POPULATION DECREASES IN LITTLE PENGUINS *EUDYPTULA MINOR* IN SOUTHEASTERN TASMANIA, AUSTRALIA, OVER THE PAST 45 YEARS

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SUMMARY

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We investigated the distribution and abundance of Little Penguins *Eudyptula minor* at 12 known colony locations on mainland southeastern Tasmania, Australia. Surveys of scientific journals, unpublished field surveys and oral records were compiled to assess the historical distribution (before 1996) of this species within a 150-km radius of Hobart. Current status of each site was assessed by conducting surveys of the areas of historical distribution during the 2002/03 breeding season. Transects were used to conduct burrow counts, supplemented by counts of penguins coming ashore at night. Of the 12 colonies examined, four have disappeared and two have decreased appreciably in size within the last decade. Potential causes of these decreases include predation by introduced vertebrates, habitat modification and destruction and incidental drowning in recreational gillnets.

Key words: Little Penguin, *Eudyptula minor,* population decrease, predation, human impacts

INTRODUCTION

Only one penguin species, the Little Penguin *Eudyptula minor,* breeds on the Australian mainland. The Little Penguin is the smallest of all extant penguin species. The species is restricted to the Australasian region, breeding in areas extending from Fremantle in Western Australia to central coastal New South Wales, Tasmania (including the Bass Strait Islands), and New Zealand (including the Chatham Islands). The stronghold of the Australian population is Tasmania, with an estimated population in excess of 100 000 breeding pairs (Marchant & Higgins 1990, Ellis *et al.* 1998, Brothers *et al.* 2001).

Most of the *E. minor* population is restricted to offshore islands in the southeast and southwest of Australia. On the Australian and Tasmanian mainlands, most individuals breed in colonies consisting of at least five to 10 pairs. However, where many of the larger colonies are found, on the Bass Strait Islands, many colonies number in the thousands (Marchant & Higgins 1990, Brothers *et al.* 2001).

Little Penguins exhibit highly asynchronous breeding patterns among individuals, seasons and locations (Stahel & Gales 1987). In Tasmania, egg-laying commonly commences between June and August, but at other colonies in eastern Australia, eggs may be found as early as May or as late as December (Stahel & Gales 1987).

Little Penguin nests are usually spaced at least 2 m apart and commonly consist of a burrow dug into sandy soil or a hollow in logs, caves, rock crevices or, in rare circumstances, under dense vegetation or in tree stumps. Suitable vegetation and substrate are paramount for the establishment of successful breeding colonies. Increased development in coastal areas has resulted in a significant decrease in the extent of suitable habitat. Housing and commercial industries are rapidly expanding into many coastal areas, resulting in the destruction or alteration of current and potential breeding habitats (Dann 1994).

In southeastern Tasmania, coastal developments have flourished since the late 1980s and many Little Penguin colonies are now under increasing pressure from habitat alterations, human activities and predation by introduced animals (Brothers *et al.* 2001). The effects of these pressures on Little Penguin populations have not been determined. In many areas of the Tasmanian mainland, anecdotal evidence suggests that Little Penguin populations on the mainland have decreased; however, the lack of long-term data sets has prevented the confirmation of this suspected decrease. The main objective of the present study was to quantify the population distribution of Little Penguins in southeastern Tasmania at 12 known breeding localities in 2002/03 and to quantify population trends in the colonies for which historical data were available.

STUDY AREA AND METHODS

Data sources

Published, unpublished and anecdotal records on the distribution of Little Penguin colonies within a 150-km radius of Hobart (43°05′S, 147°25′E) in southeastern Tasmania were compiled for the period 1960–2002/03. Published records, summarized in Marchant & Higgins (1990) were used to trace other records. Unpublished records were drawn primarily from the Birds Tasmania database, the Tasmanian Bird Report and members' personal records. Questionnaires were circulated to members of the public who responded to newspaper requests for local information, and these were supplemented with interviews and field visits. Oral records were accepted only when they could be corroborated by at least one other source.

Colony surveys

Each of the 12 colonies identified was surveyed at least once during the 2002/03 breeding season to assess the status of the breeding Little Penguin population (Table 1). At each colony, transects were established approximately 30 m apart and perpendicular to the shore, extending the length of the previously known colony boundaries. Every active burrow 10 m either side of each transect was marked and recorded. An active burrow was one that contained adult birds; chicks or eggs; or fresh excreta, nesting material or signs of disturbance. Surveys were also conducted to determine the number of birds landing. These concluded approximately 2.5 hours after dusk or one hour after the last bird was observed.

Field surveys were supplemented with aerial photographs, when available, for three colonies [Cape Direction, Marion Bay and The Neck (Fig. 1)] to assess the extent of vegetation changes. Fire history and other relevant historical data (such as introduced vertebrate trapping efforts) at each colony within the last 15 years were also quantified from all available published, unpublished and interviewee sources.

RESULTS

Historical and contemporary distribution

The 12 sites in southeastern Tasmania identified as having Little Penguin breeding colonies since 1960 (Fig. 1) were these:

1. The Neck (Bruny Island)
2. Boronia Beach
3. Cape Direction (also known as Fort Direction)
4. Pigeon Holes
5. North Clifton
6. Fortescue Bay
7. Marion Bay
8. Little Christmas Island
9. Coswell Beach
10. Stinking Bay
11. Pirates Bay
12. Red Chapel Beach

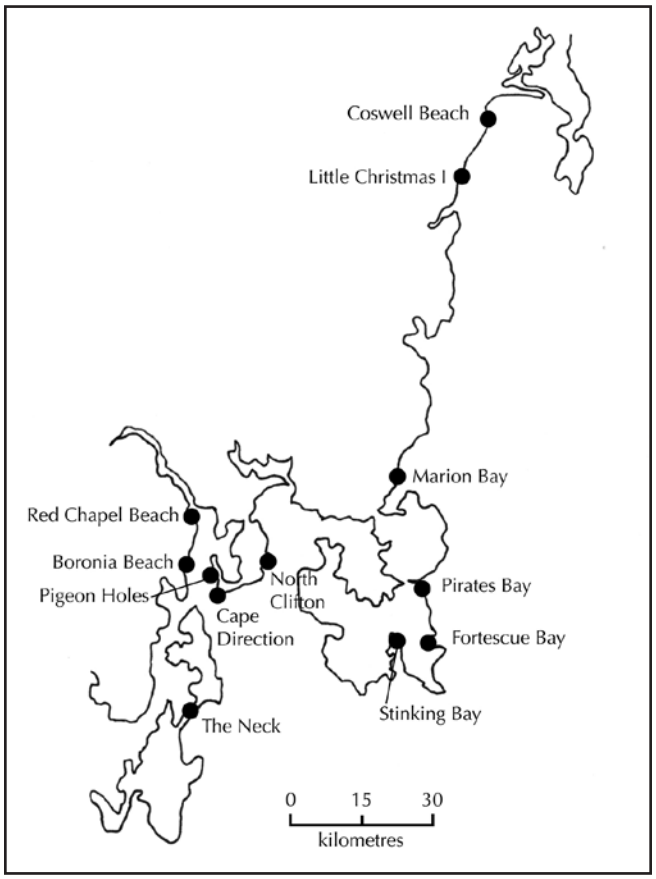

Fig. 1. Locations of Little Penguin colonies in southeastern Tasmania examined in 2002/03. See Table 1 for current estimates of breeding populations.

Surveys of these sites in 2002/03 showed that four colonies were no longer occupied and that a further two had decreased significantly in size (Table 1).

The unoccupied colonies were located at Marion Bay, Cape Direction, Pigeon Holes and North Clifton, and all had records of penguins breeding as recently as 1996 (Table 2). The former colonies at Cape Direction, Pigeon Holes and North Clifton were all located on sites with rocky headlands and adjoining sandy beaches; at Marion Bay, the former colony occurred north of a small stream crossing a sandy beach. All unoccupied colonies were located close to permanent human habitation (i.e. within 1 km).

Unoccupied colonies

Marion Bay

The former colony at Marion Bay covered approximately 5 ha. Most of this area is low dune habitat, dominated by introduced Marram Grass *Ammophila arenaria* and Coastal Wattle *Acacia sophorae*. The former colony extended north approximately 1 km from the mouth of Bream Creek. Gales & Pemberton (1990)

TABLE 1
The estimated number of Little Penguins breeding at 12 sites on the southeastern Tasmanian coast examined during the 2002/03 breeding season

Location	Breeding pairs	Dates of visits
Boronia Beach	35	Numerous, Dec–Mar
Cape Direction [a]	0	16 Oct, 17 Oct
Coswell Beach	110	Monthly, Sep–Mar
Fortescue Bay	350	Monthly, Sep–Mar
Little Christmas Island	300	Monthly, Sep–Mar
Marion Bay	0	15 Oct
North Clifton	0	10 Sep, 16 Dec, 13 Mar
Pigeon Holes	0	17 Mar, 22 Mar
Pirates Bay	30	5 Dec
Red Chapel Beach	3	Numerous, Dec–Mar
Stinking Bay	50 [b]	5 Dec, 6 Jan
The Neck	400	Monthly, Sep–Mar
TOTAL	1278	—

[a] Also known as Fort Direction.
[b] Denis Mermett (pers. comm.).

estimated a total of 400–600 pairs present in 1986/87. The present study revealed no evidence of Little Penguins breeding in this area in 2002/03, and the last breeding was recorded in 1998 (Table 2). Inspection of historical and contemporary aerial photographs indicated that both Marram Grass and Coastal Wattle have invaded the area of the former colony since the early 1980s. The boundary between the colony and the beach has now been extensively covered with a dense layer of Coastal Wattle, and the replacement of native Spinifex Grass *Spinifex* sp. with Marram Grass has changed the topography of the dunes in the area, resulting in high dune cliffs to 2 m that are unscalable by the penguins.

Cape Direction

The former breeding colony at Cape Direction extended from the southern end of Pot Bay to the northern end of the headland protruding into Storm Bay. The total area of the colony covered less than 2 ha. During the present survey, Short-tailed Shearwaters *Puffinus tenuirostris* occupied many of the former Little Penguin burrows. Gales & Pemberton (1990) estimated the penguin population at Cape Direction at less than 100 pairs in 1986/87. The last recorded breeding was in 2000, when Brereton (2000) reported penguins in the areas that Gales & Pemberton (1990) had reported used. The present study revealed no evidence of penguins breeding in these areas. From an assessment of aerial photographs, the vegetation and topography have not changed in the colony area during the last two decades.

Pigeon Holes

The Pigeon Holes colony was estimated to contain 100–200 pairs in 1993/94. In 1998/99, the colony had decreased appreciably in size, and the last observation of breeding birds was made in 2000/01 (T. Young pers. comm.). The colony extended approximately 200 m along the northern end of South Arm Bay. The beach formed the southern boundary, and pastoral areas formed the northern boundary. The colony was located in a strip of native vegetation that averaged 15 m in width between these two boundaries. Burrows were predominantly in areas of *Rhagodia candolleana* and *Tetragonia implexicoma* on small cliffs (less than 4 m in height). Burrows were also located in a small, flat dune area behind the sandy beach dominated by *Lomandra longifolia* and in a small patch of *Allocasuarina stricta* that formed the western boundary of the colony. No evidence of active penguin burrows was found during the present survey, and European Rabbits *Oryctolagus cuniculus* occupied burrows in the area of the former penguin colony.

North Clifton

The site of the North Clifton colony was in a soil fall at the base of 20–30 m cliffs at the northern end of Clifton Beach. The breeding population was estimated at five pairs for the period up to 1996 when breeding was last recorded (Table 2). During the present study, no birds were observed in the area. The site of the former colony is located adjacent to a Short-tailed Shearwater colony.

TABLE 2
Last known breeding records of Little Penguins in four colonies during 2002/03 in southeastern Tasmania

Location	Last record	Source
Cape Direction [a]	2000	Ray Brereton (2000)
Marion Bay	1998	Eric Woehler (unpubl. data)
North Clifton	1996	Eric Woehler (unpubl. data)
South Arm	2000	Tony Young (pers. comm.)

[a] Also known as Fort Direction.

Decreasing populations of other colonies?

Anecdotal evidence suggests that breeding numbers in the colonies at The Neck and Coswell Beach have decreased in recent years. The number of breeding pairs estimated at Coswell Beach is approximately 100–150 pairs (present study) and at The Neck, approximately 400 breeding pairs (B. Edwards pers. comm.).

Many members of the public reported a considerable decrease in the number of penguin footprints and activity observed at the Coswell Beach colony, but the lack of previous population data prevented a quantitative assessment of the extent of any decrease. At The Neck, Hodgson (1975) estimated 500–600 breeding pairs during her study that commenced in 1962. That study is the only previously published population datum for the colony. Limited support for the premise of a population decrease comes from nightly counts conducted by rangers at the colony. For an observation period of 66 nights between December 2000 and February 2001, a total of 1429 adult Little Penguins were observed (mean: 21.7 penguins observed per night). Between December 2002 and February 2003 (60 nights), the number of adult Little Penguins seen decreased slightly to 1173 [mean: 19.6 penguins observed per night (Department of Primary Industries, Water and Environment, hereafter DPIWE)].

DISCUSSION

A number of factors appear to be implicated in the population decreases observed on mainland southeastern Tasmania; all are anthropogenic in origin. At the four sites no longer occupied by breeding penguins, multiple factors are believed to have been acting synergistically, resulting in the complete loss of each colony. A similar situation is occurring at the two sites for which anecdotal information suggests a decrease in the breeding population. The absence of previous empirical census data for the remaining sites precludes an assessment of trends in breeding populations, but there is no reason to believe that similar factors are not influencing the penguin populations at these sites. The lack of empirical data for the four colonies no longer used by breeding Little Penguins prevents a detailed analyses of the rates of decrease, but it does not hide the fact that the colonies are no longer used as breeding sites.

Marion Bay

The two dominant plant species (Coastal Wattle and the introduced Marram Grass) may have contributed to the loss of the colony. A large fire in the colony in 1994 resulted in substantial changes in the vegetation. Following the fire, the invasion of *A. arenaria* increased extensive dune-cliff formation along the length of the beach, because the dense root system of this vegetation acts to stabilise the sand dunes. Because this species often grows much closer to the high tide mark than other plants do, dunes are often undercut by high seas, particularly during winter storms. This undercutting often results in cliff faces on dunes of considerable size (regularly greater than 2 m in height). The spread of *A. sophorae* has also resulted in the formation of a dense and impenetrable thicket of stems, beginning approximately 5 cm above the ground. The spread of both these species in combination may have prevented Little Penguins from recolonising the Marion Bay site after the fire by restricting access to the breeding area from the shore.

The number of permanent, year-round dwellings in the area has increased, with a concomitant increase in the number of dogs *Canis familiaris* and cats *Felis cattus* in the area. Predation by dogs and cats also occurred for a number of years. A feral cat-trapping program was attempted in 2002 by residents, but it was unsuccessful in reducing the local cat population. Poaching of Little Penguins for crayfish *Jasus novaehollandiae* bait was reported in the 1980s and 1990s, but no data are currently available to assess the contribution of poaching to the demise of the colony.

Cape Direction

At Cape Direction, predation by introduced vertebrates, in particular cats, is believed to have been the most important factor affecting the breeding penguin population. After a number of cat kills were identified, the Cape Direction CoastCare Group (a volunteer community group), in conjunction with the Defence Force Environmental Division, commenced a cat-trapping program in 1999. More than 70 cats were captured over a three-year trapping period (S. Chislett pers. comm.). Cats, while not considered to be major predators at many Little Penguin colonies on the Australian mainland [e.g. Phillip Island (Dann 1992)], have been reported to play a substantial role in determining the distribution and abundance of Little Penguins at some Tasmanian colonies (Stahel & Gales 1987, Brothers *et al.* 2001). The lack of historical population data makes it difficult to attribute the decrease solely to cat predation, but it seems highly likely that cats contributed, given their density in the area.

The beach adjacent to the former colony is a popular dog walking area for many locals, and dogs on leashes were observed with their owners on two occasions during colony surveys. No dog scats were found in the colony, and the contribution of dog predation to the disappearance of the colony is unknown. Considerable poaching of Short-tailed Shearwaters was evident at Cape Direction throughout the study, based on the high number of carcasses present throughout the area. Poaching of Little Penguins for crayfish bait may have occurred in previous years, but currently no data are available to assess the role that poaching may have played in the loss of the penguin colony.

Gillnetting or grab-all netting, or both, are also likely to have affected the penguin population at this site. On three occasions in 2002/03, gillnets were observed being set at dusk immediately offshore of the former penguin colony. No data are available on the impacts of this form of fishing on Little Penguin populations, but many observations have been made of Little Penguins drowned in gillnets around Tasmania (Stahel & Gales 1987, S. Rundle pers. comm.). Near one colony in southeastern Tasmania, approximately 40–50 Little Penguins were observed drowned in one gillnet (S. Rundle pers. comm.). The relative roles of cat predation and gillnetting on penguin populations are unknown, but both have the potential to affect penguin populations (Stahel & Gales 1987, Baker *et al.* 2002). The vegetation at Cape Direction has not changed in the last 15 years (based on assessments of aerial photographs), and thus cannot be implicated in the population decrease.

Pigeon Holes

A combination of habitat destruction, human disturbance and predation by introduced mammals is believed to have been involved in the disappearance of the Little Penguin colony at Pigeon Holes. Several dozen dog scats were observed scattered throughout the former colony, and predation by domestic dogs is inferred. Most extant Little Penguin burrows have been modified and form part of extensive rabbit warrens. A walking track also runs along the northern boundary of the colony and may have provided easy access to the colony for predators. Many penguins have also been observed drowned in gillnets set near this colony (T. Young pers. comm.), and this gillnetting is believed to have contributed to the disappearance. Subdivision for housing commenced in the late 1950s, with subsequent subdivisions in the 1970s and mid-1980s. The 1980s subdivision was located approximately 50 m from the eastern end of the colony.

North Clifton

The small size of the breeding population previously observed at North Clifton (typically no more than five pairs) made it extremely vulnerable to disturbance, habitat loss and predation. It is therefore difficult to identify any single factor that may have resulted in the population's disappearance. The colony was located in an area now used on a daily basis by members of the public, and disturbance while the colony was still extant can readily be assumed. Accidental crushing of birds in their burrows by people, although not likely to affect large populations, may have a significant effect on small colonies that are subject to higher-than-average levels of burrow destruction (Dann 1992). The low population may have also been susceptible to predation by introduced vertebrates. Harrigan (1992) reported finding six adult Little Penguins near Warrnambool, Victoria, that had died of extensive trauma associated with predation by dogs or foxes *Vulpes vulpes.* That finding highlights the potential of a single predation event to destroy a small colony such as the one at North Clifton.

Coswell Beach

Cat predation is implicated in the population decrease at the Coswell Beach colony, based on numerous observations of cats with dead penguins in their mouths (P. Lingard pers. comm., M. Munday pers. comm.). An extensive trapping program was operating during 2002/03. The impact of cat predation on the penguin population is currently unknown, but given the relatively low population size, cats have the potential to severely affect this colony. Human disturbance may also be involved, because the beach is a popular destination for locals and tourists, and penguin watching in the colony at night has recently developed into a regional attraction. However, no managed tours operate at the beach, and viewing is unrestricted. When returning to their nests, Little Penguins are readily disturbed by movement and light near their colonies. Unmonitored and uninformed visitors may be viewing the birds from an area or in a manner that blocks access points to the colony. The use of inappropriate illumination may delay the landing of adult birds and, subsequently, the feeding of chicks during the breeding season. Unrestricted viewing may also result in the accidental crushing of burrows as people move through the colony.

The Neck

Because of the great popularity of the Little Penguin and Short-tailed Shearwater colony at The Neck on Bruny Island, infrastructure in the form of viewing platforms and boardwalks is in place for colony viewing, and DPIWE staff monitor nightly viewing activities by visitors during the breeding season. The viewing platforms and boardwalks do not constrain visitors, and on two occasions during the present study, visitors were observed walking through the colony, off the boardwalks, to obtain closer views of the birds. Because of the high number of visitors to the area and their inappropriate behaviour, the potential therefore still exists for burrows to be crushed and birds to be disturbed.

Vegetation changes at The Neck over the past 40 years have been substantial. The spread of Coastal Wattle and Marram Grass is causing accessibility problems for the penguins. As at Marion Bay, undercutting of the dunes, with the resulting formation of 3–5 m dune cliffs and dense growth of Coastal Wattle, are believed to be preventing birds from readily accessing their burrows, leading to increased potential for predators of returning birds searching for access.

INTO THE FUTURE ...

Predation is a substantial and well-documented determinant of the location of seabird colonies. Predation by introduced species has resulted in significant decreases, both in the numbers of individual birds and in the numbers of colonies (e.g. Bailey & Kaiser 1993, Monteriro *et al.* 1996, Hartman *et al.* 1997, Hobson *et al.* 1999). Predation by introduced species has been the key factor in the reduction or extinction of more seabird populations in historic times (Moors & Atkinson 1984). All penguin colonies investigated in the present study were thought to experience predation by introduced mammals, primarily cats and dogs. The impacts of these predators on Little Penguin populations has been well documented elsewhere (Stahel & Gales 1987, Dann 1992, Harrigan 1992).

Based on the results of the present and previous studies, it appears that predation from introduced mammals has resulted in decreases in breeding populations in some colonies. However, it is not currently known whether these decreases result from birds moving to other sites or from predation. The recent introduction of foxes to Tasmania will also likely have a serious impact on mainland colonies, with penguin colonies from the southeast to northwest accessible to foxes. Foxes are highly skilled predators of penguins, and experience from Phillip Island indicates that considerable and continual effort will be required to reduce fox predation on these birds. It is likely that all mainland colonies of penguins in Tasmania will be at risk from foxes if they become established.

Human disturbance in seabird colonies has been recognised repeatedly for altering colony size and location (e.g. Frost *et al.* 1976, Anderson & Keith 1980, Harris & Bode 1981, Klomp *et al.* 1991, del Nevo *et al.* 1993, Hull & Wilson 1996, Monteriro *et al.* 1996). Human disturbance is believed to be affecting breeding populations of Little Penguins at some colonies examined during this study. All study colonies were easily accessible to humans, but the Marion Bay, Cape Direction, Pigeon Holes and Coswell Beach colonies were located in close proximity (within 1 km) to permanent human habitation and high-use areas. Many human settlements at these sites are increasing rapidly in size, with associated increasing rates of clearance of native vegetation, human activities and human disturbance. Klomp *et al.* (1991) found that the hatching success rate for Little Penguins in the most disturbed area on Penguin Island, Western Australia, was almost half that of nesting penguins in the two least disturbed areas. It is highly likely that increased levels of human disturbance close to Tasmanian colonies would result in decreases in penguin breeding success and ultimately in population decreases and further loss of colonies.

Changes in suitable habitat for nest sites may have also contributed to the decreases observed in the present study. Little Penguins, like most burrowing seabirds, require specific habitat characteristics to breed successfully. Vegetation loss, or changes resulting from fires or changes in species composition, may lead to reduced breeding success from the abandonment of burrows or entire colonies. The effects of the spread of Coastal Wattle and the introduced Marram Grass are currently unknown, but results from this study suggest that such changes in vegetation may be preventing or inhibiting recruitment to or recolonisation of the colonies at Marion Bay and possibly The Neck.

Although not documented in Tasmania, the effect of fishing activities near seabird colonies has the potential to limit both colony size and location. Rodway (1991) identified gillnet drowning as a potential threat to seabirds in British Colombia. Extensive gillnetting near a colony of Little Penguins at Fortescue Bay was observed to cause considerable mortalities (>40 birds drowned). Nets were observed being set adjacent to colonies at three locations during this study, two of which have lost their entire colonies. Similarly, previous studies have identified the threat to penguins from gillnets and nylon fishing tackle (Stahel & Gales 1987, Harrigan 1992, Darby & Dawson 2000). In Tasmania, unattended and overnight recreational gillnetting in coastal waters was banned in 2004. Before prohibition, bycatch in gillnets set close to colonies is likely to have contributed to penguin drownings.

It is not only colonies in southeastern Tasmania that appear to be declining; some populations throughout the range of Little Penguins have exhibited decreases. Decreases have been reported in New South Wales (Barton 1978), Victoria (Dann 1992), northwest Tasmania (P. Marker pers. comm.) and in New Zealand (Dann 1994). These decreases appear to have occurred almost exclusively in mainland colonies. Currently, with the exception of Bruny Island (Tasmania) and Phillip Island (Victoria), both of which have introduced predators and regular tourist activities, and both of which are connected to the mainland by bridge or ferry, there seems to be no evidence of a corresponding decrease occurring on offshore islands elsewhere (Dann 1992).

Detailed population data for Little Penguins are rare and are largely restricted to colonies in four areas: Phillip Island (Victoria), Bowen Island (New South Wales), Penguin Island (Western Australia) and Oamaru (New Zealand). In the remainder of mainland Australia and New Zealand, an absence of long-term data for all but a very few colonies has substantially hindered the determination of any population trends. Although the present study showed that colonies on the Tasmanian mainland have decreased or are no longer extant, the extent to which these local decreases can be used as indicators of overall population trends in this species is currently unknown.

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