

# Status of small colonies of the Australian sea lion *Neophoca cinerea* on Kangaroo Island, South Australia

Peter D. Shaughnessy<sup>1</sup>, Terry E. Dennis<sup>2</sup>, Dave Dowie<sup>3</sup>,  
Jane McKenzie<sup>4</sup> and Rebecca R. McIntosh<sup>4</sup>

<sup>1</sup> South Australian Museum, North Terrace, Adelaide, S.A. 5000, Australia and CSIRO Sustainable Ecosystems, GPO Box 284, Canberra, A.C.T. 2601, Australia.

Email: shaughnessy.peter@saugov.sa.gov.au

<sup>2</sup> 5 Bell Court, Encounter Bay, S.A. 5211, Australia.

<sup>3</sup> Department for Environment and Heritage, PO Box 39, Kingscote, S.A. 5223, Australia.

<sup>4</sup> La Trobe University, Bundoora, Vic. 3083, Australia.

## ABSTRACT

The status of the Australian sea lion *Neophoca cinerea* at eight sites on Kangaroo Island was assessed using criteria adopted by the National Seal Strategy Group based on numbers of pups counted between 1985 and 2005. Each site was allocated to one of three categories. At the Seal Slide, 1 to 11 pups were born over nine pupping seasons and it is classed as a breeding colony. At four sites (Black Point, Cave Point, Cape Bouguer and North Casuarina Island), small numbers of pups were recorded over two or more seasons, and each is classed as a haul-out site with occasional pupping. At three sites near Cape Bouguer, pups were recorded but each instance was several months after a pupping season began at the large breeding colony at Seal Bay, and pups born there are known to move to other sites. Therefore each of these three is classed as a haul-out site. Because *N. cinerea* is susceptible to mortality from fishery interactions, is strongly philopatric and that small colonies are especially susceptible to extinction, the status of its small aggregations on Kangaroo Island should be taken into consideration when coastal developments are planned and coastal visitation encouraged.

**Key words:** Australian sea lion, *Neophoca cinerea*, Kangaroo Island, breeding colonies, haul-out sites, coastal management

## Introduction

The Australian sea lion *Neophoca cinerea* is an endemic species that was listed in February 2005 as *Threatened* in the *Vulnerable* category under the Australian *Environment Protection and Biodiversity Act 1999*. The number of pups recorded within a breeding cycle across its range was estimated as 2,495 by McKenzie *et al.* (2005), with 80% of the population in South Australia (SA) and 20% in Western Australia (WA). There was considerable variation in the size of colonies (average 34 pups). Nearly 60% of the pups were produced in the five largest colonies, all in SA, which ranged in size from 131 to 607 pups per season (summarised by McKenzie *et al.* 2005). One of those is at Seal Bay on Kangaroo Island, SA where the breeding colony extends for 3 km on the south coast. In the 2002-03 breeding season, 230 sea lion pups were produced there (McIntosh *et al.* 2006).

The latest compilation of *N. cinerea* colonies listed 73 sites where pups have been produced: 52 breeding colonies and 21 haul-out sites with occasional pupping (McKenzie *et al.* 2005). That list included six sites on the south coast of Kangaroo Island with small numbers of pups based on unpublished reports (e.g. Shaughnessy 1997; Dennis 2005), namely the Seal Slide, Black Point, Cave Point, Cape Bouguer and a site to its north-east, and North

Casuarina Island. The status of *N. cinerea* at these six sites and another two sites on Kangaroo Island (Fig. 1) is documented in this paper, based on counts of pups from December 1985 to March 2005.

Assessing the status of sites used by *N. cinerea* is difficult because of its supra-annual breeding cycle and because the timing of pupping seasons in colonies is not synchronous (Gales *et al.* 1994). Other difficulties result from the species' elongated pupping seasons of 5-8 months at Seal Bay (Ling and Walker 1976; Higgins 1990), the likelihood that older pups move away from breeding colonies before the end of a pupping season (see below) and the difficulty of accessing many remote sites.

Coastal development, urbanisation and visits to beaches have increased in Australia in recent decades, accompanied by the "thoughtless but deliberate destruction of the essence with which they [people] identify so highly" (Hamilton and Cocks 1996, p. 183). Kangaroo Island has been part of this trend (Manidis Roberts Consultants 1997; Dennis and Masters 2006). Knowledge of the distribution and status of wildlife resources on the coast is important to avoid conflicts when developments are planned and coastal visits encouraged; this study contributes to that knowledge base.

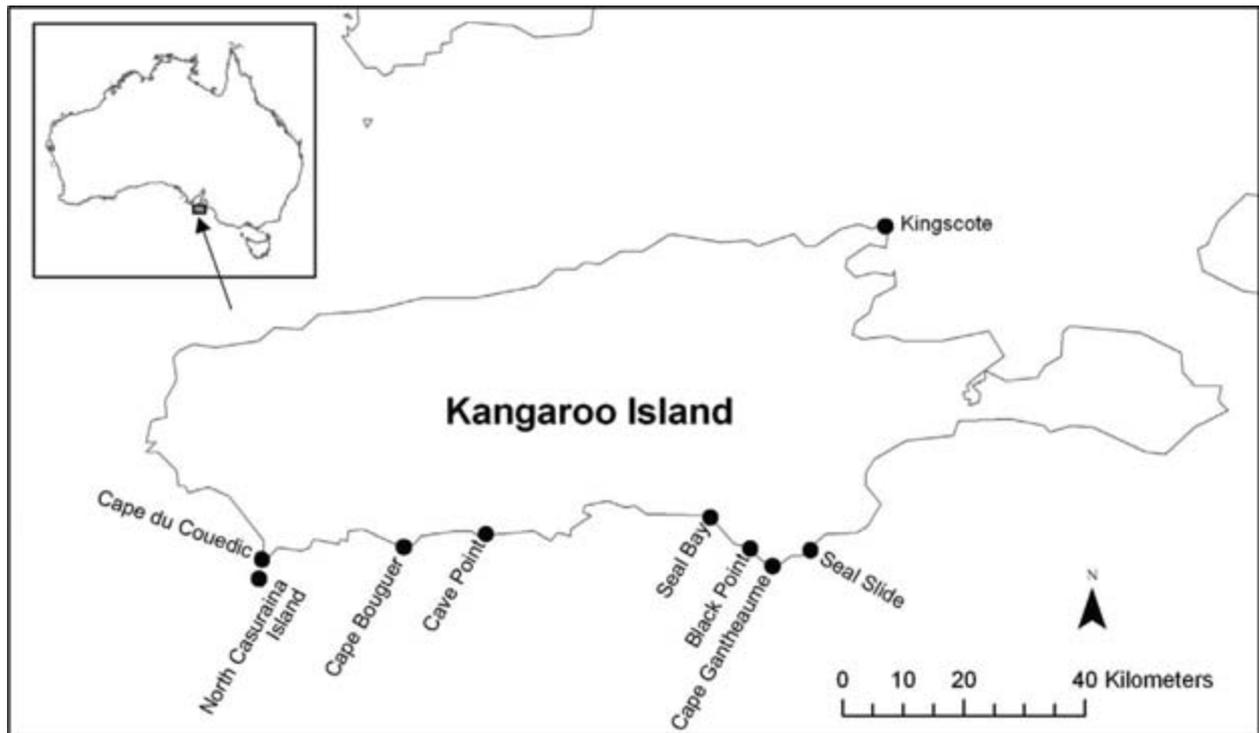


Figure 1. Kangaroo Island showing sites with aggregations of *Neophoca cinerea* and the main town, Kingscote.

## Methods

### Counts and the colonies

At the Seal Slide in 2003 and 2004, sea lion pups were counted each month by Kangaroo Island staff of National Parks and Wildlife SA (NPWSA, now Department for Environment and Heritage, DEH). Before 2003, counts were made intermittently from 1985 by NPWSA staff. Counts at Cave Point, Black Point, Cape Bouguer and the nearby sites to its north-east, and at North Casuarina Island have been made irregularly by NPWSA staff and by the authors, usually in association with estimates of abundance of New Zealand fur seals *Arctocephalus forsteri* in late January or early February. These data have been collated by Dennis (2005) and incorporated into a database after careful scrutiny.

At each site, two or three people walked through aggregations of sea lions, searching for and counting live and dead pups, and other sea lions. They also looked for signs of breeding activity, such as adult males (bulls) that showed aggression towards each other or herded adult females.

In the brief description of sea lion sites that follows, shortest distances around the coast from a named feature are used.

The Seal Slide (36.03S, 137.54E) is on the eastern side of Cape Gantheaume peninsula within Cape Gantheaume Wilderness Protection Area, 9 km north-east of the Cape. Limestone cliffs of 50 m elevation comprise the coastline. Smooth outcrops of schist at the base of the cliffs are favoured as haul-out sites by sea lions and fur seals. At the Seal Slide there is a break in the cliffs with a sandy slope that extends from the beach to the cliff top. Sea lions were counted in two areas: along the coast on the sandy beach and rocky shoreline, and in the mallee vegetation (dense, multi-stemmed, stunted *Eucalyptus* trees) near the top of the slope.

Black Point (36.04S, 137.41E) is a remote headland 6.3 km north-west of Cape Gantheaume, within Cape Gantheaume Wilderness Protection Area. It is composed of dark schist that contrasts with the pale limestone of nearby cliffs. Sea lions congregate on tussocky grass and in tidal pools immediately east of Black Point.

Cave Point (36.03S, 136.95E) is a granite headland 6.2 km west of the mouth of the Stunsailboom River in Cape Bouguer Wilderness Protection Area. There is a deep overhang up to 10 m high in a small cove 100 m north-east of the point. *A. forsteri* breed on the point (Shaughnessy 1997) and sea lions have been reported from the overhang and east of the point for a distance of 2 km.

Cape Bouguer (36.04S, 136.91E) is a granite headland that slopes down to sea level from limestone cliffs of 30 m elevation in Cape Bouguer Wilderness Protection Area. It is a favoured haul-out site for sea lions and fur seals.

North-east of Cape Bouguer are several sites where limestone cliffs have fallen away and provide habitat suitable for sea lions. One of these is 3.2 km and another is 2 km from Cape Bouguer (at 36.03S, 136.95E and 36.04S, 136.94E, respectively). In addition, there are several outcrops of smooth granite that are used by sea lions and fur seals. One of these is near the western headland of Horseshoe Bay (36.043S, 136.918E), 1.4 km from Cape Bouguer.

North Casuarina Island (36.07S, 136.70E) in Flinders Chase National Park is 300 m south of Cape du Couedic on Kangaroo Island. There is a substantial breeding colony of *A. forsteri* on the island (Shaughnessy *et al.* 1994). Sea lions are usually observed on the plateau, close to limestone outcrops and bushes, and well separated from the fur seals. Some counts of pups at North Casuarina Island were made by telescope from Cape du Couedic.

## Sightings of marked pups at sea lion sites on Kangaroo Island

*N. cinerea* pups have been marked at Seal Bay by tagging or by shaving hair on the rump as part of several studies: e.g., about 40-70% of the pups were marked in each of three seasons in the late 1970s by Ling and Walker (1976; 1977; 1979), 15-30% in each of three seasons in the late 1980s by Higgins (1990) and about 30% in 2002-03 by McIntosh *et al.* (2006). Marked sea lion pups at the Seal Slide that had been tagged at Seal Bay were first reported by Ling and Walker (1976, p. 63). Similarly, Ling and Walker (1979) reported pups at Cape Bouguer that they had tagged at Seal Bay and another was seen there in February 1990 (Dennis 2005). The sea lion colony at Seal Bay is 25 km from the Seal Slide and 37 km from Cape Bouguer.

Movements of pups from Seal Bay to other sites on Kangaroo Island have the potential to confound assessments of pup production at the latter. Therefore, we have been conservative in estimating numbers of pups born at small sites on the island. The age at which pups move to other sites is likely to vary, depending upon their body condition, the amount of crowding at the natal colony, motivation of the mother and other factors. For instance, during the 1978 pupping season at Seal Bay, Ling and Walker (1979, p.73) reported that tagged pups "began to arrive at Cape Bouguer five months after the first pups were born at Seal Bay". Here we assumed that pups seen at the small sites on Kangaroo Island that were judged to be older than 4 months had moved there from Seal Bay, because Gales *et al.* (1994) recorded pups moving away from natal colonies on the west

coast of WA aged 4.5 months. That rule was designed to prevent the error of mistakenly including mobile pups from Seal Bay being recorded as born at a small site. On the other hand, it may wrongly exclude some pups that were in fact born at a small site and result in a conservative estimate.

Live pups were recorded in two categories: brown pups in their natal pelage or moulting it, and pups that had completely moulted their natal coat. Pups with an umbilical cord were considered to be less than 3 days of age (Higgins 1990). Some pups were being attended closely by an adult female, and others were attended by an adult female and an adult male; these signs of breeding behaviour indicated that the pup had been born at the site. Pups were estimated to have been less than 4 months of age on the basis of their overall size, shape of their head and the state of their pelage (unpublished observations). Moulting is well advanced in most pups aged 4 months, although its extent is likely to depend on the pup's body condition. At about 3 months of age small patches of the new coat become apparent on pups where the natal coat has begun to moult (Marlow 1975). By 5 months of age, pups have completed their first moult and are referred to as 'moulted pups'; the birth site of such pups could not be validated.

When irregular observations were made at small sites 4 months or more after pupping began at Seal Bay, pups counted at the small sites were omitted from the estimate of pups born there, because they may have moved there from Seal Bay. Dates for the beginning of pupping seasons were estimated from information in Dennis (2005), Shaughnessy *et al.* (2006, Table 1) and for the 2004 season, from RRM (unpublished observations).

**Table 1.** Numbers of *Neophoca cinerea* pups recorded at the Seal Slide, Kangaroo Island, South Australia between 1985 and 2004.

The 'estimated number of pups born' is restricted to pups observed within 4 months of the beginning of a pupping season at the Seal Bay colony unless otherwise noted in the text. Dates for pupping seasons at Seal Bay are from Dennis (2005), Shaughnessy *et al.* (2006) and, for the 2004 season, from RRM (unpublished observations).

Pup numbers in brackets indicate those with unconfirmed birth location.

\* indicates National Parks and Wildlife SA; SB indicates the Seal Bay breeding colony

Date recorded	Live pups	Dead pups	Estimated no. of pups born	Observers	Comments	Pupping season (at Seal Bay)	Pupping began at Seal Bay
23 Dec 85	(3)	0	0	J. Wesley-Smith*	Pupping began 9 mo. earlier at SB	1985	late Mar 85
16 Aug 88	4	0	4	A. Maguire*	Pupping began <4 mo. earlier at SB	1988	late Apr 88
30 Jan 90	1	0	1	A. Maguire*	Aged <7d	1989-90	late Aug 89
28 May 91	1	0	1	M. Berris*	Pupping began <4 mo. earlier at SB	1991	early Apr 91
2 Jan 96	6	2	8	TED	Pupping began <4 mo. earlier at SB 6 Oct, 2 small pups	1995-96	early Sep 95
Oct 98	4	0	4	N. Berris*	11 Oct, 1 small pup, with umbilicus 23 Oct, 1 pup aged < 1 week	1998-99	early Aug 98
1 Jul 00	7	0	7	DD	All aged <3 mo.	2000	mid Feb 00
8 Oct 01	4	0	4	J. Nicholls*	Pupping began <4 mo. earlier at SB	2001-02	early Jul 01
4 Jun 03	8	1	9	DD	Monthly counts; incremental increase of small pups till June	2002-03	late Nov 02
22 Sep 04	10	1	11	D. Snowball*	Monthly counts; all pups <4 mo.	2004	mid Jun 04

An exception to the 4-month rule was made in the 2002-03 season at the Seal Slide when the number of pups estimated to be aged less than one month was estimated at monthly visits, based on their small size, dark pelage and lack of coordination. Each of these was deduced to have been born at the site and was added to the number recorded on previous visits.

### Classification of sites used by *N. cinerea*

We follow the classification of sea lion colonies used by the National Seal Strategy Group (National Seal Strategy Group and Stewardson 2007), based on surveys conducted in the last 20 years: *breeding colony*, five or more pups recorded in at least one survey, *haul-out site with occasional pupping*, 1 to 4 pups recorded in at least one survey, *haul-out site*, areas frequented by sea lions.

### Results

At the Seal Slide, between 1 and 11 pups were born in nine pupping seasons between 1988 and 2004 (Table 1). Four of those seasons produced between 7 and 11 pups. Pups with a shaved area across the rump seen at the Seal Slide in 2003 (one each on 4 August and 4 October, Dennis 2005) were not included in the assessment of pup production for that season.

Records of sea lion pups at several sites on the south coast are summarised in Table 2. Single pups were born at Black Point on two occasions. A third pup was not accepted as having been born there because its age was estimated to exceed 4 months. Nor were two tagged pups included that were seen on 24 July and 20 August 2002; both were part of the cohort born in the 2001-02 pupping season at Seal Bay.

In seven visits to Cave Point, pups that must have been born there were seen on two occasions, with a maximum count of three. There were small numbers of sea lions at Cave Point or up to 2 km to its east on another five occasions, but no pups were seen.

Pups have been reported at three sites up to 3.2 km north-east of Cape Bouguer (labelled a, b and c in Tables 2 and 3), but because each observation was made well after a pupping season began at Seal Bay, none has been accepted as a birth record. For Cape Bouguer, between zero and three sea lion pups were seen over nine visits between 1990 and 2005. For four of those seasons, between one and three pups were recorded that were born there.

At North Casuarina Island, one and three sea lion pups were counted in two pupping seasons.

### Discussion

*N. cinerea* interacts with fisheries, especially the bottom-set gill-net fishery and the rock lobster fishery (Shaughnessy *et al.* 2003). The effects of various reductions in the size of its colonies that could result from such interactions have been examined using population viability analysis by Goldsworthy and Page (2007). In the absence of any anthropogenic mortality,

some small populations are likely to become extinct; and this is even more likely with additional mortality from, for example, fisheries bycatch. Because the species is strongly philopatric (Campbell 2003), colonies that become extinct are unlikely to be recolonised. Therefore it is important to identify small colonies of *N. cinerea* and determine their size so that appropriate action can be taken to ensure their survival.

### Status of small sites with *N. cinerea* on Kangaroo Island

For the Seal Slide, the first record of breeding by *N. cinerea* was in August 1976, when Ling and Walker (1977) reported a newborn pup. Before that, they (Ling and Walker 1976) had reported "a small colony of sea lions" there and sighted pups that had been tagged at Seal Bay. Although they referred to the Seal Slide as "Cape Gantheaume", it is apparent from their map (Ling and Walker 1976, Fig. 5) that they were referring to a site about 9 km north-east of the actual Cape, at the locality of the Seal Slide. Later, they noted that a "few pups are born at Cape Gantheaume" (i.e., at the Seal Slide; Ling and Walker 1979, p. 73). Based on sightings of 7 to 11 pups over four seasons reported here and the criteria for classifying sea lion colonies adopted by the National Seal Strategy Group, the Seal Slide should be considered a breeding colony.

For Black Point and Cave Point, these are the first reports of *N. cinerea* pups. Because so few pups have been reported, both sites should be considered as haul-out sites with occasional pupping.

At Cape Bouguer, sea lions were first recorded by Stirling (1972). Two brown pups were seen there in October 1975 and another in July 1978 aged 3-4 weeks which is likely to have been born there (Dennis 2005). In the studies reported here, the maximum number of pups at Cape Bouguer was three and it should be considered as a haul-out site with occasional pupping.

Pups seen at three sites north-east of Cape Bouguer are assumed to have moved there from elsewhere, possibly Seal Bay, because observations were made several months after its pupping seasons began. At one of those sites, 2 km north-east of Cape Bouguer (site b in Table 2), the two pups seen in February 1996 may have moved from Cape Bouguer where breeding activity and pups were observed then. Based on these records of pups on the coast north-east of Cape Bouguer toward Cave Point, and on other sightings of adult and juvenile sea lions at these and nearby sites (Dennis 2005), small numbers of pups are likely to be found at many sites on this part of the southern coast of Kangaroo Island.

At North Casuarina Island, sea lions were first recorded in 1972 (Stirling 1972; Dennis 2005) and have been recorded on other occasions (e.g. Ling and Walker 1976, Table 2; Dennis 2005). The pups recorded in this study are the first reported there. Because so few pups were seen, North Casuarina Island should be considered as a haul-out site with occasional pupping.



### Classification of small sites used by *N. cinerea* on Kangaroo Island

Based on numbers of *N. cinerea* pups recorded in these studies, the status of eight small sites on Kangaroo Island can be documented (Table 3). Only one of them, the Seal Slide can be considered as a breeding colony, which supports its inclusion in the list of breeding colonies by McKenzie *et al.* (2005) and that of Goldsworthy *et al.* (2003). Although only small numbers of *N. cinerea* pups have been reported at these eight sites, their conservation status within the National Parks estate should be maintained because the species has been listed as *Vulnerable* and, as noted above, small colonies of *N. cinerea* are particularly susceptible to extinction (Goldsworthy and Page 2007).

Determination of breeding status of these sites has been made on the basis of occasional visits and on sightings of young pups (aged <4 months). More frequent inspections at these sites should result in more pups being sighted while they are small enough to indicate that they were born there rather than when old enough to have swum in from a known breeding colony. Furthermore, at each site some small pups may have been overlooked when their mothers were feeding at sea, because pups often rest in crevices and small caves which makes them difficult to see. Thus this study should be interpreted as leading to conservative conclusions on the status of these sea lion sites on Kangaroo Island and on the abundance of pups at each site.

### Effect of the 4-month rule on these observations

Application of the 4-month rule may lead to underestimation of pup numbers because some observations were discarded. There are two examples from the Seal Slide over the 11 seasons examined here. In 1989-90 season, three pups were seen on 24 February 1990, which was six months after months after pupping began at Seal Bay. They have not been recognised as being born at the Seal Slide where the number of births for the season was taken as one. In the 1995-96 season, nine pups were seen on 24 January 1996, three of which had moulted. The number taken for the season was six, all seen on 2 January 1996, and hence the number may have been underestimated by three for that season.

At each of the three small sites north-east of Cape Bouguer, one or two pups were seen 5-7 months after pupping began

at Seal Bay, and we have assumed they were not born on site. Thus these locations are recognised as haulout sites rather than as haulout sites with occasional pupping.

Another effect of the 4-month rule is that pup numbers at Cape Bouguer are restricted to three, whereas seven pups were seen there in November 2002. Because that was 17 months after the pupping season began at Seal Bay, it would be difficult to argue that those pups had been born at Cape Bouguer.

### Management implications

Tourism growth and coastal development are predicted to continue on Kangaroo Island (Manidis Roberts Consultants 1997). A recent example is planning for a tourist village 2.5 km west of Hanson Bay, between the sea lion site at Cape Bouguer and the large breeding colonies of *A. forsteri* at Cape du Couedic (Shaughnessy *et al.* 1994). Hamilton and Cocks (1996) have drawn attention to the rapid degeneration of coastal environments through urbanisation of previously sparsely inhabited regions which can lead to loss of biodiversity. Development at remote coastal sites on Kangaroo Island will increase habitat disturbance and have negative impacts for wildlife unless locations are well planned. Not only are sea lions at risk, but also several bird species, such as hooded plovers *Thinornis rubricollis* (Dennis and Masters 2006).

The sea lion sites reported here are within reserves managed by SA DEH, and hence tourism development is unlikely near them. All except North Casuarina Island are visited by coastal bushwalkers. The Seal Slide is subjected to more frequent visits than the other sites because it is known to local people and has been used by at least one commercial tour operator for guided tours. Unless visits are conducted with due care, they could result in disruption and disturbance to normal sea lion behaviour and, at worst, cause panic, displacement of breeding animals and trampling of small pups. In addition, untrained people venturing too close to breeding adult sea lions may be attacked (unpublished observations). These issues of colony sanctity and public safety have management implications for SA DEH that require strategies to minimise impacts at remote sites of *N. cinerea* on Kangaroo Island. These could include warnings in guidelines for remote area visitation of the dangers of approaching sea lions too closely, or even Prohibited Area status for each site under the *National*

**Table 3.** Classification of aggregations of *Neophoca cinerea* at sites on Kangaroo Island, South Australia, according to criteria adopted by the National Seal Strategy Group for that species.

Site	Classification
Seal Slide	Breeding colony
Black Point	Haul-out site with occasional pupping
Cave Point	Haul-out site with occasional pupping
Near Cape Bouguer, (a) 3.2 km north-east	Haul-out site
Near Cape Bouguer, (b) 2 km north-east	Haul-out site
Near Cape Bouguer, (c) west headland of Horseshoe Bay	Haul-out site
Cape Bouguer	Haul-out site with occasional pupping
North Casuarina Island	Haul-out site with occasional pupping

*Parks and Wildlife Act 1972*, similar to the Prohibited Areas established in parts of the Seal Bay colony (SA Government Gazette, 7 December 1972, p. 2543).

There may yet be undocumented sites on Kangaroo Island where sea lions breed which are attractive for tourism development. The first step in avoiding potential conflict between coastal development and conservation of a *Vulnerable* species like *N. cinerea* is to identify all sites on

shore that they use. This requires thorough searches of the coastline on more than one occasion to locate other possible breeding sites and haul-out sites.

Although it is apparent that there is more to discover about the distribution and status of *N. cinerea* on the coast of Kangaroo Island, this study provides a baseline against which future monitoring and investigation can be compared.

## Acknowledgements

We thank staff of National Parks and Wildlife SA who reported sea lion counts to us, particularly Mel, Naomi and Steve Berris, Robert Ellis, Anthony Maguire, Jason Nicholls and Derek Snowball. We also thank Adam McKeown of

CSIRO Sustainable Ecosystems, Atherton for drawing the map. For comments on a draft of the manuscript we thank Bill Hadrill of DEH on Kangaroo Island, Cath Kemper of the SA Museum in Adelaide and two anonymous referees.

## References

- Campbell, R. 2003. Demographic and population structure of the Australian sea lion, *Neophoca cinerea*. PhD thesis, University of Western Australia, Perth, Western Australia.
- Dennis, T.E. 2005. Australian sea lion survey (and historical records for South Australia. Report to the Department for Environment and Heritage, and the Wildlife Conservation Fund of South Australia.
- Dennis, T.E. and Masters P. 2006. Long-term trends in the hooded plover *Thinornis rubricollis* population on Kangaroo Island, South Australia. *South Australian Ornithologist* 34: 258-266.
- Gales, N.J., Shaughnessy, P.D. and Dennis, T.E. 1994. Distribution, abundance and breeding cycle of the Australian sea lion *Neophoca cinerea* (Mammalia: Pinnipedia). *Journal of Zoology, London* 234: 353-370.
- Goldsworthy, S.D. and Page, B. 2007. A risk-assessment approach to evaluating the significance of seal bycatch in two Australian fisheries. *Biological Conservation* 139: 269-285.
- Goldsworthy, S.D., Bulman, C., He, X., Larcombe, J. and Littnan, C. 2003. Trophic interactions between marine mammals and Australian fisheries: an ecosystem approach. Pp. 62-99 in *Marine Mammals: Fisheries, Tourism and Management Issues*, edited by N. Gales, M. Hindell and R. Kirkwood. CSIRO Publishing, Melbourne, VIC.
- Hamilton, N. and Cocks, D. 1996. Coastal growth and the environment. Pp. 182-191 in *Population Shift: Mobility and Change in Australia*, edited by P.W. Newton and M. Bell. Australian Government Publishing Service, Canberra, ACT.
- Higgins, L.V. 1990. Reproductive behavior and maternal investment of Australian sea lions. PhD thesis, University of California, Santa Cruz.
- Ling, J.K. and Walker, G.E. 1976. Seal studies in South Australia: progress report for the year 1975. *South Australian Naturalist* 50: 59-68, 72.
- Ling, J.K. and Walker, G.E. 1977. Seal studies in South Australia: progress report for the period January 1976 to March 1977. *South Australian Naturalist* 52: 18, 20-27, 30.
- Ling, J.K. and Walker, G.E. 1979. Seal studies in South Australia: progress report for the period April 1977 to July 1979. *South Australian Naturalist* 54: 68-78.
- Manidis Roberts Consultants. 1997. Developing a Tourism Optimisation Management Model (TOMM), a model to monitor and manage tourism on Kangaroo Island, South Australia. Final Report, South Australian Tourism Commission, Adelaide, 75 pp.
- Marlow, B.J. 1975. The comparative behaviour of the Australasian sea lions *Neophoca cinerea* and *Phocartos hookeri* (Pinnipedia: Otariidae). *Mammalia* 39:159-230.
- McIntosh, R.R., Shaughnessy, P.D. and Goldsworthy, S.D. 2006. Mark-recapture estimates of pup production for the Australian sea lion (*Neophoca cinerea*) at Seal Bay Conservation Park, South Australia. Pp. 353-367 in *Sea Lions of the World*, edited by A.W. Trites, S.K. Atkinson, D.P. DeMaster, L.W. Fritz, T.S. Gelatt, L.D. Rea and K.M. Wynne. Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska, USA.
- McKenzie, J., Goldsworthy, S. D., Shaughnessy, P. D. and McIntosh, R. 2005. Understanding the impediments to the growth of Australian sea lion populations. Final report to Department of the Environment and Heritage, Migratory and Marine Species Section. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 107 pp. SARDI Aquatic Sciences Publication number RD4/0171.
- National Seal Strategy Group and Stewardson, C. 2007. National Assessment of Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism. Australian Government Department of Agriculture, Fisheries and Forestry (DAFF), Canberra, 142 pp. <http://www.daffa.gov.au/fisheries/environment/bycatch/seals>
- Shaughnessy, P.D. 1997. Abundance of New Zealand fur seals *Arctocephalus forsteri* at some colonies in South Australia, 1995/96. Report to South Australian National Parks and Wildlife Service, Department of Environment and Natural Resources, 41 pp.
- Shaughnessy, P.D., Gales, N.J., Dennis, T.E. and Goldsworthy, S.D. 1994. Distribution and abundance of New Zealand fur seals, *Arctocephalus forsteri*, in South Australia and Western Australia. *Wildlife Research* 21: 667-695.
- Shaughnessy, P., Kirkwood, R., Cawthorn, M., Kemper, C. and Pemberton, D. 2003. Pinnipeds, cetaceans and fisheries in Australia: a review of operational interactions. Pp. 136-152 in *Marine Mammals: Fisheries, Tourism and Management Issues*, ed by N. Gales, M. Hindell and R. Kirkwood. CSIRO Publishing, Melbourne, VIC.
- Shaughnessy, P.D., McIntosh, R., Goldsworthy, S.D., Dennis, T.E. and Berris, M. 2006. Trends in abundance of Australian sea lions, *Neophoca cinerea*, at Seal Bay, Kangaroo Island, South Australia. Pp 325-351 in *Sea Lions of the World*, edited by A.W. Trites, S.K. Atkinson, D.P. DeMaster, L.W. Fritz, T.S. Gelatt, L.D. Rea and K.M. Wynne. Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska, USA.
- Stirling, I. 1972. The economic value and management of seals in South Australia. Department of Fisheries, Publication No. 2, 11 pp.

APPENDIX I



Adult female Australian sea lion *Neophoca cinerea* with a large pup. Some Australian sea lion mothers move their pups away from breeding colonies, which adds to the difficulties of assessing pup numbers.

Photo: Peter Shaughnessy.