	Volunteer
Total per annum (excluding in kind)			**$19,525**	

11.4 Althorpe Island

Management Activity	Priority	Time	Funding required	In kind
Equipment				
Boxthorn weeding and, if needed, revegetate nesting habitat and provide nest boxes	M	2 trips/ year	Up to $1,000	Friends of Althorpe
Total per annum (excluding in kind)			**$1,000**	

11.5 Troubridge Island

Management Activity	Priority	Time	Funding required	In kind
Equipment				
Continue sand bagging efforts to stabilise erosion of island	H	4d /year		Volunteer
Install signs to educate visitors not disturb penguins and seabirds	H		$500	
Buy/upgrade oil spill kits to be held at regional DENR office	H		$500	
Total per annum (excluding in kind)			**$1,000**	

12. Partners and collaborators for priority actions

The current interest groups who have facilities, volunteers and staff situated in or near the GSV penguin colonies include:

- South Australian Research and Development Institution
- Kangaroo Island Natural Resources Management Board
- Adelaide Mount Lofty Ranges Natural Resources Management Board
- Northern and Yorke Natural Resources Management Board
- Victor Harbor Council
- Kangaroo Island Council
- Local Progress Associations (Kangaroo Island)
- Granite Island Nature Park
- Penguin Centre Granite Island
- Friends of Granite Island
- Friends of Wright Island
- Friends of Encounter Seabirds
- Department of Environment and Natural Resources (Victor Harbor, Innes National Park and Kingscote offices)
- Kingscote Penguin Centre
- Penneshaw Penguin Centre
- Friends of Troubridge Island and Yorke District Conservation Parks
- Friends of Althorpe Island (working bees each year)
- Individuals (T. Soutar, G. Trethewy, T. Trethewy)
- Hooded plover conservation project volunteers
- Schools (Victor Harbor High School, Investigator College and Victor Harbor R-7 School, Urrbrae Agricultural High School).

Potential collaborators include The University of Adelaide and Flinders University, which have marine, ecology, conservation and veterinary research departments. Students could undertake honours, masters and PhD projects focused on academic questions associated with penguin research and management in GSV. Students are provided with supervision and financial support (from scholarships and projects). Research groups interested in academic and conservation research of little penguins, such as the Phillip Island Penguin Group may also collaborate.

The Penguin Centre-Granite Island is coordinated via the Nature Park and has a strong volunteer base. Local councils invest considerably in coastal management as they are key land managers. Councils also support projects that benefit the community, such as education and infrastructure. Revegetation projects may be supported with collaboration or donations from Greening Australia, Trees for Life or landscape supply companies. Community volunteer groups such as friends groups, school groups, Earthcare groups, Conservation Volunteers and Greencorp are sources of labour for on-ground works. Community members would also become educated in penguin conservation and would disseminate knowledge into the community. Both a dedicated scientific leader and volunteer coordinator is essential to train volunteers, keep volunteers enthused, to ensure that data is collected in a scientifically rigorous manner and to report on results.

Most recently a Friends of Encounter Seabirds group has been established as an incorporated body with the aims to promote and encourage members to conserve seabirds and their habitats in Encounter Bay Region and surrounds and to promote conservation of seabirds throughout the general community.

13. Funding sources to support ongoing management

There is no recurrent and directed funding through DENR to manage and maintain a region-wide monitoring project together with a research program to identify the causes of penguin declines in the region. Options are discussed below in 4 categories, 1) State Government Funding, 2) Australian Government funding, 3) non-government funding and 4) sponsorship and levies (eg. visitor entry and commercial operator fees).

13.1 State Government Funding

State Government (DENR and NRM) funding is allocated to ongoing conservation, management and community engagement programs. NRM Boards have a number of coastal community awareness activities and actions to conserve and manage coastal and marine wildlife through the Regional NRM Plans. These species include glossy-black cockatoos, hooded plovers, Australian sea lions, southern emu wrens and threatened plants. Management of little penguins in GSV warrants similar funding as evidence suggests they have declined significantly in the region. While not formally listed under the State schedule of threatened species pursuant to the *NPW Act* this report recommends that penguins may satisfy the criteria for being listed as *Threatened* in the GSV region (see section 4). The recommendations of this report are also consistent with the targets set by the state Strategic Plan, KI NRM Board and AMLR NRM Board (see Introduction) and warrant funding. Period-defined projects can also seek state funding through:

Wildlife Conservation Fund

The WCF grants scheme supports DENR's commitment to innovative science-based policy and conservation management options for South Australia. Funding for individual projects of up to $20,000 is provided for one-year projects. Particular goals that a penguin project may address include: conservation of South Australia's biodiversity, community ownership and stewardship for biodiversity and ecological knowledge that can influence decision making. Applications are due in October each year.

13.2 Australian Government Funding

The Kingscote Penguin Centre has been successful in securing grants from the Federal Government's EnviroFund to improve the penguin viewing facilities to better manage tourists. Australian government funding for period-defined projects can be sought from:

Australian Tourism Development Program (ATDP)* and *TQUAL

ATDP and TQUAL are funded by the Department of Resources, Energy and Tourism. The ATDP supports initiatives that: promote tourism development in regional and rural Australia contribute to long term economic growth increase visitation and yield throughout Australia enhance visitor dispersal and tourism expenditure throughout Australia increase Australia's competitiveness as a tourism destination. The two categories of grants are: Tourism Projects and Integrated Tourism Development Projects. TQUAL grants aim to stimulate sustainable economic growth in the Australian tourism industry by enhancing the supply of quality tourism products and experiences to support marketing promises.

Caring for our Country

Caring for our Country aims to achieve an environment that is healthy, better protected, well-managed, resilient and provides essential ecosystem services in a changing climate. Goals include: increasing the community's participation in protecting and rehabilitating coastal environments and critical aquatic habitats. Community Action Grant funding offers up to $20,000 for both landcare and non-landcare projects to conserve, protect and enhance our environment. Grants from the Voluntary Environment and Heritage Organisations (GVEHO) program help community based environment and heritage organisations to value, conserve and protect Australia's natural environment and historic heritage by assisting with their administrative funding, salaries and salary on-costs, travel, services and consumable costs. Grants are $5000 to $20,000.

13.3 Non-government funding

Non-government granting agencies generally fund period-defined research for up to 1-3 years. These agencies rarely fund salaries. Some relevant funding sources are detailed below (alphabetically):

Australian and Pacific Science Foundation

The APSF provides project grants up to $15,000 per year for up to three years. Grants are awarded to institutions within Australia or other countries of the South West Pacific region. Salaries of technicians and research assistants may be supported, but normally grants do not cover the salaries of scientific research staff or stipends of students. Administrative overheads are not funded. Applications are due early March each year.

Australian Geographic

The Society donates approximately $150,000 per year to maintain its programme of sponsorship of Australian adventurers, scientific and environmental research, and community projects. The Society offers Seed Grants (up to $3000) and Project Sponsorships ($5,000 to $15,000). BAYERBoost Scholarships worth $6,000 are also available for tertiary students who will be required to work for 12 weeks in an environmental research or restoration area. Applications are accepted quarterly.

***Birds Australia: Stuart Leslie Bird Research Award (for students*)**

This award provides a total of $15,000 per year to support post-graduate field work and travel to scientific conferences in the area of ornithology and bird ecology and behaviour. Typically, grants of between $500 and $5000 are awarded for research projects and up to $500 for conferences. Applications close in March each year

Ecotourism Australia

Ecotourism Australia is an incorporated non-profit organisation, and is the peak national body for the ecotourism industry. The organisation is involved in lobbying for decisions and initiatives that improve the viability of the ecotourism industry; advocating for sustainable practices to be implemented across the tourism industry; seminars and workshops on marketing, ecotourism business management, sustainable practices, the Eco Certification Program and Eco-guiding issues.

Foundation for National Parks and Wildlife

The FNPW funds nature conservation projects across Australia, including: agency grants for Government agencies and their contractors ($5,000 to $20,000) and small grants for individuals and community groups ($3000) for conservation projects on private land, scientific research (amounts variable), and grants for volunteer groups.

Hermon Slade

The primary object of the foundation is to "advance and enhance the progress and harmony of mankind with the Earth through the study and application of Natural Sciences". The Foundation seeks to complement, rather than compete with, other funding bodies to improve the ways in which individuals and communities interact with their natural environments. Hermon Slade offers up to $30,000 per year for up to three years. Grants are awarded to Australian institutions for activities within

Australia (excluding indirect costs such as overheads). Applications are due in March each year.

Lirabenda Endowment Fund

The fund promotes the conservation of natural features, habitat and the preservation of fauna of Australia and, in particular, South Australia. Grants of up to $3000 are available for student research projects.

Nature Foundation SA

This foundation is concerned with South Australian parks and conservation reserves, wildlife or the natural environment. Applications for funds are assessed half yearly in March and July each year. The Nature Foundation generally provides grants of up to $10,000. Student research grants and community grants of $1-2,000 are also available. Nature Foundation has previously funded little penguin monitoring at Troubridge Island.

Norman Wettanhall Foundation

This foundation has funded projects ($5000 to $10,000) that aim to maintain or restore habitat and preserve species. Projects that involve collaboration with a number of partners across a region are of special interest. Applications are due in March each year

Penguin Fund

Small grants are provided to individuals and groups engaged in penguin research and protection all over the world.

SANTOS

Santos supports environmental projects in South Australia and across Australia, such as the Conservation Centre at the Adelaide Zoo.

The Australian Bird Environment Foundation

This foundation supports practical, on ground, conservation activities to counter the constant threat to Australian bird life from vegetation clearance, habitat degradation and competition from invading species. The foundation provides small grants (up to $3,500) to conservation projects Australia-wide in the areas of: practical conservation such as native plantings for revegetation and fencing of remnant vegetation; research and survey of the needs of Australian birds and their habitats

and public education such as provision of information brochures, signage and posters. Applications are due in May.

The David and Lucile Packard Foundation (USA)

The foundation supports marine bird projects (amongst many others), particularly those that focus on the removal of invasive species from islands in the Pacific that are particularly important for seabirds. The foundation donated US$2.8 million to 8 projects on marine birds in 2010.

The Sea World Research and Rescue Foundation

The Sea World Research and Rescue Foundation fund independent marine research projects that aim to help build our knowledge and appreciation of the variety of life in our oceans. The Foundation has been a major benefactor of marine research in Australia since incorporation in 1991 and has supported over 120 research projects. In February/March each year the Foundation calls for expressions of interest from both the private and public sectors. Applicants who are short-listed are invited to submit a detailed project plan by late July.

Tourism and Transport Forum (TTF)

TTF is the peak industry group for the Australian tourism, transport, aviation and investment sectors. A national, member-funded CEO forum, TTF advocates the public policy interests of prestigious corporations and institutions in these sectors. The Natural Tourism Partnerships Action Plan is a Federal Government-funded TTF initiative to promote investment in sustainable natural tourism, through effective public-private partnerships including mechanisms to fund parks and conservation through tourism.

Toyota Australia

The “Environment” is one of the five key focus areas of Toyota’s sponsorship and community programs. Toyota currently supports Conservation Volunteers and penguin tracking projects at Phillip Island. Applications can be submitted at any time.

13.4 Sponsorship, donations and cost-recovery

Sponsorship for funding research and management from businesses and corporations should be investigated for projects in GSV. These could include wildlife tourism operators and tourism commissions that rely on the conservation of local wildlife populations. Industries including mining and desalination companies may

also be approached to provide funding to ensure native wildlife is not impacted by extraction, refining and discharge activities. Penguin research at Phillip Island has been funded by BHP Billiton, Esso/Mobil and the Southcorp Wines/Fosters Group. Conservation projects such as habitat restoration at Phillip Island Nature Park have also been funded by numerous local government and business organisations such as VicRoads, Bass Coast Shire Council, Melbourne Water, Port Phillip and Westernport Catchment Management Authority. Volunteer labour has also been provided to Phillip Island research by International Student Volunteers, Toyota and National Australia Bank, university students undertaking work experience, school groups and local coast action groups.

The sale of penguin-related merchandise at local information centres, zoos and shops can also help fund conservation projects. Examples of where this has occurred include the 'back-yard buddies' program (FNPW) and the Phillip Island Penguin Parade shop, both of which sell soft-toy penguins to support penguin research. Wildlife "adoption" (e.g. at Phillip Island, Granite Island Penguin Centre and Zoos) and philanthropic donation programs can also help to fund penguin monitoring and management.

To cover the costs of managing penguin populations on an ongoing basis, funding may be sought from a portion of visitor entry fees to tourism attractions or National or Conservation parks (DENR 2011). If a survey of penguin tour visitors were conducted, the results may indicate an expectation that part of their fees were used for management and conservation of the penguins, to ensure sustainability of the population into the future. At Granite Island, Kingscote and Penneshaw, the entry fees charged for a penguin tour are $10-$17 for an adult, $8.50-15 for concession, $6-8.50 for children and $29-40 for a family. Given that 55,000 visitors join penguin tours per year (25,000 at Granite Island and 30,000 at Kangaroo Island (Kangaroo Island Times 2011)), $1 from each entry fee would cover more than half of the estimated costs of an ongoing monitoring program across the region, as well as essential research into the causes of population declines (scenario 1). Other potential options for ongoing funding sources to support little penguin conservation in GSV would include revenue from SeaLink Kangaroo Island (which charges $84 per adult for a return trip from Cape Jervis).

A levy is employed at Phillip Island Nature Park where the Penguin Parade tourism business allocates a percentage of profits to research and management of little

penguins. This funding mechanism supports six on-site research and technical staff and a research centre to monitor the status and health of the penguin population and manage threats to the colony. The allocation also supports other management costs that underpin the economic and ecological sustainability of the park including fox and cat control, habitat restoration, and management of other wildlife. Research and monitoring results are disseminated to the visitors as part of the penguin tours, which augments the experience for paying visitors (Phillip Island Nature Parks Annual Report 2010). Levies are also in place for the Great Barrier Reef Marine Park where most visitors that participate in a tour activity pay a tax of $2.25 for up to 3 hours or $4.50 per day. A proportion of this revenue is used to fund environmental research and management (Fishing and Fisheries Research Centre, James Cook University) and education projects (Reef Guardian Schools programs). Cost-recovery programs ensure that the maximum socioeconomic benefit is returned to the community and that the natural assets are managed in accord with the principals of ecologically sustainable development.

Unless recurrent funding can be sourced from government, revenue from tourism licences, visitor fees or environmental levies should be investigated to maintain ongoing monitoring and management programs for little penguins in GSV.

Government and non-government grants, sponsorships and donations should be sought to support period-defined research projects to investigate the causes of penguin declines. Importantly, a program leader is required to seek funding, design and coordinate scientific projects and monitoring programs, continually assess the effectiveness of management actions, report on achievements and disseminate results.

Previously sourced funding

At Kangaroo Island, some funding was allocated by DENR for microchip tags. The KI NRM Board has supported an annual community penguin survey since 2007, purchased tag reading equipment, and contributed to a penguin satellite-tracking project in 2009-10. The AMLR NRM Board has provided funds for rodent baits and monitoring equipment. State NRM grant funding has also committed to funding a penguin ecologist for 4 months in 2011. Granite Island Nature Park Penguin Centre provides facilities for a paid staff member for one day a week who is supported by DENR. Most other resources have come from funds directed through external

research programs provided by SA Wildlife Conservation Fund (DENR), the Nature Foundation of SA, the Foundation for National Parks and Wildlife (Backyard buddies program), Sea World Research and Rescue Foundation, SARDI and The University of Adelaide. These programs and the funding that supported them were not recurrent.

14. Conclusions and recommendations

An analysis of available data on the abundance of little penguins in the GSV region and State suggests that some little penguin colonies have declined and may meet criteria for listing the species as *Threatened* at a regional level. As such, priority should be given to improve monitoring of colonies across the region and State, to provide more information about the conservation status of particular colonies and the species in the region.

Where declines are suspected, priority should be given to supporting research and monitoring, including trends in abundance, assessing principal causes of mortality, breeding success, prey availability, habitat and health. Such programs would also provide key performance measures to assess if the colonies are appropriately managed.

Research and monitoring programs should include long- and short-term research. Long-term monitoring should focus on the assessment of population size, abundance, breeding success and age-specific trends, colony-specific and cohort-specific survival rates. Targeted research should focus on critical management needs that identify the cause of declines and monitor and mitigate threatening processes.

Three scenarios of monitoring and research programs and specific management actions at each colony are proposed. This action plan provides direction to better coordinate investment across the region. Levies from tourism and government funding would provide a significant level of ongoing revenue to fund the proposed research and management programs for little penguin conservation. Such an approach has been used effectively elsewhere in Australia (e.g. Seal Bay, Phillip Island, Great Barrier Reef, National Parks) to support the costs of managing publicly owned assets (e.g. tourism, mining, forestry, fisheries), to ensure maximum socio-economic benefits are returned to the community, and that the resources are managed in accord with the principals of ecologically sustainable development.

The research and monitoring recommendations of this report are:

- A population monitoring program should survey all colonies of little penguins in GSV every 1-5 years, to ensure that the status and health of each colony is adequately monitored and that suspected population

declines are arrested. Surveys should also be conducted at colonies across the state to assess the level of state-wide decline.

- The research plan outlined here should be implemented to identify threatening processes (predation at sea and land, disease, food depletion, habitat degradation and climate change) and their impacts on penguin breeding and age-specific survival. These processes can then be monitored and managed.
- The population monitoring and research program requires strong scientific leadership and management, and methods and results should be reported regularly and reviewed.
- Options for ongoing funding to fund critically important population management programs should be investigated.

While the relative contributions of various causes of penguin declines in GSV are poorly understood, adaptive management actions should be implemented as a precautionary measure, to mitigate a range of threats that may be impacting penguin populations elsewhere. Conservation management actions, such as those recommended in this report, have reversed penguin declines at Phillip and Middle Islands (VIC), Derwent Estuary (TAS) and Manly (NSW).

In the absence of further data, management actions should focus on habitat restoration, provision of nest boxes, feral predator control, visitor disturbance management and education to reduce anthropogenic threats.

The management recommendations of this report are:

- Establish a mortality register.
- Improve control of feral predators (rats, cats, foxes).
- Manage nesting habitat through bush regeneration, environmental planning and assessment processes.
- Include penguin threats in planning for management of marine pollution.
- Establish a management/recovery team and hold annual meetings to evaluate the success of management actions and to develop new priorities and actions as they become necessary.
- Liaise with penguin managers in other regions to improve management and knowledge.
- Coordinate and support research into the ecology of GSV populations

Performance indicators of management activities: stabilisation or recovery of the population of the colony

Community awareness is imperative and the recommendations of this report are to:

- Educate and provide advice on penguin conservation to the community through newsletters, pamphlets, educational forums, social networking and interactive web-based materials.
- Erect appropriate signage to protect penguins in each colony.
- Educate the community about responsible pet ownership, pollution, disturbance and impacts of urban development.
- Encourage community members to volunteer in penguin management actions and monitoring.

The recommendations from this report support the objectives of State and Australian Government threatened and protected species legislation, and aim to ensure that the penguin population across the region remains viable for ecosystem function and maintenance of regional biodiversity into the future. To achieve these management recommendations, collaborative management frameworks should be employed with the SA Marine Parks process, and the targets set consistent with the state strategic plan, DENR, the KI NRM Board and the AMLRNRM Board processes, and the broader community.

It is also recommended that all other penguin species (Spheniscidae) (including vagrants), which occur in the state be considered for listing under Schedule 9 (Rare) of the South Australian *NPW Act 1972*. These include royal *Eudyptes schlegeli*, rockhopper *Eudyptes chrysolophus,* macaroni *Eudyptes chrysolophus* and king penguins *Adeptenodytes patagonica*, snares *Eudyptes robustus,* Fiordland *Eudyptes parachyrhynchus* and erect-crested penguins *Eudyptes sclateri* (Simpson and Day 1989, Robinson et al 2000).

14. Acknowledgements

Thank you to the AMLR Natural Resource Management Board for funding the preparation of this report. Thank you to Brad Page, Simon Goldsworthy and Marty Deveney (SARDI), Tony Flaherty, Martine Kinloch and Danny Brock (NRM) for providing critical feedback on the draft report. Thank you to Erin Sautter and Jason Van Weenen (DENR) for collating and providing historical data on penguins at Reevesby Island. Also thanks to Natalie Gilbert, Graham Trethewy, John Ayliffe, Peter Canty, Dave Armstrong, Simone Somerfield, Rosemary and Grant (Penneshaw Penguin Colony), Toni Soutar, Seiji Iwao, Paul Unsworth, Danny Brock, Kym Lashmar, Marine Kinloch, Tony Flaherty, Max Waterman, David Drynan, Dorothy Longden, Wayne Goedseke, John Lawley, Renate Velzeboer, Scoresby Shepherd and Wendy Cliff for information that contributed to this report.

15. References

Alexander, W.B. (1928). *Birds of the Ocean - A Handbook for Voyagers.*

Ananthaswamy, A. (2004). Massive growth of ecotourism worries biologists. *New Scientist*, 2004.

Arnould, J. P. Y., Dann, P., and the late Cullen, J. M. (2004). Determining the sex of Little Penguins (*Eudyptula minor*) in northern Bass Strait using morphometric measurements. *Emu* 104, 261-265.

Australian Bird Environment Foundation http://boca.org.au/conservation/abef.

Australian Geographic. www.australiangeographic.com.au/society/index.htm.

Australian Government Department of Agriculture, Fisheries and Forestry (2007). National Strategy to Address Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism.

Australian Tourism Development Program. www.ret.gov.au/tourism/tra/Pages/default.aspx.

Australia and Pacific Science Foundation. www.apscience.org.au/guidelines.html.

Banks, J.C, Mitchell, A.D., Waas, J.R. (2002). An unexpected pattern of molecular divergence within the blue penguin (*Eudyptula minor*) complex. *Auk*, 49, 29-38.

Barbraud, C., Weimerskirch, H., Robertson, G., and Jouventin, P. (1999). Size related life history traits: insights from a study of snow petrels (*Pagodroma nivea*). *Journal of Animal Ecology* 68, 1179-1192.

Barlow, K.E. and Croxall, J.P. (2002). Seasonal and interannual variation in foraging range and habitat of macaroni penguins *Eudyptes chrysolophus* at South Georgia. *Marine Ecology Progress Series*. 232, 291-304.

Baylis, A.M.M. and Nichols, P.D. (2009). Milk fatty acids predict the foraging locations of a wide-ranging central place forager, the New Zealand fur seal: continental shelf vs. oceanic waters. *Marine Ecology Progress Series*. 271-286.

Birds Australia: Stuart Leslie Bird Research Award. www.birdsaustralia.com.au/our-people/stuart-leslie-bird-research-award.html.

Birtles, A, Valentine, P. and Curnock, M. (2001). Tourism based on free-ranging marine wildlife: opportunities and responsibilities. Wildlife Tourism Research Report Series: No. 11 Status Assessment of Wildlife Tourism in Australia Series.

Bool, N. M., Page, B., and Goldsworthy, S. (2007). What is causing the decline of little penguins (*Eudyptula minor*) on Granite Island, South Australia? SARDI Aquatic Sciences report to the South Australian Department of Environment and Heritage, Wildlife Conservation Fund and The Nature Foundation of South Australia.

Boren, L (2010). Diet of New Zealand fur seals (*Arctocephalus forsteri*): a summary Report for Department of Conserevation Research & Development Series 319, 20p.

Brandle, R., Gilbert, N. and Geschmay, P (1996). Report for the Greater Granite Island Development Co. Pty Ltd: Granite Island Little Penguin Eudyptula minor breeding monitoring study 1995/1996. Report to the Department for Environment.

Brock, D. J. and Kinloch, M. A. (2008). *Community Census of the Little Penguin Colony at Kingscote, Kangaroo Island - 2007.* KI NRM Board Coast and Marine Program Report No. CMP08/007.

Brothers, N., Pemberton, D., Pryor, H. et al. (2001). *Tasmania's offshore islands: seabirds and other natural features*. Tasmanian Museum and Art Gallery, Hobart.

Bunce, A. (2001). Prey consumption of Australiasian gannets (*Morrus serrator*) breeding in Port Phillip Bay, southeast Australia, and potential overlap with commercial fisheries. *ICES Journal of Marine Science*, 58, 904-915.

Bunce, A. and Norman, F.I. (2000). Changes in the diet of the Australasian gannet (*Morus serrator*) in response to the 1998 mortality of pilchards (*Sardinops sagax*). *Marine and Freshwater Research*, 51, 349-353.

Cannell B, and Cullen JM (1998). The foraging behaviour of littlepenguins *Eudyptula minor*at different light levels. *Ibis* 140, 467–471.

Cannell, B., Ropert-Coudert, Y, Kato, A. (2007). The diving behaviour of little penguins predisposes them to risk of injury by watercraft. In Woehler, E.J. (ed) Abstracts of oral and poster presentations, 6th International Penguin Conference, Hobart, Australia, 3-7 September 2007, 160p.

Caring for our Country. www.nrm.gov.au/about/caring/index.html.

Caton, B., Fotheringham, D., Lock, C., Royal, M., Sandercock, R. and Taylor, R. (2007). Southern Fleurieu Coastal Action Plan and Conservation Priority Study. Prepared for Adelaide and Mount Lofty NRM Board, Alexandrina Council, City of Victor Harbor, District Council of Yankalilla, Goolwa to Wellington Local Action Plan and Department for Environment and Heritage.

Carpenter, R. Gilbert, N. and Peters, P. (2004). Monitoring the Effect of Human Activities on the Breeding Success of Little Penguins on Granite Island. Report to Department for Environment and Heritage. 1-6.

Chambers, L. (2004a). The impact of climate on little penguin breeding sucess. *BMRC Research Report* No. 100, Bureau of Meteorology. Australia

Chambers, L.E. (2004b). Delayed breeding in Little Penguins - Evidence of Climate Change? *Australian Meterological. Magazine.* 53, 13-19.

Chambers L.E., Congdon B.C., Dunlop N., Dann P. and Devney C. (2009a). Seabirds. In *A Marine Climate Change Impacts and Adaptation Report Card for Australia 2009* (Eds. E.S. Poloczanska, A.J. Hobday and A.J. Richardson), NCCARF Publication 05/09, ISBN 978-1-921609-03-9.www.oceanclimatechange.org.au/content/images/uploads/Seabirds_FINALvs2.pdf

Chambers, L., E., Renwick, L. and Dann, P. (2009b). Climate, fire and the little penguin. In Steffen, W., Burbidge, A. A., Hughes, L., Kitching, R., Lindenmayer, D., Musgrave, W., Stafford Smith, M. and Werner, P. *Australia's biodiversity and climate change: a strategic assessment of the vulnerability of Australia's biodiversity to climate change*. A report to the Natural Resource Management Ministerial Council commissioned by the Commonwealth Department of Climate Change. CSIRO Publishing. *Strategic Assessment of the Vulnerability of Australia's Biodiversity to Climate Change.* CSIRO, Melbourne.

Chiaradia, A., Costalunga, A. and Knowles, K. (2003). The diet of Little Penguins (*Eudyptula minor*) at Phillip Island, Victoria, in the absence of a major prey-Pilchard (*Sardinops sagax*). *Emu*, 103, 43-48.

Chiaradia, A., Dann, P., Jessop, R. and Collins, P. (2002). The diet of Crested Tern (*Sterna bergii*) chicks on Phillip island, Victoria, Australia. *Emu* 102, 367-371.

Chiaradia, A. & Nisbet, I.C.T. (2006). Plasticity in parental provisioning and chick growth in Little Penguins *Eudyptula minor* in years of high and low breeding success. *Ardea,* 92, 257-270.

Chiaradia, A., Ropert-Coudert, Y., Kato, A., Mattern, T., and Yorke, J. (2007). Diving behaviour of Little Penguins from four colonies across their whole distribution range: bathymetry affecting diving effort and fledging success. *Marine Biology* 151, 1535-1542.

Chiappa-Carrara X. and Gallardo-Cabello M. (1993). Feeding behavior and dietary composition of the northern anchovy, *Engraulis mordax* Girard (Pisces: Engraulidae), off Baja California, Mexico. Cienc Mar 19, 285–305.

Clarke, J., Manly, B., Kerry, K, Gardner, H., Franchi, E., Corsolini, S. and Focardi, S. (1998). Sex differences in Adelie penguin foraging strategies. *Polar Biology,* 20, 248-258.

Coastal Gardens Planting Guide www.amlrnrm.sa.gov.au/Coast/Coastalcommunitysupportandawareness/Coastalgardensplantingguide.aspx

Colborn, T., vom Saal, F.S. and Soto, A.M, (1993). Developmental Effects of Endocrine-Disrupting Chemicals in Wildlife and Humans, Environmental Health Perspectives, 101, 378-384.

Connolly, R.M. (1994). The role of seagrass as preferred habitat for juvenile *Sillaginodes punctata* (Cuv. and Val.) (Sillaginidae, Pisces): habitat selection or feeding? *Journal of Experimental Marine Biology and Ecology*, 180, 39-47.

Collins, M., Cullen, J.M. and Dann, P. (1999). Seasonal and annual foraging movements of little penguins from Phillip Island, Victoria. *Wildlife Research*, 26, 705-721

Copley, P.B. (1996). The status of seabirds in South Australia: a review. In: Ross, G.J.B., Weaver, K. and Greig, J.C. (eds) *The status of Australia's seabirds. Proceedings of the National Seabird Workshorp*, Canberra 236 p

Crawford, R.J.M. and Robinson, G.A. (1990). Impacts of seals on seabirds. Unpublished report (BEP/SW91/A9). Report of the subcommittee of the Sea Fisheries Advisory Committee appointed at the request of the Minister of Environment Affairs and of Water Affairs, to advise

the Minister on the scientific aspects of sealing, Cape Town. Stellenbosch: Southern African Nature Foundation. 81–87.
Crawford, R.J. and Dyer, B.M. (1995). Responses by four seabird species to a fluctuating availability of Cape Anchovy *Engraulis capensis* off South Africa. *Ibis*, 137, 329-339.
Crawford, R.J.M., David, J.H.M., Shannon, L.J., Kemper, J., Klages, N.T.W., Roux, J.-P., Underhill, L.G., Ward, V.L., Williams, A.J., Wolfaardt, A.C., (2001). African penguins as predators and prey – coping (or not) with change. *South African Journal of Marine Science* 23, 435-447.
Cullen, M., Blake, N. and Bickham, M. (1996). Urban Penguins. *Nature Australist,* 96, 23-28.
Cullen,J. M., Chambers, L. E., Coutin, P. C. and Dann, P. (2009). Predicting onset and success of breeding of Little Penguins *Eudyptula minor* from ocean temperatures off south-eastern Australia. *Marine Ecology Progress Series,* 378, 269-278.
Cullen, J.M, Montague, T.L. and Hull, C. (1992). Food of Little Penguin *Eudyptula minor* in Victoria: Comparison of three localities between 1985 and 1988. *Emu*, 91, 318-341.
Cunningham, M., Gibbs, P., Rogers, T., Spielman, D. and Walraven, E. (1993*). Ecology and Health of the Little Penguin Eudyptula minor near Sydney*. A report prepared for Sydney Water Corporation.
Dann, P. (1992). Distribution, population trends and factors influencing the population size of little penguins *Eudyptula minor* on Phillip Island, Victoria. *Emu*, 91, 263-272.
Dann, P. (1994). The vulnerability of Australian seabirds to oil spills. *Proceedings of the RAOU Seabird Congress, Hobart, 1993*. Australasian Seabird Group, 27, 16.
Dann, P. and Cullen, J.M. (1989). The maximum swimming speed and theoretical foraging range of breeding Little Penguins *Eudyptula minor* on Phillip Island, Corella, 13, 34-37. Victoria. *Corella* 13, 34-37.
Dann, P. and Cullen, J.M. (1990). Survival patterns of reproduction and lifetime reproductive output of Little Penguins *Eudyptula minor* on Phillip Island, Victoria, Australia. Pp 63084 In Davis, L.S. and Darby, J. (eds.). *Penguin Biology*. Academic Press. San Diego.
Dann, P. Norman, I. and Reilly, P. (1995). The Penguins: Ecology and Management*.* Surrey Beatty & Sons, Chipping Norton, Sydney.
Dann, P., Cullen, M. and Weir, I. (1996). *National Review of the Conservation Status and Management of Australian Little Penguin Colonies.* Final Report. The Australian Nature Conservation Agency.
Dann, P., Norman, F.I., Cullen, J.M., Neira, F.J. and Chiaradia, A. (2000). Mortality and breeding failure of little penguins, *Eudyptula minor*, in Victoria, 1995-1996, following a widespread mortality of pilchard, *Sardinops sagax*. *Marine and Freshwater Research*, 51, 355-362.
Dann, P., Carron, M., Chambers, B., Chambers, L., Dornom, T., Mclaughlin, A., Sharp, B., Talmage, M. E., Thoday, R. and Unthank, S. (2005). Longevity in Little Penguins *Eudyptula minor. Marine Ornithology* 33, 71–72.
Dann, P. and Norman, F.I. (2006). Population regulation in Little Penguins (*Eudyptula minor*): the role of intraspecific competition for nesting sites and food during breeding. *Emu* 106, 289-296.
Dann, P., Renwick, L., McInnes, J., Chiaradia, A., Kirkwood, R., Buick, E., Hoffman, J. and Arnould,J. (2007). Foraging areas of little penguins during guard and post-guard stages of breeding: Evidence of intraspecific competition and "Halo" effect? In Woehler, E.J. (ed) Abstracts of oral and poster presentations, 6th International Penguin Conference, Hobart, 160p.
David, J.H.M., Cury, P, Crawford, R.J.M., Randall, R.M., Underhill, L.G., Meÿer, M.A. (2003). Assessing conservation priorities in the Benguela ecosystem, South Africa: analysing predation by seals on threatened seabirds. *Biological Conservation* 114, 289–292.
David and Lucile Packard Foundation. www.packard.org/categoryDetails.aspx?RootCatID=3&CategoryID=268.
Dawson, J. (2007). Status of the Endangered Population of Little Penguins *Eudyptula minor* at Manly: Review of five years of monitoring (2002-03 to 2006-07) and the implementation of the Recovery Plan since 2000. The Department of Environment and Climate Change Report, 21p.
Department of Environment and Planning (1983). Island Conservation Parks of Backstairs Passage and Encounter Bay Management Plans: The pages, West Island, Seal Island and Pullen Island. National Parks and Wildlife Sevrice. 29p.
Department of Environment and Planning (1987). Conservation Parks of Kangaroo Island Management Plan. National Parks and Wildlife Service.
Department of Environment, Heritage and Aboriginal Affairs (1999). Flinders Chase National Park, Kelly Hill Conservation Park, Ravine des Casours Wilderness Protection Area, and Cape Bouger Wilderness Protection Area Management Plans.
Department of Environment and Conservation (2007). Shoalwater Islands Marine Park Management Plan 2007–2017 Management Plan No 58.
Department of Environment, Parks, Heritage and the Arts (2009). Macquarie Island Pest Eradication Plan
Department of Environment and Heritage (2011). People and Parks: A Draft Visitor Strategy for South Australia's National Parks and Reserves.
du Toit, M., Bartlett, P.A., Bester, M.N. and Roux, J-P. (2004). Seabird predation by individual seals at Ichaboe Island, Namibia. *South African Journal of Wildlife Research,* 34, 45–54.

Descamps, S., Gauthier-Clerc, Le Boherc, C., Gendner, J.P. and Le Maho, Y. (2005). Impact of predation on king penguin *Aptenodytes patagonicus* in Crozet Archipelago. *Polar Biology*, 28, 303-310.

Dix, B. (1993). Population changes and diet preferences of the New Zealand fur seal *Arctocephalus forsteri* in eastern Cook Strait. Unpublished MSc thesis, Victoria University of Wellington, Wellington. 99p.

Dornhaus, A., Collins E. J., Dechaume-Moncharmont F.-X., Houston, A. I., Franks, N. R. and McNamara, J. M. (2006). Paying for information: partial loads in central place foragers. *Behavioral ecology and socio-biology,* 61,151-161.

Drent, R.H. (2006). The timing of birds' breeding seasons: the Perrins hypothesis revisited especially for migrants. *Ardea*, 94, 305-322.

Ecotourism Australia. www.ecotourism.org.au/.

Eberle, A. (2003). Honours thesis. Diet of little penguins and short-tailed shearwaters in southern Tasmania during the 2002/2003 breeding season. University of Tasmania.

Egotist (1876). Egging Expedition by an egotist. *The SA Register, November 29, 1876*, p 6.

Ellis, S. (1999). The Penguin Conservation Assessment and Management Plan: a description of the process. *Marine Ornithology* 27, 163–169.

Environment Canada (1999). 'Endocrine Disrupting Substances in the Environment', Fact sheet, Minister of Public Works and Government Services Canada 1999.

Falkenberg, I.D., Dennis, T.E. and Williams, B.D. (1994). Organochlorine pesticide contamination in three species of raptor and their prey in South Australia. *Wildlife Research,* 21, 163-173.

Fernandes, M., Shareef, A., Karkkainen, M. and Kookana, R. (2008). The occurrence of endocrine disrupting chemicals and triclosan in sediments of Barker Inlet, South Australia. A report prepared for the Adelaide and Mount Lofty Ranges Natural Resources Management Board. SARDI Publication No. F2008/001026-1. South Australian Research & Development Institute (Aquatic Sciences), Adelaide, 11p.

Fernandes, M., Shareef, A., Kookana, R., Gaylard, S., Hoare, S. and Kildea, T. (2010). Estrogens, triclosan and derivatives in sediments of Barker Inlet, South Australia. A report prepared for the Adelaide and Mount Lofty Ranges Natural Resources Management Board and the South Australian Environment Protection Authority. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 20p.

Flaherty, T. (2002). Widespread Penguin Deaths. Tony Flaherty, Marine and Coastal Community Network (SA). SA Regional Ripples Vol 8.

Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury, K.J., Hundloe, T., Smith, A.D.M. and Whitworth, B.W. (2002). National ESD reporting framework for Australian fisheries: The how to guide for wild capture fisheries, FRDC Project 2000/145, Canberra, Australia, 97p.

Foundation for National Parks and Wildlife. www.fnpw.org.au/Funding/FUND1NG.htm.

Kinsky, F.C. and Falla, R.A. (1976). A subspecific revision of the Australasian Blue Penguin (*Eudyptula minor*) in the New Zealand area. *National Museum of New Zealand Records,* 1, 105-126

Gales, R.P. (1985) Breeding season and double brooding of the little penguin *Eudyptula minor* in New Zealand. *Emu*, 85, 127-130.

Gales, R. and Pemberton, D. (1990). Seasonal and Local Variation in the diet of the Little Penguin, *Eudyptula minor*, in Tasmania. *Australian Wildlife Research,* 17, 231-59.

Gibbs, P. J. (1995). Heavy metal and organochlorine concentrations in tissues of the Little Penguin *Eudyptula minor*. In Dann, P., Norman, I., and Reilly, P. (eds), *The Penguins*, Surrey Beatty & Sons, Chipping Norton (NSW), 393–419.

Gilbert, N. (2010). Encounter bay penguin breeding monitoring program 2009-2010. Report to Department for Environment and Heritage.

Goldsworthy, S.D., Bulman, C., He, X, Larcombe, J. and Littnan, C. (2003). Trophic interactions between marine mammals and Australian fisheries: an ecosystem approach. In: N. Gales, M. Hindell, and R. Kirkwood (eds) *Marine Mammals and Humans: Fisheries, tourism and management*. CSIRO Publications, 62-99.

Goldsworthy, S.D., Gales, R.P., Giese, M. and Brothers, N. (2000). Effects of the Iron Baron oil spill on little penguins (*Eudyptula minor*). I. Estimates of mortality. *Wildlife Research*, 27, 559-571.

Goldsworthy, S. D., Peters, K.J., and Page, B (2007). Foraging ecology and diet analysis of Australian sea lions SARDI Aquatic Sciences Publication Number F2007/001024-1 SARDI Research Report Series No. 251, 158p

Goldsworthy, S.D., Page, B., Rogers, T. and Ward (2010). Establishing ecosystem-based management for the South Australian Sardine Fishery: developing ecological performance indicators and reference points to assess the need for ecological allocations South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000863-1. SARDI report Series 529, 173p.

Gomon, M., Bray, M. and Kuiter, R. (2008). Fishes of Australia's Southern Coast. Reed New Holland, Australia

Graveland, J. and Berends, A.E. (1997). Timing of the calcium intake and effect of calcium deficiency on behaviour and egg laying in captive great tits, *Parus major*. *Journal of Zoology* 70, 74-84.

Hamilton, W.D. (1971). Geometry for the selfish herd. *Journal of Theoretical Biology,* 31, 295–311.

Harrigan, K. (1991). Causes of mortality of Little Penguins *Eudyptula minor* in Victoria.*Emu*,91, 273-277.
Hermon Slade www.hermonslade.org.au/guidelines.html.
Hocken, A.G. (2000). Cause of death in blue penguins (*Eudyptula m. minor*) in North Otago, New Zealand. *New Zealand Journal of Zoology,* 27, 311-316.
Holborow, J. (1999). The diet of New Zealand fur seals (*Arctocephalus forsteri*) in Southern New Zealand. Unpublished MSc thesis, University of Otago, Dunedin. 88p
Hoskins, A.J., Dann, P., Ropert-Coudert, Y., Kato, A., Chiaradia, A., Costa, D.P., and Arnould, J.P.Y. (2008). Foraging behaviour and habitat selection of the little penguin *Eudyptula minor* during early chick rearing in Bass Strait, Australia. *Marine Ecology Progress Series*, 366, 293–303.
Houston, D.M. (1999). The use of nest boxes for blue penguins (*Eudyptula minor*). *Ecological Management* No 7, 7-11. Department of Conservation, Wellington
Hutton, I. (2004). Plastic perils for seabirds. *Nature Australia*, 28, 52-29.
IUCN. (2001). *IUCN Red List Categories and Criteria: Version 3.1.* IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 30p.
IUCN. (2003). *Guidelines for Application of IUCN Red List Criteria at Regional Levels: Version 3.0.* IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 26p.
Jackson, S. and Wilson, R.P. (2002). The potential costs of flipper-bands to penguins. *Functional Ecology* 16, 141–148.
James, F.C. (1983). Environmental component of morphological differentiation in birds. *Science,* 221, 185-186.
Johnson, G. and Wiebkin, A.S. (2008). Seabirds. In: Shepherd, S.A., Bryars, S., Kirkegard, I.R., Harbison, P. and Jennings, J.T. (eds) Natural History of Gulf St Vincent. Royal Society of South Australia, Adelaide, Ch 24.
Kangaroo Island Council (2005). Kingscote urban design framework.
Kangaroo Island Council (2005). Penneshaw urban design framework.
KINRM www.kinrm.sa.gov.au/Marine/SatelliteTrackingLittlePenguins.aspx,
KINRM www.kinrm.sa.gov.au/Marine/PenguinCensus.aspx)
Kinloch, M. A. (2005). Review of Kangaroo Island Marine, Coastal and Estuarine Biodiversity Monitoring and Research Programs. Kangaroo Island Natural Resources Board, Kingscote
Kirkman, S.P. (2009). Evaluating seal–seabird interactions in southern Africa: a critical review *African Journal of Marine Science*, 31, 1–18.
Klomp, N.I., Meathrel, C.E., Wienecke, B.C. and Wooller, R.D. (1991). Surface nesting by little penguins on Penguin Island, Western Australia. *Emu*, 91, 190-193.
Klomp, N. I., Woller, R. D. (1988). Diet of Little Penguin, Eudyptula minor, from Penguin Island, western Australia. *Australian Journal of Marine and freshwater Research* 39, 633-639.
Knight, C. and Rogers, T. (2004). Factors influencing the little penguin (*Eudyptula minor*) fledgling production. *Wildlife Research* 31, 339-344.
Knight, M.A. and Vainickis, A.A (2011). Interactions with Threatened, Endangered or Protected Species in South Australian Managed Fisheries – 2007/08, 2008/09, and 2009/10. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2009/000544-1. SARDI Research Report Series No.534. 44p
Laist, D.W. (1997). Impacts of Marine Debris: Entanglement of Marine Life in Marine Debris Including a Comprehensive List of Species with Entanglement and Ingestion Records In J.M. Coe, D. B. Rogers. (eds), *Marine Debris Sources, Impacts, and Solutions*. Springer, New York, 99-139.
Lalas, C., Ratz, H, McEwan, K. and McConkey, S.D. (2007). Predation by New Zealand sea lions (*Phocarctos hookeri*) as a threat to the viability of yellow-eyed penguins (*Megadyptes antipodes*) at Otago Peninsula, New Zealand. *Biological Conservation,* 135, 235-246.
Lavigne, D.M. (2003). Marine mammals and fisheries: the role of science in the culling debate. In: Gales, N., Hindell, M.A., Andrew, M, Kirkwood, R (eds). Fisheries, tourism and management issues, Collingwood, CSIRO Publishing, 31-47.
Lawley, J. (2004). Preliminary study of little penguins on Wardang Island 27th to 30th October, 2004. Unpublished report.
Leed Engineering www.leed.net.au/Project.mvc/Detail?projectName=ChristmasCove.
Lirabenda Endowment Fund. www.unisa.edu.au/resdegrees/scholarships/lirabenda.asp.
Litzow, M.A., Piatt, J.F., Abookire, A.A., Prichard, A.K. and Robards, M.D. (2000). Monitoring temporal and spatial variability in sandeel (*Ammodytes hexapterus*) abundance with pigeon guillemot (C*epphus columba*) diets. *ICES Journal of Marine Science*, 57, 976-986.
Lloyd, B.D. (2003). Potential effects of mussel farming on New Zealand's marine mammals and seabirds: a discussion paper. Department of Conservation, Wellington. 34 p
Lord Howe Island Board (2009). *Draft Lord Howe Island Rodent Eradication Plan*, Lord Howe Island Board, Lord Howe Island 110p.
Lyver, P.O.B. (2000). Identifying mammalian predators from bite marks: a tool for focusing on wildlife protection. *Mammal Review*, 30, 31-44.
Marchant, S. and Higgins. P.J. (1990). (Eds). *Handbook of Australian, New Zealand and Antarctic birds*. Vol. 1A. Melbourne: Royal Australasian Ornithologists Union & Oxford University Press.

Marine and Marine Industries Council (2002). *A Seal / Fishery Interaction Management Strategy*
Marsh, A. (2010). Research News, SRAC Newsletter No. 13. October 2010.
Martin, J.L., Thibault, J.C. and Bretagnolle, V. (2000). Black rats, island characteristics, and colonial nesting birds in the Mediterranean: consequences of an ancient introduction. *Conservation Biology*, 14, 1452-1466.
Mason, R.W. (1985). Phillip Island, Victoria. Phillip Island Penguin Reserve Committee of Management iv, 118p.
McClung, Seddon , Massaro, Setiawan, (2004). Nature-based tourism impacts on yellow-eyed penguins: does unregulated visitor access affect fledging weight and juvenile survival? *Biological Conservation*, 119, 279-285.
McIntosh, R.R., Page, B. and Goldsworthy, S.D. (2006). Dietary analysis of regurgitates and stomach samples from free-living Australian sea lions. *Wildlife Research*. 33, 661-669.
McLeay, L. J., Page, B., Goldsworthy, S.D., Ward, T.M., Paton, D.C., Waterman, M. and Murray, M.D. (2009). Demographic and morphological responses to prey depletion in a crested tern *Sterna bergii* population: Can fish mortality events highlight performance indicators for fisheries management*? ICES Journal of Marine Science,* 66, 237-247.
Miyazaki, M. and Waas, J.R. (2003). Correlations between body size, defensive behaviour and reproductive success in male Little Blue Penguins *Eudyptula minor*: implications for female choice. *Ibis* 145, 98-105.
Montague, T.L. (1982). The food and feeding ecology of little penguin *Eudyptula minor* at Phillip Island, Victoria, Australia, M.Sc. Thesis, Monash University, Melbourne.
Montague, T.L. and Cullen, J.M. (1988). The diet of the Little Penguin *Eudyptula minor* at Phillip Island, Victoria. *Emu*, 88, 138-148.
Monteiro, L.R. and Furness, R. W. (1997). Accelerated increase in mercury contamination in North Atlantic mesopelagic food chains indicated by time series of seabird feathers, *Environmental Toxicology*, 16, 2489-2493.
Morcom, R. (2005). Decline in nightly counts of penguins on Granite Island 2000-2005. Report for Flinders University.
National Parks and Wildlife Service (2000). Endangered Population of Little Penguins *Eudyptula minor* at Manly, Recovery Plan. NSW National Parks and Wildlife Service, Hurstville.
National Marine Oil Spill Contingency Plan (2011). Australia's "National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances".
National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances (2007) www.amsa.gov.au/Marine_Environment_Protection/National_plan/
Nature Foundation SA www.naturefoundation.org.au.
Navarro RA. (2000). Cape fur seal predation on Cape gannet fledglings. *Bird Numbers,* 9, 15–19.
Niera, F.J., Sporcic, M.I., Longmore, A.R. (1999). Biology and fishery of pilchard *Sardinops sagax* (Clupeidae), within a large south-eastern Australasian Bay. *Marine and Freshwater Research* 50, 43-55.
Norman FI, DU Guesclin PB, Dann P (1992). The 1986 "Wreck" of little penguins *Eudyptula minor* in western Victoria. *Emu,* 91, 369–376.
Norman Wettanhall Foundation. www.nwf.org.au/
NSW NPWS (1995). Montague Island Nature Reserve Plan of Management (and amendments 2003).
Obendorf, D.L. and McColl, K. (1980). Mortality in little penguins (*Eudyptula minor*) along the coast of Victoria, Australia. *Journal of Wildlife Disease*, 16, 251–259.
Olsson, O. and North, A.W. (1997). Diet of the King Penguin *Aptenodytes patagonicus* during three summers at South Georgia. *Ibis,* 139, 504-512.
Overeem, R., Wallis, R., & Salzman, S. (2006). Sexing little penguins *Eudyptula minor* using bill measurements. *Victorian Naturalist,* 123, 390-395.
Overeem, R.L., Peucker (nee Mitchelson), A.J., Austin, C.M., Dann, P. and Burridge, C.P. (2007). Contrasting genetic structuring between colonies of the World's smallest penguin, *Eudyptula minor* (Aves: Spheniscidae). *Conservation Genetics* DOI 10.1007/s10592-007-9414-z.
Page, B., McKenzie, J. and Goldsworthy, S.D. (2005). Dietary resource partitioning among sympatric New Zealand and Australian fur seals. *Marine Ecology Progress Series,* 293, 283-302.
Parker, S.A., and Cox, J.B. (1978). Notes on the birds of Pearson, Dorothee and Greenly Islands, South Australia. *Transactions of the Royal Society of South Australia* 102, 191-202.
Parker, S.A., Eckert, H.J., Ragless, G.B., Cox, J.B. and Reid, N.C.H. (1979). An Annotated Checklist of the Birds of South Australia. 1. Emus to Spoonbills. Adelaide, South Australia: South Australian Ornithological Association. South Australia. *Corella*, 1, 65-67.
Paton, J.B. and Paton, D.C. (1977a). Seabird Islands No. 51: West Island, of the little penguin (*Eudyptula minor*): evidence of long-distance dispersal. *The Auk*, 126, 397-408.
Paton, J.B. and Paton, D.C. (1977b). Seabird Islands No. 52: Wright Island, South Australia. *Corella,* 1, 68-69.
Penguin Centre (2010). http://penguincentre.com.au/blog/?page_id=118.
Penguin Fund. www12.ocn.ne.jp/~penguinf/e-object.html.
Peucker, A.J., Dann, P., Burbridge, C. (2009). Range-wide phyologeography of the little penguin (*Eudyptula minor*): evidence of long-distance dispersal. *The Auk*, 126, 397-408.

Phillip Island Nature Park annual report (2010).
Phillips, R (2010). "Ingestion of fishing gear and entanglements of seabirds: Monitoring and implications for management". *Biological conservation* , 143, 501.
Preston, T. (2008). Water rats as predators of Little Penguins. *The Victorian Naturalist*, 125, 165-168.
Price, T.D. and Grant, P.R. (1984). Life history traits and natural selection for small body size in a population of Darwin's finches. *Evolution,* 38, 483-494.
Priddel, D., Carlile, N. and Wheeler, R. (2008). Population size, breeding success and provenance of a mainland colony of little penguins (*Eudyptula minor*). *Emu,* 108, 35-41.
Pryor, H. and Wells, F. (2009). Co-existing with Little Penguins in the Derwent Estuary: Information and Management Guidelines. Derwent Estuary Program (DEP) 31p.
Reilly P. N. (1994). Penguins of the world. Oxford, Oxford University Press Australia.
Reilly, P.N. and Cullen, J.M. (1979). The Little Penguin *Eudyptula minor* in Victoria. I: Mortality of adults. *Emu,* 79, 97–102.
Reilly, P. N., and Cullen, J. M. (1981). The Little Penguin *Eudyptula minor* in Victoria, II: Breeding. *Emu,* 81, 1-19.
Rippey, E., Rippey, J.J. and Dunlop, J.N. (2002a). Increasing Numbers of Pied Cormorants Breeding on the Islands off Perth, Western Australia and Consequences for Vegetation. *Corella* 26, 61-64.
Rippey, E., Rippey, J.J. and Dunlop, N., (2002b). Management of indigenous and alien Malvaceae on islands near Perth, Western Australia, International Conference on Eradication of Island Invasives, Auckland, New Zealand, IUCN Publications Services Unit, 254-259.
Robertson, J.S. (1955). Stray Feathers: An unusual visitor to Moreton Bay. *Emu,* 55, 72.
Robertson, C. J. R. and Bell, B. D. (1984). Seabird Status and Conservation in the New Zealand Region. In Croxall, J. P., Evans, P. G. H. Evans and Schreiber, R. W. (eds.) *Status and Conservation of the World's Seabirds*. ICBP Technical Publication No. 2, 573-586.
Robinson, A.C., Canty, P., Mooney, T. and Ruddock, P. (1996). *South Australia's Offshore Islands.* Australian Heritage Commission. Australian Government Publishing Service.
Robinson, A.C., Casperson, K.D. and Hutchinson M.N. (2000). *A list of the Vertebrates of South Australia,* Biological Survey and Research, Biological Survey and Research, Heritage and Biodiversity Division, Department for Environment and Heritage.
Robinson, S., Chiaradia, A. and Hindell, M. (2005). The effect of body condition on the timing and success of breeding in Little Penguins *Eudyptula minor. Ibis,* 147, 483-489.
Robinson, S., Terauds, A., Gales, R. and Greenwood, M. (2008). Mitigating fur seal interactions: relocation from Tasmanian aquaculture farms. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 18, 1180–1188.
Ropert-Coudert, Y., Kato, A., Naito, Y. and Cannell, B. (2003). Individual diving strategies in the Little Penguin. *Waterbirds,* 26, 403-408.
Ropert-Coudert, Y., Kato, A., Wilson, R. P. and Cannell, B. (2006). Foraging strategies and prey encounter rate of free-ranging Little Penguins. *Marine Biolog,y* 149, 139-148.
Ropert-Coudert, Y., Kato, A., and Chiaradia, A. (2009). Impact of small-scale environmental perturbations on local marine food resources: a case study of a predator, the little penguin. *Proceedings of the Royal Society B.* doi:10.1098/rspb.2009.1399.
Ross, G.J.B., Burbidge, A.A., Brothers, N., Canty, P., Dann, P., Fuller, P. J., Kerry, K. R., Norman, F. I., Menkhorst, P. W., Pemberton, D., Shaughnessy, G., Shaughnessy, P. D., Smith, G. C., Stokes, T. and Tranter, J. (1995). The Status of Australia's Seabirds. In Zann, L. P. and Kailola, P. (eds.). *The State of the Marine Environment Report for Australia*. Technical Annex 1. The Marine Environment. Great Barrier Reef Marine Park Authority, Townsville and Department of the Environment, Sport and Territories, Canberra. 167-82.
Rogers, T.L., Knight, C. (2006). Burrow and mate fidelity in the little penguin (*Eudyptula minor*) at Lion Island, New South Wales. *Ibis*, 148, 801-806.
Rose, K. (2005). Common Diseases of Urban Wildlife, Birds Part 1, Report for The Australian Registry of Wildlife Health, 1-29.
SANTOS. www.santos.com/sustainability-at-santos/environment.aspx.
South Australian Seabird Rescue (2006). http://www.projectdolphinsafe.com/SASR/sasr_news_050825.php
Seaworld Research and Rescue Foundation. http://seaworld.myfun.com.au/en/Research-and-Rescue/SWRRFI-Funding.aspx
Shaughnessy PD. (1978). Cape fur seals preying on seabirds. *Cormorant* 5, 31.
Shaughnessy, P.D. (1984). Historical population levels of seals and seabirds on islands off southern Africa, with special reference to seal island, False Bay. Investigational Report 127, Sea Fisheries Research Institute, Cape Town, 1-61.
Shaughnessy , P.D. and Dennis, T. (2001). Research on New Zealand fur seals and Australian sea lions in South Australia, 2000-2001. Report to National Parks and Wildlife South Australia. Canberra, CSIRO.
Shaugnessy, P.D. and McKeown, A. (2002). Trends in abundance of New Zealand fur seals, *Artocephalus forsteri*, at the Neptune Islands, South Australia. *Wildlife Research,* 29, 363-370.

Shaughnessy, P.D. (2011). Abundance of New Zealand fur seal pups on Kangaroo Island in 2010-2011. Report to the Department of Environment and Natural Resources, South Australia, 34p.
Simeone, A., Bernal, M., and Meza, J. (1999), 'Incidental mortality of Humboldt penguins *Spheniscus humboldti* in gill nets, Central Chile', *Marine Ornithology,* 27, 157-161.
Simpson, K. and Day, N. (1989). Field guide to the birds of Australia: A book of identification. Penguin Books Australia, Victoria, Australia, 352p.
Smith, L. E. and Battam, H., (1998). Five Islands Nature Reserve, Port Kembla New South Wales, A Perspective And View To Future Management, Southern Oceans Seabird Study Association Inc
South Australian Seabird Rescue (2006). SASR receiving high number of calls, http://www.projectdolphinsafe.com/SASR/sasr_news_050825.php
SRAC (2010). Research News, SRAC Newsletter No. 13. October 2010, Phillip Island Nature Parks.
Stahel, C. and Gales, R. (1987). Little Penguin. Fairy Penguins in Australia. New South Wales University Press, Kensington.
Stahel, C.D. and Nicol, S.C. (1982). Temperature regulation in the Little Penguin, *Eudyptula minor*, in air and water. *Journal of Comparative Physiology B*, 148, 93-100.
Stapp, P. (2002). Stable isotopes reveal evidence of predation by ship rats on seabirds on the Shaint Islands, Scotland, *The journal of Applied Ecology*, 39, 831-840.
State Plan www.stateplan.sa.gov.au
Stevenson, C. and Woehler, E.J. (2007). Population decreases in Little Penguins *Eudyptula minor* in southeastern Tasmania, Australia, over the past 45 years. *Marine Ornithology,* 35, 71–76.
Stahan, R. (1995). The mammals of Australia. Australian Museum, Reed Books, NSW.
Tanner, J.E. (2005). Three decades of habitat change in Gulf St Vincent, South Australia. *Transactions of the Royal Society of South Australia*.129, 65-73.
Threat Abatement Plan To Reduce The Impacts Of Exotic Rodents www.environment.gov.au/biodiversity/threatened/publications/tap/exotic-rodents.html
Threat Abatement Plan For Predation By The European Red Fox www.environment.gov.au/biodiversity/threatened/publications/tap/foxes08.html
Threat Abatement Plan For Predation By Feral Cats www.environment.gov.au/biodiversity/threatened/publications/tap/cats08.html
Threatened Species Scientific Committee (2003). Commonwealth, Injury and Fatality Caused by the Ingestion and Entanglement of Marine Life in Marine Debris, Listing Advice for Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
TOMM visitor exit survey 2009-2010 (2010). Kangaroo Island Tourism Optimisation Management Model. www.kangarooisland.sa.gov.au/site/
TOMM annual report 2009-2010 (2010). Kangaroo Island Tourism Optimisation Management Model. ht ww.tomm.info/Monitoring_programs/annual_reports.aspx).
Tourism and Transport Forum. www.ttf.org.au/
Toyota Australia. www.toyota.com.au/about/sponsorship
Troubridge Island Management Plan (2008). Department of Environment and Natural Resources
van Polanen Petel, M., Kirkwood, R., Gigliotti, F. and Marks, C. (2004). Adaptation and assessment of M-44 ejectors in a fox-control program on Phillip Island, Victoria. *Wildlife Research* 31, 143-147.
van Rensburg, M.J. (2010). Parasitism, disease and breeding ecology of little penguins (*Eudyptula minor*) on Matangi Island, New Zealand. M.Sc. Thesis, Massey University, Auckland. 240p.
van Tets, G.F. and Marlow, B.J. (1977). Seabird Islands No. 53: Dangerous Reef, South Australia. *Corella,* 1, 70-71.
Velzeboer, R. and Shepherd, S. (2004). Little penguins, *Eudyptula minor,* on Althorpe Island – how many are there? Report from Expedition to Althorpe Island (Royal Society of South Australia). 3p.
Ward V.L. (1998). African Penguins Kill A Kelp Gull, *Marine Ornithology* 26, 86.
Ward, T.M., Hoedt, F., McLeay, L., Dimmlich, W. F., Jackson, G., Rogers, P. J., and Jones, K. (2001a). Have recent mass mortalities of the sardine *Sardinops sagax* facilitated an expansion in the distribution and abundance of the anchovy *Engraulis australis* in South Australia? *Marine Ecology Progress Series* 220, 241–251.
Ward, T., Hoedt, F., McLeay, L., Dimmlich, W.F., Kinloch, M., Jackson, G., McGarvey, R., Rogers, P.J. and Jones, K. (2001b). Effects of the 1995 and 1998 mass mortality events on the spawning biomass of sardine, *Sardinops sagax,* in South Australian waters. *ICES Journal of Marine Sciences* 58, 865-875.
Ward, T.M., Ferguson, G. and Rogers, P.J. (2008). Australian Sardine (*Sardinops sagax*) Fishery, SARDI Research Report Series, F2007/00765-2, SARDI Aquatic Sciences, SARDI Aquatic Sciences, Adelaide, 74p.
Ward, T.M, Burch, P. and Ivey, A.R. (2010). South Australian Sardine (Sardinops sagax) Fishery: Stock Assessment Report 2010. Report to PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication No. F2007/000765-3. SARDI Research Report Series No 496, 105p.
Watanuki, Y., Kato, A., Mori, M. and Naito, Y. (1993). Diving Performance of Adelie Penguins in Relation to Food Availability in Fast Sea-Ice Areas: Comparison between Years. *The Journal of Animal Ecology*, 62, 634-646.

Watanuki, Y., Takahashi, A., Sato, K., Kato, A. and Bost, C.A. (2004). Inter-colony and sex differences in the effects of parental body condition and foraging effort on the brood growth of Adelie penguins. *Journal of Ethology* 22, 91-98.

Weavers, B.W. (1992). Seasonal foraging ranges and travels at seas of little penguins *Eudyptula minor*, determined by radiotracking. *Emu*, 91, 302-317.

Weerheim, M.S., Klomp, N.I., Brunsting, A.M.H. and Komdeur, J. (2003). Population size, breeding habitat and nest site distribution of little penguins (*Eudyptula minor*) on Montague Island, New South Wales. *Wildlife Research*, 30, 151-157.

White, S.A. (1918). *The Cruise of the `Avocet' in Search of Skuas and Other Things*. W.K. Thomas & Co.: Adelaide.

Wiebkin, A.S. (2010a). Little Penguins at Troubridge Island: *establishing a monitoring program for the future.* South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication Number F2010/000190-1, SARDI Research Report Series No. 443.

Wiebkin, A.S. (2010b). Satellite tracking Little Penguins (*Eudyptula minor*) from Kangaroo Island, South Australia. Report to the Foundation for National Parks and Wildlife.

Wiebkin, A.S. (2011) The feeding and foraging ecology of little penguins, *Eudyptula minor*, in the eastern Great Australian Bight. PhD Thesis. University of Adelaide (in submission)

Wienecke, B. C. (1993). *The Size and Breeding Patterns of Little Penguins Eudyptula minor in Australia: a Comparative Study.* PhD. Thesis. Murdoch University, Perth.

Wienecke, B.C., Wooller, R.D. and Klomp, N.I. (1995). The ecology and management of Little Penguins on Penguin Island, Western Australia. In: Dann, P, Norman, F.I., Reilly, P. (eds) *The Penguins: ecology and management*. Surrey Beatty, Melbourne

Wienecke, B.C., Bradley, J.S. and Wooller, R.D. (2000). Annual and seasonal variation in the growth rates of young Little Penguins *Eudyptula minor* in Western Australia. *Emu,* 100, 139-147.

Wildlife Conservation Fund. www.environment.sa.gov.au/science/partnerships/wildlife-cf.html.

Wilson, R.P., Alvrrez, B., Latore, L., Adelung, D., Culik, B. and Bannasch R. (1998). The movements of gentoo penguins Pygoscelis papua from Ardley Island, Antarctica. *Polar Biology*, 19, 407-413.

Ying, G-G., Kookana, R. and Waite, T.D. (2004). Endocrine Disrupting Chemicals (EDCs) and Pharmaceuticals and Personal Care Products (PPCPs) in Reclaimed Water in Australia, CSIRO Australian Water Conservation and Reuse Research Program, Australia.

Adelaide and Mount Lofty Ranges
Natural Resources Management Board
205 Greenhill Road
Eastwood SA 5063
Phone 08 8273 9100
www.amlrnrm.sa.gov.au

Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board